

**UNDP/GEF – DANIDA project:  
Reduction of Methane Emissions  
and Utilisation of Municipal  
Waste for Energy in Amman,  
Jordan”**

**(GEF ID 55; UNDP PIMS 13180)**

# **DRAFT Final Evaluation Report**

**For: UNDP CO, Jordan**

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## **List of Abbreviations and Acronyms**

AD	Administrative Director
CH4	Methane
CO2	Carbon Dioxide
CEGCO	Central Electrical Generation Company
DANIDA	Danish International Development Assistance
GAM	Greater Amman Municipality
GCEP	General Corporation for Environment Protection
GEF	Global Environment Facility
GHG	Greenhouse Gases
JBC	Jordan Biogas Company
JES	Jordan Environment Society
JUST	Jordan University of Science and Technology
MW	Megawatt
MEMR	Ministry of Energy and Mineral Resources
MOPIC	Ministry of Planning and International Cooperation
MSW	Municipal Solid Waste
NEPCO	National Electricity Power Company
NES	National Environment Strategy
NGO	Non-Governmental Organization
PRIF	Pre-Investment Feasibility Study
SCC	Special Consultative Committee
UJ	University of Jordan
UNDP	United Nations Development Programme
CDM	Clean Development Mechanism
PMU	Project Management Unit

## **Acknowledgements**

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## **1. Executive Summary (English)**

This report describes the findings of the independent, Final Evaluation of the UNDP/GEF Full-Size Project 13180 “Reduction of Methane Emissions and Utilization of Municipal Waste for Energy in Amman, Jordan” as carried out for UNDP Country Office in Jordan. The Project Document was signed in 1997 and the project was closed on December 26, 2005; for several reasons, the final evaluation could not be arranged for until mid-2007.

The project was established to reduce the environmental problems at the Ruseifah landfill site near Amman. A 1-MW biogas power plant was installed to exploit the methane gas as a resource for electricity generation. The methane was extracted from 12 wells at the landfill site; further, a 2000 m<sup>3</sup> biodigester was erected to produce methane directly from industrial organic waste. The plant is operated by the Jordan Biogas Company (JBC), a joint venture of the national electricity company (NEPCO, now CEGCO), and the Greater Amman Municipality (GAM). The project was funded by GEF with a grant of US\$ 2,500,000 and by DANIDA (US\$ 1,500,000). In 2005, JBC, GAM and UNDP agreed upon an expansion of the plant with 2.5 MW and 84 additional wells, which was already and operational during the mission.

The UNDP/GEF biogas project has put solid waste management on the agenda in Jordan and in the region. The project has obtained positive exposure in the media and received visitors from all over the world. The project has shown people and authorities in the region that there exist alternatives to open landfill dumping. The project has certainly contributed to inducing a transition in Amman towards more advanced waste management. Open landfills such as Ruseifah are now closed; the new Al Ghabawi site is covered and divided in cells, while measures have been taken to prevent contamination of ground water. A privately-run recycling facility is under construction at this site; methane capture technologies are under investigation and will likely be proposed under the Clean Development Mechanism.

Outside Amman, open landfill dumping is still the common standard. The biogas project did not directly address replication of improved waste management in Jordan, but it did establish a clear example that things could be done in a better way. It is concluded that a number of barriers are still in place that prevent other municipalities from cleaning up open landfill sites. These barriers are likely a combination of local priorities, a lack of national environmental regulation and a lack of investment capital. The evaluation team has identified the Greater Amman Municipality as the strongest actor to promote rational waste management in Jordan; JBC can be instrumental in such a replication campaign.

The evaluation concludes that the Jordan biogas project was not targeted at full barrier removal to establish an enabling environment for replication. The project was rather a demonstration project with a dissemination component, that was implemented on top of an environmental “hot spot”. Given the incipient environmental legislation and insufficient coordination within the government, the evaluators are convinced that in 1996 time was not ready for a systematic barrier removal approach. The selection of the Jordan biogas project by UNDP/GEF is therefore considered as opportune and timely.

The project nearly achieved the projected emission reductions (31,000 of the expected 40,000 tons CO<sub>2</sub>eq/yr) by capturing landfill gas for electricity generation. Jordan Biogas Company has not been able to secure a stable supply of adequate organic waste as feedstock for the biodigester. **The daily supply of**

organic waste is only 20 tons, which is 1/3 of the nominal value. The waste is obtained from selected sources (hotels and slaughterhouses) because the biological process in the digester is very sensitive to the quality and composition of the waste input. Biodigester technology can therefore not be considered as a substitute to replace open landfills for organic waste disposal. It was also not possible to produce fertilizer of an acceptable quality from the digester residue. Instead of fertilizer production, CDM may provide an additional revenue stream for landfill gas, compared to the open landfill baseline. For CDM however, the quality of data recording should improve drastically and include proper means of verification and monitoring.

The institutional and commercial basis for JBC is still weak. Currently, JBC does not generate the necessary resources to secure its operation over a length of years. It also operates the biodigester for producing biogas at a higher cost than the available landfill gas. This situation is not sustainable from a perspective of minimizing operational costs. Further, the quality and transport of the waste feedstock is not secured. A solid institutional and commercial basis is needed for JBC and its staff to safeguard the capacity built up during the project. This requires the development of a viable business plan, revision of the company structure, adequate structuring of assets and operational activities, a reinvestment and insurance plan; an expansion plan for disseminating the technology while broadening the working area for the company in Jordan and abroad; and incentives for the staff, possibly performance-based.

At a higher level, the envisaged government incentives for renewable energies in Jordan have not yet been implemented. Municipal and government incentives will be needed to support the long-term exploitation of the Ruseifah biogas plant. Such incentives can reflect the avoided costs related to waste mitigation by JBC, while additional rewards may be applied to sustain electricity generation based on biogas. In a long-term national strategy, such incentives may be recovered by levying waste production and consumption.

The evaluation team found that the project design was rather weak and that the individual components were hardly mutually supportive. According to the local stakeholders, the project was not negotiated and coordinated with the executing partners prior to commencing. All the activities programmed under the Jordan biogas project activities have been executed successfully; however, the project took eight years to complete instead of three. At a government igher level, the evaluation team did not observe strong stakeholder commitment and coordination. It is therefore concluded that one of the broader objectives of the project (i.e. to improve the coordination among the relevant governmental entities, in particular MOPIC, MEMR and the Ministry of Environment) has not been achieved.

## **1. Executive Summary (Arabic)**

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## **2. Introduction**

This report describes the findings of the independent Final Evaluation of the UNDP/GEF Full-Size Project 13180 “Reduction of Methane Emissions and Utilization of Municipal Waste for Energy in Amman, Jordan” as carried out for UNDP Country Office in Jordan. The Project Document was signed in 1997 [1]; the project was closed by UNDP on December 26, 2005 [2], when all activities had been carried out. According to the Project Document, a final evaluation was to be conducted within six months prior to the scheduled project termination but for several reasons, it could not be arranged for until mid-2007.

The project was established to reduce the environmental problems at the Ruseifah landfill site near Amman, particularly the release of methane gas and the odour. A 1-MW biogas power plant was installed to exploit the methane gas as a resource for electricity generation. The methane was extracted from 12 wells at the landfill site; further, a 2000 m<sup>3</sup> biodigester was erected to produce methane directly from industrial organic waste. The plant is operated by the Jordan Biogas Company (JBC), a joint venture of the national electricity company (NEPCO, now CEGCO), and the Greater Amman Municipality (GAM). The project was funded by GEF with a grant of US\$ 2,500,000 and by DANIDA (US\$ 1,500,000). In 2005, JBC, GAM and UNDP agreed upon an expansion of the plant with 2.5 MW and 84 additional wells to cover the whole Ruseifah landfill [3]. The expansion was already in place and operational during the mission.

The final evaluation was conducted by a team of four consultants (two national and two international). The mission, conducted by one international and one national consultant, was carried out from August 20 – September 4, 2007.

### ***2.1 Purpose and scope of the evaluation***

This final, independent evaluation is initiated by UNDP Jordan as the GEF Implementing Agency in agreement with the GEF RCU in response to UNDP and GEF monitoring and evaluation policy. The final evaluation is one of the instruments used by UNDP and GEF to evaluate the degree of success and effectiveness of an intervention, for enhancing project results, and to draw lessons for future programming. The UNDP/GEF guidelines for monitoring and evaluation [4], are adhered to by the evaluation team. The purpose and scope of the final evaluation of the Jordan biogas project is described in the Terms of Reference included in Annex A of this report. The evaluation will:

- (R)<sup>1</sup> Evaluate project achievements at impact level by monitoring reports of bio-physical indicators, annual progress reports and other sources of information. In terms of outcome, the Evaluation will analyse to what extent the “expected situation at the end of the project” has been reached.
- (R) Review the progress made by the Project towards achieving its sustainability in terms of project benefits. Relevant factors include development of a sustainability strategy, establishment of financial and economic instruments and mechanisms and mainstreaming project objectives and working methods into the national economy and society. It will also assess the replicability of the

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<sup>1</sup> (R) means that this aspect must be evaluated using the scale HS: Highly satisfactory / S: Satisfactory /; MS: Marginally satisfactory / U: Unsatisfactory.



- project in other areas in the country and region.
- (R) Review the M&E procedures put in place by the project, in particular examine the selection of indicators, the mechanisms of review and monitoring, and the adaptive management approach followed by the project (ExA, IA).
- (R) Review the implementation approach, in particular focussing on:
  - Execution arrangements;
  - Institutional arrangements;
  - Coordination arrangements among the various components; and
  - Efficiency of the technical backstopping by the contractors and partners (i.e. their quality of inputs and performance).
- (R) Assess the degree of participation of the various stakeholders, including scientific, technical and non-governmental organizations, and the involvement of the general public and public groups in the implementation of the Project.

The evaluation team has further reviewed the following aspects (not formally required):

- Expenditures of the Project on main items and assess the input-output quality of the achievements;
- Co-financing of the Project and draw conclusions with regard to financing project replication;
- Investment and exploitation scheme of the erected biogas plant and assess to what extent it has led to reduced implementation costs for similar plants in the region (in line with GEF OP6 priorities).

## ***2.2 Key issues addressed***

In agreement with UNDP Country Office on August 21, 2007 it was decided that the final evaluation would focus especially on the aspects of the project that are relevant for sustainability and replication, including:

- Technical operation of the biogas pilot plant at Ruseifah, including the biological process, process flows and outputs;
- Cashflow and profitability aspects of the biogas pilot plant;
- Business modality of the Jordan Biogas Company and its suitability for replication;
- Capacity building programme at universities;
- Approach towards integrated municipal waste management by GAM; and
- Progress towards a conducive policy environment for replication, including an assessment of remaining barriers.

At the end of the mission, a list of specific actions was compiled for UNDP to address specific issues that could be followed up. Although the UNDP/GEF biogas project was closed in 2005, the ongoing Phase-2 project provides a valuable opportunity for UNDP, GAM, CEGCO and JBC to implement the recommendations of this final evaluation.

## ***2.3 Methodology of the evaluation***

The methodology followed for the Final Evaluation is based on the UNDP/GEF M&E guidelines and the Terms of Reference and consists of:

- A review of the project documentation submitted by UNDP to the evaluators;
- Collection of lacking information from UNDP Country Office and other stakeholders (JBC, universitie, NGO's)<sup>2</sup>;
- Conducting semi-structured interviews with all major project stakeholders;
- Analysis of information within the Evaluation Team;
- An assessment of the outputs, outcomes and impact of the project in relation to the objectives and indicators set forth in the project logical framework;
- A review of the research and development hypotheses of the project (which are largely implicit);
- A review of the technical and financial profile of the operating biogas plant, including its institutional setup; and
- A review of the plans for replication of the project concept in Jordan and the region.

In addition, three field visits were made:

- one to the landfill, digester and biogas plant at Ruseifah (location of the project);
- one to the active Al Ghabawi landfill; and
- one to the Productive Women Cooperative at the Marka landfill.

Subsequently, the findings of the evaluation were presented to all major stakeholders for verification and to obtain additional input. This presentation was held on September 3, 2007 at the Ministry of Planning and International Cooperation (MOPIC).

It was further envisaged to meet representatives of the local community of Ruseifah town to assess the impact of the project on the local environment and on the quality of life of the nearby people. Such a meeting could not be organized however. In this respect, one must observe that no baseline information was collected before the project started. Interviews with other stakeholders (JBC, GAM), have provided some insight however.

## ***2.4 Structure of the evaluation***

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2 During the mission, the evaluators reviewed the project files manually. Older documents are only available in hardcopy. Several documents could not be retrieved however, including the annual workplans before 2004 and the GEF Project Brief, reportedly dated 1996.

### 3. The Project and its Development Context

#### 3.1 Project start and its duration

The project document of the was signed in 1997; the project was technically closed by UNDP on December 26, 2005 when all activities had been carried out (except for the final evaluation). The project was carried out through the NEX modality through the Ministry of Planning (now MOPIC) and the Jordan Biogas Company that was created as a joint-venture between the Greater Amman Municipality (GAM) and the As mentioned before, it is not easy to follow the project's timeline over the full period 1997-2005; the mid-term evaluation [5] however, lists several key data up to 2001:

June 2, 1997:	Formation of Jordan Biogas Company;
August 31, 1997:	Signature of the project document;
February 18, 1999:	Project inception report;
April 26, 1999:	Award of plant construction tender (2/98) to Farmatic;
May 20, 2000:	Construction works completed;
August 1, 2000:	Regular operation of the plant;
August 2000:	Staff training tender (1/99) awarded to Farmatic;
October 30, 2000:	Evaluation report by BC Consult about plant performance;
February 1-24, 2001:	Training of JBC staff conducted in Jordan;
March 3-31, 2001:	Training of JBC staff in Germany;
April 8, 2002:	Independent evaluation mission (January – February 2002);

It remains unclear to the evaluators why -at some point in time – it was decided to execute the university and outreach components only after finalizing the biogas plant and who took this decision. Early 2001, UNDP appointed a representative of the National Energy Research Centre (NERC) as the administrative director [6]. After that, it took significant time to contract the remaining activities. The negotiations with the University of Jordan (UJ) did not result in an agreement; instead, the Jordan University of Science and Technology (JUST) was finally granted a contract to integrate biogas technology in its curriculum and to set up a specialised biogas research laboratory. The dissemination and public awareness component was granted to the Jordan Environment Society (JES).

December 2003:	Final report on dissemination and awareness component by JES;
February 1, 2006:	Final report on introducing biogas technology by JUST;
December 26, 2005:	Letter by UNDP Resident Representative giving instruction to formally close down the project.

#### 3.2 Problems that the project seeks to address

The goal of the project as described in the project document is as follows:

*“To reduce emissions of greenhouse gases in Jordan by substituting bio-energy produced from anaerobic digestion of industrial and municipal waste in Amman, for fossil fuels. Additional greenhouse gas reduction will be achieved by reducing the uncontrolled release*

*of methane from improperly disposed organic waste and organic fertilizer will be produced. The project's main activities include a combination of a landfill operation and a biogas plant."*

Although it was presented as a technology demonstration project, the direct motivation behind the project was the urgent need to clean up the open landfill site at Ruseifah (considered as an environmental "hot spot"). Although this could have been done by simply covering the site and flaring the captured CH<sub>4</sub>, the opportunity was used to experiment with new techniques because:

- Landfill gas might prove a useful energy resource for Jordan;
- The use of biodigester technology might be a viable alternative for landfill sites, a.o. to avoid contamination of aquifers;
- There was hardly any knowledge about more advanced ways of waste disposal in Jordan; open landfills were common practice (and still are elsewhere in Jordan and in the neighbouring countries);
- A working pilot plant would show people that waste can be dealt with in a different way, which would be instrumental for initiating a change in thinking;
- The need to explore the possibility to convert waste into useful new products (originally: electricity and fertilizer) might generate income for ongoing efficient waste management and turn it into a self-sustaining business.

### **3.3 Goal and objective of the project**

The Project Document defines the development objective of the project as follows:

*"To reduce biodegradable waste accumulation in Jordan, thereby improving Jordan's environment and reducing global emissions of greenhouse gases (CH<sub>4</sub> and CO<sub>2</sub>) while at the same time reducing the dependency of oil imports. The overall objective will be reached by introducing biogas technology. Combined with the introduction of a new environmentally friendly technology a capacity training program will ensure the project sustainability."*

The immediate objective as given in the Project Document is threefold:

- *"An overall controlled treatment of 18,300 tones of municipal waste per year, subsequently reducing methane (CH<sub>4</sub>) emissions into the atmosphere by 1,540 tones annually as well as a reduction of CO<sub>2</sub> emissions by 5,950 tones annually through the utilization of the methane content of the biogas produced from the waste for replacement of fossil fuel."*
- *"An improved basis for an enabling environment which lends itself to institutional security for the demonstration biogas plant and to national planning for bioenergy in Jordan."*
- *"An enhanced capability of the Jordanian people to manage and convert their municipal waste to energy in a sustainable manner in order to prevent rapid landfill growth and greenhouse gas emissions and to reduce the dependency on oil imports for energy production."*

### **3.4 Expected results**

The project was very ambitious in the definition of its objectives, it must be observed however that the

project design does not address all barriers that needed to be removed to achieve replication of the project on a broader scale. The project document does not analyze in detail the barriers as per 1996 and refers to the Project Brief. The evaluators have not been able to retrieve this document<sup>3</sup>.

By analyzing the project using the "five-pillar framework", the evaluators conclude that the project mainly addressed the technical and information barriers. However, it did not create a basis for an enabling environment for project replication. There are a number of barriers that were not removed and were not targeted explicitly by the project.

- financial barriers;
- institutional capacity and coordination;
- implementation of policy and environmental regulation; and
- introduction of effective business models (delivery skills).

Without a comprehensive barrier removal, it is not realistic to expect an end-of-project status in which new projects are already implemented or under development in Jordan and the Middle East region. In the opinion of the evaluators, these expectations were unrealistic to achieve within the original duration of the project (3 years).

The evaluation team will therefore focus on the barriers the project actually worked upon and assess its results in terms of a contribution to removing these barriers. The indicators describing the expected end-of-project status were redefined in the course of 2004 when the project structure was revised to bring it in line with the modern logical framework approach to distinguish the levels of objectives, outcomes and output<sup>4</sup>. This structure will be adhered to in this Evaluation. The indicators will be discussed and rated later on. Qualitatively, the expected end-of-project situation can be described as follows:

- Creation of verifiable environmental benefits (installed generating capacity, tons of waste treated, avoided CO<sub>2</sub>-emissions);
- Successful construction, commissioning and exploitation of the 1-MW biogas pilot plant;
- Expansion plan for the pilot plant implemented;
- Awareness raising, training and capacity building programme carried out; and
- Creation of an enabling environment for replication (5 replicable biogas plants established, Government incentives for renewables in place, a National Plan for expansion developed).

Although not targeted by one of the components, the issue of strengthening institutional capacity and coordination was present all through the project.

### ***3.5 Development context***

The Jordan biogas project fits into Jordan's development context by:

- providing alternatives to conventional waste management;
- reducing the country's emissions of greenhouse gases;

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<sup>3</sup> In the Annex VI of the Project Document (p. 76) it is mentioned that the Project Brief is dated April 1996.

<sup>4</sup> See Annual Project Review JOR/96/G31/A/1G/99, August 2004.

- contributing to electricity generation by replacing imported fossil fuels; and
- creating in-country institutional and human capacity to use and replicate biogas technology.

A full decade after the project was approved, its development context remains in place and valid. Notwithstanding, a number of changes has happened in Jordan that are worthwhile mentioning. The first change is the growth of the Jordan population. Amman, with approximately 1.6 mln inhabitants in 1996, now counts over 2.5 mln people. The conflicts in neighbouring countries pushed large numbers of refugees into Jordan. Over half of the population are Palestinians; after the 2003 invasion, several hundred thousands of Iraqis settled in Jordan, most of them in or around Amman. Such growth imposes a huge strain on the infrastructure of the city. Organic waste production in Amman, estimated at approx. 600 tons per day in the 1993 feasibility study, has now risen to about 2,000 tons/day.

In this rapidly changing environment, the Greater Amman Municipality is the leading authority working to maintain an adequate level of urban services and to conduct controlled urban planning. When the project was designed, the Ruseifah landfill was located outside Amman; now the site is within the city's boundaries and the municipality studying alternatives to redevelop the whole area. A new landfill site has been opened at Al Ghabawi, about 30 kms southeast of Amman, while options for recycling of waste and incineration of organic waste, are also considered.

The second change affecting the execution of the project is the gradual shift towards a more open, market-driven economy in Jordan. The original national utility (NEPCO) has been separated into production, transmission and distribution company, controlled by a Regulator. The Jordan Biogas Company is now held by CEGCO, the electricity producer. Private companies, such as JBC will have to work efficiently according to market principles.

### ***3.6 Beneficiaries and stakeholders***

The following beneficiaries are explicitly targeted by the project (Project Document, p.19):

- The general population of Jordan;
- The general population of the city of Amman;
- The Ministry of Energy and Mineral Resources (MEMR), GAM and NEPCO;
- The Jordan University of Science and Technology (JUST)<sup>5</sup>; and
- Environmental NGOs<sup>6</sup>.

In addition, the following stakeholders have been identified:

- The Ministry of Environment;
- The Jordan Biogas Company (JBC);
- The National Energy Research Centre (NERC);
- The Ministry of Planning and International Cooperation (MOPIC);
- UNDP and UNDP/GEF;
- Farmers and producers of liquid biological waste flows that may benefit from biogas-digester

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5 Originally it was envisaged to work with the University of Jordan.

6 Specifically Jordan Environment Society (JES).

- technology; and
- DANIDA and other donors active in Jordan and the region.

### ***3.7 Institutional set-up***

The institutional setup of the project has not been worked out in the project document; it is rather a description of “how things should go” than a detailed project management and implementation structure. The organisation of the project as envisaged in the Project Document (p.20-22) is included in Annex E for reference. Strikingly, there is no project managing director with responsibility for the overall project execution and there is also no Steering Committee; there was an advisory Special Consultative Committee instead.

Stakeholders' involvements and competences sometimes cross each other, which makes it difficult to take decisions. An example of unnecessary stakeholder involvement is the draft agreement for setting up the Jordan Biogas Company (Annex VI of the Project Document). While the agreement could have been limited to the shareholders, MOPIC and UNDP are assigned a role as well. During the execution of the project, no appropriate action has been taken to improve the institutional set up. Once the project was approved, it took more than one year to start the inception phase. The need for a central administrator and well-defined responsibilities among stakeholders was also observed by the inception consultant. The problem is reported again by the mid-term evaluator.

## 4. Findings and Conclusions

### 4.1 Project design and scope

The Project is rather ambitious in its objectives. While pursuing replication, the creation of an investors portfolio and government incentives (Indicators 6 and 7), it presumably assumes that this can be achieved on “an improved basis for an enabling environment” (immediate objective, second line). Without a comprehensive barrier removal strategy, replication and sustainability cannot be achieved however.

In the opinion of the evaluators, time was not ready for systematic barrier removal in 1996. It would have been preferable to narrow the scope of the project and pursue less ambitious (and more realistic) targets. Based on a review of the programmed activities, the following conclusions are drawn:

- The policy and financial barriers were not addressed and effectively remained outside the scope of the project:
- Strengthening institutional capacity and coordination was a key objective of the project but no specific activities were implemented to address this. Interaction between ministries (MEMR, MOPIC, Ministry of Environmen) and governmental agencies (NERC) and NGOs (JES) is still weak; and
- The development of adequate business models (delivery skills) was targeted by the creation of the Jordan Biogas Company; the viability of the chosen business model was not subject of study however.

By consequence, the project outputs do not mutually support each other; they are rather loose components that were executed independently:

- I. The construction and operation of the pilot biogas plant (Jordan Biogas Company);
- II. The implementation of biogas into the university curriculum and setup of a laboratory (Jordan University of Science and Technology); and
- III. The execution of several outreach activities and promotion (Jordan Environmental Society).

One may raise the question however, if a systematic approach barrier removal approach would have been more effective. The fact that the project acted at a “hot spot” gave it a high visibility showing people that things can be done differently, while a less visible barrier removal project may have had less impact.

It is further observed that for a technology pilot project, there was no test or research hypothesis. Apparently, it was assumed that European biodigester technology would work smoothly under Jordanian conditions with local feedstock, even though (as stated in the project objective):

*“This technology has never been implemented in a developing country.”*

Simplifying matters somewhat, the evaluators conclude that the pilot plant component merely consisted of providing donor funding for procurement and commisioning and for basic training. The quality of the training programme was not convincing, as commented by the participants and the mid-term evaluation. The technical implications that would arise afterwards were largely left to the JBC staff. There was no test



programme prepared to learn how this technology would work under local conditions and how to work through the inevitable implications of transferring complex technology. The omission of a research component in the project is a serious failure in the project design. Instead, the Jordan Biogas Company JBCo was supposed to operate the plant cost-effectively (even generating power at a competitive price) and in addition produce fertilizers for the national market and to develop such a market. In Annex F the operational conditions for JBC as described in the Project Document, are included for reference.

Without a clear focus and mutually supportive project activities, the project lacks a strong exit strategy geared towards replication of biogas technology in Jordan and the region. According to the Project Document, the creation of Jordan Biogas Company in itself was considered a guarantee for sustainability. However, the evaluators observe that from 2000-2006, the company has not evolved towards a self-sustaining business; its activities were limited instead to running the biogas plant and solving daily technical issues. JBC in its current form cannot be considered as a replicable business model.

An adequate exit strategy would minimally have assigned clear roles to the involved institutions, especially the ministries, and negotiated the terms of business for JBC with its shareholders, GAM and CEGCO.

#### ***4.2 Institutional set-up***

Even today, the interviewed project administrators (NERC, JBC) only recognize their part of the project as their responsibility: it is not surprising that UNDP had to urge repeatedly to have reports submitted in time. Moreover, UNDP frequently refers to the SCC as the Project's “Steering Committee” (there is no such committee)<sup>7</sup>. Without appointing a strong institution to lead the project before commencing, it turned out to be impossible to correct this situation after the project was started.

It remains unclear why MEMR, MOPIC and UNDP were not able to solve this problem. The evaluators conclude from their interview with MEMR, that this Ministry was -and is- interested in biogas as an energy resource, but not in the UNDP project as a whole; it eventually handed over the project administration to NERC, which was an agency of MEMR at that time. The role of the Ministry of Planning (now MOPIC) remains unclear and nobody at MOPIC could provide information about the project. The GEF Focal Point (within MOPIC) cancelled the meeting with the evaluators and was not present during the presentation.

As a result, the project took 8 years to be implemented instead of 3 and there was overall confusion among the stakeholders about who is responsible and what each others' role should be. The following conclusion was agreed upon by all the attendees during a meeting of the former SCC on August 29, 2007:

*“The project documents were signed and approved without specifying the roles and responsibilities of the project stakeholders. After that, internal tough discussions started between the project’s stakeholders to define the roles and responsibilities for each of them, and that consumed about 2 years of the project life”.*

Another comment was that *“there were too many stakeholders”*. In spite of all people working hard to

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<sup>7</sup> Already in the 1999 Project Implementation Review it is referred to the SCC as the “Steering Consultative Committee.

carry out the assigned tasks, the situation was quite frustrating. Without leadership, the project eventually came to standstill, which becomes evident from letters from the UNDP office wondering if there is any activity; in 2002 there was no disbursement at all [7].

In 1997, Greater Amman Municipality and the electricity company NEPCO (now CEGCO), created Jordan Biogas Company (JBC) as a public joint-venture with a 50% participation each. It is unclear whether this was done in response to the UNDP/GEF project. Possibly, the approval of the 4 M\$ donor funding for erecting the Ruseifah biogas plant was a necessary condition for both partners to move forward. It seems that GAM and NEPCO never assimilated the full scope of the UNDP/GEF biogas project; from the other side, the project did not take the GAM/NEPCO alliance as a cornerstone for institution building to achieve replication. The impression prevails that the main project components were never integrated and that no attention has been given to it during the project design.

### **4.3 Project implementation**

The sources of information available to the evaluators to assess the implementation of the Jordan biogas project are limited to the project files at UNDP, the interviews with stakeholders and site visits. In agreement with UNDP Country Office, it was decided to focus on sustainability issues and enhancement of the project's outcomes<sup>8</sup>. As described above, the implementation of the project was affected by its poor organisation and the lack of responsibilities. **It took eight years to execute the project; while it could have done in four years.**

According to the Project Document, the project was to be implemented under two contracts, with a Project Administrator (PA) assigned by MEMR to overview the whole project in consultation with UNDP. In practice, JBC turned out to become the PA for the pilot plant component and inevitably had to prepare all the required reporting for UNDP/GEF. The German company Farmatic was granted the contract for supplying and building the biogas plant; it was also granted the contract for training the JBC staff (and some other people). In 2001, NERC was appointed by MEMR to execute the remaining components and contract suitable counterparts. The curriculum/laboratory component was assigned to JUST and the outreach and awareness component to JES.

#### **Cost-effectiveness**

A quantitative assessment of the cost-effectiveness of the project remains outside the scope of this final evaluation. The following qualitative observations can be made:

- The documentation of the tendering and evaluation process, including the rating of received quotations, verification of price levels, guarantee, after-sales services, etc., as present at UNDP Country Office, is rather poor. This may be related to the fact that the tendering procedure was prepared and executed by JBC and not by UNDP.
- The evaluators have not been able to compare the actual expenses with annual budget and work plans, because annual plans are not available<sup>9</sup>.
- The evaluators have reviewed the annual external audit reports, which are available for the project and for JBC. The external audits observe the absence of a separate accounts for the project

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<sup>8</sup> Especially since the Phase-2 expansion project is currently under execution.

<sup>9</sup> Annual budget projections and cash statement become available by 2004 (after the introduction of the Atlas system).

at NERC and the lack of means to track the in-kind contributions made by the Government of Jordan [8].

- The contract sum for the training component by Farmatic (DEM 650,000.-) draws the attention for training 15 people in Germany and in Jordan for 4-5 weeks; possibly the contract covered other items as well. As the equipment was supplied by Farmatic and staff needed to be trained to use it, the question arises whether companies other than Farmatic had a fair chance to compete for the training assignment.

Another aspect influencing cost-effectiveness of the project, is the chosen size of the biodigester pilot plant. This large size (2,000 m<sup>3</sup>) was proposed in the project document to generate significant amounts of biogas. The investment for the biodigester, including the feeding system (conveyor belt) and the gas pipes and valves was about US\$ 1.7 M. According to the project document, the pilot character of the project was not to probe whether the digester would work (this was not doubted although it had never been tried before), but to show that the technology could process significant volumes of organic waste for the city of Amman.

Today we know that JBC has not been able to collect the expected 60 m<sup>3</sup> of waste per day and that the production of marketable fertilizer has failed. The choice of smaller, less expensive biodigester might have been more prudent and more cost-effective.

### **Coordination among stakeholders**

The major stakeholders of the project, including the executing agencies JBC and NERC, were represented in the Special Consultative Committee. Given the poor institutional set-up of the project, the coordination among stakeholders was far from smooth. In the plenary meeting with the former SCC, the evaluators invited the attendees to write down each their two major observations. The individual answers are numbered and given in Annex G. A number of 11 (out of a total of 20) observations are related to the lack of coordination and organization. The following table shows the answers classified in four categories; the classification is made by the evaluators.

<b>Type of observation</b>	<b>No. observation</b>	<b>Frequency</b>
Lack of coordination, assignment of roles & responsibilities	2, 10, 13, 14, 15, 16	6
Lack of sustainability	4, 5, 7, 17, 18	5
Need for incentives	6, 8, 12, 20	4
Mismanagement & lack of organization	1, 3, 9, 11, 19	5
	<b>Total</b>	<b>20</b>

Summarizing the following conclusions are drawn:

- **Lack of coordination assignment of roles & responsibilities (score 6/20):** The project was not well

coordinated and it was not agreed upon at an operational level before commencing. The responsibilities of stakeholders and staff were not defined. The project did not address coordination and institution building.

- **Lack of sustainability (score 5/20):** The project did not address replication nor sustainability. The technical basis for the biogas plant is fragile. Technical issues were not well addressed and were not supportive for overall sustainability and replication.
- **Need for incentives (score 4/20):** People should be stimulated in order to make things work.
- **Mismanagement & lack of organization (score 5/20):** The project was badly prepared and organized and the situation did not really improve during the implementation of the project.

It is further concluded that the involved ministries have not interacted actively with the project in order to create conditions for replication (specifically: government incentives for renewable energies, which is one of the project indicators). NERC has produced a national Biogas Plan for MOPIC but there is no evidence as yet that such a plan can be effectively implemented in the near future. An interview with a representative of MEMR did not clarify the respective roles of JBC, GAM, CEGCO and MEMR for replication of the technology. MEMR's perspective is clearly from an energy point of view and this position has not changed during the course of the project.

Legislation for waste management is still under development; the Ministry of Environment was created in 2003 and waste will likely become one of its competences. At present, Greater Amman Municipality is by far the largest player in Jordan in the field of waste. It can play a key role for promoting efficient waste management outside Amman and, being a shareholder, it could use JBC as an instrument for disseminating landfill technology in Jordan.

### **Role of UNDP as the implementing agency**

The evaluators have very little information to make judgements on the role of UNDP as the implementing agency of this project. The current programme coordinator is the only person involved in the project who has been with UNDP CO during the whole period 1996-2006; the present programme officers were contracted in 2004, when the project had already closed many of the activities. At the end of the mission, a teleconference was made with the programme officer who was in charge of the project during the years 2000-2003 to answer some remaining questions. Other sources of information are the minutes of the tripartite meetings.

Based on the consulted correspondence between UNDP with JBC and NERC, and with the UNDP/GEF regional office, as well as on internal notes with observations and concerns expressed by UNDP, the evaluators conclude that the office has attempted, to the best of its abilities, to keep the project on track. Nevertheless, the weak institutional set-up and a lack of understanding of the project by the stakeholders resulted in inefficient communication and delay. As an example, the first recommendation included in the minutes of the Tripartite Review Meeting on July 24, 2000 [9] is:

*“The Project Document should be reviewed thoroughly by all the concerned parties together with the Inception Report.”*

This is three years after the project was formally approved by the GEF. The minutes also reveal that UNDP urges MEMR to assume its role as the entity responsible for recruiting the project administrator.

One of the lessons that can be drawn from this situation is that UNDP and its partners should carefully institutionalize a project before starting it and facilitate the setup of a professional project team. At least the Project Management Unit (PMU, project administrator and secretary) should be contracted by the project itself and not be part of the government's in-kind contribution.

Without a dedicated PMU in place, UNDP had a hard task to maintain its own files in order. The evaluators consider the quality of the available project files (of this particular project) at UNDP as below normal business standards. The information is kept in folders per project year without further structuring. There is no list of contents, which makes it impossible for the evaluators (nor UNDP) to check whether the project files are complete. A possible structure can be, for example:

- list of contents;
- correspondence in and out;
- procurements and contracts;
- technical issues;
- budget and planning;
- internal processes; and
- human resources.

Especially if a project becomes delayed, the subsequent UNDP programme officers must still be able to follow and understand it. A stable, trained PMU can then be a great help for UNDP.

The project has generated a lot of (positive) exposure for UNDP/GEF and the local UNDP Country Office. The site at Ruseifah has received many visitors from the international donor community. UNDP has also linked the project with several activities under the GEF Small Grants Programme in Jordan.

### **Monitoring and evaluation**

After transfer of authority of the project to the local UNDP Country Office, UNDP has a number of instruments at its disposal for project monitoring and steering, as well as for evaluating progress and results. Instruments for M&E include:

- 1) Project inception workshop and report;
- 2) Annual reporting (APR, PIR);
- 3) Quarterly progress reports;
- 4) Annual work plans and budgets;
- 5) Steering Committee meetings;
- 6) Tripartite review meetings (TPR);
- 7) UNDP field visits to the project;
- 8) Mid-term and final evaluations; and
- 9) Ad-hoc evaluations and expert missions<sup>10</sup>.

As mentioned before, annual work plans and budget projections could not be retrieved. This can partly be

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<sup>10</sup> The mid-term evaluation presentation [5] mentions that several evaluations had already taken place by the end of 2001. The most important previous evaluation was carried out by BC Consult (Denmark) to verify the functioning of the biogas plant before formal acceptance.

explained by the fact that JBC was responsible for implementing the biogas plant in 2000 and 2001 and managed (and spent) almost the full project budget internally during these two years<sup>11</sup>. The evaluators have not found evidence of quarterly reports in UNDP's files; as mentioned above, a steering committee was not in place. TPR meetings are not held regularly in the later project years; from the minutes it is concluded that the meetings did not strictly follow the agenda and as a result, important issues were not always addressed systematically. Once MEMR handed over the remaining project components to NERC, the high-level stakeholders (MEMR, MOPIC, GAM and NEPCO) lost their interest: they considered their involvement in the project as finished once the biogas plant was running and transferred to JBC. Between 2002-2006, UNDP focused on executing the capacity building component with NERC, JUST and JES, while JBC in the background managed and operated the pilot plant. Without an ongoing test programme however, there was no close monitoring of the pilot plant however.

The mid-term evaluation (December 2001 – March 2002) coincides fairly well with the moment of completing the biogas plant (component I) and starting the capacity building and outreach components (II and III). Effectively, the evaluation gives clear recommendations about remaining issues regarding JBC that needed to be addressed, such as:

*“Development of a company strategy for JBC to encourage the replication efforts by either the company itself or by means of encouraging private sector involvement.”*

Without direct high-level stakeholder involvement in the project, UNDP nor JBC were not in a position to work towards replication. The mid-term evaluation also emphasizes that the performance of the biogas plant is lower than expected and that the digester is not used for processing municipal solid waste (but for organic waste from slaughterhouses and hotels). The biological process in the digester is different than anticipated (mesophylic instead of thermophilic), implying a.o. that the residue needs post-treatment (pasteurization) before it can be used as a fertilizer.

The evaluators conclude that the findings of the subsequent missions to the project have not been assimilated by the project. Regarding the role of UNDP, it is observed that the Jordan biogas project is highly complex, with a large technological and hardware component, and an investment that is expected to be exploited by a company (JBC) on a commercial basis. **Each of these aspects require specific knowledge that is not available within UNDP. It might have proven beneficial if UNDP (and JBC) had counted with ongoing backstopping by experts instead of short-term visits.** In particular the need to develop a company strategy for JBC and to find a workaround for the problems with fertilizer production should have triggered a reorientation on the objectives set forth by the project. The evaluators do not share the observation [10] made by the mid-term evaluator, that:

*“The number and nature of stakeholders were clearly selected according to a specific design and goals that would ensure the completion of the activities and meet the desired objectives and outputs of the project. The roles, inputs and responsibility of each stakeholders were also clearly spelled out within the document”*

Without strong stakeholder commitment halfway the project, there were few opportunities to solve the

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<sup>11</sup> The evaluators have not had access to the internal work plans of JBC, but external audits state that JBC's administration is well-kept and trustworthy.

pending issues with JBC and the biogas pilot plant. Remarkably, one of the TPR meetings [11] deals with a request by JBC to negotiate a better price for the electricity sales. The statement is made that "*JBC's production cost is 15 fils<sup>12</sup> per kW(h) and the selling cost is 33 fils/kW(h)*". With a view on long-term sustainability, the production costs are actually considerably higher. It is concluded that, without specific knowledge, the TPR was not always able to make the proper judgements to steer the pilot plant component. In this respect, the evaluators also wonder whether there the proposition to retain part of JBC's cash flow to finance an ongoing training/replication programme, has ever been reconsidered during the course of the project. Without a well-defined company strategy and a view on future replication, the evaluators consider this activity as not appropriate and likely to jeopardize JBC's liquidity. Moreover, the evaluators have not found proof of any activities financed by this cash component.

UNDP's former programme officer<sup>13</sup> was confronted with the question whether the information gathered by UNDP from monitoring and evaluation activities, was effectively fed back into the project. The answer was that (in his view) monitoring and corrective action had been satisfactory. The available correspondence shows that UNDP CO and UNDP/GEF Regional Office certainly attempted to follow the project's course. Among others things, inquiries were made why a company from Denmark (which had expressed its interest in supplying the hardware) was not invited by JBC; and PIR reporting by the project administrator at NERC was followed up until acceptable reports were submitted to UNDP/GEF.

The evaluators are convinced however that after mid-term evaluation, a reorientation on the focus and strategy of the project and the role of the stakeholders, was urgently needed. Adaptive management should allow for such a reorientation, especially if it is required to safeguard the outputs of the project (in this case the future of JBC as a viable company; and the technical performance of the biogas plant) and to devise a successful exit strategy.

#### **4.4 Project results**

For the purpose of this evaluation, the outcomes of the project are grouped in three components. Each is assigned to a different organization, targeting different issues and beneficiaries. The components are:

- I. The construction and operation of the pilot biogas plant (Jordan Biogas Company);
- II. The implementation of biogas into the university curriculum and setup of a laboratory (Jordan University of Science and Technology); and
- III. The execution of several outreach activities and promotion (Jordan Environmental Society).

Component I was executed directly by JBC, while the components II and III were subcontracted by NERC to JUST and JES. In addition, NERC has prepared a Master Plan for MEMR financed by the project. Due to the limited time available, the evaluation team has reviewed the deliverables (reports) produced by each component, has held interviews with the people involved from JBC, JUST, JES and NERC; and made site visits to the Ruseifah plant (component I) and to JUST University in Irbid (component III). Due to time limitations, it was decided not to review the JES component, which makes up only a modest share of the project budget (\$ 122,000.- on a total of \$ 4 mln.) and is the least tangible one. It is observed that JES had a double role in this project, as it was represented in the SCC and also

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<sup>12</sup> 1.0 US\$ is equivalent to approx. 0.7 JOD.

<sup>13</sup> Teleconference on August 29, 2007.

executed some of the project activities financed by UNDP/GEF. The final report delivered by JES is given in [12].

As a general observation, the evaluators conclude that all the programmed project outputs have been satisfactorily delivered by the contracted parties. From the interviews held with the people who carried out the project activities within JBC and JUST, the evaluators conclude that the people "on the workforce" have worked hard to make this project a success and were committed to achieving the pursued objectives. **The things that did not work well in the project mostly happened at a higher level, where the evaluators have not found such levels of commitment.**

### **The biogas plant at Ruseifah**

The biogas pilot plant at Ruseifah consists of the following five main elements:

- a 1-MW biogas engine-generator set;
- 12 methane extraction wells covering 200,000 m<sup>2</sup> of the total landfill site area of 700,00 m<sup>2</sup>;
- a 2,000 m<sup>3</sup> biodigester tank with control equipment (heat exchanger, pump, stirring unit);
- a platform for trucks to discharge organic waste feedstock;
- a collection system (screw units, conveyor belt, separation line, a storage tank) to receive organic solid waste.

In 2005, UNDP and JBC embarked on an expansion plan (Phase-2) with two additional 1.25-MW engine-generator sets and 84 additional wells, covering the whole landfill area. **These systems are in place now. When the site was visited (August 22, 2007), the 1-MW engine was under repair and not in operation.** As can be seen in the pictures, there is a technological step-up between the old engine installed under the pilot project, and the new units. According to the plant manager, the cooling conditions in the old machine building are not very good; while the new units are integrated within a container with automatic temperature control.

PICTURES, will be inserted in final version of the evaluation report

The evaluators had a positive impression of JBC and the plant site. The place is clean and well-kept and the installations are in good condition. There is a small office, which looks tidy and organized. The system for receiving solid organic waste (from hotels) gave the impression that it had not been used for some days or weeks. This coincides with the fact that the digester is now mainly fed with liquid organic waste from slaughterhouses, which is directly pumped into the digester from the truck. Since the digester is not operated at full load, the pre-storage tank and the tank for the solid residue are not used either. The remaining residue (originally to be used for producing fertilizer) is spread over the landfill area.

The wells are in good condition and frequently checked by JBC staff. Each well is protected by a concrete box covered with a steel plate; the box is locked with a padlock. As one technician explained, *"neighbouring people do not understand the purpose of the plant and damaged the wells"*. Since Ruseifah is an old phosphate mine with heavy traffic and the town is much larger than ten years ago, there are many annoyances for the local people.

A detailed assessment of the technical performance and functioning of the biogas plant is outside the



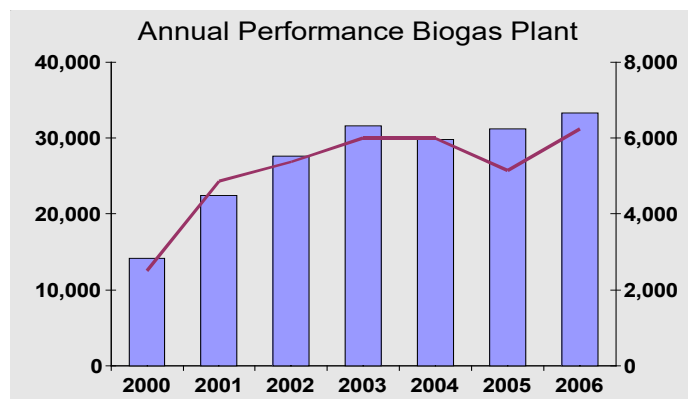
scope of this final evaluation. The evaluators have collected output and input data over the period 2000-2006 from JBC and calculated the plant performance. The results are compared with the expectations as described in the Project Document, and with the indicators.

The amount and quality of the data received from JBC falls behind the expectations. Considering that the company is paid for the electricity it sells to CEGCO, the evaluation team asked for metered data, readings of biogas production, and statements made by auditors that such volumes of electricity have indeed been produced and sold. Instead, only a table compiled by JBC was submitted with yearly data at the highest aggregated level. As a result, the evaluators have not been able to verify whether the stated amounts of electricity have actually been produced. The calculations based on the received data however, appear to be consistent and are in fair agreement with the expected values. For proper performance monitoring<sup>14</sup>, the original data should be verified by external auditors.

The following TABLE summarizes some key performance data of the biogas plant over the period 2003-2006 and during the year 2005, in comparison with the target values set forth in the Project Document.

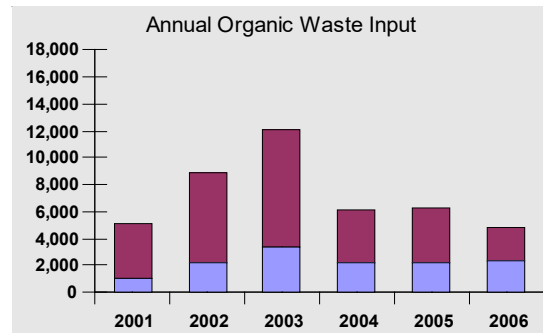
	CH4 contents biogas (%)	CH4 production (m3/yr)	nett electricity generated (MWh/yr)	Conversion efficiency (kWh/m3 CH4)	avoided GHG release by CH4 capture (tons CO2eq/yr)	amount of liquid and solid waste treated in digester (tons/day)
Achieved	58%	2,090,663	5,844	2.80	31,470	20.0
Expected	67%	1,899,300	5,552	2.92	40,000	60.0
2005 value	58%	2,070,510	5,142	2.48	31,167	17.1

The electricity volume produced (in Mwh/yr) and the associated avoided emissions of methane in tons of CO2-equivalent per year) over the period 2000-2006, are presented in the following FIGURE. As one can see, the quantitative objectives regarding electricity production and CH4-abatement have nearly been achieved.



14 As well as for monitoring CO2-savings, for example if JBC wishes to sell emission reduction certificates.

The last FIGURE shows the amounts of organic waste (both liquid and solid) that is fed into the digester.



It is clear that JBC has not been able to collect the anticipated 60 tons of organic waste per day (18,000 tons/yr). After reaching a peak in 2003, the waste input has now stabilized around 1/3 of the target value. The electricity production is more or less in line with the expectations because the landfill site produces sufficient biogas to compensate for the low gas production in the digester.

With the additional 84 wells now in place, the volume of landfill gas captured will be sufficient to feed the presently installed 3.5 MW generator capacity, with only a fraction of the biogas being produced by the digester. Since the latter represents the largest share of the capital investment, involves manual waste handling and costly transport (which is provided by GAM “for free”), it would not be continued by JBC on the longer term if production costs were the leading business principle.

Other comments received by the evaluators regard the quality of the waste feedstock. As an example, waste from slaughterhouses sometimes contains traces of antibiotics, which kill the bacteria in the digester and eventually may stop the biological process in the digester. Many sources of organic waste proved to be unsuitable and therefore, JBC finally opted for making agreements with a few selected, more or less stable, providers of organic waste. One lesson learned by this project is that the hypothesis that biodigester technology can be applied for processing a significant share of Amman's municipal organic waste, does not hold<sup>15</sup>. The agreements between JBC and the suppliers of waste are informal; as far as understood by the evaluators, the suppliers do not have any liability for the quality of the feedstock; nor does GAM guarantee the transport of the waste from the source to the digester. By consequence, the operation of the biodigester is exposed to high risks.

JBC did not manage to produce fertilizer of an acceptable quality from the digester residue. The sales of fertilizer was expected to provide a considerable cash flow, necessary to operate the digester on a commercial basis. Also in this aspect, there are important differences with the biodigester paradigm that was taken from Europe. First, digestors in Europe usually operate close to the source (farm land) and the

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15 This aspect was underestimated during the project design. Biodigester technology in advanced countries is usually tuned to a specific and controlled source of waste (for example intensive cattle farms and greenhouses); it is not suitable for generic organic waste processing.

fertilizer is spread on the land afterwards, which guarantees a closed minerals and nutrients cycle. Second, the environment in Jordan suffers from very high levels of salinity, which inevitably are found back in the residue. This circumstance imposes great difficulties for JBC and no progress has been made. The problem was already identified during the mid-term evaluation; the suggestion was made to collaborate with universities to solve the issue. The fertilizer issue absorbs valuable company resources that can be used more effectively in other areas. The fertilizer issue is too difficult to be solved by JBC and it is unlikely that it a competitive product will come out. In the opinion of the evaluators, the fertilizer component should not have been included in the project design.

### **Curriculum building and biogas laboratory at JUST University**

The capacity building component "Introducing Biogas Technology Concepts into University Curriculum" was executed by Jordan University of Science and Technology (JUST) during 2004 and 2005. The activities carried out are well described in the final report [13]. On August 26, a visit was paid to the University in Irbid. The evaluators conclude that all programmed activities have been carried out very satisfactorily and the university is eager to continue working in the field of biogas technology. The following outputs have been delivered by JUST:

- Biogas technology has been integrated in three different courses (undergraduates); the courses included a site visit to the Ruseifah biogas plant;
- Three Master Degree students have conducted a thesis in the field of biogas;
- Staff from JUST University has made visits to research centres in Germany, Sweden and China;
- The establishment of a biogas laboratory; and
- Three workshops were conducted to present the achievements to a broad public (students and staff, municipalities, ministries, NGO's, etc.).

The UNDP project has provided financial inputs for JUST to purchase research equipment for biogas technology; amounting to approx. \$ 60,000.-. The central unit of the laboratory is a small digester that can operate under aerobic as well as anearobic conditions. Ambient conditions, such as temperature, pH and pressure are controlled by a microprocessor system. This unit enables JUST to understand and characterize different biological digester processes. A second device is the bomb calorimeter, useful to determine the heat content of organic waste samples (or other organic material, such a dung or olive press cake). The third unit acquired is a portable gas analyzer. The university uses the laboratory for research purposes but also offers services to third parties against payment. Prior to the UNDP project, there were no facilities in Jordan for biophysical analysis in the field of biogas technology.

The JUST staff considers the low-cost technology developed and applied in China as very promising for implementation in the rural areas in Jordan. In November 2005, a one-week visit was made to the Biogas Research and Training Centre (BRTC) in Chengdu, which was established with UNDP support for disseminating biogas technology in Asia and the Pacific.

PICTURES, will be inserted in final version of the evaluation report

#### **4.5 Rating of the project indicators**

As described in section 3.4, the project structure was redrafted in the course of 2004 using the logical framework approach in order to distinguish the separate objective-outcome-output levels in line with the new APR/PIR formats for annual reporting. The evaluators have not found evidence of formal approval of this modification by UNDP/GEF but assume that such has been done with mutual consent.

For the purpose of this evaluation, it is adhered to this new structure, as it is more compact than the original framework given in the Project Document, and to enable a comparison of this final evaluation with the latest APR/PIR's/. In the next section, a qualitative assessment is given of the achievement of the project objectives as originally stated in the Project Document. In the new structure, the objective is defined as follows:

Objective: “reduce biodegradable waste accumulation in Jordan, thereby improving Jordan's environment while at the same time reducing the dependency of oil imports.”

Three indicators control the expected environmental impacts:

- Indicator 1: Renewable energy power generation capacity of 1 MW with annual output of 7.2MW;
- Indicator 2: Total reduction of CH<sub>4</sub> emissions by 40,000 tons of CO<sub>2</sub>eq per year by treatment of 18,000 tons of organic waste in Jordan; and
- Indicator 3: Substitution of 1,910 tons of diesel oil annually.

Four indicators are provided related linked to the financial sustainability (of the pilot plant) and replication, to assess the development objective:

- Indicator 4: The pilot plant is generating annual income from sale of electricity and fertilizers at an estimated value of \$175,000, thereby facilitating the sustainable operation of the plant and the possibility to finance and organize periodic training programmes during and after the end of the project;
- Indicator 5: Establishment of fertilizer markets in Jordan;
- Indicator 6: Establishing at least 5 replicable biogas projects to reduce GHG emissions, convert organic waste to fertilizer and to recycle materials; and
- Indicator 7: Government incentives offered to producers of renewable energy.

At the level of project results, there are only two components (outcomes) defined:

Outcome 1: “Successful commissioning and continuing operation of the first pilot plant.”

Four indicators are given to track the progressive achievement of the pilot installation in Outcome 1:

- Indicator 1.1: The construction and commissioning of the first pilot plant completed successfully;

- Indicator 1.2: The biological process in the biogas reactor for CH<sub>4</sub> production started;
- Indicator 1.3: Adequate supply of organic waste to the plant ensured; and
- Indicator 1.4: Expansion plan for the pilot plant is being introduced (or implemented).

*Outcome 2: "An improved basis for an enabling environment which lends itself to institutional security for the demonstration biogas plant and to national planning for bioenergy in Jordan and enhanced capability of the Jordanian people to manage and convert their municipal waste to energy in a sustainable manner."*

The outcome 2 is composed by the original immediate objectives 2 and 3. The following five indicators are defined:

- Indicator 2.1: Operating budget of the plant ensures its sustainable operation;
- Indicator 2.2: Successful take-over of the operation and management of the combined landfill and biogas plant by national staff;
- Indicator 2.3: A National Plan for further expansion of this technology through replication initiatives developed;
- Indicator 2.4: The targeted awareness raising, training and capacity building activities financed by the initial TA component of the GEF project completed; and
- Indicator 2.5: The targeted awareness raising, training and capacity building activities financed by the revenues of the pilot plant under implementation.

The evaluation team has analyzed the given indicators and conclude the following:

- The environmental indicators (1-3) are measurable, specific and time-bound. They are appropriate and verifiable. The target of 7,200 MWh/yr set forth appears to be not consistent with the target for CH<sub>4</sub>-production at the estimated conversion efficiency<sup>16</sup>. The corresponding value would be 5,500 MWh/yr. Regarding the corresponding amount of fuel saved, it is observed that this cannot be verified since a methodology for defining the baseline was not included in the Project Document<sup>17</sup>.
- The development indicators (4-7) are considered of limited use because the project did not deploy targeted activities to address these elements. With respect to indicator 4 (profit generated by JBC), it is concluded that this indicator is measurable and specific; however, the figure does not provide useful information as long as its context is not understood.
- The outcome indicators (1.1-1.4), related to the pilot plant are considered appropriate and measurable and verifiable by visiting the plant. The indicators are not suitable for assessing the long-term operation and sustainability of the plant and of JBC.
- The outcome indicators (2.1-2.5) related to capacity building and information are considered of limited use. The indicators 2.1 and 2.2 will be included in an assessment of the operation and sustainability of the plant and of JBC under outcome 1. The indicators 2.3-5 are qualitative and considered inappropriate to assess the achievement of outcome 2.

The given indicators provide the framework for assessing the project at the level of objectives and

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<sup>16</sup> Explain this...

<sup>17</sup> Comparing the baseline situation in 1996 and 2006, it is observed that Jordan nowadays imports large amount of natural gas from Egypt, reducing the share of oil in the country's energy mix for electricity production.

outcomes. The following table gives the achievements of the project per indicator. The indicators 3 and 2.5 have not been evaluated due to a lack of input information. The stated end-of-project values are for the year 2005. Besides giving the results for each indicator, the evaluators have rated the project performance per indicator according to the scale HS/S/MS/U<sup>18</sup>.

The indicators 3 and 2.5 have not been rated since they could not be evaluated. The indicators 5, 6, 7 have not been rated, basically because the project design did not include the necessary activities for achieving the pursued results. The evaluators consider that a lack of achievement on these indicators is not a matter of underperformance but rather the consequence of a lack of focus in the project design.

<b>Achievement and rating of project results</b>					
<b>Objective</b>					
<i>The project will reduce biodegradable waste accumulation in Jordan, thereby improving Jordan's environment and reducing emissions of GHG while at the same time reducing the dependency on oil imports</i>					
Indicator	Result (2005 value)	Remarks	Means of Verification	Rating	
1	1 MW installed generator capacity	1 MWe	JBC records	HS	
	7,200 MWh/yr electricity generated	5,142 MWh	JBC records	S	
2	40,000 tons CO2/yr reduced	32,000 CO2eq	calculated	S	
	18,000 tons/yr organic waste treated	6,234 tons	JBC records	MS	
3	1,910 tons/yr diesel replaced	not evaluated	no verifiable baseline	not rated	
4	annual revenues JBC of \$175,000	\$167,411	JBC records	MS	
5	establishment of fertilizer markets	failed	beyond reach of project	project files	not rated
6	establish 5 replicable biogas plants	failed	no barrier removal strategy included	project files	not rated
7	Government incentives for RE	failed	ad-hoc tax exemption for JBC; not targeted	JBC records, interviews	not rated
<b>Outcome 1</b>					
<i>Successful commissioning and continuing operation of the first pilot plant</i>					
Indicator	Result (2005 value)	Remarks	Means of Verification	Rating	
1.1	Construction and commissioning pilot plant	plant in place	project files, visual inspection	HS	
1.2	Biological process in the reactor started	achieved	mesophilic instead of thermophilic	project files	HS
1.3	Adequate supply of organic waste ensured	achieved	20 tons/day instead of 60	JBC records	S
1.4	Expansion plan for the pilot plant implemented	2.5 MWe additional capacity installed		Phase II documents, visual inspection	HS
<b>Outcome 2</b>					
<i>An improved basis for an enabling environment, which lends itself to institutional security for the demo biogas plant and to national planning for bioenergy in Jordan and enhanced capacity of the Jordanian people to manage and convert municipal waste to energy in a sustainable manner</i>					
Indicator	Result (2005 value)	Remarks	Means of Verification	Rating	
2.1	Operating budget of the plant ensures its sustainable operation	budget value	bad indicator logic	JBC records	S
2.2	Successful take-over of the plant by national staff	achieved	operational problems	JBC records plus interviews	HS
2.3	National Plan for expansion through replication initiatives developed	achieved	indicator not SMART	document produced	S
2.4	Awareness raising, training and capacity building activities financed by the initial TA component of the GEF project completed	achieved	indicator not SMART (activity level)	project products	S
2.5	Awareness raising, training and capacity building activities financed by the revenues of the pilot plant	not evaluated	indicator not SMART (activity level) and inappropriate	no evidence	not rated

18 HS: Highly satisfactory / S: Satisfactory / MS: Marginally satisfactory / U: Unsatisfactory.

#### 4.6 Qualitative assesment of project achievements

In this section, a narrative assessment is given of the achievement of the original project objectives as given in the Project Document. This immediate objective was three-fold (see section 3.3):

- *“An overall controlled treatment of 18,300 tones of municipal waste per year, subsequently reducing methane (CH<sub>4</sub>) emissions into the atmosphere by 1,540 tones annually as well as a reduction of CO<sub>2</sub> emissions by 5,950 tones annually through the utilization of the methane content of the biogas produced from the waste for replacement of fossil fuel.”*

From the data provided by JBC, it is concluded that the production of biogas has not been achieved through the collection of municipal solid waste (MSW) but through the capture of landfill gas, which was higher than expected. As a result the expected CO<sub>2</sub> emission reductions could be achieved. An important lesson learned is, that biodigester technology is not a substitute to replace open landfills for generic waste disposal. Only selected feedstock with a specific composition can be used, which cannot be retrieved easily from unseparated MSW.

- *“An improved basis for an enabling environment which lends itself to institutional security for the demonstration biogas plant and to national planning for bioenergy in Jordan.”*

The UNDP/GEF Jordan biogas project is one initiative in a range of efforts to promote biogas and waste management in Jordan. However, no enabling environment is currently in place, not for integrated waste management and not for bioenergy. There is no institutional security for the demonstration biogas plant. From the interviews with stakeholders it is concluded that a regulatory framework regarding waste disposal, landfill management and biogas production, is not in place yet. The Ministry of Environment was created in 2003 and environmental legislation is still very weak. MEMR has demonstrated a clear interest in renewable energies, but biogas from waste is not part of its competence. Greater Amman Municipality is presently the strongest public actor to push biogas technology based on landfill gas.

It is further concluded that the institutional basis for JBC is still very weak and little has been done by the project to improve it. After the company started operations (2000-2001), it has operated the plant, solved operational issues and tried to find a solution for the fertilizer problem. The evaluators have not found evidence of progress in a sense of business model and mandate. Currently, Jordan Biogas Company acts as the host for the demonstration biogas plant but it does not generate the necessary resources to secure its operation over a length of years. This especially holds true for the biodigester, which is operated at 1/3 of its nominal capacity. JBC has no security regarding the quality of organic waste feedstock; while transport is only secured as long as GAM is willing and able to arrange for the waste transport. The current mode of operation cannot be considered as a replicable business model. In the opinion of the evaluators, it is a missed chance that GAM, CEGCO, JBC and UNDP have not elaborated a detailed model during the second part of the project (2002-2005). At a higher level, structural government incentives for renewable energies have not been implemented.

The project has successfully created training and research capacity within the Jordan University of Science and Technology (JUST). The university has established working relations with institutes abroad and looks forward to develop and implement small-scale biodigestors for household use (mainly for rural

areas). This is a valuable outcome with important potential for follow-up and a large numbers of beneficiaries.

- “An enhanced capability of the Jordanian people to manage and convert their municipal waste to energy in a sustainable manner in order to prevent rapid landfill growth and greenhouse gas emissions and to reduce the dependency on oil imports for energy production.”

The UNDP/GEF project has contributed to putting waste management on the national agenda. As observed during the interviews, Jordan authorities are now more aware about alternatives to open landfill, such as sanitary landfill with plastic lining and coverage, leachate control, waste prevention, recycling and incineration of organic waste. While the Ruseifah landfill site has been covered, the new Al Ghabawi site is a controlled landfill divided in nine cells. Notwithstanding, technical problems also exist in Al Ghabawi and GAM and JBC are still learning how to manage a sanitary landfill. Investment capital is also needed for vehicles, pumping systems, piping and cover material. In Ruseifah, covering the landfill and capturing the gas did not eliminate all environmental problems: underground diffusion of methane gas still occurs; leachate flows still contaminate aquifers. GAM and the Ministry of Environment are aware of this situation and recognize the need for further improvement. There are also other annoyances for the people living near the site, such as the heavy traffic.

It is further concluded that the role of biogas as a fuel saver for the national electricity sector, is small<sup>19</sup>. The potential of landfill gas production is relatively small compared to the national energy demand. Biogas technology in addition needs a secure flow of feedstock, which is difficult to achieve in a centralized unit for MSW as in Ruseifah. It is therefore concluded that biogas production has a negligible impact on Jordan's dependency on imported fossil fuels.

In the following table, the evaluation team has rated the Jordan biogas project on key aspects for implementation, following the UNDP/GEF guidelines.

<b>Summary Project Achievements</b>		
<b>Description</b>	<b>Rating<sup>20</sup></b>	<b>Observations</b>
Impact generation	HS	The project was highly visible and has contributed to a change in waste management in Amman.
Outcome (expected end-of-project state)	S	The project has generated the envisaged outputs and most of the the expected outcomes.
Sustainability of project outcomes	MS	The sustainability of JBC is still weak.
Replicability	S	The project has generated useful lessons for replication. The model demonstrated by the project is not directly replicable.

19 In industrialized countries, electricity production from landfill gas is not more than 1-2% of the total installed generating capacity.

20 Using the scale HS/S/MS/US as given in footnote 1.



Monitoring & evaluation (M&E) procedures	S	The project included standard producers for M&E.
Implementation approach	US	Project preparation, institutional arrangements and negotiation with stakeholders was unsatisfactory, leading to large delay and confusion. Project components were also not mutually supportive.
Stakeholder participation	MS	Stakeholders were generally committed to their tasks; high-level commitment was weak.

#### 4.7 Assessment of the expected benefits

The Project Document gives a list of the beneficiaries that are targeted by the project and specifies the expected benefits of the project for each of them. In this section, it is assessed to what extent the targeted beneficiaries and benefits have effectively been achieved.

- The general population of Jordan: *“The waste treatment plant will produce electricity at a competitive price.”*

The installed biogas-based capacity is negligible (1 MW<sup>21</sup> on a total of 2,000 MW) and the capacity for landfill gas in Jordan is unlikely to become more than, say, 50 MW in the next decade. There is no evidence that electricity from landfill gas in Jordan is produced at a competitive price. Without granting an additional value for CH<sub>4</sub> capture (through CDM for instance) and for absorbing organic waste, it is very unlikely to become competitive with large thermal power plants. It is concluded that the expected benefit has not been reached.

- The general population of the city of Amman: *“The completed bioenergy plant will collect, receive and dispose of Amman's organic waste, thus improving the living standard of the city dwellers and improving the general economy of waste disposal in the city to the benefit of both the population and industry.”*

The evaluators conclude that the bioenergy plant has a negligible impact on the living standards of city dwellers. There is no evidence that the existence of the plant improves the economy of waste disposal in the city. Instead, the investment and operating costs of the bioenergy plants are higher than those of a sanitary landfill, which may explain why Al Ghabawi is set-up as a sanitary landfill. The UNDP/GEF project has contributed to a long-term development process in Jordan that will lead to more rational and environmentally sound waste management, which, in the longer term, will be beneficial for the general economy and the quality of life in Amman and in Jordan.

- The Ministry of Energy, GAM and NEPCO: *“The construction and operation of this bioenergy plant will be a success in development and cooperation for the various governmental bodies*

21 Under Phase-2, the capacity has been expanded to 3.5 MW.

*involved.”*

GAM and NEPCO (now CEGCO) are each 50% shareholders of the Jordan Biogas Company. It is unclear whether the project has acted as a catalyst for both to join. Apart from this result, there is no evidence that any cooperation among governmental bodies has been achieved. Instead, the interviewed stakeholders stated that cooperation and coordination was minimal. The evaluators observe that institution building has not been taken seriously in the conceptualization, negotiation and execution of the project.

- The Jordan University of Science and Technology (JUST)<sup>22</sup>: *“Will be major recipients of training and analytical/educational materials in their capacity as consultants to the bioenergy plant and in their role as the Jordan scientific center of biogas-process evaluation for replicable projects.”*

It is concluded that the academic sector has been successfully reached.

- Environmental NGOs: *“Will benefit from training and from involvement in public outreach activities.”*

It is concluded that environmental NGOs<sup>23</sup> have benefitted directly from this project and through their work, a large number of groups in Jordan have been reached. The project has further linked with several GEF Small Grants projects.

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<sup>22</sup> Originally this role was given to the University of Jordan's Dept. of Civil Engineering and Dept of Microbial Biotechnology.

<sup>23</sup> The main non-governmental organization reached by the project (and involved in executing several activities) was the Jordan Environment Society (JES).

## **5. Conclusions and Recommendations**

1. As a general conclusion, all the activities programmed under the Jordan biogas project activities have been executed successfully; however, the project took eight years to complete instead of three. The people who were directly involved in executing the project were dedicated and worked hard to make it a success. At a higher level, the evaluation team did not observe strong stakeholder commitment. It is therefore concluded that one of the broader objectives of the project (i.e. to improve the coordination among the relevant governmental entities, in particular MOPIC, MEMR and the Ministry of Environment) has not been achieved.
2. The UNDP/GEF biogas project has put solid waste management on the agenda in Jordan and in the region. The project has obtained positive exposure in the media and received visitors from all over the world. The project has shown people and authorities in the region that there exist alternatives to open landfill dumping. The project has certainly contributed to inducing a transition in Amman towards more advanced waste management. Open landfills such as Ruseifah are now closed; the new Al Ghabawi site is covered and divided in cells, while measures have been taken to prevent contamination of ground water. A privately-run recycling facility is under construction at this site; methane capture technologies are under investigation and will likely be proposed under the Clean Development Mechanism.
3. Outside Amman, open landfill dumping is still the common standard. The environmental problems at the landfill in Irbid are similar to those in Ruseifah ten years ago. The biogas project did not directly address replication of improved waste management in Jordan, it did establish a clear example that things could be done in a better way. It is concluded that a number of barriers are still in place that prevent other municipalities from cleaning up open landfill sites. These barriers are likely a combination of local priorities, a lack of national environmental regulation and a lack of investment capital. The evaluation team has identified the Greater Amman Municipality as the strongest actor to promote rational waste management in Jordan; JBC can be instrumental in such a replication campaign.
4. The project has generated valuable human capacity in Jordan. It has trained technicians within the Jordan Biogas Company on the operation of a complex biogas plant, on biodigester and landfill technology and on many aspects of (organic) waste management. The project has integrated biogas technology within the curriculum at JUST University and has set up a research laboratory.
5. The project nearly achieved the projected emission reductions (31,000 of the expected 40,000 tons CO<sub>2</sub>eq/yr) by capturing landfill gas for electricity generation. Covering the Ruseifah site was done by GAM and would also have been done without this project, but the UNDP project can have accelerated the decision-making process. From the interviews, it is concluded that many environmental problems still exist at Ruseifah and GAM and the Ministry of Environment are aware of this situation. Covering the site, capturing the methane and using it as an energy resource however, has been a large step forward.
6. JBC has not been able to secure a stable supply of adequate organic waste as feedstock for the biodigester. The daily supply of organic waste is only 20 tons, which is 1/3 of the nominal value.

The waste is obtained from selected sources (hotels and slaughterhouses) because the biological process in the digester is very sensitive to the quality and composition of the waste input. The evaluation team is convinced that it is a very difficult task for JBC to collect the anticipated daily 60 tons of waste. Biodigester technology can therefore not be considered as a substitute to replace open landfills for organic waste disposal. It was also not possible to produce fertilizer of an acceptable quality from the digester residue. The environment in Jordan suffers from very high levels of salinity, which inevitably are found back in the residue. This problem was already identified during the mid-term evaluation.

7. By analyzing the programmed activities, the evaluation team concludes that the Jordan biogas project was not targeted at full barrier removal in order to establish an enabling environment for replication. The project was rather a demonstration project with a dissemination component, that was implemented on top of an environmental "hot spot". The project has generated valuable results, but did not reach the defined -but too ambitious- replication goals. Given the incipient environmental legislation and insufficient coordination within the government, the evaluators are convinced that in 1996 time was not ready for a systematic barrier removal approach. The selection of the Jordan biogas project by UNDP/GEF is therefore considered as opportune and timely.
8. The institutional and commercial basis for JBC is still weak and the evaluation team concludes that little has been done by the project to improve it. After the company started operations (2000-2001), it has operated the plant, solved operational issues and tried to find a solution for the fertilizer problem; there is no evidence of progress towards a sound and replicable business model. Currently, JBC does not generate the necessary resources to secure its operation over a length of years. Meanwhile, it is operating the biodigester (at 1/3 of the nominal capacity) to produce biogas at a higher cost than the available landfill gas. This situation is not sustainable from a perspective of minimizing operational costs. Also the quality and transport of the waste feedstock is not secured. It is a missed opportunity that GAM, CEGCO, JBC and UNDP have not elaborated a detailed business model for replication during the second part of the project (2002-2005). At a higher level, the envisaged government incentives for renewable energies in Jordan have not yet been implemented.
9. The evaluation team found that the project design was rather weak and that the individual components were not mutually supportive. According to the local stakeholders, the project was not negotiated and coordinated with the executing partners prior to commencing. The project components did not address sustainability and replicability. For a technological pilot project, there was no test or research hypothesis. There was no critical route defined and no serious assessment of the risks and assumptions was made during the project conceptualization phase. A reorientation on the project's strategy and objectives after the mid-term evaluation could have helped to define a successful exit strategy to consolidate the outcomes generated by the project. Continuous backstopping (instead of isolated expert visits) could have provided UNDP and JBC with the specific expertise to make the appropriate judgements.

#### General recommendations:

1. A solid institutional and commercial basis is needed for JBC and its staff to safeguard the

capacity built up during the project. This requires the development of a viable business plan, revision of the company structure, adequate structuring of assets and operational activities, a reinvestment and insurance plan; an expansion plan for disseminating the technology while broadening the working area for the company in Jordan and abroad; and incentives for the staff, possibly performance-based.

2. Municipal and government incentives will be needed to support the long-term exploitation of the Ruseifah biogas plant. Such incentives can reflect the avoided costs related to waste mitigation by JBC, while additional rewards may be applied to sustain electricity generation based on biogas. In a long-term national strategy, such incentives may be recovered by levying waste production and consumption.
3. Although fertilizer production is apparently not a viable option, CDM may provide an additional revenue stream for landfill gas, compared to the open landfill baseline. Small-scale biogas projects may be clustered and submitted for CDM as well. In order to benefit from CDM, landfills should be better managed and controlled than currently attainable in Jordan. Data recording as under this UNDP/GEF project should improve drastically and include proper means of verification and monitoring.

#### Specific recommendations for UNDP:

The evaluation team has prepared and discussed specific recommendations and actions for follow-up by UNDP. The full text and suggested work plan is included in Annex H; below the recommendations are summarized:

4. It is recommended to secure the results of the project, specifically the Jordan Biogas Company, which is an urgent issue. A possibility is to organize JBC in separate entities for holding the assets (equipment); for operating them; and for providing services and consultancy. It is suggested to UNDP to obtain commitment from JBC's shareholders to develop a sound business plan and carry out a detailed analysis of the financial viability for each component (assets, operation, services). This can possibly be done within the context of the ongoing Phase 2. The evaluators do not have recommendations regarding the legal structure and ownership of JBC.
5. It is recommended to link JBC with other landfill initiatives in Jordan and the region to enhance to stimulate replication. JBC's competences can be applied elsewhere; however, (some of the) staff is still considered as GAM staff and assists in activities outside JBC without generating income for the company. This situation makes it difficult to assess the operational costs of JBC and to train personnel in a targeted way. It is suggested to UNDP to show GAM and CEGCO that the provision of operational and consultancy services to third parties represent a business opportunity and to obtain their commitment. This element can then be integrated into JBC's business plan and should include a detailed human resources development plan.
6. Finally, it is recommended to UNDP to explore the possibilities to link JUST university with initiatives in Jordan to apply small biodigestors for rural families and farmers. This would enhance the project's results and open up the potential for replication among a new group of beneficiaries. It is suggested to UNDP to meet with JUST to review how biogas can be instrumental for rural area development and to identify potential partners.

## **6. Lessons learned**

The evaluation team has identified the following lessons that can be drawn from the Jordan biogas project:

1. The hypothesis that biodigester technology can be applied for centralized processing of large amounts of municipal organic waste, does not hold for a city like Amman. The technology is sensitive to the type and composition of the waste feedstock and a stable supply of high-quality municipal waste cannot be secured. Jordan Biogas Company has therefore entered into agreements with selected industrial suppliers, providing about 1/3 of the expected input. The combination of a biodigester and a landfill is therefore not the logical choice as suggested in the Project Document; the project has not provided a basis for replication of this combination elsewhere. Separately, both technologies have potential in Jordan: landfill gas can be used for energy generation at sites such as Al Ghabawi; biodigester technology can be used for treatment of organic waste, near or at the source.
2. Fertilizer production from organic waste proved to be very difficult. Salinity levels in the environment in Jordan are high, and high salt concentrations are found back in any source of organic waste (even animal residues and blood from slaughterhouses). This issue was not considered during the design phase of the project. Although JBC tried to produce fertilizer of acceptable quality, it should have been recognized that neither JBC nor the project was prepared for tackling such a complex, high-technological problem. The first lesson drawn from this issue is the complexity of developing new products should never be underestimated.
3. The second lesson drawn is, that project partners should effectively use the mid-term evaluation as a reorientation on the propositions and strategy of a project and the underlying assumptions. If things do not work, this should be recognized and dealt with, since valuable project resources may be applied more efficiently elsewhere in the project to achieve the long-term objectives. Monitoring and evaluation can only produce appropriate feedback if based on professional expertise; for this kind of projects, such expertise is generally not available within the host country nor within UNDP/GEF. Backstopping by international experts can assist UNDP and local stakeholders in making correct judgments, especially in technological and investment projects which require detailed and sector-specific knowledge. UNDP should use its comparative advantages as a mediator for channeling resources (through GEF) and its capacity to bring together high- and lower-level stakeholders. The delivery of reports and studies alone is not enough to provide such backstopping, which has been demonstrated during this project.
4. The project has shown that biodigester technology cannot be simply transferred from Europe to Jordan; the technical implications that might arise were not considered during project setup and not identified as a risk. As a result, local staff later had to deal with the complications later on. Transfer of technology is never straightforward and therefore in a pilot project there should always be a hypothesis to be tested. In this project, such a hypothesis was not defined. What needed to be verified through this pilot and what was the expected end state? The technology, or the business (delivery) model for replication? Since there was no test programme prepared, emerging issues could not be addressed systematically. By consequence, at present there is still

no viable, replicable business model and several technical issues remain unsolved<sup>24</sup>. The most important lesson that can be drawn is, that UNDP/GEF should carefully prepare future pilots and do one thing at a time. Demonstration of a technology and creating conditions for replication may be linked, but should not be targeted in one and the same project.

5. The problems related to the implementation of the project and the roles of the stakeholders clearly illustrate that UNDP and its partners should carefully institutionalize a project before starting, negotiate it with the stakeholders and agree upon each other's role. The project should set up of a professional Project Management Unit financed by the project. The PMU should preferably not be part of the government's in-kind contribution in order to create a sufficient level of autonomy for the project. Another lesson that can be drawn is that stakeholders cannot simply be “added” to create a broad basis for a project. A suitable procedure is to first identify precisely the natural interests which potential stakeholders may have in common; if such common interests cannot be identified, the stakeholder should be left out of the project (or the project strategy should be adjusted accordingly, if possible). Stakeholders who do not see their own interests reflected in a project, do not broaden the basis but will turn out to be an obstacle for decision-making and implementation.
6. A final lesson can be drawn from the quality of the project files held by UNDP, which was below generally accepted business standards. With frequently changing and rotating staff within the UNDP system, the accessibility and transferability of project files is of utmost importance. Subsequent programme officers will lose track of complex projects and the project information will degrade over time. UNDP should implement appropriate measures to maintain an adequate project administration, since it is responsible for holding all the information base at the end of a project and has a key role for monitoring the project. A database system<sup>25</sup>, accessible by UNDP, the project administrator and the UNDP/GEF regional office can be helpful for collecting and checking the data, correspondence and information produced during the course of a project. It can also be used for electronic reviewing of periodic progress reports. It was observed in several occasions that PIR's did not provide any useful information to assess the project's status, causing to delay in reporting and lengthy communications back and forth.

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24 Among others: water problems in the wells; the methane content in the produced biogas; the type of biological process in the digester; systematic study of the sensitivity of the process to different waste inputs.

25 Such a system could be based on Customer Relations Management software.

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- Country programme outline for Jordan (2003-2007), 5 August 2002 ([www.undp-jordan.org](http://www.undp-jordan.org));
- Project Inception Report;
- Project's APR/PIR (1998-2006); and
- Project Audit Reports (1998 - 2005).



## **Annex A Terms of Reference**

Will be inserted in final version of the evaluation report

## **Annex B Mission Agenda**

Will be inserted in final version of the evaluation report

## **Annex C List of Persons Interviewed**

Will be inserted in final version of the evaluation report

## **Annex D Summary of Field Visits**

Will be inserted in final version of the evaluation report

## **Annex E Original Project Institutional Set-up**

### **Special Consultative Committee (SCC)**

*A Special Consultative Committee (SCC) will be established under this project. The SCC’s main responsibility is to assist with the information exchange, coordination and training aspects of this project. (...) The SCC will be chaired by MEMR. UNDP will also participate in all SCC meetings. Members are:*

- *Ministry of Planning;*
- *Ministry of Energy and Mineral Resources;*
- *National Electric Power Company (NEPCO);*
- *Greater Amman Municipality (GAM);*
- *General Corporation for Environment Protection (GCEP);*
- *Jordan Environment Society (JES); and*
- *Queen Alia Fund (QAF).*

*The Special Consultative Committee will follow the plant operation and will further have the responsibility to advise on the allocation of the USD 100,000 generated annually as part of the income from the biogas plant. This sum will be used for training purposes. The above mentioned committee will have over-all advisory responsibility for the promotion of biogas technology in Jordan.*

### **Contractors**

*(Because) biogas technology is new in Jordan, two types of international advisors will be used. These advisors (henceforth referred to as Contractor 1 and Contractor 2) will be hired by the executing agency of the project using competitive bidding under Jordanian standard procedures in consultation with UNDP. The roles of Contractor 1 and Contractor 2 will be:*

#### *Contractor 1 (design and construction)*

*Responsibility regarding supply of material for the plant, provision of detailed design and construction drawings, construction, commissioning and guarantee of methane production for at least two year after commissioning.*

#### *Contractor 2 (training and education)*

*Responsible for the training and capacity building program. Contractor 2 will have access to a similar operating plant outside Jordan, where the practical training can be carried out. Contractor 1 and 2 could be the same company.*

### **Project Initiation Consultant**

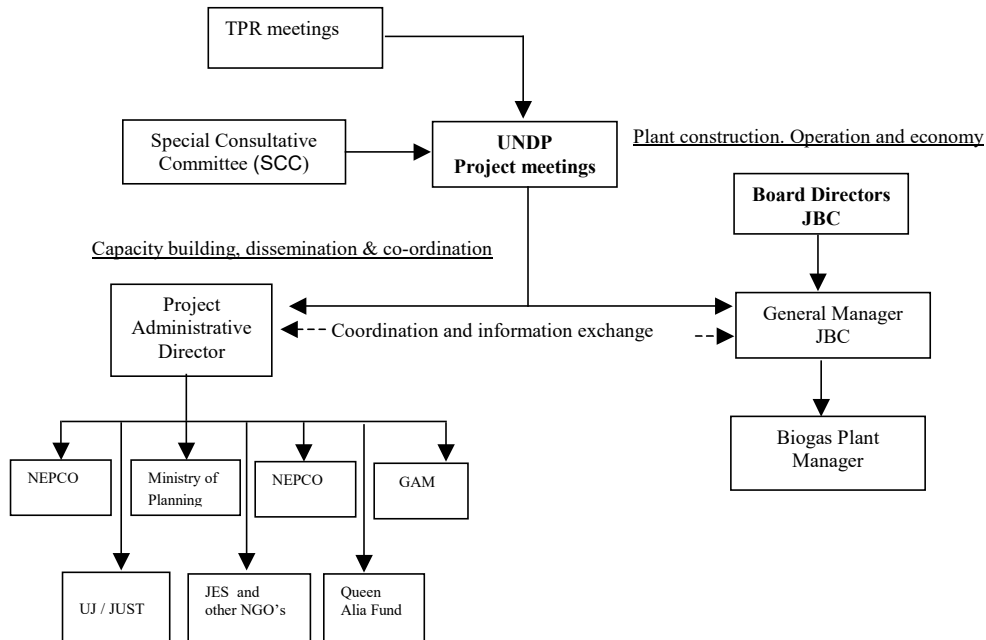
*The Project Initiation Consultant, in close consultation with JBCO, MOP and UNDP, will be responsible for tender preparation. The Project Initiation Consultant will further be present at the commissioning test to certify to UNDP and the Government that the plant performance and output comply with the specifications.*

### **Project Administrator<sup>26</sup>**

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26 Only referred to in Annex VIII of the Project Brief.

The overall implementation of the project will be overseen by an Administrative Director who will be appointed by the Government in consultation with UNDP. In matters concerning the capacity and information component of the project the Administrative Director will coordinate with and report to the SCC. On the other hand, in matters concerning the operation and construction of the biogas plant the Administrative Director will coordinate with and report to JBCO General Manager.



## Annex F Original Business Modality JBC

The envisaged business modality for Jordan Biogas Company is described in the Project Document:

A number of people will be employed by the JBCO and paid by the Government of Jordan as part of the Government contribution to the project. When the plant is fully operational, these staff will be remunerated from the income generated at the plant. The JBCO will operate under the following basic principles:

1. Economic and technical responsibility for the operation of the plant.
2. Annual presentation to the Special Consultative Committee (SCC) detailing the economic status of the plant as well as budgets for the coming two year period.
3. The income from the sale of electricity, methane and fertilizer will be used to cover the operation costs, i.e. salaries, maintenance, spare parts etc.
4. The profit will be used for expanding the plant and for promoting other replicable projects. However, part of the profit (estimated at USD 100,000 annually) will be transferred to cover an integrated training programme on a number of levels: education at the university; training in the public sector and on a commercial level in subjects related to methane release and utilization.

As part of the joint venture agreement, NEPCO has agreed to distribute the electricity and make the necessary electrical connections to the network and GAM has agreed to build the roads, fences and the foundation of the plant. NEPCO will pay an agreed rate for the electricity of 4.7 cents/kWh (rate paid by GAM). This rate will be negotiated annually as part of JBCO's general negotiation with NEPCO.

For the first 2 years of plant operation the value of fertilizer is set at zero, as this type of fertilizer is a new product in Jordan. After introduction on the market, a price per tone of 3-5 JD can be expected. This could add a potential annual income of 87,000 JD (corresponding to USD 125,000).

Based on these prices it will not be necessary to subsidize the plant once it is operating. The overall annual budget is projected as follows:

Annual expenditure:

Maintenance (3% of the cost of investment USD 2.5 million):	USD 75,000
Operation:	USD 50,000
Sundries:	USD 38,000
Total:	USD 163,000

Income:

Sale of 7.2 GWh of electricity at 4.7 cents =	USD 338,000
Gross profit	USD 175,000
Set aside for training purposes and replication	USD 100,000
Net profit	USD 75,000

In addition, income from the sale of fertilizer is expected after year 2.

## Annex G Observations by former SCC Members

During a meeting with the former members of the Steering Committee, they were invited to comment on two or three issues that, in their view, should have been dealt with more carefully. Below the literal transcription of the results:

1. *"This kind of projects suffers from mismanagement. I believe that more to attention (is needed) to the capacity building for the project management.*
2. *The circumstances of the project and liaison between the institutions are very weak.*
3. *The changes in the personal stakeholders affect the progress in the project."*
  
4. *"The capacity building shall be oriented to initiate new projects."*
5. *"Allocation of more funds for troubleshooting and maintenance of the plant, especially the technology is new and no sources of spare parts are available locally."*
6. *"Financial incentives and rewards are crucial to mobilize the staff of the project. These incentives could be on achievement basis."*
  
7. *"No measures was taken or ensured to be taken in future within this UNDP project to ensure the sustainability or replacitability of this project to other sites in Jordan."*
8. *"More incentives should be paid for the staff of this project."*
  
9. *"For the administrative director it is more efficient to provide him the work independently since can he spend 100% of his/her time for the project."*
10. *"Ministry of Planning was responsible for the monitoring and implementation of the project but the recommendations of the Master Plan was not implemented fully."*
  
11. *"Because different institutions in steering committee, may be very good idea to nominate a coordinator projects to deal with all arrangements between stakeholders and donors."*
12. *"Incentives very important."*
13. *"Nominate the stakeholder for all project life."*
14. *"Identification of all stakeholder responsibility."*
  
15. *"Have fixed responsibilities for project management, agencies & persons."*
16. *"Clearer duties and task description right from the beginning and better coordination between stakeholders."*
  
17. *"Focus more on applied research in biogas technology and in waste to energy in general."*
18. *"Think seriously in advance how to get rid of the plant residues (i.e. liquid and solid waste)."*
  
19. *"Work on reducing the paper work involved in buying equipment and make it faster."*
20. *"Improve personnel incentives in coordination...."*

In the last observation (20), the last part is omitted by the evaluators to safeguard anonymity.



The following table presents the results grouped in four classes. The classification is done by the evaluators.

Type of observation	No. observation	Frequency
Lack of coordination, assignment of roles & responsibilities	2, 10, 13, 14, 15, 16	6
Lack of sustainability	4, 5, 7, 17, 18	5
Need for incentives	6, 8, 12, 20	4
Mismanagement & lack of organization	1, 3, 9, 11, 19	5
	Total	20

Summarizing the evaluators draw the following conclusions:

- Lack of coordination assignment of roles & responsibilities (score 6/20): The project was not coordinated and not agreed upon at an operational level before commencing. Stakeholders' and peoples' responsibilities were not defined. The project did not address institution building.
- Lack of sustainability (score 5/20): The project did not address replication nor sustainability. The technical basis for the biogas plant is fragile. Technical issues were not well addressed and were not supportive for overall sustainability and replication.
- Need for incentives (score 4/20): People should be stimulated in order to make things work.
- Mismanagement & lack of organization (score 5/20): The project was badly prepared and organized and the situation did not really improve during the implementation of the project.

## **Annex H Specific recommendations for UNDP**

The Final Evaluation of the UNDP/GEF Project “Reduction of Methane Emissions and Utilisation of Municipal Waste for Energy in Amman, Jordan” was carried out for UNDP Jordan from 20 August – 04 September 2007. The Evaluation has generated, among other things, the following major conclusions and lessons learned:

### **Major Conclusions and Lessons:**

#### **Regarding to the (technical) project content:**

Biogas technology from Europe cannot simply be copied in Jordan.  
Biogas plants are not an alternative for large-scale MSW treatment in Jordan.  
The technological step-up from open landfill to sanitary landfill is not easy.  
Reliable biogas operation on landfill is only possible if they are well-managed.

#### **Regarding remaining barriers for replication of biogas technology for electricity generation:**

Policy and regulatory barriers still exist, but plans are under development; and  
Financial barriers still exist but there are also opportunities.

#### **Regarding the outcomes of the project:**

People with experience on biogas and landfill management are created in Jordan;  
Research facilities have been created in Jordan; and  
Academic staff and students have been trained on biogas technology.

### **Sustainability and Replicability**

It is further concluded that the targeted sustainability and replicability of the project's outcomes have not been fully achieved. To improve this situation, specific recommendations are given below linked to a set of actions that we suggest UNDP to follow up on. All actions are targeted at securing the outcomes of the project and enhancing the long-term impact and opportunities for replication. The suggested actions can be carried out within a time span of about 12 months. After this, UNDP can either:

decide to continue to be active in this area; or  
leave the project in the hands of the stakeholders.

The recommendations and actions can be interpreted as strengthening the project exit strategy and to adjust it to the current context. On the longer term, the proposed actions and results can feed into national policy and strategy development. Follow-up actions and recommendations regarding policy/regulation are

outside the scope of this project.

### **Specific Recommendations and Actions.**

#### **1. Secure the results of the project, specifically the Jordan Biogas Company (JBCo);**

**Status:** Urgent

**Goal:** Achieve Sustainability

**Problem description:** JBCo has an unclear mandate now and is doing many things at a time (holding assets, operating, learning and solving fertilizer problems). In addition, the assets are costly and not in relation to the revenue stream. This is often the case with “energy and infrastructure hardware”, moreover if it is donor-funded. Further the biodigester generates at a substantially higher cost than the landfill, which is not sustainable from the perspective of business economic.

The actual business model is not a valid showcase for replication and implies a direct risk for the survival of JBCo; since JBCo has started operation, little has been done on structuring its activities, on thinking about JBCo's future and integrating everything into a larger plan. A possibility is to organize JBCo in separate entities for holding the assets (equipment); for operating them; and for providing services and consultancy. The Evaluators do not have any recommendation regarding the legal structure and ownership (public/private) of JBCo.

#### **Proposed actions:**

- Meeting UNDP with JBCo shareholders (GAM, CEGCo): make clear the necessity of a detailed and viable business plan for JBCo; (4 weeks);
- Second meeting: obtain commitment and agree upon developing such a business plan within a specific timeframe; (8 weeks);
- Evaluate the results and check whether they can be combined with the Biogas Project Phase 2; (12 weeks);
- Carry out a detailed analysis of the financial viability for each component (assets, operation, services); this can possibly be done using Phase 2 budget; (6 months);
- Use the obtained results as input for GAM and CEGCo to define the “boundaries” for each component of JBCo, i.e. by defining the financial conditions for the staff to work with; (9 months);
- Develop and include a human resources development plan within JBCo; based on this plan; (9 months);
- Include the final model within the exit strategy of Phase 2 (by the end of Phase 2).

#### **2. Link with landfill initiatives in Jordan and the region (JBCo); and**

**Status:** Normal

**Goal:** Enhancement and replication

**Issue:** JBCo has gained expertise and knowledge as a result of the Jordan Biogas Project. This expertise can be applied elsewhere in Jordan. However, JBCo staff is sometimes considered (or consider themselves) as GAM staff and assist elsewhere without being rewarded for it. This makes it difficult to

assess operation costs of JBCo and to train staff in a targeted manner.

**Proposed actions:**

- (In addition to above): Meeting UNDP with JBCo shareholders (GAM, CEGCo) to point out the opportunities for providing support (operational, consultancy) elsewhere and make clear the necessity of a detailed and viable business plan for JBCo; and
- Include this element in the communication with GAM and CEGCo.

For timeframe see above.

**3. Follow up on the potential of biogas in the country (JUST).**

**Status:** Normal

**Goal:** Enhancement and replication; reaching new groups of beneficiaries

**Issue:** Jordan University of Science and Technology (JUST) has gained expertise and knowledge in the field of biogas research. They have a research laboratory as a result of the Jordan Biogas Project. They are in the process of establishing working relations with peer institutes abroad (China, possibly Europe) and wish to set up research and implementation projects for small-scale biodigestors. This technology has great potential and is being implemented in various regions in the developing world (China, South East Asia, Southern Africa). UNDP can be instrumental for donor coordination and to enhance the design and institutional setup of outreach programmes.

**Proposed actions:**

- Meeting UNDP with JUST to review how biogas can be instrumental for rural area development; identification of potential partners and scope of follow-up activities. A suggestion may be to link with European Union partners to develop the technology (typically two EU member countries are needed); (4 weeks);
- Internal meeting UNDP to determine whether biogas can be instrumental under the current country programme. A suggestion may be to link with the GEF Small Grant Programme and finance a small number of biogas units in the rural area; (12 weeks);
- If yes, try to link such an initiative with JUST research plans; (20 weeks);
- If yes, start developing an outreach programme targeted on end-users in the rural areas and identify funding for such a programme; (28 weeks).

## **Annex I    Photographs**

Will be inserted in final version of the evaluation report

## **Annex      Comments by Stakeholders**

Will be inserted in final version of the evaluation report