THE NEW YORK POWER AUTHORITY

Capitalizing on the Waste from Waste Treatment

PROJECT SNAPSHOT

PROJECT

Fuel cell powered by anaerobic digester gas (ADG) from wastewater treatment plant

TECHNOLOGY

200-kW PC25 IFC/ONSI phosphoric acid fuel cell

CO_2 EMISSION REDUCTIONS

Roughly 910 tons per year

INVESTMENT

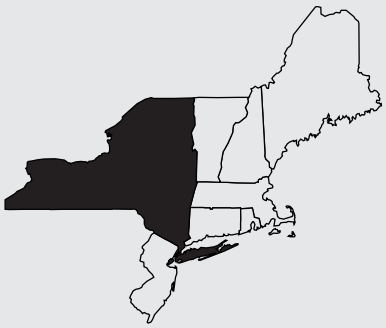
$1.3 million

LESSONS LEARNED

- ADG composition calls for enhanced fuel cell design to remove impurities from the gas. This raises the cost of the fuel cell significantly.
- Connecting the fuel cell to the electricity grid is made needlessly complex by local utility requirements.
- Standardized, and more streamlined interconnection procedures would facilitate projects like this one.

FUNDING SOURCES

NYPA, U.S. DOE, EPRI, RI, NYSERDA and U.S. EPA



INTRODUCTION

This is a story about how a state agency found a way to harness the power of unintended consequences. First, the consequences: many wastewater treatment plants generate harmful gases when anaerobic bacteria do their good work and decompose waste. Anaerobic digester gas, or ADG, is a potent agent of global warming. ADG contains carbon dioxide, and nearly two-thirds is methane – a climate change gas that is 21 times more powerful than CO_2. Often ADG is burned off or "flared," primarily to avoid direct emission of methane. However, that process generates other pollutants, particularly oxides of nitrogen and volatile organic compounds, and they contribute to the formation of ground-level ozone smog. In an effort to cut through these first- and second-order unintended consequences, the New York Power Authority (NYPA) has installed an ADG-powered fuel cell at a wastewater treatment plant. The fuel cell generates electricity and heat. This is the first working example of its kind anywhere in the world.

THE PROJECT

In 1997, NYPA installed a 200-kW PC25 phosphoric acid fuel cell at the Yonkers Wastewater Treatment Plant in Westchester County, New York. Full operation began in May 1998. Manufactured by ONSI Corporation, a subsidiary of International Fuel Cells (IFC), the unit is owned and operated by NYPA. The company received a $200,000 grant from the U.S. Department of Energy (DOE) Climate Change Fuel Cell Program for the project, with additional support from the Electric Power Research Institute (EPRI), the New York State Energy Research and Development Authority (NYSERDA) and U.S. EPA. NYPA expects to recover its share of the project cost through sale of electricity from the unit.

THE RESULTS

One challenge posed by ADG is that the methane content varies from 40 to 65 percent. As methane concentration declines, so does the heat value of the fuel. To accommodate this, operators increase the volume of the gas that the fuel cell consumes – up to maximum flow rate of 200 cubic feet per minute (the equivalent of about 50 percent methane content). Although methane concentration typically is 55 to 65 percent, this is entirely dependant on treatment plant operations. If the unit runs at full capacity, it can produce about 1.7 million kWh annually. The average, however, is closer to 1 million kWh. A second challenge of using ADG is that water, sulfur and other impurities exist in the fuel. A patented filtration system was installed to remove them.

The Yonkers fuel cell displaces the emission of global warming gases in two ways. First, as noted, it reduces the amount of ADG that must be flared, and this cuts emissions. Second, it reduces demand on the regional electricity grid. This happens because the Yonkers Wastewater Treatment Plant, which – like the fuel cell – is connected to the grid, consumes the entire output of the fuel cell to provide a portion of the plant's electricity demand, demand that otherwise would be met from the fossil-fuel-fired generators on the grid. The treatment plant pays NYPA for this electricity at the latter's retail rate. Assuming that the fuel cell generates about one million kWh a year (based on an electrical efficiency of 50 percent), it will consume about 8,050 million Btus of ADG annually. Together, reduced flaring and lower demand for power from the grid avoid the emission of some 910 tons of CO_2 a year, as well as nearly four tons of SO_2 and just over two tons of NO_x.[1] With respect to CO_2, this is equivalent to reducing oil consumption by 1,660 barrels or to taking nearly 130 typical cars off the road.

LESSONS LEARNED

The two main challenges of using ADG as a fuel source are the impurities in the fuel, which is resolved by pretreatment filtration, and the inconsistent nature of the methane content, addressed by increasing the flow rate of the fuel to the fuel cell.[2] Because the Yonkers fuel cell

tion was paid to operations and maintenance issues. NYPA contracted this work out to IFC staff. Guy Sliker, a project manager at NYPA, reported that the lessons learned at Yonkers have enabled more recent ADG projects – including those in Massachusetts and Oregon – to achieve higher reliability factors.

As is common with a distributed generation project, interconnection with the power grid proved to be an arduous process. Permission to connect to the local utility's distribution system demanded a great deal of on-site testing, and numerous administrative obstacles had to be overcome. Project financing also presented challenges. NYPA found it necessary to patch this together by working with a number of state and federal agencies. Finally, the capital cost of a fuel cell can be quite high, and installation, what with area high labor costs in the late 1990's, was not inexpensive either.

FUTURE COMMITMENTS

The initial performance results of the Yonkers fuel cell prompted U.S. DOE to award grants to similar projects in California, Massachusetts and Oregon. NYPA estimates that there are 16 to 20 other sites in New York City that could potentially host ADG fuel cells.

THE COMPANY

NYPA is the largest state-owned public power provider in the nation, operating ten generating facilities and 1,400 miles of transmission lines. Hydropower is the primary source of the company's electricity, but it also operates several natural gas- and oil-burning facilities (it recently sold all of its interests in nuclear power plants). NYPA is a quasi-governmental, non-profit organization that finances projects by selling bonds to private investors.

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This case study draws heavily from: NYPA, "Another NYPA First: 200 kW Fuel Cell Powered by Anaerobic Digester Gas," *Research Today*, Spring 1998; R.J. Spiegel and J.L. Preston, "Test Results for Fuel Cell Operation on Anaerobic Digester Gas," *Journal of Power Sources*, 86 (2000).

[1] This calculation assumes the following. The generation of 1.18 million kWhs from the New York electricity grid would result in emissions of 897 tons of CO_2, 7,315 pounds of SO_2 and 2,480 pounds of NO_x. Emissions from flaring 8,050 mmBtu of ADG are 483 tons of CO_2, 24 pounds of SO_2 and 1,610 pounds of NO_x. Emissions from the generation of 1.18 million kWhs using the fuel cell are 472 tons of CO_2, no SO_2 and 35 pounds of NO_x. See Appendix A for a generic discussion of emission rate assumptions.

[2] In some cases, although not at the Yonkers plant, natural gas can be mixed with ADG when methane concentrations fall below 50%.

CLEAN AIR-COOL PLANET CASE STUDY RATING

This case study reduces CO_2 emissions equivalent to the following:

Avoiding the consumption of 5 barrels of oil per day.

OR Taking 128 vehicles off the road per year. (1 car = 20 vehicles)

Assumptions: 1,093 lbs of CO_2 per barrel of oil. Vehicles are average passenger cars (approximately 20 lbs CO_2 per gallon of gasoline – 22.5 miles per gallon, averaging 16,000 miles per year)