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Project Summary

Landfill Gas Energy Utilization Experience: Discussion of Technical and Non-Technical Issues, Solutions, and Trends

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Clean Air Act (CAA) regulations for new and existing municipal solid waste landfills are expected to require approximately 500 to 700 sites to install and maintain a landfill gas extraction and control facility to reduce landfill emissions, which include nonmethane organic compounds, toxics, and greenhouse gases. The Air and Energy Engineering Research Laboratory (AEERL) of the U.S. Environmental Protection Agency (EPA) is conducting ongoing research to provide information on energy conversion options for landfill gas utilization as a means of assisting landfill owner/operators that may be affected by the CAA regulations.

This report is a follow-on to a 1992 publication that provides information on the different options for landfill gas utilization that are illustrated by case studies. The focus of this new report is on technical and non-technical considerations associated with the development and operation of landfill gas to energy projects. Much of the information used to generate this report is from interviews and site visits with the major developers and operators of the more than 110 projects in the U.S. This report also provides the history and trends of the landfill gas industry in the U.S. Graphs illustrate how the influence of reciprocating internal combustion (RIC) engines, compared to other utilization options, has steadily increased over time.

Landfill gas is a medium heating value fuel (approximately 500 Btu/scf or 19 MJ/m^3), and can contain corrosive compounds and particulates. The gas may be used in direct heating applications (i.e., boilers or kilns), in reciprocating engines and turbines to produce electricity, or it may be purified to pipeline quality gas, or for use in fuel cells. This report identifies the potential difficulties that may be encountered in developing a landfill gas to energy project and presents possible solutions that have been found through the experience of the landfill gas to energy industry. Possible remedies to typical technical landfill gas issues addressed in this report are 1) material modifications, 2) condensate management, 3) use of special oils (in RIC engines), and 4) engine adjustments (in RIC engines).

Some of the non-technical problems and solutions described in this report are associated with the development of energy utilization options including project economics, barriers, and incentives. Two new programs that may provide incentives are described. The information presented on non-technical barriers is primarily based on the experience of private U.S. landfill gas project developers and operators and is not intended to give a comprehensive overview of all perspectives on landfill gas utilization.

Ongoing research by EPA and others is aimed at tracking and developing new options for landfill gas utilization. This report summarizes information on new landfill gas utilization technologies, including vehicular fuel systems and fuel cells. Overall results of

programs to demonstrate the operational feasibility of innovative technologies appear quite promising. For example, the fuel cell technology for landfill gas has many potential advantages over conventional technologies including its high energy efficiency, minimal by-product emissions, and minimal labor and maintenance. The use of fuel cells may be economically feasible before the turn of the century.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Technical Considerations

This section discusses the technical issues associated with the use of landfill gas compared to natural gas—which is the primary fuel used for energy conversion equipment such as reciprocating engines, gas turbines, and fuel cells. This section reviews these technical issues and summarizes current field experience in minimizing their effects. To obtain pragmatic and recent information, interviews were conducted with five developers and/or operators of landfill gas energy projects and one engine manufacturer.

Technical issues arise as a result of the relatively low heating value or from the presence of chlorinated and toxic compounds, particulates, as well as the formation of condensates or deposits. [For landfill gas the heating value is approximately 19 MJ/m^3 and for natural gas it is approximately 37 MJ/m^3 (500 vs. 1,000 Btu/scf).] Possible remedies to typical technical landfill gas issues addressed in this report are 1) material modifications, 2) condensate management, 3) use of special oils (in RIC engines), and 4) engine adjustments (in RIC engines).

The section presents four simplified process flow charts illustrating approaches to landfill gas cleanup for utilization projects.

Non-Technical Considerations

This section discusses non-technical barriers that are associated with landfill gas recovery and utilization as encountered by the landfill gas utilization industry. Also, incentives and government initiatives to encourage landfill gas utilization are described. To obtain pragmatic and recent information, interviews were conducted with seven developers and/or operators of landfill gas energy projects.

U.S. barriers that were identified from the interviews conducted for this report include:

- Unfavorable economics due to low energy prices and high debt service rates for landfill gas-to-energy projects that generate electricity or pipeline quality gas;
- Limited or unstable marketplace;
- Obtaining third party project financing at reasonable cost, because it is difficult, time consuming, and proportionately more costly for small projects than for large projects;
- Difficulties in obtaining air permits, especially for projects located in ozone, nitrogen oxide (NO_x), and carbon monoxide (CO) nonattainment areas, because air boards and utilities often have lengthy permit processes and contract negotiations;
- Difficulties in negotiating power contracts with local utilities because they are primarily interested in purchasing low-cost power without considering environmental externalities (e.g., offsets from power plants using fossil fuel). [However, the environment has changed somewhat as a consequence of State Public Utility Commissions (PUCs) who mandate that utilities pay only avoided cost for electricity purchases];
- Unforeseen costs resulting from compliance with new air quality rules and regulations, and declining energy revenues that cannot be adjusted to offset new costs;
- Taxation by some states (e.g., California) on landfill gas extraction and energy conversion facilities; and
- Difficulties in understanding federal and state energy policies and environmental regulations that may affect these projects.

U.S. incentives for undertaking landfill gas projects include:

- Purchase of electricity at avoided cost of between 2.5 and 3.0 cents/kWh, except where a utility offers a special incentive program, consisting of a levelized higher price, and/or capacity entitlement,
- Production Tax Credits (PTCs),
- Favorable utility contracts for electricity projects,
- Tax exemptions for landfill gas extraction and energy conversion facilities,
- Technical assistance from EPA's Control Technology Center, and
- New initiatives such as the Department of Energy's research, development, and demonstration program (RD&D Program) targeted at the technical barriers to landfill methane (CH_4) energy recovery and EPA's Landfill CH_4 Outreach Program that is designed to remove regulatory, information, and other barriers.

Emerging Technologies

Emerging technologies are discussed in this report:

- Landfill gas utilization as vehicular fuel (demonstration project),
- Conversion of landfill gas to methanol (demonstration plant under construction),
- Landfill gas utilization in fuel cells (demonstration project),
- Rankine cycle converters (field tests have been conducted to recover waste heat from landfill gas flares), and
- Stirling engines (no landfill gas experience to date).

Most experience to date has been on fuel cell applications to landfill gas. The EPA initiated a research and development project in 1991 to evaluate the use of commercially available fuel cells for landfill gas applications, because of the potential environmental and energy efficiency characteristics, which include a higher energy efficiency (to 40%), minimal by-product emissions, and minimal labor and maintenance requirements.

The major technical consideration associated with the application of fuel cells to landfill gas projects is the gas cleanup system. Testing of EPA's cleanup system has just been completed, resulting in over 200 hours of successful operation. The gas cleanup system is designed to clean the gas to 3 ppmv of chlorides and 3 ppmv of sulfur. Next, a 1-year demonstration is planned to study the performance of fuel cells for landfill gas energy conversion applications. The major non-techni-

cal consideration associated with fuel cells has been the capital cost.

Appendices and Other Information

The report includes other material that is geared to the landfill gas industry. Various appendices provide information on:

- International landfill gas experience,
- Attributes of various proven technologies for generating electricity while utilizing landfill gas as a fuel,
- Landfill gas turbines,
- A demonstration project to convert landfill gas into vehicle fuel,
- An EPA memo dated July 1994 providing the EPA's New Source Review policy that regards landfill gas to energy projects as potential pollution prevention sources, and
- Non-technical issues such as the sale of electricity from landfill gas projects and alternative energy regulatory policies.

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The complete report, entitled "Landfill Gas Energy Utilization Experience: Discussion of Technical and Non-Technical Issues, Solutions, and Trends," (Order No. PB95-188108; Cost: $36.50, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
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Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

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