MSc Thesis

Environmental Policy Group

Invisible Energy Policy in the South African Mining Sector: A Social Practice Outlook on Water Use

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Abstract

South Africa is the 5th largest coal producer in the world and the intensity of mining leads to high levels of environmental degradation. With a global mandate to reduce energy usage, certain policies are in place in the South African energy sector to try and do so. However, indirect energy usage on coal mines is not necessarily accounted for in policy. Policies that are seemingly unrelated to energy may actually have indirect effects on usage, and these can be identified as 'non-energy' policies, or 'invisible energy' policies. The aim of this research was to analyse how invisible energy policies affect energy demand within the coal mining sector in South Africa. This was done by using insights from water use practices on mining sites. A documentary review as well as interviews were conducted and water use practices-as-entities were identified and grouped into four categories; coal extraction, dust control, coal washing and discarding of water. It was found that energy demand and use is a by-product of the performance of practices, which is facilitated by the interaction of materials, meanings and competences. These practices are guided by certain mining policies, which were analysed using social practice theory insights to show that they may indeed be classified as invisible energy policy. My findings allow for the problem of invisible energy usage in the coal mining sector to be repositioned into ways that are more useful from a policy perspective, such as for the understanding of unintended policy consequences and for policy coherence.

Keywords: Invisible energy policy, social practice theory, coal mining, mining policy

List of Abbreviations

DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
EMPR	Environmental Management Programme
IWULA	Integrated Water Use Licence Application
IWWMP	Integrated Water and Waste Management Plan
MPDRA	Minerals and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NWA	National Water Act
WUL	Water Use Licence

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1 Introduction

1.1 Problem Description

1.1.1 Mining in South Africa

World energy use is increasing at rapid rates, with predictions showing that this growing trend will continue (Pérez-Lombard, Ortiz and Pout, 2008). South Africa is one of the most industrialized countries in Africa, boasting a well-developed energy supply and production system (Ziramba, 2009). Energy comes mostly from coal (Figure 1), with the country coming in 5th as the largest coal producer in the world (Ziramba, 2009). Mining is the fourth largest sector in energy consumption in the country, after industry, transport and residential sectors (Koch, 2006).

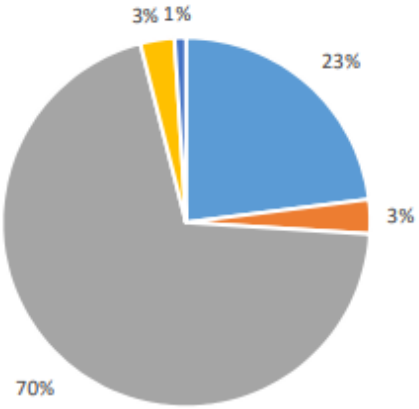

Figure 1: Primary Energy Consumption in South Africa

Source: DMR (2016)

As seen in Figure 1, approximately 77% of the country's energy needs are satisfied by coal. More than a quarter of coal mined is exported, with 92% of coal used on the African continent coming from South Africa (EIA, 2017), making it the fourth largest coal exporting country globally (*Coal Resources*, no date). Open-pit mining (~49%) and sub-surface mining (~51%) are the two types of coal mining that are carried out in the country (Department of Mineral Resources (DMR), 2016). Collieries in the country range from small-scale producers to some of the largest in the world (*Coal Resources*, no date). According to the country's Department of Energy, there were 64 operating collieries as of 2004. There are five main mining companies that account for over 80% of all coal production, namely; AngloAmerican (plc), Sasol Mining, Ingwe Collieries Limited, (a BHP Billiton subsidiary), Glencore Xstrata and Exxaro (*Africa Mining*, 2017).

This intensity of coal mining undeniably leads to serious (often finite) resource use as well as to increasing levels of carbon dioxide in the atmosphere, adding to the climate change problem, amongst other socio-environmental issues. Environmental damage caused by coal mining has been researched at length. The damage to foliage, water, air and local communities are common research agendas in the South African context. A lot of this is traced back to 'unsustainable' mining practices that include high energy usage. Here, developments for more sustainable practices and technologies have been researched and their effectiveness analysed (Azapagic, 2004; Pooe and Mathu, 2011; Wang, Zhong and Han, 2013).

The coal mining industry in general uses a large amount of energy for day-to-day operations, with energy sources drawing from electricity, diesel, gasoline, coal and natural gas (Bogunovic *et al.*, 2009). Worldwide, the consumption of energy by the mining industry amounts to around 365 billion kWh per year (Bogunovic *et al.*, 2009). In South Africa, about 126.7 Mtce (magatonne of coal equivalent) per year is used up by coal mining, which is over 1 billion kWh per year. The most notable energy consumers in surface coal mining have been found to include draglines, trucks, bulldozers and belt conveyors (Bogunovic *et al.*, 2009), as well as other general transport-related 'auxiliary' operations (Kecojevic, Vukotic and Komljenovic, 2014).

Not only is direct energy use a notable feature of a coal mining operation, but so is the use of water. In total, about 430 litres of water is required to mine one tonne of coal (Wassung, 2011). The country accumulatively produces more than 250 million tonnes of coal each year. This means that upward of 107 500 million litres of water is used for coal mining each year (this figure, however, includes the water lost to evaporation in the mining process and also takes into account any water that may be re-used). To make this slightly more comprehensible, the Western Cape Province in South Africa has a combined major dam storage capacity of 898 221 million litres (CoCT, 2018). This means that the coal mining industry uses nearly 12% of an entire province's dam capacity each year

Water is essential as a resource for the mining process, and is affected in both quantity and quality (Groenewald, 2012). Mining water management has been identified as one of the most challenging factors in the mining world (Punkkinen *et al.*, 2016). Water use and management is a continuous process "that needs to be developed and updated throughout the whole mine life cycle" (Punkkinen *et al.*, 2016, p. 4). Every mine site is unique, and depending on the context, site-specific factors will determine part of the water management process. Importantly, the water-related processes that take place on a coal mine also often require energy. For example, intercepting and diverting surface water to be used to extract coal may use energy in the form of pumps. Another example is that in order to safeguard surrounding landscapes from water pollution, water treatment needs to take place before discarding used (and often polluted) mine water. This water treatment process requires active technologies which use energy (Groenewald, 2012). Through these processes, different materials, equipment and skills are used, often directed by policy and guidelines.

The way in which actors on a mine handle water each day may be seen as a routinized behaviour – a 'practice'. By looking empirically at what people do in the mining context, as well as meanings behind why these things are done (i.e. the relevant social practices, see Conceptual Framework below), one can potentially see where energy is being used. Energy policies have been put in place to try and tackle the large demand for energy in different sectors (Winkler, 2007), but are these direct policies actually enough to reduce energy demand and usage? What about indirect energy usage as seen with water use processes?

1.1.2 Invisible Energy

While there are straightforward energy policies in place, there are also policies that exist which *indirectly* shape energy demand. Policies that are seemingly unrelated to energy may actually have indirect effects on usage, and these could be identified as 'non-energy' policies, or 'invisible energy' policies. Non-energy policies refer to sectors which are 'not explicitly designed' to have an effect on energy systems, but indeed they may. An example of invisible energy policy, in theory, can be seen with water treatment on mine sites. If a mining regulation states that used water needs to be a certain quality before being discarded into the environment, the water will need to undergo certain treatments, often requiring the input of energy to do so. This then is a mining water policy, not an energy policy, which ultimately effects energy usage on the mine site.

'Policy' in this context speaks of the outcomes produced by governmental bodies, including standards, regulations and legislation. The scale goes from the local to the global, where some policies are context-specific while others are based on international agreements. 'Policy' also may include the rules and guidelines set out by corporations that apply to their company and employees.

While different sectors can be affected by a range of non-energy policies, "there has been little systematic analysis of this issue, and the knowledge that does exist is often not integrated across disciplines and sectors" (Cox, Royston and Selby, 2016, p. 3). As identified by Cox, Royston and Selby (2016), it has generally been rare to look at how non-energy policy affects systems which demand and use energy, such as the mining sector. Some previous research has looked at invisible energy in the education sector, the agricultural sector, the health sector and more, and has linked this to social practices such as policy-making, or simple day-to-day routines. Social 'practices' here being the organised way in which people carry out a particular activity. Focusing on practices that unfold as routinized behaviours in sectors and organisations allows researchers to better understand the factors that influence these actions (such as policies). Focussing on practices also means that contradictions of guidelines and policies can be seen in reality, helping to identity and understand any invisible policies at play, which may help in increasing policy coherence, too.

Previous research done in the UK (Cox, Royston and Selby, 2016) has aimed to "understand how policies and policy-making practices steer energy demand, often in unintended or unrecognised ways" (Royston, 2016). The link between social practices and invisible energy has thus been made before, but there has been little to no work found on this in the mining sector. The gap in this sector has inspired this thesis. As discussed previously, the mining sector already consumes a lot of direct energy, but analysing invisible energy policies which inform daily practices that don't visibly act as high energy users could help to better understand energy demand. This more in-depth understanding of the consequences of policy could potentially help to improve policy, so as to reduce energy demand in other indirect yet significant ways. Thus, this thesis seeks to unravel the invisible energy policies that inform daily social practices in the mining context. In particular, the practices that underpin water interactions on coal mines.

The broader relevance of this research agenda can also be seen in line with other extractive and water-intensive industries. For example, oil and natural gas extraction as well as South Africa's largest water consuming industry, the agriculture sector (Groenewald, 2012). There is much room for research in the invisible policy realm, as the knock-on effects of indirect policy outcomes can be significant. Analysing, or simply identifying invisible energy policies can play out as a new way of thinking about and understanding unintended consequences of policies. Invisible energy adds to the relevance of these unintended consequences of policy by taking a step further back. It does not simply see where energy is indirectly being used, but it also looks at *why* that is the case. This may allow for better potential in targeting policy and action to address these consequences.

1.2 Research Objective

Analysing invisible energy policies that indirectly effect energy demand may be helpful, particularly if there is a mandate to decrease the negative impacts associated with high energy use. Consequently, finding the areas that indirectly affect energy usage are key. Simply looking at direct energy demand leaves out other crucial policies and practices that could too demand energy indirectly.

By looking empirically at what people do in the mining context, as well as meanings behind why these things are done (i.e. the relevant social practices), invisible energy policy can be brought to light. A social practice approach – as explained further in the Conceptual Framework section - encourages a more in-depth understanding of the complexities that are behaviours, infrastructures and cultural meanings, which can in turn allow for potentially more effective policy approaches (Labanca and Bertoldi, 2018). Invisible energy policies should not be overlooked, as they too can have implications for energy demand (Royston, 2016). The importance in looking at invisible energy policy lies in the weight of asking, "*what if that policy had been different? What then would people do, and how would this effect energy demand?*" Indeed seeing the causal effects of policies is crucial in trying to unravel how change happens and how policy isn't always linear with direct outcomes. It is more complex than this, and invisible energy policies can help to look at this dynamic policy-practice relationship.

However, in order to detect these invisible policies, one needs to look at reality and action – not just the policy documents themselves. This research therefore sets out to look at how water use interactions - or practices - carried out each day and informed by non-energy policy, actually may affect energy use in the mining sector. This can then allow for the identification of invisible energy policies and for potential recommendations to be made to existing policy that shapes mining water use regulation. It could help to understand unintended consequences of policies as well as to potentially improve policy coherence.

The aim of the research is therefore:

> *To analyse how invisible energy policies affect energy demand within the mining sector in South Africa. This will be done by using insights from water use practices on a mining site.*

1.3 Research Questions

The main research question that follows is:

1. *How do non-energy policies in the South African mining sector influence energy demand in on-site water use practices?*

Sub-research questions include:

1.1. How do water use practices take shape in the mining context? (SRQ1)
1.2. What are the mining policies guiding water use that indirectly/directly affect energy demand? (SRQ2)

1.4 Research Scope

There are indeed energy policies that exist in South Africa that are aimed at reducing direct energy demand and consumption (the Integrated Resources Plan (IRP, 2010) and the Integrated Energy Plan (South African Energy Department, 2013)), as well as developments of climate policies targeting energy reduction that are under way, such as carbon tax and budgets, and Intended Nationally Determined Contributions (Fisher and Downes, 2015). However, policy that explicitly addresses invisible energy (including in the mining sector) is a feat yet to be accomplished. Identifying and analysing invisible (energy) policies that inform social practices is still an undeveloped endeavour, and the focus of this research is to do so within the South African mining context.

Theoretically, the research draws from social practice theory. The goal is to identify practices that take place in the mining sector with regards to water use and then from there, to unravel the policies that inform these practices, thus potentially identifying invisible policies. Policies about energy, carbon or transport which do directly talk of energy are excluded from the 'non-energy' policy group. The South African National Constitution, the Environmental Management Act, the Minerals and Mining Policy for South Africa and other mining rules become significant, in line with water management and treatment regulations, such as the National Water Act.

The empirical research was restricted to identifying general water-use practices that take place on coal mines in South Africa. Water use interactions were chosen as they are significant day-to-day exercises that takes place on coal mines, and environmentally responsible practices, especially relating to water, have become central to the viability and acceptance of a modern mining operation (Lottermoser, 2010).

1.5 Thesis Outline

This thesis paper begins by developing the conceptual framework that was used to tackle the research questions. Social practice theory is outlined in its general understanding and then placed in the context of mining and invisible energy. Next, the methods covered during fieldwork are explained, alongside theoretical backings and certain ethical considerations.

The results of the fieldwork are analysed in the following two chapters, 'Water Use Practices on a Coal Mine' and 'Mining Policies that Inform Water Use Practices' to answer Sub-Research Questions 1 and 2, respectively. Following this analysis, there is a Discussion chapter. Here, the findings, conceptual framework and the methodology used is reflected upon. The final chapter concludes the research and main findings, as well as puts forward some future research and policy recommendations.

2 Conceptual framework

2.1 Social Practice Theory

In order to reach the research aim of unravelling invisible energy policies with regards to water use practices on coal mines, a theoretical understanding and framework of social practice theory has been undertaken. It must be noted that 'theories of social practices' and '(social) practice theories' are both terms that are used in literature. For the sake of simplicity, it is assumed here to be referring to the same thing and will be used interchangeably.

Rechwitz (2002) emphasises that practice theory looks at understanding what lies behind *action*. As a form of social theory, it is used as a conceptual understanding of "mind, things, knowledge, discourse and process of the agent" (Rechwitz, 2002, p. 245). Looking at social practices allows one to focus on the everyday, 'life-world' of people. A 'practice' is explained to be "a routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Rechwitz, 2002, p. 249). For example, a way of working, cooking or consuming is a practice. Important to note is that these practices cannot be reduced to one single element of the above mentioned definition. Rather, practices exist based in the interconnectedness of the elements. In this way, a practice can also be a pattern (a certain way of doing something), that is carried out by a 'carrier' of a practice (Rechwitz, 2002). This routinized behaviour – or practice – should not only be understood by the carrier, but also by observers. Simply put, Rechwitz (2003, p. 250) understands a practice as "a routinized way in which bodies are moved, objects are handled, subjects are treated, things are described and the world is understood."

While a 'practice' can be said to be the organised way in which people carry out a particular activity, practice theory looks not only at these actives but also the meanings and competences behind them. Social practices, rather than individuals or groups of people, can be used as the unit of analysis for research. These practices include the material, the cognitive and the symbolic elements that are involved in carrying out a practice (similarly referred to as materials, competences and meanings in this research). A feature of social practice theory is that it takes on a relational ontological position. This rejects the idea that individual structures can be the starting point of social analysis. Practices are the unit of analysis and practices, as actions, are in fact 'transactions', with implications in the social world. Social objects are not self-subsistent nor self-acting entities, rather, relationalism implies that *practices* constitute individuals and can function only as relational entities.

The following quote describes what it means to look at action within a particular system; "For theories of practice, what people do is never reducible to attitudes or choices, or indeed to anything simply individual. Rather, doing something is always a *performance* of a *practice*. It is this understanding which gives the link between changes in what people do and the rest of any socio-technical system" (Watson, 2012, p. 488). Practices in empirical work can thus be looked at when they are performed. They can be 'practices as performances' (rather than entities) because they are carried out "by actors in a precise moment in time…by which its continual reproduction is ensured" (Maller, 2015, p. 58). One also cannot observe the entire 'practice entity', only its performances. However, when recurrent enactments with a 'distinct and recognisable conjunction of these elements' are established over time, social practices become identifiable as 'entities'.

Literature on practice theory continually brings forward the notable idea of there being interconnected elements that make up practices. These 'elements of practice' have been further distinguished by (amongst others) Shove, Pantzar and Watson (2012), in the form of 'materials', 'meanings' and 'competences'. Competences articulate the explicit and implicit knowledge needed to

carry out the practice. Meanings refer to the motives, emotional states and symbolic nature of the practice, and materials are the actual physical bodies or things involved in the practice (Shove, Pantzar and Watson, 2012).

Kuijer (2014, p. 52) proposes that when studying practices, the aim is "to get an overview of these elements and the ways in which they relate". It is explained that each element is made up of a 'constellation of groupings of elements', or sub-elements. For example, 'meanings' in the context of mining practices may constitute ideas of sustainability, job creation or profitability, while materials may be bulldozers, pipes and railways. These elements are visualised in Figure 2 below. Kuijer (2014) also emphasises that over many performances different elements will become more or less 'essential' to the practice. The size of the smaller sub-elements around the main elements in the figure on the right of Figure 2 denote how valuable that sub-element is relative to another. For example, the competence sub-element of knowing how to operate machinery on a mining site may be more important than having full legal knowledge around the licencing required to operate the mine, depending on the situation. Additionally, different performances of practices will use different groupings of interconnected elements (Higginson *et al.*, 2015), and so performances may not have the same size (value attributes) or even the same sub-elements as other similar performances.

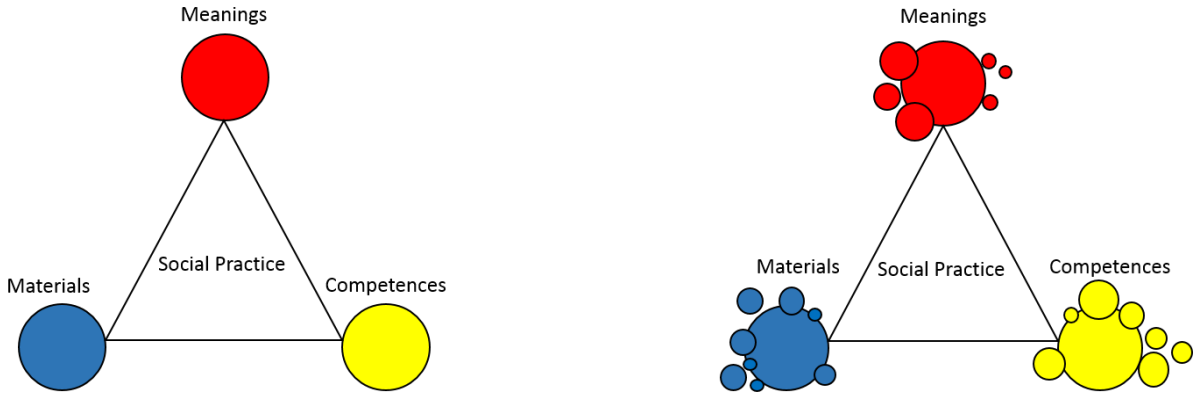

Figure 2: Elements that make up social practices (Shove et al., 2012) and their sub-elements based on Kuijer (2014).

2.2 Social Practices and (Invisible) Energy Policy

Policy, in any form, has to do with either making specific things happen (or not happen). 'Public policy' has been defined as "the measures taken by governmental bodies to maintain the status quo or to alter it when faced with a particular problem or set of problems" (Howlett and Ramesh, 2003). Subsequently, policy can be understood as an action that a government takes (or doesn't take). Policy ultimately guides the way in which people act and do things. In other words, policy has a role in changing or constraining practice. When looking at non-energy policies, it is important to see how these manifest themselves in practice, as well as how practices are informed by policy. Consequently, understanding invisible energy in the mining sector needs to be examined by looking at the processes within these complex systems, and not just by looking at policy or behaviour singlehandedly.

Policy approaches are usually informed by the idea that policy and behaviour act in a one-way causal manner, also generally identified as the Attitude-Behaviour model (Spaargaren, 2011). However, interventions based on this model, such as increased education and economic incentives, have shown

limited success in changing what people do (Watson, 2012). Social practice can then act as an alternative approach when analysing policy. Social practice theory can be seen as a framework for empirical research; as a way of studying social phenomena. Spaargaren (2003) is one author who has adapted the Attitude-Behaviour model to incorporate a more practice-based approach. "The opinions and behaviours of (people) matter increasingly for companies, policymakers and social movements" (Spaargaren, 2003, p. 687). It is argued that by looking at lifestyle and daily routine, one can avoid drawbacks associated with conceptualising sustainable consumption. Thus, 'social practices' become the "the proper unit of analysis for researchers and policymakers" (Spaargaren, 2003, p. 688). The adapted sociological model presented by Spaargaren (2003) is underpinned by behavioural practices. These practices are shared with other human beings and are bound in time and space. A social practice is described by the author as a daily routine influenced by the social context, identities and interactive patterns of people.

Importantly, the model also incorporates 'systems of provision'. This means that social structures become the centre of analysis and are not simply external variables. The institutions, policies and regulations that are in place also act as inputs that drive human behaviour and routine, and vice versa. In other words, policy and practice are interlinked and have a dynamic relationship. Social practice can bring this to light, by looking at how policy affects practice and the other way around. Giddens (1984) talks of social practices being the interaction between structures of society and actors, thus making 'policy structures' a vital pivot point in understanding consequences of practices (for example, invisible energy demand).

Even though Shove (2014), articulates that social practice theory cannot always directly translate into policy-making, indeed it is reasoned by others that practices can 'inform and inspire' policy (Keller, Halkier and Wilska, 2016). It has been highlighted by some authors (Spaargaren, 2011; McMeekin and Southerton, 2012) that much of policy-making today is influenced by technological solutions, but there remains the question of how these solutions will actually be adopted into everyday life. Individuals and structures are taken into account, but the processes and practices are not (Keller, Halkier and Wilska, 2016). Thus, a social practice perspective on policy-making maintains that a technological solution to change social life (to be for environmentally friendly, for example), or individual choice will not suffice. Rather, "the key lies in transforming and reconfiguring social practices, which are composed of material objects and environments, and socio-cultural meanings as well as the skills and competences to do something" (Keller, Halkier and Wilska, 2016, p. 76). In other words, tackle the elements of social practices.

This is where the work of Spurling *et al.* (2013) also becomes applicable. It is argued that "social practices are a better target of intervention for sustainability policy than 'behaviour', 'choice' or technical innovation alone" (pg. 4). Practices should therefore be the unit of analysis and starting point for informing policy. The authors put forward three types of practice perspective problem framings; 're-crafting' practices, 'substituting' practices and 'changing how practices interlock' (Spurling *et al.*, 2013). 'Re-crafting' practices entails replacing, or changing, the actual sub-elements and elements that make a practice (for example, making the materials more sustainable and therefore less resource-intensive). 'Substituting' practices is a framework whereby "policy might focus on discouraging current unsustainable practices and substituting them with existing or new alternatives" (Spurling *et al.*, 2013, p. 11). The third notion of changing how practices interlock tends to look at multiple practices and their relationship with one another to try and see complexities and sites of intervention for change that may 'ripple' through the practices. These framings show how a practice-oriented approach may be useful for dealing with the complexities of elements of practice and how they can be useful as sites for policy intervention. However, the ways of effecting change in social

practice theory also considers that even if one can 're-design' the relationship between these elements, it is highly complex and the desired outcome may not be guaranteed (Keller, Halkier and Wilska, 2016). Relations, by nature, are often unpredictable and multifaceted.

A notable point of interest here is that of unintended consequences. Social action may be 'formally organised', whereby "like-minded individuals form an association in order to achieve a common purpose" (Merton, 1938, p. 896). However, other actions as unanticipated consequences of the main action may arise. In energy policy, examples are easy to find; In Germany, the nuclear power sector has been eliminated under strong 'green' political pressure. However, even with increased wind and solar power generation, coal-fired electricity is more economically competitive without nuclear power on the market (Howell, 2016). The increased intensity of coal-fired electricity generation is a dramatic unintended consequence of the initial 'green' anti-nuclear policy. In a similar way, invisible energy policy can be understood as unintended policy. Energy may be used as a result of a non-energy policy, making room for unintended consequences to play out. Thus, a social practice perspective on invisible energy can add to the study of unintended policy consequences, and then as a result, to help conserve high energy use where possible.

Not only is social practice theory used in line with invisible energy policy potentially useful for understanding unintended consequences of policy, but also for possibly improving policy coherence. Policy coherence is desired, among other things, to reduce conflicts between interacting policy domains (Nilsson *et al.*, 2012). With social practice theory, action is seen as an outcome of policy, and with this as a starting point to policy-making, there could be use in reducing disjoints across policy sectors. The level of implementation of policy is important – in terms of practices - especially to allow one to have a full evaluation of policy coherence.

2.3 Social Practices on the Mine Site

Looking at social practices that happen on-site in the mining sector – such as water use practices - can be a way of identifying non-energy policies because one can see energy use in indirect energy related actions. As touched on in the introduction of this thesis, non-energy policy refers to policy that does not seemingly relate to energy but does actually indirectly affect energy demand and consumption. In order to find out what these non-energy policies are, the first step is to look at what people do. Energy demand and consumption come from practices – from routinized behaviour, from daily doings. Analysing people's practices that indirectly call for energy use may be done according to invisible energy policies. Ultimately, identifying non-energy policy can be done by tracing back the motivations behind people's action.

Taking the mining context as an example, water use practices are routinized actions that are done on a daily basis and consist of materials and competences, which are guided by certain meanings. For example, water treatment may be done in a certain way because the rules say so, but the rules themselves may be guided by an ethical obligation to protect the environment. A practice-based approach therefore allows one "to develop a greater understanding of the role of social interactions and power relations in the grounded performance of practices", as well as "a more holistic…perspective on behaviour change processes as they occur in situ" (Hargreaves, 2011, p. 79). A social practice approach not only allows one to identify invisible policies through analysing practice, but it also encourages a more in-depth understanding of the complexities that are behaviours, infrastructures and cultural meanings, which can in turn allow for potentially more effective policy approaches (Labanca and Bertoldi, 2018).

Certain 'actions' that play out on a mining site can be seen as practices. They are an organised way in which people carry out a particular activity. As explained by Shove, Pantzar and Watson (2012), these

practices are made up of elements of materials, competences and meanings. In line with this research, energy use may be observed in the mining context through the materials that are used in the day-to-day practices. Some of these materials that make up the daily practice of using water on mining sites actually require energy. Indeed looking at water-related practices on the mining site requires one to identify the materials that are associated with them. Schatzki argues that "understanding specific practices always involves apprehending material configurations" (Schatzki, 2001, p. 3). Even more to the point is Rechwitz's emphasis; "in order to play football we need a ball and goals as indispensable 'resources'" (Rechwitz, 2002, p. 252). Important to remember, however, is that it is not 'the ball' alone that makes the game, as it is also not simply the materials used on mining sites that make up the practices. The actors and their competences as well as the meanings behind the practices are important, and so looking at the policies that guide mining actions is also significant.

Practice theory has shown much of its application with regards to people and their 'ordinary doings' (Watson, 2012). This thesis hopes to unravel the 'ordinary doings' that take place within the mining context so as to identify invisible energy policy. In the mining sector, practices are usually framed by guidelines, which may draw from local, national and global policies. On-site water use is an example of this. The goal is to see how these water practices, carried out each day and informed by (non-energy) policy, actually affect energy consumption in the mining sector.

3 Methodology

My research consists of a combination of qualitative methods. Through combining methods I aim to promote the triangulation of my data. 'Triangulation' refers to "the use of more than one approach to the investigation of a research question in order to enhance confidence in the findings" (Bryman, 2004, p. 1). The strength of qualitative methods is that they can generate insights that often coincide with each other, allowing reinforcement of ideas and results found, as well as producing insights that would sometimes not be accessible without them (Morgan, 1997). Qualitative research allows for one to gain insight into people's actions, perceptions, experiences and values (Silverman, 2006), which is particularly useful in line with understanding social practices and their elements of materials, competences and meanings.

However, certain challenges may exist with this. When undertaking certain methods in line with a theory, all complexities within the empirical work cannot necessarily be brought to light. It can be argued that "the social is a field of embodied, materially interwoven practices" (Schatzki, 2001, p. 3), and thus when studying practices as separate, and only looking at them in isolation, one cannot truly both empirically and theoretically embody practice theory. Additionally, as is the case with invisible policy, "a practice theoretical approach implies a research design that encompasses many kinds of policy and many sites of policy-making. This brings methodological challenges, especially because many of these policies' effects on practice may be relatively unknown" (Royston, 2016).

3.1 General Principles of Practice Theory Methodology

The central unit of enquiry as called for by practice theory is the actual 'practice' that is undertaken. "Practices only exist to the extent that they are enacted and re-enacted. Focusing on practices is thus taking the social and material doing (of something: doing is never objectless) as the main focus of the inquiry" (Nicolini, 2012, p. 221). Methods to investigate practices therefore depend on the types of questions needing to be answered (Shove, 2017). Additionally, "research simply cannot be begun without having theoretically determined what should be investigated" (Hillebrandt, 2016). One therefore needs to delineate practices as objects of enquiry based on the questions one wants answered.

As this research aims to analyse how invisible energy policies effect energy demand in water use practices on a mine site, the general question is broadly interested in accounting for unintended consequences of policy. Subsequently, questions were interested in "how (water use) practices take shape, how they circulate or disappear, or how they link and break away from each other" (Shove, 2017). In other words, one is looking at why and how practices come to be the way that they are.

Nicolini (2012) presents 'a package of theories and methods' in which he outlines how to investigate social practices. He describes three basic actions which one can follow in order to look at social practices both empirically and theoretically:

1) Zooming in (identifying the exact details of a practice in context)
2) Zooming out (identifying connections between and influences on practices in space and time)
3) Enriching understandings through '"thick textual renditions of mundane practices" (p. 219) so as to bring to light broader effects/influences of the practices

As the name suggests, his recommendation to study practice requires bringing together theory and method so as to accomplish three things. First, one needs to 'slice' the social world terms of practices (rather than in terms of systems or individuals, for example), and then to 're-present' practice in text. Here he calls for the practice at hand to actually be transliterated as exactly as possible, so as to present the practice in text as closely to reality as possible. Lastly, he suggests that studying practices

should lead to offering "resources for building narratives and plotting the world" (Nicolini, 2012, p. 218). In other words, studying practices should allow for one to construct 'local stories', explanations and potentially further theories.

Based on this, the general organisation of the research in context was guided by the following scheme in three phases:

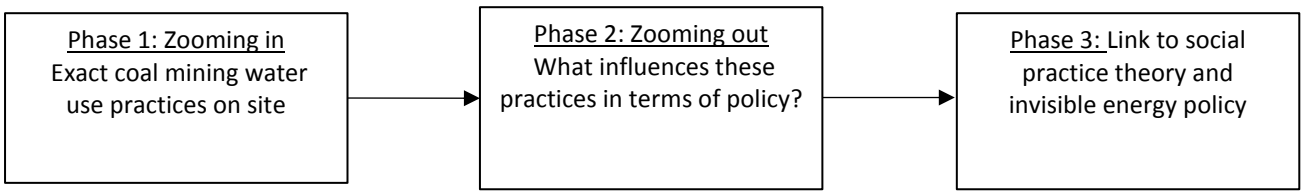

Figure 3: Progression of research based on Nicolini, 2012

In the case of water use on mining sites, relevant practices are guided by certain policies. The research seeks to see what exactly the practices are, as well as how different policies steer indirect energy demand through these practices. Consequently, if one wants to understand changing practices, one needs to consider how policies affect these practices – both intentionally and unintentionally (Royston, 2016). In this case, identifying the actual practices with regards to water management on a mining site was necessary as a first step. By making the 'practice' the unit of analyses and looking at it first, the policies that guide the practice will become relevant (Royston, 2016). Certain themes emerge from social practice literature that can be the focus of unravelling the practice (for example; materials, meanings, competences).

Figure 4 shows the line of enquiry that was followed, first addressing SRQ 1 (what the practices are), and then dealing with SRQ 2 (the policies that affect indirect energy demand through these practices). While Figure 4 shows a one-way arrow from policy to practice, this is simply my line of enquiry. Indeed practice and policy have a far more complex relationship than this, with both having the ability to influence each other.

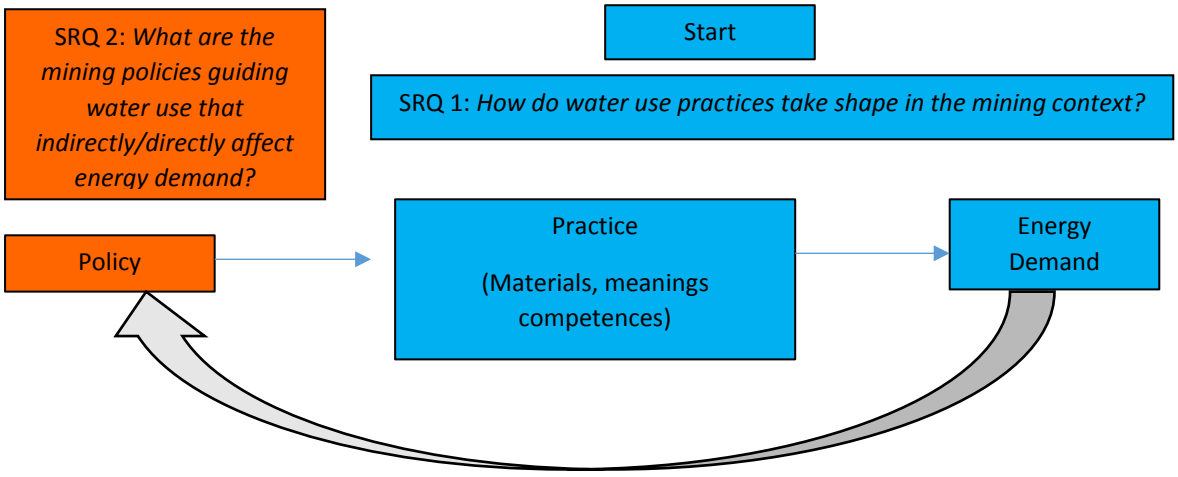

Figure 4: Basic line of enquiry for research

3.2 Research Methods

Coal mines based in South Africa are taken as the context for the empirical research. Speaking to stakeholders with knowledge around water-use interactions on a mining site is useful to understand certain practices as well as where energy is being expended. “By first zooming in on the local, contemporary accomplishment of practices, (one is) able to identify features that varied in ways that were significant for energy use” (Morley, 2016). A documentary review, including a policy analysis, as well as interviews were undertaken to try and answer the research questions.

3.2.1 Documentary Review

A documentary review around the existing processes, policies and frameworks that guide water management on South African mining sites was undertaken. Reviews included South African mining policies and both scientific and grey literature on water use in the coal mining context. The basic guidelines that legislate South African coal mining activities were crucial to look at in order to open up the opportunity of identifying invisible energy policy at all. In answering SRQ 2 (see Figure 4), the ‘policy analysis’ that took place in this research was linked to identifying regulations that influence water use practices identified in the field.

3.2.2 Interviews

A specific, localised view of water use practices on coal mines in South Africa was analysed in the ‘zooming in’ phase. Here, research sought to understand exact water use practices (SRQ 1), so as to successfully identify invisible energy policies that influence these practices. In this context, one can use people as ‘informants’ about the practices that they carry (Hitchings, 2016). Therefore, interviews were useful. Four interviews were able to be conducted. Stakeholders who are knowledgeable on the subject (such as environmental scientists, hydrological engineers and coal mining project managers) were interviewed. The selection of interviewees was done through a preliminary study of websites and networking, and from there, snowball sampling was used. Questions were semi-structured to cover important topics, but also to allow for issues to be raised that may not have been thought of. Three interviews were face-to-face, and one was carried out over Skype (See Appendix A for list of interviewees).

3.3 Data Analysis

After information was gathered from reviews and interviews, it needed to be structured and analysed. A content analysis was carried out by coding data for certain words (for example, the actual practices involved or different policies that actors brought up). This coding was done by going through all of the text from interview transcripts and notes, and labelling words, phrases, and sections of text that relate to the research questions. Subsequently, a thematic analysis unfolded, where I grouped the data into themes in order to help answer the research question. The data was organized, or ‘themed’ according to the sub-research questions and according to sub-elements of meanings, materials and competences where applicable (See Appendix D for an example).

3.4 Ethical Considerations

Out of professionalism and protection of all those involved, I insured that the following steps were taken and kept in mind at all times;

When conducting my research, I gave a detailed description of what my research is for and made sure that I had full compliance from the candidates when conducting the interviews. I respected the right of interviewees to refuse to participate and to withdraw their participation at any stage. Interviewees were able to remain anonymous if they so wished. I understand that information obtained may be of a sensitive nature and so treated it as confidential unless the participant agreed to its release. I needed

to represent answers accurately and fairly, making sure that the responses that I noted were not distorted. In order to avoid this misinterpretation in interviews, I took notes during the interviews and allowed the interviewee to read over them afterwards. In the case of the Skype interview, I sent a copy of the interview notes via email. If anything had been misunderstood or misinterpreted, it could have been changed or omitted prior to analysis.

4 Water Use Practices on a Coal Mine

4.1 Introduction

The goal of this research is to identify invisible energy policies in the South African mining context. The invisible policies are unravelled by looking at social practices that play out on coal mines. By looking at the practices that happen every day on a coal mine, one can open up possibilities of seeing whether (and how) energy is used in order to perform these practices. The importance of social practices as a step to understanding invisible energy policy cannot be understated. The meanings behind action on mining sites, the materials used to perform the actions and the competences required all come together in a way that can be understood in terms of energy demand; By looking at mining practices with energy demand in mind, one can potentially see where one can reduce usage in the way that people *do* things and *why* they do them. Not only is decreasing energy usage in line with national and international climate change carbon emission targets, but it also allows for a new perspective on how policy and practice influence each other in reality.

As seen in Figure 5 below, this chapter looks to answer one of the sub-research questions (SRQ 1);

"*How do water use practices take shape in the mining context?*"

The chapter uses a social practice lens to discuss the qualitative data collected from interviews and from literature reviews. First, the practices that involve water on mining sites, as encouraged by Nicolini's (2012) work, are described. According to Nicolini, investigating social practices on an empirical level requires one to 'slice' the social world terms of practices (rather than in terms of systems or individuals, for example), and then to 're-present' practice in text. Here he calls for the practice at hand to actually be written into words, so as to present the practice in text as closely to reality as possible. The chapter then moves on from ""thick textual renditions of mundane practices"(Nicolini, 2012, p. 219) to bringing to light the broader effects of these practices in terms of energy demand by using materials as a proxy for energy demand. The next chapter will trace back the policies that inform these practices, also looking at the competences and meanings behind these actions.

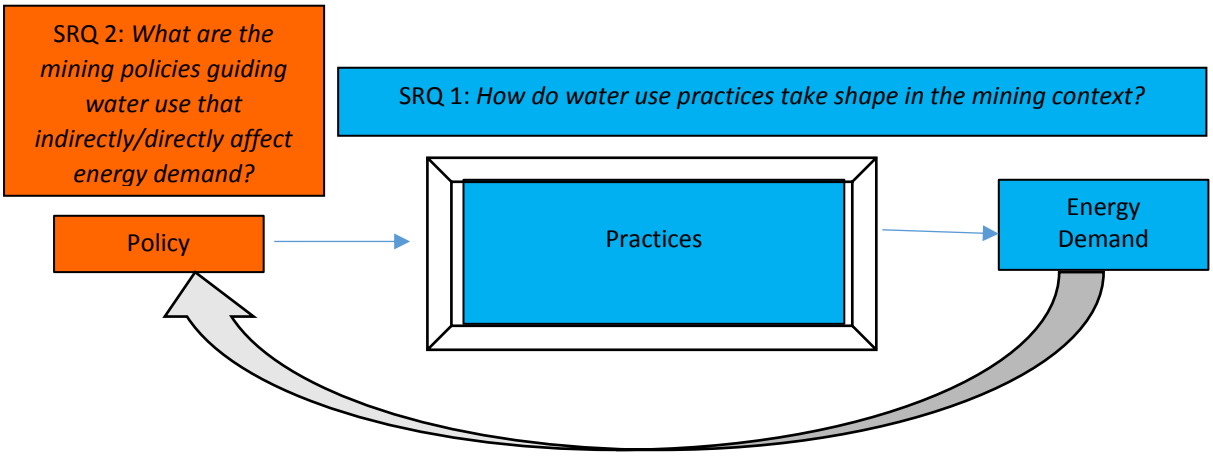

Figure 5: Systematic sketch of research analysis

4.2 Coal Mining Water Practices

Practically, not each and every practice that is performed on a mining site could have been analysed in this research, and so rather, the practices regarding water use were chosen as a focus. Water is needed for various elements of the mining process. Water is usually sourced from surface as well as groundwater water bodies, but can also be taken when it is a by-product of the mine dewatering process (Lottermoser, 2010). Mining regulations maintain that the quality of water leaving a mine site should not negatively affect downstream users. This means that mining companies need to adopt water management plans that minimize water contamination, and this may use up large amounts of energy. Mining has an effect on the quantity and quality of water in the area, and water management on mining sites has been identified as one of the most challenging factors in the mining world (Punkkinen *et al.*, 2016). In general, surface and ground water is monitored and undergoes certain treatment processes to keep that quality of the water up to standard.

Indeed practices that are related to water use are routinized, day-to-day actions performed by actors, which, in the mining context, can be recognized and understood by any other mining-related actor as they too would perform the same practice (with the same materials, competences and similar meanings (Shove, Pantzar and Watson, 2012)). People are the 'carriers' of the practice as they are the actors that perform the practices with the specific relevant materials, competences and meanings.

The practices have initially been explained by the interviewees as 'practices as performances' (rather than entities) because they have been observed and carried out "by actors in a precise moment in time…by which its continual reproduction is ensured" (Maller, 2015, p. 58). The practices which have been identified have only been observed at single moments in time by individuals and then described through interviews. One cannot *observe* the 'entire practice entity', only its performances, which also allows for practices to be studied empirically (Maller, 2015). However, this applies only to the interviewees observing and describing the practices they see and do. When talking of these practices here, they can indeed be seen as 'an organized set of activities' that is recognizable across time and space. They are 'blocks' of activities that can be grouped as entities (Røpke, 2009), as seen in Table 1 below.

Water is used in many different ways on a coal mining site, from actual coal extraction to dust suppression. Based in information from interviews, different coal mining processes that require water have been identified. The different water uses have been grouped into similar 'practices' – different routines that people 'perform', or simply, 'do'. In the mining context, they are practices in their own right as ways of people doing things in a similar manner by all coal mines. Table 1 below summarises the processes in which water is used on mining site according to interview data.

Table 1: Coal mining practice-entities requiring water

Mining and Preparation of Coal			
Coal Extraction including;	**Dust Control**	**Coal Washing**	**Discarding including;**
Cooling Machinery Backfill Support			Slurry Drainage Tailings/discharging material

Below, the different ways that water is used (and practices are carried out) on mines have been further described according to interviews and a documentary analysis.

In order to perform the coal mining practices, water needs to be collected and stored. However, the source of water used on coal mines is currently a major problem in the South African context (Interviewee 2, April 2018). A huge amount of water is actually needed, and thus the focus on water use in this research holds much weight. One mine in the Soutpansberg of the Limpopo province was said to have been given the go-ahead by the Department of Mineral Resources "without having a clear view of where it will find the water it needs to begin mining" (Groenewald, 2012, p. 3). Borehole water levels drop and surrounding communities who rely on the water for consumption and farming purposes tend to bear the consequences (Interviewee 2, April 2018). Water is therefore a very important resource.

On actual coal mining sites, once water has been collected, it is often found in dams (Interviewee 3, April 2018). Two types of dams can be found to store water on site; Normal dams around the mine site are constructed so as to collect storm water runoff that can be used at the mining plant to process the ore, and a tailings dam for polluted water and waste. Water on mine sites usually carries dissolved matter such as heavy metals and can be acidic as it has come in contact with minerals. In order to ensure that this water does not inflict negative impacts on the surrounding environment, it needs to undergo a water treatment process. The extent to which the water is treated (and therefore the amount of energy or other inputs used) depends on how polluted the water is, what chemicals need to be removed, how much water needs to be treated and on the required quality needed to be reached (Interviewee 3, April 2018). Treatment technologies can either be active or passive. Passive technologies use natural processes such as microorganisms or gravity, but this still requires regular maintenance and monitoring programs (Banks *et al.*, 1997). Active treatments are, however, the most common practices of treatment, and require energy and chemical inputs (Wolkersdorfer, 2008).

Water is also required to actually get coal out of an opencast mine in a process call strip mining. The activity requires about 160 litres of water per tonne of coal produced (Wassung, 2011). Mechanized equipment not only requires an input of power to function, but often results in generating heat, too (Maurya *et al.*, 2015). Examples include rock-breaking machinery, drills, transformers and even vehicles. Water is often used to cool these machines down when necessary (Interviewee 1, 2 & 3 April 2018).

Water is also used for backfill support on mines (Interviewee 2, April 2018). This has to be done has a form of ground improvement to stabilize excavated zones. The backfill provides regional stability so that coal can be removed from nearby areas (Sivakugan, Veenstra and Naguleswaran, 2015). Water is used here with concrete as the medium for the backfill (Interviewee 2, April 2018). The amount of water is not relatively significant.

During the actual mining process, fine elements of rock and other soil-like waste is produced. This is then compacted to structure dam-like features that can hold the water needed for further mining processes. Indeed simply the tailings (waste) can be mixed and stored with the water in these dams.

Water from tailings dams together with potable water (often provided by the state) is brought into the coal plant for the actual processing of the ore (Interviewee 2, April 2018). Once coal has been brought out of the ground, it is transported by conveyor belt to the processing plant. The coal needs to be enriched to be made into a high quality product by cleaning it and removing dirt, ash, sulphur and other unwanted elements. This washing process requires energy and water. The technique requires an average of 130 litres of water per tonne of coal (Wassung, 2011). However, this figure

varies depending on the plant and processing, with some plants using as little at 38 litres per tonne of coal (Wassung, 2011).

The general practice of spraying water on coal mines is also typically done in order to supress dust (Interviewees 1, 2, 3 & 4, April & May 2018). During the processing stage, coal that has been mined is dumped on the surface of the ground and crushed into smaller fragments. This produces significant amounts of dust and larges hoses and sprinkler-like equipment pieces are used to spray water over a high trajectory to cover the area of the coal pit (Interviewee 1, April 2018). It is estimated that 42 litres of water is required per a tonne of coal for spraying (Wassung, 2011).

Another main use of water is for slurry (Interviewee 1, 2 & 3, April, 2018), which is a semi-liquid mixture of water and finely crushed coal. The slurry makes the coal much easier to move around through pipes, rather than in big heavy solid chunks.

Water from dams or from storm water drains needs to be intercepted and diverted either to or from the processing plant or to other storage facilities. Water collected from underground sources or seepage sources from the mining pit needs to be pumped to the surface and treated before it is (re)used or discharged (Interviewee 3, April 2018). Water is moved through pipes and with the use of pumps. Interviewee 4 (May, 2018) notes that the energy costs associated with allowing a safe mine to run their watering systems "runs into many millions of Rands" (1 Euro = 14.68 Rand). Interviewee 2 (April, 2018) additionally notes that much water is also used beyond coal mining, often on site and hand-in-hand with electricity generation. Eskom – South Africa's public electricity utility – uses around 70 million litres of water a day for the cooling of towers, turning of turbines and other activities at the Kusile power station[1]. Compared to other industries, however, mining as a sector only uses 3% of South Africa's water (agriculture takes a staggering 62%) (Groenewald, 2012).

Not only is water used up though, it is also contaminated. This is a huge problem that many coal mining companies are currently under fire for. As recently as this year (2018), news coverage and media exposés have called out certain companies for their environmental damage (See Appendix E for an example). Acid mine drainage – the flow of polluted water from old mines – has detrimental effects on the surrounding environment that are both long-term and far-reaching. "These consequences include degrading the quality of the country's water systems, poisoning of food crops, endangering human health, and the destruction of wildlife and eco-systems, infrastructure and heritage sites" (Groenewald, 2012, p. 3). The actual quality of the water used on coal mines is considered to be information that is 'commercial in confidence' and access is restricted. Individual mine water data is not open to the public. Data is collected by the mines and then "submitted to the Department of Water Affairs and Forestry as part of routine pollution control monitoring operations" (Department of Water Affairs and Forestry, 2008[2]). Naturally, this raises concern around how polluted water sources actually are.

[1] Kusile is one of Eskom's coal power stations and one of the biggest in the world (Groenewald, 2012). Water is used for the generation of electricity here but also for the mining process which happens at the same site.

[2] In May 2009 the Department of Water Affairs and Forestry was divided, with the forestry responsibility being transferred to the Department of Agriculture, Forestry and Fisheries. The Department of Water and Sanitation was established in May 2014 and is the current responsible body for water affairs.

While human consumption of water is not relevant in the actual process of mining coal, two of the interviewees (Interviewees 1 & 4) touched on the fact that it is indeed an everyday interaction with water carried out on a mining site. Most mine sites have either permanent or semi-permanent structures which act as an office base for workers on site. The buildings are often in good condition with running electricity and water so day-to-day admin activities can be handled as well as being a place for employees to recuperate. Water is used for 'common' social practices here such as cooking, eating and washing. Water can be found coming out of pipes for taps and sinks as well as for bathroom drainage. Employees make food, tea or coffee, and drink water directly in terms of consumption. Water is also used for washing hands, cleaning or for other bathroom uses.

4.3 Energy-Intensive Water Use Practices

Information from the interviews shows that water is certainly significant for a coal mining operation. However, the figures around this water usage are only an indication of scale. More research into the actual quantity of energy involved would be useful to place these more specifically in terms of energy demand. However, without these exact energy use figures, recognising the materials that are needed to perform these practices can also help to see the broader effects of energy demand on the mining site (and thus, eventually, invisible energy policies). Interviewees naturally tended to talk about the materials required to perform certain actions (see Discussion, Chapter 6.4), and these have been tabulated below.

Table 2: Some energy relevant materials required for water use practices

Water Use on Mining Sites	**Energy-relevant Materials**
Dust Suppression	Sprinklers, hoses, pipes
Cooling Machinery	Hoses
Catching drainage water	Pipes, dams
Dams	Concrete mixer, rock, tailings, vehicles, excavators
Backfill support	Concrete mixer, excavators
Underground operations	Pipes, pumps, conveyor belts
Intercepting and diverting surface water	Pipes, pumps
Mixing with discard so as to deposit material	Pipes, pumps, mixer
Drainage	Pipes, pumps, excavators
Tailings/discharging material	Pipes, pumps, conveyor belts
Recycling ore process water	Pipes, pumps
Conveying/transporting material	Pipes, pumps, conveyor belts, vehicles, trains, excavators
Consumption	Stove, kettle, fridge, geyser
Sanitation	Geyser, pipes

The above-mentioned materials suggest an energy-intensive process and can be seen as a proxy for energy demand in water practices. In general, South Africa's coal mining sector has been critiqued for having 'inefficient energy use' in an 'energy-intensive' economy (Wassung, 2011). The materials used are fairly standardised throughout different coal mines, and research focused on the energy-water nexus recommends technological innovation. However, as Interviewee 4 explains (May, 2018), profit for coal mining companies is central, and investing in energy saving technologies is generally not a priority as of yet. As mentioned in more detail in the next chapter, there are also no explicit mining policies that enforce energy efficiency, only vague and nonspecific recommendations of being 'sustainable'.

However, as seen with the above practices, the consumption of energy through the use of materials required is not actually a conscious, or direct, action. Rather, the energy used is a "by-product of performing activities that require energy" (Narasimhan *et al.*, 2017, p. 3). These practices are done for the sake of mining coal, not for consuming energy. These practices can be seen as energy demanding practices.

4.4 Conclusion

In answering SRQ 1, the actual practices that take shape with regards to water use on coal mining sites have been described to ultimately be able to trace them back to different policies. First, the water uses were identified and from here, they were understood as 'practices' - which involve routines that people 'perform'. These include catching and moving water for coal extraction, washing and discarding, and for spraying water for dust suppression. Each of these different actions require different material elements in order to be carried out. These, ultimately, require energy to build or to operate. Energy is an outcome of these water use practices. They are mostly guided by certain policies and the next chapter further outlines how these practices are informed by non-energy policy.

5 Mining Policies that Inform Water Use Practices

5.1 Introduction

The actual mining process consumes a lot of direct energy itself (through the use of electricity for machinery, for example) (*Coal Resources*, no date), with the Department of Energy compiling data which shows that the mining industry is responsible "for just under two-thirds of South Africa's total electricity consumption (62% in 2012) (Eskom, 2017). About 126.7 Mtce (magatonne of coal equivalent) per year is used up by coal mining, which is over 1 billion kWh per year.

As seen in the previous chapter, there are practices that take place that also indirectly require energy, such as construction of pipelines, dams and the processing of water for coal extraction. The different water use interactions that play out on coal mining sites were explained in terms of practices. They are performed routinely and, within the mining context, can be recognised as repeated actions made up of different materials, competences and meanings. The last chapter saw how materials required to perform these practices may be seen as a proxy for energy demand. This chapter, however, seeks to unravel the policies that guide these practices, as well as going beyond just the material elements required to perform the practices. If the practices demand energy in order to be carried out, and are done according to set policies, the policies can be identified as invisible energy policies.

A practice theory perspective here stresses that policy shapes the way in which social practices are perceived, understood and performed. Indeed the other way around holds true too; the outcomes of practice may influence policy. There is a dynamic relationship here. Subsequently, the consequences of policy in terms of invisible energy demand could help to improve policy and practice, so as to reduce energy demand in other indirect yet significant ways. This may be invaluable when it comes to trying to reduce energy demand and reach national targets.

The basic guidelines that legislate South African coal mining activities will be brought to light in this chapter. This is crucial in order to open up the opportunity to identify invisible energy policy at all. The mining guidelines and legislation that stipulate coal activities are not related to energy directly. Rather, they are about the environment, water, waste and minerals. Yet these policies can steer energy demand and use in unintended ways (Royston, 2016). This chapter reveals these invisible energy policies by using a practice theory perspective.

The second sub-research question of this thesis is;

"*What are the mining policies guiding water use that indirectly/directly affect energy demand*?"

In answering this, this chapter presents the policies involved in the mining sector, with a main focus on water-related guidelines. Accordingly, the 'policy analysis' that took place in this research was linked to identifying regulations through a documentary analysis that influence social practices identified in the field, as seen in Figure 7 below.

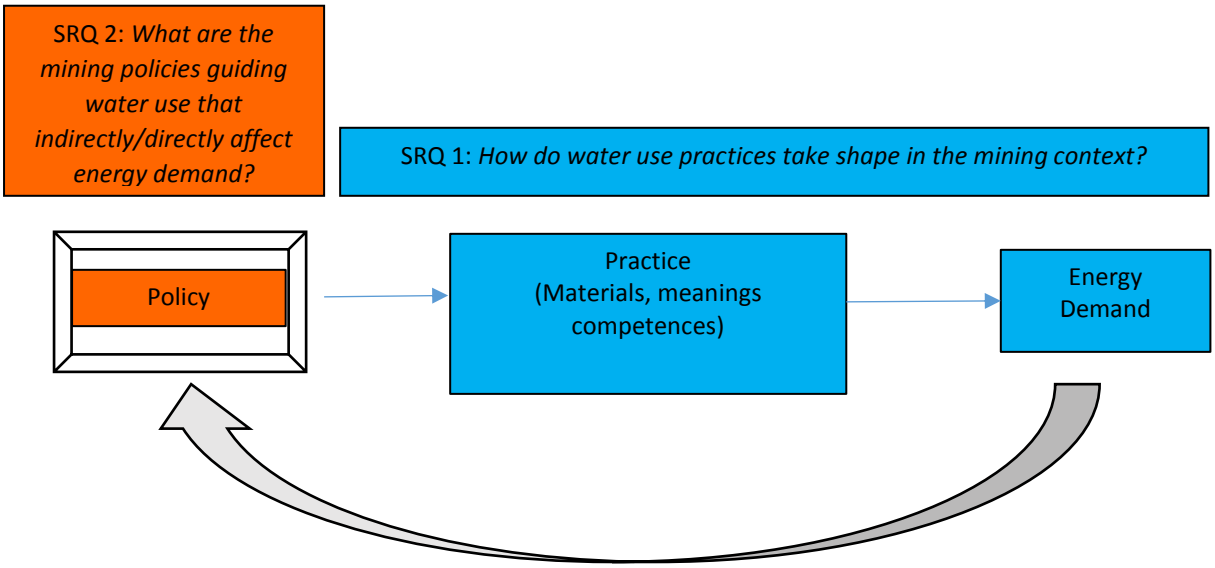

Figure 7: Systematic sketch of research analysis

First, the key South African policies that present as relevant to coal mining have been outlined. The chapter then goes on to look at the water use practices identified in the previous chapter and which exact policy stipulates these. A practice theory perspective is then implemented to identify invisible energy policies. This is done by looking across the relevant policies categorised by their effects on the mining practices, as well as their potential effects.

5.2 Relevant Legislation

5.2.1 General Coal Mining

National laws are in place so as to minimise damage when it comes to coal mining operations. Many people-oriented health and safety regulations manifest due to the dangerous nature of coal mining, but this thesis focusses on the relevant environmental regulations, especially those related to the use of water. The legislation generally aims at promoting and achieving sustainable development and includes laws that support public participation and adaptive management. Indeed these policies aim to initiate and shape social practices to be 'performed' in certain ways.

With relevance to coal mining, the first two broadly applicable laws can be found in the South African Constitution and the National Environmental Management Act (NEMA). They set 'sustainable' and 'protective' rights for people and the environment. The Constitution of the Republic of South African Act (Act No. 108 of 1996) revolves around general rights, but also specifically the environmental rights, of South African people. Section 24 of the Constitution states that "everyone has the right to an environment that is not harmful to her/his health or well-being, and for the environment to be protected for the benefit of present and future generations". This is to be achieved through reasonable legislation and other measures. The NEMA (Act No. 107 of 1998) delivers the guiding legislation and framework for environmental management in South Africa. The Department of Environmental Affairs and the Department of Water and Sanitation is guided particularly by Chapter 2 of the NEMA, which outlines various development and implementation policies, particularly for water management. Due diligence, Environmental Impact Assessments (EIAs) and Environmental Management Programmes (EMPRs) are required under this act as policy tools for implementation and compliance monitoring (Appendix C summarises the common environmental regulatory requirements for coal mines in South Africa).

The principle legal framework which governs all stages of the mining production process in South Africa is The Minerals and Petroleum Resources Development Act (MPRDA, Act No. 28 of 2002) and the Mine Health and Safety Act (Act No. 29 of 1996). The MPRDA regulates 'the prospecting for, and optimal exploration, processing and utilisation of minerals; provides for safety and health in the mining industry; and controls the rehabilitation of land disturbed by exploration and mining'. The Act specifically states that "any prospecting or mining operation must be conducted in accordance with generally acceptable principles of sustainable development by integrating social, economic and environmental factors in the planning and implementation of prospecting and mining projects, in order to ensure that exploration of mineral resources serves present and future generations." This act guides the process of applying for any mining rights at all, and its regulations state that an EIA is required for any underground mine as well as EMPRs where applicable. Continual compliance is also held under this act. The Mine Health and Safety Act regulates all matters regarding health and safety to those who work in the mining context. It encompasses monitoring systems and inspections, identifying hazards and minimizing risks for any dangerous working conditions. It also covers the training and human resource development.

Specific to water use, imperative to all mining sites is the National Water Act (NWA, Act No. 36 of 1998). The NWA emphasises the effective management of South Africa's water resources. Its seeks "to achieve social equity, economic efficiency and ecosystem sustainability, which are undertaken within a framework that includes institutional roles, an enabling environment (legislative, regulation and policy) and management instruments" (Department of Water Affairs and Forestry, 2008).

When it comes to water use, in accordance with the practices presented in the previous chapter, the NWA requires Integrated Water Use Licence Applications (IWULAs), Integrated Water and Waste Management Plans (IWWMPs) and compliance monitoring. The NWA instructs that water use licenses (WULs) must be obtained for all water uses related to mining. Section 21 of the NWA outlines eleven types of water use as seen in Table 3 below. As seen in the field and explained in the previous chapter, practices relating to water use are evident, and according to the NWA will require WULs for each activity.

Table 3: Water uses that require a licence according to the National Water Act (Section 21)

Section 21 water uses:
(a) taking water from a water resource
(b) storing water
(c) impeding or diverting the flow of water in a watercourse
(d) engaging in a stream flow reduction activity contemplated in section 36
(e) engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)
(f) discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit
(g) disposing of waste in a manner which may detrimentally impact on a water resource
(h) disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process
(i) altering the bed, banks, course or characteristics of a watercourse
(j) removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
(k) using water for recreational purposes.

5.2.2 The NWA and its Practices; Theory vs Reality

The previous chapter identifies certain practices that take place day-to-day on the mining site. These practices are related to water use and water interactions, and so the NWA becomes key policy. Below, Table 4 shows that these practices are done in accordance with NWA Section 21 water uses.

Table 4: NWA Section 21 relevant policy for water use practices on site

Water Use on Mining Sites	Direct Relevant Policy
Dust Suppression	NWA Section 21 (a)
Cooling Machinery	NWA Section 21 (a)
Catching drainage water	NWA Section 21 (b)
Dams	NWA Section 21 (b,e,g)
Backfill support	NWA Section 21 (a,e,i)
Coal processing	NWA Section 21 (a,e)
Intercepting and diverting surface water	NWA Section 21 (a,c,d,i)
Mixing with discard so as to deposit material	NWA Section 21 (f,h)
Drainage	NWA Section 21 (c,d,i)
Tailings/discharging material	NWA Section 21 (g,h,j)
Conveying/transporting material (slurry)	NWA Section 21 (e,f)
Consumption	NWA Section 21 (b,k)
Sanitation	NWA Section 21 (b,k)

Interviewee 1 (April, 2018) confirms that any use of water on a mining site is, in theory, covered by a policy which stipulates how the action should be performed and that a licence is needed before performing the action. However, in practice, some coal mines have been found not to obtain licences at all (Interviewee 1, April 2018). Media coverage has brought to light that 125 mines in 2010 were not operating with water use licences (Wassung, 2011). Even though policies exist to try and protect environmental resources, they become redundant if there is no consequence to non-compliance. This is a valuable finding. In terms of the outcomes of invisible energy policy, policy makers cannot target practices through policies to better save energy if companies do not follow the regulations at all.

Additionally, some of the NWA policy is ambiguous and nonspecific. For example, the Act states that water use should encourage "fair and sustainable socio-economic transformation and development", and that water resources should be "protected, used, developed, conserved, managed and controlled in accordance with the requirements of the policy and law" (Department of Water Affairs and Forestry, 2008). What is 'fair' and 'sustainable'? They give certain (vague) meanings to the practices that should be carried out, but they do not outline exact best practice actions. This reduces the likelihood of actually decreasing energy use on sites, because of the subjectively of the policy meanings.

What is not covered by law but is carried out by most mines is that of recycling as part of voluntarily improving mine water management (Interviewee 2, April 2018). "Faced with increasing water scarcity, some coal mines are recognising water as a critical resource that needs to be used and discharged in a sustainable manner" (Wassung, 2011, p. 12). This is not stipulated by law but indeed a practice carried out on most mines.

5.3 Invisible Energy Policy

With most water use practices undertaken alongside Section 21, this section of policy in the NWA can be considered invisible energy policy in the South African mining context. This is because the practices that they stipulate require energy in order to be performed.

As explained by Interviewee 2 (April, 2018), if any of the above practices are to be carried out, an application for a water use licence is taken in by the Regional Office of the Department of Water & Sanitation (DWS). The Regional Office will charge a licence processing fee and will do an initial assessment. The application will then be transferred to the Head Office for further processing. These processes, adhering to policy outlined in the NWA, instructs the way a practice is carried out.

The reason I highlight this process is because of the final outcome (see Figure 8 below); a national policy requires a licence application to be undertaken. If approved by the DWS, different types of water uses (in the form of social practices) can be performed, which may demand energy. Thus, the NWA policy can be argued to be an invisible energy policy.

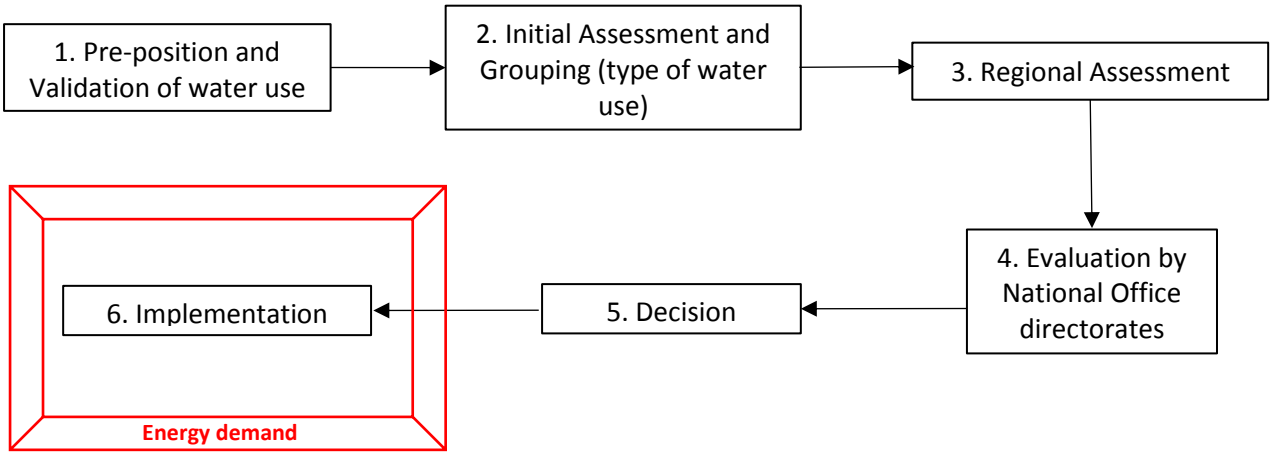

Figure 8: Adaptation of the water use licence application process as stipulated by the NWA

Once granted a water use licence, any of the 11 above mentioned activities in Section 21 can legally be carried out. Interviewee 3 (April, 2018) also explains that, for example, much energy is required for pumps to function to move water, or to keep water separate when discharging of waste material on site (applicable to NWA Section 21 (a,c,f,g,h,j,k)). This energy is consumed continually while the mine is operating, but indeed it is pointed out by the interviewee that initial energy costs for construction will be high, for example through making canals, dams, pumps, pipelines, berms etc. Thus, for most of the NWA Section 21 water uses, invisible energy policy exists.

The energy required comes in the form of the materials used and made to complete the practice. However, as explained further in the next section, policy – and invisible energy policy - does not necessarily only incorporate the 'material' element of a social practice, but also the competences and meanings behind the practices.

5.4 A Social Practice Perspective on the Mining Policies

With a social practice perspective, I argue that the applicable nation acts shape the way in which social practices are perceived, understood and performed. That is to say – they may influence the meanings, materials or competences that make up a practice. Practices are made, stabilized or broken through the integration of these three elements (Higginson *et al.*, 2015) and I maintain that policy can influence these elements.

Kuijer (2014) explains that each element is made up of a 'constellation of groupings of elements'. Different performances of practices will use different groupings of interconnected elements (Higginson *et al.*, 2015). As seen in below in Table 5, sub-elements are categorised based on information gathered from interviews and policy documents. This was done through picking out words from interviews and according to my discretion and logic, either categorising them as a material, meaning or a competence with regards to coal mining (See Appendix D).

Table 5: Sub-elements of practices in coal mining

Practice		
Materials	**Competences**	**Meanings**
Permits	Engineering & Environmental knowledge	Sustainability
Machinery	Using machinery	Energy Awareness
Infrastructure	Interpreting policy documents	Job Creation
Landscape	Understanding of the project	Profit
	Interpreting risk	People protection
	Reasonable judgements	Environmental protection

It must be noted that these are not *all* of the sub-elements, but the appropriate ones according to a combination of data around water use practices and the South African coal mining context. Kuijer (2014) also emphasises that over many performances different elements will become more or less 'essential' to the practice. The following Figure 9 illustrates the difference applicable elements for general water use practices on coal mining sites at the time of research:

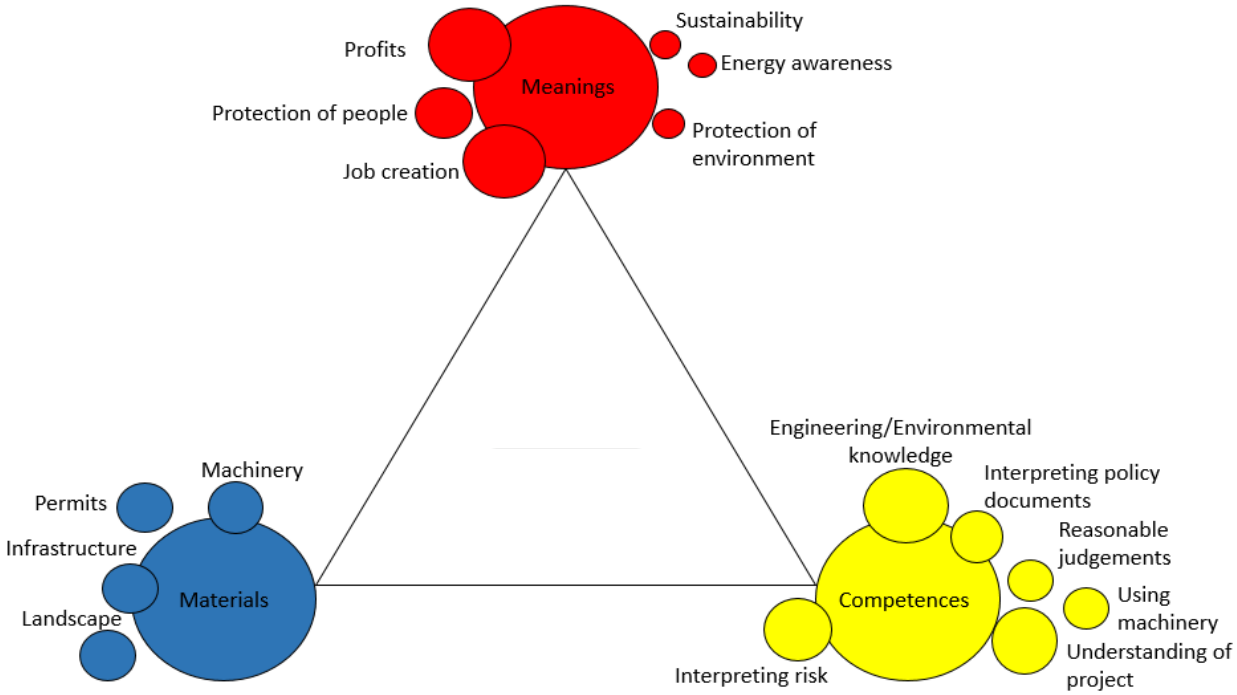

Figure 9: Policy influencing coal mining water elements of practices (Based on Shove, Pantzar and Watson (2012) & Kuijer (2014))

The figure shows the interconnection of three elements that make up practices (Shove, Pantzar and Watson, 2012). The smaller circles illustrate relevant examples that make up each element in the context of the water use practices identified on coal mines. The relative size of the 'constructing' sub-elements denotes their importance when played out repeatedly in reality. They are based on how many times each sub-element came up in interviews, what was said about them and also what other research shows. For example, the meanings of 'sustainability' and 'energy awareness' have less value placed on them (according to interviews and research) than 'profits' and 'job creation' in the coal mining world. In the case of the materials used to perform the practices, they are all similar in 'weight' as they are equally necessary to achieve the performance of the practice and are consistently present throughout all coal mining operations.

5.4.1 Effects on Materials, Meanings and Competences

The energy used in water use practices can be targeted through policy, by the different ways that policy affect the materials, meanings and competences required by the practices (as seen in the three frameworks offered by Spurling *et al.*, (2013), discussed in Chapter 2.2). As explained previously, the NWA requires all water use practices identified in the field to obtain a water use licence. The previous chapter explains that energy can be demanded in the form of the material used when performing these practices. Construction, running and maintenance of pipes, pumps, berms, dams etc. require energy. The NWA water use licence stipulation can therefore be seen as an invisible energy policy. If policy actually took into account the energy required for what it stipulates, there may be room to regulate the types of materials and technology used and therefore the overall energy consumption. However, a change in materials would need to steam from both a shift in competence and in meanings with regards to carrying out water use practices.

Current mining policy (the MPRDA and the NWA) does not specifically mention nor stipulate the competences required to perform actions. However, the competences of performers of a practice can have an effect on the materials used as well as the skills needed to carry out the practices. Both NEMA and the Health and Safety Act can influence the competences of the performers of the practices on site, for example by stipulating the skills needed, courses to be taken, background knowledge and experience required by the carriers of the practices. Legislation also calls for the protection of people's rights (National Constitution) and for the protection of the environment (NEMA). However, in the mining context I believe, based on interviewees and research, that these meanings are less significant than those of job creation and profit. Currently, there is no emphasis on energy-saving in the national mining guidelines of the MPDR. If the MPDR places value on energy consumption – which it should as a policy that actually stipulates much energy use in reality – there may be better use of energy on mining sites. Without placing value on energy awareness in policy, energy demand will remain high in practice, and not only with water use practices on site but within the entire coal mining process.

5.5 Conclusion

The coal mining sector in South Africa has major environmental consequences requiring environmentally sound and sustainable actions. Requirements that shape the specifics on compliance with water use on mining sites are outlined in mining permits and national legislation. Coal mining activities, particularly those related to interactions with water, are stipulated by national regulations. Through these processes and interactions with water, different materials and skills are used, often directed by policy and guidelines which hold certain values. Thus, here lies the scope for identifying invisible energy policy. These processes undoubtedly demand and use energy but do not stem from energy guidelines.

In answering "*what are the mining policies guiding water use that indirectly/directly affect energy demand*?", this chapter first identified relevant policy. The MPRDA, NEMA and NWA are of particular importance for this research, as they are the policies that outline all mining activities as well as water related practices. These policies target coal mining activities without taking energy use into account, but indeed they may indirectly require energy to be used based on what they specify. The different elements that are targeted by these policies, which ultimately shape the water use practices were then drawn to attention. Indeed, "energy consumption is a by-product of the performance of practices, which is enabled by the coming together of elements" (Narasimhan *et al.*, 2017, p. 3).

The interconnection of materials, meanings and competences can change the way practices are understood and performed, and this holds much weight for policies which inform these practices. These can be shaped to target key elements which make up a practice. In other words, policy has the power to change the materials, meanings and competences (with the interlinking nature in mind) of practices performed in the mining sector, and this could have major implications for reducing energy demand.

A social practice outlook also allows the problem of invisible energy demand in the mining sector to be repositioned into ways that are more useful from a policy perspective (Strengers, 2012). Rather than simply asking how energy demand can be changed, one needs to understand that the demand is an outcome of social practices first. Not only can policy coherence be strengthened, but a more practical understanding of unintended consequences may arise. This will be explained further in the next 'Discussion' chapter.

6 Discussion

6.1 Introduction

This research's aim set out to analyse how invisible energy policies affect energy demand within the South African mining sector. This was done by using insights from water use practices on coal mining sites. Policy stipulating how actors need to collect, treat, move and dispose of water on mines is done with some environmental concern in mind, but they ironically also mean that much energy needs to be used to do so. This research looked at actions on a mining site, and not just mining policy documents alone. The type of practices targeted – water use interactions – were taken as the unit of analysis, rather than individuals or groups of people. These practices were understood in terms of their materials, competences and meanings (Shove, Pantzar and Watson, 2012), ultimately looking at how policy may affect these.

By looking empirically at what people do in the mining context, as well as meanings behind why these things are done (i.e. the relevant social practices), invisible energy policy can be found. With national mining and environmental laws putting 'meaning' behind environmental protection, for example, knock-on effects of invisible energy become evident; water treatment process that are mandatory often require active technologies which use energy (Groenewald, 2012). Invisible energy policies should hence not be overlooked, as they too can have implications for energy demand (Royston, 2016) and policy coherence.

While the mining sector is a different setting entirely compared to most current literature and research with a social practice perspective (practices usually involve every-day doings such as cooking, washing, consuming etc.), the broader relevance and external validity of this research agenda can also be seen in line with other extractive and water-intensive industries. For example, oil and natural gas extraction would be another sector with which this research's line of inquiry could hold to be valuable, as these are also sectors with high energy usage (Cleveland, 2005) and potential invisible energy. South Africa's largest water consuming industry is the agriculture sector, using 62% of the country's water (Groenewald, 2012). This could also be an important sector with which to look at with invisible energy policies in mind not only to address energy usage, but potentially to help with the high water demand, too.

This chapter outlines three relevant discussion points of this research; a reflection of my findings, the theory used in line with my findings, as well as a reflection on the methodology followed. The first section also touches on the relevance of water use practices, vis-à-vis other practices. The second section of this chapter discusses the use of social practice theory as well as its use with non-energy policy, and the methodological section reflects on complexities of the research methods used and discusses certain limitations of my research. This is done in line with commenting the validity and reliability of my findings.

6.2 Reflections on the Research Findings

6.2.1 Water Use Practices and Policies

In order to reach the aim of this research, the first sub-research question needed to be answered; *"How do water management practices take shape in the mining context?"*

The practices identified through interviews in Chapter 4 ("Water Use Practices on a Coal Mine") were not immediately explicitly 'social practices'. Rather, they were general human-water interactions that stakeholders could identify, such as supressing dust or using water to process and clean coal. These water uses were then grouped into practices 'entities'. The effect of this allowed for the practices to be understood in terms of material, meaning and competence elements, which could then help identify invisible energy policy.

This research was undertaken as a new attempt to try and look at water uses as practices on mining sites with invisible energy in mind. The key understanding here is that people, as 'carriers' of the performances, use materials (with underlying meanings and competences) to perform practices of coal extracting, washing and water disposing. These practices are routinized, day-to-day actions performed by actors, which, in the mining context, were found to be recognized and understood by other mining-related actors as they too perform or perceive the same practice in similar ways.

The practices-as-entities identified can be grouped into four categories; coal extraction, dust control, coal washing and discarding of water. In order to see how these water use practices relate to policy, the second sub-research question needed to be addressed;

"*What are the mining policies guiding water use that indirectly/directly affect energy demand*?"

The policies that were unravelled in the analysis target coal mining activities (NEMA, NWA, MPRDA), yet come from different departments (Department of Environmental Affairs, Water and Sanitation and Mineral Resources, respectively), which may affect the coherence of the policies (see Chapter 6.3.2 below). A point of discussion here is what I took to be a 'policy'. In this research, it was taken to be the outcomes produced by governmental bodies, including standards, regulations and legislation. The scale stayed on the local, national South African level, where the South African governmental departments are responsible for the assembly and compliance of the policies. Traditionally, policy analyses tend to look at the effectiveness of the policies but here, the policies in terms of energy demand was the focus. This not only looks to see how the policy plays out in practice, but helps to pinpoint causal effects of these policies. The MPDRA, for example, places much value on profit and job creation (resource use should create "sustainable socio-economic transformation and development" Department of Water Affairs and Forestry (2008)). Competences vary in interpreting risk and engineering knowledge, too, and low energy awareness is held by mine managers. This in turn may affect the technologies employed with regards to water-use on site. High timing efficiency but little regard to the sustainability of the materials and manner in which water is used was found. Also interesting was the fact that companies tend to recycle their mine water even though this is not required by law. This holds value in the idea that practices can be the starting point for policy making, and that practices as the unit of analysis is useful in this regard.

The identified policies do not noticeably take energy into account. The practices that they stipulate, however, are indeed often found to require energy. One main example being that of a water-use licence as stated by the NWA Section 21. The 'implementation' phase of obtaining a licence requires actors to use water in specific ways, with materials (such as pumping systems) that require energy. Another example is that of the NWA stipulating that dirty mine water needs to be treated to become a certain quality before being discarded into the environment. Active treatment technologies

requiring energy are most commonly used to do this. Even though there are less energy-intensive options of water treatment available, policy does not specify how to treat the water, thereby potentially affecting the energy demand required to do so.

While the policies highlighted may directly steer mining activities and indirectly affect energy demand, they are certainly not *all* of the policies and neither are *all* of the potential consequences identified. Additionally, some of the mining policies discussed actually also span other sectors. The National Environmental Management Act (NEMA) is a general environmental policy, for example, not solely a mining policy. This means that the impacts of policies here is 'potentially high, but hard to access' (Cox, Royston and Selby, 2016). This research only looked at water-use practices which indirectly demand energy on coal mining sites, but indeed there are many more practices which are affected by the same policy, both within the mining context but also across many other sectors. The practices are also linked to other policy agendas such and human health and safety, as well as 'shifting norms' (for example, the values of natural landscapes). This also will have an effect on the way practices are understood and performed, and holds potential for future research in invisible energy policy across sectors and with interlinking practices.

Non-energy policies that stipulate water use practices have shown to vary across environmental, constitutional and safety regulations. None of the policies clearly talk of energy directly, yet they impact the energy demanded by the specifics of the practices that they instruct. In this way, the main research question of this thesis (*How do non-energy policies in the South African mining sector influence energy demand in on-site water use practices?)* was answered. Non-energy policies from the South African mining sector influence energy demand through the elements that make up water use practices. Materials, such as pipes, pumps and dams, are needed. Competences vary in interpreting risk and engineering knowledge, and low energy awareness held by mine managers and an emphasis to boost job creation in policy means that, indirectly, much energy is used in water use practices on mining sites. Reducing energy demand is not deeply integrated in mining practice nor policy, even though energy is indirectly demanded in this sector with regards to water use practices.

6.2.2 The Relevance of Water Vis-À-Vis Other Practices

Water use practices were the focus of this research because the topic of water is currently under heated discussion in the mining world in the South African context. Mining has an effect on the quantity and quality of water in the mine area and often negatively affects the surrounding environment. With consequences of acid mine water and pollution affecting both landscape, animals and local communities, water on mining sites is a major target for different environmental and mining policies. I therefore felt that the topic of 'water' and how water is used in day-to-day practices on a mine to be not only interesting but also appropriate.

Other mining-related practices that may have shed insight into invisible energy policies could have been found in the transport sector, for example. The coal transport sector draws not only from health and safety policy but also from environmental air pollution policy. This may have been easier to access when identifying invisible energy policy because much research has been conducted on the effectiveness on air quality policy. Air quality policy can have a direct link to changing transport demand and transport type, thus indirectly affecting energy emissions. As compared to water policy – there is no obvious mandate to change technologies or practices, which then have little obvious effect on energy demand. Thus when trying to identify the invisible energy policy in this research, 'water use practices' may have been a somewhat limiting practice to try and unravel in terms of energy, yet for reasons mentioned above, still important.

Interestingly, as Cox et al. (2016) point out, little research links issues of 'when and where energy is used *across* sectors', which may also be useful when trying to see where one can reduce energy

demand and for addressing interlinkages of practices. For example, if water use practices on mines, coal transport, electricity production *and* electricity distribution were all looked at together, the most important sectors and practices that demand the most energy can be rated and targeted accordingly. This would be a more interlocking practice approach to analysing demand (Spurling *et al.*, 2013). However this requires much more research time.

6.3 Using Social Practice Theory with Invisible Energy

6.3.1 The Use of Social Practice Theory

The link between social practice and invisible energy has been made before (Royston and Selby, no date; Cox, Royston and Selby, 2016), but little to no work on this in the mining sector has been found, nor any in the South African context. Analysing people's practices on coal mining sites that indirectly call for energy can be seen to be done according to 'invisible' policies. Ultimately, identifying non-energy policy was done in this research by tracing back the motivations behind people's action in terms of legislation. It has provided a different way of thinking about the casual effects of policy and practices. A practice-based approach has allowed for "a greater understanding of the role of social interactions in the grounded performance of practices", as well as "a more holistic…perspective on behaviour change processes as they occur in situ" (Hargreaves, 2011, p. 79). A social practice approach not only made room to identify invisible policies through analysing practice, but it also encouraged a more in-depth view of the complexities that are materials, competences and meanings, which can in turn allow for potentially more effective policy approaches.

This thesis takes into account the different elements of practice – materials, meanings and competences – and insinuates that policy can target these different elements, affecting the final practice and thus the final energy usage. This echoes the work of Spurling *et al.* (2013), who put forward three frameworks of 're-crafting' practices 'substituting' practices and 'changing how practices interlock' (See Conceptual Framework, Section 2.2). The South African policy sector that influences mining practices has room for this. Either replacing, or changing, the actual sub-elements and elements that make a practice (for example, making the materials more sustainable and therefore less resource-intensive) or even 'substituting' practices through encouragement of certain sustainable methods (such as non-active water treatment processes that use bacteria or gravity, rather than energy). Social Practice theory maintains that there is the inseparable interlocking of the three elements, and so, theoretically, it cannot be possible to target elements as stand-alone. It needs to be done with a 'systems of practices' outlook and with the interlocking nature of practices in mind. This addresses the third framework put forward by Spurling *et al.* (2013) of actually changing how practices interlock. Here, one would need to look at more than just water use on mine sites, for example, and include other practices with which water-related activities may be connected to, such as coal transportation practices, for example.

As Keller *et al*. (2016, p. 82) articulate, "the social practice theory understanding of human action is socio-material". Social and material elements are parts of practice, not external 'barriers to behaviour'. This again emphasises the intertwined nature of practices and how material, competence and meaning elements of different practices intersect. However, a theoretical (and practical) challenge in using social practice theory is one of delineating boundaries. Indeed if social action is bundled and interwoven, looking at one kind of practice is difficult, as there will be other practices that 'co-exist' with the one of research, which may have contradictory logics (Halkier and Jensen, 2011). This is perhaps why looking at multiple forms of practices with the interlocking framework could prove to be more insightful.

Importantly, social practice theory also notes that the elements of practice come together to be performed by people. People are the 'carriers' of practice. This compares but also contrasts to, for example, Actor-Network Theory (ANT). Here, the elements of materials, meanings and competences are not done by people, rather, they *are* the practice. There is non-human agency. My results may have been similar in some ways using an ANT perspective; the relational ontology, with which practice theory also leans on, shows here that actions are in fact 'transactions' with implications in the social world. However, social practice theory allows for humans to be the performers of action. While debated in practice theory literature, my research implies that, in the mining context, competences of human carries may also be targeted by policy, which is then far more effective, or useful, in terms of making policy recommendations.

Social practices are 'bundles' of sayings and doings that therefore reject view of 'individual' social objects being self-subsistent entities. *Practices* constitute individuals and consequently, practices should be the starting point for particularly an analysis on energy demand and usage. Rather than simply asking how energy demand can be changed, social practice theory has allowed my findings to show that energy demand is an outcome of practices. This is important for policy making, so that, for example, invisible energy usage can be accounted for and coherence of policies improved.

6.3.2 The Value of Invisible Energy Policy

While looking at practices and invisible energy alone cannot change trends of energy demand itself, the broader implications of understanding causal effects is significant. As also emphasized by Shove & Walker (2014), a practice perspective allows energy demand to be conceptualised as a core part of practices which make up society, and not simply as a consequence of what social systems do. This research shows that energy is used *as a part of* social practices, and not for its own sake. This link between practice and energy is an important acknowledgement as it has significant outcomes for influencing energy demand in practice and in policy. It repositions questions about what energy is actually for. Seeing energy 'as an ingredient of practice' allows for policy interventions (such as trying to reduce carbon dioxide emissions for climate change) to be far more useful. Without the practice link, energy demand cannot be engaged with on the scale required to make a difference (Shove and Walker, 2014).

A notable discussion on policy here is that of policy coherence, which is becoming an "increasingly important objective in governance and policy making" (Nilsson *et al.*, 2012, p. 395). According to Den Hertog & Stross (2011, p. 4), policy coherence refers to "the synergic and systematic support towards the achievement of common objectives within and across individual policies". It can be understood as an issue of policy interaction playing out at different levels. Policy coherence is desired to reduce conflicts between interacting policy domains (Nilsson *et al.*, 2012), particularly in the energy sector. However, if these are inconsistent (internally, or also horizontally at one policy level) and among other national and international policies (vertically across different policy levels), outcomes are not interactive and conflicts may arise (Nilsson *et al.*, 2012), sometimes reducing the overall effectiveness of the policies in the first place.

In general, it is agreed that coherence of polices is sought after, but indeed difficult to examine in an empirical manner (May, Sapotichne and Workman, 2006). According to Nilsson et al. (2012), the Organisation for Economic Cooperation and Development (OECD) made a checklist in 2002, which intended to help improve policy coherence within 'the context of good governance'. This checklist has a focus on the policy-making process, with examples of criteria for policy coherence including stakeholder involvement, commitment and leadership. However, this is where looking at social practices may add value to policy coherence research. By looking at the action as an outcome of policies, not only can regulation be better monitored, but more 'evidence-informed decision making'

(Nilsson *et al.*, 2012) can be conducted. For example, my research found that different governmental departments each have difference policies that guide the same water use practice. The Department of Environmental Affairs (with the NEMA), the Department of Water & Sanitation (with the NWA) and the Department of Mineral Resources (with the MPDRA) act as separate policy-making sectors yet that all are interested in the same water use practices on coal mines. If practices are the starting point for these departments, policies that span across them may be more coherent with one another and therefore more effective.

The policy-making process is undeniably important for coherence, but the product in terms of the way in which polices are performed as practices are too. Practices have a dynamic relationship with policy, each having an effect on one another, and so looking at these together can help to shed light on where coherencies or disjoints of policy stipulations at different levels occur.

Analysing policy that explicitly addresses invisible energy (including in the mining sector) is an uncommon research agenda. Identifying and analysing invisible energy policies that inform social practices is unique in the South African context, and while this research acts as a starting point, the unavailability of quality supporting literature has been limiting. What I have done in the previous chapters (Chapters 4 & 5) is an attempt to see how policy can be understood as a causal factor to energy demand on mining sites. This research aims to bring invisible energy policy into the realm of analysing policy at all, as the knock-on effects of indirect policy outcomes can be significant when trying to reduce demand and reach energy targets. Invisible energy adds to the relevance of unintended consequences of policy and policy coherence, but it also takes it a step further back. It does not simply see where energy is indirectly being used, but it also looks at *why* that is the case. In understanding why and how certain actions are done, and not just the consequences of these actions, there is more potential to target policy and action in addressing these consequences. Indeed focusing on practices also means that contradictions of guidelines and policies can be seen in reality, helping to identity and understand any invisible policies at play.

6.4 Methodological Reflections

6.4.1 Complexities in Empirical Work

Important to note when undertaking certain methods in line with a theory is that all complexities within the empirical work cannot necessarily be brought to light. It can be argued that "the social is a field of embodied, materially interwoven practices" (Schatzki, 2001, p. 3), and thus when studying practices as separate, and only looking at them in isolation, one cannot truly both empirically and theoretically embody practice theory. Additionally, as is the case with invisible policy, "a practice theoretical approach implies a research design that encompasses many kinds of policy and many sites of policy-making. This brings methodological challenges, especially because many of these policies' effects on practice may be relatively unknown" (Royston, 2016). The way in which I understood the policy that stipulates practice on a mine site was simply an attempt at identifying invisible energy policy at all.

6.4.2 Interviews

One of the key challenges faced was that of getting enough relevant stakeholders to agree to be interviewed. Coal mining in South Africa is currently a "very touchy, legal, environmental and political topic" (Interviewee 2, April 2018). There have been recent developments in South African news (See Appendix E) and many exposés by activists and journalists that have brought to light drainage issues on mine sites. Acid mine water – the acidic outflow from coal mines- has a hugely detrimental effect on the surrounding environment and knock-on effects for local communities, which is a hot topic for public scrutiny. Farmers' crops, livestock and land as well as community drinking water is poisoned,

and with recent exposures of mine companies not cleaning up their waste water, 'water' becomes a sensitive topic. In this same regard, it has been brought to light that some mining corporations don't follow legal requirements. Rather, corruption and simply 'paying for non-compliance' has been found to be common. The implications of this for invisible energy policy could be far-reaching. If companies do not follow and comply with legal procedures, their practices cannot be traced back to any policies at all, let alone and non-energy polices. This results in an inability to potentially decrease the country's energy demand, because policies cannot be targeted appropriately.

With recent negative details coming into the public eye and undoubtedly tarnishing company reputations, stakeholders were wary when I approached them, thinking I may have been investigating them. Mining company employees and the consultants to these companies were evidently not likely to want, or even be able to talk openly about their operations. This then has an effect on the internal validity of my results, as I was not able to have a higher number of interviews and thus a larger data base to work from in analysing and understanding the practices.

However, the reliability of my results lies in the triangulation and coding that was undertaken. Triangulation of different information gathering - literature reviews and interviews in this case – helped to generate insights that often coincided with each other, allowing reinforcement of ideas and results found. Additionally, when coding my interview data into different practice elements, basic logic as well as comparing and using similar understandings from other studies helped to strengthen the reliability of the research.

6.4.3 Can One 'Speak' About Practices?

A crucial point in discussing social practice methodology is whether practices can be examined through the use of interviews. Some social practice researchers have framed interviews as an inappropriate method for unravelling practices, one reason being that practices may be "too difficult for respondents to talk about as a result of having sedimented down into unthinking forms of embodied disposition" (Hitchings, 2012, p. 61). Interviews have been critiqued on what they *don't* bring forward (Browne, 2016a). Details and a full appreciation of the practice in its entirety may be left out. Undeniably interviews happen after the practice has taken place, and this could be argued to result in an 'unsatisfactory… washed out account' of what happened in the past (Thrift and Dewsbury, 2000).

Nevertheless, while interviews may sometimes leave out significant points of interest, I do not think that this should mean that they are entirely inadequate. Respondents of the interviews conducted in this research were indeed able to talk about 'relatively mundane actions' that happen on the day-to-day at the mining site. A challenge here was to design meaningful questions that probed for answers to the sub-research questions. This was overcome in some ways by being guided by other social practice methodological work (Nicolini, 2012; Cox, Royston and Selby, 2016; Royston, 2016; Shove, 2017). Additionally so by having done background research on coal mining water practices and policies, and then producing tailored topic guides to steer the interviews (See Appendix B).

I do believe, however, water use practices on mining sites prove to be harder to discuss than some other practices studied previously (cooking, washing, consuming certain goods and services, etc.). This then meant that data was sometimes limited and challenging to analyse with a practice theory perspective. Encouraging interviewees to talk about human-water interactions specifically, and not simply technical processes that happen on mining sites was also a task. Interviewees tended to focus on the materials required to perform certain practices, and did not seems to always reflect on *why* they performed these practices in specific ways (i.e. the meanings and competences of the practices).

The consequences of this for my results may then have led to a bias in focusing on materials of water use practices with less emphasis on the meanings and competences.

This in itself, however, proves to be insightful with how 'critically reflexive' the stakeholders actually are with regards to the practices they are carrying out (Hitchings, 2012). My data shows that this 'reflexivity' on practices in the mining sector is low. Interviewees were not always aware of what was required other than the physical materials in order to perform the practices. The interviewees – either consultants up to date with legal knowledge or managers who oversee projects – thought their engineering and technical knowledge was not sufficient, even though I was indeed looking for the 'simple' answer. The consequence of this is that I did not receive lengthy, detailed answers to my interview questions. This in turn, may have lowered the internal validity of my research. To compensate for this in future research, as the interviewer, one must be willing to ask about what may seem to be blatantly obvious. Indeed speaking about day-to-day routine may be more difficult than one thinks, and so asking basic and 'obvious' questions are necessary.

6.4.4 The Qualitative Impact vs a Quantitative One

My research took on a qualitative understanding of practices, and indeed practices were understood by talking about them. However, some practice theory litterature stipulates that "practices can't be understood (just) by talk. We need other methods that reflect the materiality, sociality and performatvity of practices" (Browne, 2016b). Thus, alternative methods such as such as 'visual' methodologies or the addition of qantitative methods would be required.

It is cautioned in litterature that qualitative data alone – espcially because of the often small data sizes – may be open to 'analytical generalisation', where one may make 'theorised claims about the patterns of…dynmaics of the material' (Browne, 2016b). While it is possible to gain rich and detailed explainations of practices on a qualitative level, it may be problematic to turn these 'local' details into something significant of broader social patterns as it simply may not be the case.

If one were to have used a more quantitaive method of statistical analsyis for example, 'bolder claims' to practice patterns may have been made (Browne, 2016b). One can potentially better generalise the findings and how they exsist across a population, incresing the external validity of the findings. Other quantitative methods in practice theory empirical work consists of, for example, time use data (Bartiaux and Reátegui Salmón, 2014). Here, the time spent on certain routines and habites are analysed and links practices to end use. This is more common in comsumption studies, however. Quantitative methods for practices are therefore useful in reflecting upon practices as '(reported) performances', and practice entities at 'one snapshot in time' (Browne *et al.*, 2014). With quantitative statistics, one can potentially look at past and future trends of change across populations, which qualitative details cannot necessarily do. However, this 'zoomed out' view may also mean that one loses sight of the connectedness between practices. The details and sub-elements regarding materials, competences and meanings of practices may not be easily drawn out without the ability to 'speak' about the performances descriptively.

Nonetheless, practice theory is used in line with policy in this research, and so reflecting on sites of intervention are important (Spurling *et al.*, 2013). The use of qualitative data here has allowed for a deeper, local understanding of water use practices in the South African context, and their political implications in terms of energy demand and invisible energy policy could be drawn from this. If time and resources permit, future research may incorporate a more mixed methodological approach, so as to "reveal different levels and layers and dynamics of practices at different scales" (Browne, 2016b).

6.4.5 Scale and Time

This thesis focuses on water use practices on coal mining sites with policies from one geographic location. The reason for the narrow focus was to provide a more detailed account of the practices playing out in the specific South African mining sector. However, as Cox et al. (2016) point out, little research links issues of 'when and where energy is used *across* sectors', which may also be useful when trying to see where one can reduce energy demand. For example, if water use practices on mines, coal transport, electricity production and electricity distribution were all looked at together, the most important sectors and practices that demand the most energy can be rated and targeted accordingly. However this requires much more research time.

Time undoubtedly served to be a limitation here. The time for this research project was constrained by other Master's degree requirements. Stakeholders took time in replying to me and the snowballing process was also found to be extremely slow. The timing of polluted water being linked to coal mining in news scandals also presented to be an unfortunately timed event for my research. Consequently, a limitation of this research lies in not being able to have spent enough time doing fieldwork with enough interviews or even observations that an in-depth study of this nature ideally requires. This subsequently means that the internal validity of the research is relatively low as data was limited. However, it does help to emphasise the need for future research on this topic.

6.5 Conclusion

The findings of my research highlight the importance of looking at the causal effects of policy in terms of practices. The practices studied were water-use related, with 'water' being a central resource in the South African context. Indeed certain constraints came with this choice of resource, as well as with the choice of placing the research in the mining context (such as the limited number of interviews). However, the external validity of the research shows in what it represents more holistically. The mining sector can be representative of other resource-intensive activities such as crude oil and natural gas extraction, and also of the agriculture sector in terms of water use. The idea of social practices and invisible energy policies can be represented here, too. The meanings of my findings in terms of social practice theory places importance on the fact that energy demand is an outcome of practice, with a key perspective of humans as 'carriers' of these practices. This helps highlight spaces for change in policy making, because invisible energy can indeed be taken into account. Invisible energy policy and practices as starting points for intervention also add to policy coherence research in potentially allowing for policies across sectors to be better aligned.

7 Conclusion

Coal mining in South Africa satisfies a large proportion of the country's energy needs, as well as acting as a major source of income through its exports. However, the intensity of coal mining undeniably contributes to the global climate change problem. Much energy is consumed with high levels of carbon dioxide released into the atmosphere for large proportions of the coal mining process. Day-to-day coal mining operations draw much energy for direct use, such as for draglines and machinery. Energy policies that directly tackle energy use and the reduction of greenhouse gas emissions exist, but little work has been found on policies that *indirectly* affect energy demand, especially in the coal mining context. In addition to this, water in the South African context is scarce, with mining activities affecting both the quality and quantity of water sources, making the link between coal mining and water an important one. This research's aim therefore set out to analyse how invisible energy policies affect energy demand within the mining sector in South Africa, by using insights from water use practices on coal mining sites.

The research took hold of a social practice perspective in looking for invisible energy policies. Focusing on practices that unfold as routinized behaviours in sectors and organisations allows for a view of the factors that actually influence these actions- such as policies. The link between social practices and invisible energy has been made before by other research, for example, by looking at the energy impact of food, farming and land-use in the agricultural policy sector (Cox, Royston and Selby, 2016), but there has been little to no known work on this in the mining sector. While it is acknowledged that the coal mining sector already consumes a lot of direct energy, identifying invisible energy policies which inform daily practices that don't visibly act as high energy users helps to understand energy demand more clearly. This alternative view on understanding the consequences of policy could eventually help to improve policy and practice in other indirect yet significant ways; to reduce energy demand in the causal effects that policy has on how certain practices are performed.

The main research question of this thesis was as follows:

> *How do non-energy policies in the South African mining sector influence energy demand in on-site water interaction practices?*

Using interviews and documentary reviews throughout, the first step in answering this question included actually identifying the practices that have to do with water use on mining sites and whether they can be seen as energy demanding practices. Subsequently, finding the policy that stipulates and guides these actions was done with a social practice perspective and were found indeed to be invisible energy policies.

Practices that underpin water interactions on coal mining sites were learnt mainly through interviews with relevant knowledgeable stakeholders (such as environmental scientists, hydrological engineers, geologists and mine site managers). The practices were described with the aim of understanding them in terms of their materials, meanings and competences. The practices identified were coal extraction, dust control, coal washing and discarding water. These ultimately require energy to be performed and can therefore be seen as energy demanding practices. Indeed it was found that energy use is a by-product of the performance of practices, which is facilitated by the interaction of materials, meanings and competences.

Furthermore, the water use practices described by interviewees – including the interaction of their elements - are mostly guided by certain policies. Legal requirements are in place to ensure that, in some respects, environmentally sound and sustainable actions are at play on a coal mining site. Ironically, however, the energy required to perform these actions is not overtly taken into account by

policy makers or mining managers. Requirements that shape the specifics on compliance with water use on mining sites are outlined in mining permits and national legislation. Through social processes and interactions with water, different materials, equipment and skills are used, often directed by these policies and guidelines. These processes undoubtedly demand and use energy but do not stem from direct energy guidelines.

Relevant water- related mining policy was studied in this research, and by supplementing it with data from interviews and documentary reviews, relevant practices and their different elements (materials, meanings and competences) that are valued by these policies were identified. The Mineral and Petroleum Resources Development Act (MPRDA), the National Environmental Management Act (NEMA) and the National Water Act (NWA) are policies of particular importance for this research, as they are the policies that outline all mining activities as well as water-related practices. Interestingly, they span across different governmental departments. These policies target coal mining activities without taking energy use into account, but indeed they indirectly require energy to be used either through the materials, processes and aptitudes that they specify are needed to perform the (water-related) practices. Not only can mining policy target the different materials required to perform practices, but also the competences of the performers and the meanings behind the practices. If mining policy put more meaning to energy usage for example, it could target the materials and competences required by water use practices that may decrease demand

An interesting finding of a practice that plays out without any policy encouragement is that of recycling mine water. While this may be done for economic reasons, it is still a water-use practice that takes place in reality without any policy encouragement. This shows that indeed looking at practices as a starting point for policy-making may be insightful. Another key finding, however, is the issue of non-compliance. Companies tend not to get their water use licences, and would rather pay the fine as a consequence at the end of the day. This discrepancy between policy and practice is instrumental in the realm of practice research. If practices are not playing out in line with policy in reality, this poses an inability for policy to be a successful tool in targeting energy reduction and simply increases policy incoherence. This not only hinders the power of policy, but also makes invisible energy policy that much more invisible.

Policy Recommendations

A social practice perspective on water use interactions on a mining site can show how practices are informed by policies. It was found that the water-related mining policies exist because of a problem that occurs as a result of the way in which actions – or practices – are carried out that may be harmful to the environment (an example being that of discarding used mine water without any treatment). In other words, social practices can act as starting points for policymaking. If one can look to practices that play out in the field, and see how different materials, competences and meanings exist or even change over time, better targeted policies may be set.

A social practice outlook allows the problem of invisible energy demand in the mining sector to be repositioned into ways that are more useful from a policy perspective. One can see which policies shape different elements of the practice and indeed can change the way a practice is performed entirely. For example, my research shows that water use practices on a mine site use energy-demanding infrastructures in line with high values of profit generation. If policy dictated the types of materials needed, or held indications regarding the amount of energy that should be used to perform the practices (with continual compliance monitoring), not only are meanings of energy awareness and environmental protection heightened, but energy demand is reduced. Crucially related to this and the

interesting finding of non-compliance being fairly common in the field, is that policies can only be effective if they are actually followed. Compliance monitoring rules should be noted alongside all water-use 'best' practices, especially given the severity of the water crisis in the country.

This is important in the current state of climate change targets and energy reduction initiatives. I argue that direct policies may not be enough if energy demand is to be significantly reduced. Rather than simply asking how energy demand can be changed, my findings show that the demand is an outcome of practices first. This is particularly valuable for policy coherence. By looking at practice and action as an outcome of policies, not only can regulation be better monitored, but more 'evidence-informed decision making' can be carried out, reducing conflicts between polices at different levels. If policy makers can understand the interlinkages of elements of practice that happen in reality, policy will be better aligned and therefore may be more effective in either reducing energy demand, or in reaching their policy goals more generally.

Future Research Recommendations

A challenge of this research was trying to understand social practices in the completely novel context of the mining world. Thus, further research done to re-evaluate the water use practices on mining sites could be useful with a different researcher's perspective or conceptual understanding.

Moreover, within a different context, different legislation may apply which could bring new insights into the invisible energy policy field. A limitation of this research was the timing; the coal mining industry in South Africa at the time was greatly under fire by media and thus stakeholders were weary to participate in research. A different research strategy may provide more opportunities for data collection. Likewise, the coal mining context could also be altered, also because current research highlights that invisible energy policy research does not span across sectors and disciplines. In a broader sense, invisible energy policy research, particularly in the South African sector is yet to be a common research agenda. Thus, closing the gaps in knowledge in different sectors in South Africa will increase policy coherence between energy effects and non-energy policies. Future research in invisible energy policy should draw comparatively from different sectors in order to propagate good practice as well as to better understand the consequences of different policies in practice. For example, research linking coal mining invisible energy to transport or electricity production and consumption, may provide a better systematic analysis of the energy demand issue.

Also useful would be more focus on practices-as-entities over time, which allows for a better understanding of the development of the practices. This understanding of change on a (longer) timeline may be more useful in providing insights surrounding how change has happened and has been stimulated previously.

While this research attempted to identify invisible energy policies with a social practice perspective in a new field, it is clear that there is much room for research in the invisible policy realm, as the knock-on effects of indirect policy outcomes can be significant. This research focuses on energy use, and the next step could be one of linking this to the sustainability of mining. What are 'sustainable' ways of performing water use practices, and can these be inspired by what non-energy policy tells us?

Analysing, or simply identifying invisible energy policies can play out as a new way of thinking about and understanding unintended consequences of policies, specifically in the energy sector, which holds much weight in today's world of deteriorating resources and climate change.

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Appendix A

List of Interviews

- Anonymous (Environmental Scientist at Jones & Wagener Pty Ltd)
- Anonymous (Geologist by profession, experience on mining sites)
- Anonymous (Hydrological engineer at Prime Resources, an engineering, geological and environmental consulting company)
- Marius van Zyl (Technical Director in Environmental Management from Jones & Wagener Pty Ltd)

Appendix B

Interview outline

Aim: To zoom in on exact coal mining water use practices on site

Introduction

- Thank you for seeing me today and offering to take part in this research.
- I would like first to outline the study so that you are able to decide whether you wish to proceed further.
- Anonymity is guaranteed if you do not want to be identified
- I have a list of topics that I want to address. It should take around 20-30 minutes in total.
- Feel free to ask questions at any stage during the interview.
- Ask permission to record and take notes.

End

- Thank you
- A transcript can be sent and any changes can be made by you prior to analysis
- Do you know anyone relevant that I could potentially contact and interview

Guiding Questions

1. Name, job title, descriptive role (if willing).
2. What is a general process through which (any) water is used on mine sites? Eg. Treated technically, or used on a day-to-day basis.
3. Please describe the (average) day of you (or an employee) at the mine site and where one would encounter water.
4. What do people use (machinery, tools, technology) when encountering water (if applicable)?
5. What do people need to know in order to carry out the above actions of interacting with water?
6. How are these actions timed? ie) What is the sequence of events carried out?
7. What rules should be followed with regards to using water? What national/local policies or company regulations guide the process? Are there informal rules over the formal ones?
8. Who holds the water management process accountable? Who regulates water use? How?
9. Do you know the details of (or are you aware of) the energy used as a result of the water management practices? Could you explain?
10. Are water-related activities closely connected to other activities that happen on site? (For example, water used at on-site offices – where does it come from? Near the mine? Or, does the specific way in which coal is mined make a difference to the way in which water needs to then be treated?). Please explain.

Appendix C

Table A: Breakdown of common regulatory requirements on coal mines

Abbreviation	Regulatory requirements	Specific requirements:

NEMA	National Environmental Management Act, Act 107 of 1998 as amended	• Environmental due diligence audits
		• ECO (Environment Control Officer) services
		• EIA's (Environmental Impact Assessments):
		  ○ Basic Assessments
		  ○ Scoping and Environmental Impact Assessments
		• EMPr's (Environmental Management Programmes)
		• Auditing and compliance monitoring
		• Section 24 application for rectification

NWA	National Water Act, Act 36 of 1998	• IWULA's (Integrated Water Use Licence Applications). • IWWMP's (Integrated Water and Waste Management Plans). • Surface water impact assessments. • Auditing and compliance monitoring. • Wetland delineations
NEM:WA	National Environmental Management: Waste Act, Act 59 of 2008	• WMLAR (Waste Management Licence Application Report) • IWMP (Industry and Integrated Waste Management Plans) • Waste classification • Contaminated land assessment reports • Auditing and compliance monitoring.
MPRDA	Mineral and Petroleum Resources Development Act, Act 28 of 2002	• EIA's (Environmental Impact Assessments) • EMPR amendment, addendum and new mining right • Mining right application • Auditing and compliance
NEMAQA	National Environmental Management Air Quality Act, Act 39 of 2004 Biophysical mapping / GIS	• Air emission licence (supported by an EIA) • ArcView software programme for drawings, maps and assessments

Appendix D

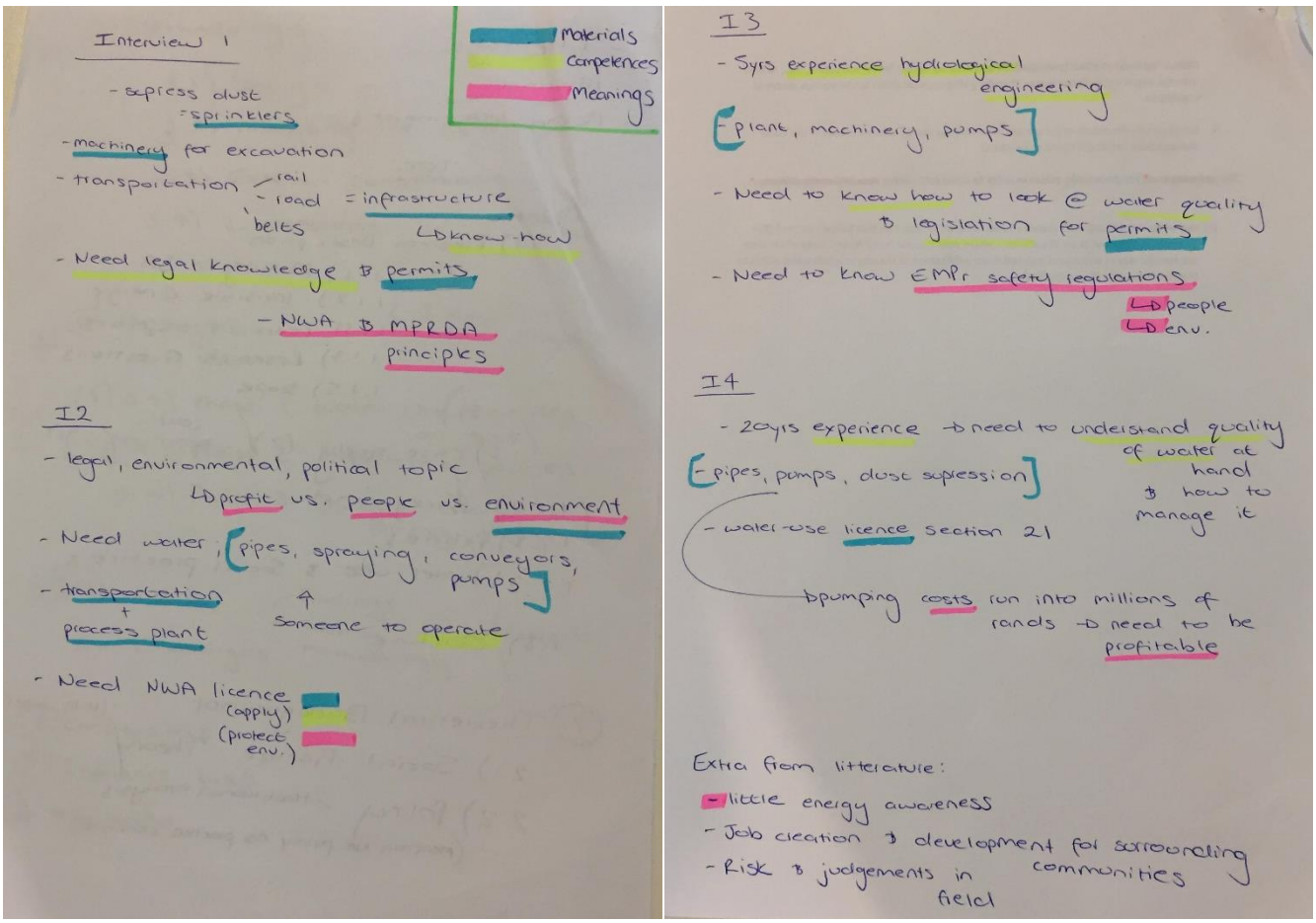

Figure A: a page of coding for sub-elements of materials, meanings and competences from interview notes

Appendix E

Figure B. An example of a South African newspaper headline

Title: Little is being done by authorities to enforce laws to fix damage from mining

Publication: by the Saturday Star on April 7th 2018

Some quotes from the article:

"The mess left behind by coal mining operations causes soil and water pollution…, and the dust from the waste dumps is one of the sources of air pollution on the Highveld."

"If mining in Mpumalanga continues at its current rate, about 12% of the country's total high-potential arable land will be ruined."