TECHNICAL AND NONTECHNICAL ISSUES REGARDING LANDFILL GAS TO ENERGY pdf

1: Toward A Twenty-first Century Landfill in Yolo County | Yolo County

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Generating renewable energy onâ€”site using a system or device at the location where the power is used e. Purchasing renewable energy through renewable energy certificates RECs â€” also known as green tags, green energy certificates, or tradable renewable certificates â€” that represent the technology and environmental attributes of electricity generated from renewable resources. Purchasing renewable energy from an electric utility through a green pricing or green marketing program, where buyers pay a small premium in exchange for electricity generated locally from renewable energy resources. Benefits of Renewable Energy Environmental and economic benefits of adding renewable energy to a state portfolio can include: Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution Diversifying energy supply and reducing dependence on imported fuels Creating economic development and jobs in manufacturing, installation, and more Barriers to Renewable Energy Price competitiveness is the most obvious barrier to renewable energy installations. In many cases, barriers to expanding renewable energy are regulatory and therefore within state control. Unfavorable utility rate structures have been a perennial barrier to increased deployment of renewable energy technologies. Unless carefully monitored to encourage the development of distributed generation , rate structures can increase the cost of renewables e. Lack of Interconnection Standards. Barriers in Environmental Permitting. Largeâ€”scale renewable energy technologies are subject to all the necessary environmental permits of major industrial facilities. Renewable energy generation using new technologies can face permitting hurdles until permitting officials are familiar with the environmental effects of the generation processes. Many renewable resources are located in remote areas that lack ready or costâ€”effective access to transmission. States that have not established clear utility regulations that enable investments in transmission to be reimbursable i. Top of Page State Policies to Support Renewable Energy The number of renewable energy installations across states varies widely, reflecting individual state or regional priorities, and not always due to resource or technical potential. States have adopted a number of policies to support greater investment in and adoption of renewable energy technologies. Renewable Portfolio Standards RPS require electric utilities and other retail electric providers to provide a specified percentage or amount of customer electricity with eligible renewable resources. Public Benefits Funds for Renewable Energy are a pool of resources used by states to invest in clean energy supply projects. Funding and Financial Incentive Policies. Outputâ€”Based Environmental Regulations establish emissions limits per unit of productive energy output of a process i. Policy Considerations for Combined Heat and Power: Policy Considerations for Combined Heat and Power. Interconnection Standards are processes and technical requirements that delineate how electric utilities in a state will treat renewable energy sources that need to connect to the electric grid. The establishment of standard procedures can reduce uncertainty and delays that renewable energy systems can encounter when obtaining electric grid connection in states that have not established interconnection standards. Net Metering enables residential or commercial customers who generate their own renewable electricity e. In effect, excess electricity is returned to the customer at a later time when they otherwise would have paid for it. Feedâ€”In Tariffs encourage the development of renewable energy by obligating electric utilities to pay preâ€”established above-market rates for renewable power fed onto the grid. These tariffs, which may vary depending on the type of resource used, provide renewable generators with a set stream of income from their projects. Property Assessed Clean Energy PACE is a financing option that attaches the obligation to repay the cost of renewable energy installations or energy efficiency retrofits to a residential property rather than an individual borrower. This mechanism encourages property owners to invest in clean energy improvements even if the payback period is longer than the owner intends to keep the property. Financial Incentivesâ€”such as grants, loans, rebates, and tax creditsâ€”are

provided in some states to encourage renewable energy development.

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2: Power | Harris Group Inc.

The paper discusses technical issues associated with the use of landfill gas (LFG) compared with natural gas, which is the primary fuel used for energy conversion equipment such as internal.

What was once considered an environmental hazard has become a potential energy source for firing boilers, generating electricity, and creating fuel for our cars. They were the original driver of this business-protecting the public-and they will continue to be with us far beyond the year We started out with simple regulations designed to control migration away from the landfill property, and progressed to rules that define the limits at the surface of the landfill itself. Get used to it-none of these rules are going away anytime soon. But with more than 40 years as an industry and about 15 years of operation under the NSPS, both the industry and the regulatory community are learning those pieces of data that actually mean something and those that simply are acquired for the sake of being data. I anticipate that the requirements for monitoring our GCCSs will continue to be streamlined. Criteria that do not contribute to the overall functioning and evaluation of the effectiveness of the GCCS will be pushed to the side in favor of criteria that will have more intrinsic meaning. The critical data points will be more easily reviewed and more readily screened for potential negative impacts, providing us with mechanisms to identify potential operational issues before they become a potential safety, environmental, and financial burden. Another major aspect of the regulatory climate is the schedule for initiating LFG collection. This schedule is independent of the status of landfill progression. If a disposal area is filled within four years, the GCCS can be constructed a single time, as part of the closure process; if the disposal area is in operation for more than five years, an interim GCCS should be installed. In some cases, the construction of GCCS components in a particular disposal area may occur as many as three or more times, depending on the fill schedule and the damage to the GCCS incurred by additional waste placement. The regulatory trend is toward more aggressive LFG collection. A great deal of discussion has been initiated in the past few years regarding how much methane may or may not be escaping during the early phases of landfill development. This is a part of the larger discussion on the potential contribution of landfills to greenhouse gas emissions, global warming, etc. Although those issues are food for another discussion entirely, they create the drivers for additional rules and policy decisions at the federal USEPA level. In this case, that implies an accelerated installation schedule. While there are variations on these two themes, the basic configurations will remain the same. What may change is the way in which some of these configurations are installed. Vertical wells-The most common mechanism for LFG extraction is the vertical well. It can be installed either at interim waste elevations or at final grades. One variant on the traditional vertical well is the construction of vertical wells as waste placement progresses, i. This is not a new technique; it has been utilized worldwide for decades using concrete manhole sections, gabion baskets, etc. However, it was often used as a replacement for employing a drilling contractor, or in cases where appropriate drilling equipment was not available. The driver toward earlier GCCS installation and control is reviving the practice, both through wells that are constructed from the base of the landfill and wells that are drilled at an interim elevation and then extended as filling progresses. This allows for the potential collection of LFG as soon as it is being generated. At least in dryer climates, we may see the implementation of a seldom-employed LFG well: No worries about crushed or fractured casings, or whether the perforations are clogged-just a nice clean column of crushed stone. Horizontal wells-Horizontal collection wells have long been a staple of interim LFG collection. Constructed as lifts of waste are placed over an area, the wells are brought into operation when sufficient LFG generation has occurred to make such activities practical. While these structures are suitable for early installation and collection, they can be susceptible to fouling from landfill liquids and differential waste settlement. Horizontal collection wells that drain liquids more rapidly or allow for the installation of an efficient pumping system would be a tremendous asset-as would sensors along the casing to let the operator know how much fuel was being extracted at a given point versus the liquid impact at that point. This could also be useful in determining

the local moisture content of the waste mass and how much leachate should be recirculated to maintain optimal methane production. Beneficial Use A number of beneficial-use applications are commercially viable today and have been utilized for several years. Among these are medium-Btu direct-fire applications boilers, kilns, and furnaces , high-Btu pipeline and alternative fuels production CNG, LNG and electrical generation internal combustion engines and turbines. Although various modifications have come along in the past few years, there are very few up truly innovative beneficial uses that were not simply copied from other industries. New applications for beneficial use will be driven by both need and technology. The need part of the equation is for better efficiency. I see prime mover technology improving efficiencies. By , these technologies will be commercialized, not only for the LFG industry but also for the automotive industry. Applications that were not considered feasible a few years ago are either reality now or well on the way to being so. Some of them involve the more efficient conversion of LFG to purified methane, i. Two of these at the head of the list are fuel cells and vehicle fuel production. Fuel Cells-Fuel cells have been around for decades. The primary fuel used in their development is hydrogen. While we do get a little hydrogen from landfills, the primary fuel is of course methane. Different techniques for converting methane to hydrogen have been developed and put into application. BMW will initially determine the feasibility of making hydrogen. Follow-up phases could result in BMW using the converted hydrogen to fuel its fleet of hydrogen-powered material handling equipment http: Once we have the hydrogen, the fuel cells need to be commercialized. The DOE, along with their commercial partners, is striving to develop fuel cells in order to provide a cleaner, more efficient means of producing electricity. The commercial viability of fuel cells would provide the means for a large range of applications, from transportation to local electrical supply, especially in areas without access to a reliable power grid and developing countries. Vehicle Fuel Production The conversion of LFG to high-Btu fuels has gained in popularity in recent years, though facilities have been in operation for many years. The use of solvents Selexol , cryogenics Kryosol , pressure-swing absorption and molecular sieves membranes have all been used to separate carbon dioxide and other contaminants from methane, creating a renewable natural gas. The commercial advantages of these projects are largely based upon the cost of natural gas. Higher natural gas prices increase the viability of LFG to high-Btu projects. The current development of shale gas projects Marcellus and Utica in the Appalachian Basin and Bakken in Montana and North Dakota should greatly increase the domestic supply of natural gas. As supplies increase, the end-use applications will also increase. The viability of CNG- and LNG-powered vehicles are anticipated to proliferate, beginning with light-duty cars and trucks and progressing to off-road construction equipment as engine manufacturers increase the torque of heavy-duty engines. What does this have to do with LFG? Landfill owners are always looking for an edge-how to cut costs while expanding services, how to create better relations with the public, how to promote themselves for a new contract. Until recently, all LFG fuel production facilities were large-scale models requiring a minimum of 2, to 3, scfm of raw LFG, many of them much larger. Recent advances in membrane technology have allowed the development of small-scale production facilities that profitably create CNG from as little as 50 scfm of extracted LFG. A general increase in the awareness of and desire for natural gas as a vehicle fuel, as well as other industrial uses as we convert from oil and coal-fired applications, will create a new markets for recovered and purified LFG. Recent conversion examples abound, and not just from large haulers like Waste Management and Republic. Rumpke Waste and Recycling announced a deal in August to start fueling 10 trucks as part of a pilot program in Cincinnati, OH. But will we still have LFG to manage? These materials are key components of long-term LFG generation. If you add a more aggressive paper and wood recycling program into the mix waste paper is becoming an increasingly valuable international commodity we begin to run out of putrescible wastestreams rather quickly. Companies utilizing thermochemical and microbiological processes to convert organics to fuel will also remove organics from the landfill equation, thus reducing the amount of LFG that will be generated. Private investment in these technologies is tremendous, but the future is uncertain; we know how to do it, now we just need to figure out how to do it cost effectively. That may take some time. All things considered, I think the LFG engineers of the

world will have plenty of work for a long time to come. It may vary a bit-all good industries develop and change to better suit the needs of the client-but it will still be there. The development of new, large-scale, beneficial-use projects may start to decline, especially as conversion technologies decrease in cost and increase in efficiency, but there will still be legacy sites in need of management. I envision well-field management via remote monitoring and access. Then again, maybe all the garbage will go into a Mr. No matter what technical knowledge you bring to the solid waste management industry, whether it be about collection, waste-to-energy or landfill gas, citizen-focused consultation is a reality. Traditional consultation was used to confirm the plans we already made. But public consultation and engagement increasingly demands attention before and during the planning for a project. Who we communicate to and how we communicate with them will adapt as long as we have strategic communication plans that are flexible. Technology will continue to dictate the most effective means of communication, however, 20 years from now, the demand for instant, transparent information will be unmistakable. Is a technical, engineering-based solid waste industry ready to accommodate nontechnical opinions? Is it ready for the open data movement where statistics about operating efficiencies are made available to anyone via the worldwide web? Open data operates under the premise that data should be freely available to anyone who wants to use it and republish it. Is it ready to listen to the thoughts and ideas that will come from open data analysis? Another thought that arises regarding landfill gas management and communication, education and marketing relates to the long-term supply of landfill gas. And what will this mean to communicators? What will happen if we spend the next generation persuading ourselves to compost our foodwaste while simultaneously spending money to recover landfill gas, only to run out of landfill gas?

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3: LFG and the Future of Landfill Management - Forester Network

The paper discusses technical issues associated with the use of landfill gas (LFG) compared with natural gas--which is the primary fuel used for energy conversion equipment such as internal combustion engines, gas turbines, and fuel cells.

Discussion of Technical and Non-Technical Issues, Solutions, and Trends Michiel Doom, John Pacey, and Don Augenstein Clean Air Act CAA regulations for new and existing municipal solid waste landfills are expected to require ap- proximately to sites to install and maintain a landfill gas extraction and control facility to reduce landfill emissions, which include nonmethane organic compounds, toxics, and green- house gases. This report is a follow-on to a 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 consid- erations associated with the develop- ment and operation of landfill gas to energy projects. Much of the informa- tion used to generate this report is from interviews and site visits with the ma- jor developers and operators of the more than projects in the U. This report also provides the history and trends of the landfill gas industry in the U. Graphs illustrate how the in- fluence of reciprocating internal com- bustion RIC engines, compared to other utilization options, has steadily increased over time. The gas may be used in direct heating ap- plications i. This report identifies the poten- tial difficulties that may be encountered in developing a landfill gas to energy project and presents possible solutions that have been found through the ex- perience of the landfill gas to energy industry. Possible remedies to typical technical landfill gas issues addressed in this report are 1 material modifica- tions, 2 condensate management, 3 use of special oils in RIC engines , and 4 engine adjustments in RIC en- gines. 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 incen- tives. Two new programs that may pro- vide incentives are described. The in- formation presented on non-technical barriers is primarily based on the ex- perience of private U. Ongoing research by EPA and oth- ers is aimed at tracking and develop- ing new options for landfill gas utiliza- tion. This report summarizes informa- tion on new landfill gas utilization tech- nologies, including vehicular fuel sys- tems and fuel cells. Overall results of programs to demonstrate the opera- tional feasibility of innovative technolo- gies appear quite promising. For ex- ample, the fuel cell technology for land- fill gas has many potential advantages over conventional technologies includ- ing its high energy efficiency, minimal by-product emissions, and minimal la- bor and maintenance. The use of fuel cells may be economically feasible be- fore the turn of the century. This section reviews these technical issues and summarizes current field experience in minimizing their effects. Technical issues arise as a result of the relatively low heating value or from the presence of chlorinated and toxic com- pounds, particulates, as well as the for- mation of condensates or deposits. The section presents four simplified pro- cess 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 encoun- tered by the landfill gas utilization indus- try. Also, incentives and government ini- tiatives to encourage landfill gas utiliza- tion are described. Emerging Technologies Emerging technologies are discussed in this report: Most experience to date has been on fuel cell applications to landfill gas. The major technical consideration as- sociated with the application of fuel cells to landfill gas projects is the gas cleanup system. The gas cleanup system is designed to clean the gas to 3 ppmv of chlorides and 3 ppmv of sulfur. Next, a 1-year demonstra- tion is planned to study the performance of fuel cells for landfill gas energy conver- sion applications.

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4: Municipal Waste to Energy - A Global Technology, Industry and Market Analysis

United States Environmental Protection Agency Air and Energy Engineering Research Laboratory Research Triangle Park, NC Research and Development EPA//SR/ May EPA Project Summary Landfill Gas Energy Utilization Experience: Discussion of Technical and Non-Technical Issues, Solutions, and Trends Michiel Doom, John Pacey, and.

Doom Pechan , J. Pechan and Associates, Inc. Much of the report is based on interviews, and site visits with the major developers and operators of the more than projects in the U. The report also provides the history and trends of the landfill gas industry in the U. Graphs illustrate how the influence of reciprocating internal combustion RIC engines, compared to other utilization op- tions, has steadily increased over time. The 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, 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 mainten- ance. The use of fuel cells may be economically feasible before the turn of the cen- tury. Some of the non-technical problems and solutions described in the report are associated with the development of energy utilization options including project eco- nomics, barriers, and incentives. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorse- ment or recommendation for use. This report is a follow on to an earlier publication entitled: The publication provides information on the different options for landfill gas utilization which 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 projects in the U. This report also provides the history and trends of the landfill gas industry in the U. Graphs illustrate how the use of reciprocating internal combustion 1C engines, compared to other utilization options, has steadily increased over time. The gas may be used in direct heating applications i. 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: 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. 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. For example, the fuel cell technology for landfill gas appears to have 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. Additional information is provided in various appendices. Appendix E presents international landfill gas experience. In Appendix H, the attributes of various proven technologies for generating electricity while utilizing landfill gas as a fuel are discussed. Appendix I details landfill gas turbines, whereas Appendix J describes a demonstration project to convert landfill gas into vehicle fuel. Appendices L and M focus on non-technical issues such as the sale of electricity from landfill gas projects and alternative energy regulatory policies. Landfill gas recovery sites in the United States 4 2. Number of projects per State 5 3. Net electrical output in MW per State per type of generating equipment 5 4. Number of projects per end use per year 6 5. Number of 1C engine projects including gas turbines per year per manufacturer 7 6. Net electrical output in MW per year per type of generating equipment 8 7. Net electrical output in MW per year per developer 8 8. Simplified landfill gas flowchart for 1C engines limited cleanup 21 9. Simplified

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landfill gas flowchart for 1C engines stringent cleanup 23 Simplified landfill gas flowchart for gas turbines example 1. Simplified landfill gas flowchart for gas turbines example 2 26 Chart to calculate production tax credits from landfill gas flow 39 Chart to calculate electricity output from landfill gas flow 40 Fuel cell 45 Chemical reactions in a phosphoric acid fuel cell 45 E Energy from landfill gas in the United Kingdom E E Special thanks goes out to Susan Thorneloe of U. Susan is a strong advocate of landfill gas utilization, because she believes in its benefits to the environment. She also has been clearly aware of the need for information transfer to encourage landfill gas utilization and to broaden the understanding of its implications among users, developers, and regulators alike. She was able to conceptualize this need and encourage the materialization of this document, by ensuring the participation of many landfill gas experts. We would like to acknowledge these landfill gas experts here and have listed them below in alphabetical order: The gas generation within any given landfill generally rises to a peak shortly after closure, and then declines at a rate that depends on waste placement, composition, moisture content, and many other factors EMCON, ; Augenstein and Pacey, Landfill gas is recovered for energy utilization at sites in the United States Thorneloe and Pacey, Extraction systems typically consist of vertical wells, and sometimes horizontal trenches or other zones filled with permeable material within the waste, from which gas is extracted by application of vacuum. The gas is drawn into a piping network by a blower suction or compressor and transported to a flare or, where economics and other circumstances are favorable, to an energy utilization plant. In spite of relatively unattractive enrgy markets, landfill gas uses are continuing to increase both in the United States and worldwide. Landfill gas is normally used for fuel in energy equipment that is widely available commercially, though primarily designed to be fueled by natural gas. The specific energy applications for which landfill gas is most commonly used are shown in Table 1. One pilot-scale demonstration project see Appendix J. One full-scale project under construction None Source: Thorneloe and Pacey, Natural gas, often referred to as pipeline gas, is typically supplied from a high pressure transmission line as a clean, dry gas. It is delivered to the energy conversion equipment at constant temperature and pressure and at a constant flow, with a constant energy content. The energy conversion equipment available for use of landfill gas is normally designed to use natural gas, although several manufacturers are now marketing modified equipment. However, landfill gas reaches the energy conversion facility in a dirty and wet state. The moisture contained in landfill gas is acidic and corrosive. Also entrained in the gas is particulate matter derived from refuse and daily cover material e. Landfill gas delivered to the facility varies in quantity and energy content on a daily and seasonal basis. All of these conditions and characteristics of landfill gas raise issues not associated with pipeline gas usage. The distinctive attributes of landfill gas, and their consequences to energy use, are reviewed in this report. The purpose of this earlier report is to provide general information on landfill gas energy uses. It also includes information on landfill gas generation, modeling, or field development. Case studies document the experience at representative U. Also, other suggestions for further reading are included in Appendix B of the current report. The current report may serve as a tool to help potential developers of landfill gas energy conversion projects select between options. Information in the current report was gathered during extensive interviews with private developers and operators of landfill gas energy conversion projects. Summaries of these interviews are included in Appendix D. The report addresses the technical, as well as the non-technical considerations involved with landfill gas utilization and it relates possible resolutions to these issues as they are applied by different operators, Design, as well as operation and maintenance considerations, are taken into account. Non-technical considerations include, but are not limited, to the following: Apart from developers and operators, these parties include but are not limited to: Landfill gas energy conversion can benefit if all above parties are aware of each others viewpoints and objectives and participate in fruitful communication. This document is not intended to provide a comprehensive overview of the many different perspectives of all parties involved. Instead, it summarizes the experience of current private developers and operators in an effort to provide information to the public and more in particular, to assist future developers and operators in developing landfill gas utilization projects as a compliance option for potential CAA regulations for landfill air emissions. A data base of landfill gas to

energy projects in the United States is being developed on both technical and non-technical issues. This will help to document the extent that the issues identified by the major developers and operators are affecting new and existing projects Thorneloe and Pacey, Additional information on technical problems encountered at 11 landfill gas utilization sites in the United Kingdom U. Appendix E presents landfill gas experiences in two European countries; the Netherlands and the U. Also, a project to research utilization of landfill carbon dioxide CO2 in the Netherlands is summarized. Facing new requirements for controlling landfill gas, many landfill owners are eager to turn the liability of the gas into an asset. Options to do so are discussed in Appendix F. The next appendix gives a step by step account on furnishing an existing landfill site with a landfill gas recovery system. Equipment size, installation and operating costs, air emissions, and plant efficiency are compared. Appendix I contains a paper that presents a detailed account on the use of landfill gas turbines, including a failure analysis, resulting in re-evaluation of the process design. In Appendix J, an account is given of the utilization of landfill gas as vehicle fuel, one of several emerging technologies, which are detailed in section 4 of the report. This data base is being updated and is to be published in an EPA report in spring The landfill gas industry is almost 20 years old.

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