



Methane to Markets

***Practical Challenges In Producing
Carbon Emission Reduction Credits
From Landfills In
The Developing World***

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On behalf of

**U.S. Environmental Protection Agency
Landfill Methane Outreach Program**

Presentation Outline

- Review of the Kyoto Protocol and the Clean Development Mechanism (CDM)
- Current CDM landfill gas projects
- Challenges encountered
- Recommendations



Review of the Kyoto Protocol and the Clean Development Mechanism

- 1992 – The United Nations adopted the United Nations Framework Convention on Climate Change (UNFCCC)
- 1994 – The UNFCCC entered into force
- 1997 – The Kyoto Protocol adopted
- 2005 – The Kyoto Protocol entered into force

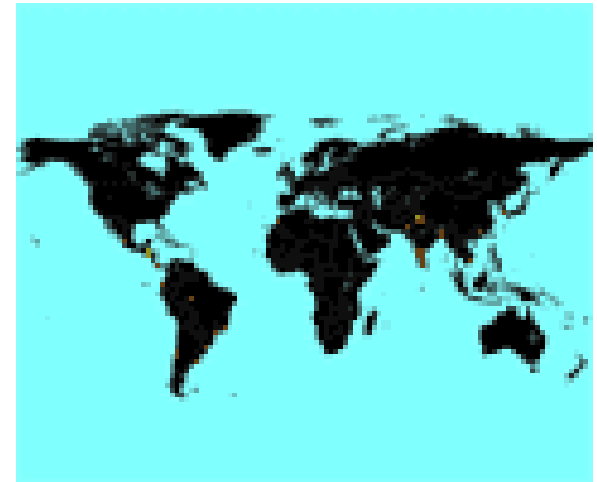


Review of the Kyoto Protocol and the Clean Development Mechanism

- **UNFCCC**
 - Addresses human-caused impacts on Global Climate Change
 - Objective is to stabilize Greenhouse Gas (GHG) concentrations in the atmosphere within a time-frame
 - Puts the lion's share of the responsibility on the "rich" nations
 - Was ratified by 189 nations

Review of the Kyoto Protocol and the Clean Development Mechanism

- **Kyoto Protocol**
 - Sets legally binding targets and timetables for developed nations to cut GHG emissions
 - Establishes mechanisms, including the CDM for developed nations to achieve the cuts
 - Has been ratified by 175 nations as of August 30, 2007



Review of the Kyoto Protocol and the Clean Development Mechanism

- **Clean Development Mechanism (CDM)**
 - Provides a “Cap & Trade” structure for developed nations to achieve GHG emission reduction targets and timetables by financing or developing GHG emission reduction projects in developing nations
 - Establishes systems for registering, verifying, and trading Certified Emission Reduction (CER) credits

Review of the Kyoto Protocol and the Clean Development Mechanism

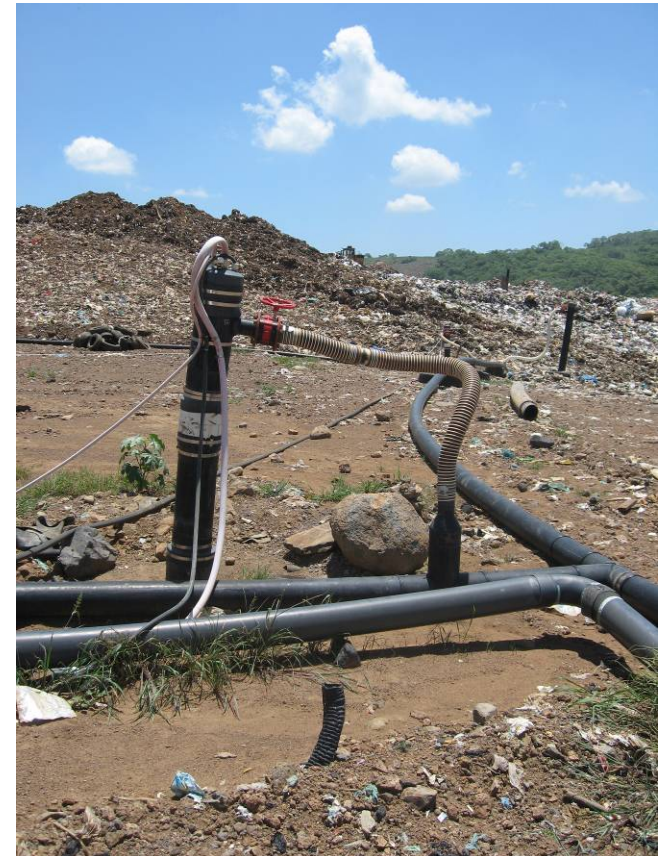
- **Clean Development Mechanism (CDM)**
 - Responsibility for CER registration, verification, and certification is to be assumed by a “Designated National Authority (DNA)” in each developing nation
 - In August 2007, projects that have passed development, third party validation, and CDM Executive Board registration were attracting a wide range of prices between €8 and €15 per CER

Current CDM Projects

- **As of August 30, 2007**
 - 765 CDM projects have been registered worldwide
 - These projects are projected to produce >1,020,000,000 CERs through December 31, 2012

Current Landfill Gas CDM Projects

- **As of August 30, 2007**
 - 54 of the registered CDM projects are LFG based with a total of 16,217,209 projected average annual CERs
 - An additional seven LFG projects with a total of 787,722 projected average annual CERs are requesting registration



Current CDM Projects

- **As of August 30, 2007**
 - 76,068,517 CERs have been issued
 - 2.36% of these have been from LFG CDM projects (1,795,102 CERs)



Current Landfill Gas CDM Projects



- **As of August 30, 2007**
 - LFG CDM project monitoring reports are available from 16 sites
 - Actual emissions certified are 5% to 109% of those projected

Predicted vs. Actual Recovery: 18 CDM and JI Projects

Year	Number of Projects Reporting	Average of Individual Projects' Performance (%)	Sum of Predicted LFG Recovery (m ³ /hr)	Sum of Actual LFG Recovery (m ³ /hr)	Actual LFG Recovery / Predicted LFG Recovery (%)
2003	1	59.9%	558	334	59.9%
2004	3	61.5%	23,655	13,308	56.3%
2005	9	63.8%	52,028	20,613	39.6%
2006	15	40.5%	60,239	17,809	29.6%
2007	8	59.7%	59,327	31,889	53.8%
Averages	7.2	52.9%	195,807	83,953	42.9%

Range of Actual % of Projected Recovery

Year	Number of Projects Reporting	<25%	25%-49%	50%-74%	75%-100%	>100%
2003	1	0	0	1	0	0
2004	3	1	0	1	1	0
2005	9	2	2	1	3	1
2006	15	8	1	3	2	1
2007	8	2	1	3	0	2
Sum	36	13	4	9	6	4

Challenges to Implementing Landfill Gas CDM Projects

- Institutional/Political
- Technical



Challenges to Implementing Landfill Gas CDM Projects

- **Institutional/Political**
 - The CDM process itself
 - Securing the “rights” to the project



Challenges to Implementing Landfill Gas CDM Projects

- **The CDM Process Itself**
 - Formalized, rigid process
 - Additionality
 - Limited time period in which to recoup investment

Challenges to Implementing Landfill Gas CDM Projects

- **The CDM Process Itself**
 - Projects have been registered in 20 countries, but many nations have been slow in implementing the process
 - 32 of the 54 registered LFG CDM projects are in just 4 countries – Brazil (14), Chile (7), Argentina (6), and & China (5)

Challenges to Implementing Landfill Gas CDM Projects

- **Securing the Gas Rights**
 - Unclear ownership
 - Unduly high expectations by landfill owners
 - Arduous or unclear procurement procedures



Challenges to Implementing Landfill Gas CDM Projects



- **Institutional/Political Result**

- The result is to further shorten the already limited time period to recoup investment and decrease the likelihood that the project will ever be built

Challenges to Implementing Landfill Gas CDM Projects

■ Technical

- Over estimating recoverable landfill gas
- Inadequate or sub-par system design
- Incomplete system installation
- Poor system operations & maintenance
- Interference by scavengers



Challenges to Implementing Landfill Gas CDM Projects

- **Over Estimating Recoverable Landfill Gas**
 - The US EPA LANDGEM model estimates gas generation - not recovery
 - Many site-specific conditions will impact recovery

Challenges to Implementing Landfill Gas CDM Projects

- **Over Estimating Recoverable Landfill Gas**
 - Finding reliable input data
 - Waste characterization
 - Waste disposal history
 - Projected future waste receipts



Garbage in = Garbage out!

Accounting for Site Conditions in Developing Countries

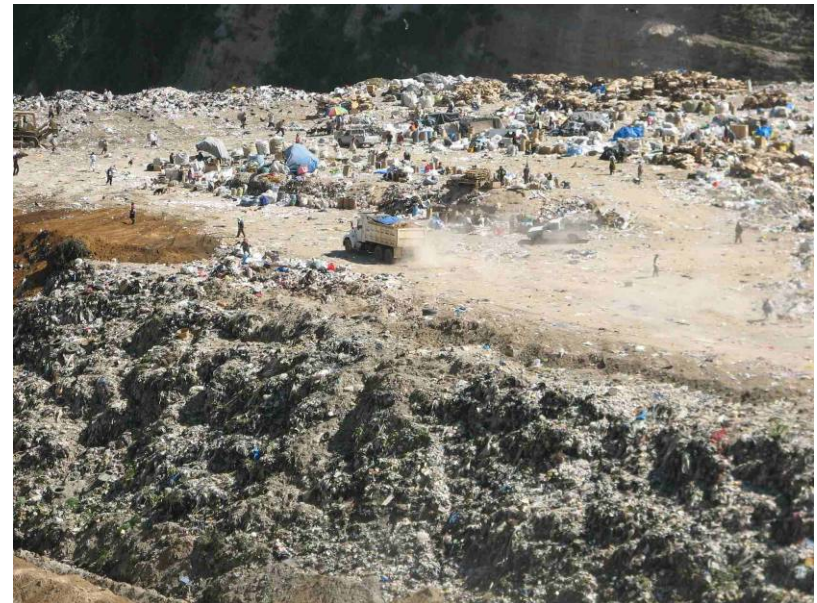
- **Site conditions that limit biogas recovery rates:**
 - Shallow waste depth, poor compaction, limited soil cover
 - Poor drainage, high rainfall, leachate accumulation
 - Fires, waste pickers, security
 - Problems with collection system design and/or operations
 - Delays in wellfield installation in active cells

Collection Efficiency Adjustments

- Evaluate collection system efficiency based on a checklist of site conditions that maximize recovery:
 1. Some degree of managed placement of waste, waste compaction, and grading
 2. Waste depths of at least 10 m, preferably >20 m
 3. Daily or at least weekly soil cover placed on deposited refuse
 4. Final cover placed in areas that stop receiving waste
 5. Composite bottom liner consisting of plastic layer over 2 feet (0.6 meter) of clay or similar material
 6. Leachate levels maintained near bottom of landfill
- Adjust collection efficiency to account for coverage factor
 - % of waste volume (area covered) with functioning extraction wells

Maximum Achievable Collection Efficiencies

- Engineered and sanitary landfills: ~60-90%
- Open and managed dump sites: ~30-60%



Methane Correction Factor

- Evaluate site conditions to estimate “Methane Correction Factor” (MCF) adjustment for aerobic decay:
 - Unmanaged disposal sites < 5 m = 0.4
 - Unmanaged disposal sites > 5 m = 0.8
 - Managed disposal sites = 1.0
 - Semi-aerobic landfill = 0.5
 - Uncategorized site type = 0.6

*Based on IPPC, 2006. Table 3.1, SWDS Classification and Methane Correction Factor (MCF).

Challenges to Implementing Landfill Gas CDM Projects

- **Poor System Design**
 - “Watering-in” of wells and collection system
 - Pulling air through landfill cover
 - System components settle or break apart
 - Corrosion and siloxane build-up on system components



Challenges to Implementing Landfill Gas CDM Projects

- **Other Technical**



- Incomplete system installation
- Poor system operations & maintenance
- Scavengers

Challenges to Implementing Landfill Gas CDM Projects

■ Technical Issues Results

- If you over-estimate the recoverable gas you will never meet your investment expectations
- If you have poor design, operations, etc. you will collect even less of the recoverable gas that already is constrained by site-specific factors

Recommendations

- **For Landfill Owners**

- Be realistic – there is a lot of risk in these projects for the investor - they are not gold mines!
- Simplify and speed up procurement processes
- Help your investor implement the project in any way you can – don't be an impediment
- The sooner the investor makes money – the sooner you will!

Recommendations

- **For Investors**

- Go in with your eyes open!
- Be realistic about project revenues and costs
- Be realistic about project implementation schedules
- Run financial sensitivity scenarios so you know if you can live with less than ideal results
- Walk away from deals that are burdened by too much uncertainty