Wastewater: From Waste to Resource

The Case of Ridgewood, NJ, USA

Achieving Energy Neutrality in Wastewater Treatment Plants

CHALLENGE
Improve the anaerobic digesters and use the biogas to produce enough renewable energy to satisfy the power demand of the plant
OBJECTIVE
Improve affordability, resiliency, and sustainability of the existing WWTP

Summary

Ridgewood, in New Jersey (NJ), upgraded its wastewater treatment plant (WWTP) in 2005 by installing two anaerobic digesters to comply with stricter federal and state environmental standards. However, the biogas produced in the process was being burned and released to the environment. The municipality saw an opportunity to use the wasted methane and convert it into energy for the WWTP. Through a successful public-private partnership (PPP), the Ridgewood WWTP achieved energy neutrality and became a referent on sustainable municipal wastewater treatment in the region.

Context

WWTPs are energy intensive with electricity costs usually between 5 percent to 30 percent of total operating costs. In low-income countries the share is usually higher, and it can go up to 40 percent or more. Such high costs can negatively affect the financial health of the plant and impact the sustainability of the service. Therefore, utilities have high incentives to implement energy efficiency and energy recovery measures to reduce operation costs and reduce the carbon footprint of the plants. For example, biogas generated in WWTPs can be used to produce electricity on-site and therefore reduce electricity costs. This can be especially beneficial in places where the price of electricity is high, as it is in many low-income countries. However, utilities do not always have the resources, time, or skills to explore these opportunities. PPPs can be a solution to address those issues, allowing for the benefits and risks to be shared.

WORLD BANK GROUP

Solution

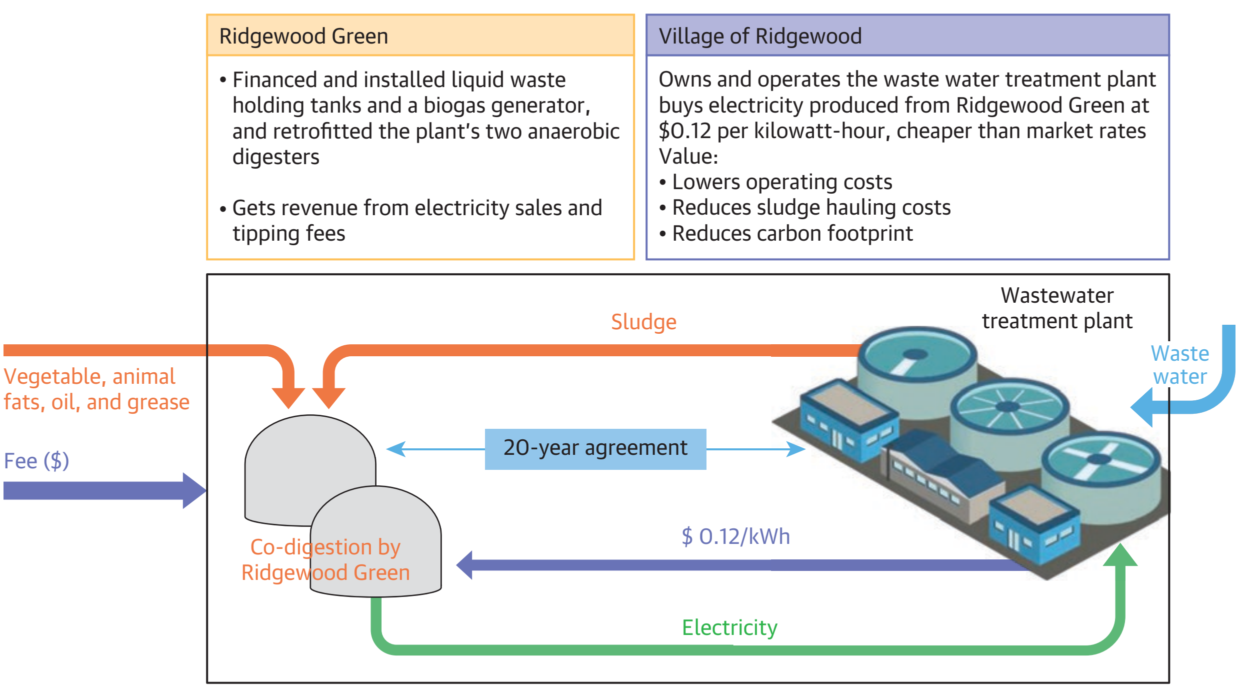
Retrofitting the existing infrastructure through a PPP. The WWTP in Ridgewood was the largest energy consumer that the village owned, costing more than $250,000 a year for electricity. Ridgewood saw this as a big opportunity cost, and explored combined heat and power solutions to both reduce the energy costs and improve the sustainability of the plant. Moreover, the village wanted to enhance its WWTP without impacting its taxpayers. The village believed that it could be done through a PPP without incurring any upfront capital investment by the village itself. Local government officials made a "request for proposal" to design and implement a project that would convert the excess methane into usable electricity. Ridgewood Green RME (RGRME) was chosen.

Ridgewood Green retrofitted the plant's two anaerobic digesters to optimize the process and installed a biogas generator. The anaerobic digestion process at the municipal WWTP has been enhanced so that enough biogas is being produced to meet almost the entire plant's energy needs. The biogas is collected, cleaned, compressed, and pumped into a biogas engine to produce electricity. The excess heat from the engine is used to heat the sludge entering the digesters, increasing the plant's efficiency. Moreover, to increase the plant's methane production and improve project economics, Ridgewood Green has financed and installed liquid waste holding tanks for co-digestion of vegetable and animal fats, oil, and grease (FOG) obtained from external sources. Figure 1 shows a simplified diagram of the project.

Financial and Contractual Agreements

The project was financed through a 20-year PPP between the village of Ridgewood and Ridgewood Green RME. Ridgewood Green made the up-front capital investment ($4 million) needed to retrofit the plant, which implied zero investment costs and minimum risk for the Village

FIGURE 1. Diagram of the Project



Note: Treatment plant image is by Tracey Saxby, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/).

of Ridgewood. In return, Ridgewood purchases the electricity generated by Ridgewood Green at a price of 12 cents per kilowatt hour (kWh). The power purchase agreement included a fixed increase rate of 3 percent per year for inflation, establishing the village's price and Ridgewood Green's revenue for the duration of the contract. The plant used to pay about 15 cents per kWh for utility power. Therefore, this agreement benefits both parts. Since Ridgewood Green invested in the new infrastructure, it owns the new equipment and the Village of Ridgewood owns and operates the plant with technical support from Ridgewood Green.

Ridgewood Green expects to recover the full investment and a reasonable return on investment through an innovative revenue model that leverages different revenue streams: (a) selling electricity to the Village of Ridgewood; (b) selling all the renewable energy certificates (RECs) to 3Degrees, a leader in the renewable energy marketplace under an agreement of several years; (c) tipping fees assessed when haulers deliver FOG to feed the anaerobic digesters. Proximity incentivizes haulers to dump FOG at Ridgewood's water plant rather than the traditional destinations.

Benefits

For the Village of Ridgewood

- Renewed infrastructure (state-of-the-art)
- No capital cost to taxpayers
- Savings: lower operating costs for the WWTP
  - Lower sludge hauling costs
  - Lower electricity costs
- More resilient: not affected by electricity price surges (locked price for 20 years)
- Lowers the village carbon footprint

For the environment

- Reduction of greenhouse gas (GHG) emissions

For Ridgewood Green

- Showcase solution as an example of sustainability in WWTP (won the Biogas Project of the Year by the American Biogas Council and Environmental Achievement Award)
- Risk mitigation: power purchase agreement set a fixed increase rate, ensuring Ridgewood Green's revenue for duration of the contract

Lessons Learned

Several key success factors can be highlighted from this case study:

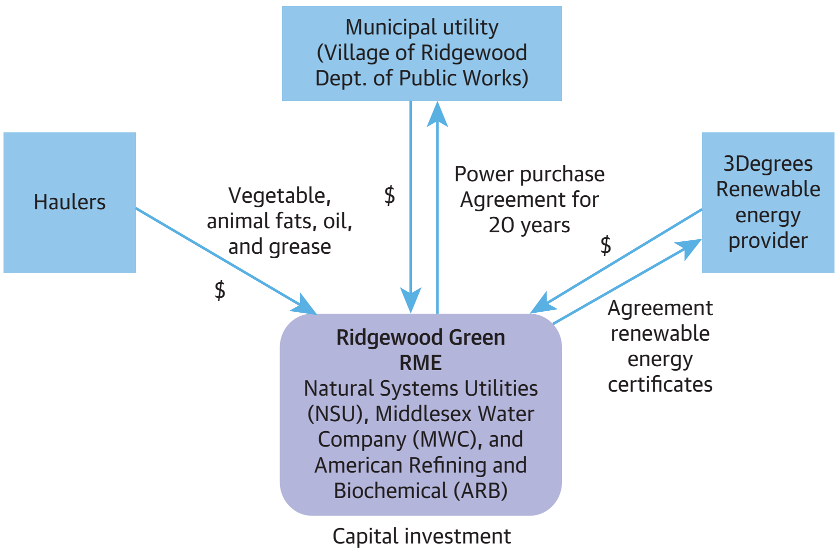
Stakeholder engagement

- 20-year partnership, lowering risks and ensuring revenue for the capital investor (Ridgewood Green) and continues involvement of key stakeholders (see figure 2)
- Right mix of expertise: Ridgewood Green was formed to leverage each organization's respective financial capacities and technical expertise: Natural Systems Utilities (NSU), Middlesex Water Co. (MSU), and American Refining and Biochemical

Technical innovation

- Reuse of existing infrastructure
- Optimization of the anaerobic digestion process with the addition of an enzyme product that increases biogas production and reduces odors
- Co-digestion: the production of electricity is enhanced when food wastes (e.g., FOG) are introduced into the process.

FIGURE 2. Key Stakeholders



PROFILE

NAME

Village of Ridgewood Wastewater Treatment Plant

LOCATION

Ridgewood, NJ, USA

SIZE

- 19,000 m^3/day design flow
- 8,500 m^3/day average flow

MAIN INNOVATION

- Energy neutrality by retrofitting existing plant
- Creative alternative revenue streams

TECHNOLOGY

Bar screens, liquid waste screens, liquid waste storage tank, primary clarifiers, aeration tanks, secondary clarifiers with chlorination, conventional anaerobic digesters, biogas engine

- Biogas production: 2,600 m^3/day; 100 percent used for energy generation
- Feedstock: co-digestion: municipal wastewater biosolids, brown grease (FOG) and septage
- End use: CHP: 240 kW electric and 440 kW thermal energy

- Use of solar panels to achieve 100 percent renewable energy use in the plant

Creative and diversify new revenue streams for the investor

- Revenue from electricity sales to WWTP, fees from haulers, and RECs to 3Degrees

Conclusion

The case of Ridgewood shows that resource recovery in WWTPs can be cost-effective even in smaller scale plants if the right stakeholders are involved and if there are the right incentives in place. Retrofitting existing plants in an innovative way can be a solution toward sustainable wastewater management instead of building new infrastructure with the latest technology.

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