CO-DIGESTING FOOD WASTE WITH WASTEWATER SOLIDS:

A WIN-WIN-WIN FOR INDUSTRIES, MUNICIPALITIES AND THE ENVIRONMENT

By Elizabeth Charbonnet and Sara Martin

The effects of climate change are becoming increasingly apparent both across the country and within the State of New York. Just this year, the New York State Climate Impacts Assessment Interim Publication was released, which builds on the 2011 ClimAID effort to quantify climate change impacts in New York and describe adaptation options (*Rosenzweig et al., 2011*).

The 2024 assessment reported that average temperatures in New York have already increased by almost 2.6 degrees Fahrenheit since 1901. The rate of this increase is higher than the contiguous 48 states' average rate of increase over the same time period (*Lamie et al., 2024*). Additionally, across New York heavy rainstorms are becoming more frequent—storms previously considered 100-year events are occurring nearly twice as often as expected. This is no surprise to residents who lived through flooding of the Mohawk, Delaware and Susquehanna river basins in 2006, Superstorm Sandy in 2012, flooding in St. Lawrence Seaway and Lake Ontario in 2017, Hurricane Ida in 2021 and historic snowstorms in western New York in 2022. Hotter temperatures, increased heavy rainstorms and more frequent severe storms are particularly exacerbated in coastal New York where sea level has risen almost 1 foot over the past 100 years and in the Great Lakes region where warmer temperatures mean increased evaporation and fewer freeze events (*Lamie et al., 2024*).

To help combat this observed climate change, New York state enacted the Climate Leadership and Community Protection Act (Climate Act) that took effect in 2020. This Act requires New York to reduce greenhouse gas (GHG) emissions by 40% from 1990 levels by 2030 and by 85% by 2050. Additionally, this act encourages renewable energy production and requires 100% zero-emission electricity statewide by 2040.

To help achieve these goals, a scoping plan was developed that summarizes recommended actions by each sector (*New York State Climate Action Council, 2022*). For the waste sector specifically (which includes landfills, waste combustion and wastewater treatment), the scoping plan recommends reducing the disposal of organics at landfills, increasing emissions monitoring and leak reduction and encouraging the beneficial use of biogas (specifically for on-site needs and electricity production).

GHG emissions from the waste sector represent 12% of statewide emissions, the majority of which come from decay of organic matter buried in landfills (*New York State Climate Action Council, 2022*). As mentioned in the scoping plan, diverting organic matter from landfills is one way New York can help meet the Climate Act emissions reduction goal. This decaying organic matter emits methane, a short-lived climate pollutant with a warming effect almost 25 times more powerful than carbon dioxide. This methane can be captured at landfills; however, it is often more efficient to degrade organics in an anaerobic digester and capture and utilize the biogas in a controlled and sealed environment.

Taking this a step further, if this diverted organic matter is co-digested anaerobically in municipal water resource recovery facilities (WRRFs) with efficient biogas capture and use, not only would methane landfill emissions be reduced, but biogas—a renewable energy source—and biosolids—a nutrient-rich resource for depleted soils—can be produced. Furthermore, existing anaerobic digesters at WRRFs in New York state often have unused capacity that could be harnessed to process this diverted organic waste. The state of California, facing similar GHG emissions reductions goals and similar statewide emissions from landfills, considered this co-digestion solution and found it both economically viable and quantitatively impactful in reaching reductions goals.

Statewide California Study Found Reducing Methane Emissions through Co-Digestion can Produce Revenue for WRRFs

Co-digesting the recoverable and digestible organic fraction of municipal solid waste (i.e., food waste) at WRRFs was assessed by the California State Water Resources Control Board (California State

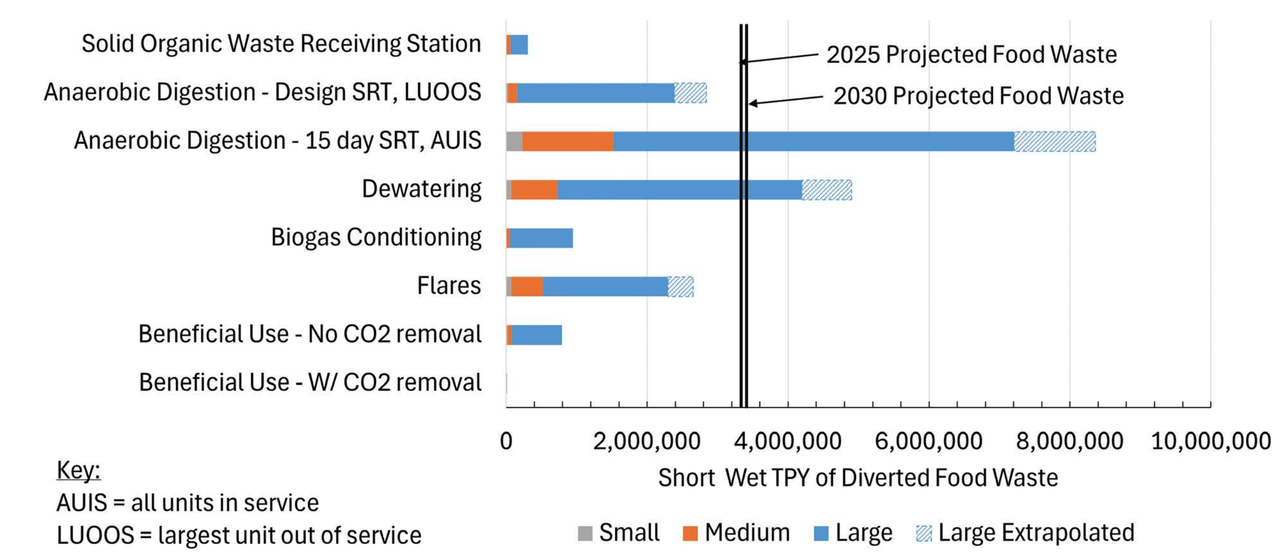
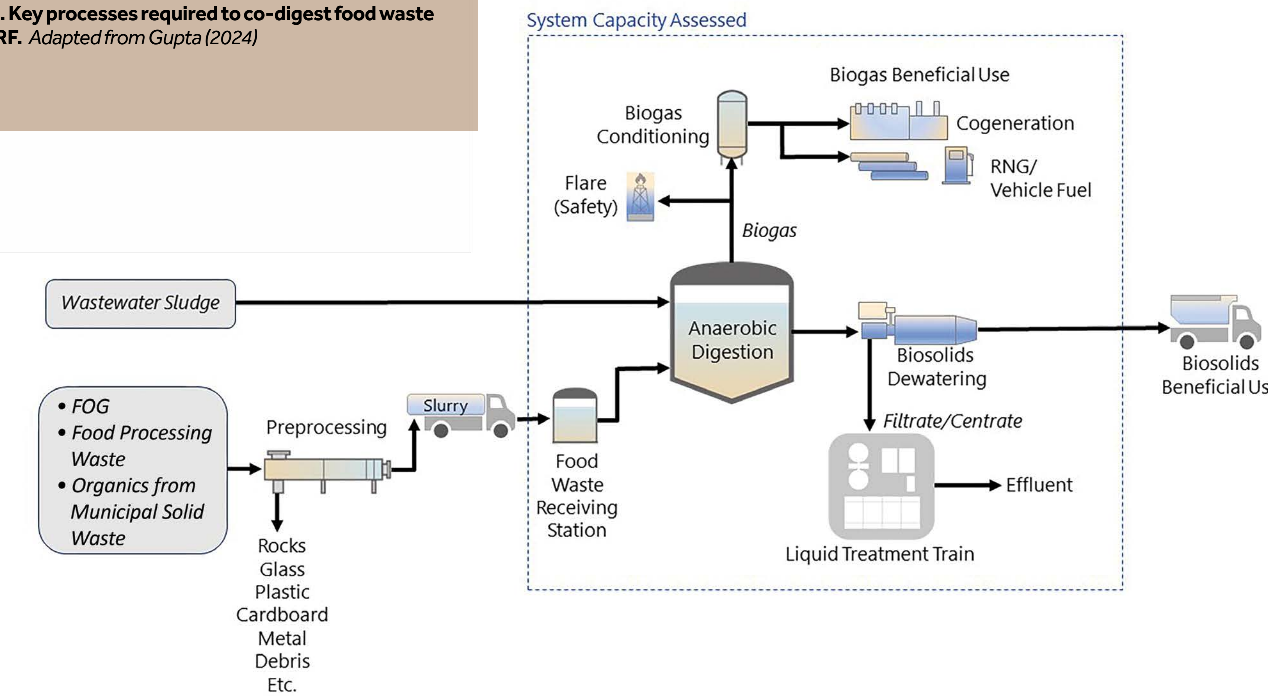


Figure 1. California statewide total existing excess capacity of key systems required for co-digestion and beneficial use of biogas. *Credit: Carollo: (2019)*

Figure 2. Key processes required to co-digest food waste at a WRRF. *Adapted from Gupta (2024)*



Water Board) in 2019. This study, conducted by Carollo Engineers, Inc., analyzed the co-digestion capacity of all WRRFs in California. Unused digester capacity at existing WRRFs across California was quantified (***Figure 1***), and the project team determined this unused digester capacity could be sufficient to co-digest most or all of California's projected food waste production in 2030, depending on assumed digester operating conditions (*Carollo, 2019*).

However, significant investments would be needed in other processes at WRRFs to receive the food waste and treat the resulting increase in both biogas and biosolids generated. This study specifically focused on the processes needed at WRRFs and assumed pre-processing of food waste into a slurry would occur off-site. Additionally, this study considered three potential beneficial uses for biogas: on-site cogeneration, renewable natural gas (RNG) for pipeline injection, and RNG for vehicle fuel (***Figure 2***).

To co-digest all 3.41 million short wet tons of digestible and recoverable food waste expected to be produced in California by 2030, California would need to invest $1.44 billion (2019 dollars) in capital improvements and an additional $138 million (2019 dollars) annually for operations and maintenance (O&M). This represents a significant investment. However, the potential revenue is also significant.

The California State Water Board study assumed revenue could be generated from food waste tipping fees; credits from Renewable Fuel Standard's D5 Renewable Identification Numbers (RINs), Low Carbon Fuel Standard (LCFS), and the Self-Generation Incentive Program; and direct revenue or cost offset from biogas end uses. With the potential revenue from these incentives and the assumption that biogas end use would be split equally between the three identified end uses across facilities in the state, co-digesting all digestible and recoverable food waste expected to be produced in California by 2030 could generate $393 million per year (2019 dollars). A simple payback with these cost and revenue assumptions for statewide implementation of food waste co-digestion would be less than six years.

Setting aside costs, maximizing co-digestion in California also helps meet California's GHG emissions reductions goals. If all 3.41 million short wet tons of digestible and recoverable food waste were co-digested and the resulting biogas and biosolids were beneficially reused, GHG emissions in California would decrease by up to 2.4 million metric tons of carbon dioxide equivalent (MT CO_2e). This GHG emissions reduction is 60% of California's goal to reduce landfill emissions by 4 million MT CO_{2e} in 2030.

While the quantity of municipal solid waste generated in New York is less than the quantity generated in California (18 million tons vs 37.5 million tons), the potential GHG reductions benefits and short payback seen with co-digestion in the California study are worth noting as New York works toward the 2030 GHG emissions reduction goal (*New York State Climate Action Council, 2022*). Specifically, for WRRFs with existing excess digester capacity, adding food waste that would otherwise end up in a landfill is worth considering, especially if there are nearby industries that produce food waste. Co-digesting all the food waste generated in New York won't on its own meet the 2030 GHG emissions reduction goal; however, if project conditions are right, co-digestion could be a straightforward and cost-effective way to make an impact and create synergy with local food industries.

Industries in New York Are Looking for Cost Effective and Sustainable Treatment Options for Food Waste

While reducing GHG emissions is a New York statewide goal, it is often other drivers that lead industries in New York to pursue food waste treatment options instead of landfilling. One major driver is the increasing difficulty and cost of trucking and disposing of food waste at landfills around New York City. After 9/11 many landfills around New York City reached capacity and upstate landfills have limited capacity to accept increased waste. Due to this, tipping fees and hauling times to landfills that remain open have increased and waste has to be transported out of state. Additionally, more industries are setting corporate sustainability initiatives, which increase industry interest in renewable energy sources, achieving zero waste and reducing their carbon footprint. These factors, along with tax incentives, grants and other funding opportunities available for biogas projects, make partnering with a WRRF to co-digest food waste and generate biogas worth considering.

Furthermore, in 2019 the New York State Department of Environmental Conservation enacted the Food Donation and Food

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Figure 3. Anaerobic digesters were added to the Oneida WPCP to co-digest food waste. *Credit: Oneida County Water Quality and Pollution Control*

Figure 4. Scott THOR Turbo Separator at the OHSWA Food Waste Processing Facility. *Credit: Barton & Loguidice*

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Scraps Recycling Law that went into effect in 2022. This law requires large food-waste generators to recycle all food waste that is not edible food if the generator is located within 25 miles of an organics recycler. Under this law recycling does include processing in an anaerobic digester, as is done with co-digestion at a WRRF.

Oneida County Water Pollution Control Plant: A New York Case Study

These drivers have already led one community in New York to pursue food waste co-digestion. Prior to New York state enacting the Food Donation and Food Scrap Recycling Act, the Oneida-Herkimer Solid Waste Authority (OHSWA) and Oneida County Department of Water Quality and Water Pollution Control (Oneida County) partnered in 2019 to create the Food2Energy program. The goal of the program is to divert food waste from the OHSWA owned and operated landfill in the Town of Ava, with the main sources being grocery stores, food manufacturing companies, local colleges and some restaurants within 25 miles of the facility.

Oneida County owns and operates the Water Pollution Control Plant (WPCP), a regional wastewater treatment facility. In the early 2010s, the facility was in the planning stages of what would become an over $350 million upgrade and asset renewal program. As part of the evaluation of upgrades at the WPCP, a 30-year financial analysis determined anaerobic digesters would have higher net returns than the initially proposed plan to refurbish the incinerators. Additionally, OHSWA conducted a 2016 feasibility study of co-digestion of commercial source-separated organics (SSO), which determined that the potential commercial SSO supply was sufficient to make pre-processing for co-digestion economically feasible and that its current compost facility had insufficient capacity for expansion.

In 2019, Oneida County completed construction of two new egg-shaped digesters (***Figure 3***), a secondary digester with a gas holding structure and a liquid waste receiving station. A Unison Solutions biogas conditioning system and three Capstone 200-kilowatt (kW) microturbines were also installed. This system conditions gas and then channels it through the microturbines, producing electricity and generating heat (Cogen) that is used to heat the digesters, digester complex, and liquid receiving station.

Due to the success of the Food2Energy program, two more microturbines were added to increase Cogen capacity in 2023. Currently the facility digests more than 5 million gallons (or almost 21,000 short wet tons) of food waste each year, without experiencing digester upsets. Because both co-digestion and anaerobic digesters were added at the same time, it is difficult to identify the specific impacts of co-digestion, but Oneida County estimates the 20% of feedstock from food slurry increases biogas production by 45%.

At the OHSWA, the SSO processing facility design was commissioned, and construction was completed in 2019. In the processing facility, commercial SSO is collected, hauled to the site and unloaded onto a sloped concrete tipping floor with a drain. Un-processible items are inspected and removed, then the SSO is loaded into a Scott THOR Turbo Separator (***Figure 4***) to reduce particle size and separate out packaging and other contaminants. The THOR was chosen for its high throughput capacity and high tolerance for contamination. Processed SSO is then continuously mixed in a 7,000-gallon conical bottom mixing tank to prevent settling and diluted with gray water to a total solids content of less than 10%. This slurry is piped underground to the adjacent WPCP via a force main, then once again screened in a Saveco Beast fats, oils and grease (FOG) screening machine at the liquids receiving station.

Current upgrades that have made the Food2Energy program possible have required an investment of over $40 million; however, tipping fees as well as cost savings due to increased biogas production are used to offset a considerable portion of the annual debt service. In addition, grants totaling $3.25 million were awarded by the New York State Environmental Facilities Corporation Green Innovations Grant Program, as well as New York State Energy Research Development Agency Anaerobic Digester to Electricity Program toward funding the microturbines at the WPCP.

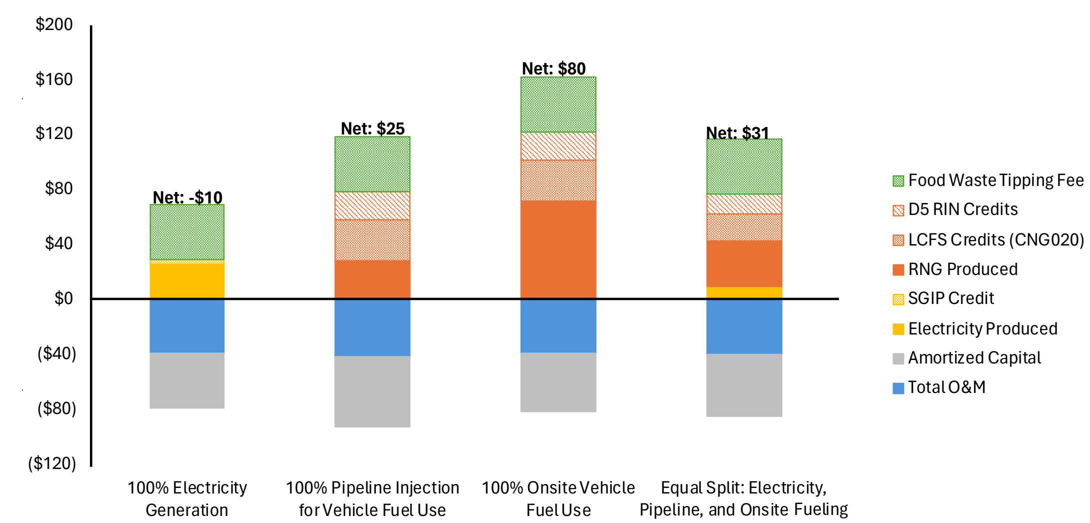

Figure 5. Normalized (costs) and revenues for an illustrative WRRF co-digesting 45,000 short wet tons of food waste annually. *Credit: Carollo: (2019)*

Is Co-Digestion Right for Your WRRF?

While co-digestion of food waste may make economic sense at a large scale when considering a state as a whole, the economics of co-digestion at each WRRF should be closely evaluated, as was done for the Oneida County facility. Typically, co-digestion at large- and medium-size WRRFs are more likely to see positive economic returns than co-digestion at small WRRFs. Additionally, the variability in ongoing costs, potential revenues and other plant impacts need to be evaluated on a case-by-case basis.

One additional datapoint developed in the California State Water Board Study was the assessment of food waste co-digestion at an "example facility." This exercise assumed the example facility had excess digester capacity to co-digest 45,000 short wet tons of food waste annually but needed to add capacity in all other ancillary processes (food waste receiving, biogas end use and biosolids dewatering). Biogas produced would be used for on-site vehicle fueling, which was identified as the most economically favorable biogas end use given costs and revenues assumed. In this example, the facility would need to invest $22.4 million (2019 dollars) in capital costs and invest $1.8 million (2019 dollars) annually in O&M costs. Expected revenue was estimated at $7.3 million (2019 dollars) annually, with the majority coming from the sale of RNG. Potential costs and revenues for other biogas end uses were also evaluated and shown in ***Figure 5.***

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This example facility is, of course, just that—a theoretical example facility with reasonable costs and revenues assumed at one particular point in time. For any project between a specific WRRF and specific food waste supplier, a more detailed evaluation is needed. This evaluation should consider the economics as well as the following other factors needed for a feasible and sustainable food waste diversion to co-digestion program: collection and pre-processing, feedstock contamination and characteristics, supportive partnerships, collaborative project delivery, regulatory constraints and pushback on unfunded mandates.

Collection and Pre-Processing

If the waste collection program is a single "black bin" residential service, collection costs will likely be lower and participation rates higher; however, these higher municipal solid waste quantities must all be processed and the potential for contamination increases. If the collection program is source-separated or solely commercial or institutional, the quantity available may be less but the quality will likely be higher.

Additionally, leveraging space at existing materials recovery facilities to add pre-processing equipment reduces permitting difficulties. However, food waste slurry dilution requirements and availability at these facilities must also be considered.

Feedstock Contamination and Characteristics

Even if food waste is source-separated, contamination is often inevitable and may require additional polishing at the WRRF or require an accounting of expected increases in O&M costs. Understanding food waste characteristics through bench-scale testing should be considered to increase the accuracy of economic analyses and operational impacts at a WRRF.

Supportive Partnerships

Developing a productive partnership between the WRRF and the food waste supplier is often critical for success. Establishing feedstock agreements can help both partners understand clearly their roles and responsibilities. These agreements can lay out feedstock quality and quantity requirements, describe how deliveries will be managed and establish a tipping fee.

Collaborative Project Delivery

New York state allows for competitive energy performance contracting (EPC) implementation if the project ensures savings can be demonstrated at completion. A few facilities in New York state, such as the Niskayuna, Oneida City and Webster wastewater treatment plants, have taken advantage of EPC implementation to upgrade digesters for co-digestion as well as other improvements to create renewable energy and drive energy efficiency. The collaboration between a municipality and the EPC partner allows the municipality to invest in infrastructure that will have a long-term operational and financial benefit to the municipality while mitigating the risk that a municipality will be left with sunk costs.

Regulatory Constraints

Adding food waste to WRRFs can have unintended consequences of increasing nitrogen, phosphorus and total dissolved solids (TDS) loading at the plant or degrading biosolids dewaterability (depending on type and quantity of feedstocks). Depending on existing WRRF permits, this additional load could require additional treatment capacity.

Furthermore, other regulatory constraints like potential PFAS regulations, stringent emission limits on stationary engines, or municipal solid waste permit requirements for receiving extruded "black bin" organics can hinder co-digestion implementation and need to be considered prior to project implementation.

Pushback on Unfunded Mandates

It can be helpful to proactively collaborate with regulators before mandates are issued so that unintended consequences, delays and pushback are minimized. Specifically, it is helpful to identify strategies to cover implementation and operational costs during regulation development. To this end, a holistic understanding of cost impacts before promulgation is essential for feasibility and sustained success. Leveraging others' experiences can help with this.

Win-Win-Win

Already food waste co-digestion has been successfully implemented in New York. Specifically in Oneida County more than 5 million gallons of food waste is processed each year to produce renewable electricity and heat. As more WRRFs and food waste generators consider similar projects, co-digestion can help offset costs and generate revenue at WRRFs, provide a sustainable end use for industries, and decrease GHG emissions across the state.

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Additional contributors for the case study in this article are Commissioner Karl Schrantz, PE, and Chief Operator Dale Lockwood with the Oneida County Department of Water Quality and Water Pollution Control.

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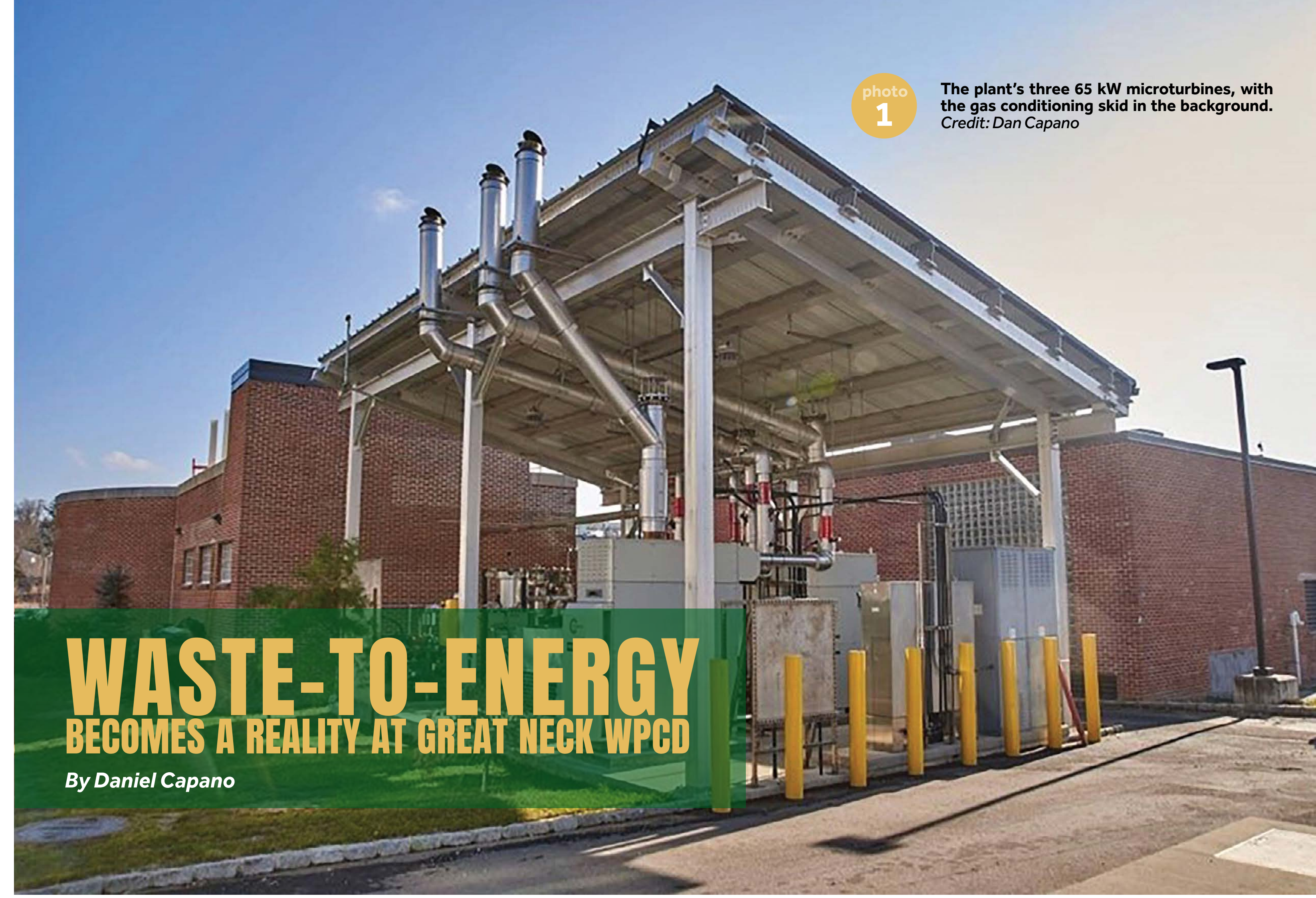

photo 1 **The plant's three 65 kW microturbines, with the gas conditioning skid in the background.** *Credit: Dan Capano*

WASTE-TO-ENERGY
BECOMES A REALITY AT GREAT NECK WPCD

By Daniel Capano

The British science-fiction writer and futurist Arthur C. Clarke once stated, "Any sufficiently advanced technology is indistinguishable from magic." To the layperson, turning human waste into electricity is certainly in the realm of magic. Taking what is flushed down household toilets and turning it into a valuable commodity is a concept well beyond the ken of the average ratepayer. Yet in the village of Great Neck, New York, the waste products of human consumption are being turned into electricity and heat. And that's not all. This "magic" is also creating a revenue stream as well as saving ratepayers' money.

Background

The Great Neck Water Pollution Control District (GNWPCD) operates a 5-million-gallon-per-day wastewater treatment facility on the shores of Manhasset Bay, which is off the Long Island Sound. GNWPCD retained the firm of Gannett Fleming to design and build a system that captures the energy in two waste streams that would be unrealized otherwise and create a model of resource recovery and innovation. Gannett Fleming's talented team of design professionals developed a method to upgrade and increase the efficiency of the facility's three existing anaerobic digesters in order to produce and store more biogas (methane) that will be used to fire the plant's microturbines. The project involved a complete rebuild of the digesters and the addition of a 65-kilowatt (kW) microturbine generator; the district had already installed two microturbines under a previous contract. The project also included a new grease-receiving station that accepts grease from local haulers.

The major components of the new systems—the digester rebuilds and the Digester Utility Building (DUB)—proceeded in parallel. The existing digesters were at the end of their useful service life, with Digesters 1 and 2 built in 1959 and Digester 3 built in 1988. All three used mesophilic anaerobic digestion with unconfined gas mixing. The plant routinely flared off waste gas. At the outset of the project, the plant operated two 65-kW Capstone microturbines and a 13 kW solar array on the roof of the microturbine enclosure. Digester gas passes through a Unison Solutions gas conditioning skid before being supplied to the microturbines.

Step 1: Add a Third Microturbine

Before the digester and grease facility work commenced, a third 65-kW microturbine was installed to bring total generating capacity to 195 kW (***Photo 1***). Each turbine recovers waste heat through turbine-mounted heat exchangers and is used to heat digester sludge and to provide 100% of the space heating throughout the plant.

To avoid flaring, the waste gas is burned in a new waste gas boiler. Future plans call for a proposal to dry sludge after pressing by using waste heat from the turbines. The microturbines are integrated into the newly expanded plant-wide Supervisory Control and Data Acquisition (SCADA) system.

Step 2: Rebuild Digesters

The three digesters were completely rebuilt to maximize process and to provide an increased capability to store biogas. Digesters 1 and 2 shared a common support building, while Digester 3 was a

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