Challenges and Pathways to Deployment of CHP at Wastewater Treatment Facilities in Ohio

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ABSTRACT

In 2002, the City of Lima, Ohio installed a 90 kW Combined Heat and Power (CHP) system at its wastewater treatment facility (WWTF). Now, the City is replacing the original turbines to increase the WWTF's total capacity by 50%. The decision to expand the system was a least-cost financial one for the cash-strapped municipality, which was able to pay for its system out of its operating budget. In 2010, the City of Toledo, Ohio installed a 10MW CHP at a WWTF utilizing both landfill and digester gas. Apparently a technology adoption success story - the capacity of the deployed CHP units increasing five orders of magnitude in ten years, these systems remain the only WWTF facilities utilizing CHP in the State of Ohio. This paper looks at the technology and financial issues that must be resolved by a municipality or sanitation authority considering CHP. Drawing on interviews with city and sanitation authority officials and CHP developers and technology suppliers, the paper attempts to understand the challenges faced by WWTF in the adoption of CHP in Ohio and identifies key issues to be addressed by CHP system developers, suppliers, financiers and government officials to accelerate the uptake of CHP in this very promising sector.

Introduction

Combined heat and power (CHP), also known as cogeneration, refers to integrated energy systems that simultaneously produce electricity and heat from a single fuel source (USEPA, CHP 2011). Possible fuel sources include natural gas, biomass, biogas, coal and waste heat. Utilization of CHP is not new. In fact, Thomas Edison's Pearl Street Station, the first commercial power plant in the United States, served lower Manhattan with both electricity for lighting and steam for local manufacturing in 1882 (USDOE Southeast Clean Energy Application Center 2012).

The principal benefit of CHP over independent production of electricity and heat is a significant increase in efficiency through utilization of a single process to convert fuel into both electricity and thermal energy. The U.S. Department of Energy estimates that independent production of heat and power achieves a combined 33% efficiency on average, while CHP systems can achieve efficiency levels of 60-80%, with higher levels possible (USDOE EERE 2012).

Wastewater treatment facilities (WWTF) use mechanical and chemical processes to remove physical, chemical and biological contaminants from raw wastewater in order to meet USEPA standards for its discharge. In addition to the liquid, effluent treatment produces a solid waste or sludge that must also meet stipulated environmental requirements (Colorado State University Extension 2012).

CHP and Wastewater Treatment Facilities

It is estimated that WWTFs that are publicly owned account for 4% of the energy used in the United States. The high level of energy use is related to their around-the-clock operation and the complexity of the treatment processes. Significant quantities of energy are required to operate large water pumps, large air blowers and mixers, solids handling equipment, a wide range of motors, solids volume reduction and disposal equipment, and for other support activities (Wiser, Schettler and Willis 2010).

As part of the treatment process, many WWTFs use anaerobic digestion for enhanced biosolids management and odor control. Anaerobic digestion is a biological process through which bacteria break down biodegradable organic matter in the absence of oxygen into a biogas consisting of methane, carbon dioxide and trace amounts of other gases. The high methane content of biogas (60-70%) means that it is highly flammable and must be carefully managed; in addition, methane is a particularly potent greenhouse gas. USEPA reports that, over the approximately 9-15 years that methane remains in the atmosphere, it traps 20 times more heat in the atmosphere than the equivalent volume of carbon dioxide does over a 100-year period (USEPA Climate Change 2012). The high methane content of biogas also makes it a valuable fuel.

A key requirement for anaerobic digestion is heat to maintain the levels of microbial activity necessary for decomposition of waste materials (and production of biogas). The Lima, Ohio digester is typical of WWTFs in using mesophilic bacteria that require a temperature range of 95 to 104 degrees F. In the absence of a CHP system, a boiler produces that heat; frequently, the boiler uses the biogas as a fuel source but may also use natural gas. CHP offers the opportunity to provide that heat more efficiently, while simultaneously producing electricity.

In a recent study, the USEPA CHP Partnership reported that there are 3,171 WWTFs across the nation that have a throughput greater than one million gallons per day (MGD) flow. (This study builds upon work done in 2007 that explored technical and economic viability of CHP at WWTFs handling 5MGD or higher; at the request of program partners, the study's scope was expanded to include facilities of 1 MGD and higher.) The study then identified those WWTFs using anaerobic digestion. By modeling the various complex factors that could have an impact on CHP deployment, the study first identified how many facilities had the technical capacity to successfully operate a CHP system. The study identifies a number of factors determining technical capacity. These include digester type, flow rate, season of operation and type of prime mover (i.e. the device that converts fuel to energy). Then, the study analyzed those facilities to determine how many could operate CHP in an economically viable manner and achieve simple payback in seven years or less. Factors modeled to determine economic viability include digester gas utilization cases, thermal credit, WWTF plant size, CHP prime mover type and size, interest rate and project lifespan.

The modeling determined that 43%, or 1,351, of the facilities using anaerobic digestion had the technical capacity to deploy CHP. The modeling of financial viability identified a subset of between 257 and 662 with a possibility of successful deployment. The breadth of this range is due to site-specific details such as existing equipment and additional required investment, price of gas and electricity, and the quality of the gas.

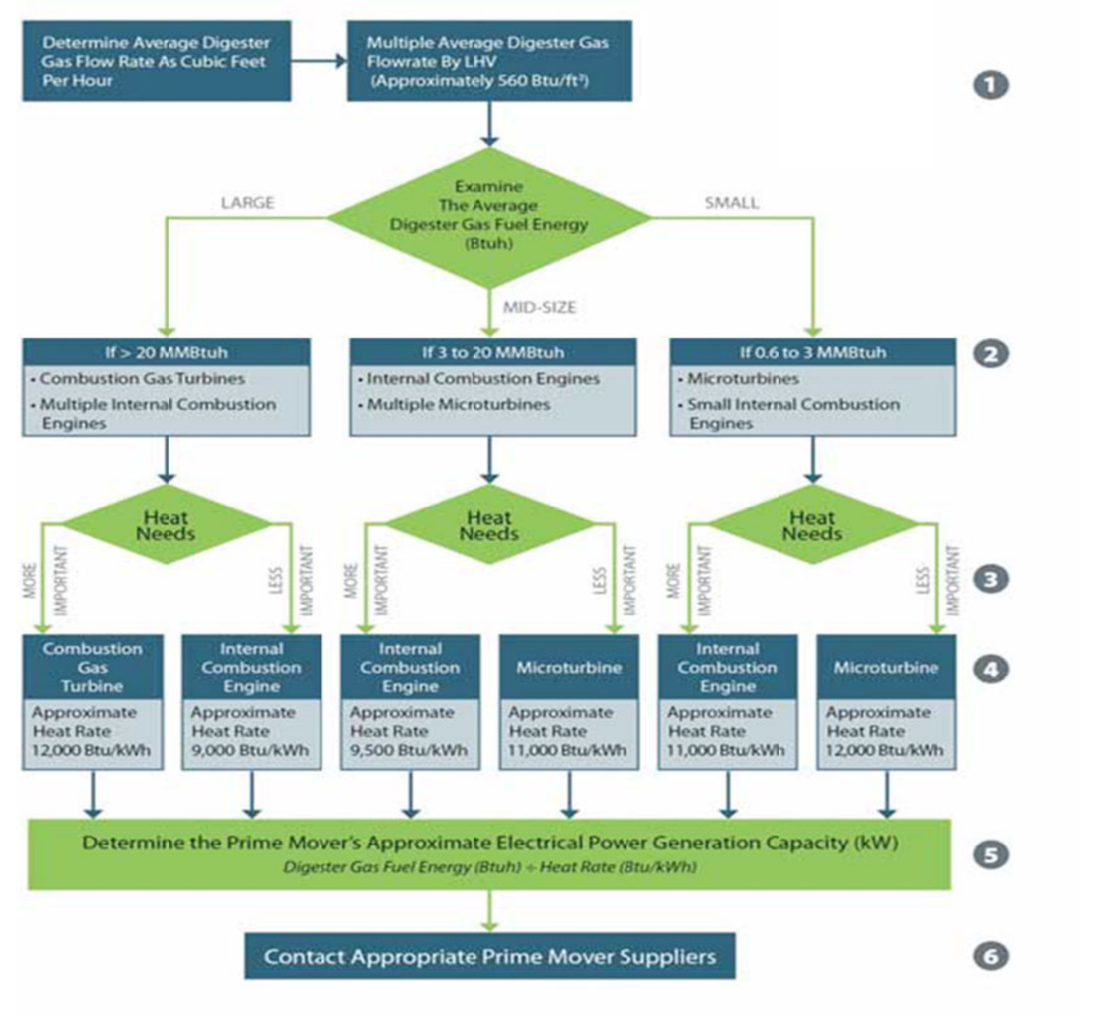
It is important to note that there are 133 WWTFs in 30 states already utilizing CHP. Almost 80% (104) use biogas as their primary fuel source. In the aggregate, these facilities represent a capacity to generate approximately 190 MW of electricity. (The remaining 29 facilities do not use biogas as the primary fuel for a variety of reasons, e.g., lack of anaerobic digesters or non-viable biogas for technical or economic reasons.) (USEPA CHP 2011.)

CHP Technology Choices

One of the critical factors in a WWTF CHP project is the selection of a prime mover, the device that converts fuel to energy. Prime movers include internal combustion engines, combustion gas turbines, microturbines, advanced lean burn engines, recuperated gas turbines and fuel cells.

A report prepared for the Columbus (Georgia) Water Works at the end of 2010, “Evaluation of Combined Heat and Power Technologies for Wastewater Treatment Facilities,” provides an excellent and detailed examination of the factors to be considered for each of these technologies. The final choice will be based upon the site-specific criteria ranging from size of the facility to intended use of the produced energy to emission levels to, of course, cost. Figure 1, below, is a six-step model decision tree from that report (Wiser et al, 3-6).

Figure 1. Technology Decision Tree



Source: Wiser et al., 2010

Another critical CHP system technology choice is the equipment to clean the biogas so that it does not damage the system's operation. In addition to methane and carbon dioxide, biogas from WWTFs can contain nitrogen, hydrogen, hydrogen sulfide, siloxanes and water vapor. The last two can represent significant risk to system functionality.

Siloxanes are a family of anthropogenic compounds that contain silicon, oxygen and methyl groups and are used in the manufacture of personal hygiene, cosmetic, health care and industrial products. They are widely present in wastewater and are easily volatilized in biogas. When that gas is combusted, the siloxanes convert to silicon dioxide and form a white powdery substance (similar to talcum powder in appearance). The powder is insoluble, hard and abrasive; it deposits on moving parts. Inside machinery, it has the same effect as sand.

The water vapor can reduce the heat value of the gas. It can also react with hydrogen sulfide to create ionic hydrogen and/or sulfuric acid, both of which are highly corrosive (OSU 2012).

In Ohio, there are currently two WWTF facilities with installed CHP systems. They are the Lima Wastewater Treatment Plant with a 90 kW CHP that became operational in 2003; and the City of Toledo Bay View Wastewater Treatment Plant, a 10 MW system placed in operation in 2010. The Lima facility uses microturbines while the Toledo facility uses a combination of technologies (ICF International 2012).

The City of Lima Waste Water Treatment Facility[1]

The City of Lima's facility provides an interesting case study for two reasons: its moderate size and the fact that it has recently decided to install new CHP equipment after almost 10 years of CHP experience.

Lima, Ohio is a city of approximately 39,000 in northwestern Ohio and is the county seat of Allen County. Since 1932, it has been a charter municipality with a strong mayor form of government. It is approximately 72 miles north of Dayton and 78 miles south-southwest of Toledo.

The city's population has shrunk as more affluent households have moved to the suburbs; the annual median income is $26,943. Nearly one-third of its citizens live below the poverty threshold. Unemployment reached 16.7% in 2010.

The city's economic challenges are declining population, exodus of middle-class residents, concentration of poor within the city, increasing unemployment and a city budget balanced only through substantial reductions in force. This economic reality puts considerable pressure on city government to achieve maximum cost efficiency in the provision of services, including wastewater treatment (Berger, 2012).

In testimony before Congress, Mayor David Berger argued that Lima's low, moderate and fixed income households could not sustain required improvements to its water and sewer systems if those costs resulted in bills increasing to more than 2% of household income. In fact, a household cost between 1.0% and 2.0% represents a medium burden and could threaten the system's viability if it results in a cost increase to non-municipal customers (townships and county), which constitute 25% of the plant's base demand, that drives them to build their own treatment facilities and thereby reduce flow and revenue to Lima (Berger 2012).

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[1] Special thanks to Mayor David Berger, Russell C. Bales, Supervisor and Eric Markley, Assistant Supervisor, Wastewater Treatment Facility, City of Lima, for spending time in interviews, correspondence and facility tours.

The city's wastewater treatment plant was constructed in 1930. The Lima Wastewater Treatment Plant initially consisted of screening, grit removal, primary sedimentation, and anaerobic digestion. In 1973, the plant was expanded to an average dry weather flow capacity of 18.5 million gallons per day (MGD), and a peak flow primary treatment capacity of 53 MGD. The design concept called for secondary and advanced treatment processes of the plant to operate at a peak rate of 33 MGD, with any remaining flow receiving primary settling and chlorination. Since 1973, the plant has provided primary, secondary and tertiary treatment, as well as biosolids and digester gas recycling. Current average daily flow is 14 million gallons. The plant treats effluent from sanitary sewers, storm sewers and combined sewers, as well as a significant industrial load. The current maximum daily flow of 53 MGD still results in overflow in heavy rain events. The facility has plans to expand to a 70 MGD maximum capacity, driven primarily by the need to reduce contaminated effluent overflow into the Ottawa River. Negotiations with USEPA are underway seeking approval of plant improvements at a cost that can be sustained by this economically stressed community.

Due to its combined system[2], the average biochemical oxygen demand (B.O.D.) loading is somewhat lower than would be expected in a separated system. As is typical for a combined system, there is a significant differential between dry weather flow and flow from a rain event both in terms of quantity and treatment challenges. Current plant requirements for treatment of phosphorous are 1 Mg/L (115 pounds per month) and 4Mg/L (450 pounds per month) for ammonia. Future USEPA requirements will decrease allowed levels to less than .5 Mg/L for both.

The plant operates three anaerobic digesters, two of which operate in parallel and one unheated secondary digester. The latter has a floating cover and the capability of storing 55,000 cubic feet of gas at 15 inches of water column.

In 2002, the City of Lima installed a 90 kW Combined Heat and Power (CHP) system at its wastewater treatment facility (WWTF), and is currently replacing the three original 30kW turbines to increase total capacity by 50%. The decision to modernize and expand the system was a financial one, a least-cost alternative allowing the cash-strapped municipality to invest in its WWTF with relatively short payback. Both the Mayor and the City Council found it attractive to identify a critical infrastructure project that would pay for itself and were willing to deploy a new technology to achieve that end. In September 2002, the original CHP project was undertaken with the installation of three 30kW Capstone microturbines at a total cost of $750,000. The project goals were to eliminate the flaring of "excess" gas, to capture heat and return it to the digester, and to achieve a 7-year payback. From the outset, it was recognized that biogas from the anaerobic digester is a very wet and dirty product. Project design focused on cleaning and compressing the gas to operable levels for the three microturbines. Once in operation, there were ongoing operational problems, particularly in cold weather. The biogas moisture content challenged the compressors, freezing in both drains and filters, and caused failures. The microturbines were capable of operating in the low temperatures but the compressors were not. To increase uptime, in 2005, a structure was constructed to house both compressor and microturbine units; this was intended to reduce freeze-related downtime. In addition, there were maintenance issues due to the presence of siloxanes in the biogas adding to downtime.

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[2] A "combined system" handles effluent from sanitary sewers and storm water sewers; in some places, those systems are separate. As noted, Lima has sanitary sewers, storm water sewers and sewers that combine the two flows.

Several years ago, the facility brought in a consultant to analyze the CHP system and suggest solutions. GEM Energy, Inc., reviewed the existing system and found that equipment to condition the biogas had been undersized originally and that additional scheduled maintenance could reduce downtime.

In 2011, there was a further review that resulted in a decision to replace the three original units with two 65KW Capstone microturbines. The first unit is now operational and the second unit is about to be installed.

The static filters of the new turbine are repacked annually due to the volume of siloxane and other particulates. Although the Capstone 65KW microturbine can operate with some level of these contaminants present, the real challenge is to prevent damage to the heat exchangers and recuperators.

The facility currently produces approximately 42 cubic feet per minute of biogas; each 65KW microturbine has capacity to use 22 cubic feet per minute. The facility hopes to increase its efficiency of grease capture in order to feed that organic into the digesters for additional gas production.

A single turbine is projected to generate approximately 512,460 kWh annually, operating at 90% availability. It will also produce and capture approximately 250,000 BTUs of waste heat per hour. The heat is sufficient to maintain the required mesophilic temperature range and to heat the CHP facility and operations.

Currently, the Lima Wastewater Treatment Plant averages 584,600 kWh consumption monthly. In 2011, the cost of that electricity was $530,249 or about $ .0755 per kWh. The offset provided by a single microturbine then would be $38,690, or just over 7% of the facility's bill. All electricity generated will be used internally.

In addition, by using the heat produced to maintain temperature in the anaerobic digester, the facility avoids operating the boilers that had been used prior to CHP and are now kept on stand-by. At current prices paid for natural gas by the facility ($1.9273 MCF), every hour of microturbine operation saves $ .4818 for an annual savings of approximately $3,800.Total annual savings for the facility in avoided energy costs is $42,490.

Each turbine will be installed at a cost of $200,000. The project hoped to achieve 4.7-year simple payback. Lima City Council approved the investment and made an appropriation for purchase of both new turbines. It is projected that maintenance costs will decrease compared to the original three turbines and, thereby, free up facility staff for other duties. After the project was approved and the first turbine operational, the facility was able to negotiate a new price for electricity. That price is $0.05659 kWh. This reduces the annual electric offset value per turbine to $29,000; payback of full turbine cost is then increased to 6 years.

The Toledo Bay View Wastewater Treatment Plant[3]

The City of Toledo is the fourth most populous city in Ohio and is the county seat for Lucas County. It is located on the western end of Lake Erie in northwestern Ohio and borders Michigan. Its 2010 population was approximately 280,200 while the metropolitan area had population of 651,400. Known as "The Glass City," Toledo built its 20th century economy on

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[3] Special thanks to Toledo City Council President Paula Hicks-Hudson, City Council member Joe McNamara, Department of Public Utilities director Dave Welch, and project manager Michael Schreidah for spending time in interviews and correspondence.

the glass industry and auto assembly. Changes in those sectors have presented social and economic challenges to the city similar to those faced in other Midwest industrial centers and include decreased employment opportunities and white flight. The city has built on its glass industry base to become a leader in solar technology research, development and manufacturing in the early part of this century. There has been significant investment in the redevelopment of downtown (City of Toledo 2013).

In 2010, the City of Toledo began operation of a cogeneration facility at its Bay View Wastewater Treatment Facility. The facility is operated by the Department of Public Utilities, Division of Water Reclamation (DPU), and is run in cooperation with the Department of Public Service, which owns and operates the Hoffman Road Landfill.

The Landfill began operation in 1975 and was approved for a significant expansion in 1999. This addition will allow the landfill to service Toledo until 2026. To meet USEPA regulations, methane gas extraction wells have been installed and are predicted to produce about 1,500 standard cubic feet of gas per minute (scfm). Unless some use for the methane is identified, the gas is flared 24 hours a day (City of Toledo Department of Public Service 2013).

The Bay View Wastewater Treatment Facility is the largest wastewater treatment facility in Northwest Ohio and is near the mouth of the Maumee River. Originally constructed in 1922, it has undergone significant capital investments every decade to meet changing environmental regulations and load. The changes reflect dedication to the continual improvement of a facility that must be reliable and efficient 24/7.

The plant provides treatment services to all, or parts, of the following communities: Toledo, Ottawa Hills, Rossford, Walbridge, Northwood and portions of Lucas and Wood Counties. Its service area is about 100 square miles (84 in the City of Toledo), with a total 2010 population of approximately 325,000. It is a combined sanitary and storm sewer system. Water sources are industrial, domestic/commercial and extraneous (21%, 30%, and 49% respectively). The high level of extraneous is due to the age of the sewer system and the effect of the combined sewer portions of the system (Water and Wastewater.com 2013).

The facility has an average daily capacity of 102 million gallons; peak daily capacity is 385 million gallons. In the period 2004-2009, average daily flow was 71.4 million gallons and peak flow was 365.3 million gallons. Combined sewer overflows impact the Maumee River, the Swan Creek and the Ottawa River. Planning documents for the Toledo Facility Planning Area project the need for $367.5 million in capital improvements in the 2013-2018 period (TMACOG 2011).

The cogeneration project began in 2004, as the DPU began exploring ways to decrease costs associated with the purchase of electricity. Starting with the idea of replacing purchased electricity with natural gas-based, self-generated electricity, the department recognized it had a common interest with Public Service as it sought a more productive (and economic) way to handle methane emissions. A $1.5 million federal grant, secured by Congresswoman Marcy Kaptur, initiated the project and supported feasibility analysis and the beginning of engineering. The engineering contract was awarded to Middough, a full service engineering, architecture and management company. Final project design called for a 10MW turbine with heat recovery capability; the contract was awarded to Solar Turbine to supply a Taurus 60 gas turbine. At the time, a 12-18 month lead-time was required for ordered equipment. Initial total project cost was estimated at $28 million, including the pipeline, associated permits and easements, and interconnection to the electric grid.

The completed project includes the 10MW multi-fuel turbine (capable of burning landfill gas, digester gas and natural gas), a two-mile LFG pipeline, a 5kV feeder and fiber optic tie, combustion turbine and generator, heat recovery steam generator, steam turbine and generator, paralleling switchgear and control, facility control system, black start generation and island operation, landfill and digester gas treatment equipment, gas compressors and a Landfill/Digester Gas-Natural Gas mixing station (Middough 2011, CCJ 2013).

In 2007, construction began on an underground pipeline from the Hoffman Road Landfill; in addition to the pipeline, a 5kv feeder line was installed to supply electricity from Bay View to Hoffman Road. This phase was completed in 2009. Although using public rights of way, the pipeline required a number of easements and permits that added complexity (and time) to the project. The route crossed the track of two railroads (CSX and CN) as well as four pipelines owned by oil companies.

The interconnection issues with Toledo Edison presented the second biggest challenge. Bay View has a “dry day” baseload of approximately 4.5MW; “wet day” peak load is 9.5MW (reached about twenty times a year). Prior to this project, all electricity was purchased and used a dedicated substation; electricity costs ran around $3 million annually. Generating its own electricity and negotiating a net metering agreement with the utility meant that the project had to pass all utility requirements for interconnection safety, grid protection and reliability. Improvements to the substation cost around $460,000. In October 2010, Bay View ran a stress test on its system and was able to generate 11MW. (Net metering is essentially an arrangement with the electric distribution utility to put electricity back into the grid and allow the customer’s meter to “run backwards.” Its primary benefit is that it credits the customer generated electricity at the same price the customers ordinarily pays; this price is usually significantly higher than selling electricity to the utility at its avoided cost.)

Final total project costs ran to $31 million. Funding sources were the initial $1.5 million federal grant, $1.75 million from the City of Toledo and a $28 million loan from Ohio EPA’s Division of Environmental and Financial Assistance, a program providing financing to municipal wastewater treatment, water quality improvement and drinking water projects (OEPA 2013). The loan was structured with a 20-year maturity at an initial interest rate of 3.55%. Much like Lima, elected officials were intrigued by a critical infrastructure investment that had the potential to pay for itself in a relatively short time frame. Based on advice from plant operators, those officials were prepared to run the risk of deploying a sizable new technology. The availability of OEPA finance assistance meant that the city did not have to advance the capital from its already strapped budget.

As discussed above, the two major construction-related challenges were easements/permits for the pipeline and interconnection issues with Toledo Edison. A third major challenge has been presented with the supply of landfill gas.

Original projections were that Hoffman Road would supply 1500 scfm of landfill gas and that this would augment approximately 350 scfm of digester gas. The cogeneration facility was designed to use both kinds of gas as well as pipeline natural gas; the turbine chosen was able to handle all three gases and to blend them.

The problem has been that Hoffman Road has not been able to supply the predicted 1500 scfm and was usually supplying 1100 scfm or less. The shortfall was attributed to methane recovery collection system issues and to the economic recession that changed both the quantity and the makeup of materials deposited in the landfill. Quality issues occurred in 2010 when weather conditions (high temperatures and humidity) resulted in too much water vapor in the gas for the system to handle. It is believed that quantity issues may be due to a portion of the collection system being crushed by the dumping of dredging from the Ottawa River (Messina 2013). Landfill gas has not been delivered to Bay View since July 2012. Repairs to the Hoffman Road collection system are now underway and officials are optimistic that they will rectify both the quality and quantity issues.

Conclusions

The promise of CHP at wastewater treatment plants is significant; it offers the potential to solve environmental challenges, produce on-site energy (heat and electricity) and to generate a revenue stream that lowers net facility operating costs. But, as these two case studies suggest, there are major challenges that must be overcome for successful deployment.

First is an array of technical issues. These projects must be undertaken with a thorough analysis of facility needs and a careful assessment of the availability of fuel gas (both quality and quantity) The technology required to achieve project goals must be carefully researched, and the ongoing operational requirements of the system understood. The model technology decision tree, above, provides an excellent starting point; other consulting engineers can provide similar models. The key to success is the capacity of the project team and contracting the outside expertise necessary to identify the optimal solution for local circumstances. Very few, if any, publicly owned treatment facilities will have all the needed expertise in-house.

Second is a series of financial analysis issues. The first part of the economic analysis must focus on the energy needs of the facility or facilities involved and the current cost of securing that energy. One item of certainty is this arena is that prices will change, perhaps significantly, over the twenty to fifty year life of these facilities; the uncertainty, of course, comes in predicting in which direction, and by how much. A detailed analysis of current and future needs, supply options and pricing scenarios must be done to determine if any project makes financial sense. That analysis must address the critical need that the facilities be in constant operation and the consequent requirement for back-up power. It may also include environmental costs offset by the investment.

Third, these projects are not inexpensive. Any analysis must include some calculation of return on investment or payback period; it must also take into full consideration the long lives of these facilities. Payback on a piece of fifty-year critical infrastructure should be considered in a very different context than shorter-term projects. Public entities should take advantage of the fact that their infrastructure projects are not typically subject to the quarterly profit and earning analysis used in the private sector. Nevertheless, initial investment is high and will continue to be a major challenge for resource-constrained local governments. Large projects will likely continue to be reliant upon state and federal assistance, whether through grants or subsidized loans.

Fourth, and connected to all of the above, public sector leadership is essential for project deployment. That leadership must occur at multiple levels. It must be at the facility's operational level; the people who actually run the plant must be willing and able to explore how to implement a new system without disrupting the vital underlying service being provided. There must also be leadership at the political level; whether the mayor, the city council or the county commissioner, an elected entity will probably have to approve the significant investment for these projects. Those elected officials must have the commitment and vision to suggest, defend and implement the projects. They must be willing to approve deployment of new technology and persevere through operational challenges that ensue.

Finally, we cannot overlook the role played by state policy. Does state policy encourage the deployment of distributed generation of electricity? Specifically, is sale and delivery of self-generated electricity to the grid facilitated? Does it encourage alternate solutions to solving environmental problems, e.g., using landfill methane to generate energy rather than just flaring it? Does it help customers pay for projects through renewable energy credits or other utility incentives? Does it provide some degree of predictability for these policies?

In its most recent state energy efficiency scorecard, ACEEE ranked Ohio second in the nation in its CHP-friendly policies. The rating is based upon the following categories: standard interconnection rules, Renewable Portfolio Standard (RPS)/Energy Efficiency Resource Standard (EERS) inclusion, applicable financial incentive programs, favorable net metering regulations, output-based emissions regulation, loan and loan guarantee programs, and additional supportive policies. The recent advances cited by the report included the passage of SB 315 that added explicit reference to CHP in both the RPS and the EERS, and an initiative launched through the Public Utilities Commission of Ohio to partner with the USEPA and USDOE to encourage consideration of CHP as a viable compliance option for the new national boiler Maximum Achievable Control Technology mandate. Ohio scored 3.5 points out of a possible 5, ranking behind only Massachusetts. Despite this high potential, six states saw more CHP installations in 2010 and nine states did in 2011(ACEEE).

Today, Ohio is on the verge of becoming a state in which a lack of regulatory predictability is a serious obstacle to CHP. In 2008, the state implemented changes in electric utility regulation that established portfolio requirements for renewable and advanced generation sources as well as for efficiency resources. Although there was not explicit CHP legislative language, the Public Utilities Commission of Ohio (PUCO) arguably still had statutory authority to include the technology in the Ohio EERS It did not choose to do so. In 2012, new legislation was passed that changed the definitions of these standards but did explicitly include CHP as an energy efficiency resource or as a renewable resource if it captured waste heat. PUCO had not drafted the rules to implement these changes as 2013 began. In 2013, legislation was introduced to revisit all of the energy portfolio mandates from the 2008/2012 laws and consider possible alteration or even repeal. Consideration of this legislation has now been extended to the fall of 2013. Given this unsettled regulatory environment and the expected life and cost of CHP facilities, it is not surprising that CHP developers have largely pulled back to wait for increased certainty.

Local officials in Lima and Toledo worked through the formidable obstacles described herein in an attempt to deploy innovative solutions to ongoing challenges. They were willing to deploy new technologies, overcome operational challenges and take financial risk. They dared to do so in the face of tightening environmental regulations and serious fiscal constraints worsened by reductions in state budget support. Predictable and consistently implemented state energy policy could encourage, and add financial support to, similar efforts in both the public and private sectors. It remains to be seen if Ohio will meet that test.

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