Gordon Institute of Business Science
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A Continuous value proposition – Waste created by food manufacturing companies and the conversion of bio-waste into biogas and bio-fertiliser.

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

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Abstract

Sustainability has become a critical element in the way business strategies are designed. Many organisations have adopted best management practices and the corporate governance of modern companies have been aligned not only to look at profits but also to take into consideration the impacts that they have on people and on the planet. There has recently been a substantial acceptance towards renewable energy sources worldwide, however anaerobic digestion of bio-waste into bio-energy has been around for decades and has not seen the equivalent recognition in South Africa. The purpose of the research is to study the business considerations including challenges and opportunities emanating from the vast amounts of bio-waste that occurs throughout the food supply chain, specifically at manufacturing and is a high level assessment of the respective value propositions available as a strategic imperative within a sustainable business model.

The research investigated the bio-waste emanating from food manufacturing which was conducted through the use of qualitative methods. In-depth interviews were held with ten experts from food manufacturing companies in which they shared their current bio-waste management practices. The triple bottom line model (Figure 2) was used as an initial framework, this model was reformulated into the sustainable business ecosystem (Figure 6) from which the interview schedule (Appendix 3) for the research questions was designed.

Vast amounts of bio-waste occurs at the processing stage of the supply chain and to these ends a viable source of input material towards anaerobic digestion has been largely overlooked. There are research studies that have been conducted on biogas as well as the energy values of various substrates, however this research study was intended to investigate alternate revenue streams for an anaerobic digestion plant for the purposes of accelerating the return on investment of such a plant. A safe waste disposal fee has therefore been identified as a valuable value proposition that can be offered to food manufacturing plants. This bio-waste could then be utilised towards the generation of much needed electrical energy as opposed to the material going directly to landfill.

Keywords

Biogas

Bio-waste

Bio-fertiliser

Value proposition

Continuous value proposition

Declaration

9 November 2015

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

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CHAPTER 1: INTRODUCTION TO THE RESEARCH PROBLEM

1.1 Introduction

"A business that makes nothing but money is a poor business"

Henry Ford

The global recession and continued concern over climate change has called into question the ability of current models for economic growth to advance long-term prosperity. With many countries facing economic hardship as well as pressing social problems, countries around the globe have pursued a wide range of policy and investment strategies to jumpstart economic recovery. "Green growth", a highly debated term that is generally defined as a means to create jobs and economic growth while concurrently reducing costs and environmental impacts over the long run, has emerged as a possible response to address these challenges according to Hammer, Kamal-Chaoui, Robert, and Plouin (2011). This report will focus on the business considerations including challenges and opportunities emanating from the vast amounts of waste that occurs throughout the food supply chain specifically at manufacturing and a high level assessment of the respective value propositions available as a strategic imperative.

There is a growing trend worldwide to use biomass in the creation of a clean energy alternative to fossil fuels (Kigozi, Aboyade, & Muzenda, 2014). Various energy crops have been successful in generating bio-ethanol such as sugar cane, sugar beet, corn and wheat. Some of the major disadvantages to the use of energy crops are that they make use of crops that are also major food sources to both humans and farm animals. Energy crops are also unfortunately grown using resources such as land and water that are in direct completion with other food crops, this in turn creates a negative impact on food security. There are however also many more positives than negatives to this form of energy, for example Germany produces 4.6 percent of the countries national electrical energy supply through biogas power generation and this excludes the compressed bio methane that is compressed into canisters for the purposes of heating and cooking (Gardiner, 2014) while the industry as a whole employed over 41 000 people in 2014 (Ferroukhi, Lucas, Renner, Lehr, Breitschopf, Lallement, & Petrick, 2015).

Other biofuel input alternatives have included using vegetable oil and animal fat to manufacture biodiesel (Kigozi, Aboyade, & Muzenda, 2014), however, the research will focus on biomass and specifically bio-waste for the generation of methane gas in anaerobic digesters as planted biomass would not be the best source of bioenergy production for biogas. It would be far more valuable to find inputs that are free or even better, using inputs that have been removed from a producer's site and charged a service and safe disposal fee for. The viability of this project will be analysed through the collection of qualitative data to ascertain whether or not a biogas sustainable energy plant can be a sustainable business within a sustainable business model of societies, economies and ecosystems also known as the triple bottom line or people, profit and planet (Elkington, 2006).

1.2 Research Problem

"Look deep into nature, and then you will

Understand everything better"

Albert Einstein

It is stated in a study for renewable energy by Ferroukhi et al. (2015) that bioenergy can provide a localised solution and transform rural communities while enhancing energy and food security. Sustainable energy and food security are two critically important topics that are currently being discussed in the news today, indeed these topics are of importance to Africa and the world in general. This report will draw attention to the vast amounts of bio-waste that occurs throughout the food supply chain, however it will focus on manufacturing and suggest that there is more than just a value proposition to food. Bio-waste from food may have a continuous value proposition, even after expiry the product still has an uncaptured value in the combustible energy that it can produce.

Bio-waste is defined as biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, as well as comparable waste from food processing plants (European Commission, 2010, 2015). Bio-waste does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood.

1.2.1 Food Waste as Bio-waste

There is an abundance of food waste occurring throughout the world and also within south Africa, however much of it is sent to landfill which is contributing to pollution as well as global warming through the emission of greenhouse gasses during the decomposition process (Samimi & Zarinabadi, 2012). Landfilling can be defined as the process of burying waste material in an area of land, also known as dumping (Parfitt, Barthel, & Macnaughton, 2010).

A study conducted by Gustavsson, Cederberg, Sonesson, Van Otterdijk, and Meybeck (2011) affirm in their research that, roughly one third of all food intended for human consumption is lost or wasted globally throughout the food supply chain (FSC), which was calculated to be about 1.3 billion tons. This demonstrates that massive amounts of food waste have been discarded around the world and continues to be destined for landfills every day. The data for these wasted products also draw attention to the argument that there is no shortage of food in the world, but that it is just not distributed evenly. Industrial waste for 2011 accounted for 36 million tons and 61 percent of South Africa's general bio-waste (Urban Earth, 2013). The research would argue that the bio matter would have had a far greater value proposition had even a small portion of it gone towards anaerobic digestion to produce biogas.

1.2.2 Alternative Energy Sources

A second reason for the importance of this research is that of the national energy crisis with which South Africa and many other nations need to create alternative solutions to overcome (Odhiambo, 2010). The world over sustainable energy is becoming a much more viable option to the energy infrastructure and large economies are committing to larger portions of their countries power to come from renewable resources in the near future (Ferroukhi et al., 2015). The research endeavoured to collect and analyse qualitative data in order to ascertain whether or not an appropriate business opportunity exists within the sustainable energy sector. The wastage is occurring at five distinct points along the supply chain which are agricultural production, post-harvest handling and storage, processing, distribution and consumption (Gustavsson et al., 2011). This study will however focus on waste generated at the processing stage of the supply chain to ascertain whether there exists a possibility of a business opportunity in the renewable energy space within South Africa.

1.2.3 Food Manufacturers as a Supply Source for Bio-waste

The motivation for the food manufacturing industry to use this service is that the past few years have seen the introduction of serious and damaging lawsuits that have arisen against food manufacturing companies causing these companies to adopt a much more cautious approach to what they send into the market place. Many of the law suits have come about due to the illness and or hospitalisation of some of their customers, which in turn triggered most established food manufacturing companies to voluntarily bolster existing or implement new food safety systems in order to align their organisations with international best practices, partly in the attempt to negate unwanted bad publicity or legal action that could ultimately damage to their brands (Fares & Rouviere, 2010).

Consequently many other complimentary industries have formed as a result such as consultancies and food safety system certification firms (Fares & Rouviere, 2010) as well as waste disposal companies. These waste disposal companies are required to guarantee safe and legal disposal, as well as supply their customers with a safe disposal certificate. Taking this into consideration the assumption could be made that this has played a role in the 36 million tons of bio-waste contributed by industry in 2011 (Urban Earth, 2013).

Food manufacturers have been required to apply stricter disposal policies in order to ensure that large amounts of unsafe products do not end up in the market place unknowingly, conversely of the options put forward by Kim and Kim (2010) there are only two viable options available for safe disposal in South Africa, incineration which is costly and produces high amounts of air pollution, and deep trenching, which involves digging a hole and burying the products which can potentially pollute ground water (Holm-Nielsen, Al Seadi, & Oleskowicz-Popiel, 2009).

1.2.4 Anaerobic Digestion

When bioenergy development is managed sustainably and efficiently it could create new markets and positively contribute to income and poverty levels (Ferroukhi et al., 2015). Most of these sustainable energy projects are in remote areas of South Africa including wind and solar farms. The bulk of anaerobic digesters are located on agricultural farms or feedlots for animal farming. The process of moving the materials for digestion requires manual labour in the form of farm workers to collect the materials and skilled labour to get the inputs to the digestion plants. In terms of the operation, this too would require highly skilled labour in the form of engineers or microbiologists to keep the internal environment operating at optimal efficiency (Ferroukhi et al., 2015).

This study would seek to highlight an alternative option to incineration or landfill dumping. Anaerobic digestion, which would form part of a business model (Wakkee, Barua, and Van Beukering, 2014) that could also partially address the energy concerns that the country is dealing with. South Africa has continuously been struggling with an energy crisis since 2007 (Odhiambo, 2010). The report will argue that there are possible alternatives to landfill dumping. Instead, this waste could provide a continuous value proposition in terms of the combustible energy that is possible to be extracted through anaerobic digestion of the bio matter.

1.3 Research Aim

- The aim of this research is to investigate whether or not biogas is an underutilised opportunity in the sustainable energy market.
- To investigate the potential benefits to society and the environment of the bio-waste to energy business model.

1.4 Outline of the Study

Chapter 1

Entails an introduction to the research study. The problem is stated and a background is given to the study

Chapter 2

The literature review is dedicated to evaluate literature regarding sustainable business practices, it makes use of the triple bottom line model as a foundation and expands on it by bringing the value proposition into business deliberations, as well as those for social innovation and eco innovation.

Chapter 3

The research questions are stated and are divided into the three sections of the triple bottom line. The aim of this chapter is to systematically investigate, challenge and explore the topic even further by posing the propositions by the researcher for analysis,

Chapter 4

Explains the methodology that was employed in conducting the study. The research methods such as sampling techniques as well as interview and selection techniques are then clarified.

Chapter 5

Results obtained from the data collection and analysis are discussed at this stage.

Chapter 6

This chapter compares the results obtained in Chapter five with what the literature is stating from Chapter two. The goal of this chapter is to harness the preceding chapters one to five in order to provide depth and insight into the findings for the three research questions.

Chapter 7

Concludes the research study, limitations are presented and further mention is made for areas of interesting future research in line with this study.

1.5 Conclusion to Chapter 1

The research that has been undertaken for this paper is highly important from an economic stand point. The world economies are only now beginning to show signs of recovery from the global economic crisis in 2008, but even this is described as a “stop and go” recovery (Giles, 2015). Business practices that may have been deemed successful before could understandably seem inadequate from a holistic viewpoint which includes academia, business people and government.

From a social perspective, the International Labour Organisation has stated that global unemployment will be at 212 million people by 2019 (Andrianov, Bourmpoula, Chacaltana, Sukti, Duda, Ernst, & Ekkehard, 2015), the same study has found that more than 61 million jobs have been lost since the 2008 global financial crisis. Not only should business be seeking to incorporate a wider view of who their stake holders are but there is also a sizable opportunity that is currently presenting itself, as our own country has a high unemployment rate of 26.4 percent (Taborda, 2015) and added to this the economy is concurrently grappling with an energy crisis, the research will postulate that given the availability of bio-waste that there is a viable option to assist in the alleviation of unemployment as well as contribute to much needed sustainable energy generation.

The study also considers an environmental outlook. There is a plethora of recent research and case studies that are have been done on biogas, in fact the research dates back a number of decades, however due to the diminishing oil reserves within the planet, as well as the energy shortages around the world, clean energy projects have become much more financially viable (Ferroukhi et al., 2015). In addition to this corporate social responsibility (CSR) initiatives that were started in 1994 and that are still around today make these projects even more attractive from a social responsibility standpoint as well as from a sustainability outlook. This study is also unique due to there being limited research on food waste at a manufacturing level, particularly in South Africa, in addition to this the method of using anaerobic digestion as a safe disposal option for bio-waste has not been explored from what could found in the literature.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Water, energy and food are all closely interlinked and these interlinkages intensify with increases in population growth and changes in consumption patterns (Ferroukhi et al., 2015). The literature reviewed included global food waste reports such as (Gustavsson et al, 2011) and also studies by South African researchers on bio-waste generated within the country by (Oelofse & Nahman, 2012). Further reviews covered bio-waste generated by food manufacturers globally (Parfitt, Barthel, & Macnaughton, 2010). The research will also discuss alternatives to landfill dumping such as biogas and bio-fertiliser using past studies as a base, including the pioneering studies conducted by (Fry, Barbara, & Merrill, 1973) where operational biogas digesters were built on his farm in Johannesburg and data was built up on the amount of energy that can be unlocked from animal meat, farm animal waste as well as plant matter, utilised in the generation of both biogas (Fry & Merrill 1973; Himanen & Hänninen 2011) as well as the promotion of the digested waste as a bio-fertiliser (Biogas journal, 2015, p. 58). Bio-fertiliser can be defined as a substance which contains microorganisms that can be applied to the soil in order to promote growth by increasing the supply of nutrients to plants (Lukehurst, Frost, & Al Seadi, 2010).

Furthermore, the continuous value that this model provides has the added benefit of reducing methane gasses released into the atmosphere. The study of the literature also looked at the social innovation side of this business concept. Waste going to landfills would be drastically reduced, and along with this, the gasses involved in decomposition which are 23 times more damaging than Carbon dioxide (CO_2) would contemporaneously be reduced (Samimi & Zarinabadi, 2012).

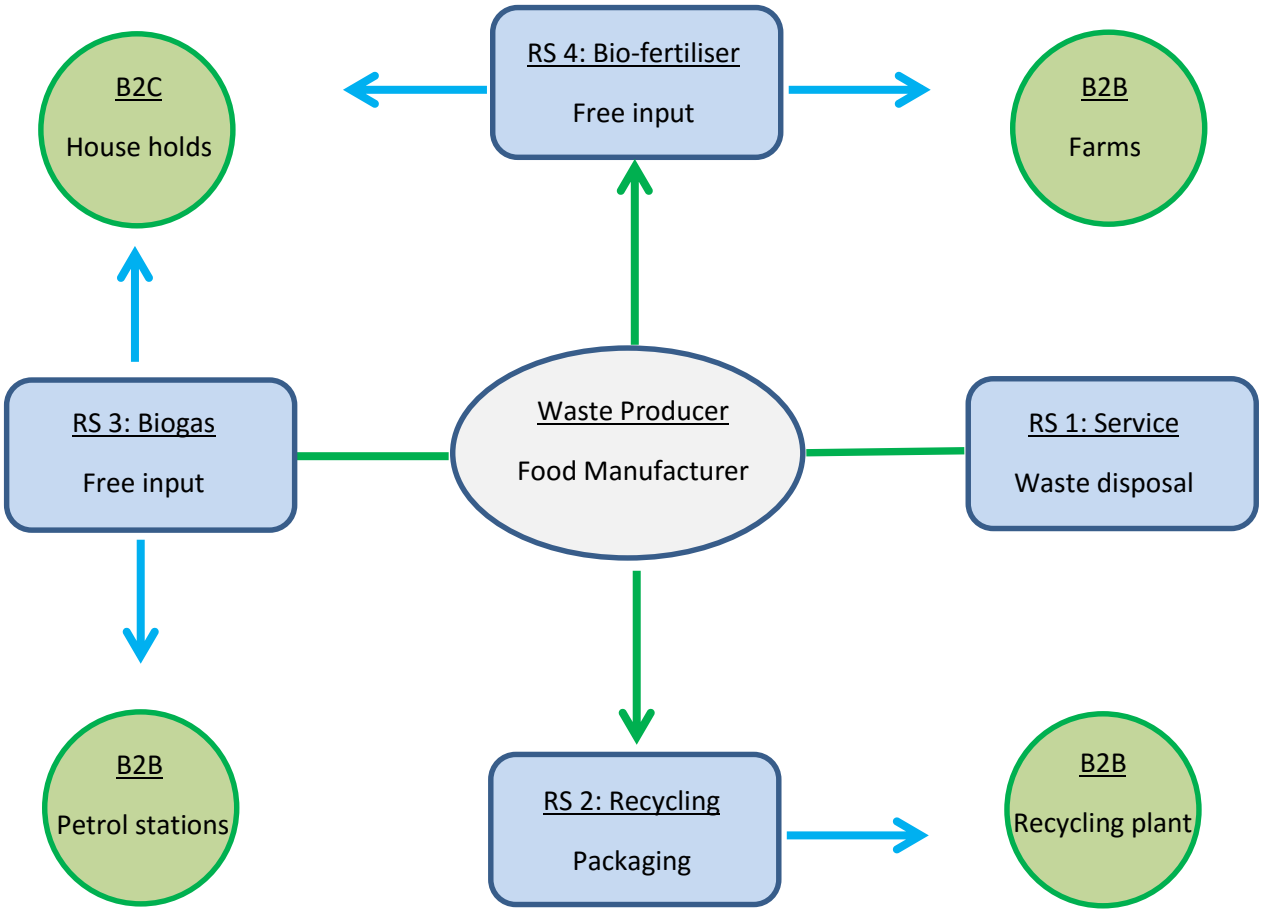
2.2 Conceptual Framework

The conceptual framework that the study will take can be found in Figure 6 and the business model with this framework can be found in Figure 1, the model has the potential to encompass four interrelated revenue streams, and would operate within an economy, which in turn would be found within a society and they both would operate within a natural ecosystem. The opportunity originates with the food processor as industrial bio-waste cannot, by legislation be discarded at landfill through the same channels as household waste

(Government Gazette, 2008). Additionally from the manufacturers stand point, they too would not want the products to find their way back to consumers. Therefore, the following is proposed:

- **Revenue stream one:** The service provided to the manufacturer by safely disposing of their product or products.
- **Revenue stream two:** The packaging that the products are discarded in may have a value in recycling.
- **Revenue stream three:** The biogas generated by the anaerobic digestion process could be burnt directly by a gas generator to produce electricity. Alternatively, the gas could be compressed into cylinders and sold to households or business for cooking or heating.
- **Revenue stream four:** The by-product of this process is a powerful bio-fertiliser that could be supplied to either local farms or sold in smaller pack sizes to the public.

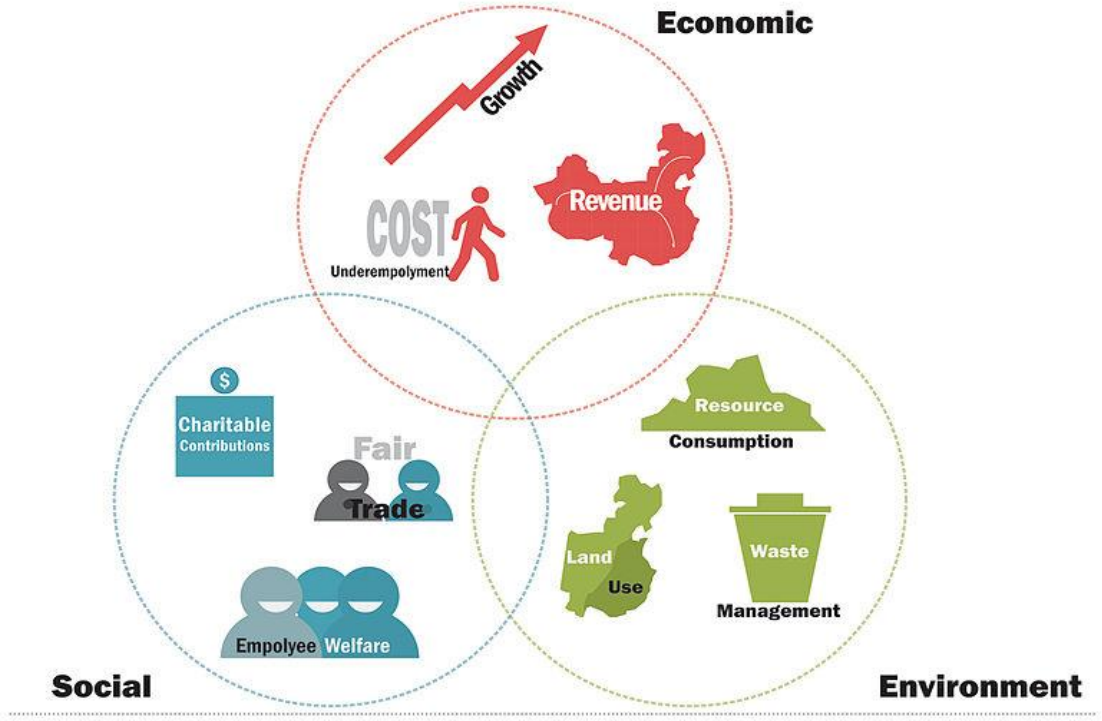
Figure 1: Bio-waste business model with potential revenue streams



2.3 Triple Bottom Line

In 1994, John Elkington coined the term the triple bottom line, which speaks to people, prosperity, and planet and how they are interrelated. Shortly after it was adopted by Mervin King in the King I, II and III reports on corporate governance, the triple bottom line refers to a scenario where companies harmonise their efforts in order to be economically viable, environmentally sound and socially responsible (Milne & Gray, 2013). It is within this framework that the biogas from bio-waste business model was evaluated.

Figure 2: The triple bottom line



Source: Triple bottom line. n.d. In Wikipedia. Retrieved October 31, 2015, from https://en.wikipedia.org/wiki/Triple_bottom_line

2.4 Bio-waste Generation

Throughout the world there is an alarming amount of food waste that is generated daily, as urbanisation advances so too does the volume of waste generated by these civilisations.

The arable land decreases and human beings encroach on areas that were once habitats of wild animals. Within metropolitan areas the waste that is generated is commonly sorted into recyclables and non-recyclables, however most of the waste does not get sorted and is destined for landfills (Kigozi et al., 2014). A report by Gustavsson et al. (2011) showed that at least 33 percent of the global food supply goes to waste annually totalling 1.3 billion tons of food waste worldwide.

Food losses constitute a waste in production resources, which includes land, energy and water inputs. The food that is produced but not consumed also produces Carbon Dioxide emissions in addition to the loss in value of the food produced (Gustavsson et al., 2011). Overall food is wasted more in industrialised countries such as Europe and North America, where studies on food waste generation estimates a range of 95 to 115 Kilograms per capita per year, while Sub Saharan Africa and South East Asia averages between 6 and 11 Kilograms per person per year (Brautigam, Jorissen, & Priefer, 2014).

According to Nahman, de Lange, Oelofse and Godfrey (2012) South African households are sending approximately R21.7 Billion worth of food waste to landfills per annum, which at the time of the study amounted to 0.82 percent of the country's gross domestic product (GDP). Most alarming is that this figure constitutes less than four percent of the total loss across the supply chain.

Gustavsson et al. (2011) denotes five system boundaries in the food supply chain, namely agricultural production, post-harvest handling and storage, processing, distribution and consumption, which can further be subdivided into vegetable and animal commodities. This study will focus on bio-waste at processing which occurs at food manufacturers.

Another study by Lin, Pfaltzgraff, Herrero-Davila, Mubofu, Solhy, Clark, Koutinas, Kopsahelis, Stamatelatou, Dickson, Thankappan, Zahouily, Brocklesby, and Luque (2012) alludes to food waste being destined for either landfill, animal feed, composting or incineration. Landfill involves little safety in terms of the product being sifted through by animals, birds or even human beings surviving on the landfill (Zurbrügg, 2003) moreover, the waste on these landfills continues with the decomposition process which, emits methane gas into the atmosphere.

Whilst composting the materials is a safer alternative in terms of the product being less likely to be consumed unwantedly, the process still produces greenhouse gasses such as CO_2, ammonia and methane, which escape into the atmosphere and contribute towards global warming (Hammer et al., 2011). Lastly, incineration, this process will eliminate the possibility

of the product being consumed, but utilises fuel and emits large amounts of CO_2 into the atmosphere during the process (Samimi & Zarinabadi, 2012).

2.5 Anaerobic Digestion

The process whereby biogas is produced is called anaerobic digestion, and is named after the anaerobic bacteria that are responsible for the conversion, these bacteria are organisms that can only thrive in the absence of oxygen (O_2), unlike most other forms of bacteria that depend on Oxygen, these lifeforms can actually be harmed or die if exposed to O_2 (Kigozi et al., 2014). It is essentially these anaerobic bacteria known as methanogens that produce the methane gas which is a valuable form of combustible energy.

Anaerobic digesters have been around in India since the year 1859 in Bombay India, where small scale farmers have been using the methane gas generated for cooking, these digesters have also been constructed in China on a large scale since the 1960's where entire lagoons have been covered for biogas production (Fry & Merrill, 1973). A South African farmer in the nineteen fifties initiated a six-year study in this field, with working biogas-producing plants until he immigrated to the United States in the nineteen seventies as he could not find traction in the South African market. In the research by Fry et al. (1973) details how to build working models on these digesters and notes that there will be a time when access to conventional fossil fuels will be a limiting factor especially in rural areas due to both scarcity and cost, a prediction that has proven to be correct. The research interestingly highlights many benefits of the process, the gas, it is stated, was not the most valuable output from the project, but rather the bio-fertiliser and the labour saving in terms of the bio-fertiliser distribution. Since the bio-fertiliser was now in a liquid state as opposed to the initial solid state, it could more easily be distributed around the farm (Fry et al., 1973).

South Africa and the rest of the world in recent years has seen a number of petroleum price increases, with parts of our rural population still without electricity it is imperative that new forms of social innovation are embraced in order for us to address our challenges (Moore & Westley, 2011).

2.5.1 The Microbiology of Biogas Formation

Biogas forming bacteria are part of a large and complex group of independent microbial species, most notable of which is the methane-producing bacteria. The process of biogas generation is split into three stages: hydrolysis, acidification, and methane. At the Hydrolysis stage bacteria decompose the lengthy and complex molecular chains of the carbohydrates, proteins and lipids into shorter portions such as peptides, monosaccharides and amino acids (Kigozi et al., 2014). Next acidification takes place by acid producing bacteria breaking down the intermediates from the first step into acids, hydrogen and carbon dioxide, these bacteria can survive under aerobic and anaerobic conditions as well as in an acidic environment. These organisms create acetic acid, which creates an anaerobic condition essential for the methane-producing microbes in the final stage (Kigozi et al., 2014). Methanogens at the third stage decompose compounds from stage two such as hydrogen, carbon dioxide and acetic acid. Methane producing bacteria are extremely sensitive to environmental changes and are exclusively anaerobic (Kigozi et al., 2014).

No single type of bacteria are able to produce this fermentation process in isolation as each prior stage creates the environments for the next organism to thrive, all the while eliminating toxins from the process and creating an odourless combustible gas and a by-product that can be used as a bio-fertiliser, which is rich in nitrites (Kigozi et al., 2014).

2.5.2 Biogas

Holm-Nielsen et al. (2009) suggest several uses for biogas for example the production of either heat or steam or both and also electricity production with combined heat and power production (CHP). Biogas can therefore be used as an Industrial energy source for heat, it can be used for steam generation, for cooling purposes and for the generation of electricity through directly burning the gas onto a generator. Biogas can be upgraded for utilisation as vehicle fuel, production of chemicals and / or proteins, upgrading and injection into natural gas grids as well as fuel for fuel cells.

Initial studies on methane plants made use of farm based manure, however other sources have gradually been accepted as substitutes including bio-waste, food crops, energy crops and municipal sewerage among others (Kigozi et al., 2014). Different types of waste can produce different output levels of gas and theoretically, if the 1.3 billion tons of global food

waste that was mentioned earlier in the study were to be used for biogas production it could yield up to 367m3 of gas per dry ton of waste. If it comprised of 65 percent methane levels with an energy content 6.25kWh/m3 it could yield 894TWh annually, which is about five percent of the world's electricity needs (Kigozi et al., 2014).

2.5.3 Compressed Biogas

Not only is the biogas combustible, but it can also be compressed for storage. A detailed study by (Vijay, Chandra, Subbarao, & Kapdi, 2006) found that biogas generated from a simple rural cattle dung digester after being scrubbed of nitrogen and hydrogen sulphide could be further enriched by removing excess water vapour with a three stage compressor. The gas could then be pumped into steel cylinders used for compressed natural gas (CNG). These cylinders are used to store the gas in order to power petrol motor vehicles that have been modified to run on CNG as long as the methane levels are between 75 and 98 percent similar levels to that of CNG. Sweden is a remarkable example of the utilisation of biogas in motor vehicles as noted by Holm-Nielsen et al. (2009), at the time of the study the country already had over 15 000 vehicles running with upgraded biogas. Aside from powering vehicles once the gas is compressed into cylinders it can also be burnt directly for heat as in gas heaters or for the cooking and grilling of food (Gardiner, 2014).

2.5.4 Bio-fertiliser as a By-product

To complement the various uses of biogas outlined above, the by-product of anaerobic digestion similarly has numerous benefits. In European countries, these projects are making significant differences in attaining greenhouse gas emission (GHG) reductions, and in addition to these benefits, the bio-fertiliser would reduce odours of the raw materials once digested. Additionally dangerous pathogens, viruses and fungi have also shown to have been reduced or eliminated after digestion. Lastly a benefit for farmers include the reduction in weed seeds after digestion (Lukehurst et al., 2010).

2.5.5 Recycling of Packaging

As most biogas plants around the world are farm based or otherwise use municipal sewerage (Weiland, 2010), the business model in this report would seek to use manufactured food waste as an extra source of input supply for the anaerobic digester. The waste itself would contribute revenues from safe disposal fees, however it is also anticipated that much of the waste would be in packaging of some sort, ranging from plastic containers to cardboard boxes, which could be recycled to recuperate some of the fees from the collection of the waste. Recycling has been growing enormously in recent years and has in its own right become a legitimate form of business and employment for many countries around the world (Nahman, 2010).

2.6 Barriers to the Use of Anaerobic Digestion - Challenges

Although there are many benefits and thus opportunities to biogas generation, there are also numerous barriers of entry exist for the use of anaerobic digesters. Technological limitations such as the efficient and cost effective conversion of perishable feedstocks into valuable products will be a barrier as well as overcoming insufficient legislative and infrastructure support challenges, these factors along with industry an public perception and acceptance will be important barriers to overcome in the implementation of large scale biogas facilities (Lin et al., 2012).

Figure 3: Barriers to the use of anaerobic digestion (AD)

Figure 3 illustrates the barriers of entry that have been adapted from Lin et al. (2012). As with any new venture, it would be pertinent to research the limitations or challenges that the business may encounter, these will form part of the investigation during the interview process to try and ascertain how these may relate to sustainable energy business.

2.7 Value Proposition

The success of many business projects depend largely on the value proposition offered. Ballantyne, Frow, Varey and Payne (2011) have traced the origins of the value proposition to (Bower & Garda, 1985), Later, Lanning and Michaels (1988) defined it as the statement of benefits offered to a customer group and the price that they are willing to pay. They further developed the concept into the value delivery system consisting of three parts, including,

choose the value, provide the value and communicate the value. The concept of the value proposition has in its early stages been applied to the customer, from a supplier's viewpoint. This study will argue that the value should not necessarily be only for this generation nor for a single person or organisation, the value can be of a continuous proposition, in that it does not have to end at disposal. Consider the example of bio-waste, this process begins at an agricultural level for both fauna and flora, it then moves along the food supply chain to post-harvest handling and storage, processing, distribution and consumption as found by Gustavsson et al. (2011). Throughout the food supply chain this bio-waste can be either reworked or reused even after the products begin to decompose, therefore there is still value in the form of energy that can be extracted as an alternative to simply wasting and throwing away. Organisations should develop business models that work with the earth's natural cycles of waste management in order for efficient and innovative businesses operations to benefit future generations (Unruh, 2010).

Ballantyne et al. (2011) have suggested that there are different types of value proposition. Early literature understood value propositions as a deliverable value crafted to customers from a suppliers perspective, a supplier would craft a value proposition for customers which involved marketing an offer or promise to customers that was thought to be of value to the customer such as telling customers what to expect from the product as well as indicate the pricing. Later models challenged this strategic management approach inherent in Michael Porter's work on the value chain to incorporate not only the supplier's perspective but also the value proposition from the customer's perspective (Ballantyne et al., 2011).

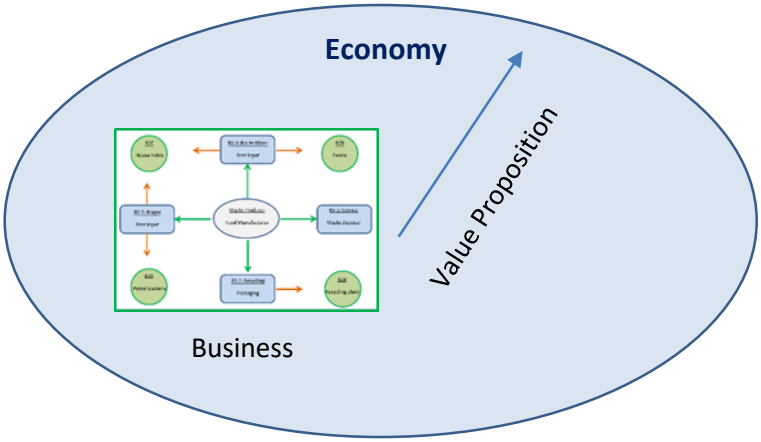
It may be suggested that should initial costing of the gas products be at a similar or even slightly higher price that there could still be an opportunity to enter the market based on the value proposition of a cleaner environment and renewable energy associated with the biogas product as opposed to fossil fuels. The value communicated to the customer as well as to the suppliers in this business model would need to take a holistic approach, from the social perspective, through to the economic as well as from the environmental standpoint in order to try and craft a continuous value proposition for all stakeholders.

2.8 Economy - Green Growth

Building onto the biogas business model the study incorporates the term green growth, this concept encompasses not only conducting business in ethical ways and doing the right thing for the environment but it is a culmination of everything mentioned as well as making a sustainable profit for the business while incorporating these best practices (Hammer et al., 2011). “Going green” is often used to refer to protection of resources or resource efficiency, as we begin to realise that we need to protect our environment, its natural systems and species and that we need to balance consumption with natures ability to replenish (Hammer et al., 2011).

Green is also commonly used to refer to certain business sectors or policies, these include technology associated with waste management, pollution treatment or prevention, abundant renewable energy and even to do with construction and design of buildings (Hammer et al., 2011). The research draws attention to the literature from which there is enough data based on studies on biogas production with numerous forms of input materials to show that it is a viable form of renewable energy production, and also that it redirects massive amounts of organic waste away from landfills. A value proposition is thus created for both manufacturers as well as consumers of the gas, making this bio-waste to energy project a remarkable example of social innovation and green growth, an initiative that can make noticeable contributions to economies and the ecosystems that it operates within. Figure 4 below illustrates that businesses exist within an economy. Some of the ways in which businesses can make a contribution to the economy is for them to create jobs, pay taxes as well as create products that do not harm the environment.

Figure 4: Business needs to add value to the economy



2.9 Society - Social Innovation

Cajaiba-Santana (2014) states that innovation is as old as humankind is, but that the study of innovation first began in economics, notably with Schumpeter. Later development by Drucker (1987) found that social innovation in the nineteenth century was almost exclusively government initiatives, Drucker went on to state that in the twentieth century it has all but been left to the private sector and to managers. This would seem to be an accurate statement were it applied to the current water, energy and social issues faced in South Africa today. There are four definitions of social innovation listed by Pol and Ville (2009). The common theme that social innovation aims to address are needs ignored by the market, it also attempts to improve the quality of life through various means and seeks to provide solutions to individual and community problems.

Pol and Ville (2009) distinguish between business innovation, which is commonly agreed to be a technological innovation, a process innovation or a product innovation. Business innovation could also be an organisational innovation, which are changes to the firms structure, strategies or procedures (Pol & Ville, 2009). The business model of bio-waste collection and digestion into biogas and bio-fertiliser, would seek to address a number of aspects for social innovation. Cherubini (2010) found that a reduction in land pollution, air pollution, acidification of ground water and greenhouse gasses are all advantages of the process of utilising bio-waste in the production of biogas and bio-fertiliser. The research on social innovation has proven to be accurate concerning these initiatives in that it has taken time for our social systems to adopt these projects. It is with this momentum in mind that the gas and fertiliser manufactured from waste products could well be accepted at an individual consumer level.

Social innovation plays an integral role and influence in the economic development, in one way it creates new forms of needs that in turn draws inputs from the economy (Gershuny, 1982), as people become more accepting of a type of innovation so the demand grows as with most products and services that offer a good value proposition. Cooking is an energy-intensive activity, even more so in developing countries where inefficient cooking practices are commonplace. There are around 2.7 billion people who rely for cooking on traditional biomass, such as fuelwood, crop residues and animal dung, which are not always sustainably produced, and in addition to this the smoke and other emissions that can be detrimental to health (Ferroukhi et al., 2015). Traditional biomass is often foraged, which demands a

substantial amount of labour and time, particularly from rural women. There are alternative local, modern bioenergy resources, and when available can be used to improve access to modern energy services while also meeting on-site energy demand for electricity and heating in the rural economies, while also eliminating air polluting smoke and creating bio-fertiliser for these communities to improve farming activities as opposed to gathering activities (Ferroukhi et al., 2015).

The study by Pol and Ville (2009) states that social innovation aims to address the needs that have otherwise been ignored by the market and according to the (National Planning Commission, 2013), the national development plan (NDP) states that there are nine primary challenges that are critical to the success of the country, these challenges are:

1. Too few people work
2. The quality of school education for black people is poor
3. Infrastructure is poorly located, inadequate and under-maintained
4. Spatial divides hobble inclusive development
5. The economy is unsustainably resource intensive
6. The public health system cannot meet demand or sustain quality
7. Public services are uneven and often of poor quality
8. Corruption levels are high
9. South Africa remains a divided society

The National Planning Commission (2013) has suggested that the country is unsustainably resource intensive, therefore in line with this it should be pertinent for government to invest into renewable energies. Gas generators are available in the market, however one could also have a conversion done, similar to that of a petrol-powered motor vehicle in order to utilise an existing petrol generator, this would allow for vehicles to be powered by biogas as the study by Vijay et al. (2006) has documented. In many cases especially smaller digesters, the gas is burnt directly to heat energy for cooking and hot water for geyser systems as this requires virtually no extra conversions or monetary outlay (Ferroukhi et al., 2015). Another very useful option for South African owners of a biogas digester is to burn the gas directly onto a generator for electrical power (Fry et al., 1973).

An important driver of innovation is the quality of human capital and its enhanced creativity create preconditions, however canalizing innovation requires mechanisms and triggers that will reinforce certain types of productive behaviour. Culture for example plays a major role especially one that is tolerant of risk taking, specifically risks associated with entrepreneurial activities (Yusuf, 2009). Such cultures are also more tolerant of failure, not only should these businesses not be stigmatised if they fail but also situations such as bankruptcy should still encourage fresh activities. This goes a long way to induce the willingness of individuals to search for significant and disruptive innovations (Yusuf, 2009).

Another driver of innovation is domestic and international competition. Competitive pressure motivates innovators to pursue rewards and also weeds out weak innovation (Yusuf, 2009). We are currently experiencing a boom of sustainable technology offerings and if the research is correct, counties such as South Africa should not allow themselves to fall to far behind these trends. Although significant improvements have been made over the past few years, the South African economy is still lagging behind the efforts of many other African countries and far behind North America, South America, Europe and Asia (Kigozi et al., 2014).

South Africa missed the opportunity to gain a competitive advantage in the biogas field, actual biogas plants were being run by John Fry a pig farmer in Johannesburg in the 1950's and there may have been a great opportunity for the country to benefit from this social innovation. Unfortunately, that is not the case today and perhaps the competition from the rest of the world will ignite the creativity of entrepreneurs to turn to innovation for improved ways of energy generation and waste management. Figure 5 below indicates that for businesses to be sustainable they need to create a favourable value proposition to the society as they form part of a company's stakeholders.

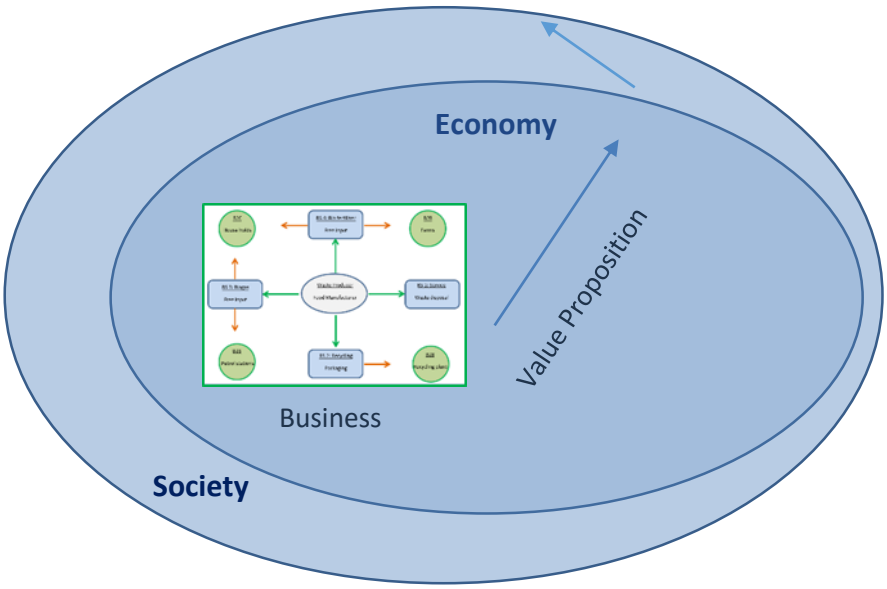


Figure 5: Business needs to add value not only to the economy but also to society

2.10 Ecosystem – Eco-Innovation

The world has made important changes to environmental protection policies and have progressed at an ever increasing rate towards incorporating environmentally friendly products, business practices and governmental legislation (Samimi & Zarinabadi, 2012). Environmental protection is by no means a new phenomenon, the regional populations of the world share the same resources and these resources are commonly agreed to be finite. According to Visser (2014) sustainable technologies are slowly but surely challenging business and transforming outdated industrial models which are no longer able to the create the value that they were intended for. There are companies in the agri-food, chemical and metal sectors that have shown that it is just as important to remove barriers and share existing technologies than it is to coming up with new and better ideas on their own (Visser, 2014).

A factor that needs to be taken into account for sustainable technologies is whether to collaborate or go it alone (Visser, 2014). Company assessments must take into account capabilities such as, in house competencies, technical readiness and capacity. Before biogas plants are built, feasibility studies need to be done on what the desired output should be, but also taking into consideration the amount of inputs that are available. Should there not be

enough inputs from food manufacturers these plants would need to collaborate with other companies for example farms with feedlots and waste disposal companies that are within a close geographic proximity.

Eco-innovators push the boundaries of their companies. They modify products, procedures and organisational structures, they also improve sustainability performance and competitiveness (Visser, 2014). Ultimately, we all share the same resources and we should not be in a competition to harvest and extract as much of these resources out of the ecosystem as we can but rather take a step back and look at the bigger picture. The companies that we either work for or own all exist within a society, within an economy, within an ecosystem as per Figure 6. Hopefully as we progress with this knowledge we will begin to witness more and more businesses being created from the start with sustainability in mind as well as many existing companies transforming their cultures to ones that are supportive of corporate social responsibility practices (Visser, 2010).

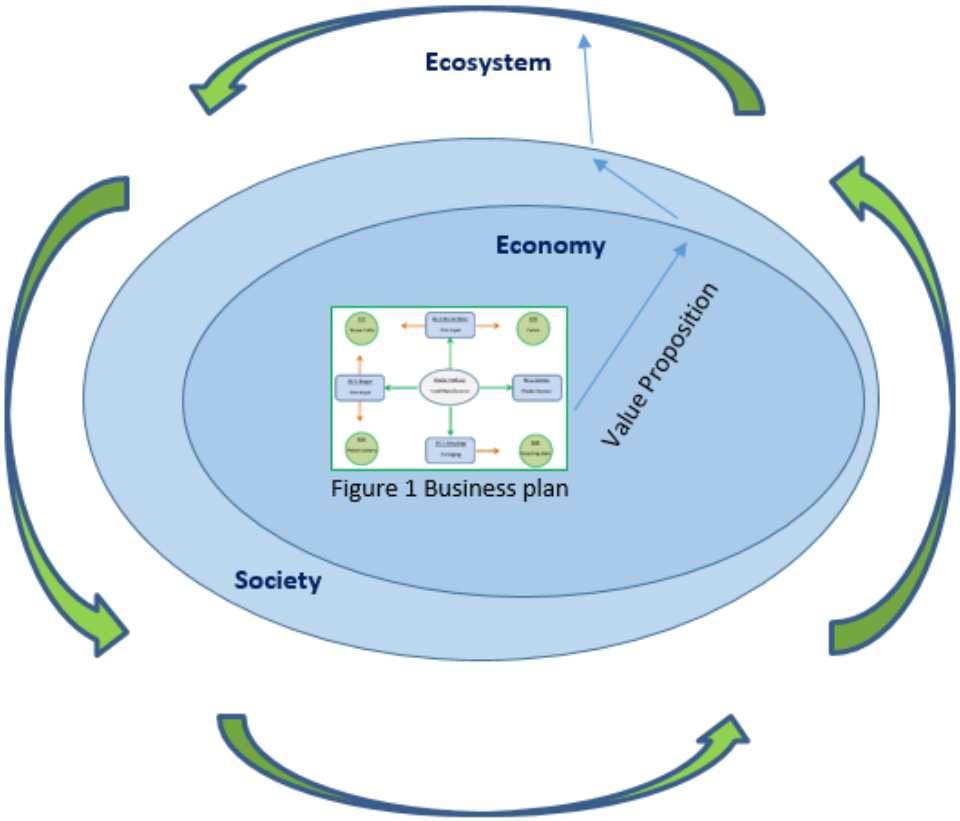


Figure 6: The sustainable business ecosystem

2.11 Conclusion to Chapter 2

"A person who won't read has no advantage over one who can't read"

Mark Twain

Literature from a number of reputable sources were studied in order to formulate the approach to the interviews that were conducted for the purposes of data collection. Through the literature it has become apparent that here is a very real need for this research, as legacy energy generation models have been adversely affecting our planet (Bose, 2010) and yet at the same time are not been able to satisfy the needs of the country. The study investigated the value proposition offered by the service of delivering safe waste disposal to the manufacturing industry and expanded on this to create a continuous value proposition offering for the redirection of bio-waste away from landfills towards the production of biogas.

It can be argued through the study of the literature that the bio-waste to biogas business model would be capable of delivering significant benefits towards social innovation. The literature postulates that there would be a reduction in CO_2, ammonia and methane gasses into the atmosphere. Concurrently Obed, Sehaswana, Maringa, and Sibande (2012) found that South Africa disposed of 108 million tons of waste in 2011 of which 98 million tons went to dumping sites, of which a substantial amount could still be reused or recycled.

Furthermore there is a direct correlation to the reduction of bio-waste to landfill sites and the reduced impacts that food manufacturing organisations would have on the environment. Not only would diverting 1.3 billion tons of bio-waste from landfill drastically reduce land pollution but also ground water and air pollution (Obed et al., 2012).

This study is unique because there exists little literature on food manufacturing waste as a major input towards biogas generation and although business models exist for biogas plants, none could be found that incorporate a service for safe disposal of industrial bio-waste as a catalyst to speed up the return on investment into the project which is often regarded as a negative factor for anaerobic digester plants that can have longer breakeven periods than solar power generation.

There is an abundance of literature on renewable energy, additionally the topic of generating biogas as a heat and energy source from simple bio-waste products is becoming an increasingly discussed subject. World populations are increasing and megatrends such as urbanisation and globalisation are becoming a very real threat to the way society interacts (Capone, Bilali, Debs, Gianluigi, & Noureddin, 2014). In order for companies to survive, it will require innovative solutions for organisations to best navigate these changes, by creating business models that are sustainable for future generations. Social innovation has a place in the way businesses conduct their affairs, likewise the value proposition that companies offer should extend beyond the customer to include the environment in which the business operates (Cajaiba-Santana, 2014).

CHAPTER 3: RESEARCH QUESTIONS

3.1 Introduction

The literature review in Chapter 2 has several themes that keep recurring such as the need for renewable energy and new forms of energy, the need for socially responsible business practices and the need for business and society to take care of the environments that they exist within. Therefore, it is with this in mind that the research study was designed around the triple bottom line model, originally conceived by (Elkington, 1994) and adopted by Mervin King in the King I, II and III reports.

This chapter clarifies the research questions of this paper, defining the research focus comprehensively. The questions of this study focused on the three elements of people, prosperity and planet, therefore the objectives set out below formed the basis of the study.

1. To determine if there is an **economic** value proposition to bio-waste to biogas conversion.
2. To determine if there is **social** innovation in the continuous value proposition of food to energy recycling.
3. To determine if a bio-waste to biogas business could have a value proposition to the **ecosystem** in which it operates.

3.2 Research Question 1

How can an economic value proposition contribute to bio-waste to biogas conversion?

This research question sought to determine the general perceptions of businesses to the possibility of biogas production as opposed to landfill dumping. The question also delved deeper into the company's operations and tried to ascertain the volume of waste being discarded as well as the costs involved in the disposal of these products.

3.2 Research Question 2

How can social innovation contribute to the continuous value proposition of food to energy recycling?

This section sought to reveal the contributions that could be made to society from a business perspective by potentially taking part in a business venture such as this. It also attempted to uncover the culture of innovation adoption within these companies particularly those that could potentially benefit society. Along the same lines the question sought to test how open and proactive these companies are to the initiation of these technologies or whether these companies are simply paying lip service to trends initiated by their customers, government or other stakeholders.

3.3 Research Question 3

What are the potential benefits to the environment of the bio-waste to energy business model?

This research question sought to understand whether or not the companies understood the implications of large amounts of refuse going directly to landfill such as greenhouse gas emissions, pollution and water table contamination. Therefore the focus of this section is to determine if these companies really have a clear understanding of what happens with their bio-waste.

3.3 Conclusion to Chapter 3

Essentially the research questions sought to reveal if these companies understood their waste in terms of volume, cost implications, destination as well as the effects of the disposal methods used. The research questions for this study focused on three major components, the first set of questions sought to understand the economic value to the manufacturer of a biogas project, whilst the second question sought to understand the social impact of the same project and lastly the ecosystem or environment was brought into the discussion to better understand the firms view on this topic. These three questions formed the basis of the results provided in chapter 5, as well as the discussion of the results that are provided in chapter 6.

CHAPTER 4: RESEARCH METHODOLOGY

4.1 Introduction

"If I have seen a little further it is by standing on the shoulders of giants"

Isaac Newton

With the research being clearly defined, this chapter defines the methodology that has been used to conduct the research. This particular study took on an exploratory approach due to the limited information on the topic of waste generated by food manufacturing companies and the conversion of bio-waste into biogas. The research is also qualitative in nature. Qualitative research is normally recognisable by the use of methods that include a variety of techniques which are apparent in the research method, design, sampling and data analysis techniques employed. The particular objective of qualitative research is to answer "why" and "how" questions and either has a commercial or academic agency concept (Bailey, 2014).

4.2 Research Method and Design

Saunders and Lewis (2012) have distinguished between three key research methods, they are as follows. Exploratory studies which may be utilised for research that is new or uncertain to the researcher, this type of study is well suited for new phenomena and utilises interviews with subject experts, concluding interviews and also academic literature. Descriptive studies which may be used in answering the "what" of the question in terms of the characteristics of the relevant phenomenon. This type of study seeks to accurately describe persons, events or situations and was not regarded as the best choice for this study. Explanatory studies which may be utilised in causal research, aims to answer the "why" of the question by identifying the cause and effect relationships between variables. This type of study typically utilises case studies, observation, historical analysis and statistical surveys (Corbin & Strauss, 2014).

Deduction:

Saunders and Lewis (2012) define deduction as a research approach where one tests a theoretical proposition, and induction as a research approach where one derives theory from data collected. This research used existing literature on food waste as well test the use of the triple bottom line model as a basis for the study, there is therefore a deductive approach that has been applied.

The qualitative method was employed as the primary research approach given that the objective of the research was to seek information on how food companies are disposing of their waste as well as how much of it there is, which was determined through interviews with business managers as industry experts. Therefore, this study as with many qualitative approaches are concerned with interpretation and understanding (Eriksson & Kovalainen, 2008).

4.2.1 Exploratory

An exploratory design was employed in this research study for the following two reasons, firstly according to Saunders and Lewis (2012), exploratory research is about discovering general information about a topic that is not clearly understood. Secondly, the research that was available had little information regarding waste from food manufacturers internationally nor from a South African context. A comprehensive analysis on data sources was conducted using EbscoHost which searches multiple academic journals revealing that most of the reports on biogas were on farm waste for energy generation.

Exploratory research lends itself particularly well to the topic of bio-waste created by food manufacturing companies and the conversion of this waste into biogas and bio-fertiliser. The research followed a qualitative methodology, as exploratory designs are well suited for qualitative studies (Salkind, 2012). Exploratory research often relies on secondary research such as reviewing available literature and data (Saunders & Lewis, 2012). During the study of the literature there was data available on food waste generated both globally and locally, however there was little that focused on the manufacturing stage of the food supply chain, particularly within South Africa. This type of design will assist to gain valuable knowledge and possibly new insights to the phenomenon.

The natural generation of bio-waste into biogas has been around for many decades, however, the proposal to safely discard food waste in this manner is also a new proposition, and one that required research into the viability and adoption of this process. Information was gathered by conducting interviews with business managers as well as by researching academic literature on waste generation, biogas and social innovation. According to Saunders and Lewis (2012) the most usual way of conducting exploratory research is by searching academic research, interviewing experts and conducting interviews. For the purposes of this paper a comprehensive literature review was conducted in Chapter 2 and interviews were arranged with a number of industry experts in the form of business managers to gain further insights to their knowledge on their company's bio-waste.

4.2.2 Population

Saunders and Lewis (2012) describe the population, as the complete set of people, organisations or places that are available to the researcher, however this definition is not limited to the afore mentioned examples. The population for this study comprised of every food manufacturing organisation in South Africa which was producing food products at the time of the study.

4.2.3 Sampling Technique

Given the exploratory nature of this study, this section of the research necessitated face-to-face, in depth interviews with industry experts in order to seek answers to the three main research questions outlined in Chapter 3. Research questions were posed to guide the empirical research methodology and the triple bottom line model (Elkington, 1994; Mine & Gray, 2013) was used as a basis to group the questions into a logical framework pertaining to economy, social and ecosystem.

There are two types of sampling techniques, namely probability sampling and non-probability sampling (Salkind, 2012). Probability sampling occurs when it is possible to obtain a full list of the population, the sample is then selected from this complete list. Non-

probability sampling involves using sampling techniques when a complete population list is not available (Saunders & Lewis, 2012). Due to the difficulty involved in obtaining a complete list of food manufacturing companies in South Africa probability sampling could not be possible as there was no sampling frame. Thus non-probability sampling was utilised in this study.

There are many non-probability sampling techniques that were possible to use which included quota sampling, purposive sampling, self-selection sampling, snowball sampling and convenience sampling. After careful consideration regarding the best fit for the research study it was decided that purposive sampling should be employed. According to Saunders and Lewis (2012) purposive sampling is used particularly to select a small sample, the researcher will use their judgement to select who will be best suited to answer the research questions.

4.2.4 Interviews and Data Collection

Qualitative research is not meant to have a lot of structure or a rigid approach to analysis, it should be interpretive, dynamic and free flowing (Corbin & Strauss, 2014). It is for this reason that an interview approach was followed for data collection, interviews can give the researcher many advantages such as the participants are not influenced by other people which can occur with focus groups. Also face to face interviews increase the amount of time that each participant has to share their insights (Aaker, Kumar, Day, & Leone, 2011).

The purposive sampling technique identified special participants that had the most knowledge of bio-waste generated within their organisations with regards to amount, cost and disposal methods. These interviews were semi-structured face to face interviews, which encompassed constructing a detailed interview schedule, the schedule however also consisted of open ended questions directed at senior level and executive managers which allowed them to share as much knowledge as possible for the purpose of understanding their perceptions, insights and opinions on their company's waste disposal policies and procedures. The informed consent form that the interviewees signed can be found in Appendix 1 and the interview schedule can be found in Appendix 2, the interviews lasted in

the region of thirty five minutes to one hour and the transcribing of the data took between five hours and eight hours per interview to complete.

4.2.4.1 Interview Technique

Semi-structured or focused individual interviews can be used when the interviewer attempts to present a specific list of topics or sub-areas, the timing of these questions are determined at the interviewer's discretion (Aaker et al., 2011). These questions which formed part of the interview schedule and can be found in Appendix two, these were particularly effective for interviewing busy executives and business experts as part of the research study. The interview schedule also made use of open ended questions which allowed the participants to speak freely on the topics that formed the basis of the three research questions from Chapter 3.

Pretesting was conducted prior to the interviews, this allowed for the researcher to be more comfortable with the interviewing and probing technique as well as the data capturing process. It was found that taking the time to inform the interviewees that participated in the study about the bio-waste to biogas process before the interviews began assisted the researcher in gaining deeper insights into the companies waste management practices. Motivational research advocates the method of in depth interviewing as well as advised the use of expert practitioners, furthermore the importance of interpretation has been stressed making the "why" questions a valuable part of the process (Bailey, 2014).

Although there were some challenges in gaining access to executive's dairies, the majority of the participants would happily assist with the research and had no issues with being recorded. However there were two participants that requested the interview not be recorded and detailed notes were made directly after the interview. Additionally, finding and ensuring the most appropriate participants for the research were identified and also available for the interviews was a challenge (Aaker et al., 2011). Many potential interviewees simply did not respond to interview requests and some could not make their time available due to travel arrangements or busy work schedules such as financial year end, which was an issue for a number of companies.

4.2.4.2 Inclusion and Exclusion Criteria

Inclusion criteria:

Interviewees were a combination of senior level managers to company directors. Functions included operations, quality, supply chain and general managers. The interviewees all had working knowledge or direct dealings with product that has been discarded. The food manufacturing industry in the context of this study are specifically value adding plants. Businesses where there is a cooking, canning or bottling of either a beverage or an edible product.

Exclusion criteria:

Initially no participants were selected from businesses outside of the greater Gauteng area due to the difficulty in having face to face meetings. However an opportunity arose to have an important interview which was held over Skype and was later followed up with a telephonic conversation with the interviewee from Kwazulu Natal (KZN).

Business that were not processing food products, traders and for the purposes of this study manufacturers that are not producing for human consumption but rather animal feed such as pet food were also excluded from the study as the literature found that manufacturing waste can end up as pet food.

The selection of the right companies was imperative, as it was essential to have large companies with substantial production outputs which could potentially mean higher waste outputs, the assumption behind this is that if major manufacturers do not have enough waste to make a biogas plant feasible then the project would need to look at alternative inputs.

4.2.4.3 Interviewees Selected

All interviewees were selected based on their relative expertise and knowledge in their company's bio-waste outputs. The interviewees were each senior in their respective organisations and the titles are listed below:

- Managing Director
- Operations Director
- Supply chain Director
- Manufacturing Director
- Executive Manager
- General Manager
- Head of Sales
- Head of Planning
- Head of Operations
- National Deployment Manager

As data saturation was obtained after the ninth interview it was no longer required to continue to collect further data as by definition no new relevant information was emerging through the interview process (Corbin & Strauss, 2014). In order to reconfirm that saturation had been reached a tenth interview was conducted late in the study. Figure 7 in Chapter 5 gives a graphical representation indicating new data collected from each participant in order to determine the saturation point.

4.3 Data Analysis and Coding

Interviews were conducted until saturation was reached. The interviews no longer differed greatly in content and a clear pattern of results was established. The analysis of the results was based on the transcription of all the interviews that were conducted. Interview recordings were transcribed and in the case where there was no recording a detailed transcript was typed up immediately after. In certain instances where the point that the interviewee was trying to bring across was not clear, the interviewee would be re-contacted in order to provide further clarity.

Saunders and Lewis (2012) list the following three steps to analysing data qualitatively:

1) Develop categories or codes,
2) Decide on a unit of data to which to attach the codes, and
3) Code the units of data based on these codes.

In developing the categories or codes, all transcripts were read and re-read to identify frequently raised issues and key themes that recurred, these themes were used as the basis for categorisation or coding. Once the data was coded, it could be comparatively analysed, to identify areas of similarity and difference (Saunders & Lewis, 2012). The data was analysed through axial coding with computer-aided qualitative data analysis software, ATLAS.ti.

Induction:

After the data was collected and analysed from the interview process in order to answer the three research questions and a theory of a continuous value proposition was proposed, to these ends an inductive approach was also utilised.

4.3.1 Data Reliability and Validity

Reliability essentially involves the degree to which a test measures something consistently (Salkind, 2012). To ensure that reliability was achieved the interview scripts were standardised as far as possible across the interviewees. Another factor that could have threatened the reliability of the research may have been subject bias, where the information given by interviewees may not be truthful for fear of being seen in a bad light (Corbin & Strauss, 2014). Creating a comfortable atmosphere and allowing interviewees to speak freely with open ended questions seemingly overcame this factor as they willingly volunteered information. Research tools and data analysis were assessed by an external research specialist in the field of qualitative research prior to the implementation of the interviews. This allowed for greater reliability of the data analysis, where consistency was also employed.

Salkind (2012) describes validity in qualitative research as the trustworthiness or credibility of the process. Given the nature of the research, the potential for unwillingness to disclose information may have occurred, however the interviewees had little issue with disseminating data on their organisations bio-waste management. In addition to this senior level positions were selected for this study and the interviewees would have had no reason to try and impress the researcher with inflated and untrustworthy information (Salkind, 2012).

4.4 Research Limitations

It should be noted that this research has the possibility of being susceptible to different types of limitations, for the proposed design it would be possible to have omission and / or inclusive bias for the qualitative interviews. Therefore, collection of the data within the limited time frame could result in bias; this limitation could be overcome by conducting future research over a longer time frame. Other potential bias may appear due to the researcher's interpretations, assumptions and perspective of the data analysis process. Hence there is a need for a sound theoretical base derived from past research as the foundation of the process.

The outcome of non-probability, purposeful sampling cannot be assumed to be extrapolated to the entire population as the universe was restricted to food manufacturing companies in the greater Gauteng area and one in KZN. Although this did result in limited variability in responses from participants, the implications of this are that the data cannot be generalisable to encompass the whole of South Africa.

The outcome of the research is highly dependent on the quality of the information provided by the participants during the interviews. Hence the importance of the selection of the interviewees. The study was limited to large manufacturing facilities with a minimum output of sixty tons per month and the average amounts of waste does not extrapolate into small and medium sized organisations.

Despite the limitations the research would still provide valuable insights for the manufacturing industry with regards to effective management and planning. The data would also be useful to future studies on food security and highlight possible areas to be addressed in waste reduction. Further studies are also recommended to take a quantitative approach to the data collection and analysis.

Most importantly the study should equip the researcher with enough data to determine if there is an economic value to the bio-waste both before and after the biogas conversion process for the purposes of a viable business in the renewable energy sector.

4.5 Conclusion to Chapter 4

A rigorous and well planned approach was followed to gather the data that is contained within this research paper. An exploratory methodology was followed due to the limited information on manufactured food waste in South Africa, particularly with regards to bio-waste to biogas production. Transcripts were uploaded onto ATLAS.ti software and coded for result analysis. Interviews were used as a research instrument for the numerous benefits that can be attributed to them, such as being able to probe deeper if one could hear new knowledge or insights being brought to the forefront.

There were few challenges with regards to recording of the interviews and all recordings as well as consent forms have been stored for verification purposes. Although two of the interviewees declined to be recorded, detailed notes were taken directly after the interviews. Despite the fact that open ended interviews were conducted with industry experts, this business study could be tested and be further enhanced with the addition of quantitative research questionnaires aimed at a larger amount of people in the food industry.

CHAPTER 5: RESULTS

5.1 Introduction

"However beautiful the strategy, you should occasionally look at the results."

Winston Churchill

This chapter presents the data that was collected using the surveys as the data collection instrument. The purpose of this research is to study the business considerations including challenges and opportunities emanating from the vast amounts of waste that occurs throughout the food supply chain, specifically at manufacturing, and is a high level assessment of the respective value propositions available as a strategic imperative within a sustainable business model of biogas generation. In this chapter the results of the ten expert interviews conducted are provided. After the transcribed data was coded, several key themes emerged with respect to the interviewees responses to the three broad research questions from Chapter 2. The results were used to complement and refine the constructs identified in the literature review and these results have been presented per research question and in the same order that they were posed in Chapter 3. Appendix 2 shows the research instrument used to collect the data.

The attainment of executive time proved to be arduous as there were a number of cancellations as well as rescheduling of bookings. Of the ten expert interviews, only two objected to being recorded, however detailed notes were taken directly after the meetings. Transcribing of the data was done by the researcher and not outsourced to a third party, this allowed for a more in depth understanding of the data in terms of what the interviewees were conveying. The interviews that were conducted lasted between thirty five minutes and one hour, with the shortest interview taking no less than five hours to transcribe. Figure 7 below is a graphical depiction of the new data that was being brought forward by each new participant.

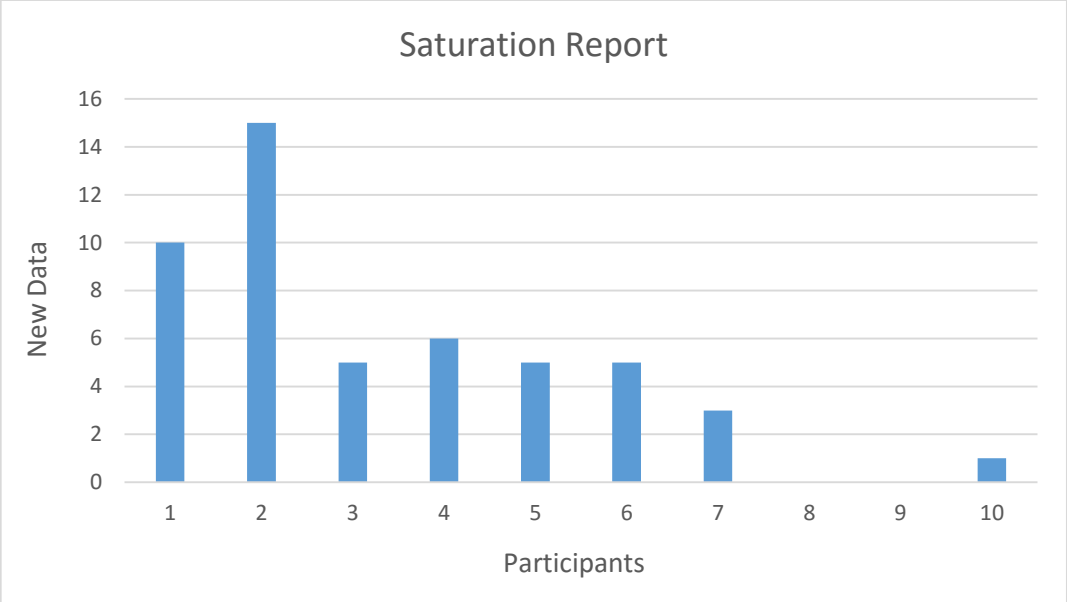


Figure 7: Graphical depiction of saturation reached in the study

After the first nine interviews were completed it was found that saturation had been reached, this was determined by generating a frequency report of the coded data from ATLAS.ti and using the first instance of a participant mentioning something new to the study then removing it from the next participants. The results were added for each participant and the totalised data was used to create the graphical depiction found in Figure 7. To increase the certainty of the verification a tenth and last interview was conducted late in the study as can be seen in the graph, saturation can be concluded.

5.2 Formulation of the Model

The conceptual model of a continuous value proposition was based on the triple bottom line model by (Elkington, 1994; 2006; 2010). In this model it is emphasised that people, prosperity and planet are all interconnected. However this study would suggest that they are more than just interconnected and that in fact for a business to flourish there should as a prerequisite be a stable social system and neither can exist without a hospitable ecosystem in which the companies' resources can be found as per Figure 6. The research goes a step further to argue that for a business to remain sustainable it should be providing a continuous value proposition to these three spheres as is presented by the bio-waste to biogas business model as per Figure 1.

5.3 Research Question 1

How can an economic value proposition contribute to bio-waste to biogas conversion?

This section broadly sought to discover the business deliberations that would be evident for a company that may develop a bio-waste to biogas safe waste disposal service or concurrently develop bio-fertiliser and biogas products. The analysis of the data for this section revealed that there are two very specific sub topics that have formed due to the answers received in the data collection process, namely, opportunities and challenges.

5.3.1 Opportunities

Through the research an emotional topic in the South African business community was unearthed, many business owners feel that the long term security of their businesses are in jeopardy due to the turbulent environment in which they operate (SAIREC, 2015). The companies that were aware of biogas plants were those that were in the investigation stage of responding directly to the energy crisis threats that they have experienced in recent years. Participant 7 *"I think it's a good alternative as the stock that is being gotten rid of is going into a landfill when it could assist in creating energy, especially since we are in a crappy situation in South Africa where prices are going up for both electricity and fuel".* Participant 4 *"I would make electricity, I would burn it straight to a generator, that's probably the primary reason for us looking into this product or project given the current circumstances with our country's power supply."*

Interview data revealed that there is a large quantity of waste that is still fit for human consumption but is not a product that these businesses usually sell. Therefore these products are being stored in warehousing and cold stores which continue to incur a costs to the products. Participant 6, a senior manager from one such manufacturer accumulated 145 tons of products in a twelve month period with a low value and no outlet to sell it to. Many of the interviewees had no idea about the bio-waste to biogas process, nor did the same of the interviewees know about biogas at all. Only two of the interviewees explained that their organisations had investigated building a biogas plant, however they believed that they did

not have enough waste to keep the plant running regularly, this viewpoint, it was discovered was from organisations expecting to go totally off the national electricity grid.

Consultants for renewable energy projects had informed the specific interviewees who had actually done investigations that they would need to employ a diverse range of solutions in order to go totally off the national power grid such as wind, solar and gas. From a potential business perspective it is preferable that companies choose to take this outlook, especially for a company which is dealing with manufactured food products.

Of the interviews conducted, all but one were making use of a professional third party waste removal contractor to various degrees, Participant 4 noted that certain plants were removing daily loads *"on a daily basis you probably looking about ten tons daily, six days a week",* while this was purely waste from manufacturing, two main points are noteworthy, for one it is all biomass that is being sent out such as blood and entrails, secondly is that a professional service is being made use of. Participant 4 had also experienced an incident where the facility had burnt down and although their cold storage was still fine, the product inside had been tainted by the smoke and they had to safely dispose of 200 tons of raw and processed stock *"That is a product which had to be dumped, where we had to get [Company] to put it into skips and truckloads of products went to landfill. The approximate weight of that incident was probably around about 200 tons of product and luckily for us insurance did cover it."*

Several of the interviewees from the sample made reference to keeping their effluent water clean, this being the water used in their processing operations, however, the need has arisen from the excessive amounts that the company could be fined as opposed to environmental concerns. Participant 6 mentioned that they clean their fat traps every day to avoid large municipal water works fines, *"last year we had a fine in the region of a hundred and fifty thousand Rand."* While participant 2 a company director for the past two decades stated that there are substantial monthly fees for maintaining the grease traps that the municipalities are testing *"well, the grease trap pumping that costs in the region of R25,000 to R30,000 per month."* This information is of particular interest as these organisations are paying for the service of waste disposal, and also the waste itself is bio-waste that can be used in anaerobic digestion.

The information that was disseminated during the interviews differed from company to company with regards to in process waste. It would seem that some facilities are running

more efficiently than others, however the point was mentioned on several occasions to do with production staff playing a role in the generation of waste. Many of the companies explained scenarios that occur from time to time, occasionally some products had to be legally disposed of due to negligence. Participant 6 shared an event that occurred when one of their more senior staff members was away on leave and another staff member took over their role, product was set to thaw over the weekend and the person did not set the room temperature to the correct setting, consequently 8 tons of product went off and had to be safely and legally disposed of, two such incidents had already occurred this year. Another incident was told of by participant 2 which also involved temperature control, and once again with regards to a defrosting process.

All participants in the sample had large volumes of processing waste that emanated from their production processes and had nothing to do with any form of negligence, however some found it simpler to deal with than others as a portion of the waste could be sold as cheap products and sold at discounted rates in their own factory shops as with participants 2, 5, 7 and 10 however this would only amount to a fraction of the volumes. The entire sample expressed the importance of delivering good quality and safe products as the entire population that were selected have one or another type of food safety accreditation.

- *"As a company, we obviously take food security or food safety very seriously, we have accreditation"* Participant 2
- *"The way we run this business we do not rework those products, if the bag is broken we do not really handle the product. Obviously there are safety concerns where the more you handle a product the more of a chance you have of contamination"* Participant 3
- *"We still want to sell a safe product and a good quality product" Participant 5*

These are important findings of the study because the return of the capital invested can be significantly accelerated by introducing a safe waste disposal service to food manufacturing companies that are in a nearby radius of the biogas plant. An opportunity is apparent, however no other companies are marketing such a solution and as with any first mover scenario a period of customer education would be required. Companies have regulations to abide by and others have accreditations that they are maintaining, the need has been established for other forms of energy generation as well as for alternative waste disposal routes other than landfill dumping.

5.3.2 Challenges

With any business considerations there should be investigation into the possible challenges, Figure 3 is a diagrammatic found in Chapter 2 on the barriers of anaerobic digestion as found in Lin et al. 2012 . The interviewees, through the in depth open ended questions have revealed many such possible challenges which correlate with the research from Chapter 2. Participant 1 and 4 both raised concerns about having sufficient inputs to feed an anaerobic digester were they to build their own. Participant 4 had run feasibility studies and had deduced that they alone did not produce sufficient bio-waste in order to power their facility, they had considered involving their neighbours that were in close proximity to them *"The company is by the way investigating the possibility of putting a biogas plant up and making use of the product that cannot be used in the production environment but for us to do it we do not have enough waste or raw material to make biogas so that would mean if we should go that route, that we would have to do it in conjunction with our neighbours in the back".* In addition to this there are also concerns about keeping the contaminated waste of neighbouring businesses on a single site. Although this may be a challenge for individual companies, it makes the business case more plausible by creating input barriers of entry even for very large organisations.

According to participant 1 there is a long payback period to building a biogas plant *"the cost of the plant was extremely high and the payback was too long so it wasn't that viable as we are looking at costs versus benefits as we are in a tough industry right now and we can't afford to work on a ten or eleven year payback."* This return on investment was calculated using the company's existing waste and energy values and an investment of R50 million.

Many of the Interviewees spoke about cost savings, possibly as part of directives that are engrained into the agendas of many companies. This study specifically takes into consideration the costs to society as well as the environment, however when questioned on the cost savings it was always answered from the businesses perspective and not necessarily from an external stakeholders point of view and this cost factor may be one of the greatest challenges to the acceptance of a business service in the form of anaerobic safe waste disposal.

"From a business point of view - I think with anything in business you got to look at the costs, and if there's any additional costs involved, and how are those costs going to benefit you more in some way. The decision becomes a bit hard, but if there's any kind of cost saving benefits it makes the decision a lot easier" Participant 2.

5.4 Research Question 2

How can social innovation contribute to the continuous value proposition of food to energy recycling?

This research question is important not only from a social perspective, but also from a business perspective as companies have realised that making money is not the only objective that a company should have. Aside from this, the initial targeted business would be those that have a culture of undertaking or supporting socially responsible initiates, this would be an opportune starting point in order to entice these companies to the value that a biogas plant could deliver to safe waste disposal.

During the interviews it was evident that the most of the interviewees were in favour of innovation in their respective companies, all of the participants reported some form of extra effort that went into making new products or doing things differently to benefit their company through the use of innovation. It did, however not become as apparent that they were implementing initiatives specifically for the benefit of the greater society. This section became the most challenging as interviewees from the various companies were all familiar with many of the business innovations within their respective companies, however very few gave examples of how they implemented changes to assist in the solving of a greater social problem. Companies see innovation as a means to gaining a competitive advantage and by this they meant from a business perspective. *"Okay, what we do, do, but it's more focused on our business, is that we have a nurse on site every day and a doctor that comes in once a week, we would allow staff to see the doctor it would run like a clinic and we would even pay for the medication."* Participant 2 in an attempt to reduce the company's' absentee rate. Participants 2 and 7 both noted that they had certain products that are regularly separated for various charities but this was not part of any of the other participant's social responsibility projects. Through the interviews it was apparent that the majority of the participants gave their own staff discounts and first choice to purchase products that were dramatically discounted.

Participant 2 made an interesting comment on marketing and social responsibility, *"I don't think we can get any kind of leverage, I do think they (customers) would be very impressed by it, and I think they would be very much in favour of encouraging it …… I am not quite sure if we would end up getting any more business from it. I don't think it would get us any more customers or will make us any more money, but I do think it is important …….. I also think that they would be proud to be associated with you if you are doing something like this, but in reality how much extra business would you really get? You won't get any more business from existing clients although you may potentially be able to pick up some new clients based on your product and what you stand for."*

There was also a common theme that evolved in that many of these manufacturing organisations were supplying a large retailing outlet as one of their customers, and in one organisations case their biggest single customer, this particular retailer seemingly played a role in many of the behaviours and thinking in the industry as all but two of the participants specifically named on a number of occasions the steps that they were taking in order to keep this customer satisfied. Participant 3 *"I did mention that [Company] is one of our customers earlier, they have ethical audits and hygiene audits. The ethical audit does touch on some of these points being mentioned…….. they used to ask us on our plans to reduce energy or emissions on our boilers and on our trucks and what our environmental impact plan was."* Participant 6 *"We supply [Company] and need to do an ethical audit, and [Company] also does a social accountability audit for [Company]. So, in line with that, we have to show that we have sustainability initiatives in place, so we are put under pressure from our customers to make sure that we are saving energy in terms of lighting and electricity and water."*

5.4.1 Energy Saving

Out of the ten participants, all had implemented energy saving programs in an attempt to bring down costs in their businesses, of the initiatives the most common and easiest starting point was to reduce the energy consumption with regards to office and factory lighting. The first stage for the interviewees was to replace fluorescent globes with LED lighting for an immediate saving of electricity, some of the participants had also taken advantage of a rebate from their electricity supplier, while other interviewees had taken steps further by installing motion sensors in various areas that turned power off when no movement had

been detected after a few seconds. Participants 1 and 6 specifically mentioned the training of employees in order to achieve a level of compliance so as to change the mind-sets of the company and create a culture of awareness to power saving.

5.4.2 Technology

The use of technology to overcome social issues such as energy reliability was widely discussed and many of the interviewees spoke of how they had either investigated, or at that time were still in the process of running feasibility trials. Most notable of the energy producing technologies was solar power generated through solar panels, all but two of the participants had explored this option in one way or another, however through the interviewing process it was established that none of the companies that were represented had actually followed through with the implementation of solar energy harvesting. It was established that a major concern for such a project would be the size and cost of a battery or battery bank in order to supply enough power to their operations. This information has been particularly useful to the business case of a bio-waste to bio energy project as the data gathering process has revealed a sizable need in the market for energy generation due to the lack of confidence with the national energy supplier. As participant 4 said "*Now that was the main reason we looked at this project (biogas), it is because of the reliability of [Company] and it wasn't because that was more important than finding another outlet for waste disposal, yes it was for unreliability of their electrical supply in the country, that was our initial thinking.*"

Participant 2 mentioned that they had conducted investigations into changing their light fuel burners used in the company's cooking process to gas burners which, according to the participant is a lot cleaner burning and more energy efficient compared to the liquid burner fuel. It was also stated by the interviewee that they believed other fuel pricing to be more erratic while the gas price had proven to be more stable. Participant 3 had already moved beyond trials and had purchased new processing lines that made use of gas. The interviewee had stated similar reasons to participant 2, however also noted that the countries unstable electricity supply played a large role in the decision.

Participants 2 and 3 had begun to invest in the upgrading or purchasing of all new forms of equipment to machinery that would run on compressed natural gas, a cleaner burning and

more efficient form of heating and cooking. The implementation of equipment designed in such a manner would further create business opportunities for the biogas model. Both participants 2 and 3 enquired about potential pricing with regards to compressed biogas and whether it would be compatible with the systems that they were running.

During the first interview with participant 1, two new forms of sustainable energy processes were mentioned that the researcher was not familiar with, the first was pyrolysis *"I will tell you rather why I look at pyrolysis, now pyrolysis is another sustainable energy solution and why I would prefer that is that waste to energy for me comes from our chicken manure, my waste streams are plastic, cardboard waste and all of those types of things with the manure and even blood. The guys that are working with pyrolysis have proved to us that our waste works, so you would be able to convert all of our waste into energy and it was proven to us where we took all of the waste and it was done, and also it was run efficiently and so from my view I see pyrolysis as a more complete solution to biogas or anaerobic digestion."* Participant 1.

"There is second concept called a fluidised bed reactor and I would think that would be preferable for our industry and I would rather support that. [Company] in Cape Town is still looking at it versus pyrolysis which is a burning process where they extract the gas from that and fluidised bed reactors are something similar." Participant 1.

It would seem from the sample that there does not exist a value proposition for changing processes to a more socially beneficial way of doing things. The business considerations are more important at this stage. Extra profits or cost cutting initiatives carry far more weighting. Some of the questioning alluded to scenarios such as, if the country were to be more engaged with environmental causes, would this in turn create a continual place for social responsibility on business agendas. Interviewees were quick to respond that it would indeed be easier for the business to go along these routes, but it was not clear that these organisations would do the right thing just because it was the right thing to do.

5.5 Research Question 3

What are the potential benefits to the environment of the bio-waste to energy business model?

This question was intended to seek out the benefits to the environment of this business model in order to establish if they outweigh the challenges which are largely regarding the payback period of the capital investment. From the responses that were given to this section of the research all participants stated that they could see the benefits of the project, however some of the participants stated that despite bio-waste going towards the production of biogas it would still need to be weighed up against the business deliberations of cost versus value. The cost of the disposal service would need to be in line with the current costs as the value proposition of being seen as an environmentally friendly company would not guarantee new customers nor would it generate extra sales from existing customers.

During the interviewing process it became apparent that in order for there to be a business to business value proposition it would be necessary to produce a similar cost structure to that of conventional landfill dumping in order for them to consider moving to this from of waste disposal *"I would prefer the product to go to a biogas plant rather than going to landfill, but with everything in business, there is a business decision to be considered, however this is definitely something that we would look at, definitely sounds like a great initiative, but the costs would have to be pretty much in the same range as what we are currently paying."* Participant 2. The value of the product going towards energy generation as well as the discarded product going to a place that no one could reuse it would be further contributors to the value proposition.

Of the ten company executives that were interviewed it was evident that all have made some sort of investigation towards energy saving initiatives. Fewer of these companies had actually taken the steps further to investigate renewable energy options for their businesses. None of the companies had investigated wind power generation, although several had looked into solar panels but no projects were taken into fruition given the capital costs of the panels and of most concern to these companies was the size of the batteries that would be required to run their factories.

Of the interviewees only two companies knew about biogas and had done significant research into this as a viable option to power contribution for their businesses, their own research included sending a team to countries such as Germany and Sweden to visit with

biogas installation experts, who then assisted with the energy generation calculations that their specific organisation could obtain given the waste types and volumes that these companies were generating. The outcomes of the feasibility trials were that there did not exist enough input materials for the manufacturer mentioned which in turn caused them to pursue other forms of energy generation investigations. However the motivation for the research was based on the frustration caused by their unreliable electrical energy supply originating from the national supplier rather than a desire to lesson environmental impacts or contribute to lower carbon emissions and greenhouse gasses.

5.5.1 Water Pollution

Manufacturing organisations often have extensive impacts on water usage and the companies that were interviewed were no exception. The usages varied between 10 000 litres and 50 000 litres per processing day. Governed by legislation these organisations required grease traps in order to filter out solid particles before being released into the municipal water supply. The impacts of such high usage and contamination of water should be recommended for further studies, however in terms of this research paper it would be of interest to utilise this waste water in addition to the solid bio-waste in the anaerobic digestion process.

Water treatment and rain water harvesting are two recurring themes that became evident during the interview process, this may largely be due to the high fines that are incurred for not treating their water which came up in a number of interviews Coupled to this is that the amount of water consumed is a part of the formulae that is used to fine companies that are not treating their water before discharging it into the municipal water supply.

An important point to mention is that some of the larger companies that were interviewed had at least investigated rainwater harvesting or had already implemented it as the cost that are incurred to get this particular initiative started is relatively low. *“Then, with water, we have considered collecting rainwater, altogether we have 7500 squares under roof. We looked at collecting rainwater into holding tanks and filtering it, that is something we've looked at”* Participant 2. During another interview the same point was mentioned *“We are also harvesting rainwater, we have two holding tanks each holding about 240,000 Litres, one for hot water and one for cold water and that is enough to sustain us for five days if we*

did not have municipal water supply, we are even looking to increase that so that we have a bigger reservoir of supply, so we are distilling it, we are filtering it, there is a whole process" Participant 8.

Another important issue for these companies was water treatment, particularly the manufacturers that were cooking at some stage in their process, whether it was a snack food producer or a producer of meat products, the water that was going back into the municipal system needed some form of treatment, some of the participants spoke of a daily cleaning routine for the grease trap or fat trap as they called it. This system was designed to capture most of the solid waste particles going back into the lines, this system is a legal requirement for any producer of food products from restaurants to manufacturers and it is also where the municipalities test the water supply going back to their water works plants. Participant 10 had a fine incurred due to the negligence and mismanagement of their staff emptying used cooking oil down the drain as opposed to having it collected for recycling *"as we found out that one of our shifts was not decanting the used oil into a container, and he was just throwing it down the drain, so it had a huge effect on the water and the guy from the council came to test and found that we were negligent and charged us R250 000."*

5.5.2 Air Pollution

Throughout the entire interview process there was very little mentioned with regards to air pollution, the interviewees that supplied one particular retailer which had implemented forms of auditing were the ones that did have an understanding of areas of their businesses that could be major contributors such as the vehicles and boiler systems. Participant 2 noted that the trucks used in the transport of their goods needed to go for a yearly testing as per government regulation and roadworthiness, which should therefore mean that the rest of the sample should also have been required to do the same if they were operating their own fleet of vehicles. The boiler systems, some fuelled by diesel and others by a burner fuel also had potential to produce large amounts of air pollution, however the interviews did not reveal that these systems required monitoring either by the companies or by government *"we are using diesel for our boilers of which you could easily be using 5000 to 10,000 litres a week."* Participant 2 indicating a significant amount of fossil fuel usage consumed during their cooking process.

5.5.3 Land Pollution

The interviewees could all attest to making use of landfill dumping, many of the interviews mentioned packaging waste and others through the discarding of product that was no longer fit for human consumption. The volumes of product going to landfill would not always be consistent as production issues as well as other unforeseen circumstances could arise, as mentioned earlier in the report one of the participants had a fire that culminated in 200 tons of the their product tainted by the smoke and these products all went to landfill. Participant 3 also spoke of an incident that caused the company to discard a large amount of product *"It was because we didn't have electricity for four days so everything that was work in process and that was being thawed, and everything that was being produced and waiting for packaging was written off, that was close to R30 million."* As an alternative to the landfill dumping, the bio-waste to biogas business could offer a means of safe waste disposal that would effectively consume less land area as well as capture many of the greenhouse gases they occur during the decomposition process.

5.5.4 Safe Waste Disposal

Of the companies that were interviewed the rendering plant from participant 5 was the only in-house form of safe waste disposal, the company had invested into technology that converted unusable meat tissue into more useful materials that could be converted into other products and even biodiesel *"in terms of an environmental and social impact we aren't sending tons and tons of carcasses that are rotting and potentially diseased to landfills."*

Waste disposal took several routes but for the majority of the output the bio-waste would go to landfill. Pig farmers also came up more often than would be expected as a form of waste disposal, two participants noted a lion park and one mentioned a crocodile farmer in the nearby geographic area.

- Participant 3 *"our waste is fairly limited, we probably looking at about five percent of our production which isn't too bad, but we do have a market for it in terms of the pig farmers."*

- Participant 8 *"so like I mentioned, our waste is minimal the biggest part is the bones which is split between sales and giving it for free to the lion park about 20 percent is given away 30 percent is dumped and 50 percent is sold."*
- Participant 6 "the crocodile farmer is only prepared to pay about three Rand per kilogram. So that's part of the reason we are sitting with the stock, that is part of the problem but this is really a big headache for us."

Although the three types of animal methods may not be seen as a conventional means of safe waste disposal, it was noted as a means of waste disposal for half the sample for the data collection. Some of the companies only made use of safe waste disposal after a certain period of time, in the region of once every six months. The product that would be disposed would be expired and would require a safe disposal certificate from the waste disposal company. These products would not have been fit for human consumption nor for animal consumption due to the products being off (decomposing). One of the great benefits of the bio-waste to biogas plant is that through the conversion process, a by-product is created where the dangerous pathogens and odours are eliminated to for a bio-fertiliser that could be used in a variety of ways.

5.5.5 Bio-fertiliser Usage

Data from the collection process revealed some interesting insights and a few challenges from a business to business perspective, exclusively from participant 4 who had prior business dealing with farmers. The interviewee was not convinced at all that selling off bio-fertiliser would be a straight forward process *"You probably have to give it to them at first so you probably won't make money out of it initially."* Even to reach that point would be difficult according to the expert, the farmers would have trusted suppliers or trusted products that they were already using and to get them to move away from these even if offering it for free would be a difficult thing to achieve. Further to this testing would need to be conducted on the bio-fertiliser such as what the chemical makeup is, the interviewee stated that there also exists a possibility of the farmers each requiring a product that carries specific formulations required by their own specific crops *"Would they still need to do some soil sampling and testing to see what additional components they might need to add?"*

The consistency of the bio-fertiliser product coming out was also called into question by participant 4, it was queried if the input waste into the digester would play a role in the product that came out at the end of the *process "What you take out this week may not necessarily be the same as what you take out next week if he had a biogas plant unless you probably feeding the system with the exact same product every day."* An important point was put forward by the participant, given a theoretical scenario, if a farmer's crop did not deliver the anticipated yield and the farmer had data from previous years to prove it, and the bio-fertiliser was the suspected cause, the case may be that the farmer could sue for losses incurred *"if he can prove it he will sue the socks off you."* After this point was made, other outlets for this by-product was discussed and the participant suggested that plant nurseries may be a good option until a consistent product can be proved.

5.6 Conclusion to Chapter 5

This chapter presented the results that emerged through the qualitative research conducted. Through an exploratory method, the questions were asked using the triple bottom line as a framework to probe for opportunities and challenges in order to test the viability of a bio-waste to biogas business model, the technique employed made use of open ended questions that the interviewees gave their responses to using their knowledge and expertise within their industry, which for the purpose of this study was the companies that formed part of the processing stage of the food supply chain.

The data that has been analysed revealed certain themes, these were discussed and some of which included the types of waste generated as well as rough amounts. The interviewees shared what they were doing with most of their waste and also where the products were going. Various types of sustainable energy projects were noted as well as environmental impacts the businesses were seeking to address. The interviews revealed a number of potential opportunities that will be discussed in Chapter 6 where the results will be compared with the literature from Chapter 2.

CHAPTER 6: DISCUSSION OF RESULTS

6.1 Introduction

"The aim of argument, or of discussion, should not be victory, but progress."

Joseph Joubert

As the previous chapter presented the qualitative results from the interviews that were conducted, this chapter fittingly, interprets and evaluates the results. The study was conducted by interviewing ten manufacturing industry experts, specifically from the food production sector in order to determine the products and the quantities of these products that were being discarded. This purposely speaks to waste, or in the case of this particular industry, bio-waste that is generated through the production of food products. The purpose of tapering down into the processing stage is an attempt to accurately gage the opportunities that may exist in supplying these companies a safe waste disposal service by probing for indicators for interest such as social responsibility campaign support and environmental impact reduction projects. Ultimately the opportunity sought is to generate sustainable energy in the form of biogas.

6.2 Overview of the Results

The results that were generated stemmed from the ten in-depth interviews that were transcribed, and then analysed. Consequently the line of questioning revolved around the researcher's interpretation of the triple bottom line model superimposed on to a business model of bio-waste to bio-energy conversion in the form of biogas. Therefore the framework for the three research questions were related to people, profit and planet, the findings of these results have been discussed in line with the findings from the literature review that was conducted in Chapter 2 in order to empirically establish any relevant value propositions inherent to the business model.

6.3 Research Question 1

How can an economic value proposition contribute to bio-waste to biogas conversion?

6.3.1 Comparison to Opportunities

In terms of revenue stream one from Figure 1, which is the service provided to the manufacturer to safely dispose of the products that are no longer fit for human consumption, the feedback was that there is interest from the companies side and also that the volumes of the waste involved are substantial. Many of the interviewees had been making use of service providers of a safe waste disposal service, which was encouraging for the prospects of future business opportunities as there has already been a take on with regards to this process. The literature that was studied found no mention of such a service, which would significantly shorten the return on investment of a biogas plant.

The proposition for capturing some of this business would need to come from a more attractive value proposition in the form of possibly cheaper costs, or a more reliable service, however the value of guaranteeing the waste would not be able to get back into the market through the process of using it as an input into an anaerobic digester may be the most favourable value proposition, which according to Frow and Payne (2011) can, in part be gained through a co-creation of the proposition.

The companies that were cooking as part of their processing had been subject to large fines imposed on them by the municipal water board, if the testing on their outgoing water was not of a certain standard. Many had begun to implement treatment plans and processes, however one particular company had actually diverted all their internal drainage to holding tankers that were collected on a regular basis by their waste management company resulting in approximately ten to twenty thousand litres of bio-waste mixed with water being taken off their premises daily.

The literature did not mention that fines were a reason for adopting anaerobic digestion implementation, however this is another relevant revenue steam for the safe waste disposal argument, regulatory authorities would potentially continue to keep companies in check as long as there was an income being generated, and as long as companies were being issued fines, they too would comply with the regulations, therefore an opportunity already exists in

the industry, with regards to water treatment and waste removal. The argument is then, if a reliable waste removal service could be built with regards to condemned waste, could there not also be an opportunity to capture business from the existing service provider on the back off a better value proposition.

Revenue stream two from Figure 1. Recycling of packaging waste as a form of income may be minimal as the vast majority of the waste is collected directly into containers and transported to landfill, there are certain companies that are using plastic bags, however the monetary recuperation from these would not be much as could be gauged from the low volumes mentioned by the interviewees. Condemned waste or off product is an occurrence that the interviewees attested not to happen very often, however as the interviewer probed for further information it became apparent that there is indeed a large amount of waste that goes off either prior to production or after. It is this waste that would be packed into boxes in order to store and eventually dispose of, there is an opportunity to recycle and receive money back from this waste, but would be the smallest of the four potential revenue streams. As most of the biogas literature was based on either farm bio-waste or municipal sewerage waste there was no mention found of recycling of packaging.

Revenue stream three from Figure 1. Supporting a project that could contribute energy back into the national power grid, even if the project generated only a small amount would be another form of value proposition that the sample was willing to support, there were many concerns raised about the reliability of the electricity supply, this relates to what is being written about in the literature and is not an occurrence that the general public of the country are not familiar with as the term load shedding has become part of daily life (SAIREC, 2015). Load shedding refers to the cutting off of power to certain areas of the county at predetermined times, in order for other areas to still have power, the areas that are without power will rotate with areas that will have (Odhiambo, 2010). Many businesses have been battling with load shedding and power outages on a regular basis, and as has been stated in the research that was studied in Chapter Two, will take a number of years to be rectified due to the adjacent priorities of government to supply communities that still do not have power (Odhiambo, 2010).

Two of the interviewees noted that their companies had conducted investigations into building their own biogas plants, although their test concluded that they would not had enough input waste to supply and keep a digester running constantly and reliably, this however is an excellent opportunity from a business perspective, there are barriers to

companies building their own plants, the challenge exists in signing up these organisations as a customer in order to regularly and reliably remove the bio-waste from the premises of food manufactures at a reasonable cost. Even though a business may not have enough bio-waste to become self-sufficient in terms of power generation, the company may still be able to self-power a section of their business.

Revenue stream four from Figure 1. Bio-fertiliser would be the largest output from an anaerobic biogas digester (Holm-Nielsen et al., 2009), and therefore would also be the key to a successful project. There are conceivably a number of challenges that would accompany the storage of a hundred thousand litres of liquid bio-fertiliser per day. For one it would not be viable to store this indefinitely, there would need to be channels for the product to go to, even if a certain amount of it would be for free. It was envisaged that this would be the least of the concerns regarding the biogas project, as selling cheap bio-fertiliser to farmers would surely be an easy option, however the interview process revealed that this would not be the case, as farmers are not readily willing to change from trusted fertiliser products to an unknown variable. Another concern for the bio-fertiliser product is the possibility that there would be no standard for the product, and that potentially every batch would differ due to the variety of inputs into the digester. Lastly it was suggested during an interview with participant four that if anything was to go wrong with a farmers crop yield, there may be potential legal ramifications.

The literature that was used had no indication of customer take on by farmers, however the study by Himanen and Hänninen (2011) did find that bio-waste, particularly that from kitchen waste had the highest nutrient value in bio-fertiliser over municipal solid waste, this study was conducted over period of one year and also found that there existed zero toxicity towards plants from the bio-fertiliser. A value proposition could therefore be put forward to farmers as potential customers of the bio-waste that scientific studies have deduced that there will be no harm to the crops, however this would most likely not be enough to convince them to switch products without proven results. Another value proposition could then be to conduct controlled trials on a section on the farm land and test the yields versus the competitor fertiliser on another piece of land the same size.

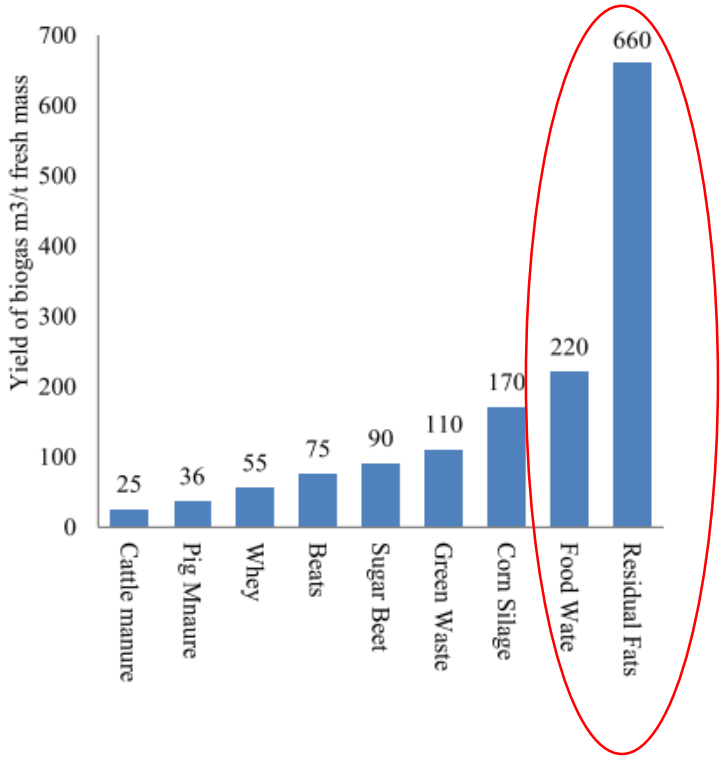
6.3.2 Comparison to Challenges

A large part of the success of a biogas plant lies in having sufficient inputs to feed the digester (Lin et al., 2012). Both of the two interviewees that had conducted feasibility trails through third party consultants found that they alone did not have enough raw material to supply a digester which is in line with an element in Figure 3 and the barriers to anaerobic digestion according to Lin et al. (2012). What was not apparent through the interviews was exactly how much electricity they intended to produce, it can only be assumed as the intention for both companies was to get off the national electrical power grid that they benchmarked the trials on a full power solution and therefore came to the conclusion that they did not have enough inputs. The reason why a partial solution from the total dependence of the erratic electricity supply was not ascertained and may be subject to future research.

Having interviewed ten manufacturing companies it is apparent that there is a substantial volume of bio-waste that is produced through the processing stage of the supply chain. From the ten companies the volume can be estimated at over one hundred tons per month, and although the inputs are important from a stand-alone biogas plant business perspective as well as an individual company, it would be feasible for an individual plant to seek out waste from various companies so as to continually feed the digester. This is line with the literature by Visser (2014) in which it is suggested that companies need to decide whether to collaborate or go it alone on their sustainability journey. The argument that could be presented to the manufacturing companies is that they should be focusing on their core business and not on energy generation and the upkeep of a plant.

Before seeking funding for an independent anaerobic digester it would be pertinent from an investor funding perspective to get signed contracts from the ten manufacturers interviewed as according to Figure 3 one of the barriers would be securing access to public funding. Further to this as many other plants as possible should be secured for input feed before the project is built. It may also be of benefit to secure current waste disposal companies to make use of the digester at little to no cost in order to get the project running from day one. It can be determined from Figure 8 that the two highest energy values exist in bio-waste from food and residual fats from cooking processes (Kigozi et al., 2014), the size of the digester could also be substantially smaller than those situated on farming operations, thus bringing the initial investment costs down

Figure 8: Biogas yields from various substrates



Source: Kigozi et al. (2014, p.112). Biogas Production Using the Organic Fraction of Municipal Solid Waste as Feedstock

6.4 Research Question 2

How can social innovation contribute to the continuous value proposition of food to energy recycling?

The study by Pol and Ville (2009) states that social innovation aims to address the needs that have otherwise been ignored by the market. The innovation of bio-waste to biogas generation would, on a small scale, potentially address three of the nine challenges listed in the national development plan which was researched in Chapter 2. The three in particular are that too few people work, infrastructure is poorly located, inadequate and under-maintained and thirdly that the economy is unsustainably resource intensive. The NDP proposes to increase economic activity and thereby also the unemployment rate. Renewable energies constitute over 109,000 jobs in South Africa alone (SAIREC, 2015), the same report has also made reference to the 200 biogas digesters that have been registered since

2011, compared to an estimated twelve million in India and seventeen million plants in China.

6.4.1 Comparison to Energy Saving

Energy saving initiatives are an important stage in the adoption process towards going green (Hammer et al., 2011). Out of the ten participants, all had implemented energy saving programs in an attempt to bring down costs in their businesses, of the initiatives the most common and easiest starting point was to reduce the energy consumption with regards to office and factory lighting. The first stage for the interviewees was to replace fluorescent globes with LED lighting for an immediate saving of electricity, some of the participants had also taken advantage of a rebate from their electricity supplier, while other interviewees had taken steps further by installing motion sensors alongside their lighting. In line with the study by Visser (2010) it was noted by Participants 1 and 8 that culture would play an integral part in the longevity of their company's sustainability projects.

6.4.2 Comparison to Technology

Social innovation also attempts to improve the quality of life through various means (Pol & Ville, 2009). In terms of infrastructure, the country still has a vast population that are without electricity, to make matters worse, the population that does have electricity, has an unreliable supply, which in turn has an impact on business operations in the country, this study found that two of the interviewees had been investigating which was the best type of renewable energy to implement into their own organisations *"we didn't have electricity for four days, so everything that was work in progress, and that was being thawed, and everything that was being produced and waiting for packaging was written off"* Participant 4 referring to an incident that occurred two years prior to the interview. Biogas is a versatile form of renewable energy, it can run on any type of bio-waste and it is for this reason that much of the research in the past has been with regards to its implementation into rural communities, yet there are very few operations that have been built in the country, leaving an opportunity open for government and business.

According to Yusuf (2009) an important driver of innovation is human capital, It is people who will ultimately come up with new ideas, and also people who will drive new ideas and turn them into viable business opportunities or technologies. South Africa has an urgent need for new sources of electrical power generation and anaerobic digesters, although they do not have as much power output capacity as a nuclear plant, still have a viable value proposition as they can be built in six to twelve months and can be producing gas within six weeks after that. Coupled with this is the dire need of employment for many of the people in the country. The scenario is therefore that there is human capital to run these operations and also a need for the energy output.

The study by Yusuf (2009) goes on to mention that culture also plays a vital role in innovation, perhaps as momentum builds and more and more people in their communities take up the challenge of becoming leaders in the societies in which they live then projects such as biogas digesters could become more common place, as Pol and Ville (2009) have stated, once a type of innovation has been around for a period of time, people become more accepting and demand for these products grow. The interviews correlated with the literature as those companies that investigated the technology were still sceptical on issues such as bio-waste input supply and reliability, even though the technology is widely accepted in other parts of the world in South Africa it is still in its infancy (Oelofse & Nahman, 2012).

6.5 Research Question 3

What are the potential benefits to the environment of the bio-waste to energy business model?

As the studies of the literature on sustainability has stated, companies need to decide whether they will go the sustainable technologies route along or will they collaborate with other organisations (Visser, 2014), this became apparent through the interview process, as participant 4 who worked for a well-known brand in processed meats said they had done feasibility trials and were considering collaborating with two of their neighbours *"we would have to do it in conjunction with our neighbours in the back, the poultry guys and possibly also bring some waste from the ice cream manufacturer in the nearby area, but now we don't actually have enough."* In most circumstances the interviews were looking for a complete one size fits all solution to their electricity needs, however this is not always possible from any of the renewables if you are running a manufacturing organisation which

incorporates energy intensive equipment. Companies that have had successful installations, either select one technology and run a portion of the business on renewable power or others will utilise an array of options such as solar, wind and gas to satisfy all their energy needs (Hancock, 2015).

According to Hill, Nelson, Tilman, Polasky, and Tiffany (2006) fossil fuel energy impose environmental costs not captured in the market. However, in order for biofuels to create a net benefit to society they would not only need to be cost competitive but also show that they offer a greater cost versus benefit to the environment as well "*While it can be used for something like energy production, then definitely I'd rather go there. I think the product would be safer. From a social point of view there is probably also a lot of benefits for that going to a biogas plant as opposed to landfill, even from an environmentally speaking outlook it is a much better option. I would definitely support that initiative!"* Participant 4.

The report by Ferroukhi et al. (2015) states that sustainable energy technologies are now a viable option as a mainstream energy source, their environmentally friendly and less resource-intensive qualities mean that they are comparable with the broader green growth objectives towards sustainable development. There are a broad array of benefits that can be derived from biogas renewable energy besides increasing energy access, biogas also enhances energy security, mitigates climate change, and can stimulate socio-economic development (Ferroukhi et al., 2015)

There is a growing recognition that renewable energy plays a significant role in alleviating some of the stains on other resources, namely food and water security (Ferroukhi et al., 2015). The share of renewables in the global energy mix is poised to grow substantially, as of 2015, renewables make up 19 percent of the worlds final energy consumption, with nine percent comprising of traditional biomass (Ferroukhi et al., 2015). The share of renewable energy will continue to grow as economies realise the relevance in conjunction with regards to social improvements, energy security. There is also a global consensus that globally any solution that will address climate change will also involve a substantial expansion into renewable energy (Ferroukhi et al., 2015). During the interviews of the ten participants, all knew about solar power generation and yet only two were aware of biogas as an alternative to fossil fuel dependency.

Biogas has been around for more than a century, however the reason that there is little known about the technology, even in industry was not investigated, what was of greater

importance to the research was to get an understanding of the types of waste and the quantities that are potentially being discarded to landfill by food manufacturing companies.

6.5.1 Comparison to Water Pollution

According to Ferroukhi et al. (2015) water use is inextricably linked to energy supply, it requires power at every step, from the source up until the point of use. Eight of the ten interviewees mentioned water treatment or conservation during the data collection. It should be noted that much of the need seems to have commenced due to the local municipalities clamping down on untreated effluent water, which is water that has been utilised in the production process or during cleaning and has now been discharged down the factory drains of these manufacturers. Of particular interest to the research is the grease trap or fat trap collection systems that food manufacturing plants are required to have by law. The residual fat that is collected inside these units are of the highest energy values of any bio-waste as can be seen from Figure 8. Not only is the fat of high value but these traps also keep a large amount of water inside them that can be utilised inside the anaerobic digestion process, participant 4 during the interview stated that they are removing around 10 000 litres of waste water and blood from their premises on a daily basis, six times per week. By collecting bio-waste from manufacturers through their grease traps the biogas plants would need substantially less water input for the biogas process, in addition a revenue stream is formed through the collection charged to the manufacturers.

6.5.2 Comparison to Air Pollution

The interview process revealed very little consideration towards the environment from the manufacturers with regards to air pollution, one of the interviewees responded that with the difficulties of running a business in conditions when you are unsure of when the power will cut out or when strikes could occur made it difficult to focus on other concerns such as the effects that their business had on the environment. According to (Hammer et al., 2011) cities should take it upon themselves to reduce air pollution through the use of regulations, environmental taxation and emissions trading. The reduction in air pollution has effects on the improvement of public health as well as other co-benefits such as limiting global warming

and damage to the ozone layer (Hammer et al., 2011). By moving towards an anaerobic digestion solution which offers a variety of benefits that are mentioned throughout this report, the added benefits include reducing the amount of bio-waste destined for landfill, this would reduce air pollution in two ways. For one, less matter would require incineration and the other is that less bio-waste would mean less greenhouse gas emissions through the decomposition process (Samimi & Zarinabadi, 2012).

6.5.3 Comparison to Land Pollution

The interviewees could all attest to making use of landfill dumping, however none had considered the environmental impacts aside from land pollution, other impacts such as potential for water table contamination and greenhouse gas emissions as stated by Weiland (2010). Biogas digesters have the means to generate gas for the use of electricity production instead of waste ending up at a landfill, thereby reducing greenhouse gas emissions that go directly into the atmosphere and are 23 times more damaging than carbon dioxide as well as land pollution (Samimi & Zarinabadi, 2012). The interviews mentioned packaging waste and others through the discarding of product that was no longer fit for human consumption. The volumes of product going to landfill would not always be consistent as production issues as well as other unforeseen circumstances could arise during daily operations. As an alternative to the landfill dumping, the bio-waste to biogas business could offer a means of safe waste disposal that would effectively consume less land area as well as capture many of the greenhouse gases they occur during the decomposition process (Weiland, 2010).

6.5.4 Comparison to Safe Waste Disposal

It is envisaged that a viable revenue stream can be created through the incorporation of a safe waste disposal service, the interview process allowed for the collection of data on the waste management practices of the companies through the expert knowledge of the interviewees, most of which were already making use of daily third party collection or at least periodic processed waste collection for safe disposal. It was also noted that 50 percent of the interviewees from the sample made use of waste disposal techniques that could not be found in the literature such as pig farmers, a lion park and a crocodile park. Participant 6

“the crocodile farmer is only prepared to pay about three Rand per kilogram. So that's part of the reason we are sitting with the stock and that is part of the problem.” Although the three types of animal methods may not be seen as a conventional means of safe waste disposal, it was noted as a means of waste disposal for half of the sample interviewed in the data collection.

6.5.5 Comparison to Bio-fertiliser Usage

From the literature it was evident that a large part of the benefits involved in building an anaerobic digester would be the bio-fertiliser that is produced as a by-product (Ferroukhi et al., 2015). Only one of the interviewees was concerned with the bio-fertiliser being of any worth, participant 4 brought up some very relevant questions concerning the consistency of the bio-fertiliser as well as the nutrient value. According to a study conducted by Lin et al. (2012) the bio-fertiliser is completely harmless to crops and is safe to use for agricultural farming applications. Participant 4 brought forward another valid point with regards to the adoption of a new bio-fertiliser product marketed at farmers, according to the interview participant it would not be a straight forward task to simply sell a new product to this market segment as they are very loyal to existing suppliers. The advice should be considered, however there should be significantly more research done as well as bigger opinion polls taken before a reasonable deduction can be made.

With all thing being taken into account one of the most important things to consider for the successful operations of an anaerobic digestion plant, whether it be for the private use of an individual company or for a commercial operation generating power back into the electrical grid is that all by-products need to have outlet channels. Even if they are not generating profits, for example selling the bio-fertiliser at a breakeven cost in order to get it off the site. If this is not done there will be a build-up of megatons of this product with no place to store it, however a study of a biogas project by Chesshire (2007) found that selling off their bio-fertiliser to nearby farms as well as using what they could on their own land was the most viable option.

6.6 Conclusion to Chapter 6

This chapter briefly compared the results that were discussed in Chapter 5 with the study of the literature from Chapter 2. The aim of this chapter was to confirm that the results from this research study add value to existing literature and also to emphasise where the research findings differ from the existing literature.

The study discovered some interesting information regarding the way in which some of the participants in the research manage their bio-waste, the use of animal farms as a means to either sell or donate some of the processing waste being the most notable. Perhaps this is a topic for another research study but it is not clear whether this type of waste disposal is unique to Africa or not, as it was not mentioned in the literature, however there should be nothing wrong with the practice on the condition that there are no off products being fed to the animals.

The first research question is directly business related, and this may be the reason that the interviewees were better equipped to answer the questions or speak freely to the open ended questions. The study sought to better understand the business deliberations regarding the opportunities and challenges that an independent biogas plant would encounter. The most important information would be regarding the type of waste used and the volumes of the different types of waste. The variety of waste is import because it will give an indication of the energy values that can be extracted from the waste, this will have an effect on the output and therefore the project payback period. The volume of the waste is important for the same reasons and will affect the calculations for the return on investment as well as required plant size calculations.

The second research question is important from a social perspective and this was perhaps the most difficult for the participants to speak to. There was little to relate back to the literature regarding social innovation and the common theme that aims to address the needs ignored by the market, it also attempts to improve the quality of life through various means and seeks to provide solutions to individual and community problems. One participant specifically noted the difficulties in daily business and said that it was hard enough just to run the day to day activities.

The third research question had to do with the companies' environmental impacts, the participants found it easier to speak to this line of questioning, possibly because it has

become more commonplace for business to make a more concerted effort into the sustainable running of companies. The study found that many on the organisations were making the effort to lessen their environmental impacts mostly to satisfy a specific customer of theirs. It can be said that only one of the companies that was researched had set up a dedicated department with a senior person to lead their sustainability initiatives. The possibility therefore exists that because people are not being measured on specific environmental objectives that they are of a lesser concern to that of the day to day business operations.

To conclude this chapter it can be stated that after gathering the data from a sample of manufacturing companies which employed a purposive method for their selection that the triple bottom line has not had the same forward thinking adoption that it probably should have in the twenty one years since the term was first coined.

CHAPTER 7: CONCLUSION

7.1 Introduction

This chapter emphasises the main findings of the research by pulling the results together into a cohesive set of findings, it also concludes with recommendations to business as well as for future research.

7.2 Principal Findings

The study was structured around the triple bottom line model found in Figure 2 and was reformulated into a model for a sustainable business ecosystem. This particular study proposed that in order for a business to be sustainable it should provide a continuous value proposition towards the economy, society and the environment as portrayed in Figure 9.

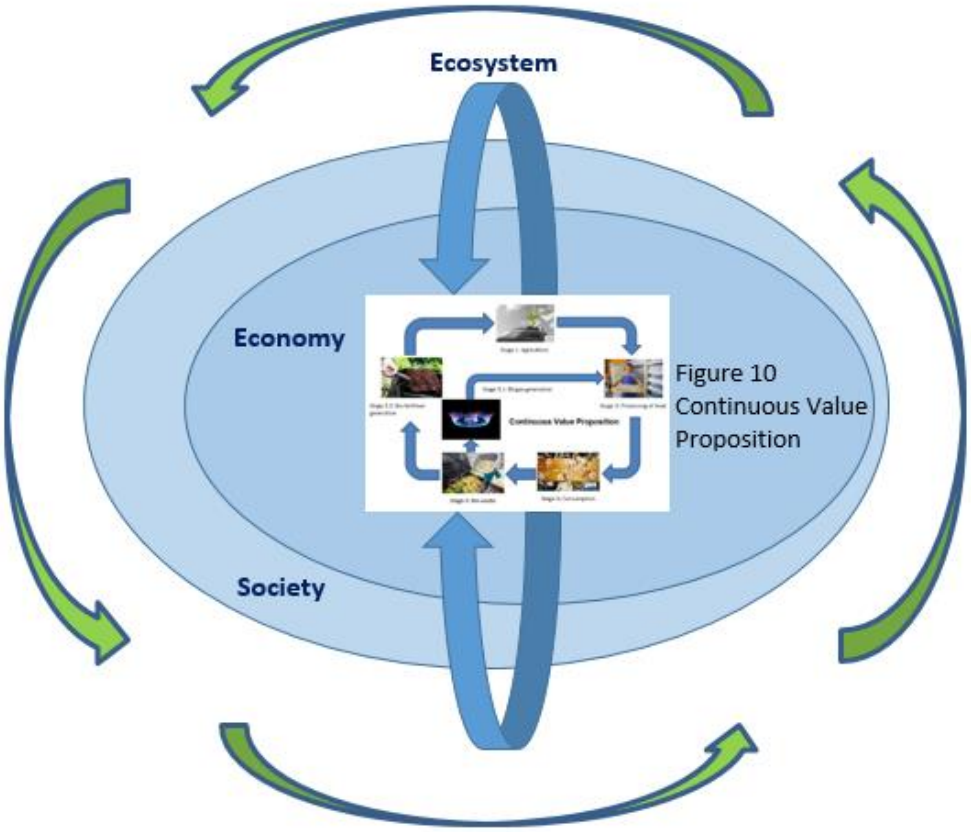


Figure 9: The sustainable business ecosystem with a continuous value proposition

Figure 10 is a representation of a biogas system transforming food back into energy to assist the environment with transforming the energy back into food. Figure 10 can also be found on page 71.

This study was conducted in order to ascertain whether or not biogas is an underutilised opportunity in the sustainable energy market and also to investigate the potential benefits to society and the environment of the bio-waste to energy business model. The purpose of the research is to study the business considerations including challenges and opportunities emanating from the vast amounts of waste that occurs throughout the food supply chain, specifically at manufacturing, and is a high level assessment of the respective value propositions available as a strategic imperative within a sustainable business model.

The research found that manufacturing businesses are intent on finding solutions to gaining access to a consistent supply of electricity and also to becoming self-sufficient to such an extent that they would no longer rely on the national power grid. Solar electricity generation through the use of solar panels came forward as the most common of the sustainable energy projects that were considered. The only other forms of sustainable energy generation that the companies were aware of at the time of the interviews was anaerobic digestion and a fluidised bed reactor, although it was only one of the interviewees that was familiar with both of these technologies.

The process of biogas generation is very similar to the way it was over one hundred years ago and even though the technology has advanced over the years it is surprisingly not very well known as a form of sustainable energy (Nahman, de Lange, Oelofse, & Godfrey, 2012). From the interviews conducted during the study it can be noted that for an organisation to be completely independent from using national power, would be difficult, From the perspectives of the companies that had investigated a biogas solution it would require far more inputs to the digester than they were producing in the form of waste (Hancock, 2015). Interviewees had considered using nearby neighbours to form a cooperative agreement, however the logistics and coordination of the day to day maintenance and upkeep of the plant became a barrier to the implementation of the project.

Most importantly the study should equip the researcher with enough data to determine if there is an economic value to the bio-waste both before and after the biogas conversion process for the purposes of a viable business in the renewable energy sector.

7.3 Limitations of the Research

The study was conducted as a high level investigation into the possibilities of the food manufacturing sector being able to supply a sufficient amount of waste through their daily operations in order to supply an independent anaerobic digestion plant that could charge a safe waste disposal fee for the removal service. The research followed a qualitative approach and used face to face interviews as the data collection instrument, this process did not allow for a large number of interviewees and it is suggested that further research be conducted utilising a quantitative methodology and gain a much larger sample.

It should be noted that this research has the possibility of being susceptible to different types of limitations, for the proposed design it would be possible to have omission and / or inclusive bias for the qualitative interviews. Therefore, collection of the data within the limited time frame could result in bias however, this limitation could be overcome by conducting future research over a longer time frame (Roulston & Shelton, 2015). Other potential bias may appear due to the researcher's interpretations, assumptions and perspective of the data analysis process. Hence there is a need for a sound theoretical base derived from past research as the foundation of the process (Bailey, 2014).

The outcome of non-probability, purposeful sampling cannot be assumed to be extrapolated to the entire population as the universe was restricted to food manufacturing companies in the greater Gauteng area as well as one from Kwazulu Natal. Although this did result in limited variability in responses from participants, the implications of this are that the data cannot be generalisable to encompass catering companies, retail food outlets or restaurants.

The outcome of the research is highly dependent on the quality of the information provided by the participants during the interviews. Hence the importance of the selection of the interviewees (Bailey, 2014). The study was limited to large and medium sized manufacturing facilities and therefore the data cannot be extrapolated into smaller organisations.

Despite the limitations the research would still provide valuable insights for the manufacturing industry with regards to effective management and planning. The data would also be useful to future studies on food security and highlight possible areas to be addressed in waste reduction. Further studies are also recommended to take a quantitative approach to the data collection and analysis.

7.4 Implications for Business

Interviews with business experts revealed that there are companies that are regularly affected by the electrical supply that is at times unreliable, this is of particular concern to manufacturers who are heavily dependent on a stable supply of power which they had at one time become accustomed to. During the past decade these companies had increasingly begun to lose productivity due to unplanned power outages (Andrianov et al., 2015). These scenarios had driven a small group of food processors to investigate their own forms of power generation which to the greater extent been focused on solar. Not many of the companies were aware of anaerobic digestion and with it the processes of producing a combustible methane gas out of decomposing bio-waste.

The business implications for this innovation could be considerable, for one a new sector which incorporates waste management as well as power generation could be born out of the dire need for a reliable energy source, and intern many new jobs could be created. Biogas plants have been built that can produce 140 megawatts per hour, and this would be capable of powering 280 000 households (Ferroukhi et al., 2015). With many of the South African people still without basic electricity, projects of this nature should be prioritised in order to meet the needs of both ordinary citizens and industry. By creating extra electricity suppliers that can contribute to the infrastructure it would allow government to simultaneously address many social issues as well as gain additional revenues in the form of taxation of this new industry.

7.5 Academic Consideration

As the investigation into anaerobic digestion progressed it became apparent that there was a great deal of benefits linked to biogas generation, which lead the research in the direction of the value proposition as well as the value chain, neither of which consider that the value may not end with the consumer, simply by taking a look at landfills it can be confirmed that products and their packing do not disappear once their perceived value has diminished. As a recommendation for academic research it could be suggested that a new perspective be used in the search of systems, processes and products that hold a continuous value proposition. Figure 10 is a simple diagrammatic relating to the continuous value proposition that can be extracted through biogas generation.

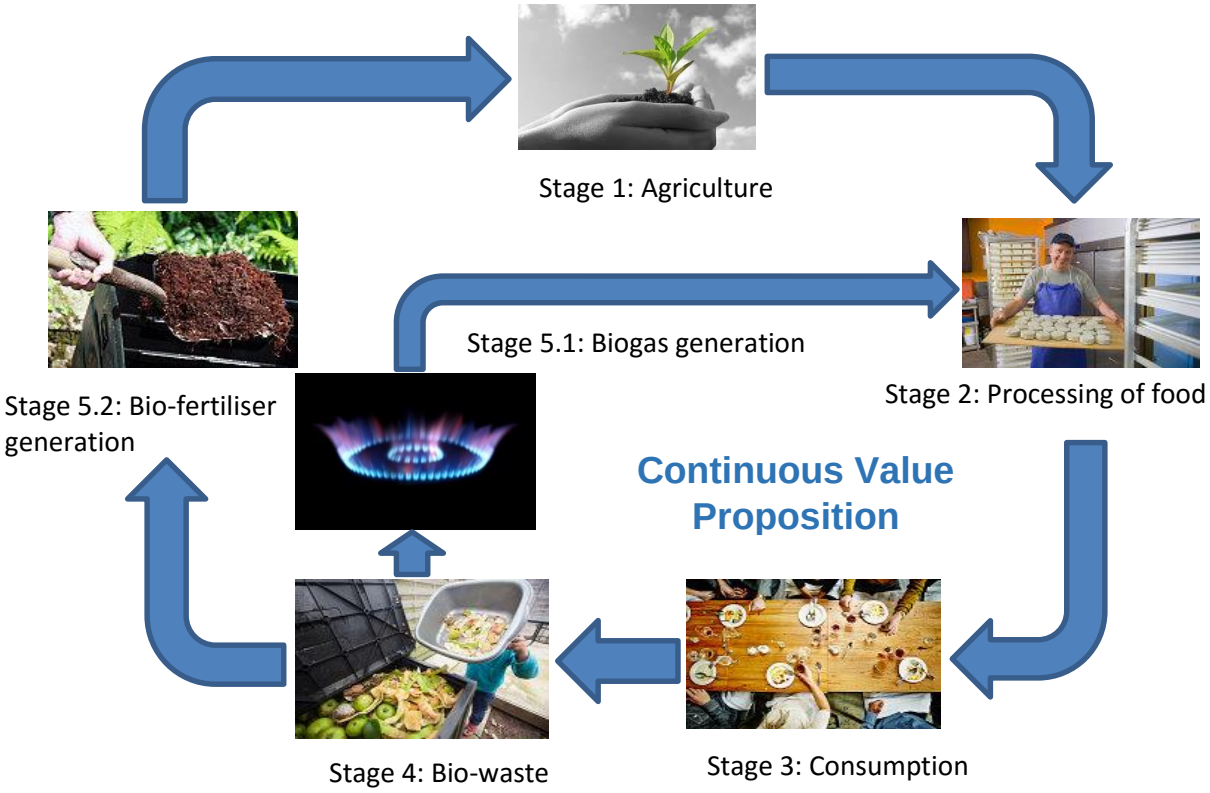


Figure 10: A Continuous Value Proposition of food to energy – energy to food

7.6 Recommendations for Future Research

One of the biggest reasons that organisations have not adapted anaerobic digestion technologies is that companies formulate their calculations based on taking their companies completely off the national power supply grid, which then increases the amount of biodegradable waste that needs to be obtained in order to meet the criteria needed. It is suggested that for future research the viability of powering specific segments of businesses be considered for study.

The research incorporated companies from the Gauteng region and one organisation from KZN, for this reason the data and findings cannot be extrapolated to form conclusive findings for the entire country. It is therefore suggested that future research should include a more diverse regional sample, irrespective of whether a qualitative or a quantitative approach is followed.

7.7 Conclusion

Literature on anaerobic digestion suggests that this is an initiative that can provide solutions for a number of challenges, these challenges are both social as well as environmental. It was for this reason that the triple bottom line model was selected to test the sustainability of a biogas business model. The research can conclude that there is an opportunity in the energy generation sector that can be partially addressed by biogas projects. These projects can be suited to any size or scale, from individual households to large scale commercial operations as have been built in many European countries, most notably Germany which leads the way in terms of number of plants as well as energy output (Brautigam et al., 2014).

As the initial capital outlay for a large scale anaerobic digester can be fairly substantial It can be suggested that before seeking funding for an independent anaerobic digester it would be pertinent from an investor funding perspective to get signed contracts from the ten manufacturers interviewed and also as many other plants as possible to secure input feed before the project is built. It may also be of benefit to secure contracts from waste disposal companies to make use of the digester at little to no cost on their side in order to get the project running from day one. By examining the graph from Figure 8, it can be observed that the two highest energy values of bio-waste are derived from food and residual fats from cooking processes, the size of the digester could also be much smaller than those situated on farming operations, thus bringing the initial investment costs down (Kigozi et al., 2014).

To conclude, biogas has been around for decades, however cheap fossil fuels have limited its applications to rural areas, particularly those away from infrastructures such as, gas lines, electricity and tarred roads (Hancock, 2015). With the impacts of global warming now becoming more apparent the world has slowly begun to unite in the battle to contain greenhouse gas emissions so that the effects of these gasses on the planet's increasing temperature can be halted (Venkat, 2011). Biogas offers a unique blend of greenhouse gas reduction, land pollution reduction and sustainable energy generation. There is a multitude of research studies that have been conducted on biogas as well as energy values of various substrate, this research study was intended to investigate alternate revenue streams for an anaerobic digestion plant for the purposes of accelerating the return on investment. A safe waste disposal fee has therefore been identified as a valuable value proposition that can be offered to food manufacturing plants as opposed to the waste going directly to landfill, it can be used for much needed energy generation.

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Appendix 1: Codes

RQ1-Economic-Business-Decision
RQ1-Economic-Business-Extra business
RQ1-Economic-Business-Statements
RQ1-Economic-Business-Support for the initiative
RQ1-Economic-Challenge-Cost savings
RQ1-Economic-Challenge-Inputs
RQ1-Economic-Challenge-Long payback
RQ1-Economic-Challenge-Low energy value
RQ1-Economic-Challenge-Reliability
RQ1-Economic-Challenge-Returns
RQ1-Economic-Opportunity-Energy reliability in SA
RQ1-Economic-Opportunity-Off waste
RQ1-Economic-Opportunity-Reworking product
RQ1-Economic-Opportunity-Standards
RQ1-Economic-Opportunity-Waste-Production process
RQ1-Economic-Opportunity-Waste-Production staff
RQ1-Economic-Opportunity -Outsourcing safe waste disposal

RQ2-Social-Alternative Processes
RQ2-Social-Alternative Processes-Biodiesel
RQ2-Social-Alternative Processes-Fat
RQ2-Social-Alternative Processes-Gas
RQ2-Social-Alternative Processes-Incineration
RQ2-Social-Alternative Processes-Water
RQ2-Social-Charity
RQ2-Social-Communities
RQ2-Social-Concerns-People repacking
RQ2-Social-Customer-Good PR
RQ2-Social-Customer Influence
RQ2-Social-Fertiliser
RQ2-Social-Governement
RQ2-Social-Own biogas plant
RQ2-Social-Pet food
RQ2-Social-Rendering plants
RQ2-Social-Staff
RQ2-Social-Sustainable Energy-Savings
RQ2-Social-Sustainable Energy-Solar

RQ3-Environment-Assessment
RQ3-Environment-Energy savings
RQ3-Environment-Landfill
RQ3-Environment-Lion Park
RQ3-Environment-Packaging
RQ3-Environment-Pig Farmers
RQ3-Environment-Safe Disposal
RQ3-Environment-Waste-Fat
RQ3-Environment-Waste-Fat-Volume
RQ3-Environment-Waste-Volume
RQ3-Environment-Water treatment

Appendix 2: Informed Consent Letter

Dear Participant

I am a part time student at the Gordon Institute of Business Science (GIBS) and am conducting research on bio-waste to biofuel conversion, I am trying to find out more about the economic and social value proposition that could be achieved through converting bio-waste into biogas as an alternative to landfill dumping of expired products. Our interview is expected to last about an hour, and will help the researcher understand how South African manufacturing firms deal with their production waste. Your participation is voluntary and you can withdraw at any time without penalty. All data will be kept confidential, no manufacturing company's name will be used in the report, but will be coded. If you have any concerns, please contact my supervisor or me.

Our details are provided below.

Researcher name: Tannon Balanco

Email: tannon@lbft.co.za

Phone: 084 522 1522

Research Supervisor: Irfaan Khota

Email: irfaank@idc.co.za

Phone: Tel: (011) 269 3621

Signature of participant: _____

Date: _____

Signature of researcher: _____

Date: _____

Appendix 3: Interview Schedule

Research Question 1: How can an economic value proposition contribute to bio-waste to biogas conversion?

This section probes for opportunities and challenges that could be evident for the company to make use of a bio-waste to biogas safe waste disposal service.

1. Do you currently have any bio-waste and what does it consist of? (Probe: The interviewer will probe to test the interviewee's understanding of the company's bio-waste).

2. What do you currently do with your waste? (Probe: The interviewer will probe to understand the business, are they reworking waste or do they already use a waste disposal company on site?).

3. Does waste have any economic or monetary benefit to you currently? (Probe: The interviewer will probe to understand if the company is recuperating some of the costs involved in waste disposal).

4. How many kilograms of bio-waste (specific food to the manufacturer) do you dispose of daily? (Probe: The interviewer will probe to find out the potential for use of the service of safe waste disposal).
5. Are you comfortable to discuss what you currently pay per ton for waste disposal? (Probe: The interviewer will probe to understand the current cost the business may be incurring for waste management).

6. What would convince your business to make use of safe waste disposal through bio-waste to energy conversion? (Probe: The interviewer will probe to test if there is interest in this model).

Research Question 2: How can social innovation contribute to the continuous value proposition of food to energy recycling?

This section covers the current social innovation initiatives that the company has looked at or will be looking at.

1. Would you think that your business could benefit from being aligned with a sustainable energy project, one that could potentially reduce the waste you send to landfill? Please elaborate. (Probe: The interviewer will probe to find out more about the culture of social responsibility in the company).

2. Would you say that reducing the amount of waste destined for landfill would be beneficial to society? (Probe: The interviewer will probe to test the interviewee's understanding of social innovation).

3. Please elaborate in what ways you would consider this to be beneficial. (Probe: The interviewer will probe to test the interviewee's understanding of social innovation).

4. Would you want to recover value from waste production? (Probe: The interviewer will probe to test the interviewee's understanding of the business benefits of social innovation).

5. Have you noticed any improvement in customer relations or perceptions to your company after making socially responsible initiatives known, if any? (Probe: The interviewer will probe to hear if the company has previously leveraged socially responsible initiatives in public relations campaigns).

6. In the South African context could you think of any other benefits that such an initiative could have? (Probe: The interviewer will probe the interviewee for any new insights into social innovation).

Research Question 3: What are the potential benefits to the environment of the bio-waste to energy business model?

This section covers the businesses' current impacts on the environment, specifically to get a broad understanding of the importance of environmental considerations within the business.

1. What are the specific processes for waste management, such as what happens to packaging, bio-waste or effluent from the plant? (Probe: The interviewer will probe to find out about the culture of waste recycling and management in the company).

2. If our society as a whole was inclined to be more proactive in sustainability, would this make it any easier for a company such as yours to contribute to sustainable energy? (Probe: The interviewer will probe to find out if the company is self-driven to implement changes or if their customers play a role).

3. Would your company be more inclined to tackle sustainable energy initiatives voluntarily or would there need to be some kind of incentive from government? (Probe: The interviewer will probe to find out if the company is more inclined to proceed with such projects given that there are incentives to do so).

4. Are there any plans to attempt something similar in-house? (Probe: The interviewer will probe to hear if the company had prior knowledge of biogas plants).

5. Are there any energy saving initiatives that your business is currently looking into? (Probe: The interviewer will probe for other ways the company has tried to cut energy costs).

6. What about sustainable energy projects, could you elaborate? (Probe: The interviewer will probe for other sustainable energy projects the company has looked into).

The interviewee is encouraged to stay on topic but is welcome to share information that is pertinent and relevant. As these are open ended questions there is a possibility that the interviewee may not necessarily directly answer the question that is posed.

Appendix 4: Ethical Clearance Approval

Dear Tannon Balanco

Protocol Number: **Temp2015-01062**

Title: **A continuous value proposition – Waste created by South African food manufacturing companies and the conversion of bio-waste into biogas and fertiliser.**

Please be advised that your application for Ethical Clearance has been APPROVED.
You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

GIBS Ethics Administrator