A Synergistic Approach to Net-Zero Resource Recovery Facilities: A Success Story and Innovations at Hermitage Municipal Authority

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A synergistic market approach to waste treatment and energy production is key to fully realizing the benefits of the circular economy, which is a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, narrowing, and closing energy and material loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling, and upcycling.

Energy utilities are facing increasing regulation by the federal government to produce clean, renewable power. Current energy management mandates state that energy utilities must produce up to 20 percent of all electric energy from a renewable portfolio by 2020, and 20 percent of all electric and thermal energy from a renewable portfolio by 2022.

At the same time, numerous states in the Northeast and Midwest, and on the West Coast, have either banned or have some regulations that limit organic food waste from ending up in municipal landfills. This has burdened the traditional solid waste utilities (haulers and handlers) with the need to develop source separation programs, find alternative use for these organics (such a composting), and/or invest in regional digestion facilities to convert the organics into biogas. Programs like the U.S. Environmental Protection Agency (EPA) food recovery challenge are further encouraging states to voluntarily ban organics from landfills, which if successful, may result in a federal ban impacting all states.

A 2012 EPA study found that organics from food waste made up 14.5 percent of annual municipal solid waste production, which amounts to around 37 mil tons/year. Utilization of even half of the food waste available annually in the United States could result in the generation of approximately 50 one thousand thousand British thermal units (MMBtu) of renewable natural gas, as well as the recycling of important nutrients, such as carbon, nitrogen, and phosphorus.

There is also a trend of wastewater utilities undergoing a transformation from conventional wastewater treatment to renewable resource recovery facilities. Wastewater utilities realize the benefits of improving bioenergy, biosolids, water, and nutrient recovery and the value it brings to the overall bottom line for the end user. Wastewater utilities are uniquely positioned to benefit from the regulations imposed on both the energy and solid waste generators.

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The EPA has identified more than 1,300 facilities in the U.S. that rely on anaerobic digestion to reduce organics from wastewater; however, per the American Biogas Council, it's estimated that over 40 percent of all anaerobic digesters in the U.S. are being operated below their design capacity. Digesters with excess capacity are energy sinks, requiring just as much heat and electricity as when operated at capacity, but with very little return in the form of biogas.

The unused digester capacity can be utilized to anaerobically codigest landfill-diverted organics to produce biogas, which in turn can be converted to biomethane for heat and electricity.

Increased biogas production is just one of the many benefits of introducing high-strength biodegradable wastes from commercial and industrial establishments into municipal anaerobic digestion systems. Digestion systems can be designed to accept organic wastes that would traditionally end up in landfills and produce Class A biosolids that can be returned to the market as biofertilizer or soil amendment.

In anticipation of a liquid stream upgrade from 5 to 7.7 mil gal per day (mgd), Hermitage Municipal Authority (authority) in Pennsylvania undertook a major upgrade

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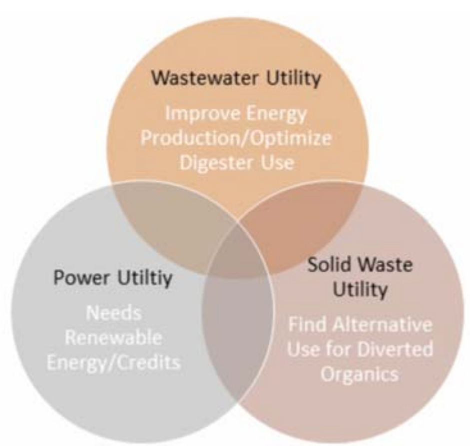

Figure 1. Waste to Bioenergy Opportunities Among Three Utilities

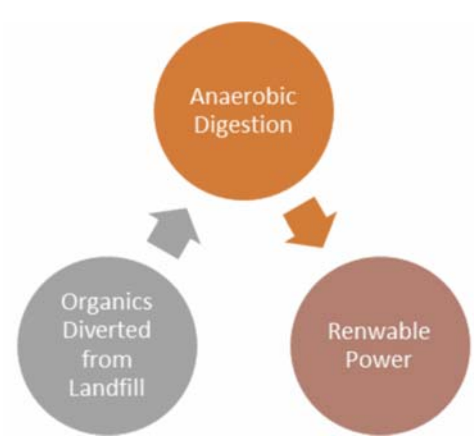

Figure 2. Key Market Drivers and Workflow

Figure 3. Phased Digestion and Gas Cleaning at Hermitage Municipal Authority

Table 1. Veolia's Depackaging Process Contaminant Testing Results

Waste Substrate Processed	lbs/batch	Tons/ batch	Total inert material		Salts, additives, etc.		Plastics, metals, etc.	
			g/lbs	%	g/lbs	%	g/lbs	%
Yogurt and pudding in plastic cup from dairy factory	13,860	6.93	2.73	2.7%	2.73	2.7%	0.0	0%
Vegetables, fruits, green waste in container	8,910	4.46	9.55	5.1%	9.55	5.1%	0.0	0%
Mixed supermarket food waste packed in vacuum foil, in plastic cup, in paper	39,644	19.82	6.36	3.4%	6.35	3.4%	0.009	<0.01%
Kitchen waste packed in vacuum foil, in plastic cup, in paper	10,758	5.38	1.82	1.6%	1.82	1.6%	0.0	0%
Dairy waste delivered in tanker	11,242	5.62	4.09	5.2%	4.09	5.2%	0.0	0%
Mixed supermarket food waste packed in vacuum foil, in plastic cup, in paper	32,472	16.24	6.36	6.1%	6.36	6.1%	0.005	<0.01%
Yogurt in plastic cup from dairy factory on paper tray	5,214	2.61	5.00	21.2%	5.00	21.2%	0.0	0%
Dewatered wastewater sludge in container	13,002	6.50	13.64	17.9%	13.64	17.9%	0.0	0%
Thickened wastewater sludge in container	6,974	3.49	5.00	16.4%	5.00	16.4%	0.0	0%

Figure 4. Veolia's Net-Positive Project in Graincourt, France, Treats 13 Different Substrates

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of its solids handling facility. The facility has only secondary treatment, meaning there was no easy-to-digest, high-calorific-value primary sludge as a feed to the new anaerobic digesters. Goals of the solids handling facility upgrade were to increase treatment capacity and to boost biogas generation for use as the primary fuel in a combined heat and power (CHP) cogeneration system to offset process heat and generate renewable electricity. This led to a solids management plan specifically designed to address high-strength codigestion of organic wastes imported to the facility and subsequent production of EPA-approved Class A biosolids for biofertilizer and generation of renewable energy.

The design at the facility included a new staging area to receive imported, packaged organic waste from grocers, large food manufacturers, the dairy industry, and other waste generators. A depackaging system for liquid waste, and subsequently, one for solid waste, were included to extract organics from packaged imported waste. A new phased digestion system was built using existing anaerobic concrete tanks and new steel tanks. A new biogas collection and treatment system and a combined heat and power unit were installed.

The phased digestion system was designed to achieve greater than 55 percent volatile solids destruction and to accept high-organic substrates such as fats, oil, and grease (FOG) and dairy wastes.

The system was estimated to produce nearly 210,000 cu ft (ft3)/day of biogas and expected to yield 4 MBtu/hour of energy using CHP, which would be sufficient to power and heat the entire digestion system.

Benefits of implementing this system at the authority include:

- Income from tipping fees for accepting organic wastes from as far away as Idaho and Florida
- Reduced fossil fuel usage due to increased biogas production
- Energy generation in CHP
- Less downstream biosolids resulting in reduced solids handling needs
- Pathogen-free Class A nutrient-rich biosolids that can be land-applied as low ammonia substitute for agricultural uses
- Carbon credit based on energy generation from anaerobic digestion of numerous high-strength wastes

The estimated energy savings by electricity generation is up to $25,000 per month

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at full capacity, with engines operating 24 hours for seven days. Overall, estimated saving through the digester upgrade is close to $0.5 million per year.

The implemented process strategy addresses needs within the three utilities (shown in Figure 1) by providing a single-point solution. Unlike other renewable resource recovery facilities, the authority's facility is unique in its capacity to receive, depackage, pretreat, and codigest organics and municipal wastewater solids.

The depackaging process, in conjunction with a high-strength waste feed staging strategy and an advanced anaerobic digestion system, allows for organics loading rates in excess of 12 kilograms per cu meter (kg/m3) or 0.75 lb/ft^3 in the first-stage thermophilic acid digester that acidifies the high-strength waste. The second-stage mesophilic gas digester is fed at a rate of 3 kg/m3 (0.19 lb/ft3), which is typical of conventional digesters.

Figure 5. Veolia's Net-Positive Project in Lodi, Italy, Supplies Biomethane to Pipeline

Figure 6. Veolia Assisted Net-Positive Project in Nagykoros, Hungary, Processes 60,000 Metric Tons of Food Waste Annually

The phased digesters are fed a combination of secondary municipal sludge and depackaged, in some instances, with preheated, high-strength waste. The organics loading ratio on a mass basis for municipal sludge to imported waste ranges between 1:0.6 and 1:1, with 20 tons of municipal waste for every 12 to 20 tons of imported waste.

The current bioenergy process is capable of treating over 125,000 ft^3 of biogas and generates up to 13,400 kilowatt hours of power (4.5 MBtu/hour). While the goal is ultimately to convert the biogas into compressed natural gas (CNG) to fully realize renewable energy credits (which can subsequently transfer to electric utilities in need of improving their renewable portfolio), the biogas is currently utilized by a CHP system for onsite heating. In addition to increasing the biodegradable fraction going to anaerobic digesters, in turn increasing bioenergy production, the authority collects tipping fees from food waste generators.

The facility currently processes 15 tons of imported organics per day and collects $0.25 million in tipping fees. This revenue is folded into the operational costs of the processing facility.

Similar facilities have been successfully installed outside the U.S., and these facilities are all operating near maximum capacity due to the availability of organics from landfills and other commercial organic wastes being sent to them. This allows the facilities to maximize bioenergy production and attain near net-zero energy use.

The project has been successfully implemented and provides the authority with a source of revenue and a location for the community to divert organics for beneficial reuse, successfully diverting these materials from local municipal landfills and increasing the production of biogas. Eventually this biogas will be treated to CNG and will be returned to the local energy utility.

Conversion of organics from landfill to renewable bioenergy within a wastewater facility is a cost-effective means of supporting solid waste utilities, while supplementing the portfolio requirements of the energy utilities.