



Landfill Gas (LFG) Recovery Projects in Developing Countries: Performance Overestimation

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Presentation Topics

- **Background**
 - **Landfill – Design / Operation**
 - **LFG Recovery Systems**
- **CDM and LFG**
- **LFG Shortfalls in ER Delivery**
- **Future Activities / Conclusions**



Landfills, Design Factors

- **Liner: natural (clay) / synthetic**
- **Leachate collection / treatment**
- **Landfill gas: venting / active collection (additionality)**



Landfills, Operation Factors

- **Cover: daily / intermediate / final**
 - **Natural (clay) / synthetic – gas permeability**
- **Mobile equipment (compactor)**
 - **Densified waste / reduces gas permeability**
- **Fires: consume organics that would generate methane**
- **Waste pickers: site security, limits use in active areas**

Landfill Schematic



What is LFG?



- **LFG composition**
 - Methane: 50%, carbon dioxide + misc: 50%
- **LFG energy content: 8,000 kcal/m³**
 - About 50% of natural gas



LFG, Design Factors

- **Collection points**
 - **Vertical extraction wells (most common)**
 - **Horizontal collectors/trenches**
- **Header pipes to connection to wells, collectors**
- **Condensate management**
- **Blower**
- **Combustion device (flare, engine)**



LFG, Development Costs

- **Collection System Cost – Varies on Site Footprint / Waste Depth**
 - **Install approx 2.5 wells per hectare**
- **Electric Generation: 1.67 kWh / m³ of LFG**
 - **Million tons in-place waste for power generation**
 - **CAPEX: 1 MW collection/generation US\$1.5 mil**
- **Flaring – Similar Capacity, CAPEX: US\$0.4 mil**

LFG Recovery System



LFG Recovery – Assessment Factors



- **Start of operations (year)**
- **Expected / actual closure date (year)**
- **Site capacity (tons / m³) – expansion potential**
- **Waste quantity received (tons or m³ / day)**
- **Waste composition: Food, Paper, Wood, Garden**
- **Moisture of waste (Precipitation)**
 - **Need for leachate pumps**
- **Leachate collection – treatment?**
- **Waste depth**

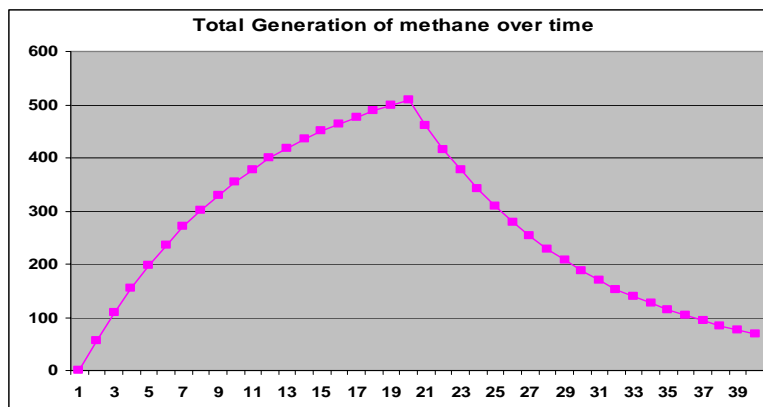
LFG Recovery – Assessment Factors (Continued)



Landfill Type	Methane Correction Factor (MCF)
Managed – Anaerobic	1.0
Managed – Semi-aerobic	0.5
Unmanaged – Deep > 5m	0.8
Unmanaged – Shallow < 5 m	0.4

- Landfill depth > 10 m optimal

LFG, Methane Generation Trend



↑
Landfill Closure

CDM and LFG



- **Importance of LFG for CDM**
 - **Landfills: 4th largest source of non-CO₂ emissions**
 - **Disposal site in almost all cities**

 - **% of registered CDM projects: 7.7%**
 - **% of WB Carbon Finance projects: 15.5%**
 - WB LFG projects: Total – 34; ERPA - 15**

CDM and LFG



Status	No. of Projects
Registered Projects	75
Registered Projects w/ Monitoring Reports	(33)
Registration Pending	7
Validation Pending	85
TOTAL	167

CDM and LFG: Annual Project Breakdown



Status	2004	2005	2006	2007	2008
Registered Projects	1	10	25	34	5
Registered Projects w/ Monitoring Reports	1	7	17	8	-
Registration Pending	-	-	-	-	7
Validation Pending	0	0	18	54	16

CDM and LFG w/ Monitoring Reports: Geographic Breakdown



	2004	2005	2006	2007	TOTAL
Africa					
South Africa	-	-	1	-	1
East Asia Pacific					
China	-	1	2	2	5
Latin America / Caribbean					
Argentina	-	1	3	-	4
Brazil	1	2	5	2	10
Chile	-	2	2	2	6
Costa Rica	-	1	-	-	1
Ecuador	-	-	-	1	1
El Salvador	-	-	1	-	1
Mexico	-	-	2	-	2
Middle East / North Africa					
Egypt	-	-	1	-	1
Israel	-	-	-	1	1

LFG, Over-Estimation Concerns



- **Reports of ER shortfalls raised concerns**
- **Bank Actions**
 - SCS study (2007)
 - LFG workshop, LCR and CFU (2007)
 - <http://go.worldbank.org/LFYR4J61J0>

SCS LFG Over-Estimation Report



- **Summary of Findings**
 - High Lo, recommend 60-85 m³ / metric ton
 - High k value, significant contributor to high estimate
 - High LFG collection efficiency rates
 - Sites with high leachate levels / unstable waste mass
- **Conclusions**
 - Models estimations larger factor in ER shortfalls than project under performance
 - Better system design / operations = improved performance

**% Actual vs. Predicted ERs,
CDM Projects with Monitoring Reports**



Project (Crediting Period)	Lo / k	Recovery Rate	2004	2005	2006	2007	2008
Brazil, NovaGerar (7/04)	163 / 0.10	85%	0%	0%	0%	29%	-
Brazil, Salvador Bahia (1/04)	180 / 0.12	80%	8%	44%			
Argentina, Villa Dominica (8/04)	NA / NA	70%	0%	28%	12%	12%	-
Costa Rica, Rio Azul (1/03)	NA / NA	50%	39%	39%	-	-	-
Brazil, Tremembe (1/06)	NA / NA	80%					
Chile, Copiulemu (1/06)	163 / 0.10	85%	NA	NA	15%	27%	-
Chile, Cosmito (1/06)	163 / 0.10	60%	NA	NA	19%	32%	-
China, Nanjing (5/05)	159 / 0.10	58%	NA	22%	-	-	-
Chile, EL Mole (12/06)	100 / 0.07	75%	NA	NA	28%	37%	-
Brazil, Bandeirantes (12/03)	81 / 0.11	NA	58%	58%	46%	59%	-
Brazil, Paulina (9/06)	83 / 0.12	NA	NA	NA	89%	90%	90%

**% Actual vs. Predicted ERs,
CDM Projects with Monitoring Reports**



Project (Crediting Period)	Lo / k	Recovery Rate	2004	2005	2006	2007	2008
China, Meizhou (9/05)	NA / NA	85%	NA	32%	16%	20%	-
Brazil, Caieiras (3/06)	116 / 0.08	60-80%	NA	NA	0%	71%	-
El Salvador, Nejapa (6/06)	116 / 0.07	70%	NA	NA	91%	106%	88%
Chile, Lepanto (3/06)	160 / 0.36	85%	NA	NA	8%	9%	-
Brazil, Maua (9/06)	160 / 0.10	75%	NA	NA	35%	29%	28%
China, Anding (1/05)	47 / 0.08	68%	NA	66%	-	-	-
Argentina, Buenas Aires (8/06)	160 / 0.03	65%	NA	NA	33%	27%	-
Brazil, Sao Joao (5/07)	96 / 0.11	80%	NA	NA	NA	60%	-
Mexico, Aquacalientes (7/06)	160 / 0.12	50-70%	NA	NA	72%	65%	-
Argentina, G.Catan (8/06)	170 / 0.05	60%	NA	NA	NA	6%	-
Argentina, Puente Gallego (9/06)	160 / 0.03	65%	NA	NA	13%	46%	-

% Actual vs. Predicted ERs, CDM Projects with Monitoring Reports



Project (Crediting Period)	Lo / k	Recovery Rate	2004	2005	2006	2007	2008
Mexico, Ecatepec (10/06)	160 / 0.12	60%	NA	NA	8%	-	-
South Africa, Durbin (12/06)	NA / NA	NA	NA	NA	NA	40%	-
Egypt, Alexandria (12/06)	136 / 0.05	70%	NA	NA	11%	11%	-
Ecuador, Zambiza (3/07)	126 / 0.05	NA	NA	NA	NA	30%	-
Chile, Santa Maria (3/07)	100 / 0.07	65%	NA	NA	NA	54%	-
Israel, Taila (3/07)	NA / 0.03	65%	NA	NA	NA	41%	-
Chile, Loma (3/07)	85 / 0.07	50%	NA	NA	NA	35%	-
Brazil, Canabrava (4/07)	189 / 0.06	60%	NA	NA	NA	5%	-
China, Shenzhen (7/07)	79 / 0.14	48%	NA	NA	NA	27%	-
China, Jinan (5/07)	98 / 0.06	60%	NA	NA	NA	31%	-
Brazil, Itapevi (8/07)	70 / 0.10	65%	NA	NA	NA	119%	75%

Future Activities / Conclusions



- On-going monitoring of publicly available documents – PDDs, Monitoring reports, Verification Reports
- Contact with project officials

- LFG has been an important part of the CDM program but continued shortfalls could result in declining interest
- Importance of increasing awareness about reasons for shortfalls to minimize situation in the future

Thank You



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