# The Promise and Realities of Biogas Produced from Landfills and Farm Waste

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## ABSTRACT

Full realization of the potential of converting landfill gas (LFG) and farm manure to biogas and LFG could, together, significantly supplement our national supply of natural gas. Another advantage of these sources is that they tend to be located near end users and may be considered analogous in some respects to distributed generation because the gas they provide does not have to be transported long distances. There are many ways to generate electricity and few ways to produce biogas. Unfortunately, factors such as constantly changing natural gas prices, the relatively small size of individual projects from a financing prospective, the fact that historic technology for converting animal waste did not always perform properly and the "comfort level" of gas sellers in remaining with existing natural gas supplies have seriously hindered the development of these sources. Federal and state tax benefits and incentive programs (such as the federal stimulus) offer the promise of increased development of these important domestic energy resources and available technology provides the possibility of realizing these domestic energy resources and contributing to gas price stability and domestic energy security.

## THE PROMISE OF BIOGAS FROM ANIMAL WASTE AND LANDFILL GAS

As a nation, we agonize about the necessity of importing increasing amounts of natural gas when, in fact, two of our most abundant and

constantly replenished gas supplies are there for the taking—biogas and landfill gas (LFG). Biogas and LFG are readily convertible to pipeline quality natural gas or available to provide fuel for electric generation or off-taking boilers or in compressed form, as a vehicle fuel, is respectively produced from farm animal solid waste (manure) and landfills. There are numerous benefits of biogas and LFG. They provide efficient energy conversion, add a widespread, readily available and reliable energy source, assist in offsetting natural gas imports, assist in stabilizing natural gas prices, provide significant benefits to farmers and municipal solid waste operators and abate greenhouse gases.

There are good reasons to be concerned with supplementing our supplies of natural gas. According to data from the Energy Information Administration, as a nation, we have only 4% of the world's natural gas with proven natural gas reserves of approximately 238 trillion cubic feet (TCF). To meet our nation's needs of approximately 22 TCF per year, prior to the downturn during 2008-9, approximately 4 TCF was imported. Nearly 90% of our natural gas imports are from Canada (approximately 3.6 TCF) but, like the United States, Canadian use of natural gas is increasing over time and Canada is likely to have less gas to export in the future. We are faced now with a situation in which our natural gas needs have generally been increasing, despite reductions during 2008 and 2009 tied to economic problems and domestic reserves, and although supplemented with finds, gas reserves have been decreasing over many years. Although prices for natural gas have declined from their peak because of reduced demand, as this article went to press, reports indicate that brisk pullbacks in drilling activities because of lowered demand are a factor beginning to drive prices for natural gas higher. Any future slack in U.S. production or imports from Canada is optimistically projected to be largely met by imports of liquefied natural gas from foreign sellers at relatively reasonable prices, which may or may not prove to be the case as world industrialization increases.

Any issues related to the relative scarcity of natural gas are exacerbated by several factors. Most new electric power plants are constructed to utilize natural gas to meet air quality concerns. Despite the construction of three new LNG terminals, there are relatively few points of entry for importation of natural gas (in any form) into the United States and much of the natural gas must be transported within the United States by pipeline over long distances. Production facilities and long supply lines are also susceptible to disruption by events such as hurricanes.

Given that the U.S. must import much of its natural gas, supplementing out of country supply with homeland production is a sensible step. The fragility of dependence upon imported natural gas was highlighted during early 2009 by Russia's dispute with the Ukraine that threatened supplies of natural gas to Europe. Nations that depend on imported gas should regard this incident as a red flag.

Conversely, animal waste is one of our most abundant fuels—more than 2 billion tons are produced each year and production is "reliable." For example, a 1,400-pound dairy cow produces over 120 pounds of manure each day. Manure imposes burdens and expenses upon farmers and released methane raises environmental issues. As suburban areas encroach upon farm areas, there are increasing issues with the odors from waste ponds and environmental degradation. Similarly, there are an abundance of landfills in the United States from which reliable LFG may be produced.

These many problems can be solved by processing animal waste through anaerobic digesters and developing the LNG potential of landfills. Anaerobic digesters are tanks that make use of proven technology and natural processes by which bacteria digest manure in an oxygen-free medium to convert animal waste to methane gas. If a majority of the existing waste were to be processed, it appears to have the capacity of producing as much as 3 to 4 TCF of pipeline-quality gas in regions of the U.S. that are otherwise served by pipelines, providing supplemental supplies, reducing price spikes caused by supply/demand imbalances and easing burdens on the pipelines. There are many sources of suitable animal waste, including dairy cows, feedlot cows, hogs, chickens and turkeys. Developing the majority of suitable landfills would supplement the estimated quantity of gas available from animal waste.

The use of landfill and biogas from animal waste has additional benefits over traditional fuel sources. There are no recognized harmful by-products from the anaerobic digestive process. In addition to biogas, the only two by-products are a dry spongy material that is excellent for animal bedding purposes or soil enhancement and an nearly odorless liquid that can be used as a fertilizer. Methane captured from processing waste from 100,000 cows would nearly offset carbon dioxide releases from a 100-megawatt coal-fired plant. Similarly, installing a well and gathering system in a landfill and treating and selling the gas or using it for generator fuel captures an energy value that is simply wasted when methane is flared. The destruction of methane for productive purposes

can also entitle the operator to tax benefits, governmental incentives and payments from the growing "carbon trading" markets in light of the fact that these facilities capture and utilize methane that would otherwise be released into the atmosphere.

Biogas gas produced by anaerobic digesters from farm waste or from landfills has been used for purposes such as distributed generation in the form of co-generation to provide electricity and thermal energy and has been compressed into biofuel for the purpose of powering equipment and vehicles.

Yet another advantage of landfill and biogas gases is that many sources of energy are difficult to site. That is not a significant problem with anaerobic digesters or landfill gathering and treatment facilities. The gas lines that connect the digesters or LFG processing equipment to gas utility pipelines are as unremarkable as any other gas distribution lines traversing public streets. There are rarely NIMBY issues to overcome, few environmental concerns, and minimal regulatory procedures or permitting required for construction. Biogas provides a reliable, domestic source of gas supply that is widespread and not susceptible to public safety and security concerns.

Another advantage to using animal waste or LFG as a fuel is that, unlike ethanol, it does not involve the growing of crops and the time, expense and use of gasoline\oil required for these agricultural purposes. In addition, there are no farm subsidies for manure like there are for corn or other sources of ethanol.

Federal and state governments are taking actions intended to enhance the development of anaerobic digesters and production of biogas from farm waste or landfills. Certain states are making financial incentives available for developing biogas and, in states that have renewable production standards (requiring utilities to purchase a percentage of their energy needs from renewable sources), purchasing electricity generated by biogas (and the purchase of biogas itself) should count toward fulfillment of those requirements, further enhancing the value of biogas.

## WHY HAS BIOGAS BEEN LARGELY OVERLOOKED?

Natural gas is a critical fuel for our nation. It generates electricity, produces heat for many purposes, powers vehicles, and serves as a feedstock for manufacturing products such as fertilizer. It also produces

less greenhouse gas and other pollutants than other fossil fuels. Natural gas can readily be transported long distances in compressed form or as liquefied natural gas. These advantages have led to the widespread adoption of natural gas. Biogas also has these positive attributes and those described above but so far the nation has not made an extensive parallel development of biogas. The question is why not?

Biogases are readily available from landfills and farms. Without treatment, these facilities emit greenhouse gases that must be destroyed. All too often, operators of these facilities flare (burn) the greenhouse gases without capturing its energy.

Biogas promotes end-user risk management by providing long-term reliability and commodity cost control. Landfills and dairy farms can predict biogas production with reasonable accuracy, and the costs of development are also well known. Governmental incentives and tax benefits are often available, as is the ability to sell certified emission reduction credits or renewable energy credits related to verified emission reductions (VERs) of greenhouse gases (GHG) in the carbon-credit markets. (GHG includes any of the atmospheric gases such as carbon dioxide ($CO_2$) and methane ($CH_4$) that are believed to trap solar radiation and warm the Earth's surface.) These voluntary carbon markets can provide funding; even advance funding in some instances, on a contractual basis for biogas projects.

There are many examples of successful LFG projects. A typical example would be a LFG developer arranging an off-take agreement with a nearby factory with a need for boiler fuel to deliver a supply of treated landfill biogas (LFG) from a nearby municipal landfill to provide medium Btu gas at a competitive index cost. It is necessary for all LFG projects to have an engineering report confirming the existence of a reliable LFG supply and to obtain a municipal permit to install a LFG extraction and beneficiation system consisting of a network of gas collection wells, interconnecting pipes, valves, probes, sensors, monitoring equipment, necessary blower stations, vacuum pumps, and a skid for treating the LFG so that treated LFG can be piped to the manufacturing plant and used for boiler gas. If electricity is to be produced, the equipment would, of course, include generation units and interconnection installations. Biogas supply confers benefits on everyone in the supply chain from the landfill owner who receives income from the sale of gas, the developer who receives a return on its investment, the end user who receives a reliable supply of biogas at a competitive price and, among

others, sellers and installers of equipment.

From a larger perspective, because biogas is typically produced close to the place of use, it "strengthens" the gas transmission system by reducing the amount of natural gas that is transported long distances. For that reason, local gas production helps alleviate congestion in the natural gas transmission system, which can lead to gas shortages for commercial, industrial, and residential uses at times throughout the country, such as in the Northeast during winter months. Reduced congestion may also defer the need for constructing new facilities, which reduces energy costs to end users.

In light of these factors, one would imagine that the U.S. would have implemented a widespread program to develop biogas projects, but the progress has been limited to date. What are the barriers?

## BARRIERS TO BIOGAS DEVELOPMENT

My experience as an attorney practicing in this area leads me to conclude that the historic convenience, availability, and reliability of natural gas are formidable barriers, among others, to the implementation of renewable biogas resources that our nation vitally needs. This historic convenience of natural gas has created a high comfort level with existing procurement systems and a general lack of comfort with renewable processes among sellers and distributers. We have also found the financial industry in general (although there are certainly exceptions) to be much less familiar with renewable gas projects than other types of energy projects.

There are some national and state tax credits and renewable portfolio standard requirements relating to the production of electricity, but the providers of biogas do not necessarily qualify for the credits, posing an additional barrier to project development. In contrast, the electrical generation facility fueled by biogas may meet the requirements.

Project size can also be a serious problem. It can be very difficult to obtain funding for renewable gas projects in light of their relatively small scale. On an individual basis, a typical biogas project is much smaller than, say, an electric power plant. For that reason, a biogas project often struggles to gain attention from the financial industry. One solution is a "cookie-cutter" approach for smaller biogas projects that work; aggregate them into a single financing that would then benefit

from the "economies of scale." While it sounds reasonable, financiers who are not fully familiar with such projects often want to take the first renewable biogas project all the way through before building others that the developer hopes can be handled in a cookie-cutter fashion. Unfortunately, the costs and issues related to getting the "first car off the line" can make the first project appear more expensive than it would be if the initial learning curve and costs were to be allocated to multiple projects. Developing and financing projects on a cookie-cutter basis would also help to address risks related to any single project among the set of projects because whatever risks may exist with respect to it would be mitigated in a "mutual fund" of similar projects. This reluctance to a cookie-cutter approach appears to be subsiding as time goes on because it makes sense and, of course, there are governmental incentives.

## THE FUTURE OF BIOGAS APPEARS PROMISING

The range of existing and new federal and/or state tax benefits, loan guarantees and other incentives are driving projects and the generally competitive cost of biogas should be powerful drivers for the wide-scale development of biogas. In addition, programs such as the Regional Greenhouse Gas Initiative, (RGGI), which involves several Northeast states, and which requires the operators of electric generators to purchase credits produced by renewable gas producers, promise to provide some stimulus to biogas.

Given the many desirable elements of biogas and the growing public favor of "green" energy solutions, it appears that end-user demand will be yet another major driving force leading to projects that contribute to realizing the our country's biogas potential.

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