

## **CHAPTER 5**

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### **Conclusion and Recommendations**

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#### **5.1 Background**

This chapter highlights the crux of the study by briefly describing objectives and literature survey. Feasibility of the proposed plant is then discussed which leads to the limitations and difficulties of the study. At the end some recommendations for future work are provided in a brief. Some of the suggestion to improve and highlight the renewable energy generation techniques are also part of the chapter.

#### **5.2 Literature Review, Survey and Interviews**

A Valorga process AD plant, with capacity of 0.8 tones food waste per day, is proposed to be established in the city of Tripoli. This plant can assist the national grid in meeting the rising demands of electricity in Tripoli and on the outskirts. Public opinion about establishing such a plant is taken by conducting a survey. The results of the survey suggest that the people of Tripoli understand the need of a WTE plant and ensure their cooperation for the separate household food waste if provided with the containers by the municipal authorities. The food waste to energy generation plant provides a solution for both household food waste management in Tripoli and generating adequate amount of electricity to meet the rising demand.

An informal session of interviews has been conducted with the experts from Energy Agency of Libya. The opinion and observation based data collection is done in order to adequately opt the interpretivist approach of research. All five respondents recommended the idea of

establishing an AD plant in Tripoli-Libya. The plant location selected in the research has also been validated by their comments and suggestion as appropriate location for establishing a plant. The idea of energy generation using sustainable methods is the main point they've endorsed. The research provide solution for both; waste management in Tripoli and introduction of sustainable energy generation method in Libya, they said.

### **5.3 Feasibility of the Proposed System**

A detailed feasibility study is conducted including technical details such as amount of biogas generation, plant type, equipment sizing, and proposed location for the plant. Initial finances, operation and management cost of the proposed AD plant are estimated in the financial analysis of the proposed plant. Life cycle assessment is compared with the food waste management to evaluate the environmental effects of the plant. The analysis suggests that the proposed AD plant is economically, technically and ecologically feasible to establish on 3<sup>rd</sup> Ring Road in Tripoli.

### **5.4 Limitation and Difficulties**

Some of the limitations and difficulties involved in the process of digestion or establishing a digestion plant are listed as follows;

- 1.** Since many WTE technologies are designed to handle mixed type to food waste such as solid waste and municipal waste etc. Running the plant with specifically food waste is difficult as food waste makes comparatively less amount than MSW as a whole.
- 2.** Some other WTE challenges include high capital cost, waste-gas cleanup, regulatory hurdles, and conversion efficiency.
- 3.** Since domestic utilization of generated electricity is a primary objective, it adds a limitation where even distribution of electricity distribution in domestic buildings is not

possible if the plant is located outside the residential area. This issue can be resolved by centralizing a substation for the proper transmission and distribution.

4. Since accuracy of the estimated analysis depends entirely on the data, missing fields effect the accuracy of the estimations.
5. Since survey is conducted among non-technical people and represents their views, no amount of primary data is available that accurately estimates the energy generation from amount of food or biogas generation. The calculations of estimation of biogas yield and energy generation are based on the equations taken from secondary resources thus can be erroneous.

### **5.5 Future Work**

This study is conducted to evaluate the effectiveness of establishing a large scale plant to provide an alternative and renewable energy solution. The whole idea is applicable and implementable in the proposed area. Instead, in the future, the idea can be evaluated for the individual high-rise buildings to make them self-sufficient in energy demand and supply and to reduce the load on nation electricity grid. A cross-national study involving cost-benefit analysis of family-sized digesters in Tripoli is yet to analyze in order to predict the future of biogas technology in Libya. Information about government subsidy on renewable energy generation plants in Tripoli is important but unknown yet.

This study revolves around the utilization of food waste collected from residential buildings only. Although hotels, restaurants, and canteens can also provide a considerably high amount of food waste and it is relatively easy for them to collect it separately. Thus further work can be based on the food waste collection from the food consumption areas.

## **5.6 Recommendations**

Although this study is comprehensive at academic level, installation of such plants need government approvals and should be correlated with the policies. It is suggested for the government to consider installing the proposed AD WTE plant in Tripoli by conducting a comprehensive feasibility with extensive amount of data. Although food waste reduction is more important than food waste processing plants. Thus the reduction of food waste should always be at higher priority than its processing. For this matter people should be educated to utilize food leftovers for pets or other animals, although rotten food is still difficult to discard. Some factors such as government policies and regulations and behaviour of the general public are also matters of great considerations and are discussed further as;

### **5.6.1. Training at Household Level**

Although people have ensured of their support in order to collect and manage household food waste but it is important to provide them with proper containers by the authorities in order to collect food waste separately. People should be educated more about the need of waste to energy conversion plant by conducting activities in residential localities in Tripoli or other parts of Libya where WTE plant is expected to be installed. Media can play an important role in guiding people about the biodegradable and non-biodegradable waste and help them learning ways of categorizing MSW and sorting of food waste separately.

### **5.6.2 Government Participation**

Any such study and installation of such plant depends entirely on the consideration of federal government for any further initiative. Thus government of Tripoli need to take greater initiatives in terms of establishing goals, integrating policies and action to promote the electricity generation from renewable resources. What government can do in a specified

amount of time is to reduce the amount of landfills and other sites of waste disposals in Tripoli city and announcing landfill taxes. Government body can also look for any partnership program for the renewable energy plants. Moreover, they can always look upon World Bank and other sources which sanction large amount of funds for such projects in developing countries. Encouragement of research and development in the area of bio-fuel, bio-energy and clean energy, at educational and government departments level can be a very helpful initiative in order to promote idea of renewable energy resources. The research at universities and college level can not only generate new and innovative ideas but also can also be further used for the development tasks.

### **5.6.3 Plant Establishment Optimization**

The main concerns about the establishment of an AD plant are odour and noise according to survey as well as per opinion from the experts. Optimization of the establishment of plant should be planned such that there would be minimum concerns for the people in the surrounding. Adopting new technology and solutions to omit the hazards and concerns related to plants will eventually help in gaining more popularity and trust of people for such plants. It'll help in keeping the plant establishment more ecofriendly and better health of the residents can be ensured.

#### **5.6.4 Stakeholder Participation**

Stakeholders' involvement in the renewable energy spread in terms of financing such efforts, developing facilities for energy generation plants in Libya has considerable ratio but private organizations should also get involved. Stakeholders and private companies *Content removed...*

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## Appendix A Questionnaire

### Questionnaire

Please take a few minutes to complete this survey. We conducting a research on Establishing an Anaerobic Digestion Plant for Food Waste Management and for Energy Generation in Tripoli as well as on analysing the current status of food waste management practices in the city. Your specific answers will be completely anonymous, but your views, in combination with those of others, are extremely important. So your response will be very valuable to us.

Anaerobic digestion is a process in which microorganisms break down biodegradable material in the absence of oxygen, one of the end products is biogas, which is combusted to generate electricity and heat, or can be processed into renewable natural gas and transportation fuels. This process is widely used to treat wastes (including food wastes) since it provides volume and mass reduction of the input material. Anaerobic digestion is considered a renewable energy sources since the methane-rich biogas which produced is suitable to be used to generate electricity for Tripoli city, also, the nutrient-rich solids and liquids left after digestion process can be used as fertilizer for farms.

Food waste generated *Content removed...*

**We really appreciate your assistance!**

**Thank you!**

**Please go to the next page**

**About You:**

Name: \_\_\_\_\_

Which age group do you belong to, please tick? 18-25  26-34  35-44  45-54  +55

Are you Male or Female?

- Male
- Female

Professional/Student: \_\_\_\_\_

If professional, which area are you working in? Please Specify \_\_\_\_\_

(Please don't hesitate to give your proper information, it is advised to give details of your profession just because we can analyse the answers in reference to your affiliation with topic or area of research)

You're resident of

- Rural area
- Urban area

How far away is your resident location from Tripoli in Libya?

- In Tripoli
- Outskirts
- Nearby city/district
- Very far from Tripoli
- More than 100 Km away

**Data Collection:**

1. How much food do you think you discard on average daily?
  - 400-600 g
  - 600-800 g
  - 800-900 g
  - 1 - 2 kg
  - 2 - 3 kg
  - 3 - 4 kg
  - 4 - 5 kg
  - +5 kg
2. How clean you think Tripoli city is? In terms of waste management
  - Extremely tidy
  - Less tidy
  - One can see waste on the roads frequently
  - Not tidy
  - Extremely dirty
2. What is general food waste habit of people in Tripoli?
  - Almost everyone uses dustbins to keep environment clean
  - People usually dispose waste negligently
  - No one cares for proper disposal, neither public nor authorities
  - People care for proper disposal but authorities show negligence
  - Food waste management authorities don't manage properly
3. Do you yourself take care of proper, hygienic disposal of household waste?
  - Yes
  - No
  - Often
  - Regularly
  - Not regularly
4. What contains most part of your household food waste?
  - Cooked food
  - Uncooked food
5. What contains the most part of your household food waste? Rank according to proportion from 1 to 5, where 1 is Largest Proportion, 3 is Medium Proportion and 5 is Negligible Proportion.

Food Type	Ranking
Poultry	
Vegetables	
Fruits	
Dairy	
Pasta, oatmeal and rice	
Other non-perishable food (Canned goods, Cheese or peanut butter crackers, Beef jerky, various sauces, Pudding, Fruit cups, Granola/ Power/ Cereal bars etc.)	

6. Do you dispose household food waste separately from other waste?

- Yes
- No

If yes, how? \_\_\_\_\_

7. Do you support the idea of food waste collection separately to run an energy generation plant in Tripoli?

- Yes
- No

Provide at least one strong reason to justify your answer \_\_\_\_\_

8. If separate waste collection method is applied by the municipal department, where department is also providing you with separate containers for different type of waste disposal, would it be feasible for you?

- Yes
- No

9. If asked, would it be feasible for you to collect food waste separately from the other household waste?

- Yes
- No

10. How you think installation of an Anaerobic Digestion plant to help generating electricity from food waste is important?

- Extremely important
- Important
- Don't know
- Less important
- Not important

Please provide one reason to justify your answer \_\_\_\_\_

11. If the proposed Anaerobic Digestion Plant for food waste has been established in Tripoli, what would you concern?

(you can choose more than one answer)

- Noise
- Hygiene
- Odor
- Aesthetic
- Safety
- Amount of energy generated
- No concern
- Other, please mention \_\_\_\_\_

12. Do municipal authorities collect waste regularly?

- Yes
- No

13. *Content removed...*

14. Which disposal method is used with which frequency? Please tick for every method

Frequency	Residential Premises				Commercial Premises			
	A	F	S	N	A	F	S	N
Open dumping								
Controlled tipping ( with occasional soil cover)								
Sanitary landfill ( with daily cover)								

Dumping into water body (river/sea etc.)								
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A= Almost exclusively used

F= Frequently used

S= Sometimes used

N= Never used

15. Have you ever used food waste as fertilizer at home?

- Yes
- No

16. Was there any major outbreak of any disease in Tripoli in past 10 years?

- Yes
- No

If yes, mention \_\_\_\_\_

17. How much do you feel climate of Tripoli have been polluted in last 10 years?

- Not polluted at all
- Less polluted
- Considerably polluted
- Unchanged
- Extremely polluted

18. Is municipal waste a major reason of pollution in Tripoli?

- Yes
- No

19. How often do you undergo electricity outages?

- Everyday
- Frequently
- Less frequently
- Once in a while
- Only in case of any major breakdown

20. What is a major source of electricity generation in Libya?

- Oil and fuel
- Hydel power

- Solar power

***Thank you very much for your participation and your time!***







