Cleaning South Arica's Coal Supply Chain

Kenneth Mathu
University of Pretoria: Gordon Institute of Business Science, South Africa

Coal is of strategic importance to South African economy as a feedstock for the generation of electricity, production of liquid-fuels, and heat production in heavy industries. Hence, there is need to pursue sustainable, and clean coal mining in order to reduce carbon emissions, while exploiting the existing abundant reserves. The study objective was to establish the means of reducing carbon emissions in the coal supply chain. A qualitative research methodology was adopted and the data collected was analyzed for themes via content process. The study outcome indicated that use of alternative sources of energy, and clean coal technologies were the ultimate solutions.

INTRODUCTION

Coal has continued to play a significant role in the socio-economic development of South Africa since its discovery over 100 years ago. The stakeholders of the coal supply chain comprise the government, and private sector role players. The commodity's role in the provision of electricity and liquid fuels among others has direct impact on the economy. The South African homes electrification reached 85.5% in 2015 (StatsSA, 2015), while the production of liquid fuels from coal accounted for 35%, and gas 5% of the national fuel requirements (DoE, 2015). However, coal usage has its absurdity in carbon emissions that polluted the atmosphere. It is therefore paramount for the coal supply chains to address the emission issues in compliance with global campaign combating the climate change phenomenon.

The public sector role players in the coal supply chain comprises the South African government, two state-owned corporations, namely Eskom, and Transnet. The role of the government includes legislation, issuing of licenses for exploration, mining, water, and environmental management among others. Eskom generates 88% of the electricity produced in the country by burning coal at the power stations (Eskom 2009), while Transnet is the only rail logistics company in the country (Transnet, 2008). The South African Energy Regulator (NERSA) is the government body responsible for regulating energy (NERSA, 2009). The private sector is dominated by five leading mining companies namely BHP Billiton, Anglo America, Xstra/Glencore; Sasol, and Exxaro that produce over 80% of the total coal produced in the country, and the the junior miners or black economic empowerment (BEE) companies produce the other 20% (Chamber of Mines SA, 2009). The five leading companies own the leading coal terminal, the Richards Bay Coal Terminal (RBCT) which is also the largest coal export terminal in the world (Jamasmie, 2014). The other crucial role player is the Chamber of Mines of South Africa which is the liaison between public and private sectors (Chamber of Mines SA, 2009).

All the role players contribute significantly to the coal-mining supply chain, and impacts immensely on the socio-economics development through energy provision, and job creation. The government

legislations provide policy guidelines for the industry's operation processes and environmental management. The energy provision by Eskom in form of electricity, Sasol in form of liquid fuels, and the coal for export are the main focus of the coal supply chain. The other players include the heavy industries such as steel, cement, paper and the smelters among others (Chamber of Mines SA, 2012).

The trend in the coal supply chain is dictated by the coal reserves' geographical distribution, infrastructure connecting the coal mines and the power stations, and the main coal export terminal at Richards Bay. Thus, the development of coal mines, coal-fired power stations, liquid fuels production and infrastructure describes the state of coal supply chain in the country. The recurrence of 2014/2015 power outages from the previous experience of 2007/2008 was due to operational constraints and deficiencies in coal logistics, and aged fleet of coal-fired power stations (Eskom, 2013). However, the constrained relationship between the government, mining industry and the labor union was another source of constraints that adversely affects the coal supply chain (Chamber of Mines SA, 2015).

South Africa has two coal utilization business models comprising domestic, and export models. The domestic model has three stages which comprises mining and stockpiling, coal transportation to the domestic customers/consumers, and processing at the customers' facilities. The export model also has three stages that comprise the mining process, transportation from the mines to the export terminals by rail, and shipping to overseas customers by sea (Chamber of Mines SA, 2009). The main export terminal is the Richards Bay Coal Terminal (RBCT) along the Indian Ocean coast of Kwa-Zulu Natal and it is the largest coal terminal in the world (RBCT, 2013).

The empirical objective of this study was to establish the carbon emissions reduction in the South Africa's coal supply chain, rendering it cleaner. It was pursued by reviewing literature on the South African coal background, coal mining industry and stakeholders, renewable energy, and clean coal technologies.

Theory of Green Supply Chain Management (GSCM)

This study is based on the 'Theory of green supply chain management' (GSCM). 'The concept of green supply chain management (GSCM) also called sustainable supply chain management (SSCM) is to integrate environmental thinking into supply chain management (SCM). Hence, GSCM is crucial for influencing total environmental impact in any organizations involved in supply chain activities (Chin, Tat & Sulaiman, 2015). A recent research expressed the growing prominence of GSCM/SSCM as the most appropriate means of managing emissions reduction from human activities in industries such as burning coal at power stations for electricity generation (Dubey, Gunasakaran & Papadopolous, 2017).

BACKGROUND TO THE STUDY

The coal characteristics, legislations, and other factors from production to consumption that contributed to pollution along the supply chain were explored.

Coal and Its Properties

Coal is a fossil fuel and a primary source of energy in South Africa. Coal is formed from accumulation of dead vegetation over many years, undergoing a slow decaying process turning into peat that transforms into coal seams (Anglo Coal, 2007). According to Abbott, Apostolic, Goodman, Hortsman, Jenner, Jewell, Labhart, Maragos, May, Sunderman, Parke, Stein, Wengler and Went, (2009) the slow formation process that takes millions of years make coal a nonrenewable source of energy.

Carbon contents determine the calorific value (heat content) and it is used in the classification of coal (Abbott *et al*., 2009):

Lignite: It is the lowest ranked coal with carbon content of 25-35% that is ideal for power stations for electricity generation.

Sub-bituminous: It has calorific content of 35-45% carbon and it is also mainly used in power stations for the generation of electricity.

Bituminous: It has calorific content of 45-86% carbon and it is used for power generation and as 'coke' in metallurgy industry for the production of iron and steel.

Anthracite: It is the highest ranked quality coal and it is hard, glossy, and black. It has the highest calorific content of 86-97% carbon, and it is mainly used for residential, and commercial space heating.

Graphite: It is the same quality with anthracite, and its use is mainly in pencil making and as a lubricant when powdered.

South African Coal Reserves

The South African coal reserves is approximately 30 408 million tons, the sixth largest reserves in the world. The exploitable reserves are found in Mpumalanga, Free State, Limpopo, Kwa-Zulu Natal and Limpopo coalfields (DMR, 2009).

The South African coalfields are mainly concentrated in the Mpumalanga coalfields where most of the coal-fired power plants are situated. The region is also serves as the terminus of the 650 kilometers rail line that transports coal for export to the Richards Bay Coal Terminal. This region presently produces over 70 percent of the South African coal, but it is estimated the reserves would not last beyond 2030 due to depletion occurring in the region (DMR, 2009). It is estimated that from around 2020, coal mines in the Mpumalanga area would start relocating to the Waterberg coalfields in Limpopo Province which has abundant of untapped coal reserves (Chamber of Mines, 2009).

There are 73 collieries in South Africa (Prevost, 2009). Most of them are owned by the five leading mining companies that produce most of coal in the country. The national distribution of the collieries by provinces is as follows: Free State (2), Gauteng (1), Kwazulu-Natal (7), Limpopo (2), and Mpumalanga (61) (DME, 2007).

Two types of coal mining business models are utilized in South Africa whereby, one type focuses on the domestic market and the other one on export market. Each of the models has three main stages comprising source (coal mining/ beneficiation), transportation (mode of transport used), and customers/ consumers (Mathu, 2011). Hence, these business models process coal for electricity generation, liquid fuels production, trading for industrial, and home use (Chamber of mines, 2009).

Legislative Environment

The legislative environment in the mining industry involves various government departments and institutions that include:

Department of Mineral Resources (DMR): The Department of Mineral Resources (DMR) was previously the Department of Minerals and Energy (DME), and use the Mineral and Petroleum Resources Development Act (MPRDA) – Act 2002 (Act No. 28 of 2002) for the administration of the mining industry. The Act was promulgated in April 2004 (Government Gazette, 2006).

National Development plan (NDP 2011-2030): One of the mandates of the NDP is to reduce reliance on coal by promoting development of renewable sources of energy, and additional nuclear build for long-term energy sustainability (NDP, 2011).

Department of Water and Environmental Affairs (DW&EA): The Department of water and environmental affairs (DW & EA) is guided by National Environmental Management Act (Act No. 107 of 1998) NEMA to control the environmental affairs (Government Gazette, 2010).

National Energy Regulator of South Africa (NERSA): The National Energy Regulator of South Africa (NERSA) regulates the energy sectors in electricity, piped gas and petroleum (NERSA, 2009).

Coal Production

The depletion of coal reserves in Mpumalanga area since the last decade has shifted the future mining focus to the Waterberg coalfields in the Limpopo Province (Prevost, 2009). The construction of one of the two new giant coal-fired power stations Medupi is located there, and will utilize the super-critical clean coal technology (Eskom, 2011). A ten-year projection report from Eskom for 2018 indicate that 43 new coal mines would be built during that period at an estimated cost of about R 100 billion, raising the production capacity from 270mtpa to 370mtpa (Eskom, 2009).

Coal for the Generation of Electricity (Eskom)

The state owned power utility company Eskom consumes the bulk of coal produced in the country as fuel for the generation of electricity through its current 16 coal-fired power plants which generate 88 per cent of the national electricity (Eskom, 2009). The company is among the global top 10 utilities by generation capacity (Eskom, 2009: iii).

Eskom consumes approximately 50 percent of the coal produced in South Africa and approximately 66 percent of the total domestic coal consumption (Eskom, 2011). The transportation of coal is 70 percent by conveyor belts, 24 percent by road, and 6 percent by rail. However, the future plan is to have more coal transported by rail to minimize carbon emissions, and other forms of environmental degradation caused by heavy coal trucks such as noise, and diesel spills (Eskom PE Division, 2008). The organization uses a network of national grid comprising 395 419km from transmission, through distribution of power directly to the consumers, or via municipalities (Eskom, 2011).

Coal for Production of Synthetic Fuels and Petrochemical Products (Sasol)

Synthetic fuels or liquid fuels, and petrochemical products are produced from coal by a South African multinational synthetic oils company (Sasol), which has operations in a number of countries including the United States of America (Sasol, 2016). The company manufactures a wide range of petrochemicals and synthetic fuels which accounts for 40% of South Africa's liquid fuel requirements (Sasol, 2012).

'Sasol's primary business is based on coal-to-liquid (CTL) and gas-to-liquid (GTL) technologies using Fischer-Tropsch synthesis that is unfortunately heavy in carbon dioxide emissions. Hence, the company's Secunda plant is one of the world's single largest emitter of carbon dioxide' (Sasol, 2008).

The Emergence of Independent Power Producers (IPPs)

The Electricity Act of 2006 ushered in the independent power producers (IPPs) in the generation of electricity from renewable sources to transition South Africa into a low-carbon, resilient, and just society. That was a positive step towards reducing reliance on coal, and making electricity supply more reliable, affordable, and sustainable (DoE, 2006). Eskom was allocated 70% of electricity generation capacity from coal and other sources, while IPPs were allocated 30% generation capacity from renewable sources. The Act was also supported by the integrated resource planning (IRP) 2010-2030 (DoE, 2013) and the country's grand plan that followed in 2011, the 'National Development Plan' (NDP) 2011-2030 (The Presidency, 2011).

The government expressed support for independent power producers (IPPs) through the renewable energy independent power producers' procurement program (REIPPPP) launched in 2011 (Eberhard, 2014). The initiative has attracted IPPs investments in renewable sources of energy of USD19 billion (Eberhard & Kaberger, 2016).

In pursuit of cleaning the South African coal supply chain, the NDP also expressed the need to use clean coal technologies in coal-fired power stations to reduce carbon emissions. Indeed, the two new coal-fired power stations under construction namely Medupi, and Kusile were designed under the clean coal technologies using super-critical and ultra-super-critical respectively as emissions control systems (Eskom, 2016).

Carbon Emissions

The advent of the global phenomenon of climate change led to the formation of United Nations Framework Convention on climate Change (UNFCCC) to combat carbon emissions emanating from combustion of the three fossil fuels namely coal, oil and gas (Kyoto Protocol, 1997). The UNFCCC convenes earth summits through which global nations deliberate on issues pertaining to the changing trend in global climate, and the adaptable modals for reducing carbon emissions (UNFCCC, 2009).

South Africa is among the world's top 12 largest carbon emitters due to its heavy dependence on coal for electricity generation (Wolpe & Reddy, 2015). For instance, the country's emissions in 2010 was 597 million tons of carbon dioxide equivalent (DW & EA, 2012). During the Copenhagen Accord in 2009, South Africa committed to cut emissions by 34% by 2020 and 42% by 2025 from business as usual

(BAU) (Wolpe & Reddy, 2015). Eskom is the leading carbon emitter in the country, followed by the petrochemical manufacturer Sasol (Eskom 2009). The government has set emissions standards for the companies heavy in carbon emissions that includes coal-fired plants, petrochemicals, cement, smelters, and others (DW & EA, 2010).

PROBLEM STATEMENT

The continuous exploitation of the South African abundant coal reserves, while reducing the carbon emissions, to render the coal supply chain sustainable and cleaner.

PURPOSE OF THE STUDY

The purpose of the study was to establish how the continued use of the South Africa's abundant coal reserves for energy provisions could be made cleaner and sustainable by reducing carbon emissions.

EMPIRICAL OBJECTIVE

The empirical objective was to establish how reduction of carbon emissions rendered the South Africa's coal supply chain clean.

METHODOLOGY

The study adopted a qualitative research paradigm to explore the coal supply chain. The qualitative interview depends very much on how the researcher prepared the participants for the interview Cooper and Schindler, (2008). 'Qualitative research has substance, gives insight, shows sensitivity and is unique in conceptualization, yet grounded in data' (Corbin & Strauss, 2008).

Research design involves activities of 'collecting and analyzing data, developing and modifying theory, elaborating or refocusing the research questions, identifying and addressing validity threat' (Maxwell, 2005). Maxwell, (2005) posited that 'research design involves activities of collecting and analyzing data, developing and modifying theory, elaborating or refocusing the research questions, identifying and identifying validity threats'.

In this study, design included the selection participants who were senior professionals in the industry, inducting them by providing value proposition for the study, undertaking the interview, use of audio-digital data recorder and a field notebook for recording the interviews. There was a total of 16 participants that comprised 92% coverage of the electricity industry. The participants were also provided feedback from the interview to ascertain validity and reliability of the data collected. A purposive sampling process was used for the selection and profile of the participants.

Data Collection and Analysis

Qualitative data is in form of words or audio that can be transformed into words (Lee & Lings, 2008). The recorded interview data was transcribed, coded, thematically interpreted, and translated via content analysis. The emerging major- themes, and sub-themes were recorded, and evaluated to establish how reduction of carbon emissions in the South African coal supply chain rendered it clean.

Validity and Reliability)

The data obtained from the interviews was triangulated to ascertain the validity, and reliability of this study by comparing the interviews, referral of the literature utilized, and feedback obtained from the participants. Triangulation enhances validity and richness of data by looking at issues from different angles (Lee & Lings, 2008). Also, 'multiple sources lead to a better understanding of the phenomena being studied' (Willis, 2007). The field notebook was also used to verify the data collected.

Ethical Considerations

Ethical adherence in research is paramount as stated by Eriksson and Kovalainen, (2008), that research is vulnerable to 'lies, fraud and wrong-doing'. In this regard, a letter was provided to the participants reassuring them of the researcher's undertakings for their confidentiality, anonymity, and the use of pseudonyms during, and after the research process.

RESULTS

TABLE 1
THEME AND SUB-THEMES EMANATING FROM THE INTERVIEWS

Themes	Sub-Themes
Coal mining stagnated	- Cumbersome legislation prevents new coal mining investors - Political uncertainty (nationalization fear) - Water shortage
Renewable energy efficiency concerns	- Not suitable for baseload supply - Weather interference - Initial cost high - Multi-source advantages - Environmental friendly
Laws and legislations (clarity issues)	- MPRDA Act of 2002 - NEMA Act of 1998 - Policy obstacles
Role players: Private: coal mines Chamber of mines, expo terminal Public: government, Eskom, Transnet	- Mining methods - Modes of transport - Arbitration
Transport infrastructures: conveyor belts, rail, road, water	- Rail for export coal and less for domestic transport - Road in power station areas - Conveyor belts for collieries tied to power stations
Importance of IPPs	- Reduce state monopoly - Energy sector transform into free market economy - Emissions reduction
Skills shortage across the industry	- Mining engineers, mangers, artisans, mining equipment, rolling stock, trains, old rail gauge
Environmental impact	- Carbon emissions, dust, noise and diesel spill, road damage

Source: Author's own

The table above expresses the themes and sub-themes that emanated from the study. There were eight major themes and several sub-themes that expressed the state of coal supply chain in South Africa, and more significantly, its impacts on the environment. The themes convey the holistic picture of the coal

supply chain particularly, the emissions aspect which is the focus of this study. The study explored through interviews with the participants, how emission could be reduced to make coal supply chain clean and sustainable for the present and future.

DISCUSSION

The issues of coal mining, role of IPPs in generating electricity from renewable energy sources, and the hindrances experienced from the legislations, featured prominently from the themes that emanated from the study. The respondents also raised the issues of environmental pollution through emissions and the use of road as the mode of transportation of coal.
However, all the respondents expressed that increased energy mix and the use of clean coal technologies drastically reduced carbon emissions.

Laws and Legislation

The laws and legislations in the mining industry contained some ambiguous clauses that discouraged the existing, and potential investors in the industry. The main Act, the Mining and Petroleum Resources Development Act of 2002 (MPRDA) has been repealed three times, with the latest repeal done in June 2017. However, it has failed all those times to provide clarity on issues of transformation, land tenure and relationship with the local communities. The opposition politicians demand for nationalization of mines also created uncertainty in the industry, and the emissions targets have also not been stipulated.

One of the respondents expressed that investors in the electricity sector do not have absolute rights as the rights were determined by the Minister of Mineral Resources. The rules stated that 'generating power for own use does not require official intervention, but if it is compulsory for commercial purposes to have a license under IRP regulations'. Therefore, one is required to seek consent in writing from the Minister concerned in order to undertake commercial generation of electricity.

Renewable Energy Development

The government support for the IPPs to generate electricity from the renewable sources through the REIPPPP initiative is hailed by the industry as a window for new investment and participation in the energy sector. However, there are concerns in the industry, as the state utility company Eskom which is supposed to connect the IPPs to the national grid appears to have halted the process citing an oversupply of electricity (Business Report, 2016). The respondents stated that when the stalemate with Eskom is over, the liberalized electricity market would flourish with reduced dependence on coal supply. Thus, enhancing the process of cleaning the coal supply chain.

Environmental Impact

The respondents expressed the environmental degradation through emissions from the coal-fired power stations. The IPPs offered the opportunity to diversify the sources of electricity with renewable sources such as solar concentrate, wind, ocean waves, and biomass. They stated that hydro power would remain limited as the country has constrained water resources. The delivery of coal by road to the power stations degraded the environment, and the use of rail would be more appropriate, and needed to be adopted for the future. The construction of the two giant coal-fired power stations was hailed as a great stride towards cutting down on carbon emissions, despite their cost that has escalated, as they were designed on clean coal technologies.

THE EMPIRICAL OBJECTIVE OF THE STUDY ACHIEVED

The themes that emanated from the interviews highlighted three crucial factor that supported the empirical objective that reduction of carbon emissions was the base for cleaning the South African coal supply chain. The three factors were favorable legislations, increased energy mix, and the use of clean coal technologies.

Legislations

The mining Act MPRDA of 2002 was perceived as cumbersome, and delayed investment in renewable sources of energy that has less carbon emissions. That was an indication that if transformation in energy industry had happened much earlier, there would be much lower level of carbon emissions presently. However, all the respondents supported the National Development Plan NDP 2011-2030 as a milestone that has fast tracked the growth of renewable energy production that has continued to reduce the overall carbon emissions in the industry, and the country.

Increased Energy Mix

The increased energy mix with the inclusion of renewable sources such as solar concentrate, wind, biomass, and ocean waves has minimal carbon emissions as the themes emanating from the study indicated. Hence, they contributed towards cleaning the coal supply chain. The respondents concurred on the NDP role in this regards.

The Use of Clean Coal Technologies

The use of clean coal technologies such as the 'super-critical' and 'ultra-supper-critical' at the two new coal-fired power stations namely Medupi, and Kusile were for the purpose of reducing carbon emissions. This is an indication that clean technologies will continue to transform the coal supply chain cleaner in future.

LIMITATIONS OF THE STUDY

It was hard to obtain interview consent from the senior professionals in the energy sector due to sensitivity of the industry. The government and the state institutions involved required persuasions to volunteer information as there were transformations still unfolding. The researcher managed to access the senior managers after clearly stating the dangers carbon emissions, in a brief presentation to the gate-keepers, as the value proposition of the study.

The private sector embraced the approach for interviews, as they took it as a platform to express the industry views to the authority.

CONCLUSION

The study explored the joint efforts to clean the South African coal supply chain led by the government as the principle role player in the energy industry. The other role players such as Eskom and Transnet, and the independent power producers contributed significantly to the study. The energy policies from Department of Energy in form of Integrated Resource Planning (IRP, 2010-2030), and National Development Plan (NDP, 2011-2030) were reviewed. The Mineral and Petroleum Resources Development (MPRDA) Act of 2002 and the environmental legislation for the control of carbon emissions were explored. The South African abundant coal reserves, coal characteristics, and the danger of carbon emissions as coal was burnt at the coal-fired power stations to generate electricity were examined. The UNFCCC role in dissemination of information on the climate change phenomenon and carbon emissions were also reviewed.

The study also examined the progress in the application of clean coal technologies, and the recent government REIPPPP initiative in support of IPPs procurement program in the electricity sector. This government initiative, and the commitment to reduce carbon emissions through legislations, indicated the drive towards low-carbon economy, and cleaning the coal supply chain.

RECOMMENDATIONS

Herewith are the recommendations of the study:

- Diversity the energy mix through inclusion of IPPs in electricity market should be expedited as stipulated in NDP 2011-2030.
- IPPs role need to be supervised by the Department of Energy (DoE), rather than Eskom to avoid conflict of interest with Eskom.
- Enforce friendly policies that attracts more investors to the electricity sector.
- Introduction of an independent IPP electricity portfolio standards committee reporting to DoE.
- IPPs be included to generate electricity from coal using the clean coal technologies.

The implementation of these recommendations would significantly clean the South Africa's coal supply chain and reduce carbon footprint of the products manufactured in the country. This would be a great step towards sustainable clean energy provision, and achieving a low-carbon economy.

REFERENCES

Abbott, K., Apostolik, R., Goodman, G., Jenner, M., Labhart, G., Maragos, S., May, M., Sunderman, A. D., Parke, J., Stein, J., Wengler, J. & Went, P. (2009). *Foundation of Energy Risk Management: An overview of the energy sector and its physical and financial markets*. Global Association of Risk Professional (GARP). Hoboken, NJ: John Wiley & Sons, Inc.

Anglo Coal. 2007. *Annual Report*.

Business Report. 2016. Concerns over Eskom position of IPPs, 22 July. [Online]. Available at: http://www.iol.co.za/business-report/companies/concern-over-eskoms-position-on-ipps-2048205. Accessed on 2016-12-27.

Chamber of Mines of South Africa. 2009. *Annual Report.*

Chamber of Mines of South Africa. 2012. *Annual Report*.

Chamber of Mines of South Africa. 2014. Coal mining in South Africa. [Online]. Available at: http://www.chamberofmines.org.za/sa-mining/coal. Accessed on 2016-12-26.

Chamber of Mines of South Africa. 2015. Mining problems: SA in crisis mode. [Online]. Available at: file:///C:/Users/Mathuk/Downloads/cmsa-20151127-future-sa-mining-industry.pdf. Accessed on 2016-12-23. Accessed on 2016-12-26.

Chamber of Mines of South Africa. 2016. All mining stakeholders must contribute towards South African development. Press Release. [Online]. Available at: http://www.chamberofmines.org.za/about/departments. Accessed on 2016-12-24.

Chin, T. A. Tat, H. H. & Sulaiman, Z. 2015. Green supply chain management, environmental collaboration and sustainability performance. *Procedia CIRP*, 26, 695-699.

Cooper, D. R. & Schindler, P. S. 2008. *Business Research Methods*. 10th. Ed. New York: McGraw-Hill.

Corbin, J. & Strauss, A. 2008. *Basics of Qualitative Research*. 3rd Ed. Thousand Oaks (CA): Sage.

Dubey, R., Gunasakaran, A. & Papadopolous, T. 2017. Green supply chain management: theoretical framework and further research directions. *Benchmarking: An International Journal*, 24(1),184-218. [Online]. Available at: http://www.emeraldinsight.com/doi/abs/10.1108/BIJ-01-2016-0011?af=R. Accessed: 2017-04-20.

Eberhard, A. 2014. South Africa's renewable energy IPP procurement programme: success factors and lessons. [Online]. Available at: http://www.gsb.uct.ac.za/files/ppiafreport.pdf. Accessed on 2016-12-25.

Eberhard, A. & Kaberger, T. 2016. Renewable energy auctions in South Africa outshine feed-in tariffs. [Online]. Available at: https://www.gsb.uct.ac.za/files/REAuctionsInSA.pdf. Accessed 2016-12-26.

Eriksson, P. & Kovalainen, A. 2008. *Qualitative Methods in Business Research*. London: Sage.

Eskom, Primary Energy Division. 2008. *Annual Report.*

Eskom. 2008. *Annual Report*
Eskom. 2009. *Annual Report*.
Eskom. 2011. *Annual Report.*
Eskom. 2013. *Annual Report.*
Eskom. 2016. *Integrated Report.*
Jamasmie, C. 2014. Coal exports from the world's largest terminal hit record high. *Mining.com*. [Online]. Available at: http://www.mining.com/coal-exports-from-worlds-largest-terminal-hit-record-high-91660/. Accessed on 2017-09-15.
Kyoto Protocol. 1997. United nations Treaty on Climate Change in Kyoto, Japan. [Online]. Available at: https://en.wikipedia.org/wiki/Kyoto_Protocol. Accessed: 2017-07-23.
Lee, N. & Lings, I. 2008. *Doing Business Research: A Guide to Theory and Practice*. London: Sage.
Mathu, K. M. 2011. *Supply Chain Constraints in South African Coal Mining Industry*. Berlin: Lap Lambert.
Maxwell, J. A. 2005. *Qualitative Research Design*: *An alternative Approach*. 2nd Ed. Thousand Oaks (CA): Sage.
National Energy Regulator of South Africa (NERSA). 2009. *Annual Report.*
Prevost, X. 2009. Underground gasification. *Inside Mining*, September, pp. 7-9.
Republic of South Africa (RSA). Department of Environmental Affairs and Tourism 2006. Environmental Management Plan (EMP). *Government Gazette* No. 28753. Vol. 490. Pretoria: Government Printer.
Republic of South Africa (RSA). Department of Minerals and Energy. 2007/2008. *South Africa's Mineral Industry (SAMI).* Pretoria: Government Printers.
Republic of South Africa (RSA). Department of Mineral Resources. 2009. *Molato (Bana le Basadi ba tlile go tlo rera Molato).* Johannesburg: Primedia.
Republic of South Africa (RSA). Department of Mineral Resources. 2010. *Mining Licenses Moratorium. Government Gazette* No. 33511, Vol. 542, 31August, Pretoria: Government Printer.
Republic of South Africa (RSA). Department of Water and Environmental Affairs. 2010. Carbon emission targets for industry. Pretoria: Government Printer.
Republic of South Africa (RSA). The Department of Presidency. 2011. National Planning Commission: National Development Plan 2030. Pretoria: Government Printer.
Republic of South Africa (RSA). Department of Water and Environmental Affairs. 2012. South Africa carbon emissions breakdown. Pretoria: Government Printer. Available at http://www.urbanearth.co.za/articles/sa-carbon-emissions-breakdown-2009. Accessed on 2016-12-26.
Republic of South Africa (RSA). Department of Energy. 2013. Integrated Resource Plan (Revised) 2010-2030. Pretoria: Government Printer.
Richards Bay Coal Terminal (RBCT). 2013. *Annual Report.*
Sasol. 2008. *Sustainable Development Annual Result.*
Sasol. 2012. *Annual Report.*
Sasol. 2016. Sasol project is too big to fail. Moneyweb. [Online]. Available at: https://www.moneyweb.co.za/news/companies-and-deals/too-big-to-fail/. Accessed on 2017-09-16.
Statistics South Africa. 2015. Energy acknowledges results of STATSSA on electrification. [Online]. Available at: http://www.gov.za/speeches/department-energy-acknowledges-results-statssa-electrification-7-jun-2016-0000. Accessed on 2016-12-23.
Transnet. 2008. *Annual Report*.
Transnet. 2013. *Annual Report.*
United Nations Framework Convention on Climate Change (UNFCCC). 2009. Conference of the Parties (COP) on climate change, fifteenth session, 18 December. [Online]. Available at: http://unfccc.int/meetings/copenhagen_dec_2009/items/5262.php. Accessed on 2016-12-08.

Willis, J. W. 2007. *Foundations of Qualitative Research (Interpretive and Critical Approach)*. London: Sage.

Wolpe, P. & Reddy, Y. 2015. Contribution of low-carbon cities to South Africa's greenhouse gas emissions reduction goals. Stockholm Environmental Institute. November. [Online]. Available at: https://www.sei-international.org/mediamanager/documents/Publications/Climate/Cities-low-carbon-future-2015-South-Africa-briefing.pdf. Accessed on 2016-12-04.