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Anaerobic Digestion Plant in Tripoli, Libya- A Case Study

Analysis of effect of AD Plant on Tripoli's
food waste management and electricity
production

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[STUDENT NAME]
[INSTITUTION]

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Table of Contents

Acknowledgements.....	1
List of Figures	5
List of Tables	6
List of Equations.....	6
Executive Summary.....	7
CHAPTER 1	8
1.1 Background	8
1.2 Anaerobic Digestion Technology	8
1.3 Study Area and Site Description	Error! Bookmark not defined.
Sustainable Energy Solution.....	9
1.4 Significance of Establishing AD Plant in Tripoli-Libya	11
1.5 Aims and Objectives of Dissertation	11
1.6 Organization of Dissertation	12
CHAPTER 2	Error! Bookmark not defined.
2.1 Background.....	Error! Bookmark not defined.
2.2 Food Waste Management	Error! Bookmark not defined.
2.3 Anaerobic Digestion as Renewable Electricity Generation Method	Error! Bookmark not defined.
2.4 Estimate of Electricity Generation from AD Technology using Household Food Waste	Error! Bookmark not defined.
2.5 Factors Influencing the Choice of Location for AD plant	Error! Bookmark not defined.
2.6 Environmental and Health Impacts of using AD plant for waste management and Energy Generation	Error! Bookmark not defined.
2.7 Missing Links in the Literature	Error! Bookmark not defined.
CHAPTER 3	Error! Bookmark not defined.
3.1 Background	Error! Bookmark not defined.
3.2 Research Strategy	Error! Bookmark not defined.
3.3 Research Design.....	Error! Bookmark not defined.
3.4 Data Collection Methods	Error! Bookmark not defined.
3.4.1 Survey Questionnaire.....	Error! Bookmark not defined.
3.4.2 Semi Structured Interview	Error! Bookmark not defined.

3.4.3. Secondary Sources	Error! Bookmark not defined.
3.5 Sampling Strategy	Error! Bookmark not defined.
3.6 Data Analysis.....	Error! Bookmark not defined.
3.6.1 Quantitative Data Analysis	Error! Bookmark not defined.
3.6.2 Quantitative Data Analysis	Error! Bookmark not defined.
3.7 Ethical Considerations.....	Error! Bookmark not defined.
3.7 Limitations and Difficulties	Error! Bookmark not defined.
CHAPTER 4	Error! Bookmark not defined.
4.1 Background	Error! Bookmark not defined.
4.2 Demographic Analysis of Respondents	Error! Bookmark not defined.
4.3 Waste to Energy: An Alternative Method of Electricity Generation in Tripoli ...	Error! Bookmark not defined.
4.4 Waste to Energy (WTE) Conversion	Error! Bookmark not defined.
4.4.1 Biochemical Conversion	Error! Bookmark not defined.
4.4.2 Thermochemical Conversion	Error! Bookmark not defined.
4.4.3 Mechanical Extraction	Error! Bookmark not defined.
4.5 Current State of Food Waste Management in Tripoli.....	Error! Bookmark not defined.
4.6 Technical Feasibility	Error! Bookmark not defined.
4.7 Factors Effecting the AD Process	Error! Bookmark not defined.
4.7.1 pH.....	Error! Bookmark not defined.
4.7.2 Temperature	Error! Bookmark not defined.
4.7.3 Retention Time (RT).....	Error! Bookmark not defined.
4.7.4 Digestion Process.....	Error! Bookmark not defined.
4.8 Proposed Geographical Location	Error! Bookmark not defined.
4.9 Financial Analysis of AD Plant in Tripoli	Error! Bookmark not defined.
4.9.1 Capital Cost.....	Error! Bookmark not defined.
4.9.2 Operational and Maintenance Cost	Error! Bookmark not defined.
4.9.3 Biogas Yield and Electricity Benefit.....	Error! Bookmark not defined.
4.9.4 Efficiency based on IRR and NPV.....	Error! Bookmark not defined.
4.10 Impact of the AD Plant on Environment of Tripoli.....	Error! Bookmark not defined.
4.11 Impact of AD Plant on Public Health in Tripoli.....	Error! Bookmark not defined.
4.12 Interview Questions Analysis	Error! Bookmark not defined.
CHAPTER 5	Error! Bookmark not defined.

5.1 Background	Error! Bookmark not defined.
5.2 Literature Review and Survey	Error! Bookmark not defined.
5.3 Feasibility of the Proposed System	Error! Bookmark not defined.
5.4 Limitation and Difficulties	Error! Bookmark not defined.
5.5 Future Work.....	Error! Bookmark not defined.
5.6 Recommendations	Error! Bookmark not defined.
5.6.1. Training at Household Level.....	Error! Bookmark not defined.
5.6.2 Government Participation	Error! Bookmark not defined.
References	Error! Bookmark not defined.
Appendix A Questionnaire	Error! Bookmark not defined.
Appendix B- Semi-Structured Interview Questions	Error! Bookmark not defined.

List of Figures

- Figure 1- a) Demographic of Libya (left) b) Demographics of Tripoli (right).. **Error! Bookmark not defined.**
- Figure 2- Per capita GDP and Energy Consumption of Egypt, Russia, Algeria and Libya (EIA, 2011) ... **Error! Bookmark not defined.**
- Figure 3- Total energy production in Libya through various resources (EIA, 2011) **Error! Bookmark not defined.**
- Figure 4- Total energy consumption in Libya (EIA, 2011) **Error! Bookmark not defined.**
- Figure 5- Peak load upsurge in Libya till 2015 (Ahwide & Aldali, 2013) **Error! Bookmark not defined.**
- Figure 6- Municipal Waste Composition in Libya (Hamad et al., 2015)..... **Error! Bookmark not defined.**
- Figure 7- Applications of food supply chain waste **Error! Bookmark not defined.**
- Figure 8- Anaerobic Digestion process (Moriarty, 2013)..... **Error! Bookmark not defined.**
- Figure 9- A generic complete mixed digester (Moriarty, 2013)..... **Error! Bookmark not defined.**
- Figure 10- The number of electric power generated/week (kW) for a hypothetical case study (Mydin et al., 2014) **Error! Bookmark not defined.**
- Figure 11- CO₂ Emissions in Libya (Left); CO₂ Emissions in Libya with respect to Production Techniques (Right) (Ahwide and Aldali, 2014) **Error! Bookmark not defined.**
- Figure 12- The mixed-method research design (source, Sauro, 2015)..... **Error! Bookmark not defined.**
- Figure 13- Gender based sample size of the survey **Error! Bookmark not defined.**
- Figure 14- Age group based sample size of the survey..... **Error! Bookmark not defined.**
- Figure 15- Distance of the people undergoing survey from the Tripoli city.. **Error! Bookmark not defined.**
- Figure 16- Source of electricity generation in Libya **Error! Bookmark not defined.**
- Figure 17- How often Tripoli city undergo electricity outages? **Error! Bookmark not defined.**
- Figure 18- Cleanliness of Tripoli city is in terms of waste management **Error! Bookmark not defined.**
- Figure 19- General habit of waste disposal in Tripoli city..... **Error! Bookmark not defined.**
- Figure 20- Frequency of waste collection from residential areas by municipal authorities**Error! Bookmark not defined.**
- Figure 21- Process flow diagram of anaerobic digestion (Serna, 2009) **Error! Bookmark not defined.**
- Figure 22- Pretreatment process in anaerobic digestion (Braun, 2007) **Error! Bookmark not defined.**
- Figure 23- Solid Waste Conversion Unit (Source; <http://www.soton.ac.uk/~sunrise/anaerobicdig.htm#ADsolidwaste>)..... **Error! Bookmark not defined.**

Figure 24- 3-Ring road, proposed location to establish an AD plant in Tripoli..... **Error! Bookmark not defined.**

List of Tables

Table 1- Categorization of Municipal Waste in Libya (Hamad et al., 2015)... **Error! Bookmark not defined.**

Table 2- Average percentage concentration of various components in Anaerobic Digestion plant (Sustainable Energy Authority of Ireland, 2013) **Error! Bookmark not defined.**

Table 3- Operating Parameters of Anaerobic Digestion (Moriarty, 2013) **Error! Bookmark not defined.**

Table 4- Summary of performance parameters in different operational phases of the AD study in China (Lin et al., 2011) **Error! Bookmark not defined.**

Table 5- RE plan of energy production in Libya by 2020..... **Error! Bookmark not defined.**

Table 6- Energy estimation from 15% of food waste in South Australia till 2021(Zaman & Reynolds, 2015) **Error! Bookmark not defined.**

Table 7- Emission for Various Fuels in Libya (Ahwide and Aldali, 2014)..... **Error! Bookmark not defined.**

Table 8- Statistical analysis of current state of food waste management in Tripoli **Error! Bookmark not defined.**

Table 9- Capital cost estimate for food waste to electricity conversion plant in Tripoli **Error! Bookmark not defined.**

Table 10- Operational and maintenance cost estimate for food waste to electricity conversion plant in Tripoli **Error! Bookmark not defined.**

Table 11- Calculated IRR and NPV..... **Error! Bookmark not defined.**

Table 12- Correlation based statistical analysis of variables impacting environment of Tripoli **Error! Bookmark not defined.**

Table 13- Correlational based statistical analysis of variables influencing health of people **Error! Bookmark not defined.**

List of Equations

Equation 1– Discount Rate Calculations..... **Error! Bookmark not defined.**

Equation 2- Internal Rate of Return Calculation..... **Error! Bookmark not defined.**

Equation 3- Calculating Amount of Food Waste per Year **Error! Bookmark not defined.**
Equation 4- Calculating hydraulic Retention Time (HRT)..... **Error! Bookmark not defined.**
Equation 5- Calculating Solids Retention Time (SRT)..... **Error! Bookmark not defined.**
Equation 6- Calculating Organic Loading Rate (OLR) **Error! Bookmark not defined.**

Executive Summary

The current study looks to research the feasibility of developing an anaerobic digestive plant in Tripoli, Libya. There has been a significant rise of scarcity of energy resources around the world which is resulting in a greater demand for alternative energy resources. There has also been an increase in the understanding that sustainable development is of great importance bringing about the rise of waste-to-energy markets. The current study examines how the use of biofuel through anaerobic digestive process can improve the health of citizens in Tripoli, reduce food waste in the city, and also improve the electrical generation output of the city by introducing this means of alternative energy production.

The research was conducted using a mixed methods research approach which combined qualitative and quantitative methods. The main research instruments used for collection of primary data was through semi-structured interviews and a questionnaire survey. The study consulted a plethora of secondary research to provide valid premises for strengthening its arguments.

The case study presented in the thesis entails the detailed feasibility study of Tripoli, Libya in order to establish an AD plant for waste to energy conversion. The considerations for total food waste expected to be gathered, geographical location for the plant, capacity and procedures, and cost-benefit analysis are estimated to provide a detailed insight into conversion process and plant establishment. The later part of the research emphasises the environment friendly nature of the plant. The impact of proper food waste management, conversion of excess waste into energy, and clean energy obtained from the AD plant on the health of general public are also discussed.

CHAPTER 1

Introduction

1.1 Background

Cumulative scarcity of energy resources around the globe is leading to the growing demand of alternate energy resources. With the understanding of importance of sustainable development, waste-to-energy market is also going through resurgence. Since electricity generation using fossil fuel produces a non-renewable form of energy having harmful effects on the environment, recycling of trash to generate electricity is gaining popularity due to its significant advantages over traditional fossil fuel energy methods.

1.2 Anaerobic Digestion Technology

In developed nations, structures have been set up into the Anaerobic Digestion Process, which has been widely practiced to generate heat and energy. However, developing nations have not been quick to adopt this method to increase power to its national grid. Anaerobic Digestion (AD) is described as biological process, which has the capability to break down biodegradable organic matter, through microorganisms' activities (Khoiyangbam, Gupta & Kumar, 2014). Oxygen has to be absent for these biodegradable organic matter to be converted biogas, which comprises of methane (CH_4), carbon dioxide (CO_2), as well as insignificant amount of other gases (Ekström, 2014). The biggest advantage of AD is that it provides a sustainable energy solution. The reduced amount of emissions of the harmful gases is another advantage of the AD plant. Solid nutrients obtained after breakdown of organic food matter is the by-products of the plant and can be used to improve the soil fertility. As cited in several reports, for a number of years, anaerobic digestion has been preferred in management of wastes produced from industries and municipals. Using an AD process presents the

option to produce energy that could be sold in the form of electricity, heat, or steam (Richards, Cummings & Jewell, 2010).

Several European Union member countries such as the UK, Denmark, Germany and France have been leaders in managing of organic wastes, with the application of the AD technology (Gupta, 2006). The AD technology produces biogas estimated at 60% methane (CH₄), and lower level of CO₂, as well as traces of ammonia. The methane could be vital in fueling a Combined Heat and Power (CHP) system, and this helps in production of electricity and heat. It is estimated that methane has 21 times the effect green gas emissions of CO₂ (Kalia, 2016). As food wastes decompose in open air, it contributes to an increase of methane to the atmosphere. For this reason, the AD process is useful in displacing conventional generation, as well as help in the reducing greenhouse emissions. The AD process leads to the production of nutrient rich solid, which could be applied to the soil to enhance its fertility. This is beneficial to horticultural farming and several other agricultural practices. In the city suburbs of Tripoli, the solid nutrients could be used in farms. In fact, the full utilization of AD technology is combining waste management and adequate use of the by-products (Khoiyangbam, Gupta & Kumar, 2014).

1.3 Sustainable Energy Solution

Sustainable energy, by definition, means provision of energy such that it meets the present energy demand without compromising the ability of future generations to meet their own needs. Two key components of sustainable energy are energy efficiency and renewable energy. Main source of electricity generation around the world, by far, is either water reservoirs or fossil fuels. Scarcity of natural resources with time is an inevitable condition. Sustainability demands to utilize methods that are alternative to the use of natural reservoirs to generate electricity. The use of sustainable energy not only saves the natural resources for the next generations but are environment friendly as well. Burning of coal or gas emit carbon

dioxide, carbon monoxide, lead oxides and other harmful gases into the atmosphere that not only contaminate the environment but also effect the health of the residents. Utilization of sustainable solutions like waste to energy conversion not only provides a solution for the proper waste management but also produce energy to meet the electricity needs.

The production of sustainable energy is taking on increasing importance in the light of dwindling resources and the increasing of energy consumption around the world. Biogas technology is considered one of the options for the deployment in conversion of organic residues (including food wastes) to renewable energy and valuable fertilisers. Anaerobic digestion technology and biogas are generally judged by many organizations and government agencies to be a sustainable method for reduction of the strengths and environmental impacts of wastes and a way for producing the sustainable form of energy.

The anaerobic digestion technology is one of the established technologies for sustainable processing of residues and wastes around world. AD process is useful for treating biodegradable wastes such as food waste and also produce saleable products such as methane. Anaerobic digestion is moreover considered of the most efficient biomass-to-energy routes, this technology saves over 90% resources most resource categories and maximises organic wastes valorization is an environmentally sustainable strategy (Priadi et al 2015). It has been very clear that the technology of anaerobic digestion will keep on taking the important place in the human's resource supply for the coming decades, it is also clear that transitions towards more sustainable sources of materials and energy is necessary. The technology of biomass is such an alternative resource that has the large potential in the application ranges as well as in mitigating climate change issues.

1.4 Significance of Establishing AD Plant in Tripoli-Libya

Energy has been instrumental in realizing economic development. The increased economic growth has contributed to overreliance in energy, leading to an enormous pressure, as demand for fossil energy keeps soaring (Richards et al., 2010). This is attributed to the fact the fossil energy is a non-renewable form of energy and fossil energy resources have been diminishing. As such, it is difficult to meet the increased demand of fossil fuel (Dosta et al., 2007). The increased use of fossil energy contributes to detrimental effects on the environment. For this reason, it is imperative to seek alternative energy sources, which are friendly to the environment. As a result, greener, renewable, and clean energy has seen an increased demand. A set of fundamental considerations are very essential in finding the suitable location for establishment of the proposed Anaerobic Digestion plant for food wastes; some of these aspects will be highlighted in chapter two. The location of the proposed AD plant should be selected such that it maintains a suitable distance from the residential area in Tripoli. Other considerations for the choice of location include choosing site that is accessible for the transportation of food waste and feasible enough for the distribution and transmission of the electricity produced.

Sustainable development and economic growth heavily relies on energy and this cannot be avoided (Ekström, 2014). Similar to several African nations, Libya has exhibited its immense potential for growth, and this is driven by the population growth. The growing Libyan population has led increased dumping of wastes to the environment (Ekström, 2014; Otman & Karlberg, 2007). As a result, Libya has seen an influx of social, environmental, and economic problems, and this has called for urgent intervention. In major cities such as Tripoli, the preferred waste management technique is the use of Collection-Transportation-Dumping, the use of landfills, and out of city boundaries (Hamad et al., 2014). In Tripoli, land scarcity has been a major concern,

resulting from increased urbanization and its geographical location. In this sense, creating landfills and dumping sites is problematic. Residents of Tripoli have claimed that waste disposal is expensive and have been restricted to one option of waste disposal (Otman & Karlberg, 2007).

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1.5 Aims and Objectives of Dissertation

The project has two aims, primary is to assess the viability of energy generation from food waste materials as a bioenergy source, and the second is to provide a feasibility study of applying an AD Plant for food wastes in Tripoli-Libya.

The main objectives of this project are therefore;

1. To provide an alternative energy generation method to assist the existing generation plants in Tripoli in order to meet the growing power demand, especially in remote areas.
2. To evaluate the possibility of establishing an AD plant for food waste in Tripoli and to evaluate the costs and benefits as well as the technical feasibility of the application of this plant.
3. To analyze the current state of food waste management in the city of Tripoli.
4. To evaluate the possibility of including the energy generated from food wastes on the national electricity grid.
5. To evaluate the impact of the energy generation from wastes on the ecology of Tripoli.
6. To carry out a health impact assessment of the energy generation from wastes disposal on the population of Tripoli resident.

1.6 Organization of Dissertation

This dissertation consists of five detailed chapters. A brief outline of each chapter is listed below.

Chapter 1 --- Introduction

This chapter introduces the preliminary terms and domains of research from which research question is extracted. Moreover, the fulfilling electricity demand in Tripoli, using waste recycling, is highlighted.

Chapter 2 --- Literature Review

This chapter will provide a comprehensive linkage between need of anaerobic generation plant in Tripoli and the related studies hitherto conducted and implemented in Tripoli or regions similar to Tripoli.

Chapter 3 --- Methodology

This chapter would entail the description of an appropriate AD plant for Tripoli. Primary data analysis of Tripoli in order to establish an AD generation plant will also be a part of this chapter.

Chapter 4 --- Results, Findings and Discussion

Outcomes of the primary data analysis and secondary research results of implementation of an AD plant would be enlisted in this chapter. Analysis of the impact of establishing an AD plant on ecology of Tripoli and on the health of people will also be discussed with reference to the results.

Chapter 5 --- Conclusion and Recommendations

This chapter concludes the study in the light of results and findings and provides a few recommendations for the improvement and for extension in the study in future.

