Methane to Markets

LFG Projects Development within the Methane-to-Market Program in Ukraine

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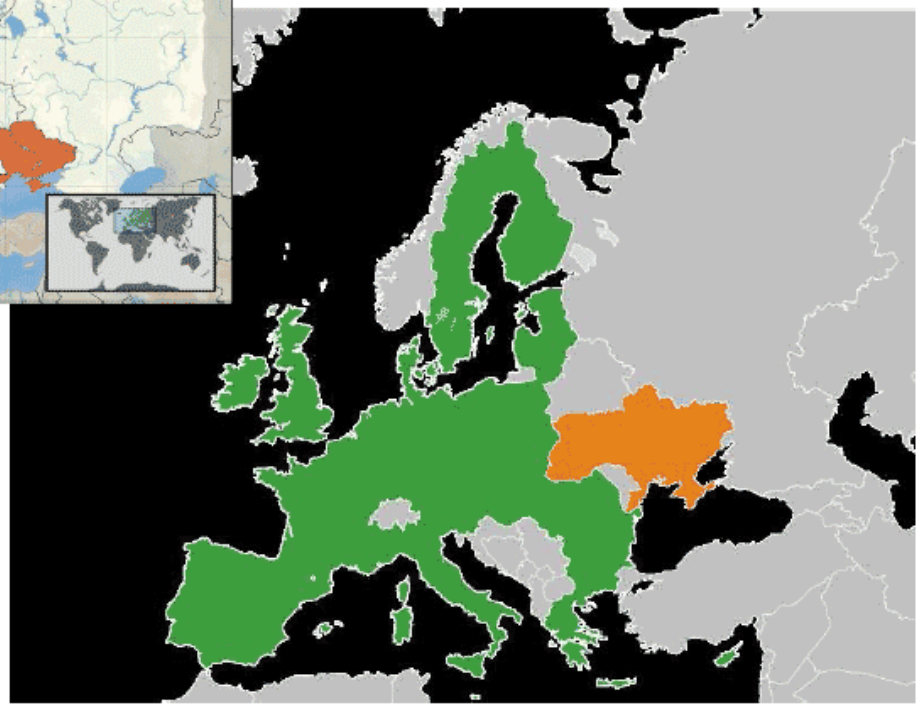
March 2-5, 2010
Methane to Markets Partnership Expo, New Delhi

Presentation structure

- Ukraine – general information
- Ukrainian landfills
- LFG capture and utilization potential
- M2M projects
  - Landfill gas assessment (Khmelnitskiy, Lutsk), pump tests (Chernivtsy, Mariupol)
  - Infrared heaters at Ukrainian landfills (Khmelnitskiy)
  - Landfill gas recovery and flaring (Rivne)
  - Ukrainian LFG model. Version 1.0
- Full scale commercial LFG projects
  - Partnership Expo in Beijing, 2008
  - Mariupol landfills
  - Other landfills
- Problems and prospects of LFG technology development in Ukraine

Ukraine – general information



- Population total – 46 mill
- Population urban – 31 mill
- Area – 603,700 km^2
- Population density – 76 inh./km^2
- GDP – 3,050 $/inh
- MSW – 10-12 mill t/year

Ukraine – general information

Urban population in Ukraine

Town size	Number	Total population	
inhabitants		inhabitants	%
50-100,000	56	3 950 000	8.2
100-200,000	17	2 220 000	4.6
200-500,000	22	6 450 000	13.4
500-1000,000	6	4 980 000	10.4
> 1000,000	5	7 670 000	16.0
Total	106	25 270 000	52.6

Ukrainian landfill and waste dumps

Town	Population	Starting year	MSW, t/year	MSW in place, mill tones	Area, hectares	Depth, meters
Kiev	2,642,000	1986	500,000	7,5	35.5	15-20
Kharkiv	1,622,000	1975	200,000	2.2	20.8	30
Dniproperpovsk	1,050,000	1998	85,000	0.5	7.5	15
Odessa	1,005,000	1972	250,000	5.3	30	22-25
Donetsk	1,000,000	1991	150,000	2.5	21.5	10-15
Zaporizhzhia	800,000	1952	270,000	8-12	47	25
Lviv	730,000	1959	230,000	8,4	33.3	35
Mariupol	480,000	1967/76	100,000	2.5+2.5	12+12	30/20
Luhansk	450,000	1979	80,000	2.5	8.4	20-25
Khmelnitskiy	250,000	1956	75,000	3,0	8.8	35

Ukrainian landfill and waste dumps

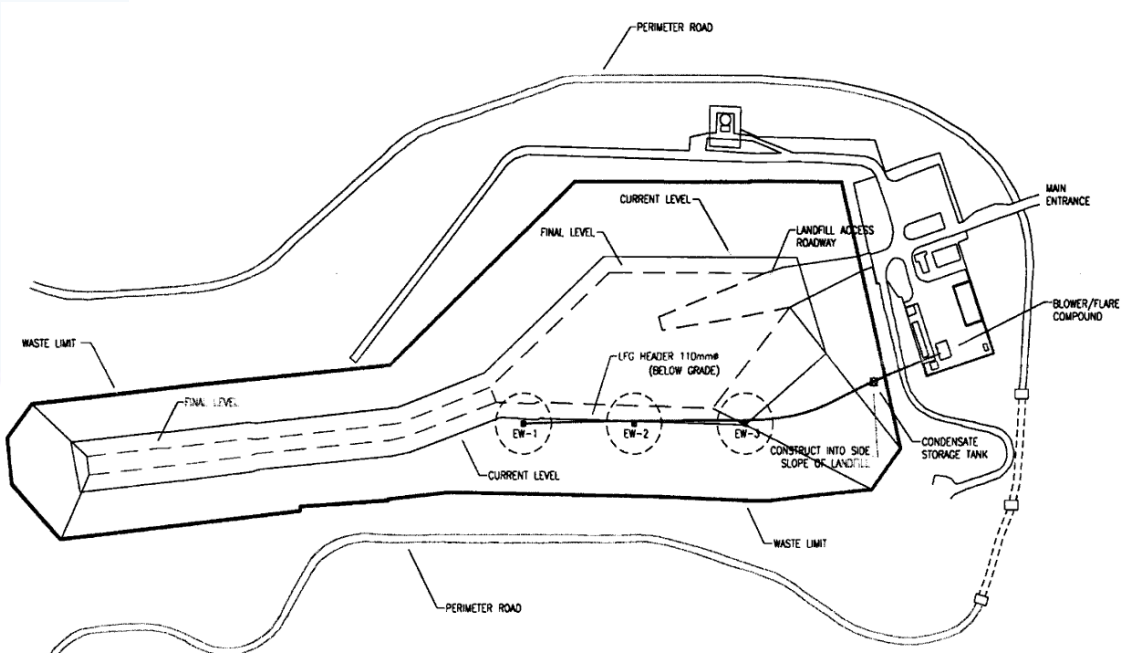
- Steep slopes (up to bottom waste loading)
- Fire events
- Improper covering (big active spot)
- Leachate flooding

Landfill gas potential

- Ukrainian towns generate **10-12 mill tones** of MSW per year
- More than **95%** of MSW is disposed at the landfills. There are **700** landfills located around the towns.
- Only **100** of them can be considered as potential candidates for recovery and utilization of landfill gas.

- Based on this facts, potential of landfill gas available for energy production comes to about **400 mill m3/year** that is equivalent to **0.21 mill toe** or **6.0 mill CO2e**

Luhansk landfill



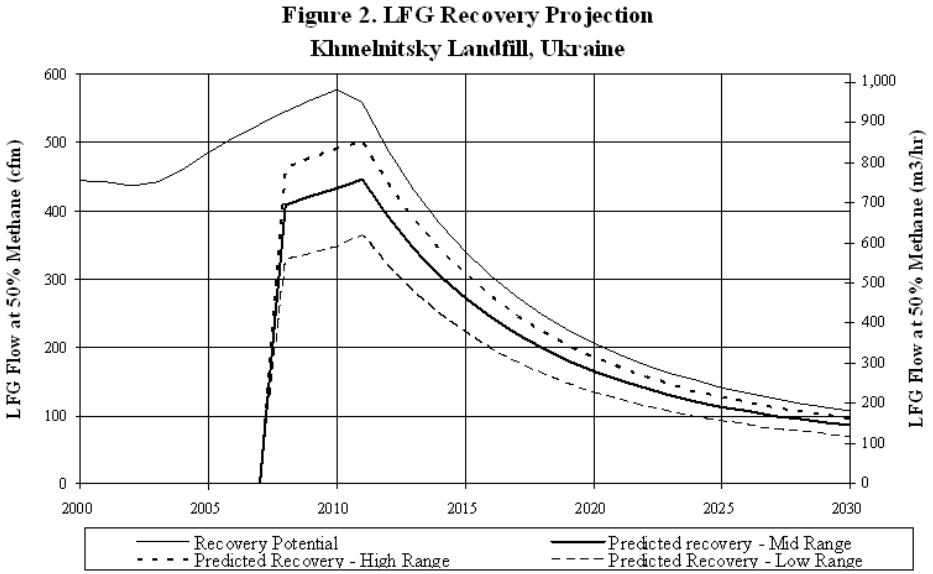
First experience –
demonstration wells (2003-2006)

60 m3/h of LFG (50% of CH_4)

M2M projects
LFG assessment reports

- Khmelnitskiy
- Lviv
- Lutsk
- Chernivtsy
- Mariupol
- Sumy
- etc.

M2M projects
LFG assessment - Khmelnitskiy



- Landfill
  - Starting year - 1956
  - MSW – 75,000 tones/year
  - Area – 8.8 hectares
  - Depth - 35 meters
  - Waste in place – 3.0 mill tones

M2M projects

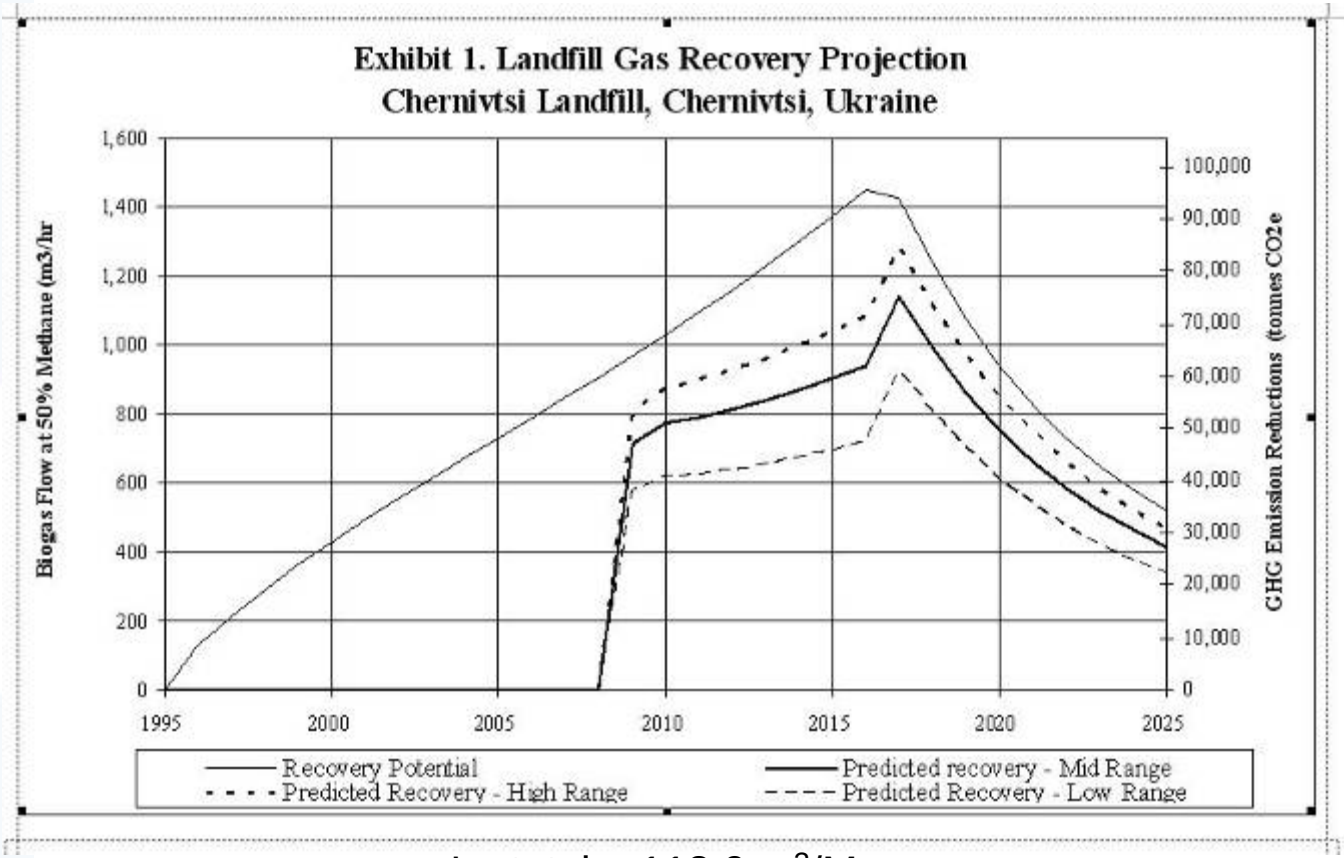
LFG projection based on pump test - Chernivtsy

- Landfill
  - Starting year - 1995
  - MSW - 70-80,000 tones/year
  - Area - 25 hectares
  - Depth - 15-18 meters
  - Waste in place – 0.8 mill tones

- Pump test
  - Duration – two weeks in July 2007
  - Three wells and four pressure probes
  - Methane flow – 75-25 m^3/h
  - Methane content – 55-40%
  - Oxygen content – < 0.6%

M2M projects

LFG projection based on pump test - Chernivtsy



Lo total = 118.0 m^3/Mg

k (fast-decay) = 0.180/year

k (medium-decay) = 0.036/year

k (slow-decay) = 0.009/year

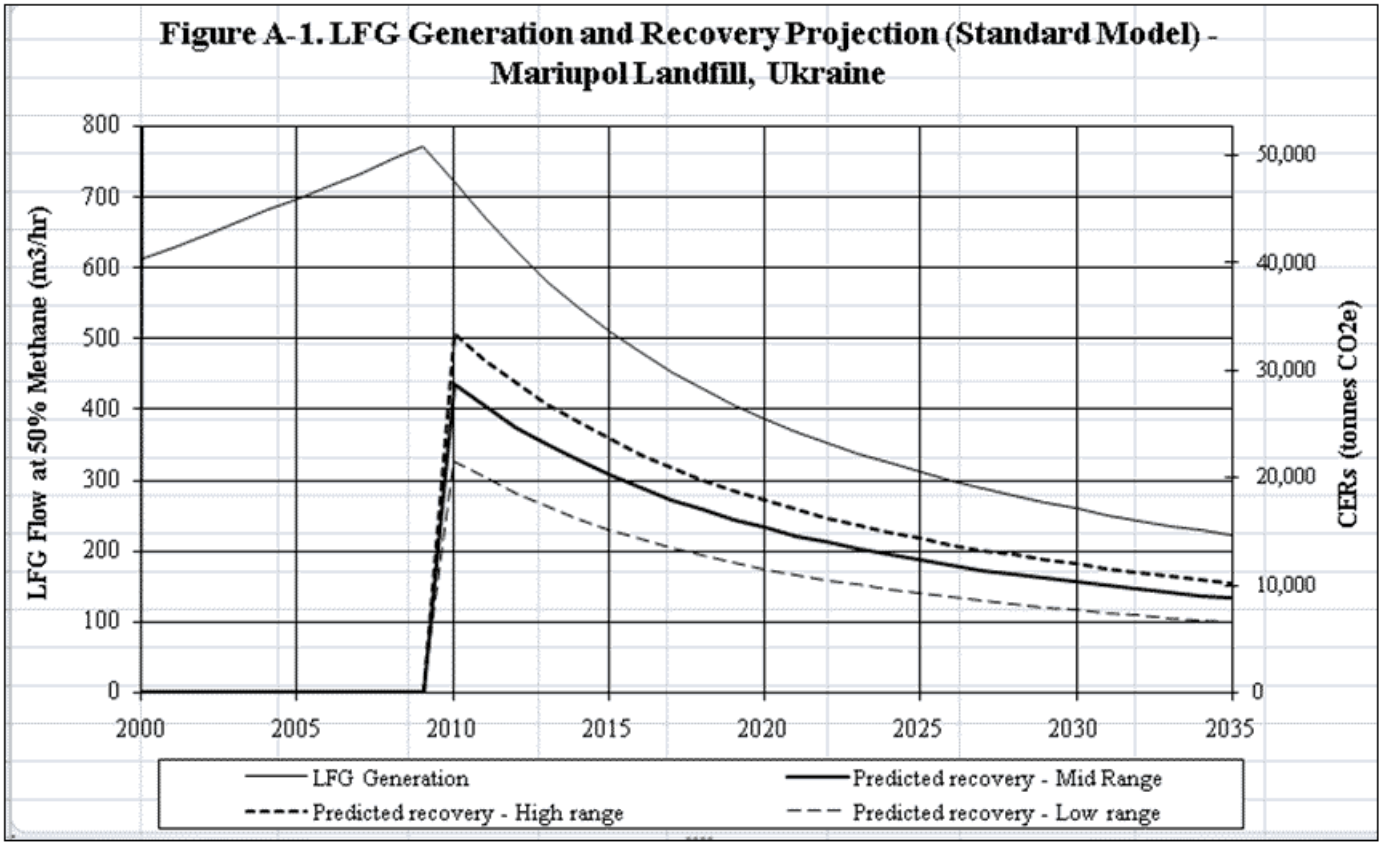
M2M projects

LFG projection based on pump test - Mariupol

- Landfill
  - Starting year – 1967
  - Closure - 2009
  - MSW – 75,000 tones/year
  - Area - 12 hectares
  - Depth – 25-30 meters
  - Waste in place – 2.5 mill tones
- Pump test
  - Duration – four weeks in August-September 2008
  - Three wells and nine pressure probes
  - Methane flow – 50-45 m^3/h
  - Methane content – 65-35%
  - Oxygen content – < 0.8%

M2M projects

LFG projection based on pump test - Mariupol



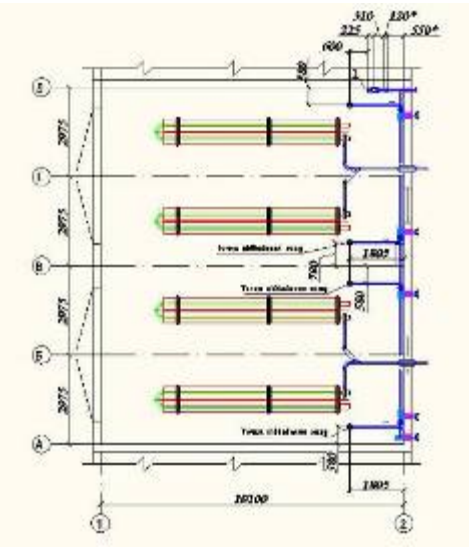
Lo total = 84.0 m^3/Mg

k (fast-decay) = 0.140/year

k (medium-decay) = 0.028/year

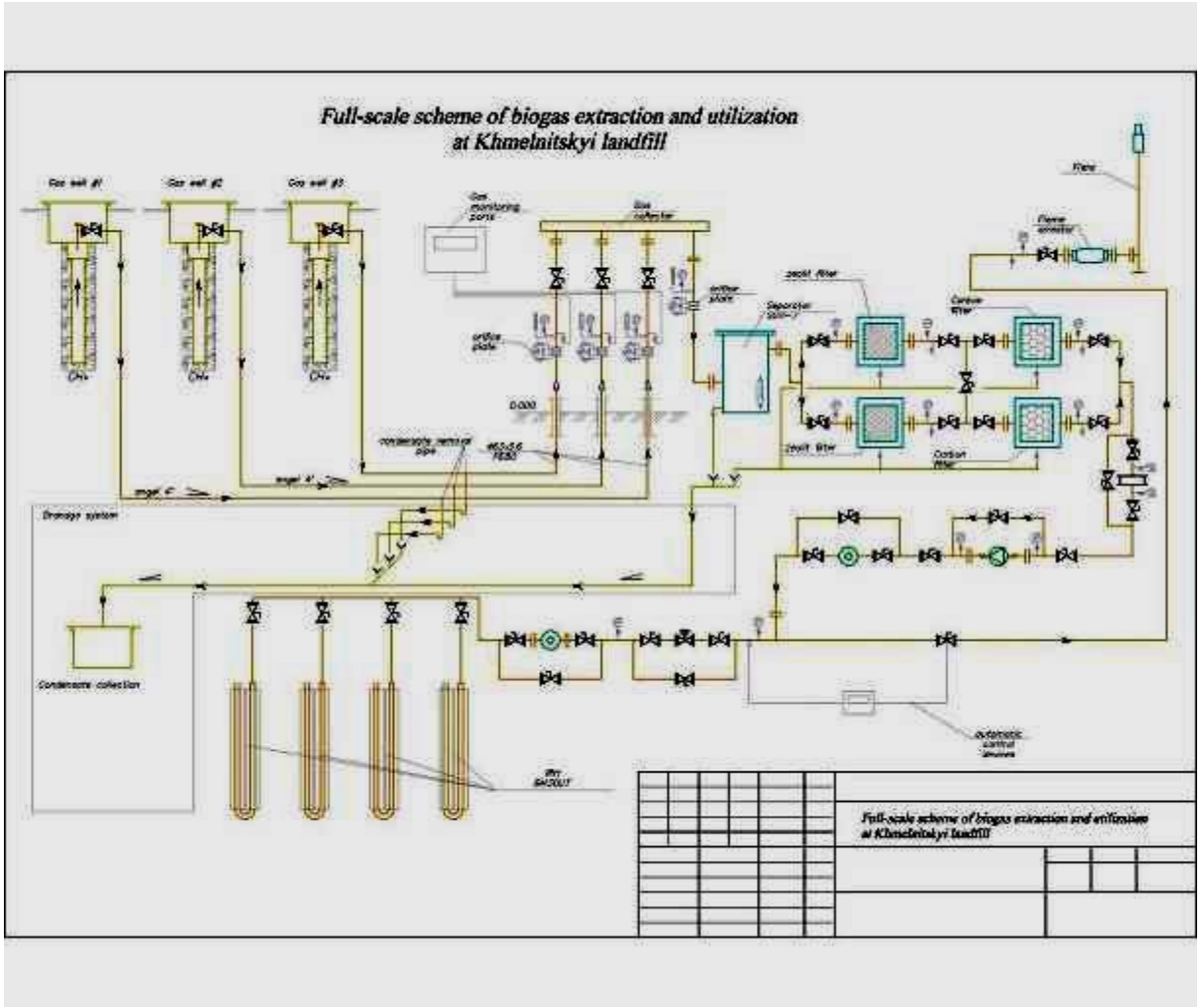
k (slow-decay) = 0.007/year

M2M projects
Infrared heaters based on LFG



- Heated area – 2 x 126 m^2
- Type of IR-heater – *Roberts Gordon Black Heat U30*
- Capacity – 30 kW
- Number of heaters - 4

M2M projects
Infrared heaters based on LFG



M2M projects
Infrared heaters based on LFG

M2M projects
Infrared heaters based on LFG

M2M projects
LFG recovery and flaring (Rivne landfill)

- Landfill
  - Starting year - 1959
  - MSW – 120,000 tones/year
  - Area – 22 hectares
  - Depth – 15-25 meters
  - Waste in place – 2.0 mill tones
- Pump test
  - Duration – May 9-20 and July 29-August 05, 2009
  - Three wells and twelve pressure probes
  - Methane flow – 55-20 m^3/h
  - Methane content – 50-35%
  - Oxygen content – < 1.2%

Ukrainian LFG model. Version 1.0

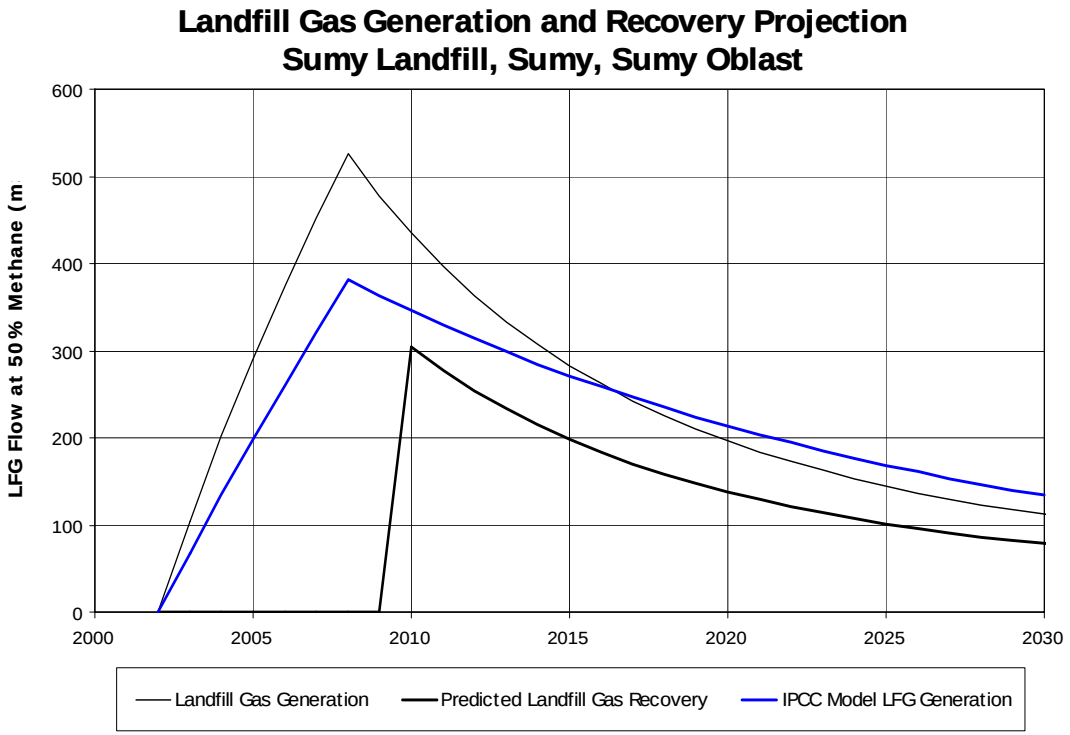
$$Q_{CH_4} = \sum_{i=1}^{n} \sum_{j=0.1}^{1} k \cdot L_0 \cdot \left[\frac{M_i}{10}\right] \cdot e^{-ktij}$$

Precipitation (mm/yr)
Region 1: 360-429 (red)
Region 2: 430-499 (yellow)
Region 3: 500-599 (green)
Region 4: 600-699 (blue)

Waste Category:	L_0 Values (m^3/Mg)
1. Food, Other Organics	69
2. Garden and Park Waste	126
3. Paper and Textiles	214
4. Wood, Rubber, Leather, Straw	201

Climate Region:	1	2	3	4
Annual Precipitation Range, mm:	360-429	430-499	500-599	600-699
Average Annual Precipitation:	389 mm	456 mm	558 mm	645 mm
Average 24-Hour Temp. (°C):	8.9	9.2	7.3	7.7
Waste Category:	Assigned k Values (1/year):			
1. Food, Other Organics	0.110	0.120	0.140	0.150
2. Garden and Park Waste	0.055	0.060	0.070	0.075
3. Paper and Textiles	0.022	0.024	0.028	0.030
4. Wood, Rubber, Leather, Straw	0.011	0.012	0.014	0.015

Ukrainian LFG model. Version 1.0



- Model accounts for fires by applying a “fire adjustment factor”
- Collection efficiency calculated by model based on site management practices, waste depth, well field coverage of waste area, soil cover type and extent, bottom liner, waste compaction, focused tip area, leachate presence

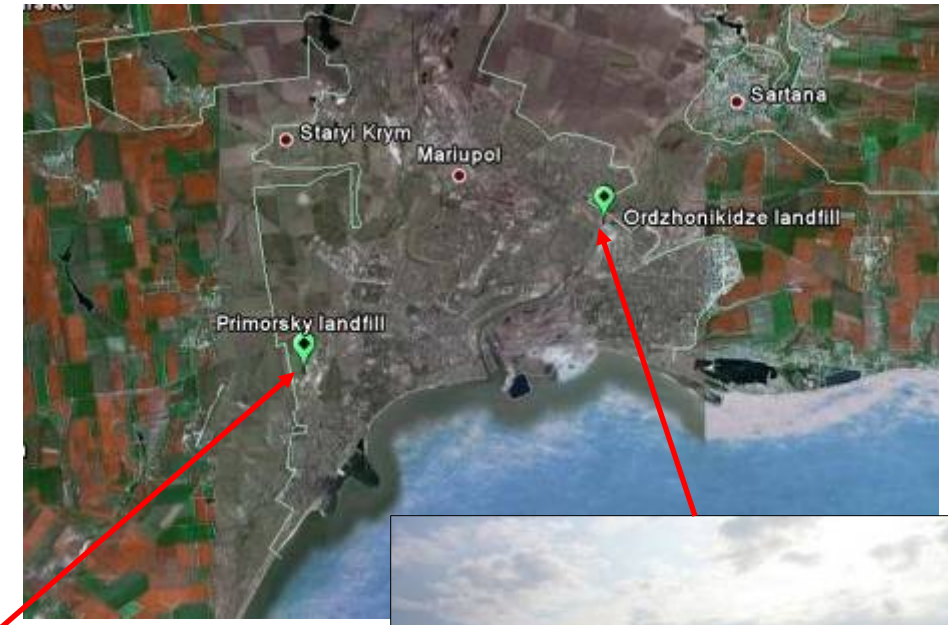
M2M projects
Partnership Expo in Beijing, 2007

- Lviv landfill
- Mariupol landfill
- Chernivtsi landfill

LFG project in Lviv (Joint Implementation)

LFG recovery and flaring, August 2009
2000 m3/hour of LFG
(Gafsa/CMM)

LFG project in Mariupol
(Joint Implementation)



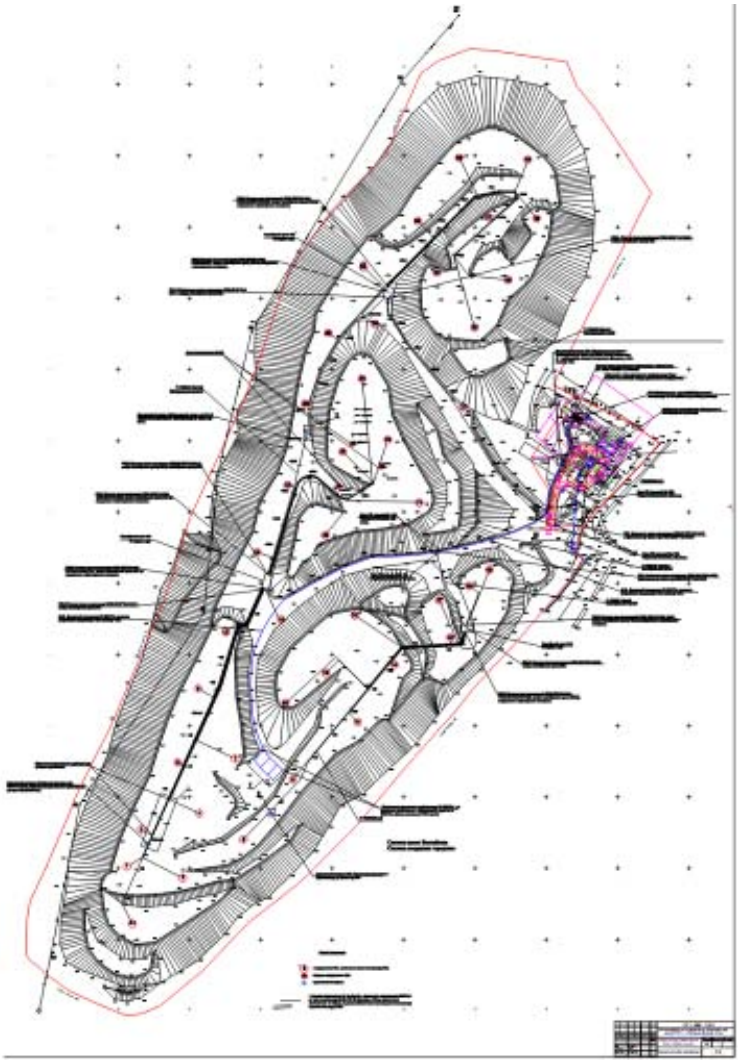
LFG project in Mariupol
(Joint Implementation)

- Population – 480,000
- Starting year – 1967/1976
- Closure – 2009/2011
- MSW – 120,000 tones/year
- Area – 12+12 hectares
- Depth – 30/20 meters
- Waste in place – 2.5+2.5 mill tones

LFG project in Mariupol
(Joint Implementation)

- Number of wells – 44;
- Total piping – 6 km
- Maximum flow – 800 m3/h

- Two options – flaring or power production



LFG project in Mariupol
(Joint Implementation)

Possible LFG projects

- Landfill gas capture and flaring (< 100,000 inhabitants);
- Landfill gas capture and directly utilization in a boiler/kiln/ furnace etc. (Odessa, Mariupol);
- Landfill gas capture and combustion for electricity production (green tariff);
- Landfill gas capture and combustion for combined heat and electricity production;
- Landfill gas use for vehicle
- Leachate evaporation (Kiev)

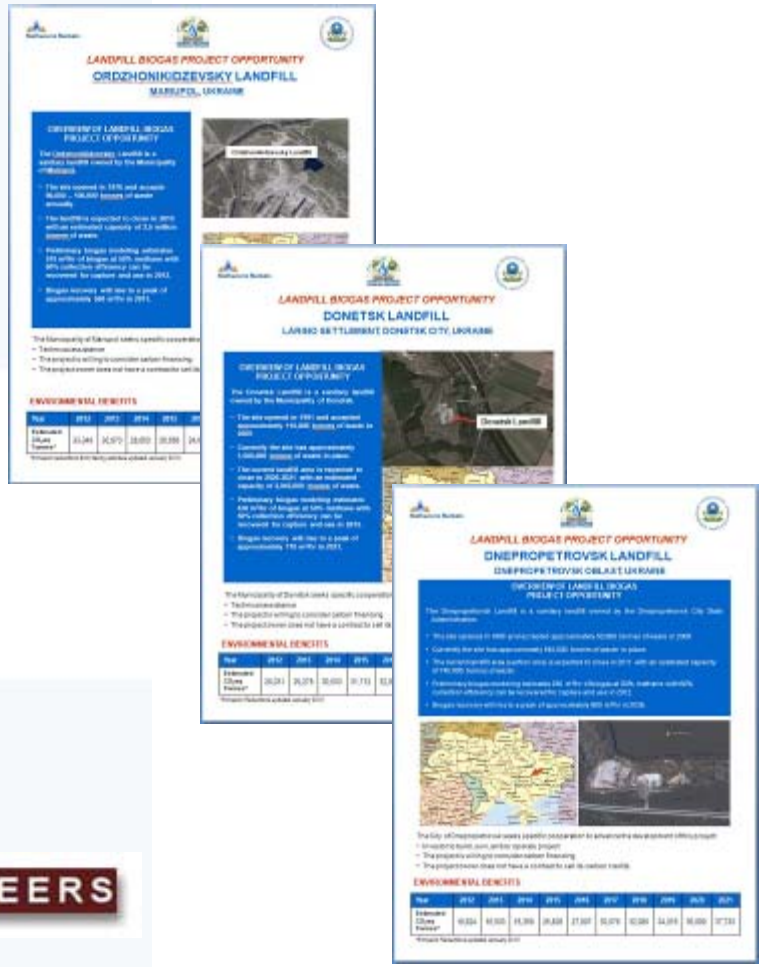
Problems and prospects of LFG technology development in Ukraine

- Local project structure and decision making – bottleneck
- Key point - financial conditions and level of interest of the owner/operator of the landfill site
- Low waste management tariffs. Co-financing from owners (municipalities) and operators can hardly be expected
- Bad technical conditions and a lack of reliable technical data at some landfills restrict practicability of potential JI projects
- Ukraine is not big. Ukrainian landfills are relatively small

Problems and prospects of LFG technology development in Ukraine

- Currently LFG projects at old landfills can hardly be implemented without Kyoto Protocol
- The main GHG emission reduction potential is connected to the towns with population more than 200,000 – 33 towns
- The usual method of LFG utilization can be power generation by IC-engines
- For smaller town with population less than 100 thousands inhabitants LFG can be captured and flared without utilization. For JI project it can be recommended to joint 3-5 landfills in the certain region under one project umbrella
- Condition would improve:
  - price for natural gas goes up
  - support of the government by green tariffs for electricity
  - implementation of the strategy of new regional landfill erection and old landfill closure

M2M projects
Partnership Expo in New Delhi, 2010



- Mariupol landfill (2)
- Donetsk landfill
- Dnepropetrovsk landfill

Thank you for your attention

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