

Circular Economy-Zero Waste Anaerobic Digestion Plant in Greater Amman Municipality

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Introduction

The Greater Amman Municipality (GAM) is responsible for waste management infrastructure in the twenty-two (22) districts of the metropolitan area of Amman and in other five (5) additional neighboring districts covering a total area of about 1,700km² and serving a population of about 4 million people. GAM is estimated to produce annually 1,100,000 tonnes of Municipal Solid Waste (MSW) of which approximately 50% is the Organic Fraction of Municipal Solid Waste (OFMSW). The potential of the utilization of MSW produced, through anaerobic digestion and energy production by biogas combustion, can become an opportunity dealing with a wide variety of environmental, economic and social benefits for GAM region. It is proposed that the anaerobic digestion (AD) plant will be designed to process in total 60,000 tonnes of organic waste per year, which is equivalent to approximately 10% of the current potential of organic waste in the total collected waste by GAM

Biowaste Collection

The targeted biowaste sources vary according to the project implementation phase:

- Phase A - 30,000 tn/y: mainly municipal/GAM managed biowaste sources
- Phase B - 60,000 tn/y: municipal/GAM managed & non-municipal/private sources

In sum, the proposed AD Plant is designed taking into consideration the input of more than ten (>10) different sources of biowaste, focusing mainly in municipal and GAM managed activities that generate biowaste. Most importantly, the estimated GAM generated/ managed biowaste quantities are secured from the initial operation of the AD facility. Moreover, the selection of multiple targeted sources of biowaste aims at risk diversification regarding the risks associated with the estimations of incoming quantities. It is noted that the equipment and infrastructure of the proposed AD Plant is designed taking into consideration the necessary provision and flexibility to operate in the future with increased incoming quantities from municipal sources (residential food waste) rather than private sources.

Anaerobic Digestion

A two-stage, continuous stirred low solids (wet) AD process in the mesophilic temperature range is proposed for the AD plant. This scheme provides the AD plant with benefits such as:

- Comparatively higher gas yield
- High decomposition efficiency resulting to a more stabilized and of higher quality digestate
- Easier to handle process
- Versatility on the variety of substrates
- Low energy consumption
- Conventional equipment requirements
- Process stability and low sensitivity to condition variations.

Sitting

The proposed site for the development of the AD facility is the Al Shaer site in the eastern part of the Amman Governorate, in Al Qweismeh district. Currently, the Al Shaer Waste Transfer Station (WTS) is operating in the site, since its initial construction in 2000, and about 3,000 tn/day municipal solid waste is received in the WTS and transferred to Ghabawi landfill at a distance of about 30km. The benefits of the proposed site include:

1. Accordance with Local Land Uses Plan
2. Accordance with UK Standard Rules for site selection criteria
3. Social Aspects & Local Amenity
4. Favorable Landscape and Topography of proposed site
5. Road access and traffic.

Environmental impacts & mitigation measures

The development and operation of such an integrated system of separate collection of biowaste, to anaerobic digestion and electricity generation, has a number of remarkable benefits on environmental and social

aspects especially for local communities. Moreover, the development of the AD plant provides an opportunity to operate also as the 1st Circular Economy and Zero Waste Park in Jordan, open to the public including an integrated Community Recycling and Environmental Education Center (schools, universities, etc).

This project is considered a main step forward to sustainable development in the GAM area in specific and Jordan in whole. It is considered an environmental solution to assist in proper solid waste management as well as proper resource efficiency in the area. It will decrease the size of municipal solid waste causing pressure on existing landfills and its effects on climate change added to the improvement of environmental, health, and living conditions for the local community. On the economical side, this project is considered as a gate to sustainable green economy where useless waste is exchanged with useful products constituting an income. On the other side, any expected negative effects on health and public safety are considered minimal and can be mitigated as mentioned within the report. Therefore, the positive impacts of this project outweigh any expected negative impacts. This project can be considered a starter of green investments and calling the private sector the opportunity to invest in this sector.

Project Financial Analysis

The Financial Analysis is based on the Discounted Cash Flow (DCF) approach. Project time horizon is estimated to 30 years and a discount rate of 4% is adopted in order to calculate the present value of the future cash flows. The project capital expenditures are summarized in the table below.

Table 1. Project capital expenditures.

	PHASE A CAPEX (30,000 tn/y) (JOD)	PHASE B UPGRADE CAPEX (additional 30,000 tn/y) (JOD)	PHASE A & B TOTAL CAPEX (60,000 tn/y) (JOD)
AD PLANT CAPEX	7,530,388	1,476,000	9,006,388
COLLECTION EQUIPMENT CAPEX	1,201,423	270,862	1,472,285
TOTAL AD Plant & Collection CAPEX	8,731,811	1,746,862	10,478,673
VAT (16%)	1,397,090	279,498	1,676,588
TOTAL AD Plant & Collection CAPEX (incl. VAT)	10,128,901	2,026,360	12,155,261
LAND ACQUISITION	300,000		300,000
TOTAL CAPEX (AD Plant & Collection & Land)	10,428,901	2,026,360	12,455,261

The financial analysis outputs are summarized in the table below.

Table 2. Project financial analysis.

Financial parameters	Non Discounted value (JOD)	Discounted value (JOD)
1 Time Horizon (Reference period)		30
2 Discount Rate		4%
3 Capital Expenditures (CAPEX)	12,455,261	11,099,350
4 Residual value	706,515	217,832
5 Revenues (discounted)		20,824,501
6 Operating costs (discounted)		11,518,441
7 Net Revenues = Revenues + Residual value - Operating costs (discounted)		9,523,893
8 Net Present Value (NPV)		- 1,575,457

According to project's outputs, $NPV < 0$ which implies that the project requires financial support (EU financial support) as the revenues generated will not cover the costs.