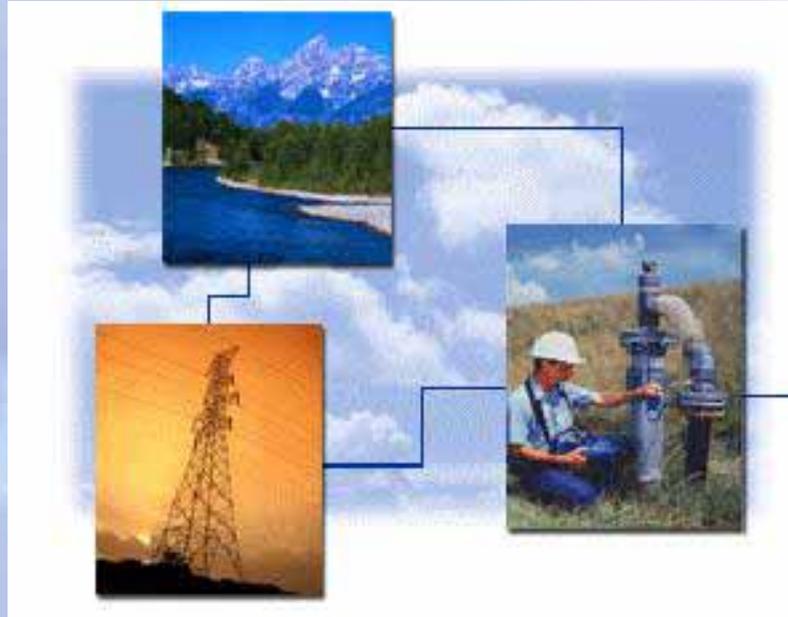


Landfill Gas Energy Projects in the United States



Kansas Works 2009 Conference

March 2009

Lori Hamburg

SCS Engineers (an EPA Contractor)

U.S. Environmental Protection Agency

Landfill Methane Outreach Program (LMOP)





State of the National LFG Industry (December '08)

- At least 469 operational projects in 43 states supplying:
 - 10.7 billion kilowatt hours of electricity and 247 million cubic feet of LFG to direct-use applications in 2008 per day
- Estimated **Annual** Environmental Benefits
 - Planting 1.62 million acres of forest, or
 - Preventing the use of 16.6 million barrels of oil, or
 - Removing emissions equivalent to 1,309,433 vehicles
- Estimated **Annual** Energy Benefit
 - Powering over 915,657 homes and heating nearly 554,000 homes





LFG Energy Projects and Candidate Landfills



Nationwide Summary

469 OPERATIONAL Projects
(1,440 MW and 247 mmscfd)

~ 520 CANDIDATE Landfills
(1,200 MW or 610 mmscfd,
14 MMTCE Potential)



OPERATIONAL PROJECTS



CANDIDATE LANDFILLS*

* Landfill is accepting waste or has been closed for 5 years or less and has at least 1 mmtons of waste and does not have an operational/under construction LFG project; or is designated based on actual interest/planning.

These data are from LMOP's database as of December 22, 2008.
◇ LMOP does not have any information on candidate landfills in this state.



Many Untapped LFG Resources

- Currently 520 candidate landfills with a total gas generation potential of 610 million standard cubic feet per day OR electric potential of 1,200 MW
- If projects were developed at all these landfills, estimated
 - **Annual Environmental Benefit =**
Planting 1.70 million acres of forest OR removing the emissions from 1.2 million vehicles on the road, and
 - **Annual Energy Benefit =**
Powering 763,000 homes per year





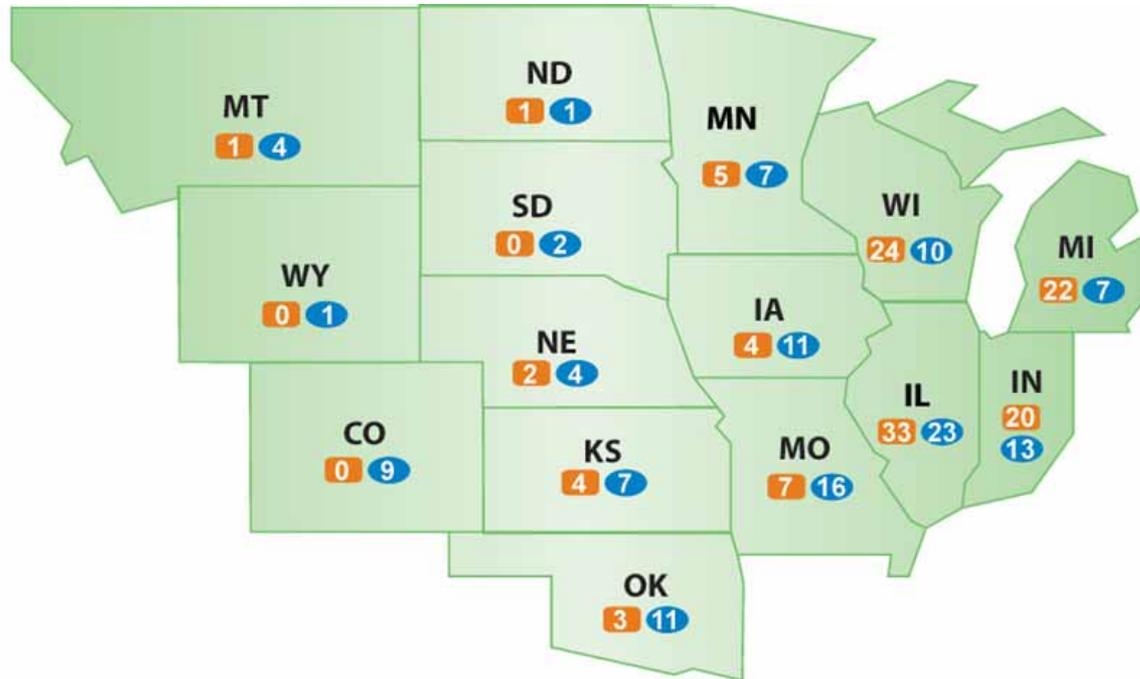
State of LFGE in Kansas

- 34 Landfills in the state
- 4 Operational Projects -Generating 17.85 million standard cubic feet of gas per day
 - 2 direct use projects (Brooks LF – Wichita and Seward County LF)
 - 1 infrared heater project (Allen County LF)
 - 1 High Btu project (Deffenbaugh LF)
- 7 Candidate Landfills
 - Could generate 12.5 MWs or 7 million standard cubic feet of gas per day
 - Over 71,200 tons of potential CO₂ emission reductions





Landfill Gas Energy Projects and Candidate Landfills



Territory 4 Summary

131 OPERATIONAL Projects
(396 MW and 46 mmscfd)

~ **125 CANDIDATE** Landfills
(260 MW or 145 mmscfd,
3 MMTCE Potential)

 **OPERATIONAL PROJECTS**  **CANDIDATE LANDFILLS***

* Landfill is accepting waste or has been closed for 5 years or less and has at least 1 mmtons of waste and does not have an operational/under construction LFGGE project; or is designated based on actual interest/planning.

These data are from LMOP's database as of December 22, 2008.
❖LMOP does not have any information on candidate landfills in this state.

<http://www.epa.gov/lmop>



Development Potential in Kansas

At least 7 candidate sites with a generation potential of approximately 12.5 MW, equivalent to:

- removing 12,492 cars from Kansas's roads
- planting 17,800 acres of trees



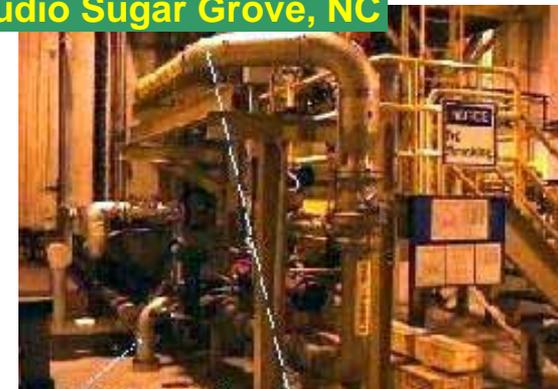


Diversity of Project Types Using LFG

Greenhouse Burlington, NJ



Pottery Studio Sugar Grove, NC

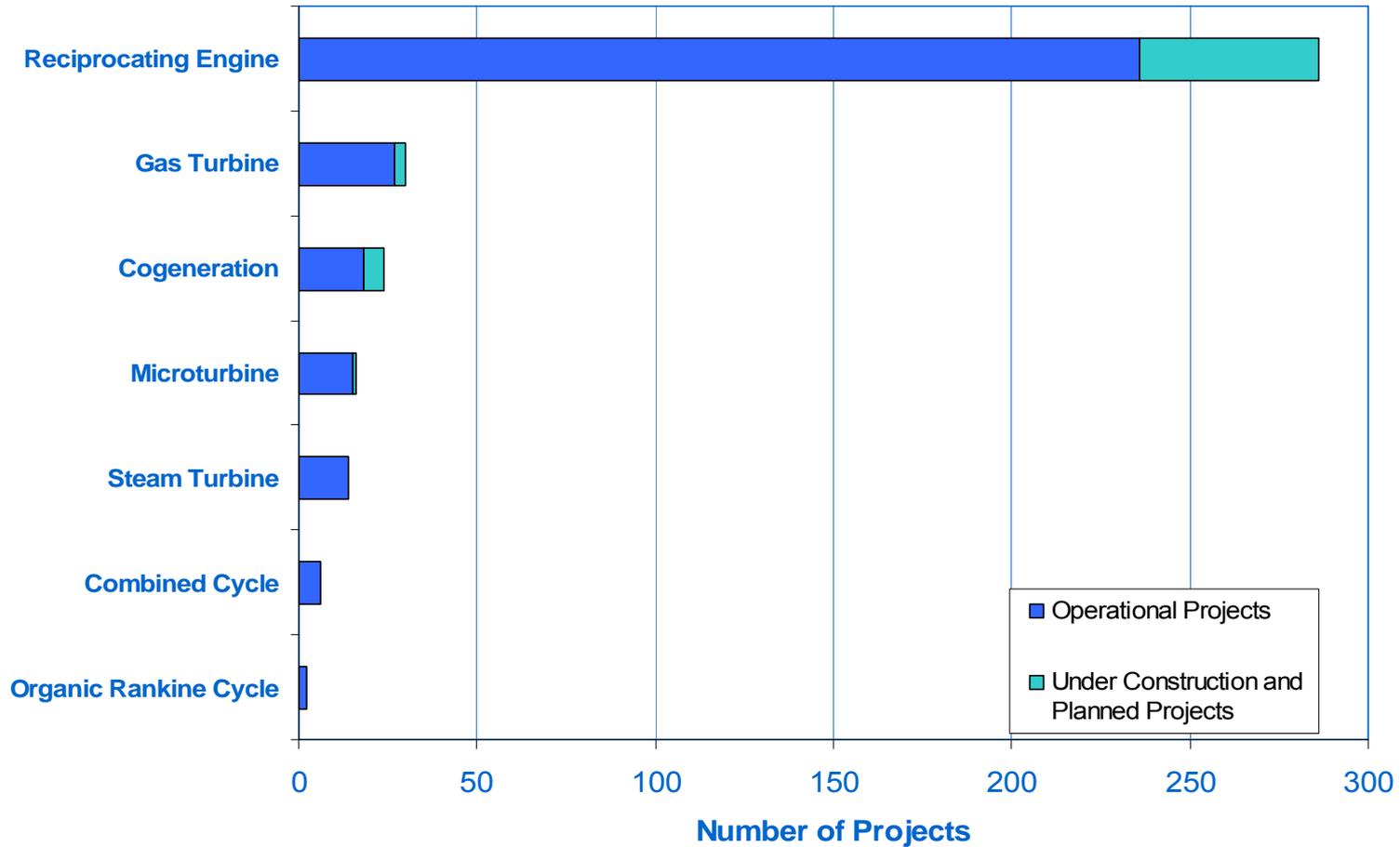


LFG-fired Boiler Ft. Wayne, IN

- Electric Generation (~70% of all projects)
 - Reciprocating engines
 - Turbines
 - Microturbines
 - Combined heat & power (CHP)
- Direct-Use (~30% of all projects)
 - Boiler applications
 - Direct thermal (dryers, kilns)
 - Natural gas pipeline injection
 - Medium & high Btu
 - Greenhouses
 - Leachate evaporation
 - Vehicle fuel (LNG, CNG)



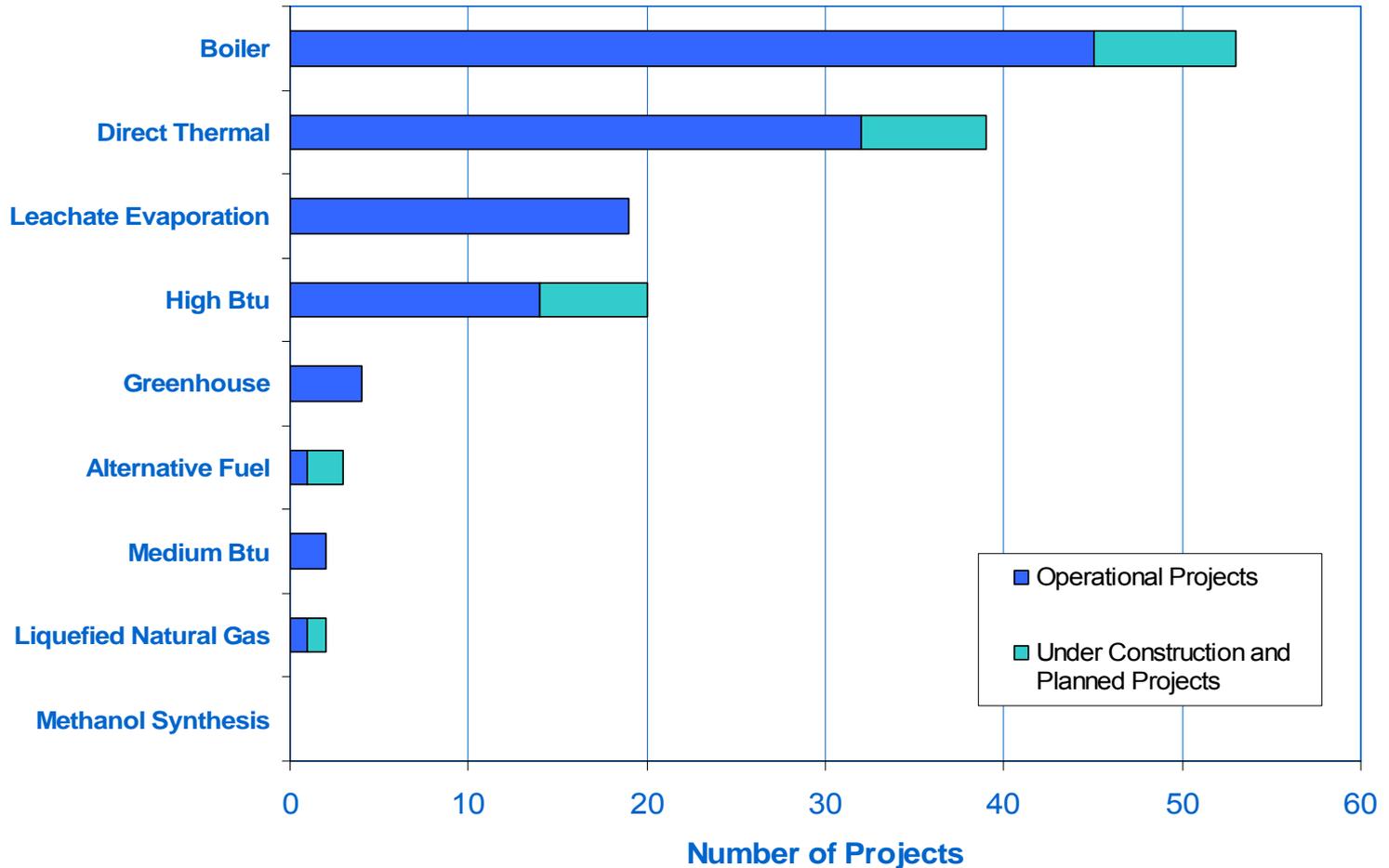
Technology Trends Electricity Projects





Technology Trends

Direct-Use Projects





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!



Honeywell

NUCOR

HILL
AIR FORCE BASE, Utah
OGDEN AIR LOGISTICS CENTER

DART

CYTEC

Rolls-Royce



SENECA Foods.com
"A World Leader In Agribusiness"

Owens Corning

Cargill



LOOK WHO'S USING LANDFILL GAS!



The Ultimate Driving Machine

The Solae Company



GM



LAFARGE

Jenkins Brick Company

AJINOMOTO

CONE corporate denim finishing jacquards

Nestlé
Makes the Very Best

INTERNATIONAL PAPER
From innovation to results.

INTERFACE

MALLINCKRODT

DUPONT
The miracles of science

Lucent Technologies
Bell Labs Innovations



SC Johnson



CHRYSLER





Direct Use Case Study Abengoa Bioenergy Colwich, Kansas



- Start-up in 1998
- Project highlights:
 - Project started in September 1998
 - DTE Biomass and LES Energy developed the project with City of Wichita and High Plains Corp.
 - Approximately 4 mmscfd of landfill gas are collected, treated and compressed and then sent down a 11-mile pipeline to Abengoa plant
 - Abengoa uses the gas to produce steam at its ethanol production plant
 - Estimate offset 80% of natural gas needs
 - Significant cost savings





Direct Use Case Study Daimler Chrysler Plant Fenton, Missouri



- Start-up in 2002
- Direct use of LFG for 2 boilers
- Project highlights:
 - 4.5 mile pipeline from Veolia Oak Ridge Landfill
 - Since 2002, Daimler Chrysler has burned LFG instead of fossil fuels to meet about half of the plant's boiler energy
 - Daimler Chrysler received the 2002 Missouri Governor's Award for Energy Efficiency and the 2002 National Association for Environmental Management Pollution Prevention Award from the St. Louis Chapter





Direct Use Case Study Fred Weber-Pattonville High School Maryland Heights, MO



- Start-up in 1997
- Direct use of LFG for boilers
- Project highlights:
 - Fred Weber, a construction company, operates the landfill and the high school ecology club initiated the project to use the remaining LFG for the high school's boilers.
 - Fred Weber funded the 0.7 mile pipeline.
 - The recovered LFG fuels to the boilers saves the school approximately \$27,000 annually.
 - Project promotes public-private cooperation and awareness.





Green Field Case Study Jenkins Brick -Jordan Plant Moody, Alabama



- Start-up in 2006
- Direct use of LFG for brick kilns
- Project highlights:
 - First major US facility that was sited and built near a landfill specifically for the use of LFG.
 - LFG is used to fuel brick kilns and LFG is 40% of plants energy needs, with 100% projected in 10 years as the landfill grows.
 - 6.5 mile pipeline from Veolia Star Ridge Landfill
 - The recovered LFG fuels to the boilers saves the school approximately \$27,000 annually.
 - Jenkins Brick also uses LFG at their Montgomery, AL Plant.

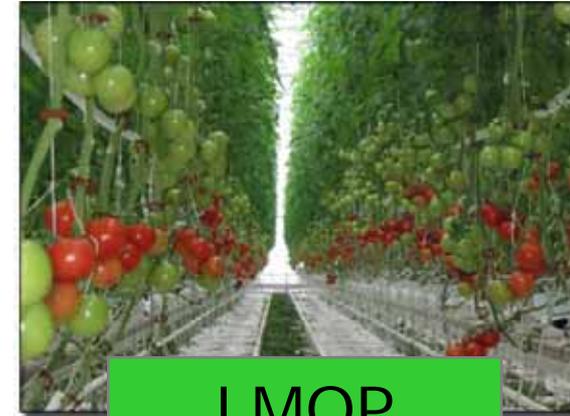
*LMOP 2006
Project of
the Year*





Combined Heat and Power Study H2Gro 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 Greenhouses
- Excess electricity sold to grid
- H2Gro 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 gas turbines retrofitted to burn LFG
 - 4.8 MW of electricity generated and 27 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*





Infrared Heaters

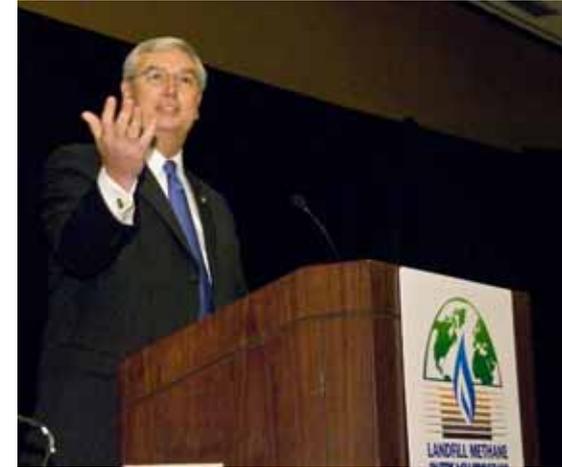
- Used to heat storage and maintenance facilities
- Allen County Kansas Landfill operates infrared heaters at their landfill
- Requires very little LFG to heat large spaces (10-20 cfm)
- Projects gaining popularity in the U.S.





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 and other public relations
- Presentations at conferences
- State training workshops
- 13th LMOP Annual Conference, Project Expo & Partner Awards in January 2010 in Washington DC



EPA Administrator
Stephen L. Johnson

Keynote Speaker
11th Annual LMOP Conference
Washington, DC

January 9, 2008



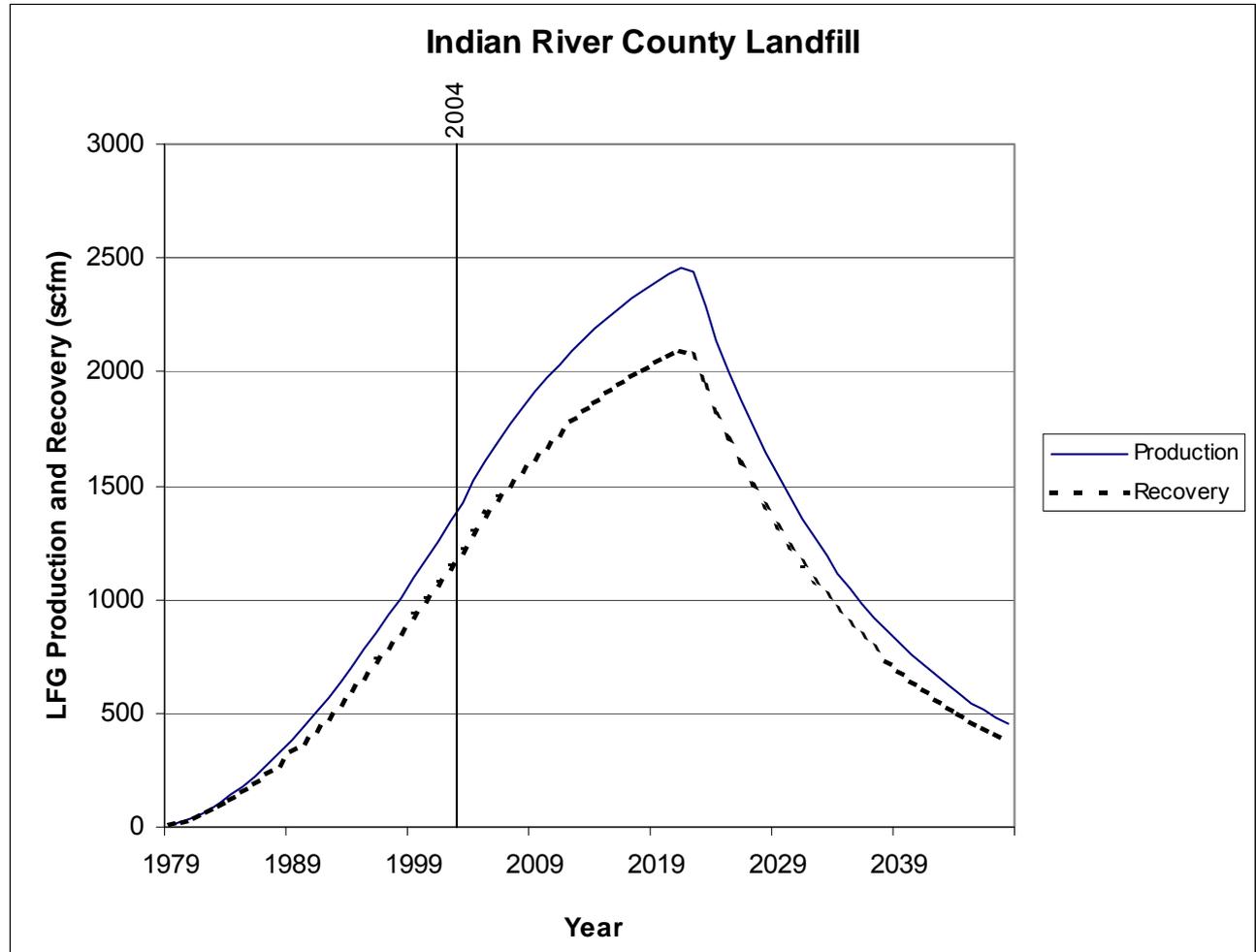
How Can We Work Together?

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*



Analyze Energy Potential from Landfill





EPA Project Expo

- Interested in an LFGE Project?
- EPA features a select number of landfills at the Annual LMOP Conference in January.
- LMOP will develop a “resume” for your landfill to feature at the conference.
- Contact Swarupa Ganguli (EPA-LMOP) if you are interested.





My Contact Information

Lori Hamburg

SCS Engineers

A Contractor to EPA on LMOP

lhamburg@scsengineers.com

919-662-3015

