CLU-IN

Contaminated Site Clean-Up Information

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Energy for the Future: Exploring Methane Gas-to-Energy Projects at Superfund Sites
Sponsored by: U.S. EPA Technology Innovation Program
Delivered: May 6, 2010, 2:00 PM - 4:00 PM, EDT (18:00-20:00 GMT)

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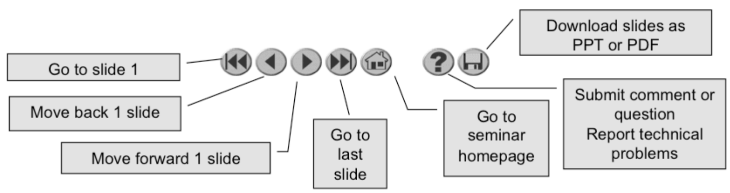

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2 of Total # of slides

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With that, please move to slide 3.

USEPA Superfund Program
Landfill Methane-to-Energy Pilot

S. Steven Chang
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US Environmental Protection Agency
Office of Superfund Remediation and Technology Innovation
May 6, 2010

EPA

Pilot Goal:

- Evaluate and increase the number of landfills on the Superfund National Priorities List (NPL) that use the methane generated on-site.

Technical Considerations for Using Landfill Gas:

- Quality of Landfill Gas (LFG)
  - » Are there any known compounds in the gas or landfill that would preclude or greatly impact the cost of using LFG? (i.e. radioactive, infectious, explosive, or ordnance waste).
- Quantity of LFG
  - » How much gas is present?
  - » What is the methane concentration?
  - » How fast is the flow rate declining?

EPA

Technical Considerations for Using Landfill Gas (concluded):

- Accessibility of LFG
  - » How expensive will it be to collect the gas?
  - » Is a gas collection system already in place?
  - » Are there complicating site factors such as flooded wells, very shallow waste, unexploded ordnances, or unmapped trench-and-fill cells?
- Energy demand
  - » What is the energy need for landfill related activities (e.g., ground water pump and treat system)?
  - » What remediation equipment is used on site?
  - » Is the landfill located in an area with nearby off-site energy demands that could be met by landfill methane-to-energy projects?

EPA 6

Gas collection systems are very expensive. If a system is already in place it can greatly improve the economics.

Flooded wells and shallow waste both reduce the gas collected by a well and result in the need for more wells.

If the landfill is located in an area where a premium is paid for renewable energy, it will bring a high price for electricity.

Initial Observations:

- Many NPL landfills in EPA Region 1, 2, and 3 in the Northeast have received so little municipal solid wastes in the last 20 years that they are producing very little recoverable methane.
- Few NPL landfills are producing marketable quantities of methane, but might produce enough to off-set on-site electricity usage.
- The cost for recovery of small methane flows from NPL landfills is expensive, and could benefit greatly from an existing well or vent field.
- Energy demands at NPL landfills are generally in the size range of microturbines.

EPA 7

Most utilities require 1 or 2 MW as a minimum for purchasing electricity.

Most sites have an on site demand of less than 0.1 MW.

Developing Screening Criteria:

- The ERG-Shaw-Cornerstone team is developing draft screening criteria that can be used in conjunction with the EPA *LandGEM* and *LFGcost* models to determine the practicality of using landfill methane to produce energy for on-site use.
- These criteria will include factors that are likely to have a significant positive or negative impact on gas recovery potential.

EPA 8

Landgem calculates the potential gas flow from the landfill and LFGcost calculates the economics of a project.

Schedule:

- Draft Screening Tool - July 2010
- Final Screening Tool - August 2010
- EPA final report – by December 2010

EPA

Next Steps:

- Encourage EPA Regions to find suitable NPL landfill methane-to-energy projects using the screening criteria
- Encourage EPA Regions to collaborate with interested municipal authorities and Responsible Parties to implement projects

EPA

Role of Landfill Gas to Energy in Landfill Remediation

WASTE MANAGEMENT

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Landfill Gas Generation

- **Anaerobic Decomposition of Organic Waste**
- **About half METHANE and half CARBON DIOXIDE**
- **450 to 550 BTU per cubic foot of landfill gas (Natural gas is 1000 BTU per cubic foot)**

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LFG Collection and Control

Gas Collection and Control System (GCCS) is installed for environmental protection:

- **Off-Site Underground Migration (RCRA Subtitle D)**
- **Groundwater Contamination (RCRA Subtitle D)**
- **Odor**
- **Landfill Cap Stability**
- **NMOC Emissions through cap (NSPS & GHG)**

GCCS is <u>rarely</u> installed for the primary purpose of supporting a LFG to Energy project

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Components of GCCS

Installed incrementally during active life of landfill and completed at closure of landfill.

- Vertical wells or horizontal collectors
- Header pipe connecting wells to blower
- Blower places vacuum on wells
- Condensate and leachate collection system
- LFG is delivered to flare or gas utilization project
- Typical Cost of $9,000 to $20,000 per acre

GCCS Well Head

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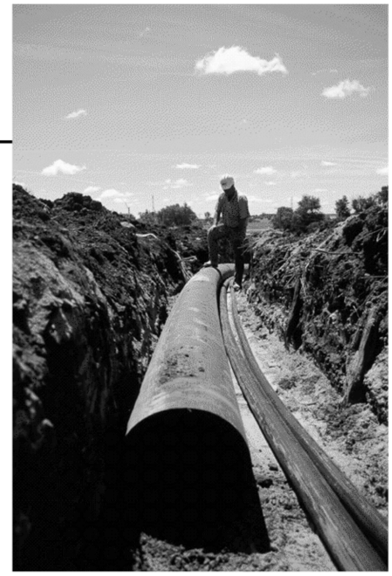
GCCS
Header Pipe



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Basic Types of LFGtE Projects

- **Electric Energy:** Wholesale to electric utilities
  - *With or without heat recovery*
- **Alternative Energy:**
  - *Gas conditioned, compressed and shipped via pipeline to user as fuel in boilers, power plants, asphalt plants, cement kilns, industrial dryers, greenhouses, etc.*
  - *Hot water recovered through exchangers shipped via pipeline to user boilers*
- **Processed Gas**: Gas purified and converted to Liquified Natural Gas (LNG) for vehicle fuel.

Active LFG Utilization Projects

WM	Project Type
90	**Electric Energy**: On-site power plants
	Alternative Energy:
19	- **Pipeline projects**
14	- **Evaporators:** disposal of waste liquids
5	**Processed Gas:** processing to LNG
128	**Totals**

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Average LFGTE Project

For discussion purposes, average size project is:

- 1,600 cubic feet per minute of landfill gas
- 400,000 million BTU (MMBTU) per year
- 4000 kilowatts of electricity
- About 32,000,000 kwh per year

3.2 MW Engine Plant

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Electric Energy Capital Cost

Capital cost of 4 MW plant: $4 -6 million.

- **Land Acquisition**
- **Site Work**
- **Building**
- **Gas conditioning**
- **Equipment pricing**
- **Interconnect**
- **Instrumentation & controls**

Electric Energy Operating Cost

Total Cost to generate power: 2.5 to 3.5 c/ kwh

- **Capital Cost**
- **Financing costs**
- **Depreciation period**
- **O&M Contract**
- **Taxes, Administration, Permitting**

Does not include LFG purchase Price

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Energy Pricing

- **Energy:**
  - PURPA avoided costs to Qualifying Facilities are typically 3 to 4 c/kwh in current market.
  - May be higher or lower in deregulated markets.
- **Green Attributes:**
  - Renewable portfolio standards (RPS)
  - Green Pricing (Renewable Energy Credits)

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Keys to Successful LFGTE Projects

- **Access to 'free', consistent, long-term supply of quality fuel**
  - *12-15 years minimum*
- **User demand matches gas supply**
  - *GCCS are 7/24/365 operations*
- **Proximity to energy user/purchaser**
  - *High voltage electric transmission lines*
  - *Higher energy demand user(s)*
- **Energy pricing competitive with fossil fuels**
- **Ability to limit capital costs**

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Antioch Community High School, District 117 Landfill Gas-to-Energy Project

2003 LMOP Project of the Year

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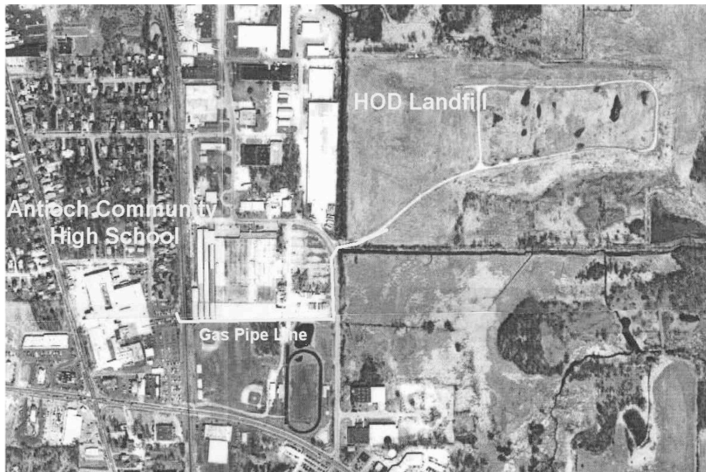
Last Update: 4/1/99

Antioch Community High School
Gas-to-Energy Project



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Antioch Community High School Gas-to-Energy Project

HOD Landfill

- 51-acre municipal and industrial solid waste landfill, active from 1963 to 1984
- 35 gas extraction wells
- Initial gas production was 325- 350 cubic feet per minute
- Design calcs estimated >200 cfm for the next 15-20 years
- ROD required thermal destruction of gas

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Antioch Community High School Gas-to-Energy Project

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Antioch Community High School Gas-to-Energy Project

Renewable Energy Project

- Illinois Department of Commerce and Community Affairs (DECCA) administers the renewable energy resource program in order to foster investments in and the development and use of renewable energy resources within the state of Illinois
- Antioch Community High School District 117 submitted a grant application under the organic waste biomass (electrical production) category in April 2002
- A grant of $550,000 was approved for the gas-to-energy project

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30-kW Capstone MicroTurbines

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Antioch Community High School Gas-to-Energy Project

Project Schedule

- "Fast track" project
- Design began September 2002
- Construction began December 2002
- System startup Fall 2003

Antioch Community High School Gas-to-Energy Project

System Design

- Tie-in to existing gas system at the landfill
- Collect, condition, and compress the landfill gas at the landfill– removes unwanted moisture and corrosive compounds
- Install 12 Capstone MicroTurbines which will produce up to 360 kW of 3-phase electricity at 480 volts. This is enough electricity to power approximately 300 homes.
- The exhaust from the MicroTurbines routed through a heat recovery system. This system is used to preheat water in the gas-fired boilers at the Antioch Community High School.

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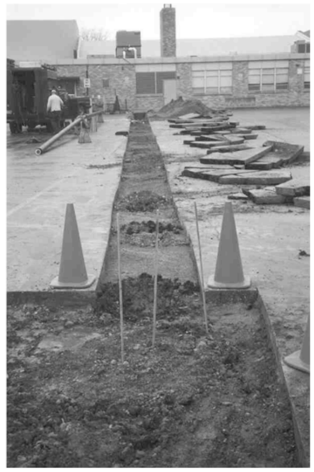
Construction at Antioch High School



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Construction at Antioch High School

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30-kW Capstone, Lunar Enclosure Rolled Out for Maintenance

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WASTE MANAGEMENT

Antioch Community High School Gas-to-Energy Project

Benefits of the Project

- Cost savings to tax payers by using recovered gas to produce energy and heat
- Beneficially reusing landfill gas to produce environmentally friendly "green energy"
- Reduction in greenhouse gas emissions to environment
- Public relations and marketing of a waste-to-energy project for the community and the state of Illinois
- Educational possibilities (physics, chemistry, economics)

KEYS TO PROJECT SUCCESS

Positive Factors

- **No land acquisition cost**
- **$550K DECCA grant from State of IL**
- **Discount on microturbines**
- **LFG provided at no charge**

Negative Factor

- **Waning gas production – currently 125-150 scfm**

FUTURE METHANE UTILIZATION

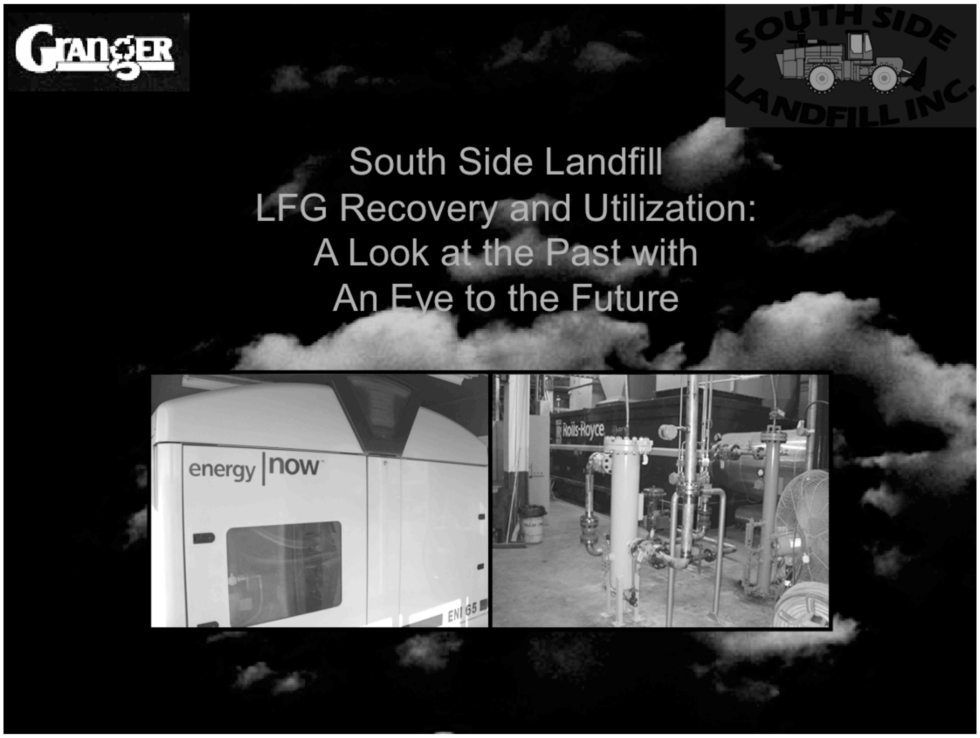
- **Objective: Closing Pricing Disparity**
  - *Coal: $0.80 - $1.30 MMBTu*
  - *Natural Gas: $3.75 - $4.50 MMBTu*
  - *Propane: $4.50 - $5.25 MMBTu*
  - *Landfill Methane: $0.10 - $1.50 MMBTu*

FUTURE METHANE UTILIZATION

- **Vehicle Fuel**
  - *LNG*
  - *Bio-Diesel*
- **Commerical/Industrial Utilization**
  - *Pipeline*
  - *Co-Locating Factories, Big Box Retail*
- **Heat Recovery**
  - *Heat exchanger on combustion devices*
  - *Geo Loops in landfills*

Potential LFGTE at Remedial Landfills

- **Most successful LFGTE projects are on large regional disposal facilities (RDFs)**
- **Most RDFs managed under RCRA Subtitle D**
- **Landfills on NPL tend to be older, smaller**
  - *Lower Btu value, lower gas generation, low prospects for long-term production*


Granger
SOUTH SIDE LANDFILL INC.
South Side Landfill
LFG Recovery and Utilization:
A Look at the Past with
An Eye to the Future
energy | now
Rolls-Royce

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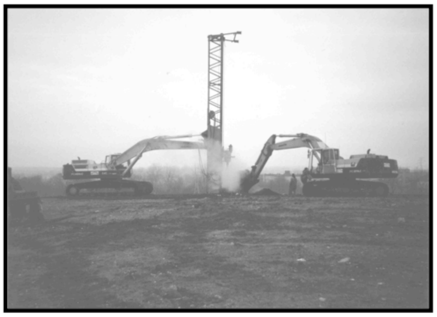
Well field installation



Well Drilling at South Side

Gas Well at South Side

Experimental Phase: First Wells Drilled in 1985

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LFG Extraction Station

Hoffman 30 HP Blowers

Watching the First Start

Investigative Phase:
First Blower Station Installed in 1989

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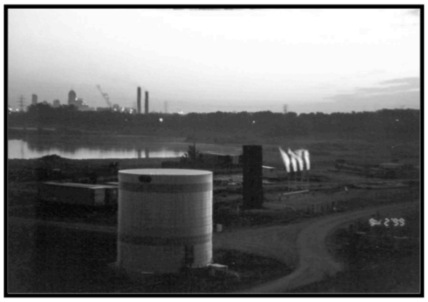
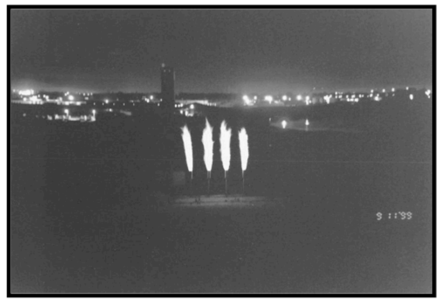
Early Project Development

Flare installation





Flares at South Side Landfill

Investigative Phase: Began Flaring in 1989 45

Early Project Development

Greenhouse boilers

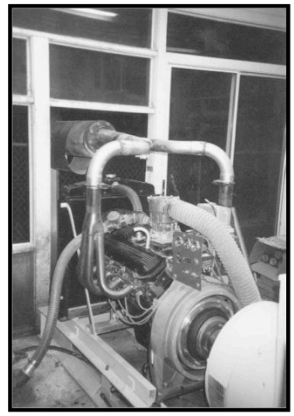
Aerial View of Greenhouse

Cleaver Brooks Boiler at Greenhouse

1st Commercial Phase: Boilers Installed in 1989
First Flowers Delivered in 1990

On-site IC generators

Waukesha Generator



Chevy Generator

1st Commercial Phase: Generators Installed in 1989

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The Project Expands With Granger

LFG Compression Station

⊕ **Production capacity: 175,000,000 cu ft/month**

LFG Compression and Treatment Facility

Pneumatech Refrigerated Gas Dryer

2nd Commercial Phase:
Plant Started in August 1999

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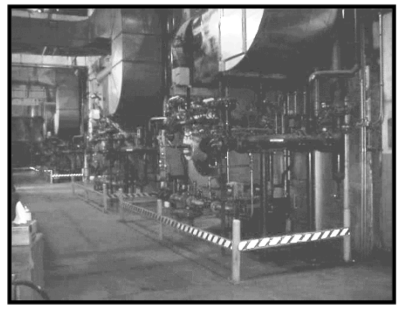
The Project Expands With Granger

Rolls Royce Plant 5

⊕ Consumption range:
68,000,000 – 175,000,000 cu ft/month

Pipeline to Rolls Royce
7200 ft. 12 inch HDPE



Rolls-Royce Boilers

2nd Commercial Phase:
First Fire on LFG in October 1999

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The Project Expands With Granger

Award winning project

2000 Indiana Governor's Award for Excellence in Pollution Prevention

2001 EPA Landfill Methane Outreach Program – Industry Ally of the Year

Rolls Royce Receives Recognition For Being Environmentally Friendly

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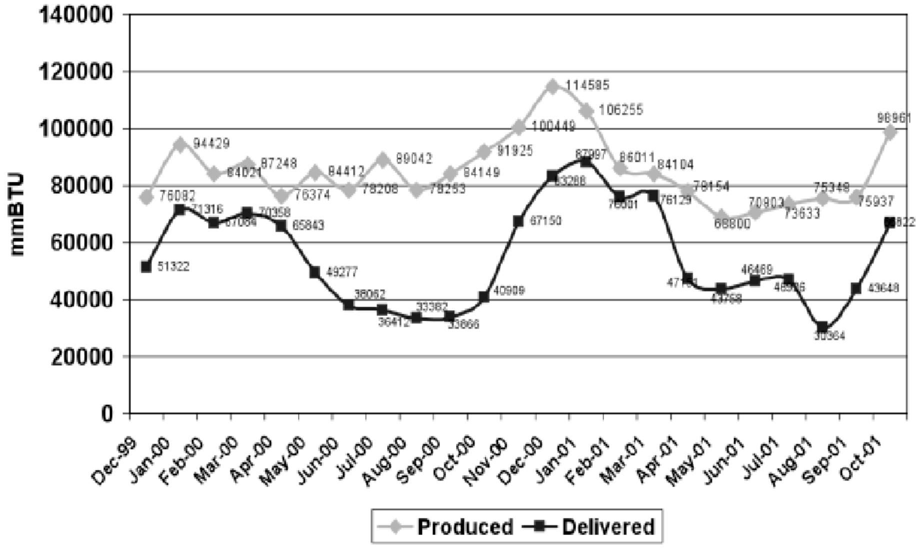
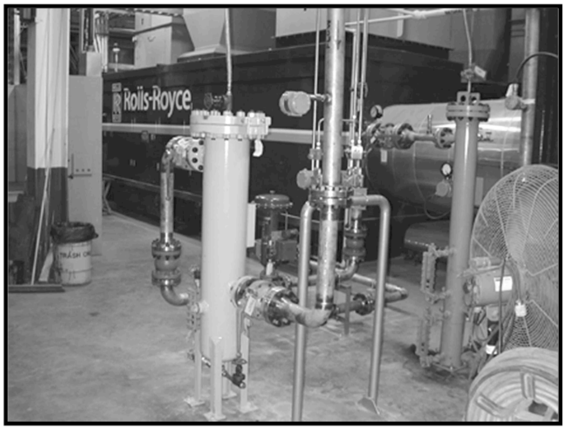
Gas Production at South Side Landfill



One Solution for Seasonal Consumption at Rolls Royce

Electrical Generation with
Rolls Royce Gas Turbine



5 MW Rolls-Royce Turbine

Consumption: 80,000,000 – 90,000,000 cu ft/month

5-Megawatt Turbine Project Overview

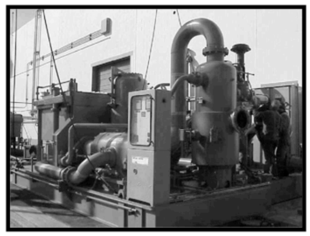
Pipeline extension to Rolls-Royce Plant 8

3400 ft. 12 inch HDPE

High Pressure Compression Station

10 psig to 300 psig

Sliding Vane Compressor in series with a flooded screw compressor



Gas filtration

3-Micron coalescing filter

Another Solution for Seasonal Consumption at Rolls Royce

Co-firing burner at
Vertellus Specialties, Inc.

Vertellus Specialties, Inc., Indianapolis Plant

Consumption: 15,000,000 to 100,000,000 cu. ft./month

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Other Possible Uses of LFG

Electrical Generation with
I Power Energy Systems

65 kW IPower Energy Systems Generator

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Environmental Benefits of LFG as a Fuel

In 2009, South Side Landfill Captured And Sold About 31,000,000 Pounds of Methane For Beneficial Use

This Equates To 270 Railcars Of Coal

Or More Than 4.8 Million Gallons Of Oil

Or…291,000 Metric Tons of CO_2 equivalent


South Side Landfill
&
Granger Energy
Transforming Waste
Into
Renewable Energy
Recycling at it's Best!

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