Putting Waste to Work for Oregon

HOW ANAEROBIC DIGESTION TECHNOLOGY CAN IMPROVE OUR ENERGY FUTURE

Energy Trust of Oregon

From Waste to Watts

Solar panels and wind turbines are recognizable sights around Oregon and play an important role in generating clean, renewable energy. Anaerobic digesters also produce renewable power using dairy cow waste, municipal wastewater solids, restaurant grease and table scraps while delivering profound business and community benefits.

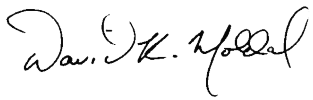
Technological advancements in anaerobic digestion provide even more for Oregon than clean, renewable electricity. They help provide a solution to managing and recovering food and other organic wastes and materials that would traditionally be landfilled. In addition, anaerobic digestion technology improves local air and water quality, recovers nutrients and produces a local source of fertilizer for our farms. These projects also reduce greenhouse gas emissions and create jobs—all while generating new revenue streams and cost savings for our farmers, small businesses and water treatment facilities.

Energy Trust of Oregon and the Oregon Department of Energy have been instrumental in the success of anaerobic digestion projects to date, and are deeply invested in expanding the development of future projects. These benefits are one of the reasons that Oregon Governor John Kitzhaber highlighted anaerobic digestion in the 10-Year Energy Action Plan and recommended that the state pursue additional efforts to advance these projects.

As you will learn in the following success stories, biopower projects using anaerobic digestion can help municipalities become more energy independent, reduce costs and create alternatives to dumping fats, oils and grease into sewers. They support Oregon's agricultural industries by helping manage animal waste and nutrients on the farm, while recycling animal bedding and reducing odors. These projects can help transform our traditional organic waste management systems through integration of food waste collection and composting programs.

Widespread throughout Europe, anaerobic digestion is still growing here in the U.S. and there are barriers facing the development of new facilities. These barriers can be overcome—with incentives, funding and policies that spark technological innovation and open up market opportunities for biopower—provided we have the shared vision, leadership and commitment. It's time to put this technology to work.

Regards,



Dave Moldal
renewable energy project manager
Energy Trust of Oregon

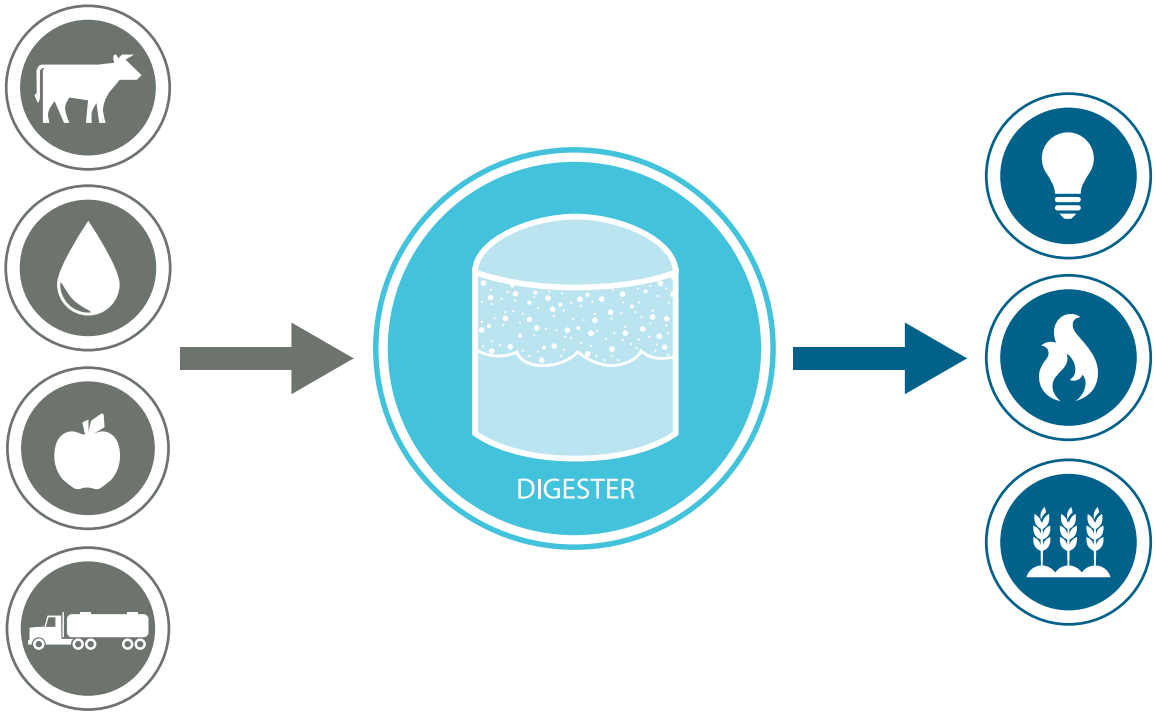
Matt Krumenauer
senior policy analyst
Oregon Department of Energy

According to The Climate Trust, Oregon's dairies, wastewater treatment plants, municipal solid waste collectors and food processors collectively produce enough organic material to generate about 100 megawatts of biogas capacity annually—enough electricity to power all the homes in the City of Salem for a year. As of 2014, there are only about 20 MW installed. This underutilized resource has enormous promise to add value to communities right here in Oregon.

How Does Anaerobic Digestion Work?

Anaerobic digesters decompose a variety of waste materials, or feedstocks, such as livestock manure, municipal wastewater solids, food waste, fats, oils and grease, and other organic wastes. Anaerobic digestion occurs when microorganisms (bacteria) break down organic material (carbohydrates, lipids and proteins) in the absence of oxygen.

Biogas, consisting mostly of methane, is produced, captured, cleaned of contaminants and used to generate electricity to power and heat facilities. Biogas may also be compressed to serve as a transportation fuel. Dairy digesters and merchant biogas plants may also produce other valuable byproducts including phosphorus and nitrogen-rich liquid fertilizer, and a fiber solid that can be used as a soil amendment, compost or livestock bedding.



WASTE MATERIALS

CLEAN ENERGY AND VALUABLE BYPRODUCTS

SUCCESS STORY 1

City of Gresham Wastewater Treatment Plant

NET-ZERO ENERGY AMBITIONS RETURN BENEFITS TO RATEPAYERS

The City of Gresham's wastewater treatment plant is transforming itself from a power user into a power producer. In 2015, the city's goal is to become a net-zero energy facility by generating all the energy that the plant needs by using a combination of energy efficiency and onsite renewable energy production.

Gresham's renewable energy work with Energy Trust began in 2005, when it installed a 395-kilowatt combined heat and power, CHP, system. This reciprocating engine, fueled by biogas produced from the anaerobic digestion of municipal wastewater solids, generated renewable electricity to help offset the plant's power demand.

In short order, Gresham's system was saving close to $20,000 per month in utility costs and reduced the wasteful flaring of digester gas to practically zero. Maintenance costs were reduced as a result of running more efficient equipment.

Five years later, an internal energy management team began to look for ways to improve plant efficiency and reviewed the CHP production data. The team found that the single engine was producing half the power the plant needed on an annual basis. Once again, the city began looking at ways to produce more biogas and increase renewable energy generation.

In late 2012, Gresham was the first wastewater treatment plant in Oregon to install a fats, oils and grease, FOG, receiving and processing facility, which feeds into the treatment plant's anaerobic digesters to produce more biogas and generate more electricity. Gresham recognized that the collection of FOG would be a significant benefit to the city as it would also reduce high maintenance costs related to sewer clogs. The FOG receiving station was expanded, allowing the city to nearly double the daily intake from 8,000 gallons to 15,000 gallons.

Waste haulers appreciate access to a convenient location to take a product that was difficult to dispose of in the past. The wastewater treatment plant generates additional revenue through tipping fees collected from haulers at the time of disposal.

Gresham is in the process of installing a second 395-kW co-generation engine to take advantage of additional biogas production. Once this engine achieves commercial operation in 2015, it will greatly increase renewable energy generation and help the facility achieve its goal of energy independence. Co-generation is just one part of Gresham's plan—a 420-kW ground-mounted solar array located adjacent to the plant produces about 8 percent of the plant's annual energy needs.

Energy Trust played an important role by providing project development assistance and incentives for the co-generation projects, and providing incentives for the solar system and energy-efficiency improvements to the aeration process and digester mixing equipment. The Oregon Department of Energy also provided Business Energy Tax Credits to help offset Gresham's investment costs.

Alan Johnston, senior engineer, City of Gresham Wastewater Treatment Plant, keeps a detailed spreadsheet to document the investment, which includes payback, capital costs, ongoing maintenance costs, revenues and savings. The city estimates that once the plant's energy-efficiency and generation projects are complete, it will realize approximately $500,000 per year in avoided electric utility expenses. Tipping fees paid by the haulers of FOG and other organic waste will generate another $250,000 per year in revenue.

"Our leadership is always thinking about benefits to our ratepayers," said Johnston. "The investment in this project will help stabilize rates and keep increases to a minimum."

“The wastewater treatment process is very energy intensive with lots of complex equipment and systems. We’re trying hard to become net-zero in a cost-effective manner. Every project we do must be energy efficient, and we have to make sure the projects we invest in have reasonable paybacks. By doing those things well, we have a better chance of achieving our goal, which will keep our costs low and stabilize wastewater rates for our whole community.”

Alan Johnston, senior engineer,
City of Gresham Wastewater Treatment Plant

From left, Jeff Maag and Alan Johnston

Fats, Oils and Grease

The fats, oils and grease, or FOG, found in fried foods, salad dressings and dairy products is problematic if dumped down the drain. Commercial food establishments—such as restaurants, hotels and hospitals—are sources of the greasy discharge that can find its way into the sewer system. If unchecked by grease traps, FOG can clog drains, overflow pipes and leach raw sewage into streets and waterways, costing utilities hundreds of thousands of dollars every year in clean-up costs. By taking FOG to a receiving station, the waste is used in the production of biogas for renewable energy production.

PROJECT-AT-A-GLANCE

Project team

- City of Gresham Wastewater Services
- Energy Trust
- Oregon Department of Energy
- PGE

Financial analysis

Phase I, first CHP system

- $1.35 million project cost
- $82,379 Energy Trust cash incentive
- $287,801 Business Energy Tax Credit from the Oregon Department of Energy

Phase 2, second CHP system and FOG receiving station

- $4.1 million project cost
- $330,000 Energy Trust cash incentive
- $1,064,774 tax credit certification from the Oregon Department of Energy’s Energy Incentives Program

395-kW co-generation engine

FOG receiving and processing facility

SUCCESS STORY 2

Forest Glen Oaks Dairy Farm

DIVERSIFYING BUSINESS WITH DAIRY WASTE

Jamie Bansen is a third-generation owner of the Forest Glen Oaks dairy farm in Dayton. The farm, established 70 years ago by her grandparents, runs three related lines of business: production of certified organic milk from 2,000 registered Jersey cows, an internationally recognized breeding program featuring prized Jersey bulls, and most recently, the production and sale of electricity derived from dairy waste.

Revolution Energy Solutions, RES, developed, owns and operates the biogas plant that transforms the dairy's 50,000 gallons of cow manure per day into clean, renewable energy. Energy Trust provided a significant cash incentive to support the renewable energy generation.

Al Tank, managing partner and CEO of RES, learned about Forest Glen Oaks' reputation for innovation and leadership through connections at Oregon State University. Tank grew up on a farm in Iowa and developed expertise in dairy biogas production in Brazil and Mexico.

"My business partner, Brian Barlia, and I walked the farm with Jamie, her father Dan and a third co-owner, Robert Kircher, in 2009. They came to view the waste-to-energy operation as an important step in upgrading their farm's sustainability and managing its resources," Tank explained.

Bansen recalled being wary at first. The dairy had been approached by a number of biogas operators, each with a different digester technology and financing arrangements. "Al told us to hold off deciding until the first RES project in Oregon, Lochmead Farms in Junction City, started up," she said. "It soon did and we saw that we could integrate a facility like that into our operations fairly easily."

In its simplest form, the biogas plant uses anaerobic digestion to transform the dairy waste into methane gas—a process similar to fermentation used in the production of beer or bread.

Jersey dairy cow


Anaerobic digesters

The process begins by pumping manure from the farm into a pair of tanks. The liquid is heated, maintained at a constant temperature and mixed in an oxygen-free environment. Bacteria in the tanks digest the manure and produce a renewable biogas comprised mostly of methane. The biogas is cleaned of impurities and then used to fuel a co-generation engine, which produces heat for the tanks and renewable electricity that is delivered and sold to PGE. The facility produces approximately 3.1 million kilowatt hours of electricity annually, enough to power nearly 300 average Oregon homes.

Forest Glen Oaks was the third biogas project in Oregon for developer RES. Each project uses the same patented low-temperature anaerobic digester technology that was introduced by RES in the U.S. at Lochmead Dairy in 2012. "The system uses heat from the generator engine to maintain a temperature of 70-75 degrees Fahrenheit," explained Tank. "The relatively low temperature of manure in the digester tanks makes it easier to monitor and control remotely."

While the biogas produced through anaerobic digestion fuels the co-generation engine, two byproducts are put to work on the farm. First, a nutrient-rich liquid provides fertilizer for the organic dairy's feed crops. The dairy composts the second byproduct, an inert fiber, for use as clean bedding for dairy cows. Excess fiber is sold to nearby vineyards to be used as mulch around the base of grape vines.

The benefits of the biogas plant extend beyond renewable energy. Greenhouse gas emissions are reduced, which improves air quality, and collecting and processing the dairy waste provides material management benefits that help protect water quality.

> **We're an organic farm and we can't use commercial fertilizers. We used to spread manure on pastures after they were grazed. The pastures bounce back much faster now when treated with the digester liquid, because the nitrogen is in a form that is more readily available to crops.**
>
> Jamie Bansen, owner
> Forest Glen Oaks dairy farm

Resulting fiber to be used as mulch or cow bedding

PROJECT-AT-A-GLANCE

Project team

- Forest Glen Oaks dairy farm
- Revolution Energy Solutions, LLC
- Energy Trust
- Oregon Department of Energy
- PGE
- The Climate Trust
- McMinnville Water & Power

Financial analysis

- $2.2 million project cost
- $441,660 Energy Trust cash incentive
- $400,000 Oregon Business Energy Tax Credit
- Oregon biomass producer/ collector tax credits

SUCCESS STORY 3

City of Pendleton Wastewater Treatment Plant

INVESTING IN EFFICIENCIES AND REDUCING COSTS

The City of Pendleton Wastewater Treatment Plant is one of nine Oregon wastewater treatment facilities that uses anaerobic digestion to treat municipal wastewater solids and reuses the resulting methane gas to generate renewable energy and power its own operations.

Inspired by its use of this renewable resource, the city views the facility as both a wastewater treatment plant and a resource recovery facility that finds new ways to recover and reuse energy, and identifies new uses for the byproducts from the wastewater treatment process.

"Anything that we can do to recover energy, and make a useable or saleable product, is worth it in terms of saving money," said Mark Milne, plant superintendent, City of Pendleton.

In 2005, the City of Pendleton started looking at a whole-plant upgrade and wanted to find a way to reuse the methane gas produced at the plant. At the time, it was simply flaring the biogas, which was looked at as a waste of a resource. A $19 million improvement plan predicted an increase in local population growth, which meant the plant would receive more waste and produce more biogas. A strategy for using the biogas became a top priority.

With support from Energy Trust, Pendleton installed two 65-kW CHP microturbine engines in 2012. The microturbines generate electricity that is used by the plant. Heat from the engines is also put to use. "Our local leadership saw the value of this investment right away," continued Milne. "Prior to installing the CHP system, we were burning our biogas in a boiler, which was oversized for the amount of heat we needed. It was inefficient, costly and a maintenance nightmare."

Anaerobic digesters

Ground-mounted solar array

With more capacity in the digester than it needed in the short term, the city installed an organic waste receiving station and now accepts grease and food processing wastes from local commercial and industrial sites. The plant's major challenge is securing enough available organic waste streams for co-digestion.

"We're not running at full capacity yet," said Milne, "but we're working on getting there. We're a rural community that's quite spread out so we're building our market among suppliers and haulers to make sure they know we're here and that we have the proper equipment to accept their product."

Prior to installing the receiving station, waste haulers had few places other than the landfill to take material from local grease traps, so the city was reluctant to enforce local grease ordinances. Once the plant was able to accept and use FOG, the city renewed its efforts to encourage restaurants and other businesses to maintain their grease traps. The city is educating haulers about the local receiving station and how they can receive state tax credits that help lower their tipping fees—a benefit not available at the landfill.

"Now that we have a local place to take the grease, we're hoping the price for hauling it away will go down and it will be more reasonable for businesses to participate," Milne explained.

Biosolids produced by the process are used as a soil amendment on city-owned farmland, which adds valuable nutrients to help replenish the soil. Long-term, the city is looking at ways to capture the fertilizer value from these biosolids and market it as a separate product.

Pendleton's program is still a work in progress. Armed with a forward-leaning energy development plan and unlimited amounts of creativity, the plant is proof that even smaller treatment operations have great capacity to become biopower producers.

> **Our goal is to keep our operations as efficient as we can, and keep costs under control to benefit the community. By becoming more efficient, and making investments that help us improve water quality and save energy, we're realizing even more benefits. We've learned that energy efficiency and our biopower system have a positive impact on everything else.**
>
> Mark Milne, plant superintendent
> City of Pendleton

PROJECT-AT-A-GLANCE

Project team

- City of Pendleton Wastewater Services
- Energy Trust
- Oregon Department of Energy
- Pacific Power

Financial analysis

- $3.7 million project cost
- $300,000 Energy Trust cash incentive
- $1,337,564 Oregon Business Energy Tax Credit

Delivering FOG

SUCCESS STORY 4

JC-Biomethane Biogas Plant

GENERATING ENERGY FROM COMMERCIAL FOOD WASTE

JC-Biomethane, LLC, in Junction City, is the first biogas plant in the Pacific Northwest to produce energy from the digestion of post-consumer commercial food waste.

While most biogas facilities process a single feedstock, such as municipal wastewater solids or dairy manure, JC-Biomethane co-digests post-consumer commercial food waste, as well as smaller volumes of dairy waste and fats, oils and grease from food processing plants and other sources. Unlike other facilities that generate energy to be used on-site, JC-Biomethane is an independent power producer and sells the electricity it produces to PGE.

Recognizing a distinct opportunity to develop a biogas plant that would convert food waste to renewable energy, developers looked to Energy Trust and the Oregon Department of Energy for financial and technical support. Construction of the biogas plant started in late 2011. The clean and nearly odorless renewable energy plant began producing renewable gas and generating electricity in fall 2013.

After trucks bring in 85 tons of organic waste per day, the multi-step process starts with a Swiss-made bioseparator breaking down the waste and removing non-digestible contaminants such as metal and plastic co-mingled with the organic waste. This state of the art bioseparator is the first known application of this technology in the U.S.

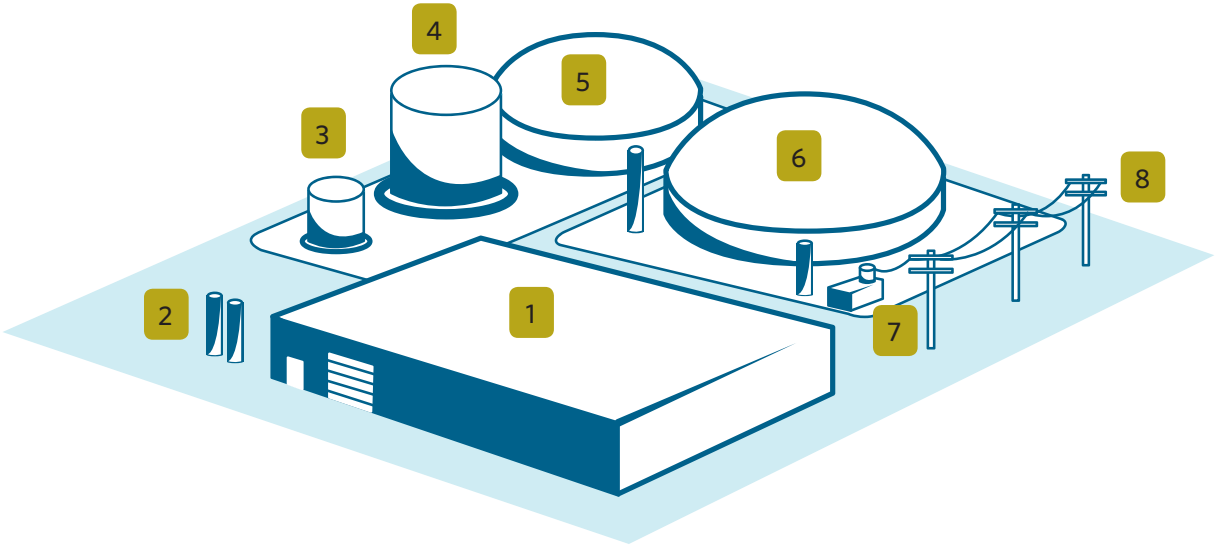
The biogas produced at the facility fuels a 16-cylinder reciprocating engine, similar to a locomotive engine, that generates electricity. With a 1.56-MW capacity, the co-generation engine produces approximately 12,250 megawatt hours of electricity annually, which is sold to PGE through a wheeling arrangement with the Blachly-Lane County Cooperative Electric Association and Bonneville Power Administration.

Approximately 25,000 tons of organic materials feeding JC-Biomethane were previously disposed of in landfills. Diverting these materials to the biogas plant prevents the release of greenhouse gases. It also recovers valuable nutrients found in the organic materials, which may be sold as agricultural fertilizer.

Like most energy projects, JC-Biomethane has hit a few bumps along the way. While revenue and power production estimates have been right on target, operating costs have been higher than anticipated. Some deliveries of organic material have included contaminants that slow down the system and require more manpower to manage. The company has received support from its regional recycling and waste management authorities, which helped improve education about disposal and sorting of acceptable materials.

> **We're proud to be the first biogas plant in the Pacific Northwest to produce energy from the anaerobic digestion of post-consumer food waste, and Energy Trust's incentives and expertise were instrumental in making this endeavor a reality.**

Dominic Vacca, CEO
JC-Biomethane



1. Bioseparator
2. Liquid waste tanks
3. Homogenization tank
4. Digester tank
5. Post-digester tank
6. Liquid digestate tank
7. Co-generation unit
8. Power interconnection

PROJECT-AT-A-GLANCE

Project team

- Essential Consulting Oregon, LLC
- Energy Trust
- Oregon Department of Energy
- PGE
- Blachly-Lane County Cooperative Electric Association
- Bonneville Power Administration
- Lane Forest Products
- FormTec GMBH

Financial analysis

- $16 million project cost
- $2 million Energy Trust cash incentive
- Approximately $3 million federal grant in lieu of an Investment Tax Credit
- $1.7 million in federal funding through the American Recovery and Reinvestment Act of 2009
- $1 million Oregon Business Energy Tax Credit (third party pass-through amount)

Estimated annual savings

- About $1 million in power sales
- About $1 million in fees from waste haulers and sales of byproducts

Post-consumer commercial food waste

Guests get a guided tour of the plant

1.56-MW co-generation engine

Participation and Assistance

FINANCIAL AND TECHNICAL RESOURCES TO LAUNCH NEW PROJECTS

In 2007, the state legislature created a Renewable Portfolio Standard that requires the largest utilities in Oregon to provide 25 percent of their electric retail sales from newer, clean, renewable sources of energy by 2025. The state adopted incentives for promoting more renewable power, and refined regulatory policies that would encourage more distributed resources.

Thanks to programs and investments by Energy Trust, the Oregon Department of Energy and utilities, the state is largely on track to meet its renewable energy goals. Growth in biopower projects will further progress toward achieving the state's objective. Resources, technical assistance and financing information are available from several organizations including:

Energy Trust

Energy Trust is an independent nonprofit organization dedicated to helping utility customers benefit from saving energy and generating renewable power. Since 2002, Energy Trust services, cash incentives and solutions have helped participating customers of Portland General Electric, Pacific Power, NW Natural and Cascade Natural Gas save on their utility bills.

Energy Trust's renewable energy sector provides project development assistance and cash incentvies to lower project costs for new biopower, solar electric, wind, hydropower and geothermal energy systems less than 20 MW in size.

Project support is available to businesses, farms and municipalities interested in using organic materials to generate clean, renewable electricity. Resources include technical assistance and cash incentives to support various project development steps, including feedstock assessments, interconnection and transmission studies, feasibility studies and pre-design studies.

Through 2014, Energy Trust supported completion of 13 innovative biopower projects, and expanded financial and technical assistance to help project developers overcome market barriers.

Learn more at **www.energytrust.org/biopower** or 503.445.2476.

Oregon Department of Energy

Through its Business Incentives program, the Oregon Department of Energy offers grants for qualifying renewable energy projects, including biomass.

Through Business Oregon, the state provides Rural Renewable Energy Development Zones, which offer an incentive to encourage investments that harness biomass, wind, geothermal, solar or other unconventional forms of energy in Oregon to generate electricity, or produce, distribute or store a wide variety of biofuels.

The Oregon Small-Scale Energy Loan Program was created in 1981 to finance small-scale, local energy projects. The program offers low-interest loans to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes and nonprofits for projects that:

- Save energy
- Produce energy from renewable resources such as biomass, water, wind, geothermal, solar, waste materials or waste heat
- Use recycled materials to create products
- Use alternative fuels
- Reduce energy consumption during construction or operation of another facility

The Biomass Producer Collector Tax Credit is administered by the Oregon Department of Energy for the production or collection of biomass that is used for biofuels or bioenergy production.

Learn more at **www.oregon.gov/energy** or 503.378.6043.

Ground-mounted solar array at Gresham Wastewater Treatment Plant

Delivering FOG to Gresham Wastewater Treatment Plant

Wastewater aeration basin at Gresham Wastewater Treatment Plant

Oregon Association of Clean Water Agencies, ORACWA

ORACWA provides access to studies and other resources regarding renewable energy projects at wastewater treatment plants.

Learn more at **www.oracwa.org**.

U.S. Environmental Protection Agency, AgSTAR Program

The AgSTAR Program is a voluntary outreach and educational program designed to reduce methane emissions from livestock waste management operations by promoting the use of biogas recovery systems.

Learn more at **www.epa.gov/agstar**.

U.S. Department of Agriculture, Rural Energy Assistance Program, REAP

REAP offers grants and/or loan guarantees for the purchase and installation of renewable energy generating systems. Assistance is limited to small businesses, farmers and ranchers with projects located in a rural area.

Learn more at **www.rurdev.usda.gov/or** or 541.278.8049.

The Climate Trust

The Climate Trust is a nonprofit specializing in climate solutions for governments, utilities and large businesses. It provides carbon financing to greenhouse gas emission reduction programs, including dairy farm biogas projects.

Learn more at **www.climatetrust.org** or 503.238.1915.

Opportunities for Anaerobic Digestion

Anaerobic digestion—a process that uses bacteria in an oxygen-free environment to convert organic food and animal waste into methane gas—has been used for decades to treat wastewater and other material.

Now this technology has grown beyond wastewater treatment and is emerging as a cutting-edge solution for many types of users to help capture, recover and extract energy from waste materials that have been traditionally discarded.

This booklet features four projects in Oregon that are putting this technology into action to accomplish energy and environmental goals. You'll find more information about how anaerobic digestion and the harnessing of its biogas has the potential to improve Oregon's energy outlook unlike any other renewable resource.

Which industries are well-suited for this technology?

- Dairy farms
- Municipal solid waste facilities
- Municipal wastewater treatment plants
- Food processing facilities and food distribution warehouses

How can cities, farms and businesses benefit?

- Facilities reduce energy use and control operating costs
- Municipalities reduce energy costs and add potential revenue sources
- Ratepayers benefit from reduced wastewater plant operating costs
- Workers improve productivity and efficiency
- Dairy farms and food waste collection facilities improve odor control and reduce pollutants in local waterways
- Communities see improved water and air quality, recovery of nutrients and reduced demand for power generated from fossil fuels

To learn more, contact Energy Trust at **www.energytrust.org/biopower** or 503.445.2476 or the Oregon Department of Energy at **www.oregon.gov/energy** or 503.378.6043.

oregon association of CLEAN WATER agencies

OREGON DEPARTMENT OF ENERGY

EnergyTrust of Oregon

Energy Trust of Oregon 421 SW Oak St., Suite 300, Portland, OR 97204 | 1.866.368.7878 503.546.6862 *fax* | **energytrust.org**