Clean Development Mechanism (CDM) and Municipal Solid Waste Management

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Presentation Topics

- **Solid waste and greenhouse gas emissions**
- **CDM and the Kyoto Protocol**
- **CDM methodologies**
- **Application of CDM to landfill gas and composting**
- **Conclusions**

Tianjin, China – LFG
Tonnage: 1,000 tpd
ERs: 913,000 tCO2e

Solid Waste and Greenhouse Gas (GHG) Emissions

- **Methane**
  - **Generated in anaerobic conditions in landfills**
  - **21x global warming potential (GWP) of CO_2**
- **Landfills**
  - **12%+ global anthropogenic methane emissions**
  - **4th largest source of non-CO_2 GHG emissions**
- **Compost**
  - **CO2 from decay of organic material consider neutral to atmosphere**

CDM and the Kyoto Protocol

- **Intergovernmental Panel on Climate Change (IPCC), 1988**
- **UN Framework Convention on Climate Change (UNFCCC)**
  - **Voluntary program (1994), after Rio Earth Summit, to stabilize greenhouse gas (GHG) emissions**
- **Kyoto Protocol**
  - **Legally binding program to reduce GHG emissions**
  - **Ratified 2005; effective period through end of 2012**
  - **CDM: Provision for sale of emission reductions by developing countries to developed countries**

CDM Process

- **Carbon finance, payment for performance**
- **Methodologies to measure reduction in GHG must be approved by UNFCCC**
- **Conditions include**

- Baseline: GHG emissions in the absence of action (landfill). For compost projects waste would go to a landfill and generate landfill gas (50% methane)

- Additionality: GHG emission reduction that would be achieved with project

o Barriers – Investment, technical, common practice

Amman, Jordan – LFG
Tonnage: 3,000 tpd
ERs (7 yrs): 1,520 tCO2e

Approved CDM Methodologies: LFG

- **Large-scale**

- ACM001. Landfill gas projects

- Related tools

1. Demonstration and assessment of additionality
2. Determination of methane emissions avoided from dumping waste at a disposal site
3. Determine project emissions from flaring gases containing methane
4. Identify the baseline scenario and demonstrate additionality
5. Calculate project or leakage CO2 emissions from fossil fuel combustion
6. Calculate project emissions from electricity comsumption

- **Small-scale**

- AMS-III.G. Landfill methane recovery

- **Power generation**

- AMS-I.D. Grid connected renewable electricity generation (<15 MW)

Approved CDM Methodologies: MSW Compost

- **Large-scale**

  - AM0025. Avoided landfill emissions (methane) from anaerobic decomposition of organic waste through alternatives, incl composting

  - Related Tools

  1. Tool for the demonstration and assessment of additionality

  2. Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site

- **Small-scale**

  - AMS-III.F. Avoidance of methane production from decay of biomass through composting (< 60,000 tCO_2e/yr)

CDM Methodology: LFG and Compost

- **Both LFG and composting approaches relie on First Order Decay (FOD) model to assess potential gas collection rates or avoided methane**
- **FOD model factorsProject emissions**

  - Waste composition

  - Ambient temp. / precipitation

  - Methane correction factor

Cairo, Egypt – Composting
Tonnage: 1,200 tpd
ERs (7 yrs): 536,500 tCO2e

FOD Model Factor: Waste Composition

Material	Income Level: Low	Middle	High
Food	40-85%	20-65%	20-50%
Paper	1-10%	15-40%	15-40%
Recyclables	4-25%	5-26%	11-43%
Fines	15-50%	15-50%	5-20%
Moisture	40-80%	40-60%	20-30%

FOD Model Factor: Ambient Temp. / Precipitation: k Value (Decay Constant)

Type of Waste		Climate Zone*							
		Boreal and Temperate (MAT ≤ 20°C)				Tropical[1] (MAT > 20°C)			
		Dry (MAP/PET < 1)		Wet (MAP/PET > 1)		Dry (MAP < 1000 mm)		Moist and Wet (MAP ≥ 1000 mm)	
		Default	Range[2]	Default	Range[2]	Default	Range[2]	Default	Range[2]
Slowly degrading waste	Paper/textiles waste	0.04	0.03[3,5] – 0.05[3,4]	0.06	0.05 – 0.07[3,5]	0.045	0.04 – 0.06	0.07	0.06 – 0.085
	Wood/ straw waste	0.02	0.01[3,4] – 0.03[6,7]	0.03	0.02 – 0.04	0.025	0.02 – 0.04	0.035	0.03 – 0.05
Moderately degrading waste	Other (non – food) organic putrescible/ Garden and park waste	0.05	0.04 – 0.06	0.1	0.06 – 0.1[8]	0.065	0.05 – 0.08	0.17	0.15 – 0.2
Rapidly degrading waste	Food waste/Sewage sludge	0.06	0.05 – 0.08	0.185[4]	0.1[3,4] – 0.2[9]	0.085	0.07 – 0.1	0.4	0.17 – 0.7[10]
Bulk Waste		0.05	0.04 – 0.06	0.09	0.08[8] – 0.1	0.065	0.05 – 0.08	0.17	0.15[11] – 0.2

FOD Model Factor: Methane Correction Factor

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

Conakry, Guinea
Dump Site

Tonnage: 500 tpd

Sample ER Calculations: AM0025 Effect of Ambient Temp. / Precipitation

- **Scenario, Base Conditions**
  - **Waste quantity: 750 tons per day**
  - **Organic fraction: 64%**
    - **Food (55%) & Paper, Wood, Garden (3% each)**
  - **Degradable Organic Carbon, Fraction: 0.50**
  - **Methane Correction Factor: 1.0**
  - **Compost Efficiency: 95%**
  - **Crediting period: 7 yrs**

Durbin, South Africa – LFG
Tonnage: 1,000 tpd (2 sites)
ERs (7 yrs): 480,000 tCO2e

Sample ER Calculations: AM0025
Effect of Ambient Temp. / Precipitation

(Total ERs: 7-yr Crediting Period)

Temperature / Precipitation	Temperate (MAT< 20°C)	Tropical (MAT>20°C)
Wet (MAP>1,000 mm)	476,500 tCO_2e	695,000 tCO_2e
Dry (MAP<1,000 mm)	214,350 tCO_2e	281,150 tCO_2e

CDM and Municipal Waste Management

- **LFG**
  - **% of registered CDM projects: 7.7%**
  - **% of WB Carbon Finance projects: 15.5%**
  - **WB LFG projects:**
    - **ERPA – 15**
    - **Total – 34**
- **Composting (municipal waste)**
  - **% of WB carbon finance projects: 4.0%**
  - **WB composting projects:**
    - **ERPA – 4**
    - **Total - 9**

Carbon Finance Project Cycle: World Bank

- **Project Idea Note (PIN)**
- **Letter of Intent (LOI)**
- **Project Design Document (PDD)**
- **Validation**
- **Emission Reduction Purchase Agreement (ERPA)**
- **Registration / Verification / Certification**

CDM and Waste Management

Status	No. of LFG Projects	No. of MSW Composting Projects
Register Projects	75	3
Registration Pending	7	0
Validation Pending	85	11
TOTAL	167	14

World Bank

- **Founded 1944 for post-war reconstruction**
- **Role to alleviate poverty in developing countries**
- **Organization**
  - **Int'l Bank for Reconstruction and Development (IBRD)**
  - **International Development Association (IDA)**
  - **International Finance Group (IFC)**
  - **Multilateral Investment Guarantee Agency (MIGA)**
  - **Int'l Centre for Settlement of Investment Disputes (ICSID)**

World Bank, Carbon Finance

- **Initiated carbon finance program 1999 to stimulate market**
- **Trustee of 11 Funds / Facilities for governments and firms**
- **Carbon Finance Unit contracts to purchase emission reductions for Fund / Facility members**
- **Carbon financee contributes to sustainable development and reduction in climate change**

Kota Kinabalu, Malaysia – Composting
Tonnage: 500 tpd
ERs (7 yrs): 566,300

Conclusions

- **Waste management of municipal discards is an important part of the CDM program to reduce greenhouse gas emissions**
- **Number of both LFG and composting projects are expected to grow**
- **For municipal solid waste, CDM focus has been on landfill gas recovery (existing disposal sites)**
- **Growing interest in compost to avoid methane generation**
- **Recent decisions of CDM EB has made composting less financial rewarding, especially in areas with dry climates**

Thank You

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Additional Information

- **World Bank's Carbon Finance Unit website: www.carbonfinance.org**
- **2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol5.html**
- **UNFCCC's CDM website: http://cdm.unfccc.int/index.html**

Selected Large-Scale Methodologies

- **LFG - ACM0001, Consolidated baseline and monitoring methodology for landfill gas project activities http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_BTH14FSTZKN0WN9PBDUG9D2U83HXBQ**
- **Composting - AM0025, Avoided emissions from organic waste through alternative waste treatment processes http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_SN0FN11ZSNL3UX7IKRZFTRZ92XUYKK**

Additional Information (Continued)

Selected Small-Scale Methodologies

- **LFG - AMS-III.G, Landfill methane recovery http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_341FT628YO0PX9D2BW9IDMHSTPY139**
- **LFG to Power - AMS-III.D, Grid connected renewable electricity generation http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_PHPV5WESACMBTJ2YY54GAJYSIEI3HD**
- **Composting - AMS-III.F, Avoidance of methane production from decay of biomass through composting http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_6NOS8D6BN7GD231AN3DVLG1EPPYXUK**

LFG, Over-Estimation Concerns

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

% Actual vs. Predicted ERs, CDM Projects with Monitoring Reports (March 2008)

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 (March 2008)

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 (March 2008)

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%