Waste Streams as Bio-energy Opportunities for Federal Facilities

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ABSTRACT

This article describes a resource assessment conducted by the National Energy Technology Laboratory (NETL) that has identified specific biomass opportunities for federal facilities. The focus on federal facilities is an outgrowth of an Executive Order promoting the use of bio-energy, and national energy policy goals to expand energy supplies, increase energy security, and protect the environment. The resource assessment is based on four primary factors determining project viability: 1) biomass resource type 2) availability and size of the resource, 3) size of the federal facility, and 4) distance between the resource and the federal facility. The resource assessment has identified a large number of biomass resources that are potentially low cost because they represent waste streams, and are located in close proximity to large federal facilities.

INTRODUCTION

In recent years, as the digital revolution has made its mark on manufacturing and commerce, there has been heightened interest in power quality and reliability. The computer software and hardware that underpins modern manufacturing, electronic databases, and e-commerce provides two key benefits: automation, and, in the case of databases and e-commerce, instantaneous access to information. However, the degree to which these benefits can impact productivity is directly related to the quality and reliability of the power supply. This is also true in the federal sector, where many facilities rely on electronic databases and communications systems to provide critical services. For example, information contained in Federal Bureau of Investigation (FBI) databases, such as criminal profiles and fingerprints, must be available to federal, state, and local law enforcement officials 24 hours a day, 365 days a year. In addition to the critical nature of many government functions, some federal facilities, like many manufacturers, rely on automated processes whose disruption can have a significant financial impact. For example, a power disruption at a distribution center for the U.S. Postal Service can result in labor costs associated with rework and downtime in addition to the cost to customer satisfaction as a result of delays in the delivery schedule.

The interest in power quality and reliability has spurred interest in distributed energy resources. Because of its environmental attributes and availability, natural gas is the dominant fuel choice for distributed energy applications. However, more recently, as natural gas prices have proven to be volatile and generally upward trending, renewable energy resources have received renewed attention. These resources have several intrinsic advantages: 1) they are typically local resources whose use can benefit the local community; 2) as renewable resources, they can qualify as green power garnering a premium market value; 3) they are greenhouse gas neutral.

Biomass is the oldest and most prevalent energy resource, and even today is the world's most popular fuel for heating. With rising fossil fuel prices and growing environmental concerns, biomass energy systems are reclaiming their positions in schools, factories, military bases, and community energy plants. Biomass recently surpassed hydropower as the nation's leading source of renewable energy and now accounts for more than half of all renewable energy used in the United States. Thousands of large and small U.S. power plants use biomass fuels to produce more than 7700 MW of electricity.

The objective of this article is to describe the bio-energy opportunity for federal facilities, focusing on three biomass resources: landfills, wood waste, and wastewater treatment plants. Because these resources are actually waste streams, they can often be obtained for a relatively low cost relative to fossil fuels. Bio-energy from these waste streams can be cost-competitive with fossil energy in many niche applications, while providing waste reduction along with the other benefits typically associated with renewable energy resources.

METHODOLOGY

The approach taken here is as follows: i) identify potentially low cost biomass resources that are widely available and for which there is considerable experience with energy applications; ii) assemble databases that contain information on the size, availability, and location of the resources; iii) assemble a federal facility database that contains information on the size, location, and uses of the facilities; iv) establish screening criteria to filter the data for the most promising resources and facilities for bio-energy applications; and v) use the ArcView™ GIS tool to ferret out potential bio-energy projects based on the proximity of facilities and resources.

Landfills

Landfill gas (LFG) was first collected and used as a fuel in the United States in the late 1970s, and the technology has developed steadily since then. This method of producing renewable energy is now regarded as one of the most mature and successful in the field of green power. The U.S. Environmental Protection Agency (EPA) estimates that LFG is collected from more than 330 landfills in the United States and put to beneficial use. More than 1000 MW of electricity is produced from more than 200 LFG-to-energy projects now in operation. Additionally,

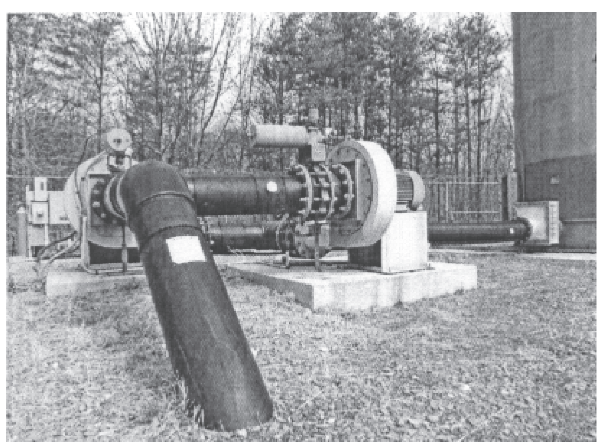


Figure 1. Landfill Gas Piped to a Boiler at the NASA Goddard Space Flight Center in Maryland

more than 100 projects are delivering useful thermal energy, either directly or as a byproduct of electricity generation.

EPA estimates that another 600 landfills are good candidates for economical LFG-to-energy projects. For the purposes of the assessment described here, we assembled a database containing information provided by the EPA Landfill Methane Outreach Program (LMOP) on over 2,000 landfills. We screened out those landfills that did not have a reported latitude/longitude and for which we were unable to geo-code based on zip code or city. As shown in Figure 2, there are 1,671 landfills that we could locate based on information in the database.

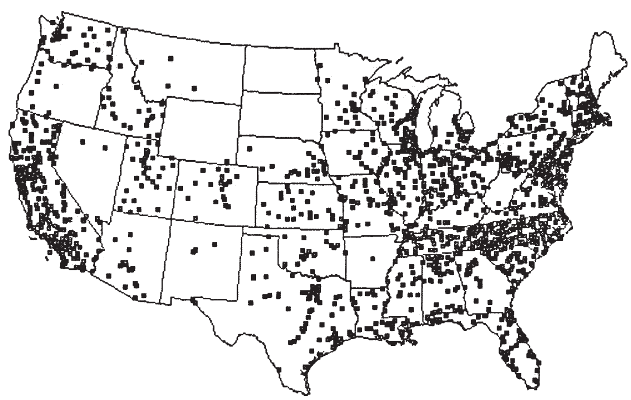


Figure 2. Location of 1,671 Landfills

The LMOP data includes information on the utilization status of the landfill gas. Approximately 340 landfills were shown to have a landfill gas project either in operation or under construction. These landfills were not screened from the database owing to the uncertainty of whether the project would still be in operation and the fact that some landfills can support multiple landfill gas projects.

Wood Waste

Wood waste is one of the most abundant, cost-competitive, and environmentally friendly biomass resources. Currently the most cost-effective wood sources are residues from manufacturing and wood waste otherwise destined for landfills. Manufacturers generate an enormous amount of waste residue in the process of making products such as lumber, furniture, pallets, and paper. In general, less than 50

Figure 3. Wood Chips from Logging

percent of the tree ends up in a final product, and the balance represents a vast underutilized resource. Wood fuels can be cheaper than coal (dollars per Btu), and emit less air pollution. In some cases, wood waste may have a negative price resulting from avoiding the cost of disposal. Energy projects using the abundant wood waste found on many federal lands can not only displace the use of fossil fuels but also reduce the risk of forest fires. To advance that cause, on June 19, 2003, the secretaries of agriculture, energy, and interior executed a joint MOU that promoted the use of woody biomass from federal property as a source of fuel for renewable energy projects.

To assemble a database of wood waste sources, we started with the Office of Management and Budget's (OMB) standard industrial classification (SIC) system and searched through the SIC descriptions for industries that generated wood waste. EPA's Facility Registration System was then queried for all industries listed under these codes. These entries were classified as either high-volume or low-volume generators of wood waste. The data showed that there are over 12,000 sources of wood waste from industry, and 5,682 of these, shown in Figure 4, are likely to be high-volume generators of wood waste.

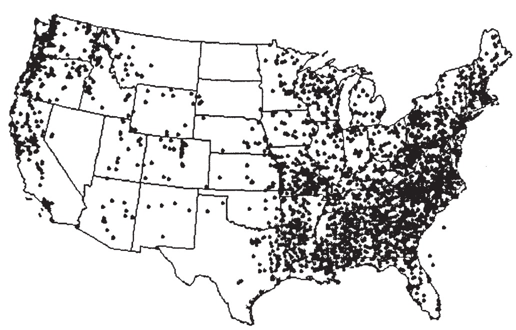


Figure 4. Nearly 6,000 Sources of High-volume Wood Waste Generated by Industry.

Wastewater Treatment Plants

Large wastewater treatment plants typically use anaerobic digesters to process sewage. These digesters produce a gas that has a high methane content (60-75 percent), making it very suitable for bio-energy applications. To identify potential sources of digester gas, we queried the EPA Water Discharge Permit Control System (PCS) database Standard Industrial Classification (SIC) Code 4952, Sewerage Systems. The source of the latitude/longitude data in the database probably comes from permit applicants—hence, the reliability of the location data is unknown. For the purposes of the assessment reported here, we screened out wastewater treatment plants with capacities less than 5 million gallons per day (MGD). A 5 MGD facility can generate at least 150 kW and possibly more with advanced recovery technologies. As Figure 5 shows, there are 1,655 wastewater treatment plants with a capacity of 5 MGD or larger.

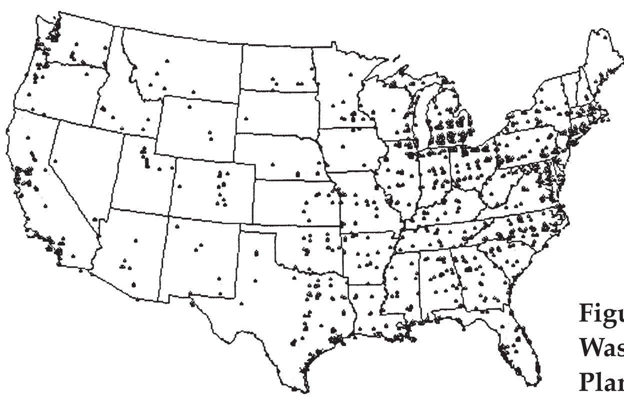
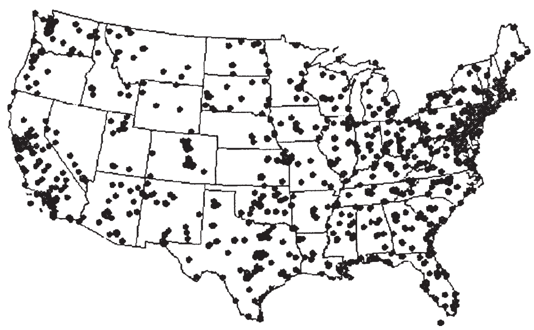


Figure 5. 1,655 Large Wastewater Treatment Plants

Federal Facilities

The federal facility database was compiled from data obtained from the Federal Energy Management Program, the General Services Administration's Worldwide Real Property Inventory System, and Pacific Northwest National Laboratory. The facility database contains information that is useful for conducting high level screening for potential bio-energy projects. For example, the database contains information on physical size (i.e. square footage) of the facilities, the location of the facilities, and the uses (e.g. office, residential, prison, hospital) of the facilities. For the purpose of conducting a broad, federal-wide assessment of potential bio-energy projects, we chose to use size and location as screening criteria. Hence, only large federal facilities were considered. Figure 6 shows the location of the 1,877 federal facilities whose size is greater than 100,000 square feet.

Figure 6. Locations of 1,877 Large Federal Facilities

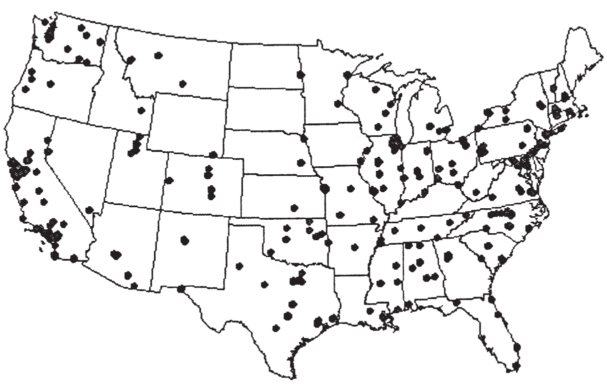


SUMMARY OF RESULTS

Landfills

As shown in Figure 7, the assessment identified significant potential for federal LFG-to-energy projects, based on the proximity of landfills to large federal facilities (over 100,000 square feet). Of the 1,877 large federal facilities, 591 are within 5 miles of a landfill—well within the limits for economic feasibility. Figure 8 shows the federal agencies with the largest number of facilities located within 5 miles of a landfill.

Figure 7. Nearly 600 Large Federal Facilities are within 5 Miles of a Landfill



Wood Waste

The assessment, based on analysis of data reported by the wood products industry, as well as the federal facility data, indicates abundant opportunities for wood waste:

- There are more than 12,000 sources of wood residues in the United States.

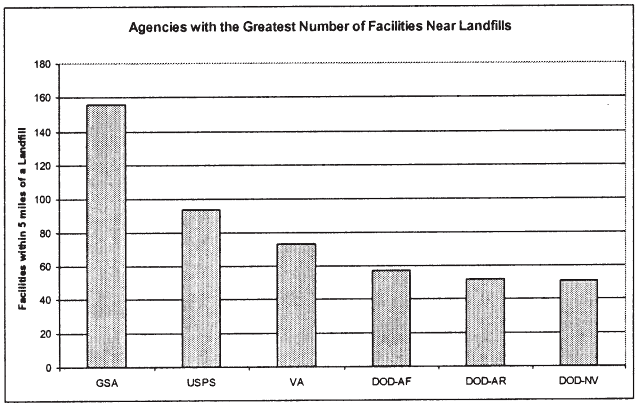


Figure 8. Landfill Opportunities by Agency

- There is at least one substantial source of wood waste from manufacturing within 50 miles of virtually every federal facility.

- For 75 percent of the larger federal facilities, there are 10 or more sources within 50 miles.

- There are more than 4700 high-volume wood waste sources within 50 miles of federal facilities.

Figure 9 shows the location of 1,266 large federal facilities that have at least 10 sources of wood waste located within 50 miles. Multiple sources are important for bio-energy projects using wood waste, since the supply for any single source can be very uneven. Figure 10 shows the federal agencies with the greatest number of wood waste-to-energy opportunities.

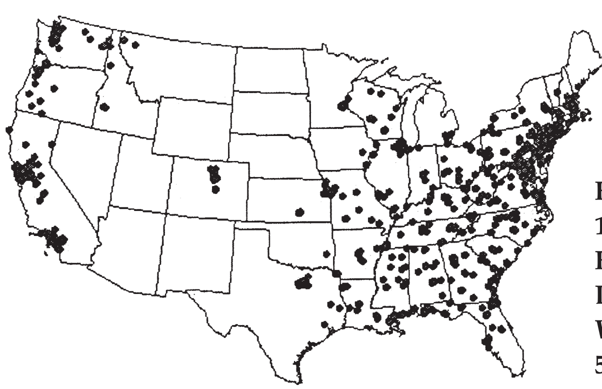
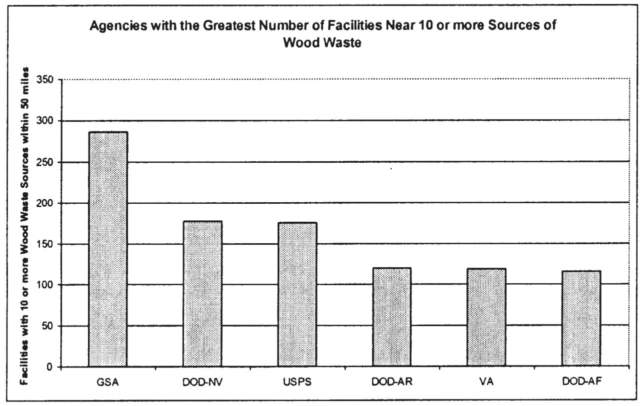


Figure 9. More than 1,200 Large Federal Facilities Have at Least 10 Sources of Wood Waste within a 50-Mile Radius.

Figure 10. Wood Waste Opportunities by Agency



Wastewater Treatment Plants

As shown in Figure 11, the resource assessment identified 235 large (capacity greater than 5 MGD) wastewater treatment plants that are within 5 miles of a large (greater than 100,000 square feet) federal facility. Figure 12 shows the number of facilities, by agency, that are located near a large wastewater treatment plant.

Figure 11. More than 200 large Federal Facilities are within 5 Miles of a Large Wastewater Treatment Plant.

CONCLUSIONS

The resource assessment has identified a large number of biomass resources that are potentially low cost, because they represent waste streams, and are located in close proximity to large federal facilities. Since transportation cost is a key driver in the economics of a low-Btu content fuel like biomass, the close proximity of these resources make them especially attractive for bio-energy projects. In total, nearly 1,500 of the 1,877 large federal facilities have at least one biomass resource that has potential, by virtue of its size and proximity, to support a bio-energy project.

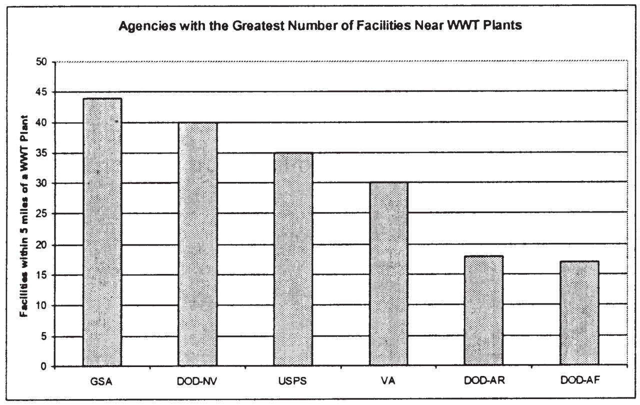


Figure 12. Wastewater Treatment Plant Opportunities by Agency

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ABOUT THE AUTHORS

Steve Cooke has been employed at the National Energy Technology Laboratory (NETL) since 1991, supporting a wide range of DOE programs including fossil energy, environmental management and, most recently, energy efficiency and renewable energy (EERE). Currently, Steve is the NETL Team Lead for the "Biomass and Alternative Methane Fuels" program. Steve also manages R&D projects for the EERE Buildings Technology Program. Previously, Steve was a systems engineer responsible for evaluating the technical, cost and environment performance of emerging fossil energy technologies. Steve received M.S. and B.S. degrees in mechanical engineering from the University of Tennessee and Tennessee Technological University, respectively, and has completed graduate course work in engineering and public policy at Carnegie Mellon University.

Chuck White has over 23 years experience in mathematical modeling and the development of computational algorithms for applications in power production and coal processing technologies. He has 16 years experience in modeling and simulation of NETL product line technologies with emphasis on fuel cells, advanced turbine systems, and carbon sequestration. Chuck received B.S. (1976) and M.S. (1977) degrees in chemical engineering from the University of Virginia, a Ph.D. in chemical engineering from University of Pennsylvania (1983), and an M.D. degree from West Virginia University (1990). Chuck formerly was a professor of chemical engineering at West Virginia University.