Department of Energy

When Life Gives You Onion Scraps, Make Electricity

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Gills Onions had a problem: Too much onion waste.

As one of the largest US onion processors, the Oxnard, Calif. company produces chopped and sliced onions for retail, bulk and foodservice sale. This creates up to 1.5 million pounds of onion trimmings a week. Until last year, the company simply spread the onion byproduct on fields. Unfortunately, this waste disposal system cost a lot of money, required storage and created odors, pests and potential groundwater contamination. At the same time, Gills Onions anticipated growing electricity costs.

"It was becoming really expensive and unmanageable to dispose of the waste by land application," says Nikki Rodoni, Director of Sustainability for Gills Onions. "Converting waste to energy was the best [solution]."

So the company commissioned a solution: a biomass and fuel cell system that turns onion trimmings into clean, renewable electricity.

Fuel cell, onion cell and electricity

The onion waste powers two 300 kW fuel cells, which produce enough electricity to meet up to 100 percent of the processing plant's baseline energy needs. That's the energy the plant needs just to stay functioning, which includes a great deal of refrigeration to keep the onions at a temperature of 36 degrees, which helps extend the life of the onions. All in all, Rodoni says, the system produces about 40 percent of the plant's energy. If run full-time, 365 days a year, it's capable of producing up to 5,256 MW-hours of electricity.

The onion-waste-to-energy system uses two parts: a biomass system that turns onion waste into hydrogen gas, and fuel cells that turn that hydrogen into electricity.

The onion tops, tails and trimmings are juiced, and the sulfur (the substance in onions that makes people cry) is removed from the juice. The juice is then mixed with water and fed through an anaerobic digester containing a series of bacteria that consume the sugars in the onion juices. One eventual result is methane, which is stripped of its hydrogen. That hydrogen is then fed into the two 300 kW fuel cells, producing electricity.

"We wanted an energy recovery system that produced clean heat and electricity, so we ruled out combusters and boilers and chose the fuel cells instead," Rodoni says.

The exhaust products are carbon dioxide and water, plus heat that will someday be recycled into the anaerobic digester. (The system currently uses waste heat from the processing plant for this purpose.) The onion solids are sold as animal feed.

"We have two dairies we sell the fibrous part of the waste after the juice has been extracted," Rodoni says. "Our profits are very minimal, but it's better than having it as a liability."

Savings spurs interest

The system has only been running since the fall of 2009, so the company doesn't have year-to-year energy consumption comparisons available. But Rodoni says it's already saving Gills Onions thousands of dollars. Savings from not applying onion waste to the fields total $450,000, and energy cost savings total about $700,000 more. The company was also able to take advantage of grants -- including a $2.7 million grant from the state of California -- incentives and tax credits. Even though the system cost a total of $10.8 million, Gills Onions estimates it will pay for itself in three to five years.

To develop its $10.8 million waste-to-electricity system, Gills Onions had help from grants and incentives including:

- A $2.7 million grant from the California Self Generation Incentive Program.
- $499,000 from the California Energy Commission's PIER-NG Renewable Grant Program to fund research on removing sulfur from onion juice.
- $1.8 million in Energy Investment Tax Credits from the federal government, for investment in fuel cells.

The system was ten years in the making, in part because nothing like it existed when development started. Now, Gills Onions is starting to help other agricultural processors turn their own waste into energy, something that could transform their industry. Rodoni says the system can't be generalized to every agricultural product, because every vegetable and animal waste has its own chemical composition that needs different bacteria and chemical reactions to process.

"We have a hard time even keeping up with the requests to understand this technology," she says.

Advancing further

Nonetheless, Gills Onions is not resting on its laurels. The company is already working on two ways to improve its onions-to-energy system. One is finding a way to store excess energy created during the peak onion processing season for leaner times. Another is addressing the system's high water demand without using up precious potable water, a sustainability issue in southern California.

"We do have a wastewater treatment plant on site, and we'd like to not use potable water, but recycle our wastewater," she says. "But we have to work on a really good filtration system, because we don't want to lose bacteria by adding something that could hurt the bacteria."

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