An Overview of Landfill Gas Energy in the United States

U.S. Environmental Protection Agency
Landfill Methane Outreach Program (LMOP)

LANDFILL METHANE OUTREACH PROGRAM

File Last Updated: July 2011

Why EPA is Concerned about Landfill Gas

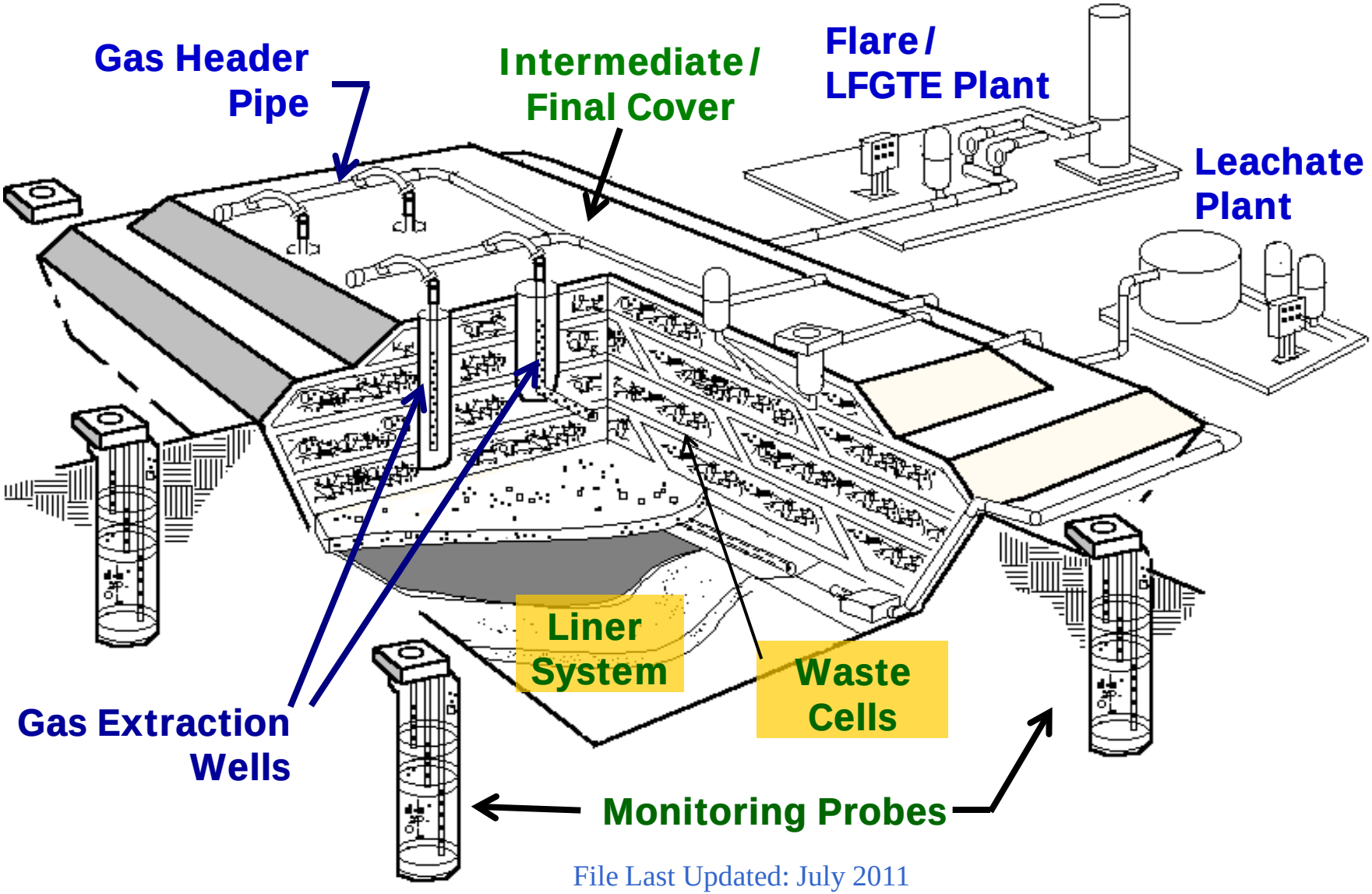
- Why is methane a greenhouse gas?
  - Methane absorbs terrestrial infrared radiation (heat) that would otherwise escape to space (GHG characteristic)
- Methane as a GHG is over 20x more potent by weight than CO_2
- Methane is more abundant in the atmosphere now than anytime in the past 400,000 years and 150% higher than in the year 1750
- Landfills were the third largest human-made source of methane in the United States in 2009, accounting for 17.1% generated

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 (LFG) energy projects.

Modern Sanitary Landfill



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Landfill Gas 101

- 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:
  - ~0.78 megawatts (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

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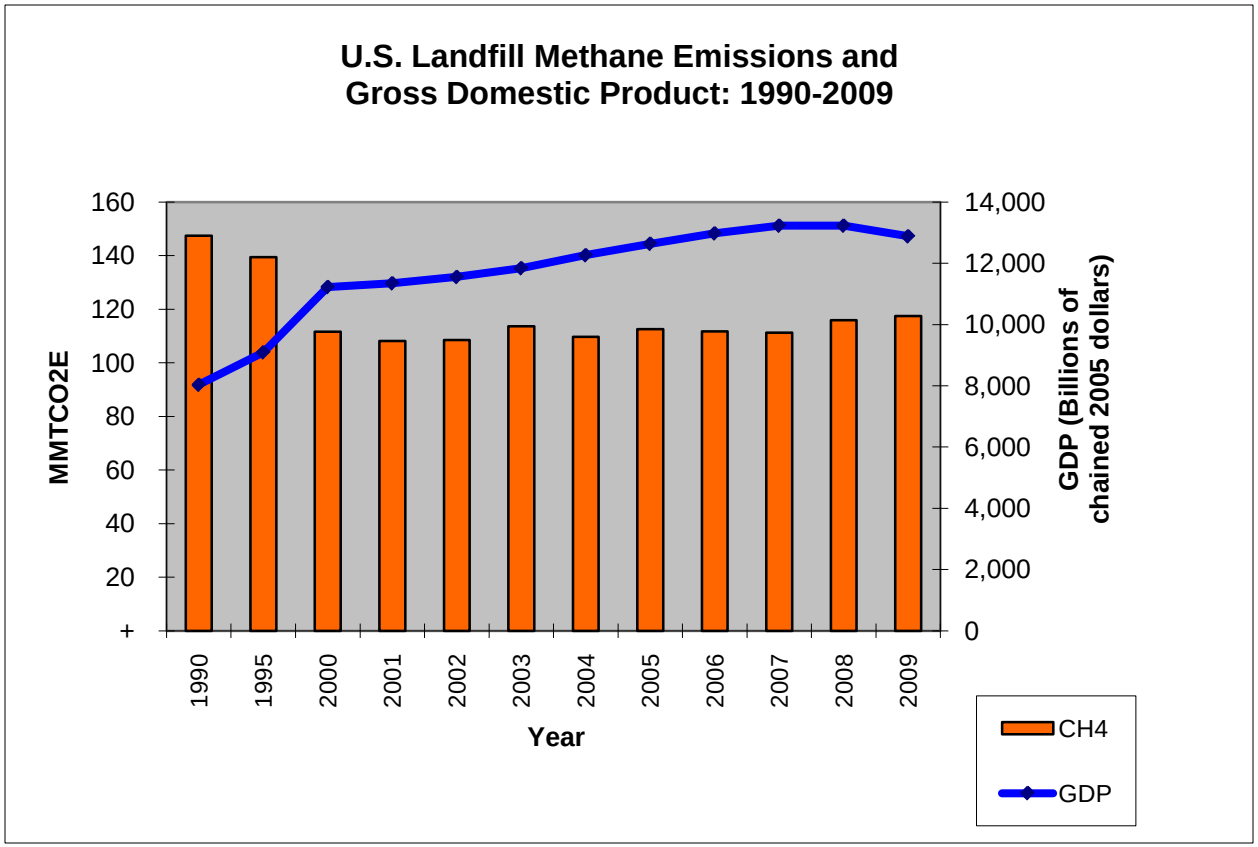
Targeting Methane… Producing Measurable Results

Since 1990, U.S. landfill methane emissions have decreased by 20% while GDP increased by 60%



Sources: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2009, U.S. EPA, April 2011; DOC/Bureau of Economic Analysis. Interactive National Income and Product Accounts Table. Last revised on June 24, 2011.

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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 non-renewable resources (coal, oil, gas), reducing emissions of SO_2, NO_X, PM, CO_2
  - LFG is a recognized renewable energy resource (Green-e, EPA Green Power Partnership, 36 states, 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

State of the National LFG Industry (May 2011)

- At least 555 operational projects in 46 states annually supplying:
  - **14 billion kilowatt-hours** of electricity and **102 billion cubic feet** of LFG to direct-use applications
- Estimated '11 **Annual** Environmental Benefits
  - Carbon sequestered annually by **~21,000,000 acres of pine or fir forests**, or
  - CO_2 emissions from **~229,000,000 barrels of oil consumed**, or
  - Annual greenhouse gas emissions from **~18,800,000 passenger vehicles**
- Estimated **Annual** Energy Benefits
  - Powering **1,000,000 homes** and heating **737,500 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)

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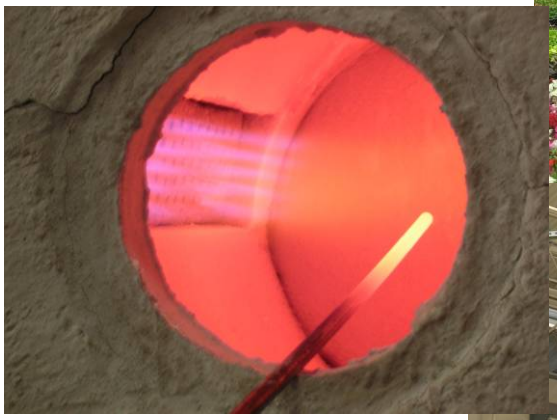
Diversity of Project Types
Direct Use of LFG

- Direct-use projects are growing!
  - Boiler applications – replace natural gas, coal, fuel oil
  - Direct thermal (dryers, kilns)
  - Natural gas pipeline injection (medium- & high-Btu)
  - Ethanol production
  - Greenhouse
  - Infrared heaters
  - Leachate evaporation
  - Vehicle fuel (LNG, CNG)
  - Glassblowing & pottery
  - Blacksmithing
  - Hydroponics
  - Aquaculture (fish farming)

Greenhouse
Jackson County, NC



Glassblowing
Jackson County, NC

Infrared heater - Lorton, VA

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Emerging Technologies: LFG for Vehicle Fuel

- Orange Co, CA – 1st commercial LFG-to-LNG facility; 5,000 gpd (Dec. 2007) – used in county waste trucks (Frank R. Bowerman LF)
- In Sept. 2009, Waste Management began producing 13,000 gal LNG per day for garbage trucks (Altamont LF)
- Franklin County, OH is creating ~900 GGE/day CNG from LFG for use in county fleet (Sept. 2008)
- POET plant in Sioux Falls, SD uses LFG from local landfill to create ethanol (Feb. 2009)
- Central LF, CA LFG-to-CNG project fuels Sonoma County school buses (Sept. 2009)
- Dane County, WI's pilot project produces 100 GGE/day bioCNG from 20 cfm LFG (Apr. 2011)

Regulations that Affect LFG Energy

- LFG energy 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)

LFG and RECs

- Renewable Energy Certificates (RECs)
  - Equivalent to 1 MWh of renewable energy generation
    - Compliance market: $1 to $23 per MWh (2009$)
    - Voluntary market: ~$1 per MWh (2010$)
- Companies looking to reduce their environmental footprint purchase RECs from utilities using LFG (2002-03)
  - Alcoa – 100% of electricity at 4 corporate locations from LFG
  - Delphi Corporation – 100% of electricity at largest corporate office from LFG
  - DuPont – 170 million kWh/yr from biomass & LFG
  - Pitney Bowes – 10% of electricity from wind & LFG
  - Staples – 46 million kWh/yr of RECs, 90% from biomass & LFG

Federal Financial Incentives

- Section 45 Production Tax Credit (PTC)
  - Electricity generation – 1.1 cents/kWh
  - Placed in service by 12/31/13
  - 10-year window for credits
  - Alternative short-term option to select a one-time 30% investment tax credit (Section 48) or convert into a 30% cash grant under 1603(b)
    - Apply by October 1, 2012
    - Begin construction by 12/31/11 and place in service by 12/31/13
- Excise Tax Credit to the Seller of CNG or LNG (PL 111-312, § 701)
  - $0.50 per gallon of gasoline equivalent
  - Investment tax credit for fueling stations - 30% of cost up to $30,000
  - Applies to gasoline sold in 2010 and 2011

Other Financial Incentives

- Clean Renewable Energy Bonds (CREBs)
  - In lieu of interest, bond holders receive federal tax credits
- Federal Renewable Energy Production Incentive (REPI)
  - Local/state government or non-profit electric co-op facilities
  - On line by 10/1/16
  - Payment for first 10 years of operation
- Many State grants, tax exemptions, and other funding mechanisms
  - www.epa.gov/lmop/publications-tools/funding-guide/index.html updated quarterly

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Electricity Case Study

Frederick County Landfills, Winchester, VA

LMOP 2010 Project of the Year

- County self-developed project & retained gas rights
- Designed project to supply local power grid without requiring new lines
- County plans to schedule project tours

- (2) GE Jenbacher 320 engines create ~ 2 MW
- Designed with space to add up to 3 more engines
- Have used 30 cfm LFG in infrared tube heaters since 2002

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Small Engine Case Study

Montgomery RSWA LF, Christiansburg, VA

LMOP 2010 Project of the Year

- Engines: (1) 265 kW and (1) 75 kW
- Purchased other necessary equipment (e.g., gas compressor, circuit breakers) on eBay

- Developer Green kW Energy pays MRSWA a % of gross revenues from power sales
- GkW owns RECs & MRSWA owns carbon credits
- Site closed in 1997 with 1.3 million tons WIP

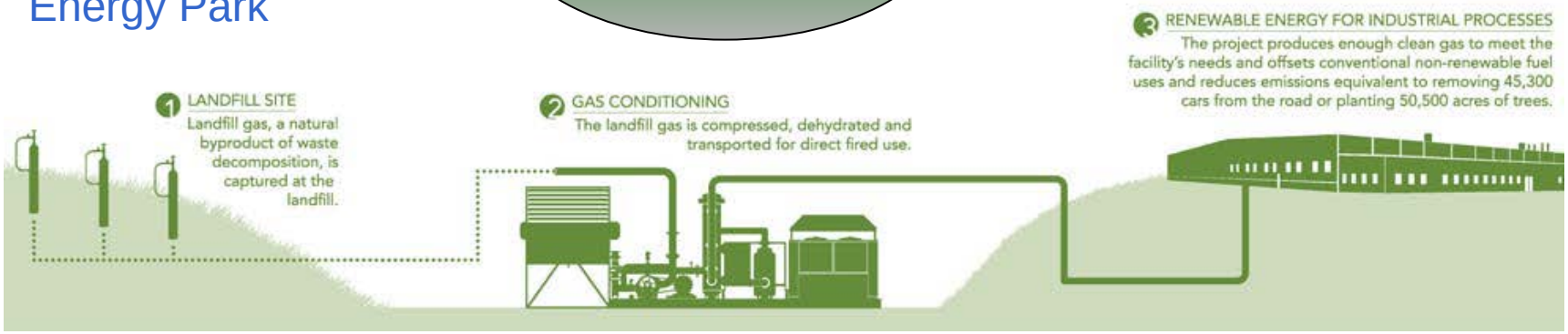
Direct Thermal Case Study

Newton County Landfill, Brook, IN

- 800 cfm LFG goes to (4) direct-fire gas burners
- Urban Forest Recyclers makes 800,000 egg cartons/day from 100% recycled materials
- 1st tenant in new Renewable Energy Park

LMOP 2010 Project of the Year

- Project partners brought new business and jobs to community
- Project designed for delivery of up to 16,000 cfm LFG in future



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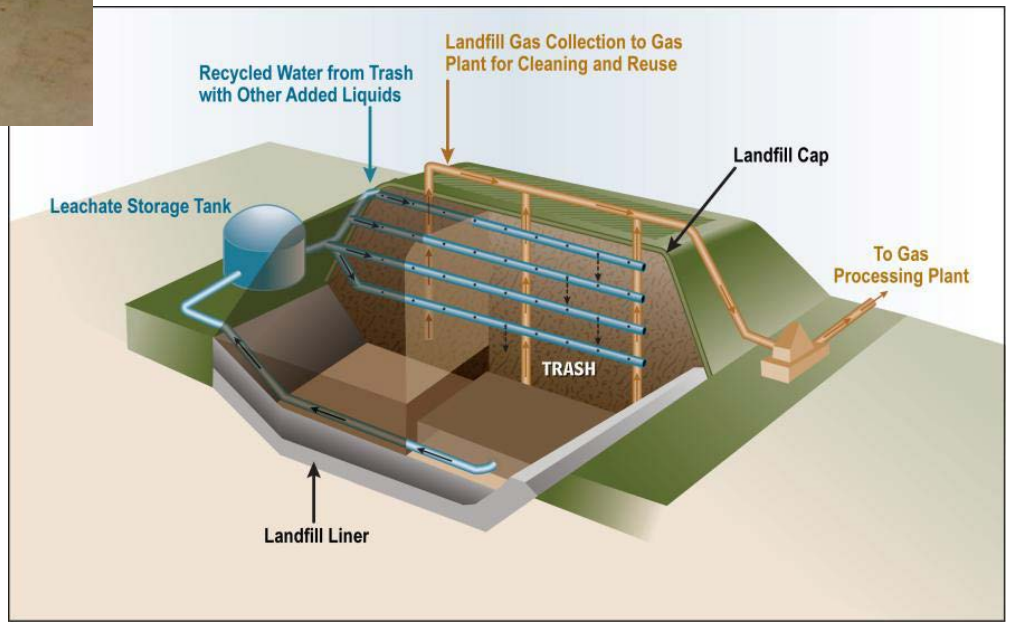
Small Boiler Case Study

Crow Wing County Landfill, Brainerd, MN

LMOP 2010 Project of the Year

- Began recirculating leachate in 1990s, installed gas wells in 2008, boiler on line in 2009
- Energy (natural gas) cost savings = $5,000/winter
- Registered project with CAR & sold verified emission reductions



- Raypack Raytherm H1125 atmospheric boiler
- Supplies heat for in-floor heating system in 11,000 sq. ft. maintenance bldg
- Uses 30 cfm LFG

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CHP Case Study

Hoffman Road Landfill, Toledo, OH

- Facility has meeting space for visitors & tour groups
- Power is for WWTP, landfill & other city facilities
- LFG piped 2 miles

- LFG and WWTP digester gas fuel a combined cycle CHP process: gas turbine with steam turbine and a heat recovery steam generator
- Total capacity of 10 MW

LMOP 2010 Project of the Year

LANDFILL METHANE OUTREACH PROGRAM

Electricity Case Study

Perdido Landfill, Pensacola, FL

LMOP 2010 Community Partner of the Year

- $950K DOE block grant funding under ARRA
- County self-developed

- (2) Caterpillar 3520C engines generate 3.2 MW total
- Designed for addition of 2 more engines in future
- Facility designed with educational areas for school groups to learn about LFG energy

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Many Untapped LFG Resources

- Currently ~510 candidate landfills with a total gas generation potential of 210 billion cubic feet per year (~12,200 MMBtu/hr) OR total electric potential of 1,165 MW (~9.5 million MWh/yr)
- If projects were developed at all these landfills, the estimated
  - **Annual** Environmental Benefit =

    Carbon sequestered annually by **~10.3 million acres** of pine or fir forests OR annual greenhouse gas emissions from **~9.3 million** passenger vehicles, AND
  - **Annual** Energy Benefit =

    Powering more than **687,000 homes** OR heating more than **1.3 million** homes per year

LMOP Tools and Services

- Redesigned website in 2010 (epa.gov/lmop)
- Direct project assistance
- Technical and outreach publications
- Project and candidate landfill database
- Network of 900+ Partners
- Newsletter and listserv
- Support for ribbon cuttings/other PR
- Presentations at conferences
- State training workshops
- *Annual LMOP Conference, Project Expo & Partner Awards*

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*