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IMPLEMENTATION COMPLETION AND RESULTS REPORT
(MULT-28268)

ON A

GRANT

IN THE AMOUNT OF US$ 6.27 MILLION

TO

BANCO NACIONAL DE OBRAS Y SERVICIOS PUBLICOS

AND

UNITED MEXICAN STATES

FOR THE

METHANE GAS CAPTURE AND USE AT A LANDFILL - DEMONSTRATION PROJECT

January 30, 2007

Sustainable Development Department
Colombia & Mexico Country Management Unit
Latin America and the Caribbean Regional Office

CURRENCY EQUIVALENTS

(Exchange Rate Effective June 30, 2006)

Currency Unit = MXN/US$

MXN 1.00 =0.1 US$

US$ 1.00 = MXN 10.4

Fiscal Year

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

BANOBRAS	National Bank for Civil Works and Public Services
BENLESA	Bioenergia de Nuevo Leon
CFE	Comisión Federal de Electricidad
CLFC	Compañia de Luz y Fuerza del Centro
CRE	Comisión Reguladora de Energía
DIF	Desarrollo Integral de La Familia
EMP	Environmental Management Plan
ERPA	Emission Reduction Purchase Agreement
ETEISA	Estudios y Técnicas Especializadas en Ingeniería, S.A. de C.V.
FMGb	Financial Management Guidebook
GoM	Government of Mexico
GW	Gigawatt
Ha	Hectare
ICB	International Competitive Bidding
INE	Instituto Nacional de Ecología
IPP	Independent power producers
IRR	Internal rate of return
Kw	Kilowatt
LAC	Latin America and the Caribbean
LFG	Landfill Gas
MOF	Ministry of Finance (Secretaría Hacienda y Credito Público)
MV	Megavolts
MW	Megawatts
MXP	Mexican Pesos
NGO	Non Governmental Organization
NPV	Net present value
O&M	Operation and Maintenance
PEMEX	Petroleos Mexicanos
PPP	Public Private Partnership

PY	Project Year
S.A. de C.V.	Sociedad Anónima de Capital Variable
SHCP	Secretaría de Hacienda y Crédito Público de México
SEDESOL	Ministry of Social Development (Secretaría de Desarollo Social)
SEISA	Sistemas de Energía Internacional, S.A. de C.V.
SEMARNAT	Secretaría de Medio Ambiente, Recursos Naturales
SGSC&A	State Government Secretariat Control and Administration
SIMEPRODE	Sistema Metropolitano de Procesamiento de Desechos Sólidos
SME	Sindicato Mexicano de Electricistas
SOE	Statement of expenditures
SUTERM	Sindicato Unico de Trabajadores Electricistas de la República Mexicana
SWM	Solid Waste Management
UMS	United Mexican States
VOC	Volatile organic compound

Vice President:	**Pamela Cox**
Country Director:	**Isabel M. Guerrero**
Sector Manager:	**Susan G. Goldmark**
Project Team Leader:	**Walter Vergara**

MEXICO
Methane Gas Capture and Use at a Landfill - Demonstration Project

CONTENTS

1. Basic Information

Country:	Mexico	*Project Name:*	Methane Gas Capture and Use at a Landfill - Demonstration Project
Project ID:	P063463	*L/C/TF Number(s):*	MULT-28268
ICR Date:	01/27/2007	*ICR Type:*	Core ICR
Lending Instrument:		*Borrower:*	UNITED MEXICAN STATES, BANOBRAS
Original GEF grant amount	USD 6.3M	*Disbursed Amount:*	USD 6.3M
Environmental Category:	B	*GEF Focal Area*	C
Borrower/ Implementing Agencies: BANOBRAS SIMEPRODE SEDESOL			
Cofinanciers and Other External Partners: Bioelectrica			

2. Key Dates

Process	Date	Process	Original Date	Revised / Actual Date(s)
Concept Review:	05/17/2000	*Effectiveness:*	01/28/2002	05/31/2002
Appraisal:	12/11/2000	*Restructuring(s):*		
Approval:	05/15/2001	*Mid-term Review:*		08/13/2004
		Closing:	06/30/2006	06/30/2006

3. Ratings Summary

3.1 Performance Rating by ICR	
Outcomes:	Satisfactory
Risk to Global Environment Outcome	Low
Bank Performance:	Satisfactory
Borrower Performance:	Satisfactory

3.2 Quality at Entry and Implementation Performance Indicators

Implementation Performance	Indicators	QAG Assessments (if any)	Rating:
Potential Problem Project at any time (Yes/No):	No	*Quality at Entry (QEA):*	Satisfactory
Problem Project at any time (Yes/No):	No	*Quality of Supervision (QSA):*	Satisfactory
GEO rating before	Highly		

Closing/Inactive status	Satisfactory		

4. Sector and Theme Codes

	Original	Actual
Sector Code (as % of total Bank financing)		
Central government administration	18	18
Sub-national government administration	4	4
Renewable energy	78	78
	Original Priority	**Actual Priority**
Theme Code (Primary/Secondary)		
Law reform	Secondary	Secondary
Municipal governance and institution building	Secondary	Secondary
Other urban development	Primary	Primary
Climate change	Secondary	Primary
Pollution management and environmental health	Primary	Primary

5. Bank Staff

Positions	At ICR	At Approval
Vice President:	Pamela Cox	David de Ferranti
Country Director:	Isabel M. Guerrero	Olivier Lafourcade
Sector Manager:	Susan G. Goldmark	Susan G. Goldmark
Project Team Leader:	Walter Vergara	Walter Vergara
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6. Project Context, Global Environment Objectives and Design

Summary of Outcomes

The Monterrey project is now fully implemented. The power plant has been in operation for more than three years with very satisfactory performance. The dissemination and training efforts were very successful. When reviewed in the context of the increasing awareness of the urgency and magnitude of the climate challenge, the project in Monterrey has to be recognized for its pioneering design, and results.

In summary, the project has promoted the design, construction and operation of the first ever methane gas power plant in Mexico, and Latin America, that incorporates local and global environmental concerns in its scope and operation. The project is currently powering city lights at night and the Metro system during the day in Monterrey, all of this is being done with landfill gas that would otherwise have been leaked into the atmosphere, contributing to greenhouse gas accumulation. The project has provided the much needed momentum in the efforts to further replicate the concept in the region. In Mexico a new carbon finance operation has been approved which will replicate the project through its expansion and at other sites. The project also contributed to the development of an innovative Public Private Partnership that addresses regulatory limitations for investment in the power sector in Mexico.

At present the project is operating at full capacity, has a positive financial performance, as well as excellent prospects to continue replication of this concept.

6.1 Context at Appraisal

Sector Background (at time of project approval). In 2001 over 82,000 tons/day of solid waste were generated in Mexico[1]: of this 49% was disposed under sanitary conditions in landfills, 10.6% under controlled conditions (not necessarily in sanitary landfills), and 38.6% under uncontrolled conditions. Only 2.4% of urban solid waste that was disposed on landfills was subject to recycling. Lack of proper treatment and disposal facilities, institutional capacity (for solid waste management (SWM)) was weak, and financial support to improve SWM at local and municipal levels was insufficient. Open dumping was the most common solid waste disposal method in small and medium sized cities in Mexico. Open dumping contributes to serious health and safety problems to surrounding communities, including the promotion of vector-borne diseases and leachate infiltration. Improper disposal causes contamination of aquifers and surface waters and reduces property values.

[1] This number corresponds to 319 kg per capita per year and to 31.5 million tons per year. In 2005 the estimated quantity of generated solid waste amounted to 332 kg per capita per year and 35.4 million tons per year (SEDESOL).

Figure 1: Sanitary landfill in Mexico

Landfill Gas Management. As waste deposited in landfills and dumpsites decomposes, it produces landfill gas (LFG) which is typically composed of 50% methane (CH4) and 50% carbon dioxide (CO2) and trace gases. CH4 is a potent greenhouse gas (GHG) which makes up 14% of global GHG emissions, the second largest contributor to GHG emissions after CO2 (77%)[2]. Emissions from the waste sector are 10% (65 Tg)[3] of total GHG emissions in Mexico[4] and 3.6% worldwide[5]. As a GHG, CH4 is 21 times more potent than CO2 on a molecular weight basis. At the same time LFG constitutes a valuable fuel and can therefore be used for energy generation and displace energy generated with fossil fuels[6]. The reduction of CH4 emissions was and continues to be a critical part of Mexico's strategy to control emissions of GHG.

At the time of project appraisal there were no LFG facilities in Mexico. In fact, only a handful of LFG utilization plants were in operation in developing nations worldwide. Mexico lacked the technical and institutional experience needed to identify, design and implement LFG capture and utilization projects. Regulations targeting LFG management of sanitary landfills had not yet been issued.

Electricity Supply by Independent Generators. Power supply in Mexico had been a traditional public sector domain, but as supply had failed to keep up with growing demand (6% per year), the Federal Electricity Commission (CFE) had opened the door to private sector participation in financing and operating generating facilities. Regulations promulgated in 2001 allowed private

[2] World Resources Institute (WRI): Navigating the numbers, 2005.
[3] An increase of 96% was observed from 1990 to 2002, as a result of the increase in the disposal of solid waste in sanitary landfills and the promotion given in the last decade to the treatment of industrial and municipal waste waters. (Secretariat of Environment and Natural Resources of Mexico and National Institute for Ecology, Third National Communication, 2006)
[4] Secretariat of Environment and Natural Resources of Mexico and National Institute for Ecology: Third National Communication, 2006.
[5] WRI: Navigating the numbers, 2005.
[6] LFG has a caloric value of approximately 5 kWh/Nm3. Typical pipeline natural gas has approximately double the heating value or fuel content of a typical LFG (ESMAP: Handbook for the Preparation of LFG to energy projects in Latin America and the Caribbean).

generators to supply electricity to the national grid or for self-use (as a co-generation company or independently). At time of project appraisal there were 80 Independent Power Producers (IPPs) that together were either generating or scheduled to provide almost 4,000 Megawatts (MW). The proposed plant was going to provide an additional 7 MW (~0.2%).

Government Strategy. In its broadest form, the Government of Mexico's (GoM) strategy for halting environmental degradation and remedying past problems was articulated in its National Development Plan: 1995-2000, and in its National Program to protect the environment. Within this framework, the United Mexican States (UMS) had initiated reforms to enhance the participation of state and municipal governments in the provision of basic conditions to improve SWM through the Official Mexican Norm (NOM-083-ECOL-1996) and was implementing a strategy to strengthen SWM at multiple levels. The strategy called for: i) strengthening of regulations and institutions at the federal and local levels conducive to more effective practices and incentives; ii) extension of services to medium and small size localities and promotion of private sector participation; iii) harmonization of SWM efforts that aimed at controlling the release of GHG (emissions of landfill methane); and iv) promotion of recycling.

Baseline Project. Mindful of the long-term costs of improper SWM, the UMS had initiated, with assistance from the World Bank, a program designed to address some of the underlying causes of improper SWM *("Baseline Project": Solid Waste Management II/Ln 3752-ME*). This loan was implemented by the ministry of social development (SEDESOL) and was assisting specific communities that were committed to policy and institutional reform to develop, design and operate long-term SWM programs.

The specific objectives of the Baseline Project were to: (a) implement a pilot program of sustainable SWM at selected municipalities; (b) strengthen the capacity of the National Bank for Civil Works and Public Services (BANOBRAS) and SEDESOL to appraise and supervise solid waste projects and provide technical assistance to municipalities and states; (c) increase technical, administrative and regulatory capacity at selected state and local level agencies to improve sector management and operations; and, (d) improve the legal and regulatory framework and cost recovery mechanisms of the sector to safeguard the environment. The Baseline Project had been successful in reaching policy and institutional agreements with various municipalities representing a wide-spectrum of local conditions. The assistance also resulted in the mapping of a comprehensive recycling plan.

Rationale for Bank Assistance. As a consequence of the Baseline Project, the UMS wished to expand its approach to SWM in small- and medium-sized cities by integrating management of LFG as one of the required elements for sanitary landfills. It also wished to expand technical and financial assistance to committed municipalities so that they might build their capacity to handle this new aspect of SWM effectively. In that context the GEF, project was intended to demonstrate the application of the technology and institutional framework necessary for the operation of methane "capture and use" plant" in Mexico. Over the longer term, the UMS intended to expand its program of assistance to additional small- to medium-sized municipalities, and such expansion programs would integrate LFG management as part of the solid waste strategy, building on the lessons learned from the demonstration project. The GEF project was designed to assist this

process by analyzing barriers and capacity gaps, and by developing a national dissemination/replication strategy

Higher Level Objectives. The Country Assistance Strategy (CAS)[7] (at the time of project approval) identified three core themes for World Bank Group Assistance to Mexico: social sustainability, removing obstacles to sustainable growth, and effective public governance. Within this broad framework, the Bank Strategy for Infrastructure mentioned support for renewable energy and municipal development plans as priorities for action. The Solid Waste Sector was noted as one of the key sectors that needed attention in order to improve service delivery. The CAS also included, as part of the environmental agenda, promotion of institutional development, decentralization of environmental management, improved cost recovery of environmental services and "win-win" investment opportunities where global environmental benefits and national economic benefits could be generated through an integrated and mainstreamed approach to development priorities.

Global Operation Strategy/Program Objective Addressed by the Project. The project was fully consistent and prepared pursuant to guidance from the United Nations Framework Convention on Climate Change (UNFCCC). Specifically, the GEF resources were utilized to finance part of the incremental costs associated with reductions in GHG emissions.

The project was consistent with both the GEF guidance (June 1997) for Operational Program Number 6 (Renewable Energy) and with the GEF Operational Strategy (February 1996) for short-term projects in the climate change focal area. Under the OP 6.0 the objectives are to (a) remove the barriers to the use of commercial or near-commercial renewable energy technologies (RETs), and (b) reduce any additional implementation costs for RETs that result from lack of practical experience, initial low volume markets, or from the dispersed nature of applications, such that economically profitable "win-win" transactions and activities increase the deployment of RETs. The project was in line with the GEF Operational Programs because it was: i) technically, environmentally and socially sustainable, ii) a national priority and country driven; iii) cost effective, capturing and substituting for GHG at an anticipated cost of about $4.99 per ton of carbon[8]; and iv) a programmatic approach to remove barriers (technical, financial, regulatory, social, political, and legal) to renewable energy technology that was expected to lay the foundation for cost-effective replication over the medium and long-term.

Sector Issues to be addressed by the Project. The sector issues related to improving SWM, including physical investments, capacity-building, social mitigation measures, and regulatory framework, were part of the Baseline Project. The Baseline Project was a key part of the UMS's commitment to improving SWM in small- and medium-sized cities. The GEF project continued this effort by addressing major sector issues in the following manner:

[7] CAS: Document Number 19289-MX; May 13, 1999 (FY 99 – 01).

[8] The portion of the GEF grant allocated to component A captures methane and reduces carbon emissions by fossil fuels at a cost of US$ 4.99 per ton of carbon.

Sector issues	Project response
Absence of sound technical information on how LFG capture and use technologies can be adapted to Mexican landfill conditions;	Support in the design and implementation of a system to capture and utilize LFG at the SIMEPRODE (Metropolitan Systems for Solid Waste Treatment) landfill (a public entity) in Salinas Victoria;
Need for a model institutional structure for implementing LFG projects;	Development of a demonstration facility at SIMEPRODE under an institutional structure with private sector participation (PPP) applicable elsewhere in Mexico;
Regulatory limitations for private sector role in power sector investments;	Design and implement PPP scheme that allows private sector investment in the sector;
Reduction of methane emissions from open dumps and landfills;	Implementation of a gas utilization project capturing an estimated 214 million m3 of methane during plant lifetime;
Lack of municipal, private, state, or federal knowledge of and capacity for LFG management at solid waste disposal sites;	Organization of workshops, dissemination of technical documents, and other outreach materials designed to train these stakeholders;
Incomplete regulatory framework as it pertains to LFG capture and use;	Support to SEDESOL to include technical specifications and standards for future LFG capture and use plants in a draft norm (083);
Absence of a replication strategy for integrating LFG capture in the SWM programs for small- and medium-sized cities;	Development of a national replication strategy and support of five feasibility studies for further projects;
Need to design a participatory approach to deal with social impacts of future LFG capture plants in Mexico and Latin America;	Preparation of a national replication strategy and regional dissemination materials;
Need to support and consolidate institutional capacity of SEDESOL.	Technical and financial support to SEDESOL to carry out workshops on LFG capture and utilization, and to publish technical dissemination materials.

Value Added of Bank and Global Support in this Project. At project preparation there were no examples in Mexico for Public Private Partnership (PPP) cooperation in this type of project. Bank/GEF involvement was key in removing obstacles to the successful demonstration of private involvement in a still mainly public sector domain. This institutional structure now offers a model for future LFG projects[9].

The involvement of Bank/GEF can also be credited with having initiated the carbon market in Mexico. The project identified a sector where substantial mitigation of GHG could take place as waste represents 10 % of Mexico's GHG emissions. As a consequence of the project, the first

[9] ESMAP Handbook for Preparation of LFG to Energy Projects includes the project as a successful example for LFG to power projects.

Emission Reduction Purchase Agreement (ERPA) was signed in Mexico for three landfills with a private company (SEISA[10]) (see section 8.1 for further details).

In addition, the involvement of the Bank/GEF in the proposed project provided an opportunity to support a critical effort by the UMS to: (i) improve SWM; (ii) improve global environmental quality through the reduction of GHG; and (iii) reduce dependence on high-carbon fuel-generated energy. Bank/GEF shared the lessons learned in SWM, provided technical know how combined with their experience in other LCR countries, and adapted it to Mexican conditions. GEF's involvement was critical to catalyzing local willingness to test and demonstrate LFG capture and use technology and was key to removing associated barriers. In brief, some of the main barriers addressed were the following:

Financial Barriers. Municipal governments resist investing in this type of project because of lack of information on financial indicators and economic benefits and because of reluctance to engage in projects that do not generate immediate results. Municipalities hold elections every three years, thereby making long-term projects difficult to sustain. The high initial investment cost of this kind of project and frequent cuts in municipalities' budgets also represent barriers. The financial and business environment barriers include: high interest rates, short repayment periods, excessive guarantees and the financial sector's lack of experience.

Institutional Barriers. Three entities are needed to make an LFG project feasible: The landfill operator; the municipality; and the technology /business sponsors. The landfill operator needs to accept the construction of the new facilities in its working area, and has the option of optimizing its operation to assure the long-term production of methane in the new solid disposal areas. By applying new criteria to its operation, it can increase the capture and production of useful methane. The municipalities play a double role: they authorize the proposed intervention and are key to the electricity generation component of the projects. By becoming partners with the other parties, energy produced could be used for street lighting, which would otherwise be more expensive if bought from CFE (see section 6.2). Finally, the technology provider and business promoter convenes the other parties that independently have no incentive to invest in LFG collection. Getting the three together is a major hurdle.

6.2 Original Global Environmental Objectives (GEO) and Key Indicators (as approved)

Project Development Objective. The proposed GEF project sought to (i) demonstrate a proven technology for landfill gas (LFG) capture and use, and (ii) reduce barriers to develop future LFG projects. The GEF project built upon an existing Government and Bank-supported program to modernize SWM in small- and medium-sized cities (Loan 3752-ME, Baseline project, closed on December 31st, 2000 with remaining funds cancelled). The project was intended to result in immediate reductions in GHG emissions and to serve as a model for the internalization of GHG control measures in SWM programs.

[10] Sistemas de Energía Internacional, S.A. de C.V.(SEISA) is with 55% part of Bioelectrica (the private consortium of the Monterrey plant together with the company Gentor). At the same time SEISA has signed the ERPA for the development of three more sites with carbon finance including the expansion of Monterrey.

The objectives of the project were to expand the assistance provided to the Recipient under the Baseline Project for the improvement of SWM by: (a) demonstrating a cost-effective technology for LFG capture and use in a selected facility; (b) demonstrating an institutional structure for the implementation of LFG projects, including private sector participation; (c) strengthening the UMS's regulatory policy and social frameworks for the introduction of LFG capture and use in Mexico; (d) designing a dissemination strategy to share the lessons learned throughout the Project implementation with relevant stakeholders in Mexico and Latin America; and (e) designing a strategy to encourage the replication of the Project in Mexico.

Key Performance Indicators. The LFG collection system and power plant to be installed and operated at the SIMEPRODE landfill located in Salinas Victoria near the Monterrey metropolitan area in the State of Nuevo León, the key physical activity of the project, was expected to capture or substitute for an equivalent of 0.99 million tons of carbon over 20 years which is approximately what 120,000 cars emit in one year[11]. The key performance indicator for this component was that the demonstration LFG facility is shown to be technically, financially and institutionally feasible within the Mexican context.
The key performance indicators that would monitor the performance of the remaining components (Capacity Building, Policy and Regulatory Reform and Regional Dissemination) were: i) the number of potential participants in LFG projects in Mexico and Latin America to which technical, institutional, and managerial knowledge on LFG were made available; ii) incorporation of LFG management issues into proposed legislation; iii) increase in number of government programs for support of LFG facility development; and iv) increase in number of planned LFG projects in Mexico.

6.3 Revised GEO and Key Indicators (as approved by original approving authority), and reasons/justification

The original GEO and performance indicators were not revised.

6.4 Main Beneficiaries, original and revised

As of October 1, 2006, 181 GWh of electricity had been generated, benefiting the population of seven municipalities in the Monterrey Metropolitan Area.[12] Furthermore, the municipalities obtained savings in an amount of MXN 0.6 million per year through the reduced electricity price (see Figure 2). The project also benefits a local population of about 10,000 nearby inhabitants (5 km. radius) through increased monitoring of methane migration (to mitigate any explosion risks).

[11] Assuming one car travels 10000 miles/year and has fuel efficiency of 20 mi/gallon, so it uses 500 gallons/year which weight about 2000 kgs or two tons of C8H16; if it combusts fully it will release about 7.2 tons of CO2. Thus 1 million tons is equivalent to the emissions of about 120,000 cars in one year.
[12] This is equivalent to 730,000 inhabitants benefiting from "clean and cheaper" street lightning.

Figure 2: BENLESA and CFE energy prices

Electricity user	BENLESA (MXN/kwh)	CFE	Price difference (%) / saving
Municipal street lighting	1.5723	1.7867	12 %
Metrorrey	0.7388	0.8208	10%
Gob. Del Estado	0.7435	0.8261	10%
Agua y Drenaje	0.7280	0.8088	10%
DIF	0.7260	0.8066	10%

Power generated by the landfill plant is used mainly in Metrorrey (the metro service in the city of Monterrey) and for Monterrey's public lightning. The methane capture plant operators have electricity supply agreements with Metrorrey, the water and sewerage state company (*Aguas y Drenaje*), the Public Child and Family Assistance Entity (DIF) and the Government of the State of Nuevo Leon. The contracts specify a 10% discount on the monthly electricity price charged by CFE as published in the internet. The solid waste of the Monterrey metropolitan area was thus used to power the massive public transport sector during the day and illuminate the city at night.

At a very local level, the project provided environmental and health benefits to the local population by reducing odor and controlling emissions of volatile organic compounds that are found in LFG.

At a global level, the project was a pioneering experience on the capture and oxidation of CH4, a powerful GHG, for power generation. As of October 1, 2006, the plant has reduced 700,000 tons of CO2 equivalents of CH4 and generated 180 GWh thereby displacing energy otherwise generated with fossil fuels. The dual benefits from this approach are of potential benefit to many urban areas throughout the world. Further, the outstanding technical and financial performance of the operation provides impetus to capture LFG as an integral element of SWM strategies in developing nations.[13]

6.5 Original Components (as approved)

A. Detailed Engineering Design and Construction of a Plant for Methane Capture and Use (Total Cost: USD 10.8; GEF contribution: USD 4.92 million; Private Sector Strategic Partner Contribution: USD 5.88 million).

This component's objective was to provide funding for the design and construction of a LFG collection system and a power plant (estimated to be 7 Megawatts (MW)) at a 44 hectares (ha) filled cell at the SIMEPRODE landfill. The design, construction and operation of the plant was to be implemented through a Public Private Partnership with responsibilities shared between the two

[13] The plant prevents the emissions of 68m3/minute of LFG (approximately 50% is methane and 50% CO2). 68m3/minute of LFG can produce 58 GWh of energy a year and has the capacity of supplying at least 16,000 medium-small houses per year.

major partners, the landfill owner (SIMEPRODE) and a private company experienced in LFG ("Strategic Partner").

As the project was designed to be a technical, financial and institutional model for replication, the development of the facility would be documented by SIMEPRODE for use in the Capacity Building and Regional Dissemination Components. These documents were to include: (i) a design and construction summary report; (ii) a quarterly operational summary report; (iii) an annual progress report that includes lessons learned during project implementation and recommendations for future project replication; and (iv) an annual environmental summary report. In addition to this documentation, a representative from SEDESOL was to be appointed as an observer of the activities at SIMEPRODE for the purpose of gathering information for the implementation of the remaining components.

B. Capacity building (Total Cost: USD 0.9 million; GEF contribution: USD 0.6 million; SEDESOL contribution: USD 0.3 million).

The objective was to build the capacity of SEDESOL, local and state government entities and private contractors to promote and manage LFG projects. In addition, this component envisioned funding the preparation of a national replication strategy.

This component and components C and D were to be implemented by SEDESOL. To build SEDESOL's capacity to assist municipalities in the design and implementation of LFG projects and directing federal assistance in the sub-sector, this component was to fund international training of SEDESOL employees. The project was also to allow SEDESOL to build capacity and promote LFG adoption in state and local governments and private companies in the solid waste industry. Funding was provided for the preparation of dissemination materials, for training workshops, and for twinning arrangements where an operating facility would provide managerial and technical assistance to a developing facility. Public dissemination was to be undertaken through news releases, tours and demonstrations.

C. Regulatory reform. (Total Cost: USD 0.05; GEF contribution: USD 0.05 million).

The objective of this component was to strengthen the capacity of SEDESOL for the future development of a modern legal and regulatory framework applicable to LFG management issues, through the provision of a regulatory reform study. The supported activities included the analysis of legislative needs of LFG for its inclusion in a research report, and the identification of how LFG legislative needs can be integrated into proposed legislation, and finally the preparation of a draft legislation.

D. Regional (Latin America) Dissemination. (Total Cost: USD 0.5; GEF contribution: USD 0.5 million).

The objective of this component was to support efforts aimed at facilitating the dissemination of design and operational experience gained in Salinas Victoria and other projects worldwide (such as those supported by the Bank in Indonesia, Latvia, Uruguay as well as others) for possible use throughout the region.

The following activities were funded by the project and implemented by SEDESOL:

i) Preparation of a study on worldwide economic and technical effectiveness of LFG plants with a focus on technical, financial and institutional barriers to implementation in developing countries and best practice models appropriate to the Latin America context. In addition, realization of a consultative workshop including public, private and other entities in Latin America that are interested in LFG;
ii) Development of information tools (a webpage and newsletter);
iii) Organization of international workshops for owners and operators of sanitary landfills interested in LFG management and other potentially interested parties from the private sector, such as independent power producers in the region; and
iv) Twinning arrangements that include internships and site visits for managers at operating LFG facilities in other countries.

The impact of this component was going to be monitored by maintaining a list of participants and monitoring what government programs or LFG projects were initiated by the participants.

E. Project Management.(Total Cost: USD 0.34; GEF contribution: USD 0.2 million; SEDESOL Contribution: USD 0.04 million; SIMEPRODE contribution: USD 0.1 million).
The objective of this component was the funding of the technical and administrative support necessary to implement the components and to provide monitoring of the project as a whole. LFG specialists were to be employed for the project in SEDESOL and SIMEPRODE.

6.6 Revised Components

Under the components B and D three sub-activities related to capacity building were substituted by five feasibility studies. The replaced activities included 14 trips by managers to twinning facilities, 7 internships at an operating facility for managers at a developing facility, and 3 of the 6 foreseen capacity building workshops in Monterrey. Instead 5 feasibility studies were carried out for the cities of León (Guanajuato), Cd. Juárez (Chihuahua), Cuautitlán Izcalli (State of México), Puerto Vallarta (Jalisco) and a study of composting as an alternative to reduce GHG. The adjusted scope eliminated travel costs and replaced these by feasibility studies for additional project sites. The modifications resulted from the need to support Mexican municipalities in their effort to replicate the Monterrey experience. The successful dissemination efforts by SEDESOL and the strong replication potential were reflected by these modifications which were approved by the task manager. The substituted capacity building activities represented a small part of the capacity building component and were deemed less sustainable and broad in their impact than the feasibility studies. For example, the landfill in Leon, analyzed in the feasibility study, is expected to start operation of a LFG plant in 2007.

6.7 Other significant changes (in design, scope and scale, implementation arrangements and schedule, and funding allocations)

Late in project implementation the UMS requested through the SCHP the change in currency (from SDR to US Dollars). This change was done in an expedient manner. However, currency

fluctuations meant a short fall in pesos under component B, which had pending disbursements. The shortfall was minor and was absorbed by SEDESOL.

7. Key Factors Affecting Implementation and Outcomes

7.1 Project Preparation, Design and Quality at Entry (including whether lessons of earlier operations were taken into account, risks and their mitigations identified, and adequacy of participatory processes, as applicable)

Overall, quality at entry was satisfactory. Many aspects were highly satisfactory and proved crucial to the success of this pilot project in Mexico and in Latin America.

The most important success factors include:

A thorough project preparation process. The extensive project preparation effort gave the project a solid technical and institutional base. The pre-feasibility and site selection process involved the analysis of several barriers and an assessment of the potential for LFG production at alternative candidate sites. Initially, 33 sites were considered that met the basic requirements (at least 500,000 inhabitants, minimum precipitation of 200 mm, and annual temperature between 15-30ºC). For the determination of the optimal site an analysis was conducted at each site on: (i) technical issues at a regional and municipal level; (ii) economic conditions; and (iii) financial, social, political and legal considerations. The analysis resulted in a short list of seven municipalities (10 landfill sites) which were provided with a questionnaire requesting technical, institutional and social information about the specific project site. The data of the questionnaire and three different gas generation models helped to estimate the LFG generation in the seven municipalities. On the basis of a barrier analysis and financial assessment, the sale of the generated electricity to the municipality was considered as the best alternative. The analysis of social barriers took into consideration the scavengers[14], the distance to settlements, the position of labor unions, and the opinion of local authorities. Victoria Salinas Landfill operated by SIMEPRODE was selected as the best site for the demonstration project based on economic, social, technical and financial criteria[15]. It was the most attractive project site after weighing the investment costs, sources of financing, likelihood of private sector involvement and cooperation of state and municipal authorities. These aspects were confirmed during project implementation.

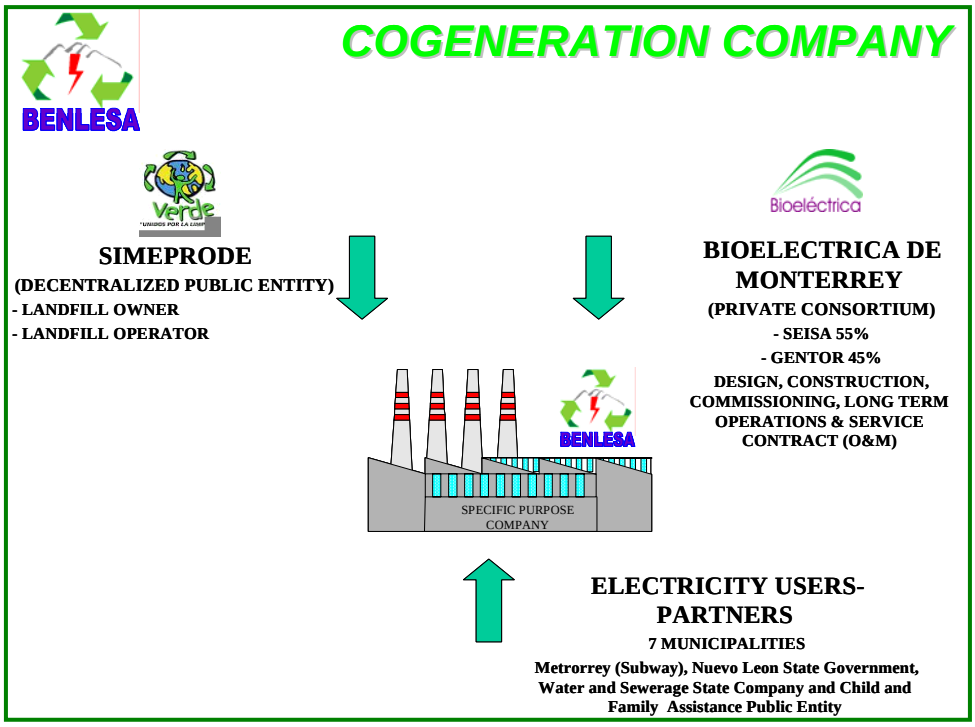
The implementation arrangements consisting of a Public Private Partnership were fully adequate to address local regulations for power generation. This dual character partnership (figures 3 and 4) helped to surmount the solution to complex institutional and regulatory barriers,

[14] The social assessment conducted in 2000 confirmed that there were no scavengers at the Salinas Victoria Site. The landfill which started operation in 1991, was developed as a secure sanitary landfill on a Greenfield site and thus scavengers were never present at the site.

[15] The SIMEPRODE's landfill is located in the north side of Salinas Victoria, Nuevo Leon in the district of Salinas Victoria. The landfill was established on a Greenfield site with a total landfill area of 212 hectares. Since operation began in September 5, 1990, the landfill has been taking mostly non-hazardous domestic and commercial waste as well as some non-hazardous hospital and industrial waste. This landfill receives 750 trucks daily corresponding to approximately 4,500 tons of tons per day of municipal solid waste. The 44 ha cell from which the LFG will be collected was filled with 7.7 million tons of waste between 1991 and 1000. The landfill continues to accept waste and is expanding to fill other cells in the 212 ha site.

including the difficulties for private participation in power generation. The institutional structure of the plant consisted in the development of a Co-generation company.[16] The responsibilities between the public landfill operator SIMEPRODE [17] and the private strategic partner "Bioelectrica" were clearly defined (figure 4): Bioelectrica designed and constructed the plant, and is responsible for its operation and maintenance. SIMEPRODE is responsible for the overall administrative implementation of the demonstration project via an agreement with Bioelectrica. Metrorrey, the water and sewerage state company (*Aguas y Drenaje*), the Public Child and Family Assistance Entity (DIF) and the Government of the State of Nuevo Leon act as energy consumers and invest a nominal amount each. The alliance between SIMEPRODE and municipalities allowed the generation of power for self-use.

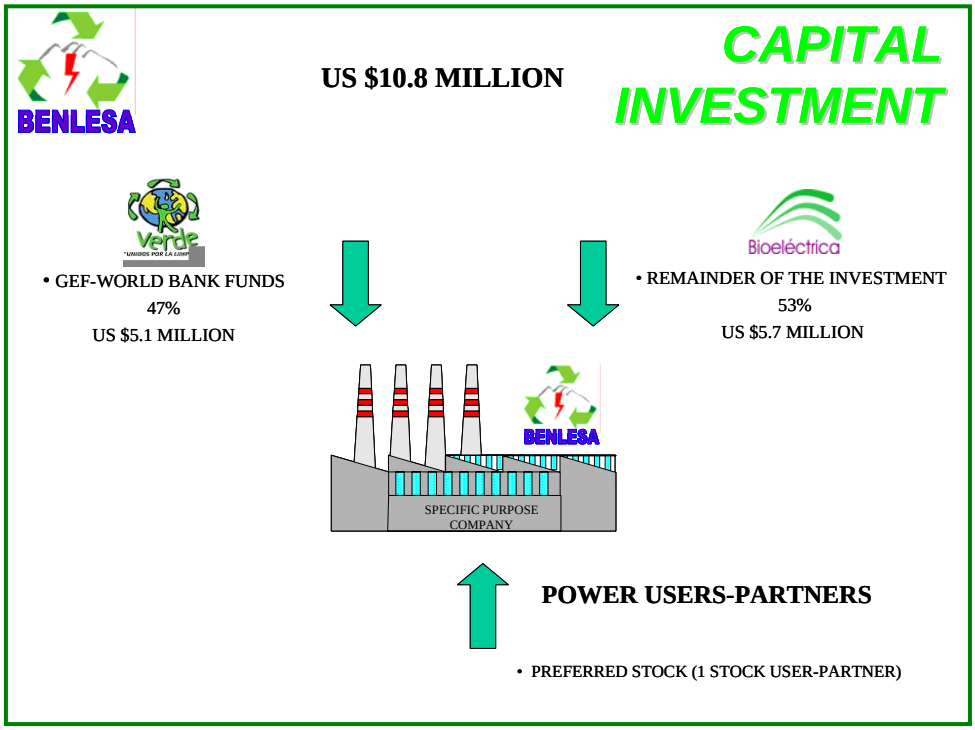
Figure 3: Cogeneration Company Framework



[16] The Electricity Law allows public or private investors to form a Cogeneration Company that provides electric services to its members or partners. Since the passing of this Electricity Lay many Cogeneration Companies have been formed in Mexico. While the law does not allow electricity to be "sold", the Co-generation Company framework allows electricity to be supplied by partners in the company to the other partners.

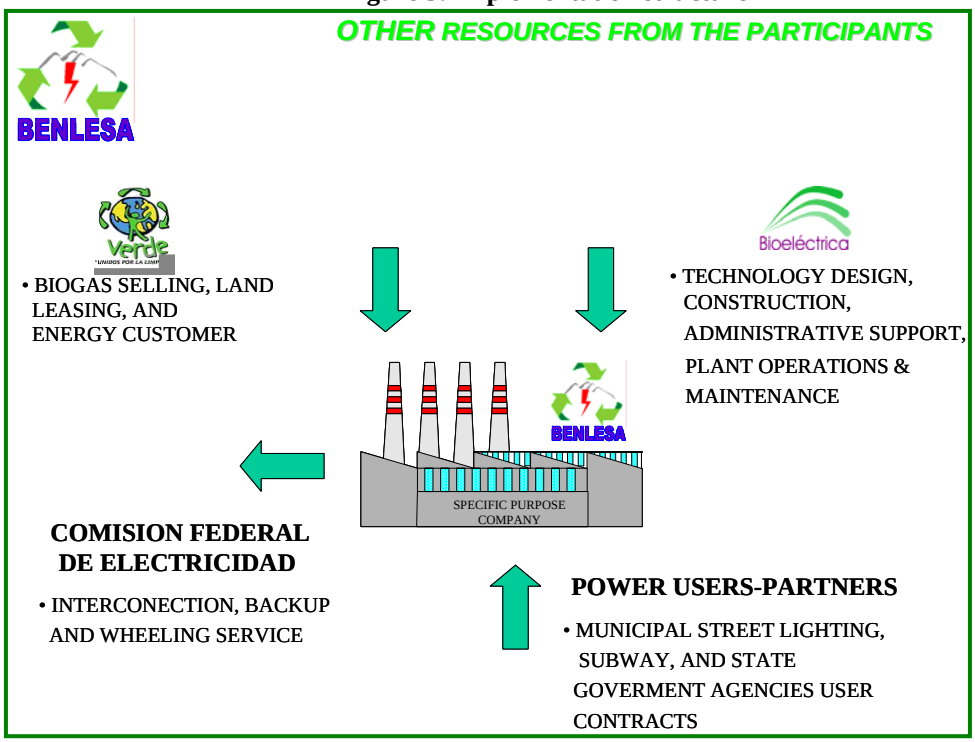
[17] SIMEPRODE is a decentralized public organism of the State of Nuevo Leon, a state company with own property and legal entity. SIMEPRODE depends on a Board of Directors that is headed by the governor as president of the board. At the same time the governor designates the General Director which is in turn approved by the Board.

Figure 4: Capital Investment



The government demonstrated a strong commitment to the project. The project received strong support from the local and federal governments as demonstrated by the inclusion of the project among the administration's strategic priorities. At the beginning of the project Mexico's Secretary of Energy directly confirmed to SIMEPRODE the priority afforded to this project based on the business model for independent generation at a time of electricity shortages. In the context of Mexico's non binding commitments to the Kyoto protocol, the National Institute for Ecology (INE) clarified at project entry that the project was part of the program of mitigation actions announced by the government to the United Nations Framework Convention on Climate Change (UNFCCC) under the Second National Communication. The project is seen by the Mexican government as a first in a series of investments to mitigate methane emissions in landfills, an important component of GHG emissions in the country.

Figure 5: Implementation structure



A few aspects at project entry led to implementation delays:

Long negotiation process with the energy regulatory commission (CRE) / Federal Electricity Commission (CFE), labor unions and the municipalities. Due to lack of precedents the negotiation process between the operators of the plant and the Federal Electricity Commission with regard to the procedures to supply electricity into the network took longer than originally foreseen and caused a 6 months delay in the provision of energy to the municipalities. This resulted in an additional cost to the strategic partner.

The selection of the consortium took longer than anticipated. The results of the bidding process were challenged by the second lowest bidder but the challenge was found to be without merit. As a consequence the project did not become effective until one year after Board approval. The performance of the implementing agencies (SIMPRODESO, SEDESOL) helped to make up for the initial delay as demonstrated by the plant's performance indicators since start up (see figure 12).

Initial overestimation of gas. The initial gas estimation developed under the feasibility study was based on the USEPA model[18] and was not validated by real field measurements. As a consequence,

[18] An USEPA LFG production model was used to estimate the amount of LFG to be produced over the project lifetime. The model has been extensively and successfully used in the U.S. as the basis for designing and financing LFG projects. The dry conditions and differences in moisture content of the waste in Salinas Victoria were accounted for in parameter estimation. The model found enough methane would be produced from the filled 44 ha cell to

once the flares and the gas collector were installed, the initial 160 wells did not result in sufficient gas to generate 7 MW. In order to guarantee an adequate amount of gas and to avoid shutting down one of the generators, 88 additional wells were installed. This made sure that the plant operated at maximum capacity and complied with the expected financial returns. The additional cost of approximately US$0.27 million was absorbed by lower cost for the construction of the plant. In addition, the quality of the gas was higher than anticipated with a methane content of up to 54%. Delays were avoided because these decisions were taken on a timely basis.

Integration of lessons learned at project entry:

The design of the project built positively on the experience and lessons learned from other GEF supported projects in order to improve project design and benefit from best practices. The project design was especially effective and appropriate in that it took into account the following lessons:

Lessons learned from other GEF projects	Responses in project
Decision-makers at the municipal level should support the project objectives prior to site selection.	The project was conceived and prepared with full participation of the municipal authorities and the proposed owner-operator (SIMEPRODE).
Workshops and training are critical for enabling the replication of project activities.	As part of the capacity building and dissemination component training of SEDESOL and technical staff from municipalities was carried out. SEDESOL has successfully disseminated the Monterrey experience, leading to several feasibility studies for replication projects.
Technical assistance provided to municipalities is essential.	The baseline project provided the necessary technical assistance and training in municipal SWM to support an integrated approach which includes LFG capture and use. The GEF project continued the technical assistance initiated under the Baseline project and trained 468 technical staff involved in municipal SWM in LFG projects.
Development of integrated plans is essential for effective management of municipal solid waste.	The baseline project has provided needed training and technical support to local and national decision makers in developing integrated municipal SWM plans. The project built upon these plans by integrating LFG management and utilization and by demonstrating a cost effective and environmentally friendly option to modernize SWM in small- and medium-sized cities.
Full cost recovery is necessary to	The LFG plant was financed with GEF equity financing (grant) and

support a 7 MW power plant The model indicated 313 million m^3 of methane will be produced over the 20 year project lifetime. Of the total methane produced in the landfill, it was estimated 214 million m^3 of methane (70% of LFG production) would be captured by the collection system. From this quantity of methane, it was estimated the project could generate 700 GWh of electrical energy for a total installed capacity of 7 MW. The effect of model uncertainty on project viability was assessed in the financial sensitivity analysis where the estimated LFG production was varied +/- 20 %. The model also showed that, as expected, the gas produced by the 44 ha filled cell would decline over the lifetime of the project as is the case with all LFG projects on filled landfills or filled portions of landfills. Parameter Estimation: Among the most important parameters in this model are the methane gas generation constant (k) and the methane gas generation potential (L_o). L_o were estimated using typical values from operating US LFG projects and adjusting for differences in the composition of the SIMEPRODE waste. k was estimated by measuring the methane gas production on site and using the USEPA E-PLUS model equation to solve for k.

promote sustainability.	financing from a private investor. The GEF grant was key to remove barriers that replication projects will no longer face. With the GEF grant the plant was financially viable and all costs were recovered**.** Today the plant continues to operate in a financially sustainable manner. Current financial estimates demonstrate an IRR of 17% and a NPV of US$7 million for an operation period of 20 years. Incomes from electricity sale to the municipalities have been provided continuously and on time. Even though the project faced higher initial cost due to technical and regulatory barriers, it was able to recover its cost throughout implementation.
Clear managerial and institutional responsibilities are required.	The responsibilities were clearly defined right from the beginning: Implementation of the first component, the construction and operation of the demonstration project, was the primary responsibility of SIMEPRODE. The other components of the project were under the purview of SEDESOL. Because of the interdependency of the components both implementing agencies required continuous coordination during project implementation, which was reached on a satisfactory level

7.2 Implementation (including any project changes/restructuring, mid-term review, Project at Risk status, and actions taken, as applicable)

Excellent performance of the power plant in Monterrey. As of October 2006, the plant had burned approximately 700,000 tons of CO2 equivalents of methane, which represents 70% of the target value set for 20 years of operation. This is due to the excellent performance of the plant, the mean power rating achieved and the better than anticipated quality of gas. The business model and the technology employed have proven more than adequate, meeting all expectations in terms of the company as well as the plant. The plant has generated 180 GWh, supplied to illuminate the city's public lighting at night and power the metro system Metrorrey during the day. The better than expected performance and the relatively higher electricity prices have represented a windfall for SIMEPRODE. The price for electricity charged by the CFE is among the highest in the region which contributes to improve financial indicators of the LFG in Mexican power plants. The operation costs however have increased due to more frequent stops for maintenance than anticipated caused by the presence of siloxanes (silicate oxides and complex silica compound, see in same section paragraph: Adaptation of European technology to Mexican conditions).

Figure 6. Panoramic view during construction of methane capture and use plant in Monterrey under construction (left side)

Figure 7. Panoramic with data tower for national dispatch center and civil works

Institutional arrangements have proven effective and constitute one of the most important lessons for the replication of the project in Mexico. The model institutional arrangements were a key reason for success. The special purpose company BENLESA has effectively combined the experience with landfill management and the actual control of the landfill of SIMEPRODE with the provision of technology, know how and financing of Bioelectrica from Monterrey. Bioelectrica financed 53% of the initial capital cost of the plant and was in charge of the civil works, the start up of the plant, and its operation and maintenance. The PPP was ideally suited for the purposes of the project and provides a useful lesson and experience for renewable energy in the country. The involvement of the private sector gave the management the needed continuity insofar as it operated independently from the municipal administration agenda and political changes. The cooperation between the landfill owner and the strategic partner was transparent and complementary. The institutional arrangement is being used for the follow up project, with carbon financing. Under the carbon finance project three LFG facilities will be developed with an expected emission reduction of 2.2 million metric tons of CO2e until 2015 (see section 8.1). The Emission Reduction Purchase Agreement (ERPA) (first in Mexico) for that project was signed on March 18, 2005.

Payments by municipalities (a concern during project preparation) have been 100% on time. The timely payments by the municipalities provided the plant operator with the needed security to cover the operation cost of the plant. This proves that the legal arrangements, including the participation of the municipalities in BENLESA and the incentive created by providing electricity at a 10% lower price in contrast to CFE tariffs have been effective. Benefits to the municipalities include the reduced costs of power supply as well as revenues accrued from their participation through shares in the special purpose company and the planned reforestation program in the area of influence of the plant that will ultimately lead to a zero emissions LFG to power project.

Successful dissemination and training program. This program was very successful and is a one of the key reasons behind the high level of awareness and interest in LFG use in Mexico and in the region today, ultimately leading to numerous initiatives on the subject. SEDESOL has effectively

implemented the dissemination and training activities with substantial success. Two international workshops and over ten national events and training seminars were held (copies of materials produced are in the project files). Capacity building in the field of LFG management has been substantial. Altogether 468 technical staff employees involved in municipal SWM were trained on LFG projects. Video and written materials have been produced and distributed inside Mexico and abroad. As a consequence several municipalities in Mexico have developed feasibility studies and some are now in the process of starting operation of their LFG plant based on the dissemination efforts by SEDESOL and on the Monterrey experience.[19] The project achieved a high buy in by the public sector as well as by the private sector and the academic community. The ESMAP initiative was launched during a workshop in Monterrey in 2004. The resulting "Handbook for the Preparation of Landfill Gas to Energy Project in Latin America and the Caribbean" includes the Monterrey project as a successful example which is being followed throughout the region. Besides providing a model for LFG to power, the project can also be credited with having led to improved final disposal practices in the region, with reducing environmental risk in landfills such as uncontrolled fires and with reducing GHG from landfills.

The implementation of the project dealt with various technical issues that included:

Adaptation of European technology to Mexican conditions. Even though the best available technology was used for the project, the environmental conditions of Mexico made adjustments to the technology necessary. This caused additional variable operation and maintenance cost to Bioelectrica as a result of the learning and adaptation procedures. These costs affected the profitability of the project for Bioelectrica. The adaptation of technology continues to be a dynamic process and is now being considered in the replication projects economic feasibility studies. The two main technology adaptation aspects, which may be of use for future activities, include:

a) High daytime temperatures, forced the addition of heat removal equipment to avoid loss of performance.

b) The widespread content of siloxanes (silicate oxides and complex silica compounds), resulting from the disposal of cosmetic and paints, contributed to the accumulation of hard deposits in the compressor heads, which required a continuous cleaning process to maintain output pressure.

Interruption in interface between plant and regional grid. The link to the grid from the plant site proved to be unreliable and lead to several plant stoppages. In addition a "backup" cost charged by CFE to Bioelectrica during plant stoppages increased the already sizable cost to the unit. As a consequence the modernization of the link to the grid was considered by BENLESA and CFE through the set up of a substation at the plant site and the installation of a 115 kv dedicated

[19] (i) León, Guanajuato. With private sector initiative, the first phase for the burning of LFG is about to begin. (ii) Cuautitlan Izcalli, Estado de México. The new municipal authorities are resuming the project. (iii) Puerto Vallarta, Jalisco. The bidding process has begun for the use of landfill LFG, with the participation of private sector initiative. (iv) Cd. Juárez, Chihuahua. The bidding process has begun for the use of landfill LFG, with the participation of private sector initiative. (v) With regard to compost in Tlalnepantla, Querétaro and Nuevo Láredo. The new municipal authorities are resuming the project.

line to the grid. The installation of the substation resulted however at this stage more costly to Bioelectrica than the cost caused by the stoppages. The expansion of Monterrey considers the installation of the substation. The substation would improve the plant conditions substantially and reduce uncertainties for the investor.

Figure 8: Connection to the CFE grid

Figure 9: Extraction of LFG

Uncertainty and slow progress in Mexican legislation with regard to LFG. At project entry and in the first years of project implementation, the treatment of LFG was barely regulated by Mexican legislation thus creating uncertainties in the set up and operation of the plant as well as delays in the procedures related to agreements with the federal electricity regulator. At the same time, the progress to modify the Law on the Use of Renewable Energies to include LFG as a formal "renewable energy" has been slow. The key reason for the slow progress of the LFG legislation is the gridlock experienced in the Mexican Congress during the last few years. The consideration of LFG as renewable energy source would enable the virtual storage of power generated from the plant for sale at the most advantageous rate. While the impact on the financial performance of the Monterrey plant would be significant, it is also a major incentive for the replication of the experience, elsewhere in Mexico.

Scarce municipal participation in long term projects. Due to the municipal administration period (three years) and the high turn over of staff with each new administration, continuous commitment by municipalities is difficult to achieve. This is particularly relevant for the replication of the Monterrey experience in other municipalities. The learning process by municipal civil employees is compromised by short administration periods which make greater participation of federal agencies like SEDESOL necessary to assure continuity in technical capacity. The Public Private Partnership (PPP) structure in Monterrey, however, provides a good model that demonstrated strong cooperation with municipalities. Also the project resulted in substantial and continuous capacity building of municipal employees with regard to LFG projects. The project has achieved major buy in by municipalities due to the benefits it generates such as reduced electricity price, a reforestation program and the participation of municipalities in the plant in the form of shares.

7.3 Monitoring and Evaluation (M&E) Design, Implementation and Utilization

The system for monitoring and evaluating project performance was implemented as described in the PAD and resulted in keeping implementation on track and in identifying and resolving critical issues affecting the achievement of desired outputs and outcomes. As per the design of the system, the indicators identified in the Project Design Summary (Annex 1 of the PAD) were reported on by the Project Implementation Agencies, were discussed by regular supervision missions, and were the focus of the assessments conducted as part of the Mid-Term Review and the final evaluations done at the end of the project.

Realistic and tangible (and where possible quantitative) indicators were defined at appraisal for the project for all its objectives. All the indicators turned out to be both appropriate and useful to the process for assessing the progress towards achieving the project's objectives.

The monitoring and evaluation component included reporting requirements by the implementing agencies on a frequent basis to the project team. This entailed the development of a Design and Construction Summary report, quarterly operational summary reports, workshop participant list, distribution list for dissemination materials, and dissemination and training reports. The reports were delivered on time and in a satisfactory manner to the Bank through the financial intermediary, Banobras. For each sub-activity specific reports were defined and delivered by the implementing agencies.

The multimedia materials prepared by SEDESOL for dissemination purposes provide a good overview of the deliverables achieved in their respective components.

7.4 Safeguard and Fiduciary Compliance (focusing on issues and their resolution, as applicable)

Safeguards. The project is Environmental Category B. An environmental assessment was conducted in September 2000 and approved by the Bank in December 2000. As a result of the assessment an "Environmental Management Plan (EMP)" was developed. The EMP was incorporated as a disbursement condition into the signed contracts of the Cogeneration Company. Throughout project implementation the environmental standards have been exceeded. Examples include: engine emissions were much lower than established by Mexican norms, waste oil volume was below Mexican standards, no methane leakages occurred, and no complaints by neighbors were received during the whole implementation period. Finally the global environmental benefits through the reduction of GHG were much higher than anticipated.[20] The plant is currently in the process of receiving the highest Mexican environmental certification for the industry sector, awarded by the Ministry of Environment. Throughout the project SIMEPRODE issued environmental management reports evaluating the environmental performance of the plant in accordance with the reporting requirements defined in the Grant Agreement. The reports were

[20] The plant was expected to capture or substitute for an equivalent of 0.99 million tons of carbon over 20 years and has already achieved a reduction of 0.7 million tons of CO2e in its third year of operation.

found to be adequate. With regard to social issues, a social analysis was contracted during project preparation and reviewed by the Bank and deemed satisfactory. No scavengers were at the project site in Salinas Victoria and the municipalities and entities involved with solid waste collection and disposal openly supported the project and collaborated during preparation and implementation. No social issues occurred during project implementation.

Financial Management. During project implementation the implementing agencies maintained acceptable accounting, financial reporting, and auditing arrangements. The financial intermediary, ***BANOBRAS,*** supervised project implementation and compliance with all legal covenants related to financial management. All audit reports were submitted by the implementing agencies, and reviewed by the Bank. Identified issues were discussed and addressed in a proper and timely manner. The latter includes suitable follow-up, e.g. remedial actions undertaken.

Procurement. The Joint Venture Agreement[21] between SIMEPRODE and the strategic partner Bioelectrica for a value of US$11.50 million [22] was subject to prior review. The strategic partner was procured through an international competitive bidding process. The goods, works and services required were procured in according with the applicable procedures of the strategic partner. SIMEPRODE organized the bid. The bidding process included prequalification followed by bidding. The bidders had been pre-qualified based on their experience in design, construction and operation of LFG facilities, their personnel and financing capabilities.

One Procurement Post review was conducted in May 2005 by the Bank procurement specialist. Two contracts, for a value of approximately US $59,983 equivalent were reviewed. The review of the sampling centered on the procedures utilized and their compliance with the Bank's procurement Guidelines. In general, the review found that:
- Documentation related has been well kept and organized
- Based on the documentation reviewed, the selection was found to have been conducted in compliance with Bank Guidelines

Most of the contracts were done under prior review process. The Methane plant started operation in September 2005, thus no additional goods and services were required after this date. SEDESOL contracts were relatively small and under the threshold for expost review.

7.5 Post-completion Operation/Next Phase (including transition arrangement to post-completion operation of investments financed by present operation, Operation & Maintenance arrangements, sustaining reforms and institutional capacity, and next phase/follow-up operation, if applicable)

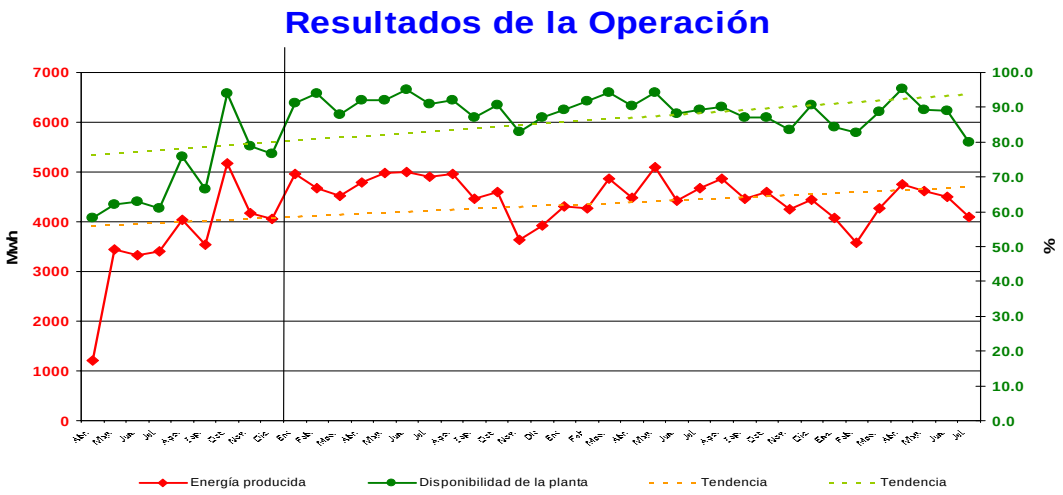
The plant continues to operate satisfactorily and current performance indicators of the plant exceed expectations (see figures 10 and 12). The project assumed an annual CO2e reduction of approximately 50,000 t CO2e, instead an annual reduction of 180,000 tCO2e was achieved every

[21] The Joint Venture Agreement refers to the expenditure for goods, works and consultants services procured by the Strategic Partner contracted to design, build and operate the LFG power plant and provide the training activities referred to tin Component A of the project.
[22] Estimate at approval stage; the actual value was US$ 10.8 million. The GEF grant covered US$ 4.93 million of the total cost of the LFG facility.

year since operation start. The goal set for 20 years of operation regarding the expected reduction of GHG (0.99 million t CO2e) has already been achieved by 70% within 3 years of plant operation. A major factor was the high quality of the LFG that had a higher methane content than previously anticipated.[23] The planned expansion of the plant demonstrates the technical and financial capacity of the operators to expand the production of the plant. However, the expansion of the plant suffered delays in the previous administration. The new administration of SIMEPRODE and SEISA have finalized contractual arrangements and expect the expanded plant to be set up by the end of 2007 (see Annex 11 for further details on expansion of plant). The set up of the substation considered for plant expansion will smooth out operation and reduce costs.

The equipment of the plant has a lifetime of approximately 20 years and issues due to the adaptation of the technology to local conditions have mostly been overcome as described above in paragraph 7.2. Well data provides assurances of continuous supply for the remainder of the LFG. The figure below shows the increasing trend in the energy production as well as in the availability of the plant (the plant has been on average on line 91%).

Figure 10: Energy Production and Plant Availability[24]



The project continues to have a strong commitment by the local and federal government. The technical capacity of SEDESOL has been strengthened and regulations on the treatment of LFG have been formalized, providing greater security to the project over the long term.

8. Assessment of Outcomes

8.1 Relevance of Objectives, Design and Implementation (to current country and global priorities, and Bank assistance strategy)

The project's objectives continue to be consistent with the country's current development priorities and Bank's country and sectoral assistance strategies.

[23] The initially estimated methane gas content was 45-50%, the actual methane content goes up to 54%.

[24] The upper line shows the plant availability in percentage, the lower line shows the electricity produced by the plant in MWh. The x axis represents the time over approximately three years since plant operation start

The latest Country Partnership Strategy (**CPS)**[25] identifies four core themes for Mexico: reduce poverty and inequality, increase competitiveness, strengthen institutions, and promote environmental sustainability. Within this broad framework, the Bank Strategy for promoting environmental sustainability, mentions support to address air pollution, SWM, promote clean energy, and GHG emissions. Under the second CPS pillar: Increasing Competitiveness (Country Development Objective: promoting balanced regional development) the project contributes to efforts to expand coverage, improve quality, and reduce cost of basic services and infrastructure. The CPS Medium Term Indicators Country Targets seek to increase renewable energy capacity to 1,700 MW, to have at least 10 Clean Development Mechanism (CDM) projects under implementation, and to increase levels of installed capacity for handling solid waste to 20%.

The project's achievements are completely in line with the strategy's objectives and indicators. The project resulted in the demonstration of an option to simultaneously generate clean and cost effective energy and to address climate change. At the same time the successful implementation of the project served as a model for replication and has led to the first carbon finance operation in Mexico. The Mexico Waste Management Carbon Offset project (P088546) seeks to reduce GHG emissions caused by methane released during land-filling of solid waste in Mexico. The project will support the development of three LFG facilities. The project is expected to displace an estimated 2.2 million metric tons of carbon dioxide equivalent up to 2012 and 3 million tons up to 2015. The project will also contribute to improve solid waste management practices through a remediation program to strengthen the integrity of closed landfills, and will support a "proof of concept", off grid renewable energy supply at a poor community in Nuevo Leon.

The project continues to be consistent with both the GEF Operational Strategy (February 1996) for short-term projects in the climate change focal area and with the GEF guidance (June 1997) for the **GEF Operational Program 6**: Promoting the adoption of renewable energy by removing barriers and reducing implementation costs (OP 6). Being a pilot effort the project faced initially several barriers. It achieved to surmount technical, financial, regulatory and institutional barriers (see section 8.2) and demonstrates successfully an option for cost effective clean energy.

Mexico has played an important role in the **Climate Change Convention** and the subsidiary meetings. It is the first country in Latin America to have submitted the Third National Communication (November 11, 2006). At the same time Mexico City is the first city worldwide to have developed a local climate change strategy which includes the waste sector among the priority sectors for mitigation of GHG. Mexico is also one of the two largest emitters of GHG in the region (1.5% of global GHG emissions[26]) and a country that has shown substantial vulnerabilities to the impacts from Climate Change.

8.2 Achievement of Global Environment Objectives
(including brief discussion of causal linkages between outputs and outcomes, with details on outputs in Annex 4)

[25] Country partnership strategy of the World Bank Group with the United Mexican States, **March 18,2004 ;Report No. 28141-ME**), covering the period FY 05 – 08**.**
[26] WRI, Navigating the Numbers, 2005.

The overall project objective was to demonstrate a proven technology for landfill gas (LFG) capture and use and to reduce barriers to development of future LFG projects. In addition the project was expected to result in immediate reductions in emissions of GHG and to serve as a model for the internalization of GHG control measures in SWM programs. These objectives have been achieved in a highly satisfactory way. This rating is based on the outcomes of the project, the ratings of the sub-objectives, the indicators of project impact, and the results of the stakeholder workshop.

Results of Key indicators

Key indicator	*Result*
Landfill gas capture and use facility proven to be technically, institutionally and financially feasible within the Mexican context.	Plant operates beyond performance indicators: Approximately 180 GWh have been produced to date, around 70 million cubic meters of methane collected and destroyed (October 2006, see Figure 12 [27]). Plant is in process of expansion with operation of expanded plant scheduled for the end of 2007 Management of plant continues to operate satisfactorily after project closing date. Current financial indicators are adequate.
Number of potential participants in LFG projects in Mexico to whom technical, institutional and managerial knowledge on LFG were made available.	468 municipal staff has been trained on LFG: Consultation Workshops in Mexico City: 60 participants LFG workshop in Monterrey: 60 LFG Congress in Mexico City: 63 LFG Workshop in Puerto Vallarta: 72 LFG workshop in Leon: 36 Latin American LFG workshop in Bogota, Colombia: 125 Latin American LFG workshop in Puerto Vallarta: 64
Study on landfill gas management issues completed.	Study completed satisfactorily: The study resulted in a first draft for the regulation of LFG. Based on the results of this study technical SEDESOL staff participated in the formulation of the Official Mexican Norm NOM-083-SEMARNAT-2003. Production and dissemination of a manual for project promoters (Mexican model) for the calculation of LFG potential at Mexican sites, based on local information.
Increased Mexican state and federal government programs for support of LFG facility development during the five years following project launch.	The project has resulted in the support to four municipalities to develop feasibility studies for LFG facilities, and in the development of a composting study: i) Leon (Guanajuato) ii) Ciudad Juarez (Chihuahua) iii) Cuautitlan Izcalli (State of Mexico)

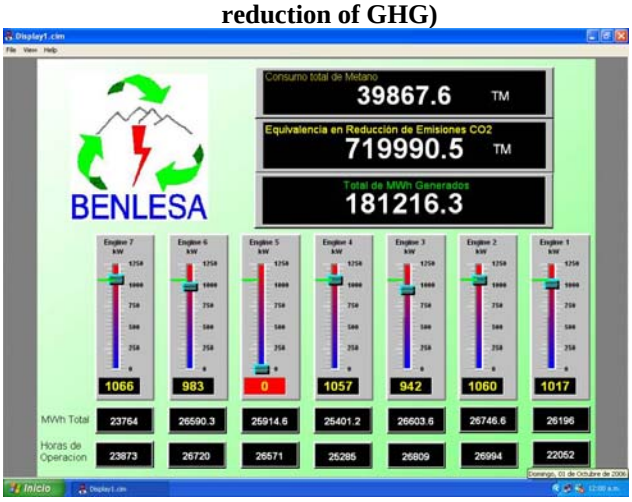
[27] Figure 12 represents a snapshot of the plant's performance in terms of generated electricity per generator, methane emissions reduced and translation of reduced methane emission reductions into CO2e. These measurements are being done continuously.

	iv) Puerto Vallarta (Jalisco) v) Composting studies for Queretaro, Tlanepantla, Nuevo Laredo.
Increase in the number of planned LFG projects in Mexico during the five years following project launch.	The replication strategy has resulted in the development of three more sites in Mexico, supported through carbon finance under the Kyoto Protocol. The expansion of Monterrey is one of the three sites included in the signed ERPA. SIMEPRDOESO and SEISA are currently finalizing arrangements, following delays during the previous administration. The plant is expected to operate by the end of 2007.

At the beginning of the project LFG facilities, Public Private Partnerships (PPP) in waste management projects and carbon markets were non existent in Mexico. The project can be credited with having: (i) successfully developed a LFG to power facility that generates clean and cost effective energy; (ii) provided the technical know how and experience for this and for future LFG to power projects; (iii) demonstrated a PPP and thus an innovative and efficient institutional structure for this type of project; and (iv) initiated the carbon market in Mexico in a sector where substantial mitigation can take place. This opened the door to the development of future CDM projects in Mexico.

Figure 11: Motor-Generators

Figure 12: Plant Performance (electricity generated, reduction of GHG)



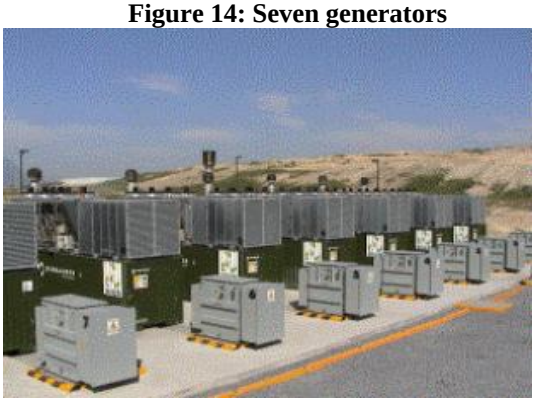
Sub-objective (A): **Landfill gas facility successfully collecting energy and selling electricity**. The achievement of this sub-objective was rated satisfactory insofar as the plant operates above design performance indicators. The plant which is the first LFG facility in Latin America has been built without delays and started operation in September 2003[28]. Seven generators are installed and

[28] The LFG system includes: 248 extraction wells with monitoring valves, collection pipes for conduction and control, three vacuum pumps, filters, two flare stations for gas flaring. The latter operates as needed. The power generation equipment consists of 7 modular generator sets, automated control equipment, seven set up transformers, switchgear to feed the grid (CFE) lines. Other installations include: remote terminal unit, measurement equipment, offices, warehouse and maintenance facilities, training facility.

generating 7.42 MW of which during the night 4.9 MW are sold to the municipalities for street lighting[29]. CFE receives 2.3 MW, of which 0.2 MW are used for self consumption (see figure 12). During the day Metrorrey (see figure 13) receives 5.9 MW satisfying 80% of their demand[30], 1 MW is distributed between "Aguas y Drenaje", DIF and the State, and the remaining 0.3 MW are used for self consumption. The PPP structure of the plant has proven to be successful and independent of changing administrations. The plant is currently in a process of expansion. In addition to good performance, efforts have been invested in making sure that the plant looks good. A board announces the support of the Bank-GEF, a real-time display accounts the methane used, power generated and equivalent CO2 displaced. Gardens surround the site, including a lagoon, and a gardened path leads to the entrance of the plant. The information and capacity building center and the plant count with a high number of national and international visitors.

Figure 13: Metrorrey

Figure 14: Seven generators



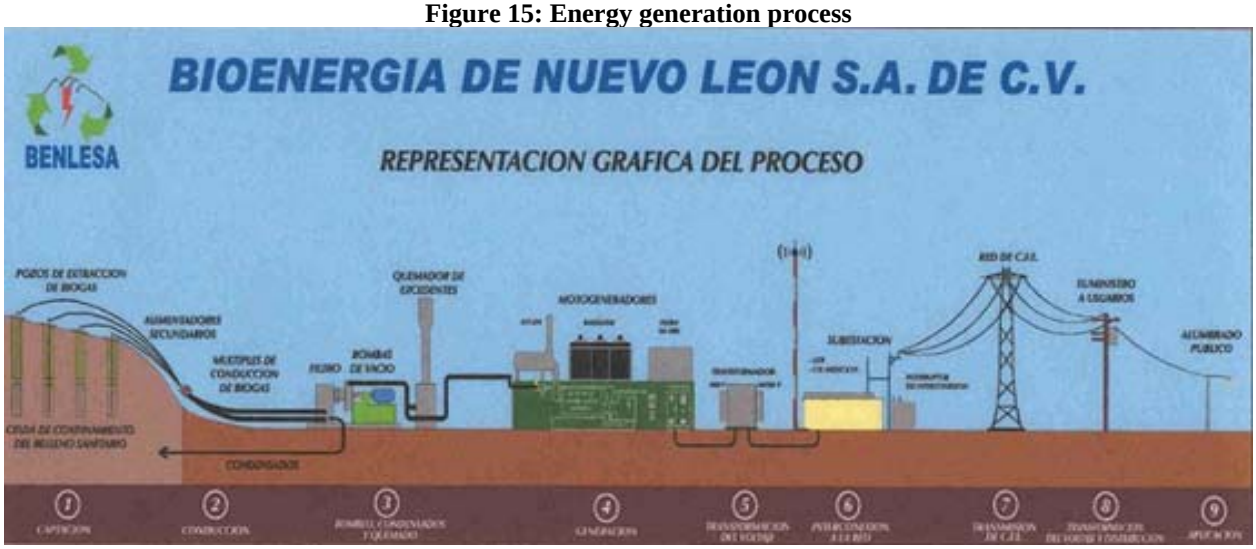
Sub-objective (B): Landfill gas technical, institutional and managerial knowledge and results of demonstration project disseminated to potential LFG project participants through technical reports, workshops, training, twinning arrangements and development of a national strategy. The achievement of this sub-component was rated satisfactory. The rating reflects the fact that at the start up of the project little knowledge was available in Mexico and in the region on LFG projects as well as of its potential for Mexico and the region. The activity has contributed to train SEDESOL staff on technical, institutional and managerial aspects of LFG projects. Specifically, five high level SEDESOL employees were trained on topics ranging from the generation of methane in landfills to its composition and several uses.

The activity also resulted in the visit of three SEDESOL employees to landfill facilities in the US in order to become more familiar with the technology used for LFG capture and use and operation of LFG facilities. This sub-component was key in developing technical support material about each stage in the use of LFG including social and legal aspects as well as in elaborating associated dissemination documents. SEDESOL developed an inter-active CD about the use of LFG and two videos on: (i) the actual situation of waste management in Mexico and the use of LFG, and (ii) the use of LFG generated in landfills for final disposal of municipal solid waste in the case of Monterrey. With the objective to disseminate the elaborated material and specifically the

[29] 30% of power requirements for street lighting of the metropolitan area of Monterrey are provided by the Monterrey plant.
[30] With the expansion of the Monterrey plant, 100% of Metrorrey's power requirements will be covered.

Monterrey experience to as many municipalities as possible SEDESOL carried out several fora, seminaries and workshops and developed a Manual for the Mexican LFG Model. In 2004 SEDESOL organized a national congress in order to disseminate the Monterrey experience. The congress counted with the participation of public employees, representatives from the private and the academic sector, and other interested parties. The broad participation in the national congress was crucial to gaining public acceptance of the LFG Model. The results of the congress were broadcast live by radio.[31] Following the dissemination of the congress results, the National Politechnical Institute started to include the use of LFG as an option to reduce GHG emissions in its professional interdisciplinary engineering program.

Figure 15: Energy generation process



With regard to **capacity building** SEDESOL held three workshops with a total of 156 participants from 42 municipalities. The activity achieved its objective of building knowledge and developing technical capacities among public employees with regard to LFG management, including the planning, evaluation, supervision, design and operation of LFG facilities. The workshops also addressed the development of a **replication strategy**. The workshops identified the need to support the municipalities in the development of feasibility studies for the capture and use of LFG in their solid waste disposal facilities as a first step in the decision making process on the use of LFG. The project's capacity building and dissemination components were subsequently restructured to provide funding for the feasibility studies (see paragraph 6.5 for further detail).

Four feasibility studies and a composting study were completed:.

i) Leon (Guanajuato)- with an estimated potential of 127 million m3 of methane and an anticipated installation of 2 MW. The expected emission reduction would amount to 1.3 million tCO2e in 20 years.

ii) Ciudad Juarez (Chihuahua) -with an estimated potential for 0.85 MW and a CO2e reduction of 0.58 million t in 20 years.

[31] The radio station "Radio Capital" of the Toluca municipality also broadcasted an interview with the General Director of the SEDESOL department for equipment and infrastructure in marginalized urban zones, and the General Director of consultant firm "Estudios y Técnicas Especializadas en Ingenieria, S.A. de C.V." (ETEISA). The interview pointed out the importance of the Monterrey Project and the negative implications of not improving waste management practices and addressing related GHG emissions.

iii) Cuautitlan Izcalli (State of Mexico)- with an estimated potential of 1 MW and a projected reduction of 0.48 million t CO2e in 21 years;

iv) Puerto Vallarta (Jalisco) -with an estimated methane production of 54.14 million m3 corresponding to a reduction of 0.75 million t CO2e (in 21 years) and with an installed capacity of 1 MW.

v) Composting studies for Queretaro, Tlanepantla, Nuevo Laredo, analyzing their technical, political and social feasibility were conducted. The studies indicated that composting would be economically feasible if the total generated compost was sold. The analysis did not include the savings generated by avoiding the disposal of the waste used for composting which would contribute to covering operational costs.

Sub-objective (C): Identification of LFG legislative needs and manner by which these needs could be integrated into federal legislation. The achievement of this sub-component was rated satisfactory. The study resulted in a first draft for the regulation of LFG. Based on the results of this study technical SEDESOL staff participated in the formulation of the Official Mexican Norm NOM-083-SEMARNAT-2003. This norm established the extraction, capture, conduction and control of LFG generated in final disposal facilities. At the same time SEDESOL actively collaborated in national and international fora with representatives from the public and private sectors in order to advance on the consideration of the LFG generated in final disposal facilities as a renewable energy source. While LFG to power as a renewable energy has not been fully integrated into federal legislation, efforts undertaken under component C did result in modifications to the regulations for solid waste management.

Figure 16: Flares and lake

Figure 17: LFG facility

Sub-objective (D): Mexican Experience disseminated regionally. The achievement of this sub-component was rated satisfactory. The dissemination efforts have been very successful. SEDESOL has managed to disseminate the Monterrey experience and the potential of LFG use and capture projects throughout the region SEDESOL developed several activities, such as it conducted a study of economic and technical effectiveness of LFG plants worldwide and identified the technical, financial and institutional barriers to implementation in developing countries as well as a best practice model appropriate to the Latin American context. It also managed to issue over 20 technical documents (now in project files) and produced several videos. SEDESOL has held two international conferences, with 189 participants representing 12 Mexican

municipalities and 7 countries (Colombia, Ecuador, Bolivia, Argentina, Honduras, Guatemala and Perú). They also produced a manual for project promoters and disseminated information on the Mexican model for the calculation of LFG potential at Mexican sites, based on local information. Listed are some of the documents that were prepared: i) design of capture and use of LFG in closed disposal facilities; ii) study of scavengers situation; iii) design of a national strategy for the construction and start up of landfills; iv) evaluation of financial capacities for the construction and start up of capture and use of LFG projects; v) viability in the use LFG as renewable energy for municipal services; vi) evaluation of the impact of recycling strategies on LFG projects; and vi) replication methodology for Mexico. In 2004 SEDESOL set up a website with an interactive information system on the use of LFG (http://www.biogas.gob.mx). SEDESOL entered into an agreement with the Latin American Institute for Educative Communication, in 2003, to conduct teleconferences on topics related to municipal and urban services with special emphasis on solid waste and opportunities for the capture and use of LFG. In addition, ESMAP's "Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean" includes the Monterrey project as a successful model for LFG to energy projects, which is being followed region wide.

Sub-objective (E): SEDESOL and SIMEPRODE Project management team in place and operating successfully. The project management was rated satisfactory. Both implementing agencies and the private sector partner have operated during the whole implementation period in a very efficient manner achieving pre-defined performance indicators. Progress reports were satisfactorily delivered to the Bank in time. They enabled the evaluation of progress and the identification of critical issues. During project implementation SEDESOL and SIMEPRODE counted on specialized technical and administrative staff providing full time support to the project. The management structure of the plant (PPP) serves as a model for future projects. The construction process, the operation and maintenance of the plant, and the process of acquiring necessary permits and agreements for the operation of the plant as well as for the supply of the electricity to the users were conducted in a very satisfactory way by Bioelectrica.

8.3 Efficiency

(Net Present Value/Economic Rate of Return, cost effectiveness, e.g., unit rate norms, least cost, and comparisons; and Financial Rate of Return)

This project has demonstrated:

- a proven, cost-effective technology for LFG capture and use that results in reduction of GHG and serves as a model for the internalization of GHG control measures in SWM programs;
- an institutional structure for implementation of LFG projects, including private sector participation;
- clean energy generation at affordable, low cost.

	Appraisal	Achieved to date
IRR	27.6% (with GEF grant)	17%
NPV	US$ 7.2 (with GEF grant)	US$ 7.1 (million)

In terms of financial indicators, at project appraisal the internal rate of return of the project was estimated at 13.4 % and the NPV at USD 2.2 million without GEF financing. With the GEF grant the IRR was expected to increase to 27.6% and the NPV to 7.2 million. The financial analysis was run until 2021. At the end of the GEF project the project shows an IRR of 17% and a NPV of USD 7.1 million. The analysis per actor results in an IRR of 21% and NPV of USD 5.5 million for SIMEPRODE, and an IRR of 13% and a NPV of USD 1.5 million for Bioelectrica. The annual revenues show an increasing trend for SIMEPRODE and Bioelectrica. The difference between the initially estimated financial indicators and the actual ones lies in three unexpected factors (see paragraph 7.2 for further details):

- Additional operation and maintenance cost because of siloxanes and initial problems in the adaptation of European technology to Mexican conditions
- Additional back up and transmission costs charged by CFE
- Problems in the transmission line caused interruptions in the energy supply to the energy users

The investment estimated for the expansion of the Monterrey plant is US$6.5 million for 5.3 MW in comparison to US$10.8 for 7MW for the first Monterrey plant. This demonstrates how the project has resulted in promoting gains in efficiency and economics of scale.

Economic Analysis. The economic analysis conducted for a period of 20 years is based on the estimation of the plant infrastructure cost, the operation and maintenance cost, and the transmission cost. In addition the residual value of the plant at the end of the lifetime of the analysis is considered. On the benefit side, the analysis considers the electricity generated valued at the price sold to the energy users specified in figure 12 and the environmental benefits in terms of reduced GHG. The project also generates health benefits through reduced local pollutants and reduced explosion risk. However, the analysis does not take the reduction of local pollutants and their impact into account.

The project generates GHG emission reductions through two sources. In the site the LFG is collected and burned for combustion, thus converting its methane content into CO2, reducing its GHG effect. In addition, the generation and supply of electricity to the electrical grid, displaces a certain amount of fossil fuels used for electricity generation. The Baseline scenario for the emission reductions associated with the delivery of electric energy to the interconnected national grid is the electricity delivered to the grid multiplied by an emission coefficient (measured in kg of CO2e/KWh) calculated in a transparent and conservative manner for the Mexican National Grid as the average of the “approximate operating margin” and the “build margin”, where:

(i) The “approximate operating margin” is the weighted average emissions (in kg CO2e/KWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;

(ii) The "build margin" is the weighted average emissions (in kg CO2e/KWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the 5 most recent plants.

The relative weighting of the operating margin emission rate and the build margin emission rate will depend on the characteristics of the electric sector. The proposed default weighting is an average of the operating and the build margins, where:

$$BaselineEmissionRate(tCO_2 / MWh) = \frac{0.764 + 0.404}{2} = 0.584$$

The results of the project's economic assessment over a target period of 20 years are presented in the following table. The analysis considered two different emission reductions price scenarios (USD 10 / t CO2e and US$ 15/ t CO2e) .

Emission reduction price: US$ 10 / t CO2e	
ERR	25%
NPV	US$ 11.10 million
Cost Benefit Ratio	2.65

Emission reduction price: US$ 15 / t CO2e	
ERR	34%
NPV	US$ 19.34 million
Cost Benefit Ratio	3.06

8.4 Justification of Overall Outcome Rating

(combining relevance, achievement of GEOs, and efficiency)

Rating: Satisfactory

This rating reflects the fact that the project achieved all the outcome indicators as defined in the PAD. Specifically the project was able to demonstrate a cost-effective technology for LFG capture and use in the selected facility; to demonstrate an institutional structure for the implementation of LFG projects, including private sector participation; to strengthen the UMS's regulatory policy and social frameworks for the introduction of LFG capture and use in Mexico; to design a dissemination strategy to share the lessons learned throughout Project implementation with relevant stakeholders in Mexico and Latin America; and to design a strategy to encourage the replication of the project in Mexico.

8.5 Overarching Themes, Other Outcomes and Impacts

(if any, where not previously covered or to amplify discussion above)

(a) Poverty Impacts, Gender Aspects, and Social Development

Through the operation of this plant, as of October 1, 2006, 181,216 MWh of electricity have been generated, benefiting the population of seven municipalities in the Monterrey Metropolitan Area with clean and cheaper energy. In addition nearby inhabitants (approximately 10,000) have benefited from the project through reduced landfill emissions.

(b) Institutional Change/Strengthening *(particularly with reference to impacts on longer-term capacity and institutional development)*

The implementation of the first LFG facility in Latin America has demonstrated a feasible institutional structure involving the private sector in a mainly public sector domain. The project has contributed to the process of incorporating the treatment of LFG as a cost-effective and clean option in waste management approaches. One of the major barriers identified during project preparation was the participation of the municipalities in this and future projects. This barrier is based on short administration periods and reluctance to invest in this kind of project because of high initial investment cost without immediate results and because of lack of information e.g. on economic benefits and financial indicators. However, municipalities in the Monterrey metropolitan area have been fully on board during the whole implementation process. The reduced electricity price was key in the negotiation process and continues to represent a strong incentive as well as additional resources for the municipalities. At the same time the capacity building and dissemination components of the project have resulted in the training of 468 technical staff country wide involved in municipal waste management on LFG. Several municipalities are now in the process of developing replication projects (four feasibility studies have been supported under this project; the follow up project involves three more sites under carbon finance). The project has also strengthened SEDESOL's capacity with regard to LFG initiatives.

(c) Other Unintended Outcomes and Impacts (positive or negative, if any)

None

8.6 Summary of Findings of Beneficiary Survey and/or Stakeholder Workshops (optional for Core ICR, required for ILI, details in annexes)

Participants in the closing workshop were represented by both the implementing agencies, Banobras (the financial intermediary), the Bank, and representatives from four municipalities and from the Ministry of Environment. The whole day session highlighted the achievements of the project and demonstrated the progress in replicating the Monterrey experience.

9. Assessment of Risk to Global Environment Outcome

Rating: Low

The risk that the development outcomes of the project will not be maintained is very low. The plant is operating very satisfactorily and in a financially and institutionally sustainable way. The project can be credited with having built public and private sector capacity to promote and manage

LFG projects in Mexico thus strengthening the sustainability of this project and promoting the development of future projects. In addition, the project has removed most of the barriers to the implementation of LFG projects in Mexico.

On the contractual side, the agreements with CFE are long-term and valid as long as the plant is operating. The contracts with the municipalities and with the other energy consumers are for a duration of five years. The contracts specify that unless one of the parties wishes to terminate the agreement, they are automatically extended. Considering the economic benefits for the municipalities through the reduced price of electricity, the risk of the discontinuity in purchasing the services is very low. The cost of street lighting represents one of the highest expenses carried by the municipalities. The cost savings provides municipalities with additional resources for other expenditures.

Plans are already underway for the expansion of the Monterrey plant. Together with SEISA, Monterrey II has been developed as a carbon finance operation (see paragraph 8.1 for further details). The risk incurred in the original project related to the deficient transmission line is expected to be solved by setting up a substation for the expansion of the Monterrey plant. All the risks identified at appraisal stage as substantial have been overcome during project implementation, such as: (i) identification of adequate non-GEF financing mechanisms for future replication; (ii) effectiveness of dissemination and training programs in reducing barriers to replication in Mexico and LAC; and (iii) payment by electricity consumers. The risk of not identifying adequate non-GEF financing mechanisms for future replication has been mitigated by supporting future projects through carbon emission reduction revenues. The first ERPA in Mexico has been signed for three sites and the related projects will be implemented following the Monterrey example in 2007. Regarding the payment by electricity consumers, no delays in the payments by the municipalities have been reported to date.

The capacity building, dissemination and replication components developed by SEDESOL are further strengthening the sustainability of this and of future projects. Under the replication activities five feasibility studies have been developed and the potential for composting has been identified for Mexico. The Aguascalientes plant has already started operation this year (2006 - gas flaring; 2007 - cogeneration facility) based on the Monterrey experience and benefiting from emission reduction revenues. The GEF project can be credited with having developed the capacity for developing and implementing LFG projects in Mexico and with having removed the barriers for its implementation.

10. Assessment of Bank and Borrower Performance

10.1 Bank

(a) Bank Performance in Ensuring Quality at Entry
(i.e., performance through lending phase)

Rating: Satisfactory

The Bank performance at project entry was satisfactory. The project was well identified, responsive to the request and needs of the country and consistent with the Bank's Country Assistance Strategy (CAS), government priorities and the UNFCCC. The delay in the project's effectiveness was smoothed out by the performance of the implementing agencies and the Bank. The technical assistance and appraisal process provided a thorough assessment that resulted in a smooth project implementation. The project site was adequately selected. The performance indicators were realistic and useful for assessing the progress towards achieving the project objectives. The support provided to the implementing agencies was adequate and issues and potentials were identified and addressed on time.

(b) Quality of Supervision
(including of fiduciary and safeguards policies)

Rating: Satisfactory

Bank supervision is rated as satisfactory. The Bank team visited the project approximately twice a year. In addition to the review of progress reports provided by the clients and to continuous interaction with the clients, the visits further helped the team to address issues proactively and to support the achievements of project objectives. At the same time the Bank team was flexible and proactive, accelerating the replication efforts by revising the project technical assistance to support several feasibility studies and by developing the first carbon finance operation based on the Monterrey model.

(c) Justification of Rating for Overall Bank Performance

Rating: Satisfactory

The overall performance rating of the Bank is satisfactory. This is based on the quality of preparation and supervision, and the experience and proactivity of the Bank team. The clients also rated the performance of the Bank as satisfactory. The technical and financial knowledge of the team was deemed very useful for project implementation. The twice a year supervision missions by the Bank were just right to stay abreast of implementation progress to guarantee an overall project supervision beyond desk reviews of issued progress reports and continuous interaction with the client. The Bank support was considered beneficial for the capacity building and dissemination activities. The involvement of the Bank reassured the clients that the funds would be managed in a transparent and efficient way. The clients however expressed some concerns that the bureaucracy of the Bank would increase transaction cost because of lengthy and complex procedures inside the Bank.

10.2 Borrower

(a) Government Performance

Rating: Satisfactory

The overall government performance is rated satisfactory. The project set a precedent in dealing with LFG power projects. The ground breaking nature of the project explains much of the delay between approval and effectiveness, during which complex arrangements were required to secure the agreements between different agencies involved in project implementation. To justify this rating it is essential that we emphasis the role of the many public actors involved:

Municipalities: Municipalities were key in the business model, they issued letters of intention which ensured the revenues generated by the electricity sale to the municipalities could be considered at the time the rate of return was calculated.

State of Nuevo León: As Grant recipient and gas provider, it played a key role in decreasing the project's risk. It also facilitated negotiations with federal authorities.

CRE/CFE: Government entities that issued permits and contracts. Despite willingness to support the project, the bureaucracy made it slow and complicated.

Legislation: The lack of legislation on this subject caused delays, confusion, lack of support, and discontent by stockholders when costs increased.

(b) Implementing Agency or Agencies Performance

Rating: Satisfactory

Implementing Agency	Performance
SIMEPRODE	The performance of SIMEPRODE was rated satisfactory insofar as it complied with the responsibilities assigned during appraisal. The responsibilities consisted in supervising the construction of the plant, operating the plant and realizing the technical and financial evaluation of the project. In addition SIMEPRODE carried out the following activities: • Competing with different cities around the country to obtain the GEF grant to carry out the project. • Carrying out the bidding process to select the strategic partner. • Processing documentation and permits with CRE, CFE, and SUTERM. • Processing environmental documentation and permits. • Monitoring and surveillance of LFG production. By project completion SIMEPRODE has achieved: • Construction of the plant in accordance with pre-defined schedule, design and budget; • Exceeding performance indicators in terms of plant operation and environmental impacts; • Expansion of Monterrey plant.
SEDESOL	The performance of SEDESOL was rated satisfactory. The rating reflects the achievement of most of the pre-defined performance indicators. In addition SEDESOL issued the progress reports in a timely and satisfactory manner. In terms of specific outcomes SEDESOL can be credited with the production of:

	• Study of LFG projects worldwide • Method for the development of a LFG project in Mexico • Design of a system to capture and use LFG • Mexican LFG model • Preparation and dissemination of extensive dissemination material • Four capacity building workshops with 220 participants from 55 municipalities • Two international conferences • Set up of Website for project • Four feasibility studies for LFG projects in Mexico and one composting study • Legal study for LFG inclusion into federal legislation

(c) Justification of Rating for Overall Borrower Performance

Rating: Satisfactory

The overall performance of the overall borrower performance was satisfactory.
This rating reflects the fact that the project was able to demonstrate a cost-effective technology for LFG capture and use in a selected facility; to demonstrate an institutional structure for the implementation of LFG projects, including private sector participation; to strengthen the UMS's regulatory policy and social frameworks for the introduction of LFG capture and use in Mexico; to design a dissemination strategy to share the lessons learned throughout project implementation with relevant stakeholders in Mexico and Latin America; and to design a strategy to encourage the replication of the project in Mexico. The implementing agencies are credited with these achievements.

Further, the Monterrey plant has outperformed most technical standards. It has delivered emission reductions at a rate twice the original estimate; it has been on line 91% of the time and has successfully adapted the technology to local environmental conditions. The dissemination and training program was closely linked to the operation of the plant and has delivered on all of its objectives. The current carbon finance facility for LFG use units under SEISA can be deemed a direct result of the success of the Monterrey experience.

BANOBRAS was the financial intermediary. BANOBRAS appointed a core group of staff with the required expertise to assist in the intermediation process. During the preparation and supervision stages, BANOBRAS provided the necessary inputs. BANOBRAS also participated in most field visits during supervision and was instrumental in providing information on the status of accounts, contracting processes, including bidding, and procurement information on a timely basis. Audits were done on a timely basis. The project did benefit from the participation of BANOBRAS.

The performance of the strategic partner was highly satisfactory. The private sector partner was selected through an international competitive bidding process (using Bank Procurement guidelines) and has provided 53% of the financing of the plant (USD 5.9 million of a total investment of USD 10.8 million). The construction process, the operation and maintenance of the plant, and the process of acquiring necessary permits and agreements for the operation of the plant as well as for the supply of the electricity to the users were conducted in a very satisfactory way by Bioenergia.

11. Lessons Learned

Adaptation of foreign technology to local conditions needs to be taken into account in the initial economic evaluation of a project. The acquisition of foreign technology entails adaptation to local conditions but also additional maintenance cost during operation of the plant. In the case of Monterrey this has led to considerable additional cost for the operator and to delays.

Due to current LFG legislation, additional time is needed to process the corresponding permits and/or contracts. Though the project has removed several regulatory barriers and Mexico implemented its regulation of LFG there are still uncertainties and gaps within Mexican Law with regards to the consideration of LFG as renewable energy source. This may lead to lengthy procedures in obtaining the necessary permits and in establishing contracts with energy consumers which need to be taken into account while planning LFG projects.

Initial gas estimation. Future projects should seek more certainty on the amount of available gas in order to avoid additional cost once the plant is set up. Field measurements and conservative mathematical model to estimate the gas amount will help in that regard.

Continuous dissemination and capacity building process. The administration periods of municipal authorities in charge of SWM are relatively short (three years). This makes the learning process on LFG management at times difficult. For that reason a continuous dissemination and capacity building program is essential to sustain municipal buy in. In this regard incentives such as discounts on electricity prices, and the potential for improved local environmental and social conditions through LFG projects, have proven to be helpful. Project financed feasibility studies have been important factors in the municipalities' decision to engage in LFG projects.

Involvement of the private sector. The involvement of the private sector has been very effective and proven feasible in a mainly public sector domain. In the context of changing governments, the private sector involvement helped ensure that the plant management would be consistent and uninterrupted.

High energy prices benefit LFG to power projects in Mexico. The energy price charged by the CFE is relatively high in the regional context (twice as high compared to Colombia). This had a considerable impact on the project's financial indicators. However, in countries with lower energy prices the LFG to power option might not be financially feasible. The flaring of the LFG provides an option that generates emission reductions and helps at the same time improve final disposal practices. Future energy price scenarios should be taken into account while assessing the feasibility of LFG to power projects.

Financing tools for LFG projects. In future many uncertainties while planning and setting up a LFG facility can be overcome with the perspective of a long-term and reliable revenue generated from emission reductions. The availability of emission reductions revenues provides an investor with more certainty on his investment and also bears the possibility of addressing social and environmental programs with part of the revenues. The option of carbon finance as a financing tool needs to be further disseminated.

12. Comments on Issues Raised by Borrower/Implementing Agencies/Partners

(a) Borrower/implementing agencies
See Annex 10.

(b) Cofinanciers

(c) Other partners and stakeholders
(e.g. NGOs/private sector/civil society)

Annex 1. Results Framework Analysis

Global Environment Objectives

Project Development Objective:

The proposed GEF project sought to demonstrate a proven technology for landfill gas (LFG) capture and use and reduce barriers to development of future LFG projects. The GEF project built upon an existing Government and Bank-supported program to modernize solid waste management in small- and medium-sized cities. The project was intended to result in immediate reductions in emissions of greenhouse gases (GHG) and to serve as a model for the internalization of GHG control measures in solid waste management programs.

The objectives of the Project were to expand the assistance provided to the Recipient under the Baseline Project for the improvement of solid waste management by: (a) demonstrating a cost-effective technology for LFG capture and use in a selected facility; (b) demonstrating an institutional structure for the implementation of LFG projects, including private sector participation; (c) strengthening the UMS's regulatory policy and social frameworks for the introduction of LFG capture and use in Mexico; (d) designing a dissemination strategy to share the lessons learned throughout Project implementation with relevant stakeholders in Mexico and Latin America; and (e) designing a strategy to encourage the replication of the Project in Mexico.

Key performance indicators:

The LFG collection system and power plant to be installed and operated at the SIMEPRODE landfill located in Salinas Victoria near the Monterrey metropolitan area in the State of Nuevo León, the key physical activity of the project, was expected to capture or substitute for an equivalent of 0.99 million tons of carbon over 20 years. The key performance indicator for this component was that the demonstration LFG facility was shown to be technically, financially and institutionally feasible within the Mexican context. The key performance indicators that monitor the performance of the remaining components (Capacity Building, Policy and Regulatory Reform and Regional Dissemination) were: i) the number of potential participants in LFG projects in Mexico and Latin America to whom technical, institutional, and managerial knowledge on LFG were made available; ii) incorporation of LFG management issues into proposed legislation; iii) increase in number of government programs for support of LFG facility.

Revised Global Environment Objectives
The original GEO and performance indicators were not revised.

(a) GEO Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	Landfill gas capture and use facility proven to be technically, institutionally and financially feasible in the Mexican context.			
Value (quantitative or	Landfill gas is not being captured,	At least 155,000 MWh of electricity produced, at least 54 million cubic meters of methane collected and		Plant operates beyond performance indicators: Approximately 180,000

Qualitative)	landfill gas facility not constructed	destroyed, at least 95 % of energy sold to members of Cogeneration company.		MWh have been produced to date, around 70 million cubic meters of methane collected and destroyed, 95% of energy sold to members.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	The plant reached 70% of the emission reductions foreseen for 20 years in 3 years of operation.			
Indicator 2 :	Number of potential participants in LFG projects in Mexico to whom technical, institutional and managerial knowledge on LFG were made available.			
Value (quantitative or Qualitative)	0 Participants.	LFG technical, institutional, managerial knowledge and results of project disseminated to potential LFG project participants.		To date 468 technical staff involved with municipal waste management have been trained, five feasibility studies have been supported, Carbon finance operations developed for three landfill sites.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100%			
Indicator 3 :	Identification of LFG legislative needs and the manner by which these can be integrated into federal legislation.			
Value (quantitative or Qualitative)	No study realized in that regard.	Results of legislative study integrated in draft proposed legislation.		Legal study completed. Based on study formulation of the Official Mexican Norm NOM-083-SEMARNAT-2003.
Date achieved	05/30/2002	12/30/2005		10/20/2006
Comments (incl. % achievement)	80% of the objective has been achieved as the supported study has identified the LFG legislative needs and their integration in federal legislation. While LFG as renewable energy has not been fully integrated into federal legislation, efforts undertaken under component C did result in modifications to the regulations for solid waste management.			
Indicator 4 :	Mexican experience disseminated regionally.			
Value (quantitative or Qualitative)	No dissemination.	Region-wide dissemination through conferences, workshops, website. At least six follow up projects identified and initiated based on Monterrey experience.		Two international conferences held. ESMAP handbook includes project as model, followed regionwide. Five feasibility studies developed under project, one plant about to start operation next year, Carbon finance operation developed for three landfill sites. Project disseminated in Mexico and in Latin

				America.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100%			
Indicator 5 :	SEDESOL and SIMEPRODE Project Management Team in Place and Operating Successfully.			
Value (quantitative or Qualitative)	No Project Management.	Project successfully executed meeting all indicators by year 5.		Project was successfully executed and achieved performance indicators very satisfactorily. The implementing agencies executed their components as defined and in time.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100			

(b) Intermediate Outcome Indicator(s)

Indicator	Baseline Value	Original Target Values (from approval documents)	Formally Revised Target Values	Actual Value Achieved at Completion or Target Years
Indicator 1 :	LFG collection system, LFG treatment plant, Power plant, electrical substation and interconnection line in place and operating, and associated training provided.			
Value (quantitative or Qualitative)	No plant in place	Plant has successful record of operation.		Plant operation exceeds performance indicators. Plant in process of expansion.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100%			
Indicator 2 :	SEDESOL staff trained on LFG; Study tour for SEDESOL staff completed; technical materials disseminated to government and private entities; Public dissemination of project; LFG training courses held; National replication strategy developed.			
Value (quantitative or Qualitative)	No training and dissemination plan	SEDESOL staff trained; best practice manual developed; public dissemination conducted nationally through workshops, conferences, media; national replication strategy developed;		As a consequence of the project 468 technical staff trained, (replication efforts) five feasibility studies developed and ERPA for three sites signed.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100% The objectives of this component were fully achieved on the training and dissemination components even though some activities were replaced by feasibility studies. The			

	replication study went beyond its objectives by preparing the ground to the actual replication of the Monterrey experience through the financing of feasibility studies.			
Indicator 3 :	Legal study completed;			
Value (quantitative or Qualitative)	No legal assessment	Results of study integrated in proposed federal legislation.		Consideration of LFG use as renewable energy source on stand by; Resubmission to new administration. Regulation on establishment of LFG facilities advanced.
Date achieved	05/30/2002	12/30/2006		10/20/2006
Comments (incl. % achievement)	80%			
Indicator 4 :	Study on LFG projects worldwide conducted; International LFG workshop carried out; dissemination materials: Production of manual for project promoters dissemination of Mexican LFG model;			
Value (quantitative or Qualitative)	No study	Study completed		Study completed; project successfully disseminated through various media in Mexico and Latin America; Project serves as model for this type of project.
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100% Beside the study on LFG projects worldwide, the component resulted in two international conferences and in producing a manual for project promoters and in developing the Mexican LFG model. The project is integrated as model in the ESMAP handbook.			
Indicator 5 :	2 feasibility studies for LFG projects in Mexico developed and 2 more are planned in the framework of the project (replication);			
Value (quantitative or Qualitative)	No studies of additional plants	Four feasibility studies have been commissioned.		Five feasibility studies developed (including a composting composting study) and providing good basis for replication
Date achieved	05/30/2002	06/30/2006		10/20/2006
Comments (incl. % achievement)	100%			

Annex 2. Restructuring (if any)

Annex 3. Project Costs and Financing

(a) Project Cost by Component (in USD Million equivalent)

Components	Appraisal Estimate (USD M)	Actual/Latest Estimate (USD M)	Percentage of Appraisal
DETAILED ENGINEERING DESIGN AND CONSTRUCTION OF A PLANT FOR METHANE CAPTURE AND USE	4.92	4.92	100.00
CAPACITY BUILDING	0.60	0.60	100.00
REGULATORY REFORM	0.05	0.05	100.00
REGIONAL (LAC) DISSEMINATION	0.50	0.50	100.00
PROJECT MANAGEMENT	0.20	0.20	100.00
Total Baseline Cost	**6.27**	**6.27**	
Physical Contingencies	0.00		
Price Contingencies	0.00		
Total Project Costs	**6.27**		
Front-end fee PPF	0.00	0.00	0.00
Front-end fee IBRD	0.00	0.00	0.00
Total Financing Required	**6.27**	**6.27**	

b) Financing

Source of Funds	Type of Cofinancing	Appraisal Estimate (USD M)	Actual/Latest Estimate (USD M)	Percentage of Appraisal
Borrower		0.40	0.52	> 100%
GLOBAL ENVIRONMENT FACILITY		6.27	6.27	100%
FOREIGN PRIVATE COMMERCIAL SOURCES (UNIDENTIFIED)		6.58	5.8	88%

(c) Disbursement Profile

Annex 4. Outputs by Component

Component and Objectives	Achieved output and rating
Detailed Engineering Design and Construction of a Plant for Methane Capture and Use: Landfill gas facility successfully collecting LFG, producing energy and selling electricity.	The achievement of this sub-objective was rated **satisfactory** insofar as the plant operates above design performance indicators. The plant which is the first LFG facility in Latin America has been built without delays and started operation in September 2003[32]. Seven generators are installed and generating 7.42 MW of which during the night 4.9 MW are sold to the municipalities for street lighting[33]. CFE receives 2.3 MW, of which 0.2 MW are used for self consumption (see figure 12). During the day Metrorrey (see figure 13) receives 5.9 MW satisfying 80% of their demand[34], 1 MW is distributed between "Aguas y Drenaje", DIF and the State, and the remaining 0.3 MW are used for self consumption. The PPP structure of the plant has proven to be successful and independent of changing administrations. The plant is currently in a process of expansion. In addition to good performance, efforts have been invested in making sure that the plant looks good. A board announces the support of the Bank-GEF, a real-time display accounts the methane used, power generated and equivalent CO2 displaced. Gardens surround the site, including a lagoon, and a gardened path leads to the entrance of the plant. The information and capacity building center and the plant count with a high number of national and international visitors.
Capacity building. Landfill gas technical, institutional and managerial knowledge and results of demonstration project disseminated to potential LFG project participants through technical reports, workshops, training, twinning arrangements and development of a national strategy.	The achievement of this sub-component was rated **satisfactory.** The rating reflects the fact that at the start up of the project little knowledge was available in Mexico and in the region on LFG projects as well as of its potential for Mexico and the region. The activity has contributed to train SEDESOL staff on technical, institutional and managerial aspects of LFG projects. Specifically, five high level SEDESOL employees were trained on topics ranging from the generation of methane in landfills to its composition and several uses. The activity also resulted in the visit of three SEDESOL employees to landfill facilities in the US in order to become more familiar with the technology used for LFG capture and use and operation of LFG facilities. This sub-component was key in developing technical support material about each stage in the use of LFG including social and legal aspects as well as in elaborating

[32] The LFG system includes: 248 extraction wells with monitoring valves, collection pipes for conduction and control, three vacuum pumps, filters, two flare stations for gas flaring. The latter operates as needed. The power generation equipment consists of 7 modular generator sets, automated control equipment, seven set up transformers, switchgear to feed the grid (CFE) lines. Other installations include: remote terminal unit, measurement equipment, offices, warehouse and maintenance facilities, training facility.

[33] 30% of power requirements for street lighting of the metropolitan area of Monterrey are provided by the Monterrey plant.

[34] With the expansion of the Monterrey plant, 100% of Metrorrey's power requirements will be covered.

	associated dissemination documents. SEDESOL developed an inter-active CD about the use of LFG and two videos on: (i) the actual situation of waste management in Mexico and the use of LFG, and (ii) the use of LFG generated in landfills for final disposal of municipal solid waste in the case of Monterrey. With the objective to disseminate the elaborated material and specifically the Monterrey experience to as many municipalities as possible SEDESOL carried out several fora, seminaries and workshops and developed a Manual for the Mexican LFG Model. In 2004 SEDESOL organized a national congress in order to disseminate the Monterrey experience. The congress counted with the participation of public employees, representatives from the private and the academic sector, and other interested parties. The broad participation in the national congress was crucial to gaining public acceptance of the LFG Model. The results of the congress were broadcast live by radio.[35] Following the dissemination of the congress results, the National Politechnical Institute started to include the use of LFG as an option to reduce GHG emissions in its professional interdisciplinary engineering program. With regard to **capacity building** SEDESOL held three workshops with a total of 156 participants from 42 municipalities. The activity achieved its objective of building knowledge and developing technical capacities among public employees with regard to LFG management, including the planning, evaluation, supervision, design and operation of LFG facilities. The workshops also addressed the development of a **replication strategy**. The workshops identified the need to support the municipalities in the development of feasibility studies for the capture and use of LFG in their solid waste disposal facilities as a first step in the decision making process on the use of LFG. The project's capacity building and dissemination components were subsequently restructured to provide funding for the feasibility studies (see paragraph 6.5 for further detail). Four feasibility studies and a composting study were completed:. iv) Leon (Guanajuato)- with an estimated potential of 127 million m3 of methane and an anticipated installation of 2 MW. The expected emission reduction would amount to 1.3 million tCO2e in 20 years. v) Ciudad Juarez (Chihuahua) -with an estimated potential for 0.85 MW and a CO2e reduction of 0.58 million t in 20 years. vi) Cuautitlan Izcalli (State of Mexico)- with an estimated potential of 1 MW and a projected reduction of 0.48 million t CO2e in 21 years;

[35] The radio station "Radio Capital" of the Toluca municipality also broadcasted an interview with the General Director of the SEDESOL department for equipment and infrastructure in marginalized urban zones, and the General Director of consultant firm "Estudios y Técnicas Especializadas en Ingenieria, S.A. de C.V." (ETEISA). The interview pointed out the importance of the Monterrey Project and the negative implications of not improving waste management practices and addressing related GHG emissions.

	iv) Puerto Vallarta (Jalisco) -with an estimated methane production of 54.14 million m3 corresponding to a reduction of 0.75 million t CO2e (in 21 years) and with an installed capacity of 1 MW. v) Composting studies for Queretaro, Tlanepantla, Nuevo Laredo, analyzing their technical, political and social feasibility were conducted. The studies indicated that composting would be economically feasible if the total generated compost was sold. The analysis did not include the savings generated by avoiding the disposal of the waste used for composting which would contribute to covering operational costs.
Regulatory reform. Identification of LFG legislative needs and manner by which these needs can be integrated into federal legislation.	The achievement of this sub-component was rated **satisfactory.** The study resulted in a first draft for the regulation of LFG. Based on the results of this study technical SEDESOL staff participated in the formulation of the Official Mexican Norm NOM-083-SEMARNAT-2003. This norm established the extraction, capture, conduction and control of LFG generated in final disposal facilities. At the same time SEDESOL actively collaborated in national and international fora with representatives from the public and private sectors in order to advance on the consideration of the LFG generated in final disposal facilities as a renewable energy source. While LFG to power as a renewable energy has not been fully integrated into federal legislation, efforts undertaken under component C did result in modifications to the regulations for solid waste management.
Regional (Latin America) Dissemination. Mexican experience disseminated regionally (LAC)	The achievement of this sub-component was rated **satisfactory.** The dissemination efforts have been very successful. SEDESOL has managed to disseminate the Monterrey experience and the potential of LFG use and capture projects throughout the region SEDESOL developed several activities, such as it conducted a study of economic and technical effectiveness of LFG plants worldwide and identified the technical, financial and institutional barriers to implementation in developing countries as well as a best practice model appropriate to the Latin American context. It also managed to issue over 20 technical documents (now in project files) and produced several videos. SEDESOL has held two international conferences, with 189 participants representing 12 Mexican municipalities and 7 countries (Colombia, Ecuador, Bolivia, Argentina, Honduras, Guatemala and Perú). They also produced a manual for project promoters and disseminated information on the Mexican model for the calculation of LFG potential at Mexican sites, based on local information. Listed are some of the documents that were prepared: i) design of capture and use of LFG in closed disposal facilities; ii) study of scavengers situation; iii) design of a national strategy for the construction and start up of landfills; iv) evaluation of financial capacities for the construction and start up of capture and use of LFG projects; v) viability in the use LFG as renewable energy for

	municipal services; vi) evaluation of the impact of recycling strategies on LFG projects; and vi) replication methodology for Mexico. In 2004 SEDESOL set up a website with an interactive information system on the use of LFG (http://www.biogas.gob.mx). SEDESOL entered into an agreement with the Latin American Institute for Educative Communication, in 2003, to conduct teleconferences on topics related to municipal and urban services with special emphasis on solid waste and opportunities for the capture and use of LFG. In addition, ESMAP's "Handbook for the Preparation of Landfill Gas to Energy Projects in Latin America and the Caribbean" includes the Monterrey project as a successful model for LFG to energy projects, which is being followed region wide.
Project Management. SEDESOL and SIMEPRODE Project Management Team in Place and Operating Successfully	The project management was rated **satisfactory.** Both implementing agencies and the private sector partner have operated during the whole implementation period in a very efficient manner achieving pre-defined performance indicators. Progress reports were satisfactorily delivered to the Bank in time. They enabled the evaluation of progress and the identification of critical issues. During project implementation SEDESOL and SIMEPRODE counted on specialized technical and administrative staff providing full time support to the project. The management structure of the plant (PPP) serves as a model for future projects. The construction process, the operation and maintenance of the plant, and the process of acquiring necessary permits and agreements for the operation of the plant as well as for the supply of the electricity to the users were conducted in a very satisfactory way by Bioelectrica.

Annex 5. Economic and Financial Analysis (including assumptions in the analysis)

A detailed financial analysis was performed at the beginning and at the end of the project. The results are shown below:
Investment costs: At appraisal the costs of design and construction of the LFG capture and use facility were determined through a detailed technical design of the collection system and power plant to be constructed at the SIMEPRODE landfill. The costs were confirmed through quotes by suppliers. The following table demonstrates the cost estimates at appraisal with actual costs. Exchange rate changes need to be taken into consideration:

	Appraisal	**Actual**
Item	**Cost (pesos)**	**Real (pesos)**
	Budget	Budget
Gas collection system	18,020,000	22,225,276
Treatment plant	500,000	
Engine house	400,000	3,894,120
Engines	49,815,000	
	9963000	75,284,324
Electrical substation (34.5 kV)	7,670,000	2,088,000
Interconnection line	4,000,000	5,481,000
Training	350,000	
Subtotal	90,718,000	108,972,720
Contingencies (10% physical; 7% price)	15,422,060	3,779,280
Total Investment	106,140,060	112,752,000
Total Investment (USD)*	(US $11.5 million)	US $10.8 million

*The total investment costs are provided based on the exchange rate valid at the time of the financial evaluation.

Differences between the originally estimated and the actual cost items include:

- The training of the operators was carried out as part of the capacity building under component 2 of the GEF Project, and thus not considered under component 1.
- The LFG treatment plant was found to be not necessary anymore.
- An engine house as such was not built. The actual item includes civil works for the set up of the generators, the office, workshop and capacity center.
- The substation resulted more economic than previously estimated.

The current and projected project cash flow including the financial indicators per actor is as follows (in USD):

Estimated Project Cash Flows			
Bioenergía de Nuevo León, S.A. de C.V.			
YEAR	Simeprode (investment includes GEF grant for component 1) *	Bemsa*	Global*
0	($5.08)	($5.72)	($10.80)
1	$0.09	$0.09	$0.18
2	$1.01	$0.93	$1.94
3	$1.49	$0.48	$1.97
4	$1.19	$0.84	$2.03
5	$1.22	$0.86	$2.09
6	$1.26	$0.89	$2.15
7	$1.30	$0.91	$2.21
8	$1.34	$0.94	$2.28
9	$1.38	$0.97	$2.35
10	$1.42	$1.00	$2.42
11	$1.46	$1.03	$2.49
12	$1.51	$1.06	$2.57
13	$1.55	$1.09	$2.64
14	$1.60	$1.12	$2.72
15	$1.64	$1.16	$2.80
16	$1.69	$1.19	$2.89
17	$1.74	$1.23	$2.97
18	$1.80	$1.27	$3.06
19	$1.85	$1.30	$3.16
20	$1.91	$1.34	$3.25
IRR	21%	13%	17%
NPV* 10%	$5.54	$1.53	$7.07

:

In the first 3 years of implementation the SIMEPRODESO and Bioelectrica have obtained the following results on average:

Cash Flow by actor for the first years of implementation in USD:

Year	Simeprode	Bioelectrica de Monterrey (BEMSA)
2003	$90,916	$89,155
2004	$1,010,289	$929,830
2005	$1,488,528	$478,887
2006*	$477,144	$286,673

* as of June 2006

Average results in Benlesa (2003-2006) in USD	
Investment per MW	$1,348,000
Average sale price per kwh	$0.0813
Sale cost per kwh	$0.0654
CFE cost per kwh:	$0.0085
O&M cost per kwh:	$0.0217
LFG cost per kwh:	$0.0225
Cost for technological support per kwh:	$0.0127
Administration cost per kwh	$0.0124
Profit before financial cost and taxes:	$0.0035

Economic analysis:

The economic analysis conducted for a period of 20 years is based on the estimation of the plant infrastructure cost, the operation and maintenance cost, and the transmission cost. In addition the residual value at the end of the lifetime of the analysis is considered. On the benefit side, the analysis considers the electricity generated valued at the price sold to the energy users specified in figure 12 and the environmental benefits in terms of reduced GHG. The project also generates health benefits through reduced local pollutants and reduced explosion risk. However, the analysis doesn't take the reduction of local pollutants and their impact into account.

The project generates GHG emission reductions through two sources:
In the site the landfill gas is collected and burned for combustion, thus converting its methane content into CO2, reducing its GHG effect.

In addition, the generation and supply of electricity to the electrical grid, displaces a certain amount of fossil fuels used for electricity generation.

The Baseline scenario for the emission reductions associated with the delivery of electric energy to the interconnected national grid is the electricity delivered to grid multiplied by an emission coefficient (measured in kg of CO2e/KWh) calculated in a transparent and conservative manner for the Mexican National Grid as the average of the "approximate operating margin" and the "build margin", where:

(iii) The "approximate operating margin" is the weighted average emissions (in kg CO2e/KWh) of all generating sources serving the system, excluding hydro, geothermal, wind, low-cost biomass, nuclear and solar generation;

(iv) The "build margin" is the weighted average emissions (in kg CO2e/KWh) of recent capacity additions to the system, which capacity additions are defined as the greater (in MWh) of most recent 20% of existing plants or the 5 most recent plants.

The relative weighting of the operating margin emission rate and the build margin emission rate will depend on the characteristics of the electric sector. The proposed default weighting is an average of the operating and the build margins, where:

$$BaselineEmissionRate(tCO_2 / MWh) = \frac{0.764 + 0.404}{2} = 0.584$$

The results of the project's economic assessment over a target period of 20 years are presented in the following table. The analysis considered two different emission reductions price scenarios (USD 10 / t CO2e and US$ 15/ t CO2e)

Year	Initial investment	Total cost	Total revenues (15 US$/t CO2e)	Net revenues (15 US$/t CO2e)
2002	-10.8			-10.8
2003		1.02	4.06	3.04
2004		4.02	8.06	4.05
2005		4.38	8.25	3.87
2006		4.48	8.29	3.80
2007		4.40	8.36	3.96
2008		4.43	8.36	3.94
2009		4.68	8.61	3.93
2010		4.99	8.89	3.90
2011		4.34	8.20	3.85
2012		4.60	8.44	3.84
2013		4.91	8.72	3.80
2014		4.10	7.84	3.74
2015		4.38	8.09	3.72
2016		4.62	8.34	3.72
2017		4.92	8.61	3.69
2018		3.89	7.49	3.60
2019		4.15	7.73	3.57
2020		4.42	7.99	3.57
2021		4.73	8.28	3.54
2022		4.82	9.21	4.39
TOTAL (NPV)		21.83	66.89	45.06
ERR				34%
NPV				$19.34
Cost Benefit Ratio				3.1

Year	Initial investment	Total cost	Total revenues (10 US$/t CO2e)	Net revenues (10 US$/t CO2e)
2002	-10.8			-10.8
2003		1.0	3.3	2.3
2004		4.0	6.8	2.8
2005		4.4	7.0	2.6
2006		4.5	7.3	2.8
2007		4.4	7.3	2.9
2008		4.4	7.3	2.9
2009		4.7	7.6	2.9
2010		5.0	7.8	2.8
2011		4.3	7.1	2.8
2012		4.6	7.4	2.8
2013		4.9	7.7	2.7
2014		4.1	6.8	2.7
2015		4.4	7.0	2.7
2016		4.6	7.3	2.7
2017		4.9	7.6	2.6
2018		3.9	6.4	2.5
2019		4.2	6.7	2.5
2020		4.4	6.9	2.5
2021		4.7	7.2	2.5
2022		4.8	7.6	2.8
TOTAL (NPV)		21.83	57.83	23.01
ERR				25%
NPV				$11.1
Cost Benefit Ratio				2.6

Annex 6. Bank Lending and Implementation Support/Supervision Processes

(a) Task Team members

Names	Title	Unit	Responsibility/Specialty
Lending			
Cecilia Maria Balchun	Finance Analyst	LOAG1	Disbursement
John Morton	Environmental Spec.	EASEN	Environmental assessment
Victor Manuel Ordonez Conde	Sr Financial Management Spec.	LCSFM	Financial Management
Lea Braslavsky	Procurement Spec.		Procurement
Walter Vergara	Lead Chemical Engineer	LCSEN	Task manager
Supervision/ICR			
Jose M. Martinez	Procurement Spec.	LCSPT	Procurement Post review
Victor Manuel Ordonez Conde	Sr Financial Management Spec.	LCSFM	Financial Management
Rosa G. Valencia De Estrada	Consultant	LCSPT	Procurement
Efraim Jimenez	Lead Procurement Spec.	LCSPT	Procurement
Seraphine Marie Haeussling	E T Consultant	LCSEN	Supervision, ICR
Walter Vergara	Lead Chemical Engineer	LCSEN	Project manager

(b) Ratings of Project Performance in ISRs

No.	Date ISR Archived	IP	GEO	Actual Disbursements (USD M)
1	06/19/2001	Satisfactory	Satisfactory	0.00
2	06/28/2001	Satisfactory	Satisfactory	0.00
3	11/28/2001	Satisfactory	Satisfactory	0.00
4	04/12/2002	Satisfactory	Satisfactory	0.00
5	08/29/2002	Satisfactory	Satisfactory	1.87
6	12/16/2002	Satisfactory	Satisfactory	3.35
7	05/21/2003	Satisfactory	Satisfactory	5.34
8	07/16/2003	Satisfactory	Satisfactory	5.34
9	12/01/2003	Satisfactory	Satisfactory	5.48
10	06/04/2004	Satisfactory	Satisfactory	5.90
11	11/30/2004	Satisfactory	Satisfactory	5.90
12	04/26/2005	Highly Satisfactory	Highly Satisfactory	6.19
13	11/30/2005	Highly Satisfactory	Highly Satisfactory	6.19
14	05/24/2006	Highly Satisfactory	Highly Satisfactory	6.27

((c) Staff Time and Cost

Stage of Project Cycle	Staff Time and Cost (Bank Budget Only)
	USD Thousands (including travel and consultant costs)
Lending	
FY99	12.38
FY00	391.23
FY01	98.27
Total:	**501.88**
Supervision/ICR	
FY99	0.00
FY00	0.00
FY01	0.00
FY02	37.99
FY03	49.16
FY04	46.53
FY05	52.87
FY06	37.99
FY07	49.16
Total:	**235.71**

Annex 7. Detailed Ratings of Bank and Borrower Performance

Bank	Ratings	Borrower	Ratings
Ensuring Quality at Entry:	Satisfactory	Government:	Satisfactory
Quality of Supervision:	Satisfactory	Implementing Agency/Agencies:	Satisfactory
Overall Bank Performance:	Satisfactory	**Overall Borrower Performance:**	Satisfactory

Annex 8. Beneficiary Survey Results (if any)

A structured interview with key beneficiaries was conducted after project completion in October. The beneficiaries were asked the following questions:

- Are you familiar with the Bioenergia company and its activities?
- What is your perception of the benefits provided by Benlesa?
- Do you think Benlesa should be replicated in other sites?

The beneficiaries of the survey included the director of CECODAP (Control Center for street lighting), three directors of street lightning, and the director of public maintenance.

The specific results are provided below:

Municipality of San Pedro Garza García, N.L.

1. Do you know what Bioenergía de Nuevo León, S.A. de C.V. is and what it does?
Yes, the sale of electricity from the decomposition of organic waste that produces methane gas. What he doesn't know is whether we use a furnace or gas turbines to operate the generator.

2. What is your perception of the benefits that Benlesa provides you?
The price. He knows how much the savings are, and also that it's worthwhile for him to deal directly with us (Benlesa) because it's a better deal than with CFE.

3. Do you think Benlesa should be replicated in other parts of Mexico?
Of course, it should be replicated everywhere, because there's trash everywhere, besides the way it can be used.

Municipality of Escobedo, N.L.

1. Do you know what Bioenergía de Nuevo León, S.A. de C.V. is and what it does?
Yes, it uses the methane gas generated in SIMEPRODE as a fuel to operate the turbines and thereby generate electricity, which in turn is conveyed through CFE which provides them with 700 kW electricity.

2. What is your perception of the benefits that Benlesa provides you?
Actually, very good for the price, even the service is good.

3. Do you think Benlesa should be replicated in other parts of Mexico?
Definitely yes, for the price and service. With more providers we can select the best option.

Municipality of Monterrey , N.L.

1. Do you know what Bioenergía de Nuevo León, S.A. de C.V. is and what it does?
Yes, a company that sells electricity to the urban areas of the state of Nuevo León, at a cheaper cost than that of CFE, by generating from waste.

2. What is your perception of the benefits that Benlesa provides you?
The cost per kWh is 10% cheaper than CFE. They currently give us only 700 kW but we'd like them to sell us more electricity, 50% at least of the 7 MW we require.

3. Do you think Benlesa should be replicated in other parts of Mexico?
Of course, because it's a program of savings for municipalities. I don't know exactly what the process is for generating from waste–that's your business—but there's no question about the savings. It's very easy to understand.

Municipality of Santa Catarina, N.L.

1. Do you know what Bioenergía de Nuevo León, S.A. de C.V. is and what it does?
Yes, it generates electricity from waste and obtains methane gas.

2. What is your perception of the benefits that Benlesa provides you?
The greatest benefit is the savings, between 10 and 12% for us directly. Besides, I've heard about the ecological benefit but I don't know much about it.

3. Do you think Benlesa should be replicated in other parts of Mexico?
I think so, because for us it's a real savings that comes from electricity.

Municipality of Guadalupe, N.L.

1. Do you know what Bioenergía de Nuevo León, S.A. de C.V. is and what it does?
Yes, it takes electricity from SIMEPRODE's methane gas and conveys it to CFE, and we sell it cheaper to them.

2. What is your perception of the benefits that Benlesa provides you?
That Benlesa charges less than CFE.

3. Do you think Benlesa should be replicated in other parts of Mexico?
Yes, but we would supply more energy to them.

Annex 9. Stakeholder Workshop Report and Results (if any)

Summary of Comments from the Workshop on the Closing of the Methane Gas Project
Grant TF-028268-ME

The workshop was held in Mexico City on October 17, 2006.

Twenty-five public servants from ten municipalities and federal agencies, such as SEMARNAT and BANOBRAS, attended. SIMEPRODE and World Bank staff participated as well.

The Monterrey experience was presented, not only as a starting point for the start-up of operations at plants that process the methane gas generated in final disposal sites of urban solid waste, but also for the growth and development of Monterrey II.

The workshop also presented the participation of Mexican municipalities that are carrying out projects for the use of LFG, besides the Grant project, such as Aguascalientes which is developing its own project under the scheme of Carbon Revenues, and León which is presently carrying out the bidding process for the use of methane gas from its sanitary landfill.

The attendance of municipalities with a strong potential for replicating the project to capture and use methane gas from their sanitary landfills, made it possible to demonstrate various project financing options using World Bank resources and those of the Mexican Government.

Attendees agreed on the importance of continuing to hold this type of workshops which disseminate national and international efforts to develop projects for the use of methane gas generated in final disposal sites of urban solid waste, thus allowing other Mexican municipalities to implement such projects.

World Bank - ESMAP LFG to Energy Initiative for the Latin American region - Launching workshop

The World Bank, with ESMAP support, is undertaking a project to promote LFG-to-Energy projects in the LAC region. In this framework, a launching Workshop was carried out in the city of Monterrey, Mexico, during 23 and 24 October 2003. The main objectives of the workshop were:

- Dissemination of LFG-to-energy projects
- Presentation of the handbook for the preparation of LFG-to-energy projects in the LAC region
- Collection and inclusion of pertinent comments from participants to the workshop in the handbook

The following link provides information on the background of the initiative, its objectives and components and includes all the technical documents
http://www.bancomundial.org.ar/lfg/gas_about_004.htm.

Annex 10. Summary of Borrower's ICR and/or Comments on Draft ICR

Summary of executing agencies' ICR

Bank's Performance

The Bank performance was rated by both implementing agencies as highly satisfactory. In summary, the following aspects were highlighted:

· The Bank has professional staff with adequate technical and financial staff for the project.

· It fulfilled the agreed commitments regarding economic contributions and technical-financial advisory services.

· Bank staff monitored the project, visiting installations twice a year to learn about project progress and to carry out a general supervision of the project.

Executor's Performance

· Supervision of engineering, operation, and technical and financial evaluation of the project.

· Dissemination of technology at local, national, and international levels.

Summary of SIMEPRODE's Actions

- Competing with different cities around the country to obtain non-reimbursable World Bank funds through the GEF to carry out the project.
- Carrying out the bidding process to select the strategic partner.
- Processing documentation and permits with CRE, CFE, and SUTERM.
- Processing environmental documentation and permits.
- Monitoring and surveillance of LFG production.

Factors that Affected Performance

- The use of motor generators that worked properly in their country of origin (Austria) but, when operated in a state (Nuevo León) under totally different environmental conditions (mainly high temperatures), the operation of the machines had to be modified.
- The constant maintenance of units, affected by various factors, including the presence of xiloxanes in the gas.

Sustainability

With respect to contracts, those dealing with CFE are open-ended contracts during the plant's operation. Contracts for the supply of energy to municipalities and for other energy receptors (Metro, DIF, Water and Drainage, State Government) are for a period of five years and may be extended without the need for written notification. Thus, as long as the plant maintains economic benefits, it is unlikely that any user will consider the contracts terminated.

The plant contracts with SIMEPRODE are for 20 years (Provision of Gas, Technical Assistance, and Corporate Services). The lease contract between BENLESA and SIMEPRODE is for 5 years and is extendable.

Lessons Learned

- The electricity generation equipment purchased in another country must be adjusted and tested in accordance with local conditions.

- Until Mexico's legislation is adjusted, it will be necessary to schedule in greater detail the time to process the corresponding permits and/or contracts.

Performance Indicators

- Efficiency of motor generators.
- Amount of electricity generated.
- Variation in LFG composition (CH_4, CO_2, and O_2).

Products Obtained by Component:

1. Engineering, Design, and Construction of the Methane Use and Capture Plant:

· The plant was constructed on time, in the correct form, and within budget.
· The plant has exceeded performance expectations.
· The company is in the process of expansion.

2. Development of Institutional Capacity:

· Institutional arrangements between the public partner and private partners were carried out satisfactorily.
· Contracts for Joint Venture, Social Statutes, Provision of LFG, Land Leasing, Engineering, Design and Construction of the Plant, Operation and Maintenance, as well for Assistance and Corporate Services, were approved and signed by all parties involved.
· SEDESOL prepared a document that describes the project in all its stages as well as the elements involved in it.

3. Regulatory Reform:

· It was not possible to carry out the regulatory reform with regard to LFG as renewable energy.
· Procedures and document processing to develop new projects are in place but are lengthy and very complicated.

4. Regional Dissemination:

· SEDESOL carried out a series of dissemination workshops and events in Mexico and abroad.
· The project has been promoted in all media.
· SEDESOL created a project web page.
· SEDESOL created CDs showing Monterrey's experience.
· The plant has received a large number of visitors.

5. Project Management:

· Specialists were trained in the subject of LFG at the plant and at SEDESOL.
· 100 percent of the Environmental Administration Plan was met.
· A structure was created for project management and administration.

· A training room was built inside the plant.

Environmental and Social Performance

- Through the operation of this plant, as of October 1, 181,216 MWh of electricity have been generated, benefiting the population of seven municipalities in the Monterrey Metropolitan Area. Furthermore, with the savings obtained through the payment of this service (around $600,000 pesos per year) each municipality can carry out social infrastructure works.
- During the month of July 2006 electricity began to be delivered to the Metrorrey Collective Transportation System and to several other government agencies. Internationally, Metro was the first to be fueled by clean energy from trash.

As of October 1, 2006, the emission of 39,867 MT of methane into the atmosphere, equivalent to 719,990 MT of CO_2, has been avoided.

Summary of Banobras' ICR:

Background	This grant, in the amount of US$6.27 million, was granted by the Global Environment Facility (GEF) through the World Bank on October 29, 2001 to the Mexican Government, to be executed by the Secretariat of Social Development (SEDESOL) and the Metropolitan Solid Waste Processing System (SIMEPRODE), for the purpose of financing the Demonstration Project on the Capture and Use of Methane Gas from Sanitary Landfills located in Salinas Victoria in the metropolitan zone of the City of Monterrey, Nuevo León.
Disbursements	The resources were fully used and the performance of the operating mechanism was highly satisfactory. **Comments and lessons learned:** The execution of the project and the operating mechanism for disbursements were especially efficient for this grant. The factors that, in our opinion, influenced this efficiency include: • SEDESOL's experience in the execution of programs with external resources; • The good coordination undertaken by the executors to reach agreements and take the corresponding steps in a timely manner; • The good design of the projects that were financed and the executors' sense of ownership of these projects; and • The good preparation of the program approved by the World Bank with regard to the characteristics of the projects supported and the characteristics of the executors.
Financial Management	In our opinion, the project's financial management by the executors and the support provided by the financial agent were satisfactory. However, coordination with the World Bank, at the time when it was decided to change the currency denomination of the special rights grant to dollars, should have been better in order to avoid problems in terms of programming expenditures and budgets for executing agencies.

This change in denomination generated an overdraft of US$382,327 in the category of goods under the responsibility of SIMEPRODE, which caused the balance to be disbursed on behalf of SEDESOL to decrease by US$195,792, and its internal expenditures had to be readjusted with areas of the budget.

Comments and lessons learned: In our opinion, the World Bank could have given more timely notice to the financial agent and the executors regarding the change in the grant's currency denomination and the implications this would have.

In particular, it is important to consider that this type of modifications can have significant budgetary implications that affect the executors' other areas of work.

Conclusions

The execution of the grant is considered to be very satisfactory because project objectives were achieved broadly, thanks to the outstanding participation of SEDESOL and SIMEPRODE executors, the efficient coordination of SHCP, and the good project preparation by the World Bank's technical team.

For BANOBRAS this operation was of special interest due to the synergies between the sectors of the projects financed and this Bank's mandate. Of particular interest was the use of the Clean Development Mechanism because of its great potential for application in this and other sectors that BANOBRAS serves on a daily basis throughout the country.

It is of strategic interest for BANOBRAS to continue its cooperation with the World Bank and SEDESOL on these matters.

It is worthwhile to note that, in our opinion, the project's success is due in great part to the good cooperation that SEDESOL and SIMEPRODE established in their respective spheres of influence, to achieve the collaboration of federal, state, and municipal agencies and institutions, and of these and the private sector and academia.

We also consider this project to be a successful case that should be used as a case study to determine the key factors that played a role in the efficiency of execution, and seek to replicate them in other projects.

Annex 11: Comments of co-financiers and other stakeholders

Annex 12. List of Supporting Documents

- Project Appraisal Document for Mexico: Methane Gas Capture and Use At A Landfill – Demonstration Project. Report No. 22112-ME
- Grant Agreement for Mexico: Methane Gas Capture and Use At A Landfill – Demonstration Project.
- ESMAP: Handbook for preparing LFG-to-Energy Projects in Latin America and the Caribbean – September 2003.
- Project Appraisal Document for Mexico: Waste Management and Carbon Offset Project. Report No: 30430-MX.
- Proyecto para captura y uso de gas metano en varios rellenos. SEISA, Febrero 2004
- Proyecto piloto para la captura y uso de gas metano. Actividades de diseminacion. SEDESOL. Febrero, 2004
- Environmental Impact Assessment and Environmental Management Plans for the Solid Waste Management Project, SCS Engineers. November 2004.
- Financial and sensitivity analysis for the three project sites. SEISA, December 2004.
- Social Impact Assessment, December 2004.
- Business Model for Association with Landfill Operators (PPT file). SEISA, January 2005.
- Feasibility study for Monterrey facility by ETEISA.
- Mexican LFG model, SEDESOL.
- Proyecto Piloto Para El Aprovechamiento del Biogas de Los Sitios de Disposicion Final de Residuos Sólidos Municipales, Estudio de Factibilidad de Aprovechamiento del Biogas Generado en el Relleno Sanitario del Area Metropolitana de Monterrey, N. L. Estudios Y Technicas Especializadas en Ingeniera S. A. de C. V.(ETEISA)
- Projecto Piloto Para El Aprovechamiento del Biogas Generado en Sitios de Disposicion Final de Residuos Sólidos. January, 1999 (Estudio de Prefactibilidad), ETEISA.
- Proyecto Pilot Para El Aprovechamiento del Biogas de Sitios de Disposicion Final de Residuos Sólidos Municipales, presentacion del Estudio de Prefactibilidad, ETEISA.
- Proyecto Piloto Para El Aprovechamiento del Biogas Generado en Sitios de Disposicion Final de Residuos Sólidos. October, 1999, ETEISA.
- Estudio Preliminar de Impacto Ambiental Para Proyecto: Conversion de Biogas a Energia Eléctrica, SIMEPRODESO, September 2000.
- Proyecto Piloto Para El Aprovechamiento de Biogas De los Sitios de Disposicion Final De Residuos Sólidos Municipales, Analisis Social, ETEISA, September, 2000.
- Conditions of Selling Price of Electric Energy from Private's and Cooperative Small Scale Power Generation, Minister of Mines and Energy, The Republic of Indonesia.
- Advancing Sugar Cogeneration Development in Uttar Pradesh, India, Policy Review and Power Purchase Agreements, George E. St. John, P.E.
- Sugarmill Power Sale Contracts, International Cane Energy Network, Winrock International.
- Standardised Agreement for Purchase of Electrical Energy Between The Ceylon Electricity Board and (Renewable Source Small Power Producer).
- Electricity Energy Supply Contract and Proposal for Arrangement of Financing. Bio-Gen Project, Honduras.

- Draft Power Purchase Agreement From PT PLN (Persero).
- Project Description for Proposed Bamboo Fired Biomass Power Plant Project in Sula Valley, Honduras.
- World Resources Institute: Navigating the Numbers, 2005.
- SEMARNAT/INE: Second National Communication. December 2003.
- SEMARNAT/INE: Third National Communication, 2006.
- ESMAP Handbook for Preparation of LFG to Energy Projects includes the project as a successful example for LFG to power projects.
- Mexico - Country partnership strategy progress report; Report No. 37934-MX, FOR THE PERIOD FY05-08, January 8, 2006.
- Mexico – Country assistance strategy, Report No. 23849-ME, April 23, 2002.

Annex 13. Expansion of Monterrey Plant

Basic concepts:

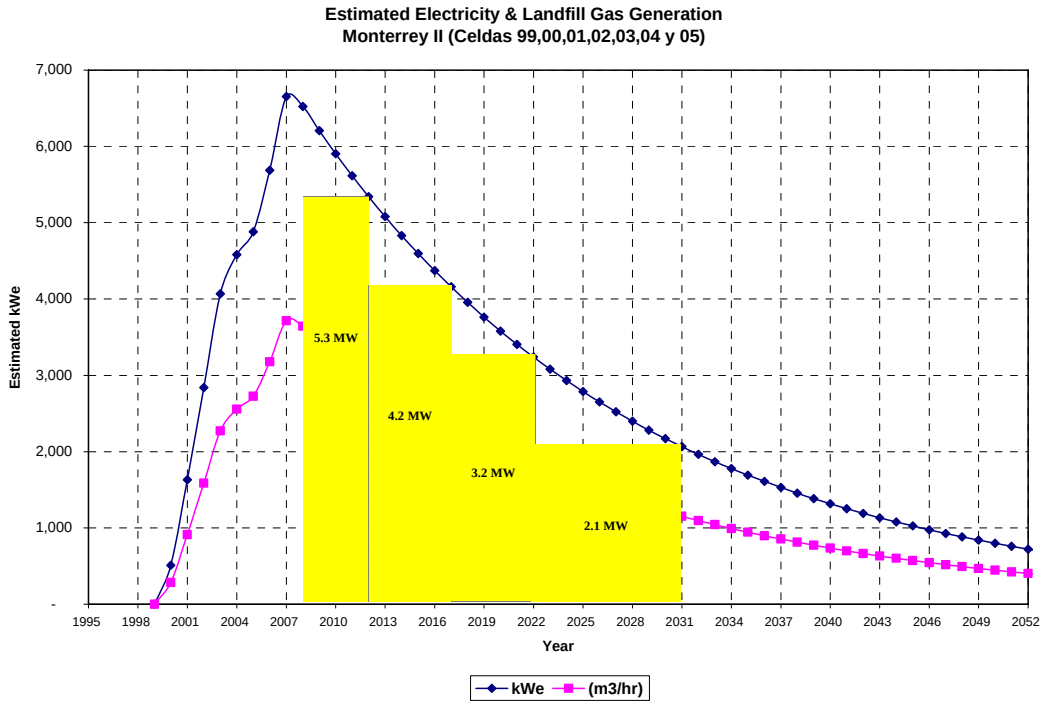
POWER PURCHASE AGREEMENTS
Current contracts will be modified offering more energy to users.

GAS SUPPLY AGREEMENT
Current contract will be adjusted including new extraction areas to assure the gas supply to the expansion in Benlesa.

INTERCONECTION, WHEELING AND BACKUP CONTRACTS
Current contracts with CFE will be modified.

ENGINEERING, CONSTRUCTION, OPERATION, MAINTENANCE AND CORPORATE SERVICES AGREEMENTS
Current agreements will include expansion.

Estimated potential:



Economics:
Proposal: Design, financing, construction and operation for expansion of LFG to power installation using gas from cells 99, 00, 01, 02, 03, 04 and 05 at Simeprode's landfill (equivalent to 6.1 mill. metric ton. of waste).

Financing: The project will be financed with equity from the shareholders using the current share participation (53%-47%).

Project Cost: The initial investment estimation is around US$6.5 million for 5.3 MW plant capacity.

Project Lifetime: 20 years.

The next steps involve:

- Use the current permits and contracts of Bioenergía de Nuevo León, S.A. de C.V.
- Expand the ongoing facility to produce more energy on a lower cost basis.
- Project estimations predict that the solid waste placed between 1999 to 2006 will produce enough gas to install a 5.3 MW power plant, decreasing to 2.1 MW by 2027.

Benefits:

Destruction of at least 180,000 metric tons of CO2 per year.
5 MW of renewable energy contribution.
US$1.1 million will be invested for electrification of rural areas.
Reforestation using native species.
Rural jobs generation.
US$ 6.5 million investment in electricity sector
12% discount cost for street lightning energy supply.
Prevents consumption of 4,000 metric tons of heavy oil to produce energy