CHP and Bioenergy for Landfills and Wastewater Treatment Plants: Market Opportunities

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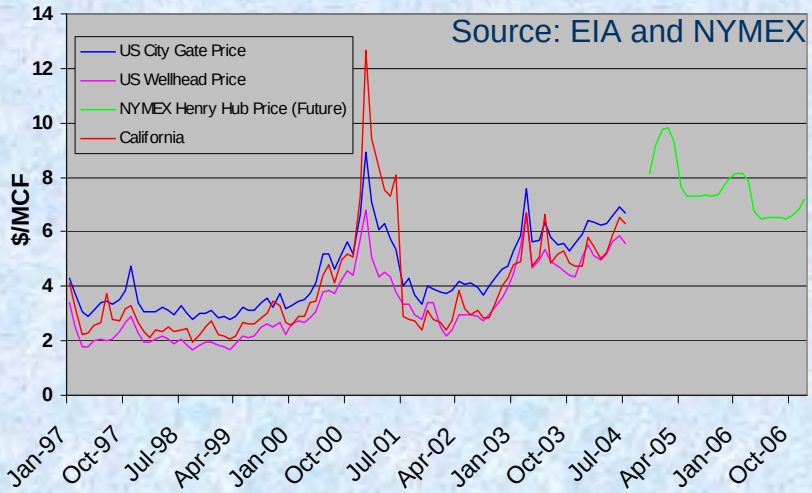
The Opportunity for Alternative CHP Fuels

- High natural gas prices have decreased spark spreads and reduced CHP market potential
- Proposed solutions focus on increasing natural gas supply or reducing demand, neither will likely help much in the short run



- Renewable portfolio standards, public benefit funding, and other renewable incentives are spurring investment in biomass fueled projects

Alternative Solution: Develop Other, Cost-Effective Fuels

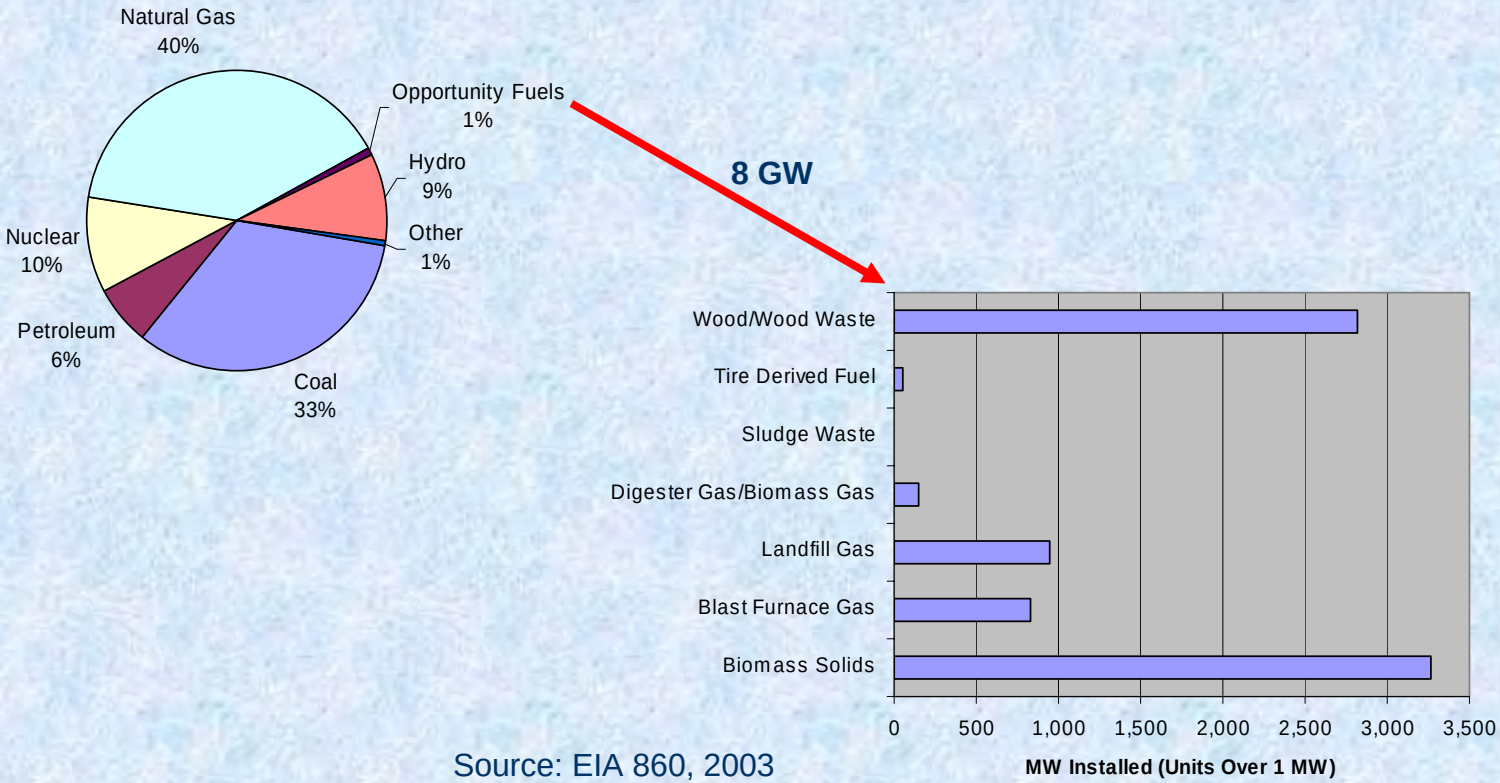
- Opportunity Fuel: any fuel that has the potential to be used for economically-viable power generation, but is not traditionally used for this purpose
- Opportunity fuels include:
  - Anaerobic Digester Gas
  - Biomass (General)
  - Biomass Gas
  - Black Liquor
  - Blast Furnace Gas
  - Coalbed Methane
  - Coke Oven Gas
  - Crop Residues
  - Food Processing Waste
  - Industrial VOC's
  - Landfill Gas
  - Municipal Solid Waste
  - Orimulsion
  - Petroleum Coke
  - Sludge Waste
  - Textile Waste
  - Tire-Derived Fuel
  - Wellhead Gas
  - Wood
  - Wood Waste

Why are Opportunity Fuels Not Used More Often?

- Availability of fuel source often inconsistent in volume and in quality, resulting in variations in fuel volume, BTU content, and contaminants
- Often requires changes (adding $) to generating equipment or purchasing processing equipment (digester, filtration, gasifier)
- Site where fuel is located has little thermal and/or electric demand
- Costs to transport fuel to ideal site can kill projects
- Producing/processing fuel can be labor intensive
- Technology not yet commercialized for small-scale use in U.S.

Currently, Opportunity Fuels Contribute Little to U.S. Generating Capacity

2003 Nameplate Capacity (1024 GW)



Source: EIA 860, 2003

Anaerobic Digesters at WWTPs

- Primary benefits are waste treatment and odor control
- Gas is 50-80 percent methane and 20-50 percent carbon dioxide, and is usually flared or used to heat digester tank
- The cost of anaerobic digesters can vary widely, as sealed concrete tanks with gas collection and transportation equipment can range from $900-1,500 per kW (based on producing enough gas to fuel a 30 kW or larger CHP unit)
- Occasional maintenance is required, costing 1-3 cents per kWh
- Many plants already have digesters, so these costs may be sunk
- Other value streams include reduction in disposal costs by reducing volume

CHP Units for ADG

- CHP units range from $900-5,000/kW installed, depending on size, technology, and installation complexity
- Fuel treatment equipment is one of the major cost drivers (siloxane, H_2S and other particulates must be removed from the gas)
- Equipment modifications are likely required for NG units, though microturbines and smaller reciprocating engines have “off-the-shelf” models that will operate with low-Btu fuels like digester gas
- Larger (>1 Million GPD) facilities can see paybacks in the 2-4 year range when investing in CHP and already possessing a digester

ADG Applications

- Wastewater treatment plants, with wastewater flows of at least 1 million gallons per day (MGD)
  - Municipal treatment plants*
    - At least 4,290 plants with 1 MGD or greater
    - Over 1,700 of these have anaerobic digesters, and over 1,500 are not currently utilizing digester gas
  - Industrial plants vary, depending on characteristics of effluent (food processing and pulp and paper mills are two of the most prevalent industries). At least 2,500 plants could potentially benefit from ADG.
- Manure farms, generally over 200 cows or 1,000 pigs

*Data taken from EPA 2000 Clean Water Needs Survey

Example ADG Installations - Wastewater Treatment Plants

- Central Weber Wastewater Treatment Plant in Ogden, Utah
  - A 1.2 MW reciprocating engine at this Utah plant has been producing power from ADG for over 5 years
- Papillion Creek Wastewater Treatment Plant in Bellevue, Nebraska
  - 6 small IC engines have been installed throughout the past 30 years to power the plant's operations
- Columbia Blvd Wastewater Treatment Plant in Portland, Oregon
  - A fuel cell and several microturbines have been installed at this Oregon plant
- Lewiston Wastewater Treatment Plant in Lewiston, New York
  - Two 30 kW Capstone microturbines produce power from ADG

Using Anaerobic Digester Gas (ADG) as a Fuel for Wastewater Treatment Facilities

- Primary benefits are waste treatment and odor control
  - Gas is a secondary, but potentially valuable, byproduct to heat digester tank, fuel a CHP unit, or sold (to pipeline or other customer)
  - Other value streams include reduction in disposal costs by reducing volume
- Many wastewater treatment plants already have digesters and flare the gas
  - Cost of processing fuel a barrier, especially where siloxane is an issue
  - Negative past experience with ADG fuel use can also be a barrier
  - CHP equipment is more reliable now, and many facilities are installing on-site generation

Landfill Gas

- Methane gas produced in landfills - can be collected and used for power generation applications
- EPA's Landfill Methane Outreach Program provides information and assistance to LFG project planners
  - Over 435 LFG to energy projects are currently underway
  - EPA estimates there is potential for over 600 more projects
  - Most projects pipe the gas to a nearby facility - the pipeline construction costs can limit potential project locations
- LFG is typically just over 50 percent methane and just under 50 percent carbon dioxide - the energy content varies, but the average is around 500 Btu/ft^3
- LFG behaves very similarly to ADG - a landfill is essentially an inefficient anaerobic digester

Landfill Gas Powered Microturbines - Jamacha Landfill in San Diego County

PHOTO: SCS ENGINEERS

- LFG is piped from the landfill to the microturbines
- The gas is cleaned and dried before entering the genset
- A special carbon filter is required to prevent siloxane formation

LFG Economics

- LFG is essentially a free fuel - only the capital costs of gas collection, pipeline and treatment systems are required
- Landfills with over 2.5 million metric tons of waste in place are required by federal law to collect and either flare or utilize their gas
- Regional laws may have similar requirements for smaller landfills
- Landfills can expect to pay about $600,000 per million tons of waste to install gas collection equipment
- Pipeline construction typically costs about $260,000 per mile - most projects fall within the 2-5 mile range
- The efficiency of prime mover equipment is downgraded about 10 percent compared to NG, due to LFG's lower energy content - special equipment modifications may also be required

LFG Applications

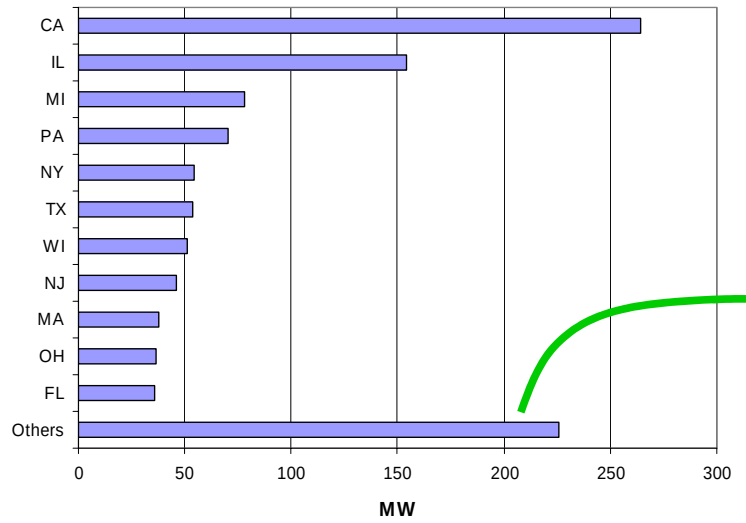
- LFG is rarely utilized by landfills themselves unless most of the electricity is sold - site demand is usually too low to justify a project otherwise
- Any facility with a suitable thermal and electric demand that is located close to a landfill can utilize LFG and potentially benefit - project financing is usually the largest hurdle
- LFG has been used to power schools, homes, commercial and industrial buildings, and other facilities - only limited by demand, location, economics, and sometimes local authorities
- Even with 425 LFG to energy projects (315 of which produce electricity) already installed at many of the best-suited landfills, many locations still have large quantities of excess gas that can be used

Example Landfill Gas Installations

- Davis County Landfill in Layton, Utah is the state's first electricity-producing LFG to energy project - a 1 MW reciprocating engine system is currently under construction
- Antioch Community High School in Antioch, IL installed twelve 30-kW microturbines in 2003, powered by gas from a nearby landfill
- Most LFG to energy projects involve the purchase of electricity by a nearby utility:
  - Four 70 kW Ingersoll Rand microturbines were installed in 2001 at San Diego County's Jamacha Landfill to produce power for SDG&E
  - Salt River Project's Tri-Cities Facility in Scottsdale, AZ pipes gas from three nearby landfills to power five 800 kW engines for utility power
  - At the Sauk County Landfill in Wisconsin, eight 30-kW microturbines were installed in 2003 - electricity is sold to WP&L

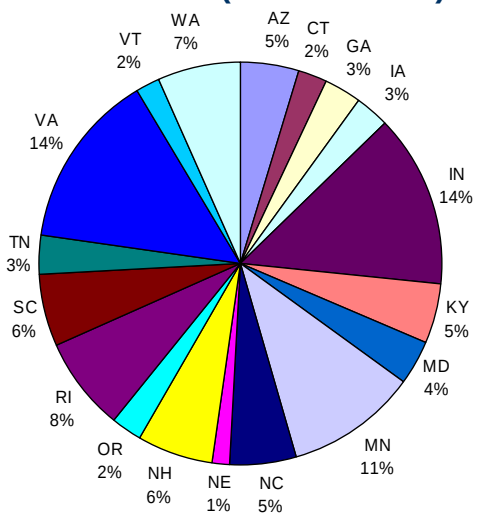
LFG Capacity Concentrated in High Electricity Price, Highly Populated States

Installed LFG Capacity by State (Total 1,107 MW)



Source: EPA LMOP 2005

Other States (Total 226 MW)



Status of Utah Landfill Projects

Landfill Name	Waste In Place (tons)	Landfill Closure Year	Project Status	Project Start Date	Project Developer Organization	Direct-Use vs Electricity	LFGE Project Type	MW Capacity	LFG Flow to Project (mmscfd)
Davis County Solid Waste Management SSD LF	3,300,000	2022	Construction	1/10/2005	Ameresco, Inc.	Electricity	Reciprocating Engine	1.0	0.648
Salt Lake Valley LF	11,000,000	2020	Construction	1/1/2005	DTE Biomass Energy	Direct	Boiler		1.008
Trans-Jordan LF	5,600,000	2017	Construction	12/1/2006	Granger Electric/Energy	Direct	Direct Thermal		
Bountiful City Sanitary LF	2,171,531	2058	Candidate						
City of Logan Sanitary Landfill	1,400,000	2016	Candidate						
South Utah County SSD/Bayview LF	1,100,000	2094	Candidate						
Uintah County/Vernal City LF	2,773,000	2008	Candidate						
Washington County Solid Waste SSD #1 LF	1,292,000	2067	Candidate						
42 Other Utah Landfills	9,893,939	N/A	Potential						

*Candidate landfills have been studied by the EPA and determined to be good candidates for LFG energy projects. Potential landfills have not been through this analysis, but they meet general size and location requirements

Most Intermountain CHP States Have Some Renewable Emphasis on ADG and LFG

State	Renewable Portfolio Std	Digester Gas	Landfill Gas	Net Metering Standards
Arizona	Yes		X	Statewide standards being developed*
Colorado	Yes	X	X	Statewide standards being developed*
New Mexico	Yes	X	X	Net metering of LFG/Biomass** up to 10 kW
Utah	No			Net metering standards do not include ADG/LFG
Wyoming	No			Net metering of Biomass** up to 25 kW

*It is uncertain whether or not ADG/LFG will make their way into the new statewide standards
**Biomass is a general category that often includes ADG and LFG

And the Market Opportunities Are .....

- Two of the top opportunity fuels that currently have the most potential for US DER/CHP projects are:
  - **Anaerobic Digester Gas** - over 6,800 municipal/industrial WWTPs could potentially benefit, as well as over 7,000 dairy farms and 11,000 hog farms - well over 6 GW of electric capacity could be achieved.
  - **Landfill Gas** - currently about 425 landfills participate in LFG-to-energy projects, of which about 315 produce electricity (1.1 GW) - over 1,000 more landfills could have project potential, which could add 3-4 GW.
- Together, these fuels have the technical potential to add 10 GW of DER capacity