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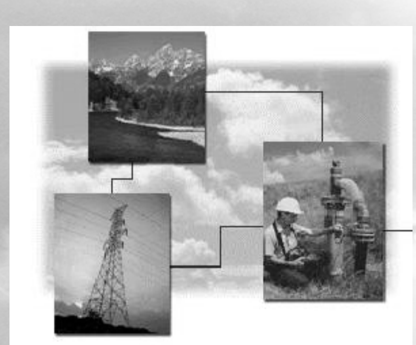
An Overview of Landfill Gas Energy in the United States



Responsible Management of Methane Gas at Superfund Landfills Webinar
June 24, 2008

LANDFILL METHANE OUTREACH PROGRAM

LANDFILL METHANE OUTREACH PROGRAM

Overview

- LMOP/LFG Basics
- Economic Benefits
- Project Types & Examples
- Revenue Sources
- Technical Support

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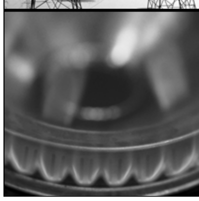
LANDFILL METHANE OUTREACH PROGRAM

Why EPA is Concerned About Landfill Gas

- Why is methane a greenhouse gas?
  - Methane absorbs terrestrial infrared radiation (heat) that would otherwise escape to space (GHG characteristic)
- Methane as GHG is over 20x more potent by weight than CO_2
- Methane is more abundant in the atmosphere now than anytime in the past 400,000 years and 150% higher than in the year 1750
- Landfills were the second largest human-made source of methane in the United States in 2006, accounting for 22.6% generated

LANDFILL METHANE OUTREACH PROGRAM



EPA's Landfill Methane Outreach Program

- Established in 1994
- Voluntary program that creates alliances among states, energy users/providers, the landfill gas industry, and communities

Mission: To reduce methane emissions by lowering barriers and promoting the development of cost-effective and environmentally beneficial landfill gas energy (LFGE) projects.

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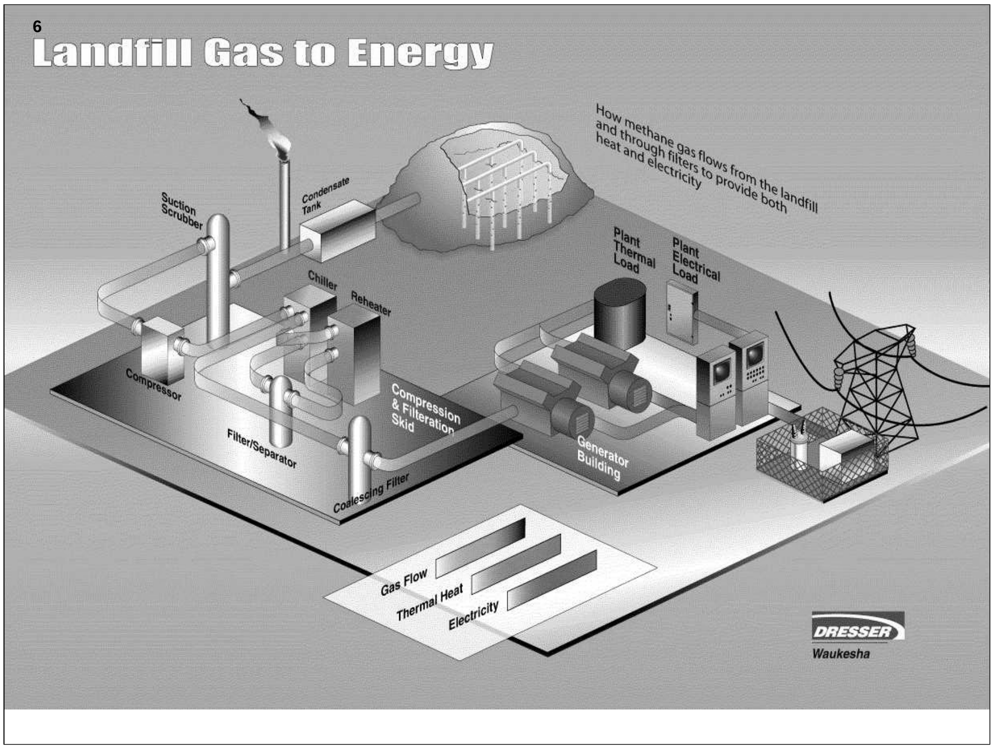
LANDFILL METHANE
OUTREACH PROGRAM

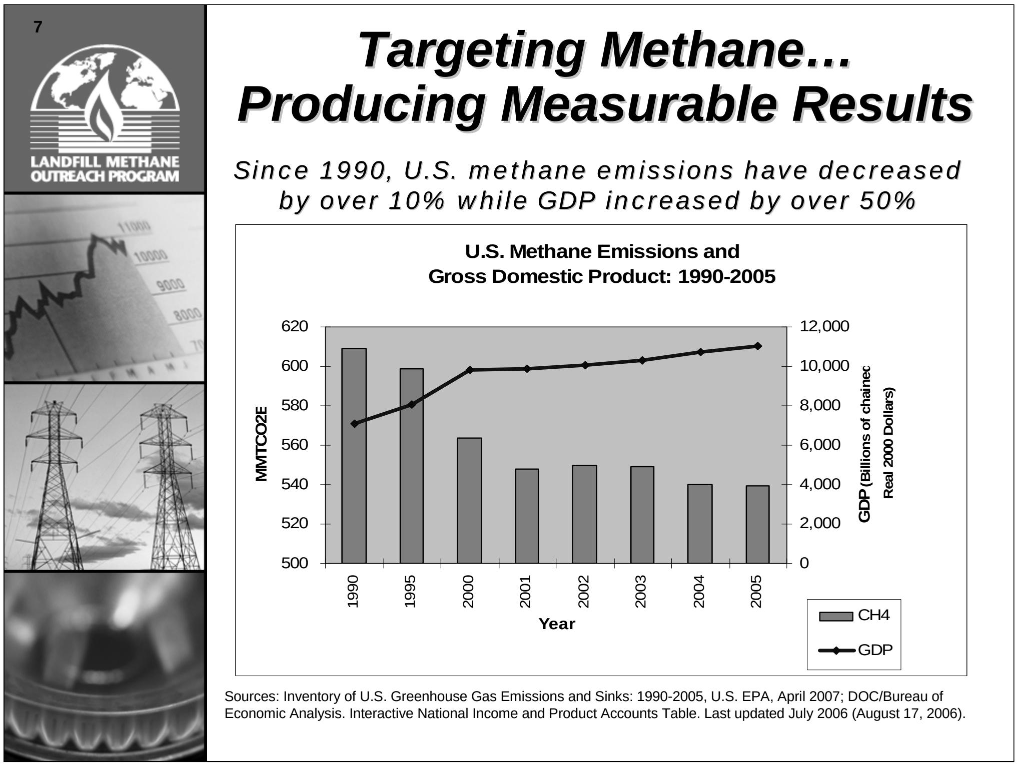
Landfill Gas 101

- Landfill gas (LFG) is a by-product of the decomposition of municipal solid waste (MSW):
  - ~ 50% methane (CH_4)
  - ~ 50% carbon dioxide (CO_2)
  - <1% non-methane organic compounds (NMOCs)
- For every 1 million tons of MSW:
  - ~ 0.8 MW of electricity
  - ~ 432,000 cubic feet per day of LFG
- If uncontrolled, LFG contributes to smog and global warming, and may cause health and safety concerns



The level of LFG treatment needed prior to combustion depends on site-specific factors and the type of combustion device

Some LFG treatment systems are simpler than the one shown in this diagram



As of 2005, CH4 emissions have decreased by 11.5% below 1990 levels while GDP has continued to increase (55% growth) over that same period.

Sources of data: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005, U.S. EPA, April 2007; DOC/Bureau of Economic Analysis. Interactive National Income and Product Accounts Table. Last updated July 2006 (August 17, 2006)

LFG Has Been Used to Help Produce…

- Aluminum
- Alternative fuels (biodiesel, CNG, ethanol, and LNG)
- Aquaculture (e.g., tilapia)
- Arts & crafts (blacksmithing, ceramics, glass)
- Biosolids (drying)
- Bricks and concrete
- Carpet
- Cars and trucks
- Chemicals
- Chocolate
- Consumer goods and containers
- Denim
- Electronics
- Fiberglass, nylon, and paper
- Furthering space exploration
- Garden plants
- Green power
- Ice cream, milk, and tea
- Infrared heat
- Juice (apple, cranberry, orange)
- Pharmaceuticals
- Pierogies and snack food
- Soy-based products
- Steel
- Tomatoes (hydroponic)
- Taxpayer savings and increased sustainability!

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State of the National LFG Industry (April 2008)

- At least 450 operational projects in 43 states supplying:
  - 11 billion kilowatt hours of electricity and 77 billion cubic feet of LFG to direct-use applications annually
- Estimated **Annual** Environmental Benefits
  - Carbon sequestered annually by **~17,800,000 acres of pine or fir forests**, or
  - CO_2 emissions from ~**182,000,000 barrels of oil consumed**, or
  - Annual greenhouse gas emissions from ~**14,300,000 passenger vehicles**
- Estimated **Annual** Energy Benefit
  - Powering more than **870,000 homes** and heating nearly **534,000 homes**

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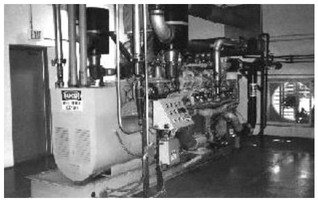
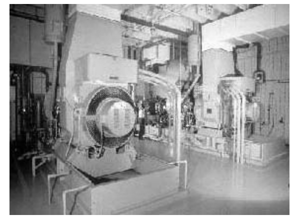
Diversity of Project Types
Electricity Generation



Internal Combustion Engine (range from 100 kW to 3 MW)



Gas Turbine (range from 800 kW to 10.5 MW)

Microturbine (range from 30 kW to 250 kW)

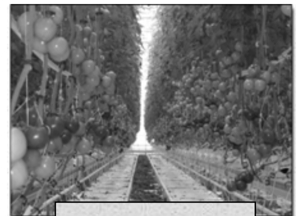
IC engines are the work horse of the industry

CHP Case Study

H_2Gro Greenhouses

Lewiston, NY

- Innovative Energy Systems' Model City Energy Facility at the Modern Landfill went online in June 2001
- 11 engine-generator sets produce a total of 12 MW of electricity
- Provides all electrical & heating requirements of H_2Gro's Greenhouses
- Excess electricity sold to grid
- H_2Gro initially constructed a ½ acre hydroponic greenhouse test cell and yielded 180,000 lb/yr of tomatoes
- Test so successful, expanded to 7½ acres and produces 3.5 million lb tomatoes/yr



LMOP
2005
Project of the Year

CHP and Direct-Use Case Study
BMW Manufacturing
Greer, SC

LMOP 2003
Project of the Year

- 9.5-mile pipeline from Palmetto Landfill to BMW
- 2003 – 4 KG2 gas turbines retrofitted to burn LFG
  - 4.8 MW of electricity generated and 72 million Btu/hr of heat recovered
- 2006 – Converted paint shop to utilize LFG in oven burners and for indirect heating
- LFG accounts for nearly 70% of BMW's energy needs
- BMW saves at least $1 million/yr

LMOP 2006
Energy End User Partner of the Year

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Landfill Gas and Green Power A Winning Combination

- Dual benefit ➡ destroys methane and other organic compounds in LFG
- Offsets use of nonrenewable resources (coal, oil, gas) reducing emissions of
  - SO_2 , NO_X , PM, and CO_2
- LFGE is a recognized renewable energy resource
  - *Green-e*, EPA Green Power Partnership, 24 states, Sierra Club, NRDC
- LFG is generated 24/7 and projects have online reliability over 90%
- LFG can act as a long-term price and volatility hedge against fossil fuels

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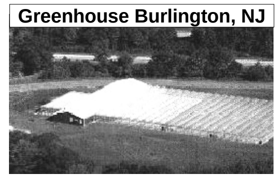
Diversity of Project Types
Direct-Use of LFG

- Direct-use projects are growing!
  - Boiler applications – replace natural gas, coal, fuel oil
  - Combined heat & power (CHP)
  - Direct thermal (dryers, kilns)
  - Natural gas pipeline injection
    - Medium & high Btu
  - Greenhouse
  - Leachate evaporation
  - Vehicle fuel (LNG, CNG)
  - Artist studio
  - Hydroponics
  - Aquaculture (fish farming)

Greenhouse Burlington, NJ



Pottery Studio Sugar Grove, NC

LFG-fired Boiler Ft. Wayne, IN

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Emerging Technologies: LFG for Vehicle Fuel

- City of Denton, TX uses LFG to fuel a 3 million gal/yr biodiesel production facility
- Los Angeles, CA converts LFG into CNG to fuel landfill equipment (Puente Hills LF)
- Orange Co, CA – 1st commercial LFG-to-LNG facility online Jan. '07 – used in county waste trucks (Frank R. Bowerman LF)
- Central LF, CA plans to convert LFG to CNG to fuel Sonoma County school buses
- Franklin Co, OH is in the process of using LFG to produce methanol as a feedstock for biodiesel
- Waste Management in CA plans to produce 10-20K gal LNG per day for garbage trucks

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Infrared Heaters

- Used to heat storage and maintenance facilities
- Requires very little LFG to heat large spaces
- Easy to install
- 5 operational projects in the U.S.

5 operational projects and 2 under construction projects

Operational projects: Frederick County, VA; Fairfax County, VA; Allen County Landfill, KS; Forest View Landfill Kansas City, KS, Franklin County NY

Under construction: Fairfax County, VA (2nd landfill); Prince William County, VA

Current operational projects use between 20 to 50 m^3/hr, average flow to project is 29 m^3/hr

One of the under construction projects is much larger with a flow of 170 m^3/hr

Capital cost of heaters is about $2,000 US dollars each. This does not include pipeline.

Pipeline cost will be less than the typical pipeline if project is at the landfill – no easements or road crossings.

For example the total capital cost for one of the VA projects was $293,000

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Artisan Applications

- Used to fuel ceramic kilns, glass furnaces, or blacksmith forges
- Provides large cost savings to industries and artists
- 2 operational projects in the U.S.
- 2 projects in development in the U.S.

Average greenhouse projects = 0.054 mmscfd (37.5 cfm)

Project of this kind have annual acceptance rates from 13,000 tons/yr to 700,000 tons/yr, with an average of 271,300 tons/ year

37.5 cfm can be accomplished with 1 or 2 strong gas wells. More wells required for landfills that are closed and older.

Partial well field can be installed to fuel ceramics and glass studios.

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Combined Heat and Power Illinois, USA

- First school co-generation (CHP) project on LFG
- 12 microturbines with 360 kW capacity
- Exhaust energy produces 290,000 BTUs/hour at 550º
- School expects to save $100,000/year

Microturbines are more financially feasible when operated in a CHP application.

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Typical Electric Project Components & Costs

- 3 MW engine project for 15 years:
  - Gas compression & treatment, engine, & generator
    - Installed capital cost = ~$3.5 million
  - Annual operation & maintenance
    - Cost = ~$570,000/year
  - Interconnect equipment = ~$260,000
- Total capital cost = ~$3.76 million
- Total annual cost = ~$570,000

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Typical Direct-Use Project Components & Costs

- 800 scfm project for 15 years:
  - Gas compression & treatment
    - Installed capital cost = ~$230,000
  - Pipeline
    - Installed capital cost = ~$280,000/mile
  - Annual operation & maintenance
    - Cost = ~$140,000/year
  - End-of-pipe combustion equipment retrofits, if needed
- Total capital cost (5-mile) = ~$1.63 million
- Total annual cost = ~$140,000

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Potential LFG Revenue

- Electric projects
  - Sale of electricity (4 - 6 cents/kWh)
  - Sale of Renewable Energy Credits (RECs)
  - Premium pricing for renewables through RPS/RPG or voluntary green power markets
  - Tax credits & incentives
  - Clean Renewable Energy Bonds (CREBs)
- Direct-use projects
  - Sale of LFG (~$4.50 per MMBtu)
- Both
  - Greenhouse gas emissions trading
  - Energy cost savings

$4.50/MMBtu is default price for LFG in LFGcost

Market price for direct-use of LFG is often tied to some percentage of the NYMEX rolling average of natural gas or some other price index (e.g., Henry Hub, Appalachian Index for Natural Gas delivered to a certain market)

The actual percentage of the NG price is project specific and also reflects the capital costs of the infrastructure supplied by each party. These types of contracts typically have a floor and ceiling for the fuel costs to protect both the landfill and the end user.

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Regulations that Affect LFGE

- LFGE projects may be affected by a variety of federal, state, and local air quality regulations. Applicable federal Clean Air Act regulations include:
  - New Source Performance Standards (NSPS) / Emission Guidelines (EG)
  - Title V
  - Maximum Achievable Control Technology (MACT)
  - New Source Review (NSR)
  - Prevention of Significant Deterioration (PSD)

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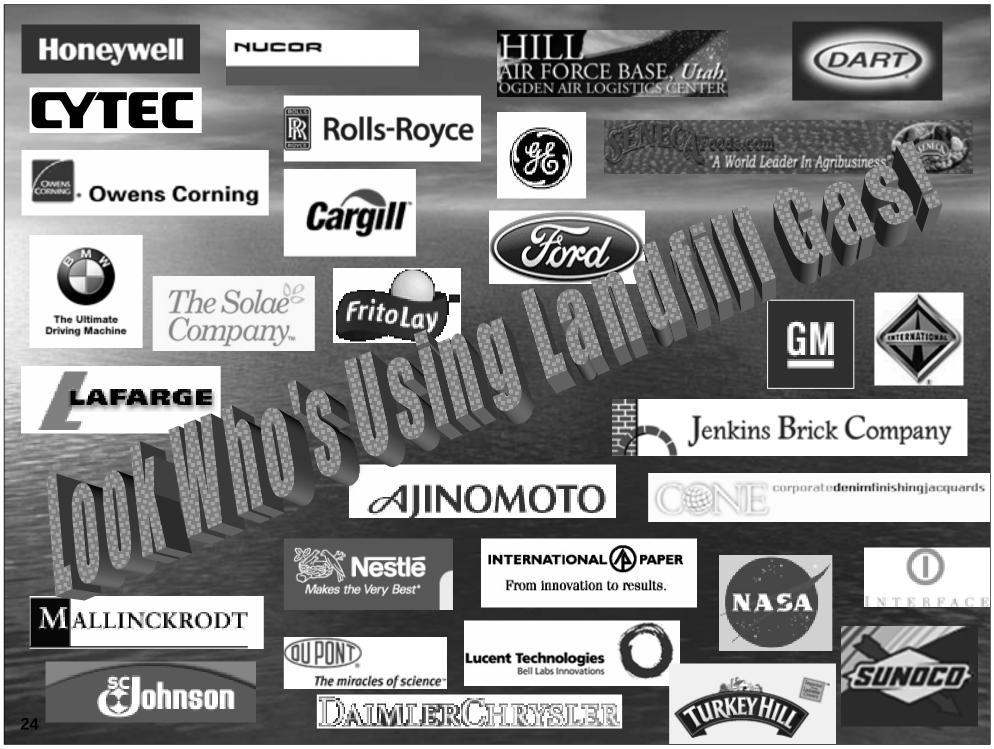
Federal Financial Incentives

- Section 45 Tax Credit
  - Electricity generation – 1.0 cent/kWh
  - Placed in service by 12/31/08
  - 5- or 10-year window for credits depending on placed-in-service date
- Clean Renewable Energy Bonds (CREBs)
  - National allocation of $1.2 billion
  - Current issuance period of 1/1/07 to 12/31/08
  - In 2006, IRS granted issuance of 36 bonds for LFGE projects
- Renewable Energy Production Incentive (REPI)
  - Local/state government or non-profit electric co-op facilities
  - Online by 10/1/16
  - Payment for first 10 years of operation


Look Who's Using Landfill Gas!
Honeywell
NUCOR
HILL AIR FORCE BASE, Utah
OGDEN AIR LOGISTICS CENTER
DART
CYTEC
Rolls-Royce
SENECAfoods.com "A World Leader In Agribusiness"
Owens Corning
Cargill
Ford
The Ultimate Driving Machine
The Solae Company
FritoLay
GM
INTERNATIONAL
LAFARGE
Jenkins Brick Company
AJINOMOTO
CONE corporatedenimfinishingjacquards
Nestle Makes the Very Best
INTERNATIONAL PAPER From innovation to results.
NASA
INTERFACE
MALLINCKRODT
DUPONT The miracles of science
Lucent Technologies Bell Labs Innovations
SUNOCO
SC Johnson
DAIMLERCHRYSLER
TURKEY HILL
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LANDFILL METHANE OUTREACH PROGRAM

LMOP Tools and Services

- Network of 700+ Partners (and growing)
- Newsletter and listserv
- Direct project assistance
- Technical and outreach publications
- Project and candidate landfill database
- Web site (epa.gov/lmop)
- Support for ribbon cuttings/ other PR
- Presentations at conferences
- State training workshops
- *LMOP 12th Annual Conference, Project Expo & Partner Awards – Jan. 13-14, 2009 in Baltimore, MD*

EPA Administrator
Stephen L. Johnson

Keynote Speaker
11th Annual LMOP Conference
Washington, DC

January 9, 2008

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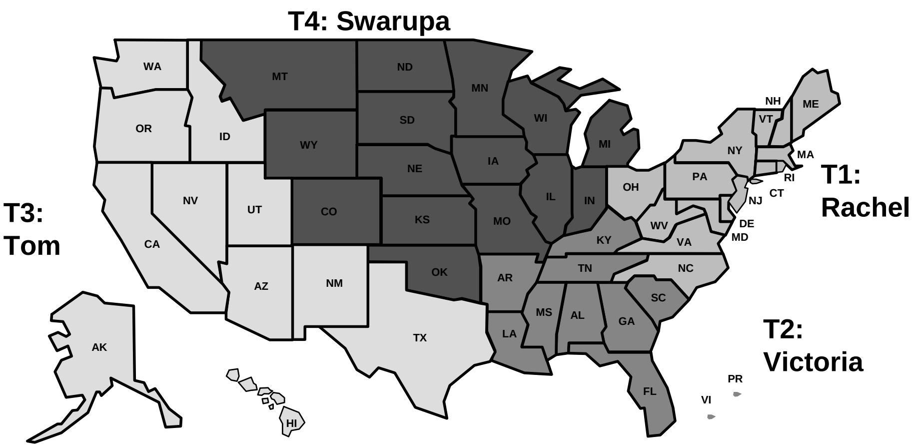
How Can We Work Together? Direct Project Assistance

- Analyze landfill resource – gas modeling
- Identify potential matches – *LMOP Locator*
- Assess landfill and end user facilities
- Look at project possibilities
  - Direct-use (boiler, heating, cooling, direct thermal)
  - Combined Heat & Power (engine, turbine, microturbine)
  - Electric (engine, turbine, microturbine)
  - Alternative Fuels (medium or high Btu, LNG, CNG)
- Initial feasibility analyses – *LFGcost*

For More Information

www.epa.gov/lmop



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Evaluating Landfill Gas Emissions from Superfund Sites

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Office of Research and Development
National Risk Management Research Laboratory
Air Pollution Prevention and Control Division

June 24, 2008

Presentation Outline

- Health and environmental concerns
  - Trends impacting future emissions and exposure
  - Differences between Superfund sites & Subtitle D landfills
- EPA guidance for evaluating landfill gas emissions
- Effective landfill gas control
- Combustion by-products
- Summary

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Landfill Gas (LFG) Health & Environmental Concerns

- Landfills are a major source of methane resulting from anaerobic decomposition of biodegradable waste – emissions are generated for decades
- Concern for explosive potential of the gas, landfill fires, and odor nuisance
- LFG contains 40-60% methane, 60-40% CO_2, and trace constituents of volatile organic compounds (VOC), hazardous air pollutants (HAPs), and persistent bioaccumulative toxics
- Landfills identified in EPA's Urban Air Toxic Strategy for residual risk evaluation
  – More than 30 HAPs detected in LFG
  – Updated LFG concentration data suggest H_2S concentration may be increasing (EPA, 2007 - http://www.epa.gov/ORD/NRMRL/pubs/600r07043/600r07043.pdf)

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Is a designated pollutant under the Clean Air Act because of the explosive potential of the gas, emissions of volatile organic compound (VOC), hazardous air pollutants (HAPs), persistent bioaccumlative toxics (PBTs), and greenhouse gases (methane, CO2).

Landfill methane most amenable to cost-effective control through methane utilization

United States Environmental Protection Agency

Trends Impacting Emissions

- Urban sprawl is increasing potential exposure due to
  - near-by neighborhoods or commercial property being developed adjacent to sites
- Adoption of wet/bioreactor operations (even being suggested for superfund sites where there are no existing liners and greater difficulty to predict potential emissions)
- Use of porous materials as alternative covers to promote infiltration (resulting in larger loss of fugitive emissions)
- More widespread use of landfills for recreational use or development
  - Desire is to put controls in and walk away. However, effective LFG control requires maintenance of cap and well field over time.
- Increasing interest in improved GHG inventories; quantifying uncontrolled emissions from landfills is considered key to implementing successful mitigation strategies.

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How are Superfund Sites Different from Subtitle D Municipal Landfills?

- Sites are typically older and have not been accepting waste for 20 or more years
- Limited data to characterize composition and quantity of waste that is buried
- Typically there has been co-disposal of municipal and hazardous waste
- Sites do not have liners or types of controls that minimize environmental impact
- For sites that have not yet been remediated, often cover material is spotty and not effective at capturing landfill gas

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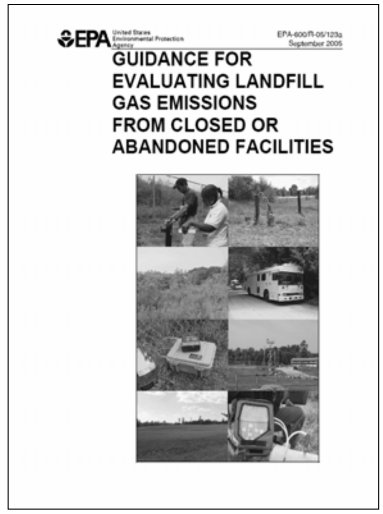
EPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities

- **Available at:** **http://www.epa.gov/ORD/NRMRL/pubs/600r05123/600r05123.pdf)**
  - **Provides overview of guidance for evaluating landfill gas emissions at older sites where the NSPS/EG requirements are not applicable**
  - **Reports also available for application of guidance to 3 different landfills**
    - ***Bush Valley Superfund Landfill, Abingdon, Maryland* (EPA/600/R-05/143). Available at: http://www.epa.gov/ord/NRMRL/pubs/600r05143.**
    - ***Rose Hill Regional Landfill; Kingstown, Rhode Island* (EPA/600/R-05/141). Available at: http://www.epa.gov/ord/NRMRL/pubs/600r05141**
    - ***Somersworth, NH* (EPA/600/R-05/142) Available at: http://www.epa.gov/ORD/NRMRL/pubs/600r05142/600r05142.htm**



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Guidance for Evaluating LFG Emissions at "Old" Landfills

Tiered approach

- 1^{st} Tier -Serpentine pattern sampling of surface using PID/FID and sampling of any existing perimeter probes & passive vents
- 2^{nd} Tier – Use data from 1^{st} Tier to identify sampling points for more comprehensive screening (using punch probes and canisters)
- 3^{rd} Tier – Use of Optical Remote Sensing (ORS) technology which allows results to be used directly in risk evaluation rather than use of emission and dispersion models

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Developed in Collaboration with EPA's Environmental Response Team*

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*ORD also worked closely with OSWER, OAQPS, and EPA Regions 1 and 3 in developing guidance

Serpentine Pattern Sampling of Landfill Surface

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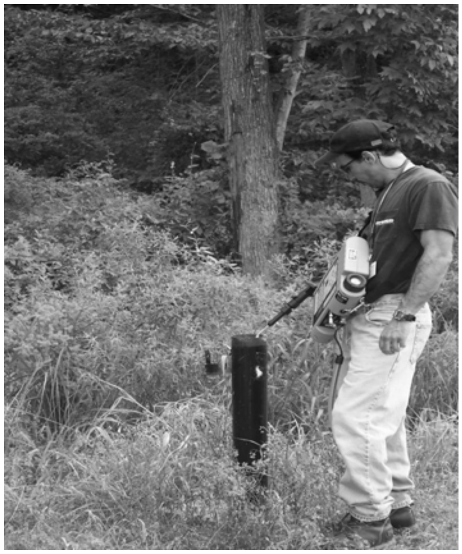
PID/FID Sampling of Any Existing Perimeter probes (or Passive Vents)



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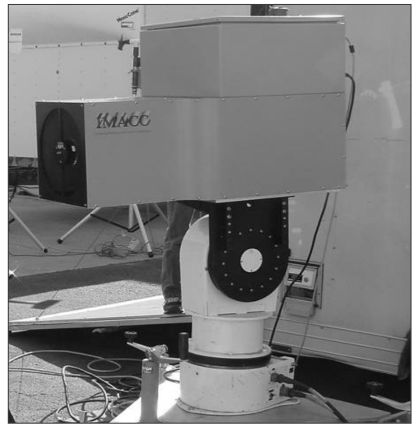
ORS Technology Using Radial Plume Mapping (RPM)

- The RPM method using ORS instrumentation is considered preferred approach for characterizing fugitive emissions from large area sources such as landfills. However, landfills pose unique challenges as compared to other area emission sources.
- Research was sponsored by the U.S. EPA's Office of Superfund Remediation and Technology Innovation, Technology Integration and Information Branch under its Monitoring and Measurement for the 21st Century (21M2) initiative.
- For further information on ORS technology–
  http://www.clu-in.org/programs/21m2/openpath/
- For further information on EPA protocol (OTM10) for conducting ORS measurements– http://www.epa.gov/ttn/emc/tmethods.html

Scanning Boreal Tunable Diode Laser System & Open-path Fourier Transform Infrared (OP-FTIR) Spectrometer



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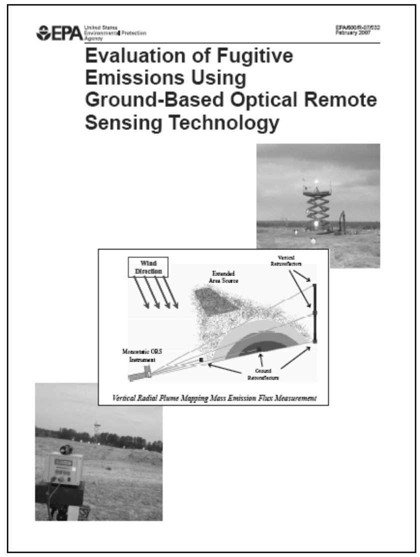
Final Report from EPA Field Tests Using ORS Technology

- Available at: http://www.epa.gov/ORD/NRMRL/pubs/600r07043/600r07043.pdf)
  - Provides overview of ORS technology and application to landfills
  - Includes summary of previous field tests at brownfield and superfund sites
  - Includes results from plume capture study conducted in 2006



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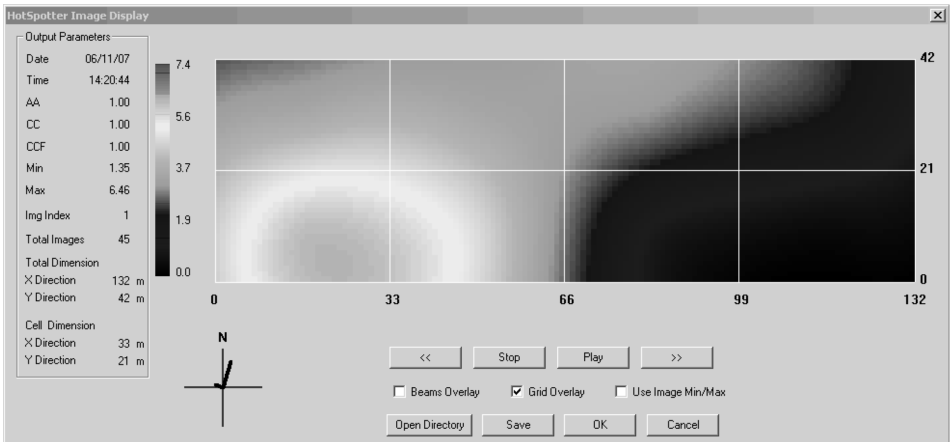
Challenges for EPA OTM 10 Landfill Applications

- Landfills are large and complex areas sources
  - Additional landfill guidance for OTM 10 is considered need to ensure capture of total emissions across entire landfill footprint
- Cooperative Research and Development Agreement (CRADA) with Waste Management is helping to gather information to advance OTM 10 applications to landfills. Research includes
  - Conducting field studies at 12 U.S. landfills using ORS RPM
  - Use of tracer release studies and different test configurations to evaluate capture of total emissions including side slopes and difficult topographies
- Draft EPA report to be completed by Fall 2008

Horizontal RPM Output from Software



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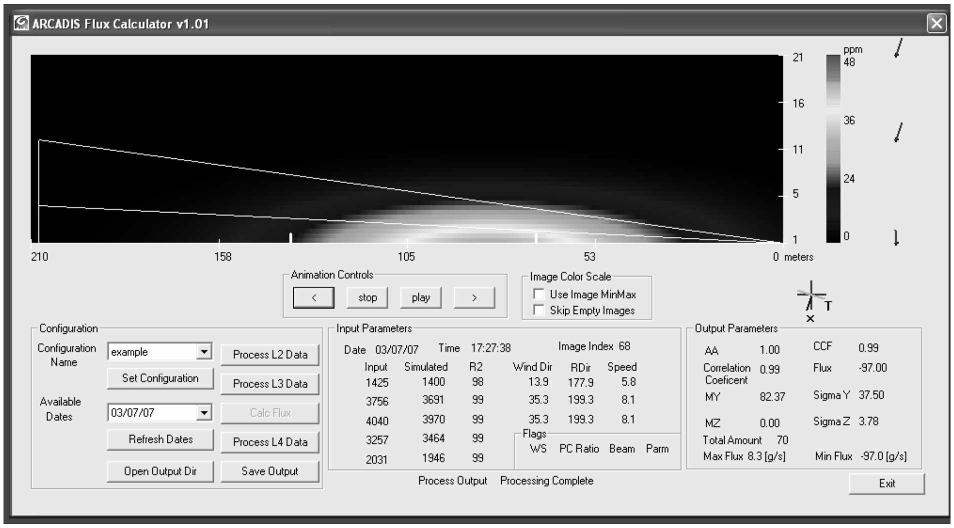
EPA
United States
Environmental Protection
Agency

Vertical RPM Output from Software



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Effective Landfill Gas Capture?

- Landfill gas emissions have both temporal and spatial variability. This needs to be taken into account when designing and operating an effective LFG control facility.
- Effective LFG capture requires maintenance and monitoring over time of the
  - cover material,
  - gas well field and header pipes,
  - and combustion technology.
- Often alternative cover materials are used to promote “infiltration” to accelerate waste decomposition. However, this also leads to larger loss of methane and other emissions.
- Even the best landfill gas capture and control systems do not collect all of the gas that is generated.

Combustion By-Products

- Combusting landfill gas through either flaring or utilization of methane will result in combustion by-products (e.g., CO, dioxins/furans, HCl, NOx, SOx).
  - Best way to minimize exposure is to place combustion unit away from any near-by residents.
  - Combustion by-products can be an issue for nonattainment areas for EPA criteria pollutants.
- The amount of combustion by-products varies by technology (i.e., flare, turbine, engine, boiler).
- EPA has data on combustion by-products available through AP-42 (http://www.epa.gov/ttn/chief/ap42/ch02/final/c02s04.pdf).
  - These factors are in the process of being updated but are specific to municipal landfills.
  - For superfund sites, there may be more of a concern depending upon the characteristics of the waste buried at the site.

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EPA/ORD LFG Publications

- Field Test Measurements at Five MSW Landfills with Combustion Control Technology for Landfill Gas Emissions, Prepared for EPA's Office of Research and Development (EPA/600/R-07/043, April 2007) http://www.epa.gov/nrmrl/pubs/600r07043/600r07043.pdf
- Landfill Gas Emission Model (LandGEM) - Software and Manual, EPA-600/R-05/047, May 2005. http://www.epa.gov/ORD/NRMRL/pubs/600r05047/600r05047.htm
- Measurement of Fugitive Emissions at a Bioreactor Landfill (EPA 600/R-05-Aug 2005) http://www.epa.gov/ORD/NRMRL/pubs/600r05096/600r05096.pdf.
- Measurement of Fugitive Emissions at a Landfill Practicing Leachate Recirculation and Air Injection (EPA/600-R-05/088, June 2005); http://www.epa.gov/ORD/NRMRL/pubs/600r05088/600r05088.pdf
- Evaluation of Fugitive Emissions Using Ground-Based Optical Remote Sensing Technology (EPA/600/R-07/032, March 07; http://www.epa.gov/ORD/NRMRL/pubs/600r07032/600r07032.pdf
- First-Order Kinetic Gas Generation Model Parameters for Wet Landfills, EPA-600/R-05/072. http://www.epa.gov/ORD/NRMRL/pubs/600r05072/600r05072.htm
- Thorneloe, S.A. (2007) U.S. EPA's Research to Update Guidance for Quantifying Landfill Gas Emissions Proceedings Sardinia 2007; Eleventh International Waste Management and Landfill Symposium; S. Margherita di Pula, Cagliari, Italy; 1 - 5 October 2007

EPA/ORD Landfill Gas Publications

- ***Measurement of Fugitive Emissions at Region I Landfill*** **(EPA-600/R-04-001, Jan 2004). Available at: http://www.epa.gov/appcdwww/apb/EPA-600-R-04-001.pdf**
- ***Evaluation of Former Landfill Site in Fort Collins, Colorado Using Ground-Based Optical Remote Sensing Technology*** **(EPA-600/R-05/-42, April 2005). Available at: http://www.epa.gov/ORD/NRMRL/pubs/600r05042/600r05042.pdf**
- ***Evaluation of Former Landfill Site in Colorado Springs, Colorado Using Ground-Based Optical Remote Sensing Technology*** **(EPA-600/R-05/-41, April 2005). Available at: http://www.epa.gov/ORD/NRMRL/pubs/600r05041/600r05041.pdf**
- ***Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities*** **(EPA-600/R-05/123a). Available at: http://www.epa.gov/ORD/NRMRL/pubs/600r05123/600r05123.pdf**
- **Case Study Demonstrating U.S. EPA Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities at the Bush Valley Superfund Landfill, Abingdon, Maryland (EPA/600/R-05/143). Available at: http://www.epa.gov/nrmrl/pubs/600r05143/600r05143.pdf**
- **Case Study Demonstrating the U.S. EPA Guidance for Evaluating Landfill Gas Emissions from the Rose Hill Regional Landfill; Kingstown, Rhode Island (EPA/600/R-05/141). Available at: http://www.epa.gov/nrmrl/pubs/600r05141/600r05141.pdf**
- **Case Study Demonstrating the U.S. EPA Guidance for Evaluating Landfill Gas Emissions from the Somersworth Sanitary Landfill; Somersworth, NH (EPA/600/R-05/142) Available at: http://www.epa.gov/nrmrl/pubs/600r05142/600r05142.pdf**

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Summary

- Characterizing emissions from landfills can be challenging and superfund sites are even more challenging
- EPA recommends use of optical remote sensing when quantifying area source emissions such as landfills.
- Guidance is available for conducting measurements at superfund landfills. The 3rd tier is based on use of optical remote sensing technology.
- Research is underway to
  - Develop additional guidance for use of ORS technology for landfills.
  - Update emission factors for quantifying LFG emissions (AP42).

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Case Study - HOD Landfill

- HOD Landfill
  - Antioch, Illinois
  - 51 acre Superfund landfill
    - Operational from 1963-1984
    - Accepted approximately two million tons of municipal and industrial waste
- Record of Decision (Sept 1998)
  - Detected low level VOCs, SVOCs, pesticides, PCBs
  - Identified vinyl chloride as contaminant of concern in groundwater
  - Remedy:
    - Cap restoration and maintenance
    - Landfill gas collection and treatment
    - Leachate collection and treatment
    - Groundwater monitoring

Gas-to-Energy Project

- Antioch Community High School identified as potential user of landfill gas
  - Gas production of 300 cubic feet per minute
  - School located .5 mile from landfill
- $550,000 grant from Illinois Department of Commerce and Community Affairs' Renewable Energy Resources Program
- EPA Superfund Redevelopment Initiative

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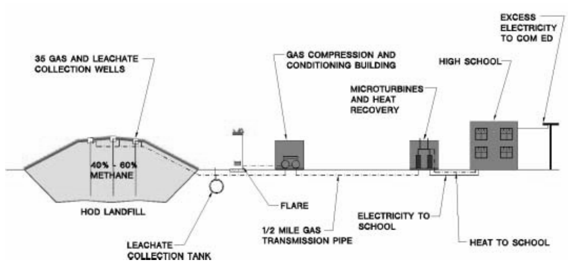
HOD Landfill



Design by RMT, Inc.

Design

- Tie-in to existing 35-well gas collection and treatment system

- Condition and compress the landfill gas on landfill property
  - Drop gas temperature to remove moisture and siloxane compounds
  - Compress gas
  - Remove impurities with activated carbon filter

Design

- Electricity:
  - Gas routed .5 mile to 12 microturbines located at school
  - Each microturbine produces up to 30 kW of electricity at 480 volts, using 12 to 16 cubic feet per minute of landfill gas for a total of 360 kW of electricity
- Heat:
  - Each microturbine produces exhaust energy of around 290,000 Btu/hr at 550°F
  - Exhaust from microturbines is routed through heat exchangers that heat water that is then circulated through school's boiler system

- Excess electricity not used by school is sold to utility

Benefits

- Low energy costs for school and taxpayers
- Reductions in greenhouse gas emissions by:
  - reducing the need for traditional electrical generation sources
  - complete combustion of landfill gas
- Use of waste heat for internal use in the high school
- First school district in U.S. to get electricity/heat from landfill gas

For additional information:

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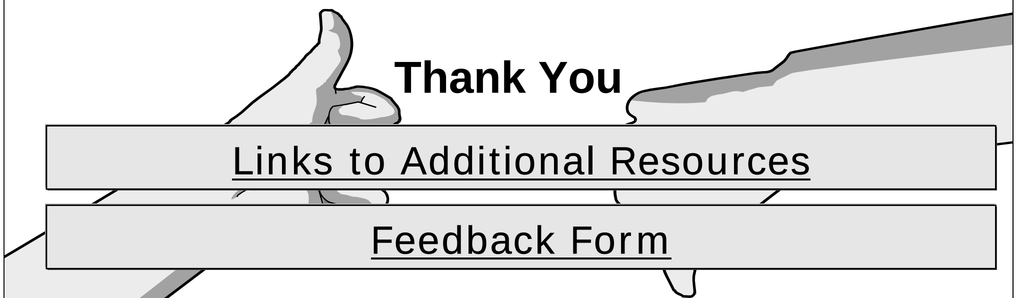
EPA United States Environmental Protection Agency

After viewing the links to additional resources, please complete our online feedback form.



Thank You

Links to Additional Resources

Feedback Form

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