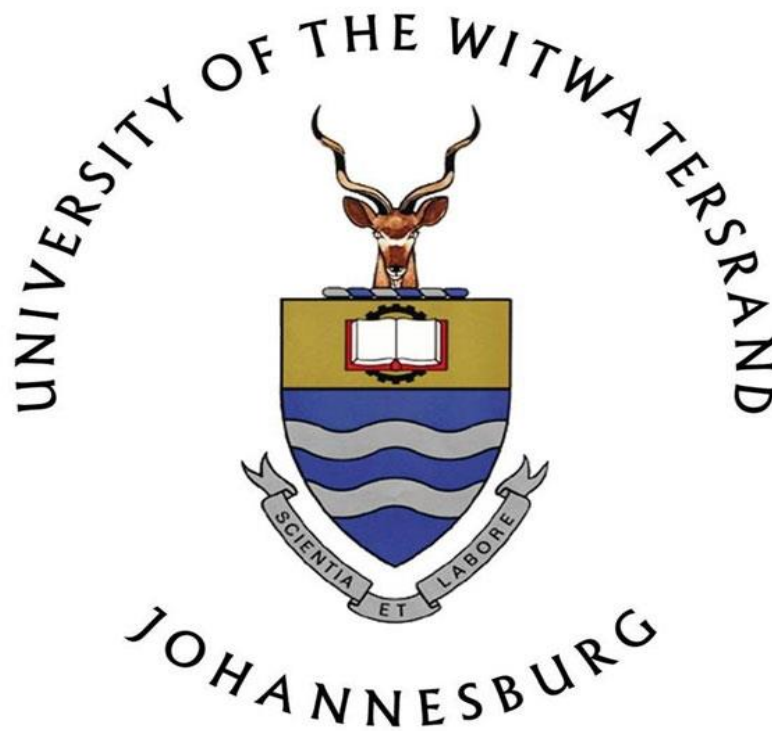




The incorporation of renewable energy in the manufacturing of paper packaging within the city of Ekurhuleni

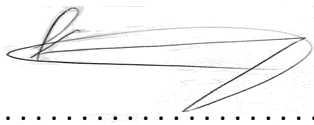
Khabonina Masango

A research report submitted to the Faculty of Engineering and Built Environment, University of Witwatersrand, in partial fulfilment of the requirements for the degree of Master's in Urban Studies in the field of Sustainable Energy and Efficient Cities

Johannesburg, October 2020

DECLARATION

I declare that this research report is my own unaided work. It is being submitted for the degree of Master's in Urban Studies in Sustainable Energy and Efficient Cities to the University of Witwatersrand, Johannesburg. It has not been submitted before any degree or examination at any other university.



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Signature

26 October 2020

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Date

Abstract

Energy security is defined as the vast availability of various energy sources at affordable pricing within a country. Energy security encompasses all energy forms, external and internal linkages which bring energy to the final consumer. South Africa can reach energy security by incorporating alternative renewable energy sources such as solar power in the national energy system to generate and transmit sustainable electricity for consumption. Renewable energy can develop a consistent energy supply whilst lowering GHG emissions and reducing energy waste output. A consistent energy supply can also increase production in the manufacturing industry specifically the plastic packaging sector.

The main fuel consumed in municipalities is electricity as the industrial nature of certain municipalities dominates their energy and emissions profile because of the nature of the industries in which they exist. The economy of South Africa relies heavily on the packaging sector. The manufacturing industry needs packaging goods to complete the supply chain distribution of manufactured goods from the manufacturer to consumer. The growing population in urban areas encourages the increase of consumer spending which ultimately increases the demand for the supply of packaging goods.

The growth of the production process of the plastic packaging sector in the CoE is affected by the inconsistent energy supply of electricity in South Africa. The research report is focused on the plastic packaging sector of the manufacturing industry, specifically the Mpact plastic packaging factory. There is a lack of literature regarding the distribution of renewable energy in the plastic packaging sector and how policy, investment and technology may be integrated to achieve this. Thus, the researcher extracted primary data from the Mpact packaging factory situated in Wadeville, Germiston in the city of Ekurhuleni to investigate whether incorporating renewable energy, specifically solar power in the energy system can increase production in the factory and can it be applied in the packaging sector. The researcher conducted fieldwork by interviewing a senior manager in the Mpact factory and a senior executive in the energy department in the city of Ekurhuleni. The primary data was analysed with secondary data in the plastic packaging sector trajectories and South Africa's national energy policies. The incorporation of renewable energy as a sustainable energy source in the

energy system of the packaging sector can increase production in the sector, mitigate climate change and reach energy efficiency. The implementation of national policies such as the Integrated Resource Plan, IRP (2018) ensures the industrial sector builds efficient renewable energy technology to incorporate renewable energy within the energy system to generate and transmit sustainable energy for consumption. Mpact's focus on sustainability and environmental conservation has ensured that the Mpact plastic packaging factory reduces energy use for production through installing ancillary equipment for production and their solar roofing energy system that generates sustainable energy. This also includes decreasing the waste – to – landfill sites by recycling used materials to produce new plastic packaging goods as a climate mitigation strategy.

Key words: renewable energy, energy efficiency, energy system, climate change, plastic packaging sector.

Dedication

I dedicate this research report to my beautiful mother, Eve Mahlangu who has always been supportive and helping me achieve my dreams. I also dedicate this report to my sister Phumzile Mahlangu who has always been my source of inspiration, giving me light and love. Special credit goes to Dr. Brian Boshoff, my supervisor for replying to my countless emails, his patience and academic guidance.

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List of abbreviations, acronyms, and units of measure

ACC	American Chemistry Council
ASGI – SA	Accelerated & Shared Growth Initiative for South Africa
CEIDP	City of Ekurhuleni Integrated Development Plan
CO ₂	Carbon Monoxide
CoE	City of Ekurhuleni
CFC	Chlorofluorocarbon
DH	Director Head
DoE	Department of Energy
DTI	Department of Trade & Industry
EE	Energy Efficiency
EES	Energy Efficiency Strategy, Republic of South Africa
EMM	Ekurhuleni Metropolitan Municipality
EV	Electric Vehicles
FMCG	Fast Moving Consumer Goods
FP&MSETA	Fibre Processing, Manufacturing Sector Education & Training Authority
GDP	Gross Domestic Product
GDP	Gross Domestic Product
GDS	Growth & Development Strategy 2055 of the City of Ekurhuleni
GGDA	Gauteng Growth & Development Agency
GGP	Gross Geographic Product
GHG	Green House Gas

GWh	Gigawatt hour
HDPE	High – Density Polyethylene
HOD	Head of Department
IEA	International Energy Agency
IEA	International Energy Agency
IEP	Integrated Energy Policy
IPAP	Industrial Policy Action Plan
IPP	Independent Power Procurement
IRENA	International Renewable Energy Agency
IRP	Integrated Resource Plan
Kl	Kilolitres
KWh	Kilowatt hour
kWp	kilowatt Peak
MI	Megalitres
MMC	Municipal Mayoral Counsellor
MtCO ₂ ^e	Million tons of Carbon Oxide Emitted
Mtoe	Million tons of oil equivalent
MW	Megawatts
NDP	National Development Plan
NIPF	National Industrial Policy Framework
NPC	National Planning Commission
OECD	Organisation for Economic Co-operation & Development

PET	Polyethylene Terephthalate
PHEV	Plug-in Hybrid Vehicles
PPA	Power Purchase Agreement
QTR	Quadrennial Technology Review
RE	Renewable Energy
REIPPP	Renewable Energy Independent Power Producer Programme
REN21	Renewable Energy Policy Network for the 21 st Century
RTE	Recycle – to – energy
SACN	South Africa Cities Network
SACN	South African Cities Network
TEW	Thorium Energy World
TWh	Terawatt hour
UNCSD	United Nations Commission on Sustainable Development
WEC	World Energy Council

Chapter 1

Introduction

1.1 Overview

In South Africa there are concerns with the dominant dependence on fossil fuels to provide energy security. Energy is the backbone of the economic growth of a country. The residential and industrial sectors of a country rely on the steady supply of energy to function and to grow. Furthermore, greater access to reliable and consistent energy improves social, ecological, and human conditions. These include green infrastructure, cleaner transportable water, and potential health improvements. The current dependence on fossil fuels for energy supply to generate electricity has contributed to an increase in ecological degradation and rising GHGs emissions that have accelerated global climate change. The reliance on fossil fuels to be the main energy supply source has also caused the decelerated production of South Africa's manufacturing industry. However, it should not be presumed that generating electricity from alternative renewable energy sources such as solar is not possible.

The concerns on energy security arises because South Africa has been experiencing an energy crisis which has led to frequently growing interruptions of generated electricity supply. These interruptions (named load shedding) are projected to increase in the coming years if recourse is not applied. Moreover, there is a universal call for countries to lower GHGs emissions to mitigate accelerating climate change. South Africa's energy supply system contributes to poor local air quality which has been seen to contribute to climate change and human health issues. Thus, an alternative clean energy source can assist in mitigating climate change and the adverse environmental impacts.

Moreover, an alternative renewable energy source with municipal implementation of national government policies is required to increase production in the manufacturing industry in South Africa. The institute for Packaging South Africa (IPSA) (2014: 2) reported that "in 2012, the total value of South Africa's packaging industry was estimated at R48 billion. This figure contributed to about 1.5% in South Africa's gross domestic product (GDP)." The packaging industry however has been challenged over the course of the recent years, largely

due to the decline of the supply value chain (IPSA 2014). The reduced supply and demand of packaging products, the unreliability of the energy supply of electricity and economic uncertainty have all contributed to the lagging growth of the packaging sector.

The plastic packaging manufacturer Mpact identified a vital energy challenge within the industry. This includes the fluctuating pricing hikes of electricity services provided by the municipality. Thus, the plastic packaging manufacturing process needs an alternative renewable energy source in their energy system to advance the production process within their factories. The incorporation of solar as a renewable energy source within the energy system of the Mpact factory to generate better production will be investigated in the research study.

1.2 Background

The South African National Planning Commission (NPC) (2019) asserts that South Africa's emission status has been raised as a global challenge. This is because the country's energy supply is a coal – based energy system on agronomic land. Subsequently, the industrial nature of the city of Ekurhuleni dominates their energy and emissions profile as the manufacturing sector uses an immense amount of energy to generate production (BP Statistical Review 2018: 7).

Manufacturing in South Africa relies heavily on coal-based electricity supply which produces substantial greenhouse gas emissions per energy unit (Sustainable Energy Africa 2015: 24). Kempener & Saygin (2014: 13) posit that “the share of electricity use in the industrial sector can increase by 30% by 2030. The demand will grow in the manufacturing industry due to an electrification of production processes.” Clean energy manufacturing is preferred as it provides limited negative energy and environmental impacts of the production, use and the disposal of manufactured goods (Quadrennial Technology Review, QTR, 2016). Furthermore, clean energy manufacturing can ultimately improve utilization and yield economy – wide reductions in GHG emissions. This will be enabled by the advancement of new materials and technological processes (Ibid.).

The manufacturing supply chain progression is heavily reliant on packaging. Products cannot be distributed across the supply chain without proper packaging (FPMSETA 2014). IPSA (2012:

4) mentions that “South Africa’s packaging industry manufactured 3.68 million tonnes of packaging during the year 2012”. Glass and paper are the biggest contributors to the packaging industry at 3.24% and 31.2% of total packaging market volume respectively, whilst plastic contributes 41.8% in the packaging industry production process (Ibid. 2012). FPMSETA (2014: 4) mentions that “the packaging industry is strictly regulated, particularly in relation to environmental management.” The legislation comprises the National Environmental Management Waste Act, Act 59 of 2008 and the National Water Amendment Act, Act 27 of 2014.

The prominent objective of the IPAP (2017/18) is to limit de-industrialisation and provide support to the advancement and diverse dynamics of South Africa’s manufacturing sector. Therefore, this goal will be achieved through diversifying electrification options and include renewable energy. Moreover, the NPC’s 2050 vision and pathways for a Just Transition to a low carbon, climate resilient economy and society under Chapter 5 of the National Development Plan (NDP) guiding framework must be applied. The framework must be consulted to find ways to generate a low carbon and climate resilient economy within the plastic packaging industry within the city of Ekurhuleni. The clean energy generated from RE can provide opportunities for factories such as providing unlimited sustainable energy supply which can be sold back to the municipal energy system.

The city of Ekurhuleni must take municipal efforts to implement policies such as the Integrated Energy Plan (IEP) of South Africa’s national energy department to develop RE projects for the city and industry energy systems. Implementation must include building energy infrastructure that considers renewable energy and ecological factors within the manufacturing sector.

1.2.1 Renewable energy in context

The international Renewable Energy Policy Network for the 21st Century, REN21 (2019: 8) asserts that ‘affordable energy services are among the essential ingredients of economic development, including eradication of extreme poverty as called for in the United Nations Sustainable Development Goals (SDGs).’ The modern-day services created by oil and gas energy sources to generate electricity is essential for job creation and industrial development.

However, affordable clean energy is vital for improving health, production, and educational conditions (REN21, 2019).

To meet South Africa's energy needs, a balanced energy portfolio is required that will be suited to the economic, social and resource conditions (Ibid. 2019). RE sources such as solar, hydro and biofuel have a substantial role alongside fossil fuels, in an energy portfolio that supports achievements of the United Nations (UN) SDGs (Ibid. 2019). Fossil fuel dependence needs to be reduced in South Africa and pave the way for RE options and technology. This will be implemented and advanced in the manufacturing industry to reduce emissions and increase production whilst providing an unlimited supply of clean sustainable energy that will ensure better energy output.

The IEP (2016: 51) mentions that 'South Africa is well – endowed with RE resources in the form of radiation from the sun, wind in coastal and mountainous areas', which have in the past remained largely untapped.' South Africa receives plentiful sunlight across the nation and in various provinces that is enough to support both a solar power industry (IEP, 2016). In 2003, a 10 - year target of 10 000 GWh, that is equivalent to 0.8 million tons of oil equivalent was set for RE. This target was envisaged to contribute to the manufacturing industry, however only 8% of this target was reached by 2008 (IEP, 2016). The IEP (2016) points out, total installed capacity of RE technologies would be in the magnitude of 26.3% of total installed capacity by 2030 (Ibid. 2016).

Both these targets can be reached if the exploration of RE sources, policies such as REIPPP and technologies are properly explored for transmission and distribution. The build-up of domestically produced clean energy supply can provide greater energy independence and security specifically, in sectors such as the plastic packaging industry. The distribution of clean and safe energy will have fundamental environmental benefits in all phases of the energy process, due to reduced CO₂ emissions and energy waste output. Furthermore, it can act as a significant driver for positive economic growth through continuous innovation (Kammen, Patadia, Wei, 2009).

1.3 Problem Statement

Creamer (2018: unpaginated) reports that there has been a concern over the lagging growth of the industrial sector within the city of Ekurhuleni. The specific sectors indicated were

manufacturing and construction. This has resulted in retrenchment and the loss of sales because of slow production. This is due to an inconsistent energy supply of electricity and increasing electricity tariffs implemented by Eskom to improve their financial position and supply through additional generational capacity. Moreover, the relationship between energy and sustainability is therefore complex and holds both positive and negative factors. In its positive form it enables better production, transportation, and communications.

In its negative form, energy can be produced and deployed in ways that pollute the environment and increase GHGs (Greenstone, 2014). The alternative route to using RE to supplement the inconsistent energy supply within industries has not been widely researched. In South Africa close attention needs to be paid to altering the negative effects of energy generation through the usage of alternative types of energy, especially in industries. Attention must be given the increasing electricity prices as being linked to Eskom's unsustainability, the lack of universal accessibility to electricity and safe alternative energy. Moreover, the extent to which the usage of RE in the plastic packaging sector to alleviate the challenges within the production process has not been explored. Following the measures to which the manufacturing industry can benefit in RE has not been investigated which includes RE sources generating and transmitting sustainable electricity and increasing production. Lastly there has not been any effective exploration in the packaging industry to produce a low carbon and climate resilient economy in the production value chain process that will mitigate accelerating climate change and environmental degradation.

1.4 Rationale of the Study

The study will provide an analysis of incorporating RE in the energy system of the plastic packaging industry. It will investigate whether the RE solar power source will generate improved production in the Mpact factory. The study is expected to find out whether incorporating RE solar source will assist in mitigating accelerating climate change. Moreover, will the incorporation reduce the energy waste output and GHG emissions? Since manufacturing packaging products distributes vast energy intensity, will incorporating RE in the energy system ensure energy efficiency increases? Furthermore, the research further explored whether incorporating solar as a RE source in the energy system offered value – added benefits for the factory to sell additional energy generated to the city of Ekurhuleni. The benefits will then show the results of how fruitful the production process of sector can

become because of the cost-efficiency and reliability of RE. The CoE as it is the enabling environment of the manufacturing of plastic packaging to incorporate RE in their energy systems to increase production, the study elaborated on policy formulation on the national government level. This was established to determine how national policies are implemented in the CoE, local municipality to institute RE in improving the productivity of plastic packaging manufacturing for industry growth.

1.5 Research Question

To what extent can incorporating renewable energy in the energy system of the plastic packaging Mpact factory in the city of Ekurhuleni be a reliable energy option to increase production and how it can be integrated in the plastic packaging sector?

1.5.1 Research sub-questions

What are the barriers to implementing renewable energy to generate sustainable energy and increase production in the plastic packaging manufacturing sector?

Which policy measures in the local municipality can be implemented to steer industries to integrate investments to generate electricity from renewable energy?

Can renewable energy infrastructure and technology ensure that there is a consistent energy supply within the manufacturing industry specifically in the plastic packaging sector?

1.6 Research approach

The research applied secondary data from conducting policy analysis of the Integrated Energy Plan (IEP) 2016. The IEP 2016 elaborates on the REIPPP that was formulated to advance renewable energy sources within South Africa's energy supply (IEP,2016). The research also reviewed the policy documents of the National Industrial Policy Framework (NIPF) and the Industrial Policy Action Plan (IPAP) 2017/18. The purpose was to gain an understanding of the existing interventions made by relevant government entities to ensure that the manufacturing sector generates better production to increase economic growth. The study draws from the existing literature on the link between energy security, energy efficiency, the advantages and disadvantages of alternative renewable energy sources and technology in the manufacturing process in the plastic packaging industry. The study will focus on incorporating

renewable energy as the primary theoretical framework. Moreover, the Energy Efficiency Strategy of the Republic of South Africa (EES) will be reviewed for further research analysis.

The primary data was collected during the fieldwork process through one – on – one interviews on two separate occasions over the course of the fieldwork duration. The interviewees were selected through purposive sampling. Purposive sampling is a ‘non-probability sampling’ in which the selection of the participants was taken based on a variety of criteria. This includes their experience and knowledge of the research issue (Teddlie and Yu: 2007). The Mpact factory general manager was interviewed and a senior official in the local municipality of the city of Ekurhuleni. Fieldwork also included participant observatory analysis of the energy systems in both settings. The Mpact factory general manager was interviewed to investigate how the current energy supply of electricity has affected production. The interview aimed to find out whether incorporating RE in the energy system can increase production. The research study aims to explore the policy frameworks the city of Ekurhuleni uses to develop RE in the municipality and generating sustainable energy. Moreover, to find out if the city of Ekurhuleni promotes RE in the manufacturing sector and if they are any current energy projects.

An analysis was conducted between secondary and primary data to investigate the characteristics of RE, policy interventions and energy projects that are implemented in the plastic packaging factory. The analysis also aims to define whether incorporating RE, solar power in the energy system can generate better production. The research study is focused on a qualitative approach as it is focused to capture an in-depth meaning of the phenomena explored (Maxwell, 1998).

1.7 Expected Findings

Within the research scope the researcher excerpted findings that determined the integration of RE in the plastic packaging manufacturing will increase production. The research also investigated whether plastic packaging manufacturing is environmentally conscious and contributes to lowering carbon emissions which will develop a sustainable economy within the city of Ekurhuleni. The research further explored the tenets of RE, the opportunities the plastic packaging manufacturing sector will possess. The research aims to find out if these lessons can be applied to other respective manufacturing sectors in the city of Ekurhuleni.

Furthermore, the researcher discovered the policy aims to increase the share and need of RE and technologies in the manufacturing sector. Lastly the researcher found out if energy policies are implemented effectively in the city, and whether renewable energy projects are implemented to assist the manufacturing sector in incorporating RE integration in their energy systems.

1.8 Definition of key concepts

This section provides an overview on the definitions of the key terms used in the study:

Energy security refers to obtaining reliable energy supplies at a reasonable price. Energy security is about stability. Any prolonged interruption of steady and plenty flow of energy would harm a country's economic output. Furthermore, energy insecurity would harm the political stability and personal wellbeing of country's citizens. Moreover, energy security is attached to other energy concerns such as providing equitable access to modern energy infrastructure and mitigating accelerating climate change (Baumann, 2008).

Energy efficiency relates to the most cost-effective way to reduce emissions, improve energy security and energy competitiveness. Energy efficiency makes energy consumption more affordable for consumers as well as create employment. This includes the manufacturing and export industries which consume the most energy within a country. Energy efficiency is also about accomplishing energy efficient services that include recycling plastic bottles and using timber instead of concrete for house construction (World Energy Council, 2004).

Energy intensity relates to the amount of energy used per unit of economic output such as the Gross Domestic Product (GDP) in a country. The total primary energy supply per unit of GDP has fallen sharply since the first oil price shock (Wu, 2010). Energy intensity within a country is also driven by changes in social and economic activities such as improving energy efficiency in energy end – use in the manufacturing industry can cause the decline of energy intensity in primary energy per unit.

Renewable Energy refers to energy sources that are continuously supplied by the sun, wind, and water. RE sources are inexhaustible. Renewable energy sources do not get affected by production fluctuation, economic consequences and triggering price variations. They offer an opportunity for countries to generate electricity from lower energy costs. They are

environmentally friendly and possess sustainability characteristics such as lowering carbon emissions. On a larger scaler, renewable energy sources must be carefully articulated when choosing the right location for wind and solar power. The right area with suitable weather conditions will generate maximum energy production without being vulnerable to adverse weather conditions (IRENA, 2015).

Solar Power relates to an endless and inexhaustible source of renewable energy derived from the sun. Solar powers' main characteristic is that it reduces CO₂ emissions. Solar power has minimal energy waste in generating electricity from the energy source (Gekas, Frantzeskaki and Tsoutsos, 2005). Solar power environmentally, reduces the required transmission lines of the electricity grids and improves the air and water quality of resources. Economically, solar power increases a country's energy independency, the security and diversification of energy supply.

Climate change in the past was the result of natural processes. Present day, global climate change is accelerating rapidly because of human activity which threatens to destroy Earth's natural life base. The first sign of human influence on the international climate change system began with industrialisation. The intensification of agriculture, industries & transport systems rely on the continuous burning of fossil fuels. This releases plenty of carbon dioxide, methane and other GHGs into the atmosphere resulting in an immense amount of solar heat being absorbed and can no longer be radiated back into the atmosphere (Bedarff and Jokabeit, 2017).

Packaging refers to a connecting link between production and consumption of consumer goods. The development of packaging is that production and consumption take place on separate occasions. The importance of packaging is growing in urbanised areas of a country as the urban population grows daily (Pongracz, 2007). The level of urbanisation determines the amount of food and distribution of goods the population will consume. Thus, the role of packaging becomes important.

1.9 Delimitation of the scope of the study

Given the focus of the study on incorporating RE in the manufacturing process in the CoE it is important to mention that there are related case studies that this research could not address.

The two additional case studies that were approached in the Wadeville, Germiston area of the CoE, which manufacture plastic packaging, were not available for the fieldwork process due to time constraints. Furthermore, although the case studies were environmentally conscious, their sustainability approach did not heed to incorporating RE sources and infrastructure in their manufacturing production process.

The Mpact plastic packaging factory in Wadeville, Germiston is the one of the largest packaging manufacturers in the area. The factory has a sustainability review that is committed to responsible conservation of natural resources and an energy strategy that has incorporated renewable energy sources and infrastructure in their production process. The CoE, as it is the manufacturing hub of South Africa, is the enabling environment that allows RE to be incorporated in the manufacturing process of the plastic packaging factories. The CoE provides an enabling environment for the manufacturing industry process of plastic packaging through their RE integration programmes and institutions that provide sufficient policy implementation. Thus, for the purposes of completing the research in the duration of the allocated time, the researcher focused on the Mpact plastic packaging factory to determine whether incorporating RE increased production in the CoE.

1.10 Structure of the study

This chapter has provided an introduction of the study and the research aims to investigate the incorporation of RE in the energy system of the Mpact plastic packaging factory generating better production. The chapter has highlighted South Africa's energy security concerns relating to the inconsistent supply of electricity, specifically in the manufacturing industry. The limitations and research approach have been recognised, followed by an outline of the structure of the rest of the study as guided by the research question and method of study. The rest of the research report is structured as follows: chapter two clarifies the literature appraisal based on secondary data collated based on themes to motivate the theoretical framework. Chapter three stimulates the research approach and techniques used in the research study. Chapter four discusses the city of Ekurhuleni in greater detail whilst elaborating on the primary data collected from the one – on – one interview with the city's energy departments senior official. Chapter five appraises the packaging sector and incorporating RE in the energy system based on findings from primary data. Chapter six

consolidates the findings from the primary and secondary data and concludes the overall findings of the study.

Chapter 2

Literature Review

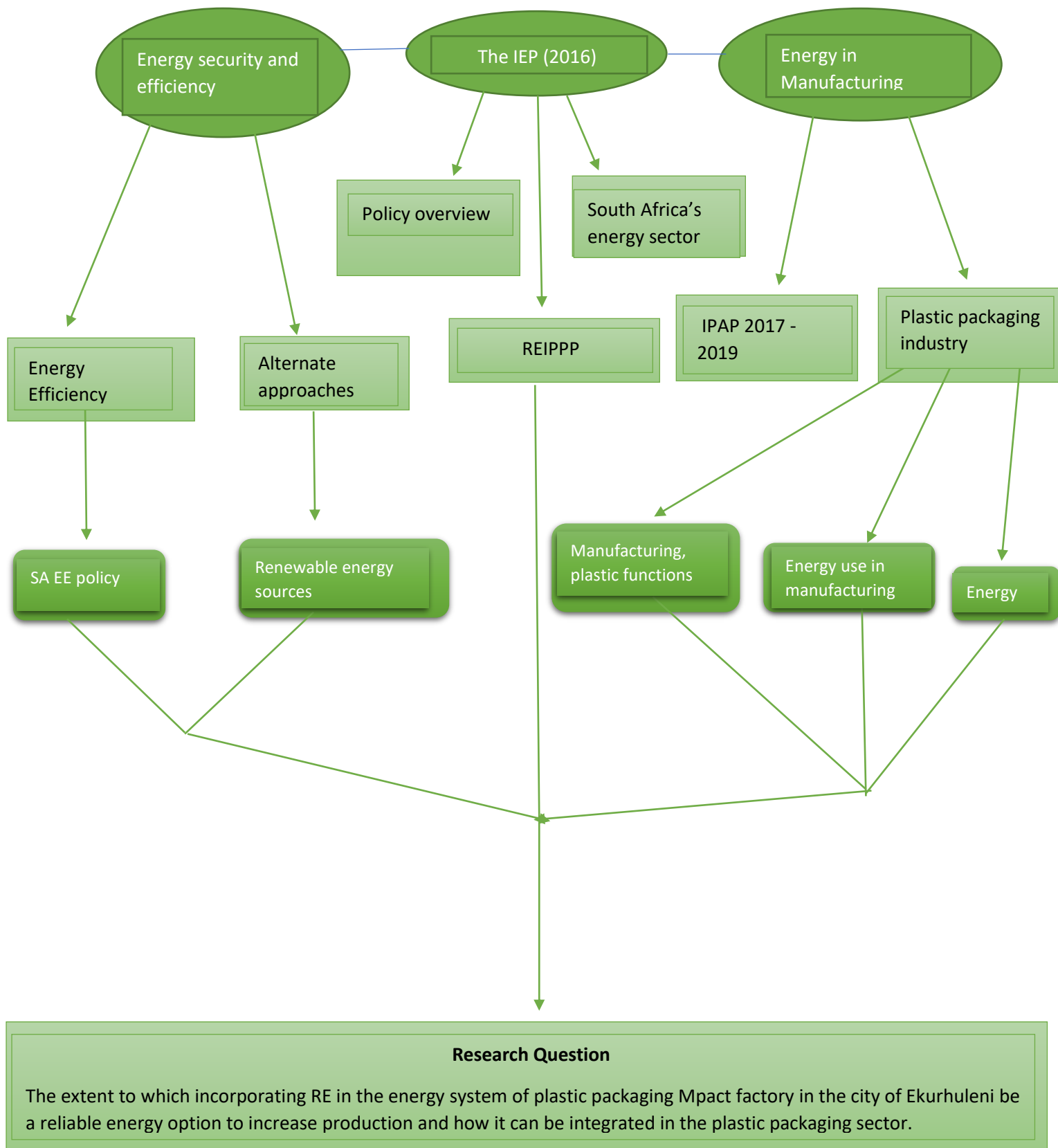
2.1 Introduction

The city of Ekurhuleni is home to the manufacturing hub of South Africa. This results in large areas of the city being occupied by factories that produce items made from paper, plastic, and wood. The growth of the South African manufacturing industry, however, has declined from 1994 (Creamer, 2018). This is largely due to the country's lack of economic growth and energy supply interruptions of electricity that the industry has faced over the years. The consequence of inconsistent access to electricity in the manufacturing industry specifically within the plastic packaging industry has resulted in slow production and retrenchment (Creamer, 2018).

The literature review aims to explore the role of energy security within South Africa, specifically within the plastic packaging manufacturing industry. Furthermore, the literature review will go in depth to investigate the role of energy in environmental and economic development. The literature review will explore the fundamental tenets of RE, particularly the benefits and disadvantages of integrating solar power in the plastic packaging industry and whether incorporating RE in the energy system of the packaging factory will generate better production. The first section will provide a theoretical background on the relevance of energy security, development and access within a country and energy efficiency. Moreover, the following section will focus on energy within the manufacturing industry whilst emphasizing on the plastic packaging industry sector.

Furthermore, it will explore the policies South Africa has regarding an alternative energy mix and how municipalities implement the policy within their respective manufacturing industries. The sections will also appraise why renewable energy is a relevant option that needs to be considered in the plastic packaging factory. The literature will then appraise the options the plastic packaging industry may consider for renewable energy integration as an energy source. Finally, the literature appraisal will provide an analytical conclusion of the literature reviewed.

2.2 Conceptual framework diagram



2.3 Energy Security and Efficiency

2.3.1 Energy Security

“Energy security” is a term coined to define the vast availability of various energy sources at affordable pricing (Barnes, Chalabi, Khatib, Steeg & Yokobori, 2000: 2). Energy sources must be available in continuous and adequate quantities to meet the national interests of a country. Cherp and Jewell (2014: 415) argue that “as a policy problem, energy security emerged in the early 20th century in connection with supplying oil for armies.” The energy security dichotomy became less interesting when oil prices stabilised, and political embargoes became less of a threat in the late 90s and 80s (Cherp & Jewell, 2014). Today, energy security is intertwined with challenges that collaborate with energy policies such as providing accessibility to infrastructure and technologies for different energy sources (Levi 2010). Furthermore, energy security is entangled with the global challenge of climate change and how countries implement measures for mitigation and adaptation to slow down global warming and reach energy efficiency.

Barnes et al. (2000: 113) mention that “adequate global energy supplies, for the world as well as for individual countries, are essential for sustainable development, proper functioning of the economy and human well-being.” Thus, energy security focuses on less vulnerability in long term disruptions of energy sources that are imported within a respective country. Energy security demands accessibility to local and imported energy sources to meet the growing industrial and household demands over time at adequate prices (ibid., 2000).

Chester (2009: 12) argues that “energy systems vary from one place to another which gives rise to different energy security problems.” This critique can be measured in the context of the global North and South divide. Akizu and Lopez – Guede (2017: 1845) argue that “in the Global North every energy crisis has been overcome, with a transition that has led to an increase in the average per capita energy consumption.” Whilst in the Global South, the attempt to reach energy security has had more severe environmental and social impacts. This is largely due to the high consumption of fossil fuel-based energy models that countries have adopted (ibid., 2017). However globally, more than 80% of today’s energy demand is still generating electricity from fossil fuel-based energy sources (Thorium Energy World, 2019).

This results in significant harm to the environment in the form of greenhouse gas emissions, air pollution that ultimately leads to rising global warming. Thus, based on the current energy growth trends, the international community will inevitably be resource and carbon constrained in its attempt to mitigate climate change (Ibid.).

The BP Statistical Review (2018) further reports that primary energy consumption growth averaged 2.2% in 2017 up from 1.2% in 2016 and fastest since 2013. The figures in developing countries such as South Africa however doubled in 2018 (Ibid.). The global energy mix is projected to still be dominated by fossil fuels by 2030 due to the current global energy systems accessibility to the energy sources and infrastructure (Thorium Energy World, 2019). However, South Africa's current energy supply, relying strictly on fossil fuels will no longer be a viable option. South Africa needs to generate more than 50 GW of new electricity from alternate energy sources by 2028, doubling current requirements (Singh 2011:6). The country needs to take urgent action in implementing energy security measures in the energy system for the next 20 years. This can be achieved through incorporating RE sources, building RE infrastructure and technology to supplement the on-going inconsistent energy supply.

2.3.1.1 Energy Security: Alternative approaches

Baurmann (2008: 5) posits that “energy security is more than sustainability, competitiveness and security supply. It is a multi-dimensional concept, including external as well as internal action.” Political economy measures need to be integrated to create a holistic policy approach such as considering the regional geopolitical risks of decreasing the import of fossil fuel-based energy sources whilst implementing RE sources and its technology. Baurmann (2008: 5) adds that energy security is a “cited triangle of – supply security, sustainability and competitiveness.” To achieve Baurmann's triangle, energy security must be established in all four energy processes within South Africa. That are the generation, transmission, distribution, and consumption phases of energy supply within the energy system.

Consequently, Aeck and Flavin (2015) define energy security as the low vulnerability to vital energy systems (Ibid.). This definition has three advantages. Cherp and Jewell (2014) argue that it connects to Baldwin's (1997) definition of security; the substitution of ‘low probability of damage’ by ‘low vulnerability’, connecting acquired values to vital energy systems. Moreover, energy security is not restricted to specific sectors and elements of supply chains.

Therefore, it is flexible enough to be applicable to historic, contemporary, and future energy systems in diverse contexts. The third advantage points to areas where specifications of energy security can be developed through energy infrastructure and improving the energy supply chain from generation to consumption (Aeck and Flavin, 2015). These specifications also include exploring the vulnerabilities within energy security and understanding the political priorities that lead countries to create a type of an energy system, such as South Africa previously creating an energy system that is dominated by fossil fuel energy sources (Ibid.).

Vital energy systems address the fundamental question of what to protect? Vital energy systems refer to energy systems that are linked together with the type of energy source and technologies that are used. Vital energy systems support critical social functions and are limitless in their geographical boundaries (Ibid.). This includes oil supplies to armies and hydro powered electricity that extends across more than one country. Moreover, vital energy systems place emphasis on integrating RE and building RE infrastructure to ensure inexhaustible supply of energy sources whilst limiting energy import revenues (Baurmann ,2008).

Xuetang (2006: 31) mentions that “the competition among great powers over energy resources and pathways has gotten increasingly intense in recent years.” The evolution of energy security has further integrated political, economic and even military factors that have either improved or impeded international energy cooperation in various regions within the global community (Ibid. 2006). The region that has faced increasing energy insecurity is the global south. In addition to the scarcity of fossil fuels, the global distribution networks of energy sources are a major factor of insecurity (Ibid. 2006). Baurmann (2008: 6) assert “while crude oil is preponderantly transported over-sea lanes, most of the natural gas is pipeline bound. Thus, an ambivalent interdependence evolves that binds consumers and producers together in the long-term.” This has resulted in nations having a high reliance on one geographical source of supply (Ibid. 2008).

Therefore, any study on energy can no longer be limited solely to a discussion of supply and demand in the energy world market. But must also seek to examine international energy security from geopolitical and geo-economic perspectives (Ibid. 2006). In the context of South Africa, special focus must be placed on creating an alternative energy mix based on

incorporating RE sources in the energy system to achieve sustainable energy supply and economic growth. Particularly in the industrial economy such as the plastic packaging sector.

Countries in Southern Africa have slowly started to review alternative energy sources, technology, and infrastructure. This includes the development of hydro power in a river running across the region (Adamson, Pollet and Stafell, 2015). Moreover, in South Africa the development of REIPPP to procure technology and generation of electricity from RE sources will be discussed further in detail later in the literature review. Countries in the global south to reach a vital energy system that creates sustainability, competitiveness, and security a policy model needs to be formulated and implemented by the public and commercial sector. An example is implementing a policy strategy in the plastic packaging sector which provides a sustainable solution to the link between production and consumption of manufactured goods in South Africa to create a more efficient vital energy system.

2.4. Energy Efficiency

2.4.1. Energy Efficiency: ascertaining sustainable energy

Energy efficiency refers to reducing the quantity of energy required to provide products and services in a country. In economic terms, the World Energy Council (WEC) (2014: 12) asserts that “energy efficiency encompasses all changes that result in decreasing the amount of energy used to produce one unit of economic activity. An example is the energy used per unit of GDP or the value added.” Energy efficiency aims to meet the energy requirements for a given level of comfort. Thus, energy efficiency includes the integration of technological, economic, and behavioural changes (Ibid. 2014). The International Energy Agency (IEA) (2017: 12) asserts that “this reduction in energy consumption is not necessarily associated with technological changes, since it can also result from better organisation or improved economic efficiency in the sector.” This includes retrofitting a factory with better lighting technology options to reduce energy used for lighting to reach energy efficiency.

The IEA (2017: 27) contends that “long – term energy security requires adequate and timely investments that take account of economic development and environmental concerns.” Short – term energy security requires the energy system to react promptly to sudden disruptions in energy supply, changes in market conditions or government interventions to maintain a system balance (Ibid. 2017). An example of how a country’s energy security can benefit from

energy efficiency is through reducing the reliance on imported energy. Allcott and Greenstone (2012: 5) attest that “in countries that rely on imports to meet domestic energy demand, energy efficiency can enhance energy security by reducing imports of coal, oil and gas.” Furthermore, the IEA asserted that efficiency improvements between 2000 and 2016 avoided early USD 50 Billion in expenditure on energy imports (IEA, 2017). These import savings were also achieved in six major emerging economies in sub-Saharan Africa.

Moreover, the reduction of importing energy through energy efficiency can also benefit a country economically (Lehr, Marrouki, Missaoui, Monning and Salem, 2016). This reduction is especially favourable in countries where energy is a large contributor to trade balances. This will improve national accounts and reduce the need for costly supply and storage infrastructure (Lehr et al. 2016). Lehr et al. (2016: 224) state that “reductions in electricity demand resulting from efficiency can also limit requirements for new electricity transmission and generation infrastructure.” This can be achieved during a transition of limiting the reliance on fossil fuel-based energy sources and incorporating RE in the energy system of the plastic packaging sector.

Consequently, Lehr et al. (2016) assert energy efficiency as “governments wish to decrease energy dependence, to improve access to energy and to contribute to the mitigation of climate change.” The growth of the commercial sector of South Africa will align new areas of activities and opportunities for businesses through the increase of consistent energy supply. Furthermore, the need for reliable electricity within developing countries also demands energy efficiency. Greenstone (2014: 3) positions that “achieving widespread access to electricity will be transformative for many developing countries.” The reliability of electricity will have significant effects on how households, industries and urbanisation are apportioned. The plastic packaging sector also can generate better production as the supply chain will transmit sustainable energy from consistent energy supply to the factory.

The Organisation for Economic Co-operation and Development (OECD) contribution to the United Nations Commission on Sustainable Development (UNCSD) (2015: 12) reports that “the future use of global energy transmitting carbon emissions depends almost entirely on growing energy demand in the developing world.” The UNCSD (2015) states that energy consumption will increase from 11 200 Mtoe to 17 200 Mtoe by 2030. This will be due to the increase in generating electricity and one-fifth to meeting the rise of transport needs (OECD

2015: 9). The sectoral contributors to growth in the energy consumed is expected to power industry by 15% and power generation by 35% (Ibid. 2015).

Moreover, the literature postulates that achieving affective policy support can generate positive effects of energy efficiency in developing countries (Lehr et al, 2016). The literature review will explore the South African policy frameworks that aim to achieve sustainable energy, energy efficiency and integrating RE in the energy system of the country such as the Integrated Energy Plan, IEP (2016) formulated by the Department of Energy. Furthermore, the review will elaborate on how the policy frameworks can be implemented in the plastic packaging sector to generate better production and mitigate climate change.

2.4.2. Energy Efficiency: South African policy approach

Globally in the beginning of the decade countries began to face up to the challenge of sustainable energy (EES, 2005). Geller, Harrington, Rosenfeld, Tanishma and Unander (2006: 556) contend that 'industrialised nations have become significantly more energy efficient since 1973.' Several countries in the international community have intensified their energy efficiency efforts in recent years as part of their energy efficiency strategy to cut GHG emissions. The WEC (2004: 4) contends that in market economies 'policy measures are therefore necessary to reinforce the role of energy prices, firstly to create appropriate market conditions for efficient equipment.' Policy measures are essential to drive consumer choices towards the most cost-effective solutions and to alleviate the recognised failures in energy market mechanisms (Ibid. 2004).

Energy efficiency policy measures in economic terms need to be implemented in a broad sense. The WEC (2004: 4) asserts that 'it includes all public interventions aiming at improving energy efficiency in a country, through adequate pricing, institutional setting, regulation and economic or fiscal incentives.' Information policies have a target to increase awareness of final consumers about the individual and national benefits of energy efficiency (Ibid. 2004). Policy measures must aim to overcome the commercial barrier raised by the initial developer of efficient equipment and devices, as compared to less efficient ones.

2.4.2.1 The South African policy model

South Africa's manufacturing industry is by nature energy intensive and has declined from 2000 due to the inconsistent energy supply of generated electricity within its production supply chain. The EES (2005: 7) contends that "this energy intensive industry largely relies on indigenous coal reserves for its driving force". At first it appears to be an apparent paradox between less energy and developing a prosperous nation based on energy intensive activities, however, by providing the manufacturing industry with sustainable energy from generating electricity from RE sources (EES, 2005). This can generate the decline of energy intensity per unit production to reach energy efficiency whilst mitigating climate change.

South Africa remains one of the highest emitters of the Greenhouse Gas CO₂ per capita across the globe. USAID (2012) points out that South Africa's GHG emission profile grew 44% from 1990 – 2012 and sat at 464 MtCO₂^e in 2012. Which is 0.97% of world total emissions (USAID, 2012). The energy sector accounts for 84% of South Africa's total emissions in 2012. Whilst the manufacturing industry accounts for 15%. The figures indicate that the energy and manufacturing sectors must evaluate their energy systems and how they can decrease their GHG emissions profile. This can be done through using alternate energy sources that are more viable to mitigate climate change whilst promoting energy efficiency.

Furthermore, EES (2005) postulates that at the local level the problems of GHG emissions have been the focus of concern for many communities living alongside heavily industrialised areas. Energy efficiency thus can address both the microscopic and macroscopic aspects of atmospheric pollution (EES, 2005). The Energy efficiency Strategy (2005: 7) will also contribute to 'the alleviation of fuel poverty, job creation, improvements to human health, better working conditions.' These factors will significantly contribute towards the aims of sustainable socio-economic development.

The existing energy policy of South Africa was formulated from the White Paper on Energy Policy of 1998. The policy aims to provide the nation with wider access to energy services whilst ensuring that the environmental impacts of energy conversion are minimised considerably. This is relevant to Africa as South Africa uses about 40% of the total electricity consumed within the continent (Ibid. 2005). The White Paper on Energy Policy clearly states

“government would create energy efficiency consciousness and would encourage energy efficiency in commerce & industry, will establish energy efficiency norms and standards for commercial buildings and industrial equipment and voluntary guidelines for thermal performance of housing. Targets for industrial and commercial energy efficiency improvements will be set and monitored.”

The policy strategy also sets a national target for energy savings, of at least 12% to be achieved in 2015 (Ibid.). Furthermore, the target assumes that the Energy Efficiency interventions outlined in this strategy are undertaken through the pretext of low-cost interventions that can be achieved with minimal investments such as building a solar roofing system to generate sustainable electricity (Ibid.).

The vision behind the policy strategy is centred on the encouragement of a sustainable energy sector and energy use through energy efficient practices (Ibid.). Moreover, the vision intends to minimise the undesirable impacts of energy usage upon health and the environment. Whilst contributing towards a secure and affordable energy for all. EES (2005: 10) emphasises that the policy strategy will improve the health of a nation “energy efficiency reduces the atmospheric emission of harmful substances such as oxides of Sulphur, Nitrogen and smoke.” Such substances are known to have adverse effects on health as they damage air and water quality resources.

Furthermore, EES (2005: 5) posits that the policy will improve industrial competitiveness through “one of the most cost – effective ways of maximising commercial profitability is the adoption of appropriate energy efficiency measures.” This will improve South Africa’s export performance and improve the value that the economy derives from indigenous energy resources. The policy strategy also intends to improve energy security. Energy conservation will reduce the quantity of imported primary energy sources, specifically crude oil and increase the country’s resilience against external energy supply disruptions and price fluctuations (Ibid.).

However, to date the South African energy system has not met any energy efficiency targets (IEA, 2017). Instead the country is faced with an unstable energy supply that is centred on fossil fuels to generate electricity for both industrial and residential sectors. Further policy strategies within South Africa need to be absorbed to achieve energy security within the country, specifically the manufacturing industry.

2.5 The Integrated Energy Plan (IEP) 2016

2.5.1 The IEP: Overview

Energy is essential to the social and economic development of a country (IEP, 2016). The development of the National Integrated Energy Plan (IEP) was envisaged in the White Paper on the Energy Policy of the Republic of South Africa of 1998. This policy development was conducted under the guise of the National Energy Act, 2008 (Act No. 34 of 2008) (Ibid. 2016). Consequently, the IEP (2016: 11) asserts that “the purpose of the IEP is to provide a roadmap of the future energy landscape for South Africa which guides future energy infrastructure investments and policy development.” The National Energy Act requires the IEP to have an implementation process that is projected for up to 30 years.

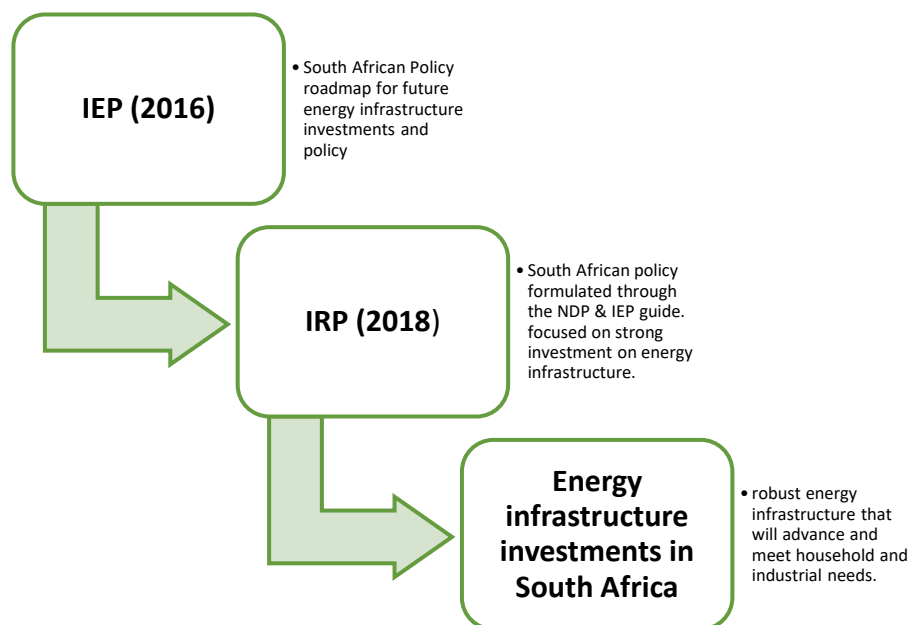


Figure 2.1: Diagram of the interrelation of the IEP (2016) and IRP (2018).

Figure 2.1 Defines the Integrated Energy Policy (IEP) (2016: 12) illustrates that “South Africa needs to grow its energy supply to support economic expansion whilst alleviating supply bottlenecks and supply – demand deficits.” A rapidly growing economy needs to have a sustainable balance for continued economic growth with its social and ecological needs. Thus, it is crucial that all citizens are provided with modern and clean forms of energy at an affordable price. There is a high dependence on import of liquid fuels because of the lack of production capacity that does not meet the export and national demand. As the IEP (2016) further points out, electricity production is heavily constrained due to the inadequate availability of existing infrastructure and insufficient capacity. This inefficiency indicates that

planning at an individual institutional stance is commercially driven. Whilst investments which are required to ensure that the policy objectives of the country have been left untapped (Ibid. 2016).

Moreover, figure 2.1 above illustrates that the Integrated Resource Plan (IRP) (2018: 3) mentions that “the NDP identifies the need for South Africa to invest in a strong network of economic infrastructure.” Energy infrastructure is a critical component that underpins economic activity and growth across the country. Thus, energy infrastructure needs to be robust and advanced enough to meet household and industrial needs (Ibid. 2018). The IEP (2016: 3) also aims “to guide future energy infrastructure investments, identify and recommend policy development to shape the future energy landscape of the country.” The IEP (2016) and IRP (2018) policy coordination needs to be implemented through investing in RE infrastructure and technologies to fast track South Africa’s energy mix doctrine. This will assist in generating electricity from inexhaustible RE sources. And ultimately restoring a consistent energy supply of electricity in South Africa.

2.5.2. Overview of the energy sector in South Africa

The IEP (2016: 43) identifies that the WEC (2014: 25) states that ‘according to the 2014 energy sustainability index, South Africa ranked 83rd on the Energy Sustainability Index out of 129 Countries.’ The low performance in environmental sustainability is due to the electricity sector’s heavy reliance on coal and high GHG emission rates. The low environmental sustainability performance is also due to the increasing petroleum prices, coupled with rising electricity tariffs which determined the low score on energy equity (Ibid. 2016).

Adamson et al. (2015) state that South Africa’s energy production is one of the most coal reliant countries in the world. The electricity generation industry revealed that 90% of electricity was generated from coal, following nuclear and hydro at 5%. Whilst petroleum products (diesel in particular), natural gas and renewable energy sources such as wind, biomass and solar contributed less than 0.5% toward electricity generation capacity (IEP: 2016).

There are various sectors in South Africa’s economy which make heavy use of coal. Adamson et al. (2015: 16687) states that this includes “43% of industrial demand, 32% of commercial agriculture and 28% of residential demand are met directly by coal.” The production of fuel

from renewable energy sources and waste have remained in its infancy. The South Africa Sustainable Cities Overview (2017) asserts that RE as an option for alternative energy sources is needed to meet sustainable energy supply in South Africa. South Africa's municipalities along with small towns typically use much less coal but much more petroleum products and industrial cities use a much higher proportion of electricity. The South African Cities Network (SACN) (2017: 12) argues that "municipalities have a role to play in sustainable energy including being an engine for the generator of renewable energy." Cities can deploy additional energy efficiency measures that will result in carbon emission savings, better infrastructure, urbanisation, and city building. Thus, there needs to be a tailored local planning strategy for the implementation of the main functions of the national energy policies.

2.5.3 Energy mix policy, the integration of renewable energy

The Integrated Energy Plan (IEP) (2016) points out the policies implemented by the DoE aim to reduce over-reliance on fossil fuels for the supply of energy. This is due to the increasing threat of climate change, together with global developments in renewable energy and its technologies. This phenomenon could see South Africa's future energy mix being quite different from that of the past. The Integrated Resource Plan (IRP) (2018: 4) "envisages that by 2030, South Africa will have an energy sector that provides reliable and efficient energy services at competitive rates." The energy sector will be socially equitable through expanded access to energy at affordable tariffs and be environmentally sustainable through reducing energy waste. The IRP was promulgated in March 2011 as a living plan that will guide the development of the future energy mix established under the IEP (Ibid.).

The IRP (2018) aims to reach energy security and efficiency through incorporating government objectives. These refer to affordable electricity, reduced GHG emissions, reduced water consumption, diversified electricity generation sources, localisation, and regional development. The plan proposes that coal will contribute 46%, renewables 26% and nuclear 13% of the energy mix by 2030 (IRP, 2018). The IEP and IRP policy strategies need to be implemented in the local governments such as in the city of Ekurhuleni. The city of Ekurhuleni can implement RE sustainability projects based on the tenets of the policies in the manufacturing sector, specifically in the plastic packaging sector.

2.5.4. Renewable Energy in South Africa

The IEP (2016: 51) indicates that “South Africa is well endowed with RE resources in the form of radiation from the sun.” These resources in the past remained untapped. South Africa receives a substantial amount of sunlight that is enough to create a sustainable solar power industry. In 2003, a 10-year target of 10 000 GWh was envisaged for RE (Ibid. 2016). The IEP (2016: 52) asserts that RE sources to final energy consumption contributed less than 8% of South Africa’s primary energy supply by 2013. Moreover, the IEP (2016) states that the IRP (2018) “envisaged electricity generated from RE technology forms contributing up to 9% by 2030.” Overall, the projected installed capacity of RE technologies would be in the magnitude of 26.3% of total installed capacity by 2030 (Ibid. 2016). The formulation of the REIPPP to generate electricity from procured RE sources can ensure South Africa reaches the 26.3% projection by 2030.

Following the promulgation of the IRP 2010 – 2030, the DoE implemented the IRP by issuing Ministerial Determinations in line with Section 34 of the Electricity Regulation Act No. 4 of 2006 (IRP, 2018). Following the IRP promulgation, the DoE embarked on a vigorous Renewable Energy Independent Power Producer (REIPP) programme (IEP, 2016). The IEP (2016: 52) argues that the programme “has seen a steady increase in the share of RE technologies in the energy mix.” As the IEP (2016) points out, in the Ministerial Determination under the DoE initiated the IPP Procurement Programme. This was launched to procure renewable energy generation from the private sector in the series of bid windows. A sum of 3725 MW of RE capacity were procured from respective IPPs (Ibid. 2016).

To date the DoE has procured over 4000 MW of renewable energy across Bid Windows 1 – 3.5 under the REIPP Programme (Ibid.). To develop safe, clean, and reliable alternative energy sources to fossil fuels, RE options have been undergoing numerous developments in South Africa. Factories and local government buildings have begun building their own solar roofing systems to absorb solar power to generate sustainable electricity such as in the Mpact plastic packaging factory. The REIPP programme is a substantial policy strategy to discover RE sources to generate energy efficiency and security within South Africa.

2.5.4.1 The REIPPP

The REIPPP is an internationally recognised public – private partnership programme (Hasley et al. 2018). It has facilitated rapid deployment of new RE generation capacity, following a competitive bidding and selection process (Ibid.). Hasley et al. (2018: 19) posit that “IPPs build the electricity generation infrastructure. Since there is independent project financing any cost overruns are borne by the IPPs themselves and not passed onto the public through increased tariffs.” The power purchase agreements (PPAs) set a tariff at which Eskom will purchase all electricity supplied for a 20-year period.

The respective bidding IPPs also must meet local economic development (LED) requirements (Ibid.). Eberhard and Naude (2016: 2) proclaim that “since 2011, new RE capacity of 6422 MW has been procured, of which 2902 MW has been connected to the national grid.” The total investment accounted to R201.8 billion in September 2016. The investment amount was inclusive of 24% from foreign sources Europe, the USA, Asia, and other African countries (Ibid.). Since the establishment of the REIPPP there has been an immense drop in prices for large scale RE supply sources (Ibid.).

Hasley et al. (2018: 13) identifies “tariffs awarded for solar PV energy have fallen from ZAR 3.65 – ZAR 0.62 per kWh, thus making RE the lowest cost new – build electricity generation option in South Africa.” The REIPPP has overall made large scale renewables economically competitive in South Africa. This is a considerable positive step for the energy sector (Ibid. 2018). However, the IPP procurement office has been slightly distanced from the DoE and has been in operation without the usual level of political interference. Eberhard et al. (2016: 3) argues that “private investors and financiers like the process since it is well – designed, is sufficiently profitable whilst certain key risks are borne by government.” The programme has been pivotal in successfully kick - starting the utility – scale RE industry in South Africa. Which could lead to the transformation of the energy sector (Ibid. 2016).

Despite the successes of the REIPPP, the price reduction of grid supply is not optimal for driving localisation of manufacturing (Ibid. 2018). There has also been limited success in turning project developers’ LED commitments into lasting impacts on the ground (Ibid. 2018). Trade unions have expressed opposition of the programme as they fear job losses in the

historical energy sector that has been dominated by fossil fuels. However, the development of RE sources in the energy system will create more jobs through building RE infrastructure, technology, and maintenance.

2.5.4.2. Renewable Energy: advantages and disadvantages

Advantages

Abolhosseini, Altmann, Heshmati (2014: 3) postulate that “a large amount of investment has been made during recent years and the advancement of technology has enabled countries to produce renewable energy more cost effectively.” As Abolhesseini et al. (2014) have determined, it is forecasted that the number of countries producing above 100 MW of RE increased significantly in 2017. The technologies may not be comparable with conventional fuels in terms of production cost. However, they are comparable if associated externalities are considered, such as their environmental and social effects (Ibid. 2014).

The transportation sector is one of the main sources of emissions. RE has encouraged the improvement of fuel efficiency in transport systems through large fuel savings and CO₂ reduction on a short-term basis. Thus, the increased usage of Electric Vehicles can play a key role in the longer term. Moreover, Abolhossieni et al. (2014) state that the IEA (2012) projected an increased share of plug – in hybrid electric vehicles (PHEV) over the next two decades. Thus, in the long – term; smart – grid technology may enable EVs to be used as distributed storage devices, feeding electricity stored in their batteries back to the system when needed.

Turner (2019: 1) argues that “a persistent belief is that renewable resources require more energy in their manufacturing process however, actual calculations show a very rapid payback.” An example is that the energy payback for current PV systems has been calculated to range from 3 – 4 years, depending on the type of PV panel (Turner, 2019). This also includes the energy costs for processing the semi-conductor and assembling a module. This is expected to be reduced to 1 – 2 years as manufacturing techniques improve.

The UCSUSA (2019: 2) asserts that “the air and water pollution emitted by coal and natural gas plants is linked with breathing problems, neurological damage, heart attacks and a host of other serious problems.” The lifecycle costs and public health effects of coal to be an

estimated \$74.6 Billion every year (Ibid. 2019). That is an equivalent to 4.36% KWh of electricity produced. UCSUSA (2019:3) postulate that “wind, solar and hydroelectric systems generate electricity with no associated air pollution emissions.” Geothermal and Biomass systems, however, emit some pollutants, though total air emissions are generally much lower than those of coal and natural gas – fired power plants (Ibid. 2019). Thus, RE improves public health and the negative impacts that create air and water pollution do not come from RE technologies.

Disadvantages

Hydro power is currently the largest RE source of power generation globally (Ibid. 2014). Hydro power is clean and enables the storage of both water and energy whilst the stored energy can be used for peak – time generation. However, Abolhossieni et al. (2014: 5) contend that “hydro power development is difficult due to a large initial fixed investment cost and environmental concern.” Hydro power has a negative attribution as it has caused problems for residents associated with the need to relocate large populations. Following the construction of dams is permanent with a sunk cost of construction because of large engineering works (Ibid. 2014).

Garrett – Peltier (2017: 439) postulates “the installed capacity of wind power has increased from 4.8MW in 1995 to more than 239 GW in 2011. Today each wind turbine could generate as much electricity as a conventional power plant.” Garrett – Peltier (2017). The problems associated with the use of wind energy sources include the intermittency of wind energy and an added cost for power transmission to residential areas (Ngo and Natowitz, 2009). This adversity has encouraged stakeholders to opt to install wind turbines on windy sites where the population density tends to be lower.

2.6 Energy in Manufacturing

2.6.1 Energy, Manufacturing industry and Policy

The Industrial Policy Action Plan, IPAP (2007: 1) identifies that “South Africa has implemented a number of industrial policy initiatives since 1994.” As the IPAP (2007) points out, the Cabinet adopted the National Industrial Policy Framework (NIPF) in January 2007. The NIPF sets out government-based approach to industrialisation in the context of the Accelerated and Shared

Growth Initiative for South Africa (ASGI – SA) (IPAP, 2007). The ASGI – SA has a target to decrease the unemployment and poverty rate by 50% in 2014 through accelerated growth of a projected 6% from 2010 (Ibid. 2007).

The National Industrial Policy Framework (NIPF) (2007: 12) articulates “South Africa’s overarching approach to industrial development, providing a strong basis for the policy certainty that must underpin it.” The IPAP (2007: 3) asserts that one of the NIPF’s main objective is to “contribute to industrial development on the African continent with a strong emphasis on building its own productive capabilities.” However, South Africa’s industrialisation process has faced numerous challenges that have resulted in low manufacturing profitability. The IPAP (2007: 3) argues that “this is turn has led to low investment, low output, poor export and unemployment performance particularly in low – and – medium skill manufacturing industries.” The constraints include inadequate state support for investment and an unstable energy supply of power to meet production targets (Ibid.). Thus adequate, reliable, and cost – effective energy supply is a key contributor to the successful implementation of various elements of the industrialisation policy.

2.6.2 The Industrial Policy Action Plan (IPAP).

The IPAP was established by the government of South Africa to provide a programme of action to ensure implementation of the NIPF objectives (IEP, 2016). The IPAP (2017/18: 12) states that “the overriding goal of the IPAP in this policy context is to prevent industrial decline, support the growth and diversification of South Africa’s manufacturing sector.” Manufacturing is the engine of growth for all economies that have achieved high gross domestic product, GDP, and employment growth.

The IPAP (2017) posits that another policy objective is the process of greening economies. This will be established through driving energy – efficient production and carbon mitigation efforts which will have to be phased into all sectors of the economy in a manner that allows for sustainable energy adaptation (Ibid. 2017). The IPAP (2017/18) highlighted that the REIPPPs’ first two bid windows were operational. A total of 2 738MW electricity generation capacity from 51 IPP projects have been connected to the nations’ grid. IPAP (2017/18) mentions that “it created 28 484 jobs and generated R256.2 million in socio – economic development contributions and R80.5 million in enterprise development contributions.”

Moreover, fundamental developments include Pioneer Foods rolled out large commercial solar systems at five of its manufacturing facilities in the country, for a combined size of 25 MW (IPAP, 2017/2018).

2.6.2.1 IPAP Policy Projects

The IPAP (2018/19: 171) posit that “the REIPPP has proved to be a highly successful green economy project, attracting investment to the value of R201.8 billion, contributing 3 162 MW of electricity generation – capacity.” The DTI has supported key action programmes under its guise to achieve energy efficiency in South Africa, particularly in the manufacturing industry. The key policy action highlighted is the Industrial Energy Efficiency Project. IPAP (2018/19: 174) asserts that “the project aims to increase industrial energy efficiency in South Africa to contribute to national efforts to improve energy security and electricity supply continuity.” The project seeks to enable an energy transition where GDP growth is not continually constrained by energy shortages and rising prices. This will be achieved through the implementation of energy system optimisation in industrial projects. It will further extend the capacitation of energy exports to support industry energy implementation (Ibid. 2018/19).

The targeted outcomes will include mainstreaming energy management standards, based on ISO 50001 in industrial companies, to ensure sustained energy savings (Ibid. 2018/19). The targeted outcomes will include the development of energy efficiency experts in the industry with a special focus on increasing the number of women capacitated and empowered as experts in industrial energy efficiency. This project is a key component to be implemented in municipalities such as Ekurhuleni in the manufacturing industries, such as the plastic packaging industry sector.

2.7 Energy, plastic packaging industry sector

2.7.1 Plastic packaging industry

The International Renewable Energy Agency, IRENA (2015: 18) identifies that cities of the global South “face rapid demographic growth combined with relatively low incomes, rapid urbanisation, and important socio-economic development needs.” Moreover, South Africa will be particularly confronted with substantial energy challenges over the period of 2010 – 2030 (Ibid.). South Africa has experienced consistent energy supply interruptions since 2008

which has resulted in load-shedding that has contributed to the lagging growth of the manufacturing sector. The energy supply interruptions are expected to intensify if alternative energy sources are not explored to generate electricity. As IRENA (2015) points out, energy demand in the global South is expected to increase at around 3% – 4% per year and electricity demand would grow at a rate of 6% per year over the same period. RE, thus has been a plausible alternative source as it presents socio-economic benefits and is perceived as an opportunity for industrial diversification.

2.7.1.1 Plastics Industry Skills Development, Testing and Innovation Cluster

A fundamental key action plan under the guise of the IPAP, is the Plastics Industry Skills Development, Testing and Innovation Cluster (IPAP, 2018/19). The cluster intervention is focused on improving innovation and competitiveness in the plastics industry through skills development, R&D and testing (IPAP, 2018/19). The cluster will be predominantly based on shared infrastructure and equipment. The IPAP (2018/19: 143) claims that ‘the primary focus of the skills development component will be targeted on three areas of improvement.’ This includes critical skills for sustainable growth, development and equity which improves the quality and relevance of training provision. The cluster intervention entails promoting the employability, sustainable livelihoods, and energy efficiency. The intervention will be supported by partnerships that can be created with other entities like the CSIR and other energy institutions (Ibid. 2018/19) whilst developing new products and markets through the advancement of energy efficiency within the sector.

2.7.2 Manufacturing, plastic packaging sector and RE

Green and Zhang (2013:7) articulates “the availability of relatively cheap energy to drive machines in factories was one of the defining features of the first industrial revolution.” The energy intensity of manufacturing is usually greater than that of the country’s economy. As Green and Zhang (2013) point out, the level of energy use in manufacturing over the next few decades depends largely on the amount of output and energy intensity of its production.

The energy intensity of manufacturing can be reduced through the integration of energy efficiency and energy security of incorporating RE sources in the energy system. Green and Zhang (2013: 14) contend that “material efficiency involves reducing the amount of a

material, such as aluminium required in a product” such as in producing a car. Further reduction can be implemented in the amount of waste made producing a car such as scrap from castings (Green and Zhang, 2013). Material efficiency can also be achieved through recycling the amount of waste made to reduce the amount of energy – intensive aluminium processing needed.

Moreover, the largest contribution of emission savings, comes from carbon capture and substantial sequestration within the relevant industries (Ibid.). Thus, electricity given the projections would be very low on emissions by 2050. Whilst bio – energy from waste recycling would be able to provide half the sectors energy.

There are many strategies in saving energy, however the barriers to energy efficiency are well – known. Beier, Hermann and Thiede (2015: 651) articulate that “energy efficiency often requires investment and must compete with revenue – generating projects for scarce funds.” In the past, many firms did not prioritise energy issues and were unaware of efficiency levels (Beier et al. 2015). In present day, many firms have chosen to acquire specialist energy and environmental consultants in charge of climate change issues usually outperform those that do not (Ibid. 2015). Thus, the adoption of a range of modern management good practices is associated with higher productivity and a 17% or more reduction in energy intensity (Ibid. 2015). As the awareness of climate change has increased over the years, energy saving processes is likely to get cheaper in the future.

Green and Zhang (2013: 16) argue that “manufacturers could also reduce their carbon emissions by switching to lower – carbon fuels.” The new dawn of looking to RE has been widely considered internationally in sectors such as manufacturing to combat climate change and reaching energy security within countries such as South Africa. Milford (2011: 16) states that “up to 21% of the final energy used by industry world – wide could be met by renewables by 2050.” A third of this would come from biomass, with the rest from heat pumps and solar heating (Milford, 2011). Thus, within RE distribution, the manufacturing sector needs to consider energy sources that reduce carbon emissions from the energy generation to the distribution process.

2.7.3 Packaging functions

Pongracz (2007: 239) identifies the 'functions of packaging are as follows: protection, distribution, household, intermediate, image – component and value forming functions.' Packaging has further waste reduction tenets that can be explored. The literature review will focus on the protection, distribution, and waste reduction function.

The most important function of packaging is the preservation and protection function. The protective function has increased largely due to the increase of urbanisation. As the urban population grows, the more products are consumed. Thus, the distribution of goods needs to be done in protective packaging (Pongracz, 2007).

Packaging has been combined with the means of assuring the preservation of the product. These include protective gas, oxygen removal and water resistance (Pongracz, 2007). Smart packaging relates to packaging produced for additional safety (Ibid.). Additional safety includes protecting the product from temperature, leaking and spoilage. Moreover, the distribution function assists with loading, collection, and transport of the product. Pongracz (2007: 240) argues that "distribution of bulk and liquid products is virtually impossible without packaging." The protective packaging such as foam peanuts or bubble wrap ensures products go through a safe journey. Prior to the loading process, cartons are stacked on pallets and wrapped with a sheet of self – clinging stretch wrap (Ibid.). Pongracz (2007: 240) asserts that "this very strong, yet thin, film stabilises the load, keeping it from shifting and falling." This ensures that if they will ever be falls, it would be at a lower rate. This will reduce damage and breakage keeping both waste and related disposal costs to a minimum.

Finally, the packaging waste – reduction function reduces waste in two fundamental ways. It ensures food does not spoil and having to be discarded (Ibid.). An example: in the United Kingdom (UK), the proportion of food that is unfit for consumption before it reaches consumers is 2%. In developing countries, where packaging is not as widespread, this loss can be more than 40% (Ibid.). The second fundamental function of waste – reduction permits food to be processed more efficiently. 50 years ago, for 1000 chickens sold, the butcher threw away 750 kg of feathers and other waste products. Today, chicken producers ship the edible

parts to markets and process the rest into by-products such as fertilizer and animal feed (Ibid.). The increase in plastic packaging has created the greatest reduction in food wastage. For every 1% increase in packaging, food waste decreases by 1.6% (Ibid. 2007).

2.7.4 Types of packaging materials

A wide range of materials are used for packaging applications, including metal, glass, plastic, or a combination of more than one material as composites (Ibid.). They are applied in 3 broad categories of packaging which consists of primary packaging which creates sales unit and in direct contact with the goods (Ibid.). Pongracz (2007: 242) states “secondary or collection packaging such as cardboard boxes, or plastic containers used to carry quantities of primary packaged goods.” Lastly, tertiary packaging consists of transport packaging that is used to assist freight transport of large quantities of goods, such as plastic shrink-wrap (Ibid. 2007). Based on the literature review, plastic materials are used for all 3 categories of packaging functions.

Plastics

Franklin (2014: 245) posits that ‘plastics are macromolecular polymeric materials. Most of plastics in packaging are thermoplastic organic polymers, that is in the main chain have only carbon bonds, such as polyolefins.’ Furthermore, Pongracz (2007) points out, plastics represent 20% by weight of all packaging materials and is used to package 53% of all goods. All types of plastic are based on petroleum and natural gas. Plastic packaging accounts for about 1 – 5% of a product’s overall weight although it is largely used for packaging purposes (Franklin Associates, 2014).

Plastic is literally used everywhere in all the three categories of packaging. An example is high – density polyethylene (HDPE) plastic is used in applications such as containers, bags, and industrial wrapping (Ibid.). Whilst low – density polyethylene (LDPE) plastic is used for pallet and agricultural film, bags, containers, and coatings (Ibid.). Whilst plastic is commonly used in secondary and transport packaging through re-usable plastic boxes and trays are replacing single – use cardboard and wooden boxes (Ibid.).

The consequence of plastic packaging is very effective in packaging in all three categories and fundamental recyclable attributes. However, plastic packaging materials have negative

ecological impacts. Plastics have a negative impact due to fossil content (Franklin Associates, 2014). Franklin associates (2014) conducted a comparison between plastics and gasoline based on their crude oil equivalent and revealed that, the average per – capita plastics consumption in Western Europe equals 32litres of gasoline (Ibid.). This further suggests that only 5% improvement in gasoline mileage would offset the total amount of energy required to produce plastics and packaging markets (Ibid.). This is a small improvement to enjoy the benefits of plastics.

2.7.5 Plastic packaging manufacturing in South Africa

The Fibre Processing and Manufacturing Sector Education and Training Authority, FP&MSETA (2014: 2) states that “in 2012, the total value of South Africa’s packaging industry was estimated at R48 billion, contributing about 1.5% to South Africa’s gross domestic product, GDP.” The IPSA (2012) states that packaging contributes only 1.5% of GDP. However, the manufacturing economy relies heavily on packaging as shipping cannot be shipped from the source of manufacturer to retailer to consumer, through a supply chain, without proper packaging. FP&MSETA (2014: 2) states that “South Africa’s packaging industry manufactured 3.68 million tonnes during 2012.” The paper and glass paper sectors manufactured the largest volume of packaging plastic contributing the most value at 41.8% (Ibid.).

The packaging industry is strictly regulated, in relation to environmental management. The legislation that must be adhered to includes the following: National Environmental Waste Act, Act 59 of 2008 (FP&MSETA, 2014). Globally, environmental damage resulting from improper disposal of used packaging material, including their residues is not tolerated (FP&MSETA, 2014). The concern for looking after the environment has resulted in the development, growth of the recycling and reconditioning industries as they process old packaging materials into new materials in an environmentally friendly – manner. FP&MSETA (2014: 4) states that in 2012 ‘global industry players identified the following trends in the packaging industry.’ This is through strategies to use renewable energy, materials, recyclable materials, and smart packaging in the next 10 years. This is a clear call for innovation and collaboration throughout the value chain.

The challenge that has been in the macro-environment in the packaging industry in recent years, is economic uncertainty, combined with raw materials and energy price inflation on

packaging producers (FP&MSETA, 2014). Pongracz (2006: 5) states that packaging producers “rely on sophisticated printing and converting machinery to deliver the quality, efficiency and innovation that the market demands.” Management needs to be skilled at determining how much to spend on maintaining and adding to the capabilities of their machine park. Impact, the plastic packaging manufacturer identified the following challenges in the packaging industry. Production waste can be as high as 40% transmitted because of inadequate packaging materials and poor infrastructure (FP&MSETA, 2014).

2.7.6 Environmental consequences of plastic packaging

Pollution within the ecological system arises from wastewater discharge from the packaging material manufacturing process. Franklin (2014) points out air pollution is caused by emissions such as vinyl chloride, hexane, and CFC. Which can arise from waste – incineration activities and accidental fires within the manufacturing process (Ibid.). Final packaging emissions arise from landfill sites through the decomposition of plastic, releasing CO² and methane. Pongracz (2007: 281) identifies that ‘packaging – related solid wastes arise already at extraction and processing of raw materials.’ Solid wastes usually end up in landfill sites. However, most of the solid packaging is recycled in the household through using it for secondary use. The non-recyclable part of consumer packaging waste is disposed of (Ibid. 2007). The environmental consequences of plastic packaging also include pollution from electricity generation and transport – related emissions such as hydrocarbons and GHG emissions.

2.8 Energy use in plastic packaging

Packaging materials use energy in their manufacturing, distribution, and the supply chain of transporting products. Pongracz (2007) posits that energy input is required to produce and distribute packages through converting the basic raw materials into packaging raw materials. The secondary phase is through the conversion of packaging materials into packages. The first and secondary stages take place in different locations. Moreover, recycling systems also add to this energy demand (Franklin, 2014). This requires further energy for transportation demand and processing of discarded packages. Pongracz (2007: 251) mentions that “recycling systems add to this energy demand, with further transportation need and processing of discarded packages.” The energy consumption of the plastic packaging process is small,

however. An estimate of 2% - 4% of petrol consumption is used for plastic packaging production. Plastics use the energy needed in the manufacturing and content of processing the material itself (Ibid.).

Brandt, Fehringer and Pliz (2010: 13) state that “energy used to produce plastic packaging goods is considerably less than the energy needed to produce alternative packaging with other materials.” The energy input is less even when the energy value of plastics’ raw materials is factored in. This phenomenon indicates that without plastic packaging, the packaging sector would consume more energy to meet the packaging needs of South Africa (Brandt et al.2010). Further energy savings account to plastic packaging. Plastic has the most reusable items of packaging that can be used in the residential sector, thus there is little to no energy required to prepare plastic packaging goods for reuse.

2.9 Conclusion

The literature review has discussed secondary data to define whether the incorporation of renewable energy in the plastic packaging factory can increase production. Furthermore, it has identified the opportunities incorporating RE in the energy system can lower GHG emissions, reduce energy intensity in the production process and reach EE. The secondary data was extracted from relevant sources such as the national policy documents, online journals, academic reports and documents. The city of Ekurhuleni is home to the manufacturing hub of South Africa. There has been lagging growth in the manufacturing industry since 1994.

The secondary data has identified that this is largely due to the country’s lack of economic growth met with consistent and rising energy supply interruptions of electricity. This has resulted in the plastic packaging sector in slow production and persistent retrenchment. South Africa over the years has failed to reach energy security because of the over-reliance on fossil fuels. This is followed by the lack of proper energy infrastructure coupled with fragmented political economy measures that executives within the Eskom monopoly energy supplier. EE aims to reduce the amount of energy required to provide products and services within industries and nationally. EE also aims to reduce the waste created whilst generating and transmitting energy within the industrial sector. The policy document of EES South Africa

states that the benefits of EE in the environment are self-evident in lowering GHG emissions and ensuring that waste is recycled for energy recovery.

Moreover, the IEP institutes that an alternative energy mix strategy is needed within residential and industrial sectors to reach EE. Followed by a sustainable energy supply and demand energy system. The literature review also adds that the IPAP encourages industries such as the packaging sector to incorporate alternative energy sources such as RE in their energy systems to increase production that has been previously slowed down due to the rising energy insecurity of South Africa. The literature concerning the energy input in plastic packaging is limited. However, it elaborates that plastic packaging production consumes lesser energy than packaging produced from other materials.

Furthermore, plastic packaging has better reusable attributes that demand little energy input. Thus, incorporating RE in the plastic packaging factory can have significant advantages in increasing production. The primary data collated from the fieldwork process further investigated whether the incorporation of RE in energy system of the plastic packaging factory increased production based on the research study. Furthermore, the literature extends that the city of Ekurhuleni supports the national policy documents. The city of Ekurhuleni encourages industries within the municipality to incorporate RE sources in their energy systems to attend to the call for a sustainable energy system and mitigating climate change. Thus, the secondary data sources reviewed in this chapter provided fundamental analysis to addressing the research question. The secondary data coupled with the primary data will be further discussed in chapter 4 and 5 to investigate the objectives of the research study.

Chapter 3

Research Methods

3.1 Introduction

This chapter focuses on the research methods employed within this study. The research study is investigative in nature and embarked on a case study approach as the key method to determine the research objectives of the research question. It sought to discover an in-depth understanding of the energy process of incorporating RE in the energy system within the plastic packaging factory and whether it will increase production. The research used participatory approaches as a primary research method. The case study method is qualitative in nature which differs with a quantitative study through the different methods of data collection, analysis, and philosophical assumptions (Creswell, 2009). The research possesses statistical analysis that is apparent within the relevant sections and chapters of the study in relevant numerical tables and figures.

Qualitative research method encourages the researcher to develop empirically supported new ideas and systems through various investigations into meaning (Ospina, 2004). This is achieved through emphasising qualities of processes, meanings and entities that are not measured in terms of intensity, frequency, quantity, and amount. Thus, qualitative research methodology provides an opportunity for the researcher to analyse existing data and reality in the real-world context (Bacon – Shone, 2015).

Qualitative research methodology places the researcher in a distinctive role in conducting qualitative research. Ospina (2004: 4) asserts “all qualitative researchers aspire to illuminate social meaning.” The researcher must place themselves in a position to try and understand the meaning of the research question from the interviewees’ perspective within their natural context rather than analysing data from an external point of view. An example is coordinating the one – on – one interview with the Mpact general manager in the Mpact factory and having a visual analysis of factory’s RE energy system. The research questions formulated extracted detailed information from the interviewee’s correspondent on how RE is a social experience and how does the Mpact factory and the respondent give its meaning (Bacon – Shone, 2015).

An example is extracting information from correspondents on RE, the energy system of the plastic packaging factory. To determine whether incorporating RE, solar power in the factory's energy system can increase production and assist the factory in mitigating climate change.

Combining multiple sources of data such as interviews, documents and observations is a fundamental characteristic of qualitative research methodology. The researcher is required to analyse and review the data collated then organise new ideas and assumptions to derive findings that will define the research question. Qualitative methodology is dynamic and ever-changing, which may make the initial plan of the research to shift after the researcher conducts fieldwork and begins to collect data (Creswell, 2009). This objective entails the researcher must make ongoing interpretations of what they experience, hear, see and understand (Ibid. 2009).

An inductive data analysis approach is often applied to discover new ideas, categories, and themes through a bottom up approach to reach a more abstract level of insight, information and understanding (Bacon-Shone, 2015). This inductive process requires the researcher to do a continuous analysis between the data sources and themes concerning the study objectives to addressing the research question. The researcher must aim to identify and report on multiple perspectives of the study objectives of the research question.

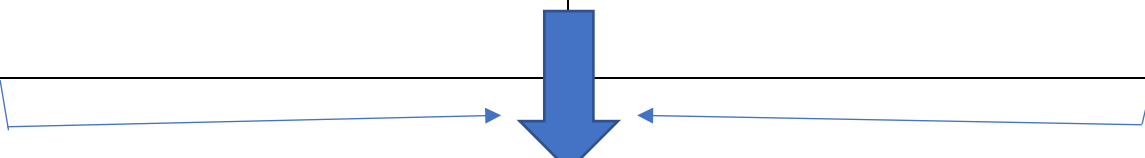
Moreover, qualitative research determines that the researcher investigates the meaning that participants ascribe to the phenomenon being researched and not the assumptions the researcher wants to bring to the research (Creswell, 2009). The focus is on the participants real experiences with South Africa's inconsistent energy supply and how this has affected energy output in the local government of the city of Ekurhuleni and the production process of the Mpact factory. The discussed characteristics were applied in vital stages of the study, especially during the fieldwork process.

3.2 Research Approach / Design

Table 3.1 below summarises the data sources and methods of collection to address the research question. The presentation of the tabular form was chosen as an effective means to providing direct links between the research question and the data collection sources.

Table 3.1 Data sources and methods

Primary Data	Secondary Data
• In-depth interviews • Participant Observation	• RE resources and technologies • RE in manufacturing • Energy policies and programmes • Plastic and paper packaging factory statistics and information
• Interviews: - ○ Mpact Factory executive manager ○ The city of Ekurhuleni's energy department executive correspondent	• Published Data: - ○ Journal articles ○ Report findings ○ Research documents ○ Book chapters



Research Study

The incorporation RE in the energy system of plastic packaging factory to increase production.

The research approach was motivated to address the primary concern of the research report which is to discover whether the incorporation of the RE in the energy system of the plastic packaging factory will increase production and whether can it be implemented across the packaging sector. The research study was conducted in the plastic packaging Mpact factory in Wadeville, Germiston in the industrial sector of the city of Ekurhuleni. In order to determine whether RE will increase production, a qualitative research approach was implemented. This was completed through a fieldwork process that deemed one-on-one interviews necessary (Creswell, 2009).

The usage of secondary data is used to validate the data collected through the process of obtaining primary data. Atienno (2019) asserts that secondary data provides validity and data reliability which is used to cross – check primary data that was collated. The secondary data was extracted from national and municipal policies obtained from the DoE, DTI and the city of Ekurhuleni. This was carried out to analyse the ongoing plans of RE and the energy supply and demand systems. An example is the REIPPP as the public – private partnership programme aims to increase buying and selling of RE to generate and transmit electricity in the national or municipal grid. Additional secondary data was sourced online from national and significant journal publications, institutions and think tanks.

Moreover, reports were extracted from substantial research institutions such as Sustainable Energy Africa (SEA). The SEA institution promotes equitable, low carbon, clean energy development within urban South Africa and Africa. SEA completes this through research, capacity building and policy engagement. Other secondary data on quantitative analysis for yearly and quarterly projections was sourced from Stats SA and Paper Manufacturers Associations of South Africa (PAMSA). In Chapter 2, the literature review was conducted to explore secondary data of current and previous literature that would inform the interview questions for the substantial research study. Moreover, primary, and secondary data are analysed in detail in Chapter 5 in addressing the substantial research question.

3.3 The research approach: case study

3.3.1 The Case Study Mpact plastic packaging factory

The case study approach embarked on within this study is applicable to both qualitative and quantitative research (Yin, 1994). In qualitative research, the researcher produced a better analysis of the study in identifying whether incorporating RE in the energy system can mitigate climate change and increase production in the Mpact plastic packaging factory. May (2001: 212) states that ‘case studies investigate social life within the parameters of openness, communicative, naturalism and interpretively, as informed within their respective paradigm.’ The case study approach was chosen for this study because it is exploratory in nature as it seeks to develop a pertinent proposition for further inquiry (Ibid. 2001). Furthermore, the case study is appropriate for this research question because it provides an in-depth analysis

and studies entire the unit, as opposed to aspects of units and produces first – hand information (Yin, 1994).

This type of case study approach is exploratory in nature to develop a proposition such as inquiring about the effective use of resources to increase sustainable production within the Mpact factory (Ibid. 1994). The case study method was chosen as it is appropriate for an in-depth analysis and produces first – hand information (Ibid. 1994). In embarking on the research, the researcher aimed to conduct fieldwork in one-on-one interviews with four respondents. The interviewee respondents took long to reply to my request of conducting one-on-one interviews. Thus, in the interest of time, the researcher had to resolve completing two case studies instead of four. The two case studies were selected, Mpact plastic packaging factory being the focus to facilitating the primary analysis of the research study. The city of Ekurhuleni (CoE), energy department case study being used as a consultative distinction to determine the CoE being an enabling environment for the manufacturing industry to incorporate RE in the energy system to increase production.

3.3.2 Primary data collection

The researcher interviewed two key types of respondents for the primary data collection. These respondents were the Mpact factory manager as the energy end – user and energy policy implementers within the government structure of South Africa. Policy makers are government entities with municipalities being the main policy implementers such as the CoE's municipal energy department. The face-to-face interview process provided the researcher with the vital role of facilitating and control the process questioning to gather relevant information for the research study. This is done to keep the focus on the interview questions and their responses in relation to the data needed for the study objective. The participant observation fieldwork process provides value added information to the data collected in obtaining visual imagery in the Mpact's and the municipal department energy systems.

3.3.2.1 Mpact plastic packaging factory interview

The Mpact packaging factory was sampled purposefully within the industrial area in Wadeville, Germiston in the city of Ekurhuleni (see figures 3.1 & figure 3.2 below). The data

sampling was guided by the Mpact factory being in the industrial hub of the city of Ekurhuleni. Mpact focuses on a business model system that focuses on manufacturing plastic packaging through recycling through the usage of sustainable energy (Mpact, 2018). The researcher determined whether the Mpact factory aligns itself to national policies and municipal projects to incorporate RE in their energy system. Another criterion is that as Mpact factory is a private entity that are prominent for maximising profit, the study objective seeks information on whether the factory attends to climate change management and intends to use RE to generate sustainable energy output and increase production. The researcher conducted one – on – one interviews and participant observations of the energy system of the Mpact factory to gain a visual analysis.

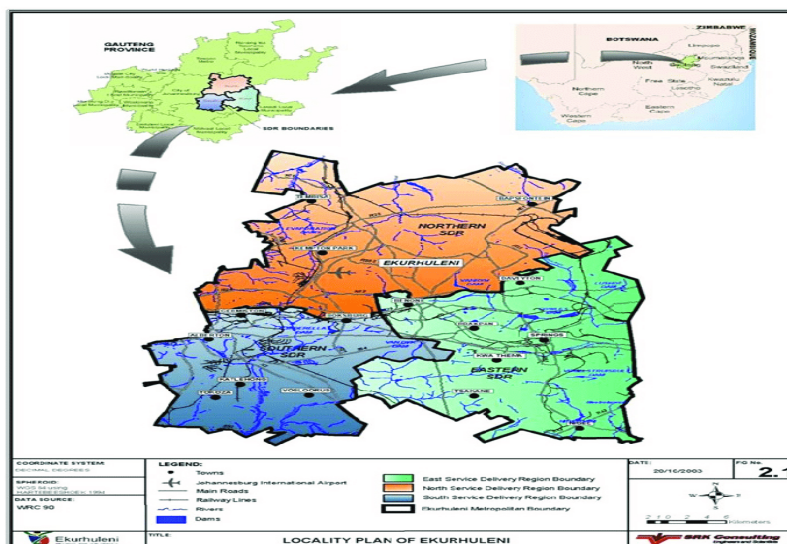


Figure 3.1: Integrated map showing South Africa, and the city of Ekurhuleni (Source: AfriGIS, 2019).



Figure 3.2: Map showing the Mpact factory in Wadeville, Germiston (Source: AfriGIS, 2019).



Figure 3.3: Aerial view of the Mpact plastic packaging factory in Wadeville, Germiston (Source: AfriGIS, 2019).

The preparation for the interview with the Mpact factory manager respondent, prior contact was made through email and telephonic correspondence in which the purpose of the interview was explained. The approach was quite similar as with the interview with the municipal executive respondent. The researcher conveyed communication of the purpose of the objectives of the study and interview process. Furthermore, the researcher mentioned that it was not obligatory to participate and/or answer any questions that the respondents may not feel uncomfortable with answering.

The Mpact Factory interview was conducted in the morning during the work week for the purposes of not misaligning the working schedule of the manager. The researcher was well received, and the respondent was willing to participate. The detailed findings of the Mpact

factory interview were successfully captured and will be analysed in chapter 5. Further detail on the interview questions are contained in Appendix B.

3.2.2.2 CoE Energy Department Municipal Interview

Primary data was collected and analysed in the form of a structured interview with the city of Ekurhuleni's energy department executive correspondent. The selection of the Ekurhuleni's energy department for primary data collection was due to the department's primary role in managing the energy supply and demand of the municipality which includes the industrial and residential sectors. Moreover, the researcher wanted to establish the position the municipality has taken on the policy formation and implementation process of policies such as the IEP (2016), IRP (2018) and EES (2015). Furthermore, the department was chosen to gain clarity on the measures the municipality has taken to integrate RE and RE technologies in the industrial sector, specifically in the plastic packaging factory. The researcher intended to find out whether the department has formulated its own guidelines and /or policies to integrate RE in the energy system of the entire city. This objective is encouraged by the valuable RE projects launched within the city that recognises the IEP's plan for an alternative energy mix within cities to deter the on-going energy insecurity of South Africa.

The researcher asked for the respondent to sign the required documentation of confidentiality which would help build trust between the respondent and researcher throughout the interview process. This process ensured that the researcher followed the University of Witwatersrand's ethics protocols. The respondent was willing to go the 'extra mile' and sourced additional information that she deemed necessary for the purposes of addressing the research question. The researcher conducted one – on – one interviews and participant observations of the energy system and design of the municipal energy system.

In addition, the research approach anticipated a snowballing effect would emerge with the respondent in which the researcher was introduced to other senior personnel in the same unit whom dealt with RE infrastructure within the CoE regarding substantial follow up questions. In some cases, one finding would lead to other factors that needed further research through semi-structured interviews. This is also extended to secondary data from reports and policy documents. Further analysis can be found in chapter 4 of the municipal interview.

3.4 Data Analysis and Interpretation

Pearce (2002: 104) mentions that “using multiple research approaches to respond to research questions allows the researcher to gather varied data for the study.” The data then either proves (or disproves each other) or complements the research study to determine whether incorporating RE in the energy system will increase production as each method focuses on different aspects of the research objective.

The research study demonstrates that using interview and survey data leads to an improved understanding of incorporating RE in the energy system. It also assists in finding out whether it improves production and can help reach EE and mitigate climate change. The procedure for data analysis for the study consists of the interactive play of interview survey data and participant observation. The one research approach strengthens the other. Moreover, participatory observation was applied through observing the solar roofing energy systems of the Mpact plastic packaging and the CoE’s’ municipal energy department. Furthermore, the interview survey data was extracted from the respondents that assisted in gaining first hand analysis of their experience with energy, RE and the fragmented energy supply and demand in their natural context.

The researcher after completing fieldwork continuously analysed the data findings recorded and written for the purposes of verification and accuracy (Creswell, 2009). The objective of analysing the data is to enable the researcher to respond to the primary research question mentioned in chapter 1. In chapter 2, the researcher coded the secondary data in relation to RE, energy system, energy related policies and the plastic packaging factory data sources. Maxwell (1998: 89) asserts that ‘coding affords the researcher an opportunity to breakdown the data collected from the field research into categories with the aim of drawing comparison to determine patterns in the research context.’ The field research coding is analysed in detail in chapter 4 and 5.

3.5 Ethical Considerations

The study is implemented based on the Ethics guidelines of the University of Witwatersrand. The study under the methods and research employed did not cause harm to the respective participants. Moreover, the participants were treated with respect in the data collection stage

of the study. The relevance of the research study was explained by the researcher and the participants were informed that their participation within the study is voluntary, confidential and that no rewards were to be expected from the participation. The purpose of the study was introduced to the participants on a written Participation Information Sheet and the consent of the participants was obtained through a signed consent form. This helped build trust between the respondent and the researcher throughout the research process. The participants agreed to audio-recordings of the interviews and the confidentiality and anonymity. The copies of the ethics clearance certificate and questionnaires will be attached as Appendices. All respondent names are organised using pseudonyms within the report. This process ensured that the researcher followed the University of Witwatersrand ethics protocols.

3.6 Conclusion

Chapter 3 focused on elaborating on the research methods employed within the research study. The research methods focused on discovering an in-depth understanding of the energy processes of incorporating RE in the energy system within the plastic packaging factory and whether it will increase production. The researcher chose the case study method that is qualitative in nature to analyse the data in a real-world context to develop empirically supported new ideas and systems through various investigations into a defined outcome.

The coordination of one-on-one interviews with the Mpact factory general manager and the CoE's energy department senior official allowed the researcher to place themselves in a position to understand the meaning of the research question from the interviewee's perspective. This was achieved within the interviewee's natural context, rather than analysing data from an external point of view. The one-on-one interviews thus allowed the researcher to determine how RE is a social experience and how the Mpact factory, CoE's energy department, respondents give it meaning.

The CoE and its municipal energy department was chosen because the Mpact factory is situated within the industrial area of the CoE in Wadeville, Germiston. The CoE is the enabling environment as the energy department's role is managing the energy supply and demand of the municipality which includes the industrial and residential sectors. The researcher identified the CoE's position in being an enabling environment to incorporating RE in plastic

packaging manufacturing regarding policy implementation programs such as the IEP. Furthermore, the researcher identified what role the CoE has taken to integrate RE technologies in the industrial sector, specifically in plastic packaging manufacturing which will be discussed in chapter 4.

Ethical considerations based on the university of Witwatersrand ethics protocols were applied during the one-on-one interviews with the respondents through a signed consent form. The respondents were treated with respect and were made to understand that the data collection interview was voluntary, confidential and no rewards were to be expected. The research study demonstrated that using primary and secondary data analysis lead to an improved understanding that incorporating RE in the energy system of the plastic packaging factory will increase production. The secondary and primary data analysis and collection ensured that the one research approach strengthened the other as secondary data provided a research basis to successfully complete the primary data collection. This was done to determine the focus on participants real experiences with South Africa's inconsistent energy supply and how this has affected the energy output in the local government of the CoE and manufacturing process of the Mpact factory.

The continual data analysis after the fieldwork process ensured data accuracy and enabled the researcher to respond through verified analysis to the research questions. A more descriptive fieldwork research coding will be analysed in detail in chapter 4 and 5.

Chapter 4

The city of Ekurhuleni and the manufacturing industry, focusing on the plastic packaging sector analysis and interpretations

4.1 Introduction

This chapter provides an analysis of the data collated in relation to the primary research question and research sub-questions. The research question posits the extent to which incorporating renewable energy in the energy system of the plastic packaging Mpact factory in the city of Ekurhuleni and how it can be a reliable energy option to increase production and can it be applied across the plastic packaging industry? This chapter will focus explicitly on the case study area of the city of Ekurhuleni (CoE). In addressing the research question, the study analysed the primary data obtained from the one – on – one interview with the municipal energy department respondent. The primary data will be elaborated with secondary data from Stats SA on demographics of the study area. Secondary data analysed from StatsSA is important for understanding the relationship between the city of Ekurhuleni and the energy supply and demand status in the municipality.

Moreover, secondary data is substantial in analysing the manufacturing industry, focusing on the packaging sector and whether incorporating renewable energy in the energy system will increase production. The inclusion of secondary data in the form of quantitative data extracted from StatsSA enables a more systematic understanding of the research question. This chapter will also elaborate on the CoE's national policy implementation objectives to developing a sustainable energy system with incorporating RE in the energy system to reach energy efficiency. Whilst identifying the policy implementation measures made by the CoE in the manufacturing industry through energy projects.

4.2 The city of Ekurhuleni municipality

It is fundamental to mention that although the geographic description of the City of Ekurhuleni and purposive sampling are discussed in sections 2.3 and section 3.3 respectively, this section analyses the CoE as part of secondary data. It is of critical significance to

emphasise that this data analysis is not part of the case study description. Data is analysed to explore characteristics of the CoE which is the enabling environment that determined that RE can be incorporated in the Mpact plastic packaging factory to increase production. Which was not immediately available in published sources.

Ekurhuleni means 'the place of peace' in the Tsonga language, a city situated in the eastern region of the Gauteng province. The city of Ekurhuleni (CoE) emerged over twenty years ago and comprises of 2 million inhabitants who live in an agglomeration of 17 townships and 9 small towns (CEIDP, 2018). The merge of the 17 townships and 9 towns was created to establish an efficient local government through merging the different administrative systems. The administrative system is responsible for service delivery and governance in the 17 townships and 9 towns (CEIDP, 2018). The CoE defined its own path to creating a public administration, institutional system and urban plan that will best serve its citizens (Ibid.).

Ekurhuleni is one of the six municipalities that were part of the restructuring process of local government (GGDA, 2014). Prior to the restructuring, the city lacked an urban core which created immense population densities over vast stretches of land. The land was used for economic activities such as agriculture, mining and manufacturing. This created an opportunity for the city to create a new urban planning approach to develop functional spatial and economic transformation such as the current plan to build an aerotropolis that will connect the airport with the economic activities within the city (CEIDP, 2018). The city then had to create a single uniform identity by creating socio-economic linkages in townships, towns, and economic centres through service delivery such as access to electricity. The merge also included the accessibility to facilities, services, protection, maintenance of open spaces and the aquatic system within the municipalities (Ibid.). Today, the municipality is the 4th largest municipality in the country which consists of 101 wards and 9 local authorities.

4.2.1 EMM Economic status

The economy of the EMM is diverse and larger than some countries in Africa. The GDP of CoE sat at 23% of the provincial GDP in 2015 and contributed to 8.8% of the national GDP in 2016 (State of the Cities Report, 2016). This is an 0.6% increase from the 1995 GDP rate and indicates that the CoE plays a significant role in the economy of South Africa. The development of the economy of the CoE can ultimately have a significant impact on the

growth of the economy of the province and South Africa. The Ekurhuleni Growth and Development Strategy (EGDS: 2016) asserts that 'Ekurhuleni is often referred to as 'Africa's Workshop'. The municipality encompasses the largest concentration of industrial activity in South Africa. The industrial sector contains 33 000 business entities, 5 000 supporting enterprises and 8000 industries in an active commercial sector (Mncube, 2015).

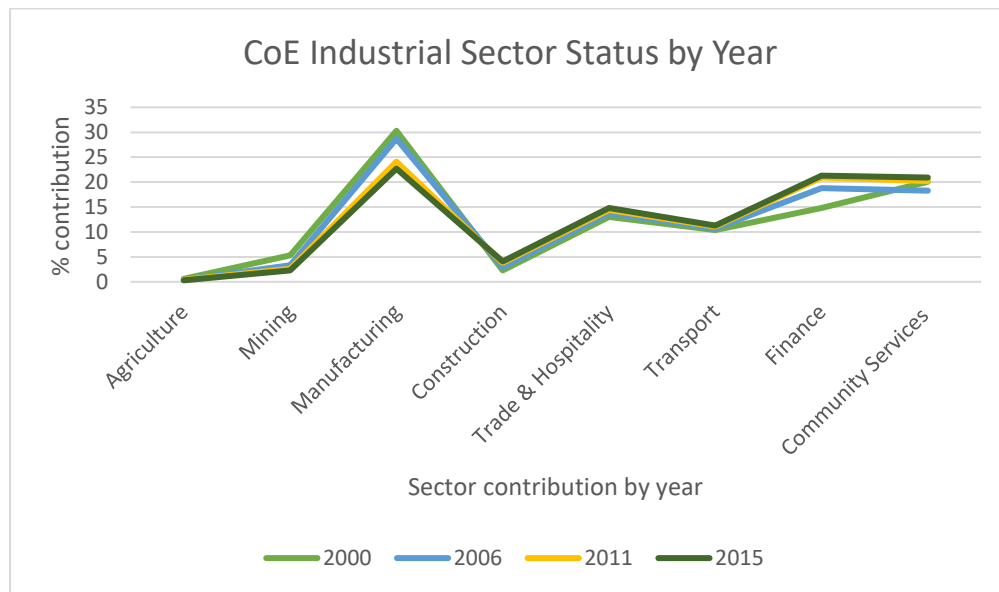


Figure 4.1: CoE industrial sector status by year, source: Global Insight 2016

Figure 4.1 illustrates that the CoE's economy is largely dominated by five sectors namely manufacturing, finance, service delivery, trade, and hospitality. The GDP in 2015 sat at R301 billion and the CoE was ranked 3rd in the regional economies of the total Gauteng Province (CEIDP, 2018). In terms of the GDP share, in 2015 it reached 21.4% which was smaller compared to the growth in 22.2% in 2005. The annual growth rate of the city's economy however was 2.7% from the period of 2005 – 2015. The CoE's GDP growth is forecasted at 21.2% in 2020 of the total Gauteng GDP (Ibid.). The ranking is projected to sit at an annual growth rate of 1.47% in the period of 2015 – 2020 of the CoE's GDP growth.

The CoE economy outpaced the City of Johannesburg in 2005, 2006 and 2007. However, the economy has lagged considerably since 2008, except for 2010 and 2014 as depicted in figure 4.1 above. The performance of the economy or lack thereof has resulted from a plethora of issues. These include the inconsistent energy supply of electricity within the country that has impacted the commercial sector specifically, in the CoE industries (Ibid.). Moreover, figure 4.1

illustrates that there has been over the past 15 years structural changes in the economy. This includes the decline of the dominance of production in the manufacturing sector that dropped from 30.3% in 2000 to 22.7% in 2015. Furthermore, the CoE is a municipality that is host to global competitive industries such as the manufacturing sector. It is also the transportation base of South Africa as it is home to the OR Tambo International Airport, which is the biggest and busiest airport in Africa (Ibid.).

4.2.2 Manufacturing hub in the CoE

The manufacturing industry contributes to 28% of the gross value-added output in the municipality. The manufacturing industry in the municipality accounts for 19.7% of the gross domestic product (GDP) of the Gauteng province. The industry was previously a support base for the mining operations that existed locally in the 1970s (Rogerson, 2005). Thus, manufacturing in CoE is intensified with chemicals, metals, equipment, machinery, as well as plastic and paper products sub-sectors.

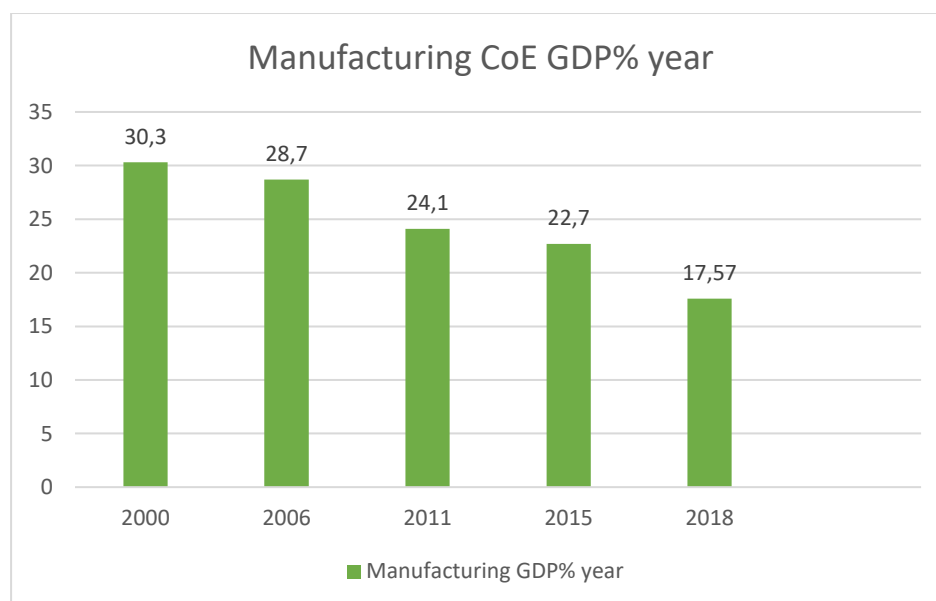


Figure 4.2: Graph of the Manufacturing GDP value added. Source: Stats SA, GDP manufacturing industry 2019

Figure 4.2 illustrates that the manufacturing sector in the CoE has declined by 20% since 2001. This is due to the competition of increasing imports', energy costs and the inconsistent energy supply and demand system of South Africa that has resulted in South Africa experiencing load shedding sessions since 2008 (Bhorat & Rooney, 2017). The manufacturing industry has had

policy and regulation uncertainty, infrastructure, and fiscal challenges. That include newly introduced taxes on carbon emissions, waste, and sugar (Ringwood, 2017). Moreover, the global call for countries to mitigate accelerating climate change through lowering carbon emissions, has demanded that the plastic packaging sector lowers its production waste output and promote more sustainable recycling options for consumers.

However, the local economy still largely depends on the production of the manufacturing sector. There are major concentrations of industrial activities within the CoE which consists of 20 separate industrial areas. The major manufacturing economic concentration is in the Wadeville / Alrode industrial complex. The manufacturing industry has made a positive impact in resource efficiency. An example is in the packaging sector, that has achieved the highest recycling rates in South Africa. The recycling of beverage cans sits at 72% and glass at 56%. The manufacturing industry can do better in waste, energy management and energy recovery such as incorporating renewable energy in the energy system of the plastic packaging factories to increase production and mitigate climate change (Ibid.).

The CoE intends to revitalise the manufacturing industry to advance economic growth and job opportunities (CEIDP, 2018). EMM has formulated a long-term development strategy, namely the Ekurhuleni Growth and Development Strategy (GDS 2055). The strategy outlines its desired growth and development trajectory and seeks to transition the city into a sustainable city from 2030 – 2055 (Ibid.). Therefore, the GDS intends to re-industrialise the manufacturing sector to an inclusive industrial economy that regards climate change mitigation and integrates the usage of renewable energy in their supply chain. This will assist in reducing unemployment and poverty within the city and ultimately create a clean, green, and sustainable African manufacturing complex and city development network (Ibid.).

4.3 Energy use in the city of Ekurhuleni

The energy insecurity in South Africa has resulted in the CoE taking steps to commit to generating sustainable, clean renewable energy. The CoE has like other cities in South Africa experienced challenges in the consistent supply of electricity services. This adversity has been negatively affected on the growth of CoE's GDP, particularly the industrial sector. There is a need in implementing a better energy strategy which places emphasis on incorporating renewable energy in the city of Ekurhuleni.

Executive Mayor Masina of the CoE in 2017 announced that, the city has invested R2.2 billion in energy infrastructure specifically in RE and RE technology over the next three years at the manufacturing indaba (Ringwood, 2017). The investment is part of CoE's local energy strategy that aims to generate 10MW of energy by 2021. This strategy will bring about energy stability in the region without the CoE completely relying solely on the grid. The city has since established a solar farm at the OR Tambo precinct in Wadeville. The CoE installed 1 MW of energy generators from methane gas at the Jack and Simmer Landfill site in Germiston. Furthermore, the Boskborg and Kempton Park Civic Centres were installed with solar panels and the EMM intends to collaborate with 5 MVA in producing 300 MWs of RE (CEIDP, 2018).

The 2004 Ekurhuleni State of Energy Report provides a status report on the use of energy in the CoE (Mncube, 2015). The report has documented that the energy consumption data is not easily accessible at the local city industrial and commercial sectors. Statistics South Africa (Stats SA, 2016) further mentions that both the DoE and the CoE rely on Eskom as their data source for electricity. The researcher focused on the energy statistics focused on the manufacturing sector in the city of Ekurhuleni to investigate the study objective. The manufacturing sector is 1 of the 3 biggest users of electricity in the CoE.

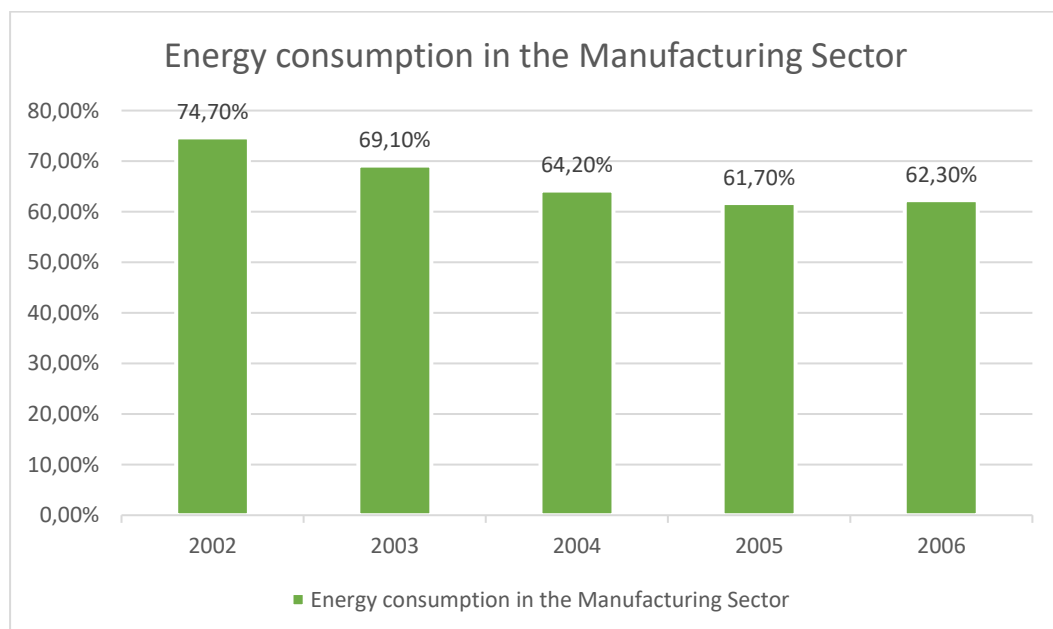


Figure 4.3: Total energy consumption in the manufacturing sector 2002 – 2009, source: StatsSA 2009

Figure 4.2 illustrates that from 2002 – 2011 the manufacturing production and sales had a 6.2% decline, whilst figure 4.4 asserts that the energy consumption in the manufacturing

sector from 2002 – 2006 declined by 12.43%. The data analysis argues that there is direct correlation to the decline of manufacturing production and energy consumption within the sector. An alternative energy approach needs to be taken within the sector to generate a sustainable energy output to increase production and decrease energy intensity to reach EE.

4.4 CoE, National and Local Policies, Strategies.

The CoE has a plethora of local strategies and policies implemented by the city to reach sustainable development and an energy supply to re-industrialise to eradicate unemployment and increase production. Local strategic outcomes such as the integrated development plan (IDP) and the Growth and Development Strategy (GDS) 2005 need to be aligned to both national, provincial policy and planning directives relating to the local government. The IDP aims to refocus the city to successfully institutionalise the implementation of the GDS 2055 (IDP, 2018).

4.4.1 National Development Plan (NDP) 2030

The South Africa NDP was formulated to serve as the state's benchmark in which all government structures adhere to, to reach the objectives of the country by 2030. The NDP intends to align its growth aspirations with the United Nations Sustainable Development Goals (SDGs), an international planning framework developed that all countries under the UN should adopt (CEIDP, 2018). The SDGs play a significant role as they define the destination the country wants to reach by 2030 whilst identifying the role that different sectors of society such as energy needs to play to reach sustainable development (Ibid.). The city of Ekurhuleni to create a sustainable energy supply for its citizens must adhere to the relevant policy objectives and align with the respective SDGs.

4.4.2 Provincial Planning: City – region integration imperatives

The province of Gauteng's government policy priorities is to achieve socio – economic transformation, modernisation, and re-industrialisation (TMR). The Gauteng City Region (GCR) is anchored on TMR to develop Gauteng and South Africa whilst taking a lead in Africa's new industrial revolution. There are apparent synergies between the TMR pillars and existing Ekurhuleni programmes such as the national outcome of creating employment through inclusive growth focus on the GDS 2055 objective of re-industrialisation.

4.4.3 Municipal Planning; GDS 2055, IDP 2018/2019 – 2020/2021

The IDP was formulated under the legislative context of Section 34 of the Municipal Systems Act, 2000 as a continuous framework of the implementation of the Municipality's five - year objectives. The IDP ensures there is continuous improvement of service delivery and responsiveness to the citizens residing in the City (CEIDP, 2018). The Constitution in Section 153 demands that the EMM must structure and manage its administration, budgeting, and planning processes to give priority to the basic needs of the community. This will be done to promote the socio-economic development of society (Ibid.).

The GDS 2055 has five themes that strategically influence one another to achieve the CoE's objectives. In addressing the research question, the study objectives focus on three themes that are to promote safer, healthy, and socially empowered communities, protect the natural environment and promote resource sustainability whilst creating an enabling environment for inclusive growth and job creation (Ibid.). These themes will be used as a developing trajectory for the institutionalisation of the GDS and development of the IDP for its term, Service Delivery and Budget Implementation Plan (SDBIP) (Ibid.).

GDS 2055 (50) asserts that the agenda intends to create a diversified local economy. The local economy will be able to meet local needs, support sustainable development and adapt to changes in accordance with the global economy. The CoE's comparative advantage lies in the manufacturing sector. The City's manufacturing and logistics economy is re-orientating itself gradually around new mega projects and freight logistics investments to re-industrialise (City of Ekurhuleni Integrated Development Plan (CEIDP), 80). This must be supported and accelerated for the economy and the manufacturing sector to grow, both the industry stakeholders and the CoE must develop a skilled workforce. This advantage must be coupled with the availability of raw material and good transport linkages around the manufacturing base. Moreover, to develop industrialisation, it is required that greater diversification of the economy into value – added manufacturing and beneficiation (GDS 2055, 20). This consequence will develop sustainable manufacturing, inroads into the new quadrant of the economy – ICT industries, as well as attempts to realise sustainable development.

4.5 Data analysis on the city of Ekurhuleni's energy department policy objectives

As previously mentioned in chapter 3, the CoE energy department was chosen for primary data collection due to the department's primary role of managing the City's energy supply and demand system that supplies the industrial sector. The researcher wanted to find out whether the department had formulated its own policies to integrate RE in the energy system of the city. Furthermore, to establish the position the municipality has taken on the implementation process of national and provincial policies of South Africa. Furthermore, what measures has the city taken in implementing RE and RE technologies in the industrial sector, specifically the plastic packaging sector of the manufacturing industry.

The conclusions founded on the CoE's energy system which supplies the industrial sector were founded on the municipal interview and discussion the researcher had with the respondent of the City's energy department. The respondent first gave an overview of the structure of the leadership of the energy department in which the Head of Department (HOD) sits in authority after the Municipal Mayoral Counsellor (MMC). Following the HODs are the 5 Director Heads (DH) which manage the leadership, sales, municipal energy grid, energy sources and policy imperatives. The one-on-one interview began with the researcher asking the respondents position on the city's energy system and EE status within the city. The respondent asserted that the CoE's energy department regards EE on the energy infrastructure that they use that caters for RE, specifically solar power which reduces the energy consumed by limiting the waste omitted through energy transmission. The RE infrastructure also assists the municipal building during power outages, i.e load shedding in providing important alternative lighting options from the electricity generated from solar power and its technology.

Moreover, the CoE follows the auspices of the IRP (2018) policy through calculating technical losses in their revenue to make recommendations to resolve the consequence. Such as investing in better technical maintenance for the technology and infrastructure used in the CoE's energy system. The respondent stated that EMM has a landfill gas project in Germiston. The project is focused on extracting 80% of the Methane in the landfill, which is 80% of the mega capacity of the energy source. The CoE generates electricity from the energy source and transmits it back into the municipal grid. The landfill gas project is in line with the EES (2005) policy directives for local government structures to lower GHG emissions for communities

living adjacent heavily industrialised areas. The landfill gas project addresses energy recovery options in reducing output waste in the city to produce EE in the CoE's energy system. This will bring positive contributions in the city's ecology and ultimately citizens social well – being.

Moreover, the CoE has a solar power project in which the municipality intends on building solar rooftop technology and infrastructure on the CoE's municipal buildings. The solar power project began in the municipal civic centre buildings in Boksburg and Kempton Park when the load shedding began that brought on consistent power outages which created disruption in public service delivery. The rooftop solar energy system, generates and transmits electricity from the solar power absorbed from the sun. The respondent declared that the solar rooftop project follows the guidelines of the IRP (2018) and IEP (2016) in investing and building energy infrastructure that will advance the local governments energy needs.

These two-fundamental municipal alternative energy projects reduce the energy the city buys from Eskom and are grid tight. The city does not use any RE solar power storage technology with the solar rooftop technology. The respondent revealed that the current RE storage in the energy market is not as advanced yet for the energy capacity that needs to be stored. The existing RE storage unit will cause complications and defect the building as time passes. The lack of a functional RE solar storage unit has resulted in the municipality being unable to cover the energy demand needed for the municipal buildings when there is a power outage (load shedding). Only priority lights will have electrical power to stay on, resulting in other technical facilities being switched off causing public servants to have a backlog of municipal work.

The financial benefits that the projects have generated however, support the municipal department in accelerating other energy projects. Specifically, in the residential sectors such as installing additional solar geysers in areas of the township they could not previously because of financial constraints. The municipal projects have also resolved the challenge of inconsistent energy supply they experienced previously with Eskom. Thus, the municipal projects are good energy infrastructure investment and have assisted the municipality in developing other solar projects to promote EE and sustainable energy use.

The respondent stated that the current lack of consistent energy supply of electricity that results in load shedding negatively affects the CoE. The CoE acts as both an energy supplier and demand parity of the electricity distributed from Eskom. The CoE needs a consistent

electricity supply to cater for the energy demand of the industrial and residential sectors. Moreover, the municipal respondent added that the electricity needs to be affordable and energy efficient. The electricity must be sustainably generated to lower South Africa's current GHG emissions profile to mitigate climate change.

Thus, the load-shedding negatively affects the municipality as it creates losses to revenue of the CoE. If they are not selling to customers (both the industrial & residential sector), they are losing money. Moreover, it damages the public opinion of the EMM, creating tension between citizens and the municipality. The respondent asserted that Industry leaders, i.e. plastic packaging manufacturing managers such the Mpact factory manager used to come and complain about the inconsistent supply of electricity in the sector when the load shedding started. The industry leaders would require the municipality to resolve the problem itself when it is a national challenge. However, they have sought to ascertain and generate their own private alternative energy supply options. This includes purchasing their own back-up generators and built RE energy technology and infrastructure options such as building their own solar plants.

Subsequently the respondent stated that the CoE does not have an alternative plan when load shedding occurs in the entire city. This is due to the lack of functional RE storage systems that can be incorporated in the municipal energy system. This results in the municipal energy system being grid tight, relying on Eskom's electrical transmission. Which means that when the power supply from Eskom is switched off, the municipal grid also switches off cutting the transmission of electricity to citizens. The respondent noted that because of the lack of storage technology, the municipality recommends that citizens use generators and RE technology installed in their homes and industrial infrastructure if they possess them. Until the municipality's RE sustainability project that will cater for the entire city is fully developed and ready for implementation.

Furthermore, to lower carbon emissions and create long term energy efficiency, the municipality follows the guidelines of the Integrated Resource Plan (IRP) (2018) in investing in energy technology that will provide a sustainable energy generation and transmission in the energy system. The municipality is moving away from MV & HPV energy technology they currently using that is consuming more energy. And moving towards LED lights and RE technology which includes sensors that has a better sustainable energy output within the

municipal buildings. The City also has an EE awareness campaign under the IDP 2018/2019 – 2020/2021 framework to educate the industrial sector on best energy practice to lower energy intensity practices and reach EE.

In chapter 2, the Industrial Policy Action Plan (IPAP) was outlined the policy objective of the NIPF to implement measures to prevent industrial decline and support the growth and diversification of South Africa's manufacturing sector (IPAP, 2017/2018). Under this policy directive, the respondent mentioned that the city's manufacturing sector is the backbone of their economy, the energy department does take the supply and demand of energy in the industry into serious consideration. The respondent further noted that as they do take mindfulness to meeting the energy supply and demand of the industry. The municipality in addition to the landfill and solar rooftop projects, they are looking towards expanding their RE sustainability project in the municipality by procuring independent power producers. This action is under the auspices of GDS 2055 and REIPPP under the policy objectives of the IRP (2018).

Furthermore, the respondent stated that they also they demand more generated electricity from Eskom as the manufacturing industry is energy intensive. Resulting in the industry constantly needing more energy supply. Consequently, the respondent also stated that the manufacturing industry has considerable energy output waste. The municipal IDP 2018/19 – 2020/21 under the waste management priority, demands the industry to reduce waste through implementing recycling options and an energy recovery process such as the municipality's landfill energy project.

The researcher asked whether the municipality implements their own policy frameworks in the manufacturing sector. The respondent mentioned that national and provincial policies do not have a binding legislative process for the industrial sector, especially energy related policies. Thus, the municipality cannot launch policies that bind the manufacturing industry to abide by anything. However, the EMM is currently formulating a sustainable energy growth policy which will go to Ekurhuleni's council. The policy will outline specific guidelines that industries within EMM must adhere to for the building of RE energy infrastructure and capacity of the energy system onsite. These guidelines will be launched under this policy to protect the municipality from back feeding for safety purposes and maintenance. The respondent further mentioned that the municipality does not have any renewable energy

projects implemented with the manufacturing industry, specifically the plastic packaging sector.

The respondent argued that this consequence is based on the non-binding policies that do not require the manufacturing industry to either cooperate with the local municipality or build RE infrastructure and technology in their energy systems. Furthermore, this objective would pose a monetary challenge. If an integral project may be launched, there may be disputes with investment options and profit sharing between the manufacturing industry and the municipal energy department. The respondent added that the manufacturing industry in sectors such as plastic packaging has their own installed RE systems in their factories. This is to resolve electricity supply prices from the municipality and create a steady supply of electricity generated from RE sources.

The researcher went on to find out if the City takes cognisance of the energy mix doctrine of the Integrated Energy Plan (IEP) (2016) national policy. The respondent pointed out that the CoE does apply the energy mix doctrine, the alternative energy source used within their energy system beside the cheap energy generated from Eskom include methane from Gas and Solar power energy. The IRP (2018) policy framework intends for a 26.3% projected installation of RE technologies and capacity by 2030 in South Africa. This project will be made possible through the REIPPP. The programme was launched to procure RE generation in the private sector or independently from Eskom. The respondent under the guise of this policy objective, mentioned that the city under its own budget has formulated a R2.2 billion city budget for an energy investment strategy that will advance the current RE plants constructed by the city as part of the EES (2015) and REIPPP. Moreover, in 2017, the city launched a proposal bid for IPPs to supply 10% of electricity targets of the municipality.

The respondent mentioned that IPPs are expected to build RE generating stations with their own money. 47 service providers won the bid under a 20 - year contract to supply only to the City as part of the Electricity Regulation Act of 2006 enacted by the Parliament of the Republic of South Africa. The Act states that IPPs may not generate more than 10 MW of electricity at a given time and enforces the national electricity regulatory framework that South Africa's electricity must be supplied by Eskom (Electricity Regulation Act, 2006). The act further states that IPPs must procure a license to generate and transmit energy from the DoE. The service

providers will supply electricity generated from solar, waste and biofuel through their own infrastructure and technology.

The IPPs will supply energy to municipal buildings, residential and industrial sectors. The respondent states that the notice came out in 2019, on radio stations such as Kaya FM and KFM. The municipal energy department conducted community engagement under Section 33 of the financial model of the CoE. The financial model states that the City must connect with the public to investigate how the community would respond to the launch of the project. And whether the community would benefit from the energy project. A report was then done of the responses and findings from the public and then the report went to council to discuss whether the project would be well-received by the citizens of the CoE.

The respondent emphasised that incorporating RE, solar power in the energy system of the plastic packaging sector is necessary to increase the production of the industry. When the CoE's energy department can generate 50% of their own electricity from RE options whilst find functional RE storage technology and transmit it to the industrial sector. The plastic packaging sector will grow economically and not suffer with a steady supply of electricity as much. Furthermore, a safe and sustainable RE option that can be implemented in the manufacturing industry is solar power because it has a fundamental advantage geographically. The city is located where the sun is most strong, even when it is raining. Energy output waste options such as energy recovery of generating electricity from methane is also efficient. However, they can take longer to generate electricity and the infrastructure is more expensive to build than that of solar.

The respondent argued that there are also barriers to incorporating RE in the manufacturing sectors energy systems. The sector may have the financial capacity to do so, however there are legal licensing policies and processes that the sector must follow through with the DoE such as the Energy Regulation Act of 2006. The DoE will then decide to give the plastic packaging sector licensing or not. This also limits the plastic packaging sector to be part of revitalising the city's economy to become a low carbon and climate resilient economy.

However, the respondent further argues that policies are also there to protect the municipality and the industrial sector. An example is the municipal energy department and the industrial sector choosing to generate more than 10MW of independent electricity

without a license, the DoE can lay serious fines on them and result in other legal consequences. Thus, the respondent insists that RE energy projects such as the project launched in 2017 is currently the best option moving forward. The current RE projects of the municipality assist with the current inconsistent energy supply of electricity from Eskom, provide employment opportunities in the construction of the RE technology and infrastructure in the CoE and share the electricity from RE sources the municipality generates externally from the electricity transmitted from Eskom.

4.6 Conclusion

The CoE has the largest concentration of industrial activity in South Africa which includes the manufacturing industry. The manufacturing industry has declined by 20% per year since 2001 largely due to globalisation and the inconsistent energy supply experienced since 2008. The CoE's policy and planning directives are aligned with the national and provincial policy objectives of the IEP (2016) and IRP (2018), namely, investing in sustainable RE infrastructure and technology, promoting an energy mix doctrine that emphasises incorporating RE in the municipal energy system, and strengthening the manufacturing industry, specifically plastic packaging production to increase production to develop the economic growth of the CoE.

The one – on – one interview fieldwork process with the municipal energy departments respondent identified the current RE sustainability project in the municipality that focused on a landfill methane and solar rooftop project. The CoE RE projects are a result of the municipal energy department taking steps in generating, sustainable clean energy. These RE projects indicate the CoE energy department's role in implementing the national policy directives in line with the IDP 2018/2019 – 2020/2021 waste management objectives. The municipal energy department takes account of the energy demand of the manufacturing industry, specifically the plastic packaging sector. The energy department regards the sector's output waste and the energy intensity of the production process, whilst making recommendations on how to lower waste output and GHG emissions to mitigate climate change.

The national and municipal policy and planning directives, however, do not bind the manufacturing sector to cooperate with the CoE and implement any policy directives laid out the policies such as the IEP (2016). This has proven to be a challenge for the municipal energy department in extending RE projects in the industrial sector of the CoE. Furthermore, the

Energy Regulation Act of 2006 passed by The Presidency in the DoE has created constraints for the municipal department to procure IPPs as part of the REIPPP to maximise the generation of RE in the CoE's energy system. However, the IPP, solar and methane projects are good initiatives to integrate RE in the city whilst alleviating the residential and industrial sectors from the inconsistent energy supply in South Africa. Proving the municipal department has taken steps to incorporating RE in the CoE and implemented the auspices of the IEP (2016) and IRP (2018).

Chapter 5

The packaging industry, Mpact factory and incorporating RE in the energy system

5.1 Introduction

The chapter analyses data relating to the main research question which seeks to identify whether incorporating renewable energy within the energy system of the Mpact plastic packaging factory can increase production. The chapter will investigate the research sub-question; whether RE infrastructure can ensure that there is consistent energy supply within the manufacturing industry, specifically the plastic packaging sector. The data used to answer this question included primary data gathered from the respondent one-on-one interview with the researcher at the plastic packaging Mpact factory, in the industrial area of Wadeville, Germiston located in the City of Ekurhuleni. The primary data will be coupled with secondary data from Mpact's 2008 sustainability report and other substantive sources to elaborate on the advantages or disadvantages of incorporating RE, solar power in the Mpact factory energy system to increase production. Furthermore, the analysis will provide a reminder as to why I chose the packaging industry within the manufacturing industry as a case study to address the research question.

Moreover, I will reiterate the advantages and disadvantages of RE solar power, RE technology and investments. This chapter will also provide an analysis from the collated primary data on the energy supply of electricity from Eskom and what the packaging factory intends to do to ensure a better energy supply within the factory's energy system. This chapter will begin with providing a brief overview of South Africa's packaging industry. The analysis will follow with elaborating on why RE, specifically solar power, is a viable option to incorporate in the energy system of the plastic packaging system to generating sustainable energy and increase production. Moreover, it will elaborate on the primary data extracted during the one – on – one interview in my fieldwork at Mpact plastic packaging factory.

5.2 The Packaging sector (of the manufacturing industry)

The economy of South Africa relies heavily on packaging (Pongracz, 2007). Manufactured goods cannot move effectively through the supply chain to reach consumers without proper packaging. Packaging functions as a protection, household, distribution, image – component, intermediate and value – forming element. As discussed in chapter 2, the FP&MSETA (2014) asserted that the total value of South Africa’s packaging industry was estimated at R48 billion, contributing to 1.5% of the country’s GDP in 2012. The contribution is projected to increase when South Africa’s urban base grows. The population growth in an urban area encourages the increase of consumer spending that will increase the demand for the packaging of goods. When the demand grows, the energy demand in the supply chain to produce packaging in factories increases ensuing the need for a consistent supply of energy to transmit generated electricity.

South Africa’s packaging sector of the manufacturing industry is regulated strictly in terms of environmental management. The fundamental legislation that must be adhered to includes the National Environmental Waste Act 59 of 2008 (FP&MSETA, 2014). Chapter 2 demonstrated that environmental damage from the improper disposal of used packaging material is prohibited by South Africa’s environmental legislation. The concern for ecological conservation, climate change mitigation, and sustainable development has resulted in the development of repairing the sector as the plastic packaging factory processes old packaging materials into new material in an environmentally friendly – manner.

Moreover, the plastic packaging sector encourages consumers to reuse the packaging items in the residential and industrial areas. For example, a plastic bottle that originally packaged rice, can be reused in the household to store children’s stationery. The economic instability of South Africa combined with raw materials (that distribute large amounts of waste) and energy price inflation has a negative impact on plastic packaging producers. The production process can be successfully fixed by incorporating RE sources such as solar power in the factories’ energy system, reducing output waste to mitigate climate change and the usage of sustainable raw materials throughout the production value chain.

The “throw away” practice in South Africa of packaging materials has created the biggest pollution issue concerning GHGs. Waste landfill sites near industrialised areas of the CoE

produce hazardous gases such as methane from discarded plastic, paper, and other packaged materials. Furthermore, the CSIR (2011) baseline report suggested that South Africa creates around 108M tonnes of solid waste from disposed packaging materials. This pollution is landfilled 90% in creating systematic landfills around South Africa's respective cities which further create challenges in environmental degradation, water, and sanitation (CSIR, 2011). Moreover, municipalities such as the EMM collect between 20 – 25 million tonnes of such waste per year (Ibid.). Below is a comparative analysis of the plastic packaging waste collected between 2014 – 2015.



Figure 5.1: BMI Packaging Cycling Report for 2014 -2017 in the city of Ekurhuleni.

The figure above shows a 3% growth of waste recycled from 2014 - 2017 and a collection rate of 46.5% of all plastics packaging material diverted from landfills for recycling. Organisations such as the Plastics SA and the Multilayer Packaging Forum are focused on an industry-managed system to develop sustainable packaging production options. The organisations aim to maximise the diversions away from landfills to clean up the environment specifically, the landfill sites affecting the communities adjacent the industrial areas of the CoE that emit the output waste.

The organisations intend to develop a system which will also reduce energy consumption in the production of packaging goods and create employment. Furthermore, organisations are creating guidelines that production factories must follow to develop better recyclable options of the packaged goods and unused raw materials in the supply chain of plastic packaging production (Plastics SA, 2017).

5.2.1 Sustainable Packaging

The constant pressure from government, consumers, and the call to mitigate climate change has placed pressure on the packaging industry to produce packaging in a sustainable manner. Debates on the type of material used to produce packaging have been centred on the usage of more paper and print products over plastic packaging items. However, there is an environmental impact for *each* of the packaging materials in the waste stream. An example is that a paper – based packaging product may be lighter than a plastic – based one. However, the disposal of card and paper landfills leads to the formation of methane which contributes largely to global warming (Packaging SA, 2018).

PricewaterhouseCoopers (PwC, 2010) asserts that the packaging industry needs to become more proactive in developing a consensus as to what exactly defines sustainable packaging. Industry leaders in the plastic packaging industry with the collaboration of government institutions such as the CoE energy department should set the standards to develop the increase of sustainable packaging. To create sustainable packaging, the following attributes need to be considered that include the packaging weight and volume and how it will be effectively reduced. The waste – to – landfill cycle will be dramatically reduced through a designed – in recyclability, reusability of the substrate. The packaging will also effectively reduce the waste through extending shelf life, preventing contamination and possible damage. The packaging will have a lower environmental footprint in terms of resources used in the production process lowering GHG emissions resulting in better air and water quality (PwC, 2010). Lastly sustainable packaging needs to be economically viable whilst ensuring that the packaging business meets profit growth whilst heeding to accelerating climate change concerns (Ibid.).

PwC (2010) points out that although the packaging industry intends to become more sustainable, there is a barrier in which consumers want sustainable packaging, but they are not prepared to pay for it. The challenge to achieve sustainable packaging is to look at the production cycle as a whole and not focus specifically on the packaging manufacturers. It is important to look at the sustainability impacts in the process of production and its end use and not just the packaging production process unilaterally. As previously mentioned, the inconsistent supply of energy of electricity from Eskom has lowered production by 20% per year since 2001 and limited the packaging industry to reaching EE (Creamer, 2018). Thus, to

effectively reach sustainability in the packaging sector holistically based on the research objectives, an alternative RE supply such as solar power may be incorporated in the energy system to increase production.

5.3 Renewable Energy Supply: Solar Power

Energy plays a fundamental role in the economic activity of a country and it is considered a substantial indicator of growth where a country that is most energy – consuming is the most advanced and the industry is most productive. Every energy source that generates and transmits power inevitably affects the environment. Gekas, Frantzeskaki and Tsoutsos (2005: 289) assert that ‘it is obvious conventional generating options can damage air, climate, water, land and wildlife, landscape, as well as raise levels of harmful radiation.’ Conventional energy sources such as fossil and nuclear require millions of years to form. RE sources are readily available in the ecology such as solar from the sun and hydro power from water. Thus, RE sources, infrastructure and technologies offer a safer solution to a plethora of social and environmental problems associated with conventional energy sources.

The main advantage of RE sources is their sustainability characteristics offering a positive impact on the environment, such as generating electricity from RE sources emits little to no harmful GHG emissions and has lower energy output waste. However, the main disadvantage of RE sources is the slow development of RE technology and infrastructure innovation in the energy market (Jozsa, Sljivac, Spajic, Topic and Vezmar, 2014). RE sources can solve the increasing global demand for alternative clean and unlimited energy sources. As RE demand continues to increase in South Africa so will the need for RE technology and development. A recall is needed in countries to create innovative technology measures to generate, transmit and store RE sources. To effectively use RE to generate sustainable electricity and create a consistent energy supply and demand system that will cater for the manufacturing industry specifically, incorporating RE, solar power in the plastic packaging sector.

5.3.1 Solar Energy: Advantages and Disadvantages

RE offers an opportunity for future lower energy costs. RE sources also provide options to mitigating climate change and generating sustainable energy. Solar energy has existed since the world began. It can be exploited in three ways through solar thermal power plants to

obtaining electricity and heat. Solar energy can be exploited through solar thermal systems for thermal energy and photovoltaic (PV) systems for electricity generation (Jozsa et al. 2014). PV systems generate electricity directly from solar energy radiation. They are based on semiconductor materials such as silicon in a variety of designs (Ibid. 2014). Solar thermal power plants possess three basic designs that include parabolic collectors, a central tower and power plants that possess parabolic dishes. Moreover, a solar thermal system uses solar energy to produce energy for heating and or for hot water. The sun is highly advantageous as it is free and provides endless source of energy (Ibid. 2014). Solar energy is being widely used by countries in the global North and slowly developing in the global South. Solar energy technology and infrastructure is easy to install. Most of the resources are constantly being developed as the energy source demand increases. Furthermore, it is highly energy efficient as it reduces the energy intensity for heating, cooling, and lighting (if daylight techniques are not used that need energy input).

Solar power advantages

Solar energy, infrastructure and technology have positive benefits to the environment and socio-economic development. Solar energy in the environment has positive implications in reducing the emissions of GHGs, whilst preventing toxic gas emissions such as SO₂. Solar energy sources provide an opportunity for the reclamation of degraded land and reduces the required transmission lines of electricity grids.

In relation to socio-economic benefits, solar energy, infrastructure, and technology increase the regional and national energy independency whilst providing significant work opportunities (Kadar, 2014). Furthermore, solar energy diversifies the energy supply of the country providing energy security and better energy resource management prospects. Solar energy also supports the deregulation of energy markets and accelerates rural electrification in developing countries. Moreover, solar energy can increase profit growth within industries through the increase of production.

Disadvantages of solar power

The unfavourable effects of solar energy, infrastructure and technology are minimal and can be minimised by appropriate mitigation measures. The disadvantages of solar energy include

high energy pay – back time in that there is immense energy needed to produce solar energy technology. Although solar power is limitless, it is seasonally produced in that it is stronger in summer and is less in winter (Kadar, 2014). Moreover, the reflected light from solar panels negatively affects millions of insects and birds as they mistake the solar panels for lakes. Furthermore, large areas that solar infrastructure take up can be used for agriculture to develop food security in South Africa (Ibid.). Solar infrastructure has weak mechanical resistance against ice fall in storm and the battery storage system technology is weakly manufactured making it unable to hold a large amount of energy capacity for longer periods of time (Ibid.).

However, solar infrastructure takes up large areas can be ordered in an appropriate central solar system. This involves careful evaluation of alternative locations that will be away from protected areas such as agricultural land. Solar systems that are needed in the residential sector can be installed anywhere, especially integrated in the roofs. Proper training of workers who install solar energy technology for appropriate operational practices is also needed. This includes rational water use, waste disposal practices, safety measures and the use of biodegradable chemicals (Gekas et al. 2005). Furthermore, there are a few companies in the solar industry that produce solar technology and infrastructure. The energy market needs to develop innovative technology and infrastructure to cater for the growing demand of solar power in South Africa and globally. The unexpected release of chemicals in generating electricity from solar power can be alleviated through the recycling of used chemicals, good practices, and appropriate disposal.

Solar energy has positive attributes and disadvantages that can be resolved through improved technology, better land use and the adoption of standards and regulation for environmentally friendly design and usage. Thus, solar energy can be a viable energy source that can be incorporated in the energy system of a packaging factory to increase production whilst reaching energy efficiency and mitigating accelerating climate change. Mpact's sustainability and operations profile will be elaborated in the next section to determine whether Mpact's energy consumption affects the plastic division operational sales and profit. Moreover, to define Mpact's energy, environmental profile to investigate Mpact's sustainability practices.

5.4 Mpact factory's sustainability profile

Mpact's business model is focused on an integrated approach in closing the loop in plastic and paper packaging through recycling and beneficiation. Its mission statement is labelled as smarter and sustainable solutions (Mpact, 2018). The Mpact company is the largest packaging and recycling business in Southern Africa focused on turning paper and plastic into sustainable packaging. its consumers include fruit producers, FMCG companies, packaging converters and other industrial packaging companies. Mpact possesses 40 operating sites which employed up to 6 000 workers in 2018 in Namibia, Mozambique and South Africa and generated a sum of R10.6 billion in revenue (Ibid.).

Mpact's national footprint in the leading packaging market position and its proximity to customers has helped with reduced transport costs in the city. This has contributed to Mpact's sustainability framework in achieving sustainable business practice (Ibid.). Moreover, Mpact is the largest collector of recyclable packaging that includes paper, plastic and glass. In 2018, Mpact collected 630 111 tonnes of plastic and paper recyclables pre and post – consumer sources. Thus, reducing the amount of waste material that goes into landfill sites (Ibid.). The liquid packaging recycling plant recycles 24 000 tonnes of used liquid cartons, saving 65 240m² of landfill space. Mpact's PET recycling plant processes 29 000 tonnes of used PET bottles per year, which saves around 180 000m² of landfill space, thus supporting the global drive to reduce plastic waste. Mpact's entire recycling division has ensured that the business has lowered 11 400 tonnes of carbon emissions (Ibid.). Thus, Mpact's entire recycling division supports the promotion of local beneficiation of raw materials and provides support for over 50 small business development that are involved in the recycling process.

Mpact's plastic packaging division and operational performance

Mpact's business plastic division focuses on sustainable business growth through innovation, the substitution of alternative packaging materials with rigid plastics. Business expansion through optimisation, acquisitions and securing new projects includes the plastics converting unit converted 86 928 tonnes of Polymers PET into plastic packaging products in 2018 (Ibid.).

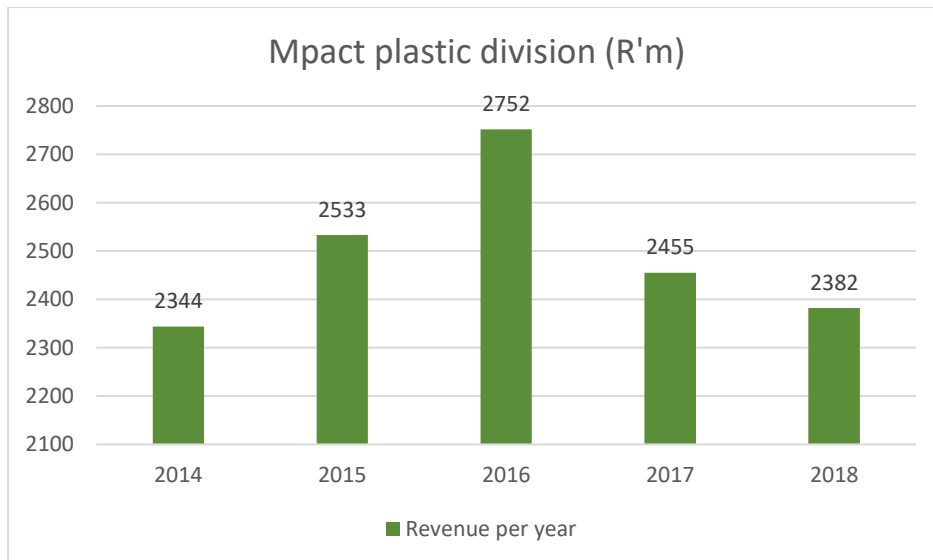


Figure 5.2: Mpact 2014 - 2018 plastic division segment revenue in millions. Source: Mpact sustainability profile 2018.

Figure 5.2 illustrates that the plastics division accumulated revenue of R2.4 billion in 2017, a decrease of 3% of 2016's revenue, due to lower sales volumes, that was offset by an average higher selling price (Ibid.). The sales volume in the plastics converting unit decreased by 10.6% because of performance decline. Sales of PET trays were up on new capacity; styrene trays were down due to increased competition and lower demand. Backward integration by consumers, the effects of sugar tax and inconsistent supply of energy in the divisions energy system also led to lower performance sales.

The operational profit for the plastic business decreased by 9% to R129 million. Due to the overcapacity in the styrene sector and increased polymer prices, Mpact could not recover in the weak market, resulting in lower margins. Mpact's plastic division reported an operating loss of R80 million as the business experienced low yields and higher maintenance costs due to dirty feedstock of PET bottles and inadequate washing (Ibid.). During the 4th – 1st quarter of 2018 – 2019 there was a delay of the delivery of new bottle washing equipment due to interruptions in securing funding. The loss was also due to units of products sold decreased from 2017 because the agricultural sector experienced continuous drought in their key markets. This affected the volume sale of apple trays and jumbo bins (Mpact, 2018). This consequence identifies the negative changes accelerating climate change causes for Mpact and the agricultural sector.

Mpact plastics division has formulated an action plan to improve competitiveness in their current challenging environment. This includes developing a plan to relocate some of the styrene capacity from Paarl to Johannesburg, increasing PET operations in Versapak and restructuring factories in Paarl, Wadeville and Versapak to increase performance (Ibid. 2018). The reduced market demand ultimately decreased production increased the energy intensity of per tonne of product production. The energy consumption per tonne of product increased to 5.08GJ in 2018 from 4.88GJ per tonne of product in 2017. As a result, GHG emissions increased by 1.4% in 2017 to 1.41% in 2018 (Ibid. 2018). Mpact's plastic division energy system transmitted electricity is generated from unsustainable energy sources such as fossil fuels that have high GHG emissions costs. The incorporation of RE in the energy system can generate sustainable energy whilst increasing production.

Mpact plastics has achieved substantial progress in reducing its environmental footprint. Furthermore, Mpact plastic division has implemented the IPAP (2017) policy objective in greening economies with integrating energy efficient production capacity and carbon mitigation efforts in their production process. Mpact plastics has an ongoing programme of upgrading plants with ancillary equipment that will implement a new production process that will reduce energy usage and allow for sustainable energy use (Ibid. 2018). For example, decreasing the production output waste that would have filled landfill sites in their adjacent residential communities whilst lowering their GHG emissions profile. The programme also included the installation of second solar PV array at the Wadeville plant in which the researcher conducted the respective one – on – one interview with the plastic packaging factory respondent. The environmental programme consists of a recycling initiative that includes the wheelie bin and crate recovery programmes. These have been created at Mpact's plastic division container manufacturing plants to reduce the demand for virgin polymers. The rPET manufacturing plant also remains a vital asset which is important in reducing production output waste to landfill amount. If Mpact uses the plant to its full capacity, it will save 180 000m² of landfill space each year (Ibid. 2018).

5.4.1 Mpact's sustainability profile: Environment and Energy Efficiency

Environmental sustainability is one of the core values of Mpact. As environmental legislation in South Africa continues to evolve, Mpact ensures that it complies with all relevant legislation that applies to their manufacturing process. Mpact reflects the role played by the business in

closing the loop on the circular economy (an economic system aimed at eliminating waste and continued use of natural resources) with recycling activities. Mpact is solely supplied by the recycling division for sustainable raw materials such as fibre, PET and HDPE (for manufacturing wheelie bins and crates) (Mpact, 2018).

Business operations especially in paper mills, is very dependent on water. Mpact's in this regard focuses on optimising water usage in a sustainable manner. The total water consumption for 2018 increased by only 1% at 4378 MI from 4340 MI in 2017, compared to the 5% increase in total production in previous years (Ibid.). Mpact's water conservation efforts over the past two years have resulted in municipal water consumption decreasing by 47% against the 2015 baseline. The Versapak Paarl and Wadeville achieved a saving of 72%. Mpact's water resource programme is also substantial in mitigating climate change as the decrease of water usage in the manufacturing process also improves water quality resources. There will be less liquid output waste which will fill landfills and ultimately filtering the water resources of neighbouring communities.

Mpact possesses a group energy manager that is responsible for analysing the energy usage profiles of the business manufacturing plants whilst developing programmes to monitor and report usage. That will also assist with projects to reduce energy use and generate electricity from an alternative energy source where possible (Ibid.). Mpact's energy focus is sourcing alternative energy sources which are clean and sustainable such as RE, specifically solar and wind power. The energy programme processes are already put in place to reduce energy use, Mpact's ecological footprint with lowering GHG emissions, fossil fuel use and ash generation.

For instance, all Mpact's manufacturing sites use online metering to ensure accurate reporting and availability of real-time and routine energy reporting data (Ibid.). The energy savings are evaluated in every manufacturing site each month against the 2014 baseline consumption. In Wadeville a 1 026 kWp facility was installed in 2018 and further solar PV installations are being negotiated by the group energy manager for other Mpact sites (Ibid.). The energy efficiency initiatives that were implemented in 2018 include upgrading boilers at Piet Retief and Springs Paper mills and achieving and exceeding the targeted 15% energy reduction at Wadeville and the Felixton mill (Mpact, 2018). This percentage projection is well on its way and the energy reduction is expected to increase as the incorporation of adequate RE in the energy system to achieve sustainable energy generation and increase production.

The following section will investigate whether incorporating RE, specifically solar power in the energy system will increase production. And can it be applied to the rest of the plastic production sector of the manufacturing industry. Moreover, the primary data extracted from the one – on – one interview investigated whether incorporating RE in the energy system created the generation of sustainable energy. Furthermore, did it assist Mpact in mitigating climate change through lowering GHG emissions of energy generated and consumed.

5.5 Mpact plastic packaging factory production and RE solar power

The Mpact plastic packaging factory was chosen as a core case study to gather primary data. Due to Mpact's focus on achieving sustainable profit growth through the usage of clean green energy and ecological conservation. Mpact's plastic packaging factory's business model system aims to manufacture plastic packaging through beneficiation and recycling. Mpact is the largest collector of recyclable packaging products from post and pre-consumer sources. The factory is situated in the CoE's industrial sector and has a plethora of factory plants in the CoE taking up a substantial amount of area within the city's industrial sector (Mpact, 2018).

The researcher wanted to find out can incorporating RE in the energy system of the plastic packaging Mpact factory can be a reliable energy option to increase production and can it be implemented across the plastic packaging sector. In addressing the research sub-questions, the researcher further aimed to identify the barriers in the packaging sector to implementing RE in the energy system to increase production. Furthermore, the research objective was focused on investigating which RE infrastructure and technology can ensure that there is consistent energy supply within the manufacturing industry, specifically the plastic packaging sector.

The respondent began the interview with giving a brief overview of the plastic packaging factory. The respondent mentioned that the packaging factory has three different divisions that are coordinated through recycling, production and selling the plastic packaging products. Recycling is fundamental to the Mpact factory, because it ensures that the factory sources raw materials such as PET, HDPE and fibre solely from the division thus, reducing the waste to landfill ratio. The factory has been operating since the 1970s and has changed ownership 3 times until Mpact bought it and started to produce plastic packaged products.

When asked since the factory has been operational, how long has the production been affected by inconsistent energy supply from Eskom, the respondent argued that since the power outages also known as load shedding started in 2008 across South Africa (SEA, 2015). The power outages cause serious concerns for the factory as any interruption of power sets production back by 4 hours to re-start the process. Moreover, the solidifying and moulding process of plastic sets the factory 12 – 16 hours back for it to be ready again and able for producing packaging products. Since the factory has identified these constraints caused by the inconsistent energy supply, the factory has not done a great deal of changes. The respondent stated that the energy supply interruptions are not as constant enough for the factory to build its own energy unicorn and detach itself from the energy transmitted from the national energy system supplied by Eskom.

The factory consumes only 7MW of electricity a day and it would take R10 – R15 million for the factory to build its own independent energy system to generate and transmit electricity from RE, solar power. Although the factory does experience production loss, it can be regained when the power comes back on. This can be done through the production of plastic products that have a quicker return time, such as plastic lids for PET bottles.

The factory has however started putting smaller generators below the factory. The Mpact factory began installing the generators around 2010 when they saw that the power outages caused by load shedding were still running and an alternative energy back up was required. The generators keep the raw materials dry and save a huge amount of production that would be lost if the generator was not operational. The cost of maintaining a generator has its own constraints. The cost to service a generator is quite expensive and some of the factory's generators are not only used when the power is down. The respondent mentioned that the current load shedding schedule is not accurate. The factory needs to keep a certain number of generators and run concurrently with the electricity transmitted by the grid in case there is a power outage. To save the production time of packaging products that would set the factory back by 12 – 16 hours if the power outage occurs.

In business terms since the dawn of inconsistent electricity supply, there has been a short supply of goods produced as customers have opted to lower the risk of their businesses. Consumers who purchase packaging goods from the Mpact factory and the packaging sector at large since the power outages began have adopted vertical integration in their business

practices. Consumers no longer put their 100% supply in one company, instead they formulate a basket case approach in dividing supply into 2 – 3 companies to achieve best results. Moreover, some consumers have opted to build their own packaging wing in their companies to decrease the risk of not achieving best packaging business results at a quicker return rate. The inconsistent energy supply thus has created a snowball effect for the factory, the packaging sector and the business value chain of supply and demand at large.



Figure 5:3 Solar roofing system on the Mpact plastic packaging factory in Wadeville, Germiston.

As part of Mpact's sustainability programme in their manufacturing factory's achieving energy efficiency, Mpact's plastic packaging factory in Wadeville, is focused on sourcing alternate energy that is clean and sustainable such as RE, specifically solar energy power (Mpact, 2018). As illustrated in figure 5. 3. The factory has installed a solar roof energy system that generates and transmits electricity from solar power into the factory. The installed solar energy system generates and transmits the consumption total of 1.2 MW – 1.5 MW of electricity a day.

The interview respondent further declared that the factory chose to use solar power as RE alternate source because it is easily accessible and inexhaustible. RE solar technology and infrastructure is also relatively cheap to build as compared to other RE technology such as wind and biofuel. Mpact has land area to build the infrastructure and the technology can be incorporated easily in Mpact's energy systems grid. The factory does not have an independent renewable energy battery storage system as the technology existing in South Africa for it has not advanced effectively for longevity and is quite expensive.

The company is focused on sustainability, specifically in achieving a positive recycling and environmental impact in their production process. The respondent stated that the company has formed projects to incorporate RE supply within the production of the manufacturing process. The paper production area of Mpact is currently investigating waste – fuelled energy supply from recycling. The research is conducted through paper fibre and how steam would be used to go into a cylinder to generate electricity as it would for gas, oil or coal. This would be done to burn waste to generate steam that would later be used to generate sustainable and reliable energy.

As a follow up question, to the measures taken to ensure the factory does not suffer from the inconsistent energy supply of electricity from Eskom. The researcher noted that to incorporate RE within the energy system of the factory, it would need substantial technology and infrastructure that will include an energy battery storage system. Which will store the solar power absorbed and then used to generate and transmit electricity in the factory when the power outage takes place. The researcher then asked the respondent if the Mpact company would build its own RE, solar power energy base to ensure production runs smoothly. The respondent stated that, the company would not as South Africa's Energy Regulation Act of 2006 does not allow companies and citizens to generate more than 10 MW of their own independent electricity (Energy Regulation Act, 2006). Thus, Mpact building its own RE energy base would be of a disadvantage to the company. They would not be allowed to exploit the energy systems technology and infrastructure to generate the maximum amount of electricity from RE, solar power.

Instead Mpact's plastic division installs technology and infrastructure in each factory's plant that reduces energy consumption in the production process to reach energy efficiency. Whilst ensuring factories incorporate RE, solar power in their energy systems to increase production and lower GHG emissions to mitigate climate change. The Mpact plastics division is upgrading their factory plants with ancillary equipment that will give factories a new production process that consumes 15% less energy and water usage (Mpact, 2018). The respondent stated that in the Wadeville plastic packaging factory the ancillary equipment has been installed. Following the second installation of solar PV arrays. The new technology has decreased the plastic packaging goods energy intensity. Whilst the solar PV arrays will increase the electricity

generated and transmitted in the factory from solar power by 5% - 10% from the 1.2 MW – 1.5 MW by the end of 2019.

The respondent made a point in elaborating on Scandinavian countries such as Sweden & Finland and how their towns generate their own electricity from RE specifically, hydro and solar power. Mpact possesses waste – fuelled energy stations that maximise the natural resources of hydro and solar. Thus, if the factory did build its own energy base and the Energy Regulation Act of 2006 allowed companies and citizens to generate limitless independent energy, the framework would be centred on an optimisation principle. It will focus on generating electricity from clean, green RE sources and using little to no fossil fuel-based sources to obtain energy power. Moreover, the factory would also minimise waste to landfill in conducting energy recovery by generating electrical power from the waste. And absorb enough solar power per day to generate electricity that would be transmitted through the grid to increase plastic packaging production. However, waste optimisation is not enough for the factory to generate self – sustaining and reliable energy. Moreover, as mentioned, solar power battery storage technology is not advanced enough to generate and transmit self – sustaining energy either. Thus, both RE sources can assist in limiting the damage done by the inconsistent supply of electricity currently. However, it is not enough for the factory to go off the grid and rely solely on an energy base that would be built.

The researcher further investigated whether factories situated in the industrial area of Wadeville have a union that was formed to resolve the current inconsistent energy supply challenge. The respondent stated that the industrial area's factory executive unfortunately has not. However, factories and operational managers within the Wadeville area in Germiston have not come together to formulate a solution to the inconsistent supply of electricity. This consequence needs a collaborative unit that will work together to achieve an area energy system that will generate and transmit sustainable and reliable energy for the Wadeville industrial area to increase production and reach energy efficiency.

Furthermore, the respondent stated that globalisation has caused the immense decline in the manufacturing sector through liberalising global markets. Resulting in cheaper imports of manufactured goods than those manufactured in South Africa. However, the supply and pricing of electricity has also caused a 20% decline since 2001 within the manufacturing sector (Bhorat and Rooney, 2017). The rise of electricity pricing over the years has caused profit

eroding (in that the price of producing a product becomes greater than the profit that can be obtained from the product). This has caused the closing down of many factories in the CoE. The more the plastic packaging factory goes down the value chain, energy supply is the 3rd highest unit cost and has increased in the last 10 years. This has then resulted in the decline of the GDP in the manufacturing sector. Thus, a price competitive advantage of incorporating RE in the energy system in the factory can help increase production in the business perspective. This can be achieved only if RE can counter the current price of transmitting electricity generated by Eskom in the factories grid.

The respondent asserted that that the factory has a limited relationship with the local CoE municipality, specifically the energy department. The Mpact factory aligns its energy processes to the national and municipal energy policies and guidelines. South African policies and the CoE guidelines do not legally bind the manufacturing sector to implement the formulated principles to create an alternative energy mix from RE sources in the energy system and invest in the RE technology and infrastructure. Mpact coordinates these principles under the sustainability programme of their company and their concern to mitigate climate change and conserve the ecology. The packaging factory operates within the legal policies that are currently available such as the DoE's Energy Regulation Act of 2006 guideline. That citizens and companies are prohibited from generating more than 10MW of electrical energy per month.

Furthermore, the respondent stated that although the CoE has frameworks and guidelines to incorporating RE in the city and the manufacturing sector such as the NIPF main objective to contribute to industrial development in the CoE in building its own productive capabilities (IEP, 2016). It has not done much in promoting RE projects in the packaging sector. The relationship between the factory and industries in Wadeville as a whole and the CoE, municipal energy department is distant and concerning. Once the relationship can be repaired through, i.e. a sustainability energy project, this can also fast track the incorporation of RE in the energy system to increase production, reach energy efficiency and mitigate climate change.

The respondent asserted that the Mpact factory does take cognisance of the UN 17 SDGs under Mpact's sustainability programme. Mpact factory focuses on goals that aim to mitigate climate change and life on land. The respondent mentions that in achieving sustainability and

lowering GHG emissions, businesses need to make money, or else the business will cease to exist. Thus, the Mpact factory aims to achieve sustainable profit whilst aiming to reach the SDGs focused on climate action, life on land and ecological conservation. Mpact plastic packaging factory aims to achieve sustainable energy generation and transmission to achieve sustainable profit and sustainable business practice. Furthermore, the factory can, if the opportunity deemed it so, collaborate with the municipality to complete energy projects.

The collaboration between the factory and municipality would work best in implementing solar power generating energy projects. An example would be for the municipality to fund the project and then buy the generated electricity back at R0.90 per unit from the factory of packaging sector at large. Furthermore, the CoE municipal energy department can begin by mending its association with the manufacturing industry. By creating a consortium within the manufacturing industry and leverage what investments and energy resources they have available. The respondent noted that the CoE has the potential to recreate the manufacturing sector to become a green island that distributes 0% waste, facilitate guidelines to decrease climate change and conduct sustainable environmental planning. Whilst focusing on implementing an energy and sustainability project in the plastic packaging sector to lower energy consumption to reach energy efficiency and drastically reduce the waste to landfill in the adjacent communities. Consequently, to form an interconnection with the manufacturing industry can assist the CoE with the upkeep of energy infrastructure, technology and the maintenance.

5.6 Conclusion

The economy of South Africa relies heavily on packaging as it has contributed to 1.5% of the country's GDP in 2012. The population growth in the urban area encourages an increase in consumer spending which will increase the demand for plastic packaging goods. This will ultimately increase the energy demand in the supply chain of producing packaging goods. Energy is a substantial indicator of growth in a country and an industry is most productive when it has a consistent supply of energy to increase production. Thus, the consistent energy supply to transmit sustainable generated electricity from RE sources, specifically solar power is needed. Solar energy has positive socio-economic benefits through creating work opportunities, lowering energy costs in generating electricity for consumption. However, the disadvantage of solar power is the limited options for solar technology that currently exists in

the market. The energy market needs to create innovative technology, specifically the battery storage system, so that the Mpact factory can create a sustainable solar energy plant that stores, generates and transmits sustainable energy.

The 'throw away' practice in South Africa of packaging goods has created environmental concerns resulting in pollutions of high GHG's emissions. The adjacent communities of the industrial areas suffer the most from the pollution and increasing waste in the landfills. The CoE collects 20 – 25 tonnes of waste per year resulting in a 3% waste reduction from 2014 – 2017 a year and recycles 46.5% of plastic packaging materials from landfill sites. The CoE uses the waste collected for energy recovery in generating energy from methane to transmit sustainable electricity. Furthermore, in 2018 Mpact collected 630 111 tonnes of plastic and paper recyclables from pre and post – consumer sources. The CoE and Mpact recycling process mitigates climate change and environment conservation in reducing waste in the adjacent communities in the industrial area of the Mpact plastic packaging factory, using GHG emissions for energy recovery projects and producing plastic packaging products from recycled materials.

Mpact's business model is focused on sustainability and creating smart solutions whilst regarding the conservation of the environment. The Environmental Waste Act of 2008 focuses on mitigating climate change and ecological conservation. Thus, Mpact focuses on closing the loop between waste and packaging production through a circular economy with recycling activities. Mpact takes cognisance of reducing pollution, lowering GHG emissions and ensuring sustainable conservation of water and land resources. Mpact's sustainability profile engenders EE and the usage of renewable energy sources in the factory production plants. The Mpact plastic packaging factory has installed a solar roofing system to generate 1.5 MW of electricity from solar to transmit sustainable energy, resulting in lowered GHGs emissions from the reduced energy waste output. Furthermore, Mpact plastic packaging factory has had a 15% energy reduction because of the installed ancillary production equipment that reduces the amount of energy input needed to produce plastic packaging goods.

The creation of an industrial union of the plastic packaging factories in the Wadeville area is needed to develop further RE projects for the plastic packaging sector to develop a consistent energy supply from RE, solar power. Furthermore, as the Mpact plastic packaging factory cannot build its own energy base to resolve the inconsistent supply of energy from Eskom.

The industrial union can invest and build innovative RE, solar technology and infrastructure specifically an energy battery storage system that will ensure the packaging sector has a consistent supply of electricity generated from solar power that operates externally from the national grid energy supply.

Furthermore, the CoE municipal energy department needs to repair its relationship with the plastic packaging sector in the manufacturing industry to ensure that the sector and the city develops its sustainable energy projects from RE, specifically solar power. This will ensure that the plastic packaging sector follows the CoE's energy guidelines, creates a better maintenance plan for RE technology and infrastructure in the city and the incorporation of RE, solar power increases production in the Mpact plastic packaging factory and the plastic packaging sector whilst mitigating climate change and reach EE.

Chapter 6

Conclusions and Recommendations

6.1 Introduction

Throughout the research report, an effort was made to shed light on the importance of South Africa achieving energy security which is the vast availability of energy sources at affordable pricing. South Africa needs to incorporate an alternative energy mix in its energy system with a focus on RE to reach EE, mitigate climate change through reduced energy waste output and lowered GHG emissions. RE sources are vastly available and have lower energy costs in the generation and transmission of electricity production. Incorporating RE in the national energy system will ensure South Africa achieves a consistent energy supply to generate and transmit sustainable electricity to increase production in industries, specifically the plastic packaging sector.

The research case study focused on the Mpact plastic packaging factory because of its business model that focuses on sustainable packaging and ecological conservation such as reducing energy consumption in the production process of plastic packaging goods. This includes implementing a circular economic system that eliminates waste and the continued use of natural resources with recycling activities. An example, the Mpact plastic packaging factory is solely supplied by the recycling division for raw materials such as fibre and PET. The incorporation of RE, specifically solar power in the energy system of the Mpact plastic packaging factory can increase production, mitigate climate change and reach EE.

This chapter consolidates the findings and gives an analysis of the arguments presented in the research study on, to what extent can incorporating RE, specifically solar power in the energy system of the Mpact plastic packaging factory increase production and whether it can be implemented in the packaging sector. A consolidation of the background of the research study is given to elaborate why conducting the research study was necessary. This will be followed by a review of the research question and sub - questions and an analysis on the research question and sub – questions findings. The chapter will conclude with outlining recommendations that can be applied in the plastic packaging sector and the CoE. The

recommendations can be used to develop a consistent energy supply from RE, specifically solar power, increase production in the plastic packaging sector, generate sustainable energy, mitigate climate change and reach EE.

6.2 Background

South Africa's energy system is dominated by the dependence on fossil fuel-based energy sources which has since 2008 created the inconsistent energy supply of electricity from Eskom. This has resulted in frequent power outages (known as load – shedding) that have affected livelihoods in residential sectors and decelerated production in the manufacturing industry slowing down the process. Energy is the backbone of the economic growth of countries in the global community and a substantial indicator of growth where a country is most advanced when the industry is most productive. Thus, it is imperative for South Africa to reach energy security to create a consistent energy supply in the country's energy system.

Energy security is necessary to develop the national interests of South Africa which include sustainable development, human well-being and proper functioning of the economy such as the plastic packaging sector having access to consistent energy supply from Eskom to produce plastic packaging goods. The energy policies, such as the Integrated Energy Plan (IEP) provide implementation frameworks to build and invest in infrastructure and technologies for different energy sources. The CoE has vital RE projects such as the solar roofing projects on municipal buildings as an implementation programme established under the IEP (2016) energy mix doctrine. That focuses on incorporating RE sources in the energy system of South Africa and municipalities to develop a consistent energy supply, generate sustainable energy that reduces energy output waste and GHG emissions per energy unit.

The economy of South Africa relies heavily on packaging, without proper packaging, the distribution of manufactured goods to consumers would pose as a challenge. The manufacturing industry experienced a 20% production decline since 2001 because of the inconsistent energy supply from Eskom caused by power outages in their production supply chain. The decline in production resulted in the plastic packaging sector losing demand for produced plastic packaged goods previously supplied for businesses in the FMCG, agriculture and mining industries. As urbanisation grows, the population encourages the increase of consumer spending, which increases the demand for packaging goods. This will increase the

energy demand in the supply chain to produce the increased demand of plastic packaging goods.

RE, specifically solar power can ensure a consistent energy supply is created in the manufacturing industry, specifically in the plastic packaging sector. RE, solar power mitigates climate change through reducing GHG emissions and energy waste output in the environment and ensures the energy system reaches EE in the energy distribution process. RE technology options in South Africa are minimal and the energy battery storage system is weak. This creates an opportunity for the plastic packaging sector, specifically the Mpact factory to build innovative technology to create a consistent energy supply that generates sustainable electricity. Thus, the incorporation of RE, specifically solar power in the energy system can increase production.

6.3 Research Questions

The research study answered the research question, “to what extent can incorporating RE in the energy system of the plastic packaging Mpact factory in the city of Ekurhuleni be a reliable energy option to increase production and can it be implemented in the plastic packaging sector?” In order to respond to this question, it was necessary to develop sub-questions which would identify the barriers, national energy policies, infrastructure and technology to incorporate RE, solar power in the energy system of the Mpact plastic packaging factory to increase production. Chapter 4 examined incorporating RE, solar power in the CoE to answer the research sub questions, “Which policy measures in the local municipality can be implemented to steer industries to integrate investments to generate electricity from renewable energy?” Following “Can renewable energy infrastructure and technology ensure that there is consistent energy supply in the manufacturing industry, specifically in the plastic packaging sector?”

Chapter 5 responded to the research question and research sub-question, “what are barriers in the manufacturing sector in implementing renewable energy in the energy system to generate sustainable energy and increase production?” The findings in chapter 4 and 5 of the research questions and sub-questions allowed for the analysis of incorporating RE, specifically solar power in the energy system of the Mpact plastic packaging factory in increasing production and how can it be applied to the plastic packaging sector. The next

section will provide a condensed analysis of the research findings presented in chapter 4 and 5 of the research question and sub-questions. The chapter will conclude with outlining recommendations that can be applied to incorporate RE, specifically solar power in the energy system of Mpact plastic packaging factory and can it be applied to the plastic packaging sector.

6.4 Overall Findings and Conclusions

6.4.1 Mpact plastic packaging factory, RE, solar power

The incorporation of RE, solar power in the energy system of the plastic packaging Mpact factory is a reliable energy option to increase production and it can be implemented in the plastic packaging sector. Solar power energy is the most viable RE source to diversify the energy supply of the Mpact plastic packaging factory and the plastic packaging sector. Solar power is inexhaustible and has infrastructure that can be easily installed and incorporated in Mpact's energy system. However, the current solar energy battery storage system technology that exists in the energy market is inadequate because it is not durable. Thus, limiting Mpact's solar energy, roofing system on the plastic packaging factory in Wadeville, Germiston to function externally from the municipal grid system. The solar roofing system stretches across the roof taking up minimal space of the building of the factory and is grid tight (it generates and transmits electricity concurrently with the energy supply from Eskom).

The operational profit in the Mpact plastic business division decreased by 9% to R129 million in 2018. The loss was due to units of products sold decreased from 2017 in the FMCG and agricultural sectors. The reduced demand decreased production and increased the energy intensity per tonne of the product production. The energy consumption per tonne of product increased to 5.08 GJ in 2018 from 4.58 GJ per tonne of product in 2017. The GHG emissions increased by 1.4% in 2017 to 1.4% in 2018. The energy system transmitted electricity that was generated from unsustainable energy sources such as coal that possesses a high GHG emission profile.

Brandt et al. (2010) assert the energy used to produce plastic goods is considerably less than the energy needed to produce packaging with other materials such as paper and glass. Mpact plastics division has since installed ancillary equipment to implement a new production process that has reduced the energy use to produce packaging goods. Mpact has installed a

second solar PV array in the roofing system of the plastic packaging factory in Wadeville which generates and transmits 1.2 MW of clean sustainable electricity. These technological developments have increased production through producing units at a quicker return time with lesser energy use, enabling more plastic packaging units to be produced. The technological developments have also decreased output waste that would have filled landfill sites and lowered the GHG emissions profile, mitigating climate change.

The Mpact plastic packaging factory has been affected by the inconsistent energy supply of power outages from Eskom since 2008. The power outages set production back by 4 hours to restart the production process and 12 – 16 hours to restart the solidifying and moulding process. The factory has not done any significant changes as the energy supply interruptions are not constant enough for the factory to build its own energy base and detach itself from the national energy system supplied by Eskom. The factory consumes 7 MW of electricity a day and 1.2 MW is generated from solar power and the production loss is regained when the power comes back on. This is usually accomplished by producing plastic production that have a quicker return time such as plastic lids for PET bottles.

Mpact plastic packaging factory to incorporate RE, solar power in the energy system in the factory to effectively increase production and generate sustainable energy, it would need innovative technology and infrastructure that includes an energy battery storage system. It will store solar power absorbed from the sun, generate and transmit clean sustainable electricity in the factory when the power outages take place. The factory does not have its own energy battery storage technology system as the current battery systems available in South Africa's energy market are weak and cannot store the amount of MW of solar power needed to generate, transmit and be consumed by the factory external from the grid. Furthermore, the factory would need R10 - R15 million to build its own independent energy system to generate and transmit electricity from RE, solar power. The factory has installed generators that run concurrently with the electricity transmitted from the grid to save production time that would set the factory back by 12 – 16 hours if the power outage occurs.

Thus, the Mpact plastics division installed solar power technology and infrastructure in the Mpact plastic packaging factory that has reduced energy consumption by 15% and reached EE. It has ensured the reduction of energy intensity used to produce packaging goods whilst increasing production and lowering GHG emissions to mitigate climate change. Furthermore,

the installed solar PV arrays will increase the electricity generated and transmitted in the factory from solar power by 5% - 10% by the end of 2020 providing additional sustainable energy incorporated in the energy system of the Mpact plastic packaging factory.

The incorporation of RE, solar power can be implemented in the plastic packaging sector in integrating the technological improvements and online metering evaluation the Mpact plastic packaging factory has established in their plants to increase production, generate sustainable energy and lower GHG emissions.

6.4.2 Barriers in implementing RE, solar power in Mpact plastic packaging factory

Mpact plastic packaging factory is limited to building its own RE, solar power energy base to ensure there are no energy interruptions in the production process, increase production, generate sustainable energy and the factory becomes independent from the national energy systems grid. The South African Energy Regulation Act of 2006 prohibits companies and citizens to generate more than 10 MW of their own independent electricity. Thus, the Mpact factory would not be allowed to exploit the energy bases' energy systems capacity to maximise the amount of electricity from solar power it can generate a day. Unless, the Energy Regulation Act of 2006 is revised, the construction of a solar power energy base would be at a disadvantage to the Mpact plastic packaging factory as the excess of electricity generated and transmitted would be illegal. This could result in legal fines and action for the Mpact factory from the National Energy Regulation Authority.

Although solar power technology and infrastructure is cheap and easy to install, there are minimal options available in South Africa such as the battery storage system. Mpact factory needs a battery energy storage system that will function externally from the national energy systems grid. The battery storage system will ensure that the factory gains energy independence from Eskom's energy supply, increase production in the long – term, generate sustainable energy and lowers GHG emissions. However, the current solar energy battery storage system available in South Africa's energy market is weakly manufactured and expensive. The technology has not advanced enough for longevity and cannot store the maximum solar power absorbed from the sun for a day needed for the Mpact factory to generate and transmit electricity when power outages take place. Thus, Mpact factory needs

to invent alternative RE, solar power technology to resolve the inconsistent energy supply from Eskom and increase production in the long – term.

6.4.3 Policy measures in the CoE to incorporate RE

Although the Mpact factory aligns itself with South Africa’s national energy policy principles such as the IEP (2016) energy mix doctrine and the IRP (2018) investment in RE technology and infrastructure, the national energy policies do not legally bind the factory and plastic packaging sector to implement the formulated principles. The Mpact factory operates within the legal guidelines such as the Environmental Management Act of 2008 and the Energy Regulation Act of 2006 that prohibits the factory in generating more than 10 MW of electricity per month. The Mpact factory abides by the legal guidelines because of Mpact’s business model focused on sustainability and smart solutions.

The Mpact plastic packaging factory and the plastic packaging sector has a very limited relationship with the CoE, specifically the energy municipal department. The municipal energy department has formulated RE frameworks and guidelines for an investment strategy and incorporating RE, solar power, technology and infrastructure in industries. The CoE guidelines have been formulated under the GDS 2055 and CoE IDP policy strategies to create investment opportunities to develop the manufacturing industry and promote resource sustainability such as incorporating RE, solar power in the plastic packaging sector. However, it has not done much to promoting the implementation of the guidelines, frameworks and creating RE projects in the Mpact factory and plastic packaging sector. The respondent in the Mpact plastic packaging factory stated that the relationship between the factory, the CoE municipal energy department and factorys in the plastic packaging sector is non-existent. Once an association can be established in, i.e implementing a sustainability RE project, it can fast track the incorporation of RE in the energy system to increase production, reach energy efficiency and mitigate climate change in the plastic packaging sector.

RE, solar power is a reliable energy option that can be incorporated in the energy system of the Mpact plastic packaging factory and be implemented in the plastic packaging sector. The technological improvements in the production equipment and the installation of additional solar PV arrays had reduced energy use by 15%, ensured that plastic packaging goods are produced at a quicker return rate which increased production. The incorporation of RE solar

power and technology has guaranteed the Mpact plastic packaging factory generates sustainable energy, reduces energy and production waste output which has lowered the GHG emissions profile. To increase production in the long – term, further recommendations need to be made to ensure the incorporation of RE solar power in the energy system of the Mpact factory and the plastic packaging sector achieves this.

6.5 Recommendations

The technological installations in the Mpact plastic packaging factory by the Mpact plastics division have increased production, generated sustainable energy and lowered GHG emissions. However, to increase production in the long – term and resolve the inconsistent energy supply in the Mpact factory a RE, solar power battery storage system needs to be installed in the energy system of the factory that will function independently.

Since the Mpact factory cannot build its own solar power energy base because of the Energy Regulation Act of 2006 that restricts them from generating more than 10 MW per month, the Mpact plastic division can invest in building an innovative energy battery storage system. The energy battery storage system must be manufactured for longevity and absorb enough solar energy from the sun to generate and transmit sustainable electricity in the factory for when a power outage occurs. This will reduce the number of generators used during a power outage which will also alleviate the Mpact factory from maintenance plan costs of the generators. The Mpact factory will not have to regain any production losses when the power from the energy supply from Eskom comes back on and the production process can continue without interruptions. Moreover, Mpact can sell the solar power battery storage systems and a maintenance plan to the plastic packaging sector to increase production and generate sustainable energy. This will create additional revenue for the Mpact plastics division that can be re-invested in Mpacts plastic division sustainability profile programmes such as the water resource programme.

Mpact's plastics division business model and sustainability profile's core value is focused on adhering to South Africa's environmental legislation. An example is the Environmental Management Act of 2006 and applying it to their factory plants. Although Mpact aligns itself with the national energy policies such as the IEP (2016) formulated principles, it is not legally bonded to adhere to them. Thus, the DoE can use the formulated principles under the IEP

(2016) and IRP (2018) to create a legislative Act such as an Alternative Energy Mix Act of 2020 that obliges industries in South Africa to incorporate RE, solar power in their energy system to increase production.

The Act can bind industrial sectors such as the plastic packaging sector to install RE technology and infrastructure in their factory plants and invest in implementing energy recovery models in their circular economic systems, to generate electricity from recycled products such as methane and paper. The generated electricity can be sold back to Eskom's national grid as part of the REIPPP programme. The Act will ensure that South Africa moves away from fossil fuel-based sources dependence and obtains a balanced energy mix to generate and transmit sustainable electricity in the national energy system. This will ultimately lower South Africa's GHG emissions profile, increase the production of the manufacturing industry and reach EE.

The plastic packaging sector and the municipal energy department need to create a union to formulate solutions to the current challenge of the inconsistent supply of electricity from Eskom. The union can ensure that the plastic packaging sector follows the guidelines of the policy programmes of the CoE. This will assist the CoE in implementing policy strategies to growing the local economy and increase production in the manufacturing industry. The union will provide institutional capacity for the plastic packaging sector to create an energy system that will generate and transmit sustainable electricity sourced from RE, specifically solar power.

The energy system can be built in the Wadeville, industrial area as an alternative energy system that transmits clean energy when the power outages in the area occur. The energy system will limit the use of generators and the union can create a better maintenance plan for the energy system to function properly. RE, solar power is a reliable energy option that can be incorporated in the energy system of the Mpact plastic packaging factory and the plastic packaging sector to increase production. RE, solar power reduces energy waste output resulting in lower GHG emissions and provide energy independence for South Africa and the plastic packaging sector.

The recommendations can be implemented to eradicate the legislative and technological barriers to increase production in the long – term in Mpact factory and the plastic packaging sector. Furthermore, the recommendations can be implemented in the manufacturing

industry to ensure that the effective use of sustainable energy in their production process increases production, lowers GHG emissions and reaches EE.

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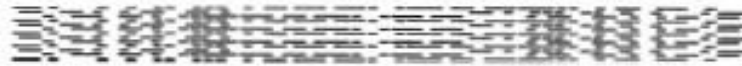
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Appendix A

Ethics Clearance Certificate



SCHOOL OF ARCHITECTURE AND PLANNING HUMAN RESEARCH ETHICS COMMITTEE



CLEARANCE CERTIFICATE PROTOCOL NUMBER: SOAP064/06/2019

PROJECT TITLE: The incorporation of renewable energy in the manufacturing of plastic & packaging within the city of Ekurhuleni

INVESTIGATOR/S: Rhaborina Masango (Student No: 6798018)

SCHOOL: Architecture and Planning

DEGREE PROGRAMME: Master of Urban Studies (SEEC)

DATE CONSIDERED: 12 August 2019

EXPIRY DATE: 12 August 2020

DECISION OF THE COMMITTEE: Approved

X 
Dr Brian Boshoff
SoAP Ethics Committee Chair

CHAIRPERSON _____ (Elec. Signature under lockdown)
(Dr Brian Boshoff)

DATE: 16.4.20

cc: Supervisor/s: Brian Boshoff

DECLARATION OF INVESTIGATORS

I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any

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Appendix B

Plastic packaging Mpact factory interview questions

Interview/ Questionnaire for the plastic packaging Mpact factory

Interviewee Name:

Type of Interview: Interview research questions.

Date of Interview:

Instructions: Please answer questions as truthfully as you can.

1. What does the factory produce and how long have you operating for?

2. Do you know of the factories carbon emission status? YES / WHY NOT?

3. If so, does your emissions profile affect the local air quality and consequent human health issues?

4. Continuing on the emissions profile, what is the factory's stance on climate change?

5. What is the factory and the company at large position on the current coal-based energy system of South Africa?

6. During the course of the running of the factory, has the production been affected by the inconsistent South African energy supply (Load-shedding) by Eskom? YES/ WHY NOT? _____

7. If so, how has this affected your production process?

8. What measures has the company taken to ensure that the inconsistent energy supply does not further interrupt the production within the factory, or any possible interruptions can occur within the future?

9. What does the factory think it means to conduct energy efficiency?

10. Does the reputable factory take heed in exploring alternative energy sources? YES / WHY NOT? _____

11. If so, what sort of alternative energy sources does the company use or would explore?

12. The company takes heed to recycling and environmental impact within the production process. Would the company push towards integrating renewable energy supply within the production of the manufacturing? YES / WHY NOT? _____

13. If so, how would the factory intend to do so under the auspices of energy efficiency?

14. To integrate renewable energy within the factory, would need the respective technology and infrastructure, can the company build its own base for this to ensure production is always running smoothly? YES / WHY NOT? _____

15. If so, do you think the company can do this for themselves in your factory area & later expand it within other companies within the area?

16. Does the company have a good relationship with the local municipality you are currently operating in? YES /

WHY NOT _____

17. Does the company take heed to policies carried out by the municipality from the national department with regards to an alternative energy mix?

18. Can the company integrate with the municipality with regards to energy projects to make the plastic & packaging manufacturing more productive? YES/

WHY NOT _____

19. If so, what sort of projects can be implemented?

20. Do you think this factory can make a difference in creating a low – carbon & climate resilient economy?

Appendix C

City of Ekurhuleni's energy department Interview Questions

Interview/ Questionnaire for the energy department in the Ekurhuleni Municipality

Interviewee Name:

Type of Interview: Interview research questions

Date of Interview:

Instructions: Please circle a yes or no below and answer questions as truthfully as you can.

1. What is the municipality's position on energy and energy efficiency within the respective city?

2. How is the current energy supply of electricity affected by load-shedding in South Africa affecting industries & households within the city?

3. Does the municipality have an energy supply alternative plan for when the load-shedding occurs within the city? YES / WHY NOT?

4. If so, is the plan in line with lowering carbon emissions and sustainable for long term?

5. Given the energy discourse that is currently on-going in South Africa, does the municipality take heed in energy demand and supply within the manufacturing industries in the city as Ekurhuleni is a manufacturing hub? YES / WHY NOT?

6. If so, how does the municipality implement their policy frameworks within the respective manufacturing industry

7. Does the municipality have integral energy projects within the respective industries within the city? YES / WHY NOT? _____

8. If so, what specific energy projects does it have with the manufacturing industry?

9. Does the municipality take heed in the energy mix doctrine of the national policy of the Integrated Energy Plan (IEP)? YES / WHY NOT? _____

10. If so, what measures has the municipality taken in introducing renewable energy within the city?

11. What policy measures does the department use specifically in the manufacturing industry for energy supply within the city?

12. Do you think an energy mix, particularly renewable energy is necessary to be implemented in the cities policy framework to make the industry more productive? YES/ WHY NOT? _____

13. If so what sort of renewable energy options can there be implemented within the manufacturing industries in the city?

14. Do you think there are any barriers in the manufacturing sector to implementing renewable energy in the manufacturing sector? YES /

WHY NOT _____

15. If you answered yes, what are they and what can the municipality do to help the manufacturing industry break them to generate a sustainable production?

16. Do you think the manufacturing sector can revitalise the city's economy to be a low carbon and climate resilient economy? YES / WHY NOT?

17. If so, in which ways can it do so, if renewable energy is implemented within the energy supply mix?

