Cogen Expansion Project

Gresham Wastewater Treatment Plant Goes Energy Net Zero

APWA-Oregon Public Works
Project of the Year

Category:
Environmental,
Less than $5 million

City of Gresham
Carollo Engineers
JRT Mechanical
ADK Electric
Veolia North America

PUBLIC WORKS PROJECT OF THE YEAR NOMINATION FORM

AMERICAN PUBLIC WORKS ASSOCIATION

SUBMITTAL DEADLINE: Monday, August 31, 2015

PROJECT INFORMATION

Cogen Expansion Project: Gresham Wastewater Treatment Plant Goes Energy Net Zero
Project Name

January 2015
*Project Completion Date**

City of Gresham
Public Agency

PROJECT CATEGORY (select one):

- ☐ Structures
- ☐ Transportation
- ☒ Environmental (Water, Wastewater, Stormwater)
- ☐ Historical Restoration/Preservation
- ☐ Disaster or Emergency Construction/Repair

PROJECT DIVISION (select one):

- ☒ Less than $5 million
- ☐ $5 million to less than $25 million
- ☐ $25 million to $75 million
- ☐ More than $75 million

*Must be substantially complete and available for public use within two calendar years prior to nomination.

MANAGING AGENCY

Jeff Maag
Name

Civil Engineer II
Title

City of Gresham
Agency/Organization

1333 NW Eastman Parkway
Address (if post office box, include street address)

Gresham
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Zip

jeff.maag@greshamoregon.gov
Email

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Phone

(503) 665-6825
Fax

PRIMARY CONTRACTOR

Sven Johnson
Name

Project Manager
Title

JRT Mechanical, Incorporated
Agency/Organization

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State

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Phone

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Fax

PRIMARY CONSULTANT

Jeff McCormick	Principal Engineer
Name	*Title*

Carollo Engineers, Incorporated

Agency/Organization

720 SW Washington St Suite 550

Address (if post office box, include street address)

Portland	OR	97205
City	*State*	*Zip*
JMcCormick@carollo.com	(503) 227-1885	(503) 227-1747
Email	*Phone*	*Fax*

NOMINATED BY *(only managing public agency or APWA Chapters eligible to nominate)*

Jeff Maag	Civil Engineer II
Name	*Title*

City of Gresham

Agency/Organization

1333 NW Eastman Parkway

Address (if post office box, include street address)

Gresham	OR	97030
City	*State*	*Zip*
jeff.maag@greshamoregon.gov	(503) 618-3455	(503) 665-6825
Email	*Phone*	*Fax*

SUBMIT APPLICATION PACKET TO:

Public Works Project of the Year • Awards Program
City of Oregon City
ATTN: John Lewis, P.E.
P.O. Box 3040
625 Center Street
Oregon City, OR 97045
jmlewis@orcity.org
503.496.1545

NOTE: Supporting documentation is **limited to twenty (20) pages,** exclusive of photographs (10 to 20 photos of the project including a few "before" photos if possible) and the nomination form. **This submittal will not be returned.** Please submit your application by the deadline identified at the top of this application by both of the following methods:

- **Email** – Send by email a digital copy of the nomination form and supporting documentation. If possible, include 10 to 20 photographs of the project which can be sent, if necessary, by more than one email.
- **Hard Copy** – Hand deliver or send by US mail (postmarked by due date) or delivery service one "hard" copy of the nomination form and supporting documentation. Include a USB flash drive (or CD) with 10 to 20 photographs of the project along with a digital copy of the nomination form and supporting documentation.

SUBMITTAL GUIDELINES
Public Works Project of the Year

PLEASE ADDRESS EACH OF THE FOLLOWING AREAS IN YOUR SUPPORTING DOCUMENTATION ADHERING TO THE BELOW SEQUENCE WHEN POSSIBLE.

- General description of the project.
- Completion date contained in contract. Any time extensions granted should be addressed in the submittal.
- Construction schedule, management, and control techniques used.
- Safety performance including number of lost-time injuries per 1,000 man hours worked and overall safety program employed during the construction phase.
- Community need – a summary of how the project met the community needs as related to economic challenges, value engineering, creative use of resources, to the measurable benefit to the community.
- Sustainable practices – use of alternative materials, practices, or funding that demonstrates a commitment to sustainability.
- Environmental considerations including special steps taken to preserve and protect the environment, endangered species, etc., during the construction phase.
- Community relations – a summary of the efforts by the agency, consultant and contractor to protect public lives and property, minimize public inconvenience and improve relations.
- Unusual accomplishments under adverse conditions, including but not limited to, adverse weather, soil or site conditions, or other occurrences over which there was no control.
- Additional considerations you would like to bring to the attention of the project review panel such as innovations in technology and/or management applications during the project. Include a description of special aspects of the project.

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Title of Entry: Cogen Expansion Project: Gresham Wastewater Treatment Plant Goes Energy Net Zero

Project Category: Environmental (Water)

Project Location: Gresham, Oregon

Project Purpose: Make the Gresham Wastewater Treatment Plant energy net zero to benefit ratepayers and the environment.

Completion Date: January 2015

Final Completion: Fall 2015

Timing and Schedule for Implementation:

FOG Feasibility Study 2009

Cogen Expansion Pre Design 2013

Cogen Expansion Design 2013/2014

Notice to Proceed April 1, 2014

Engineering Predesign and Design:

$571,841

Construction cost:

$2,172,712

Managing Agency:

City of Gresham, Department of Environmental Services, Wastewater Division

Primary Consultant:

Carollo Engineers, Incorporated

Primary Contractor:

JRT Mechanical, Incorporated

Introduction

With the completion of the Cogen Expansion Project, the City of Gresham Wastewater Treatment Plant (WWTP) has achieved its seven year old goal of becoming energy net zero. Using the biogas byproduct from anaerobic digesters to fuel cogeneration (cogen) engines the plant now generates more electricity than it uses on an annual basis and has turned the City's biggest energy user into the City's biggest energy producer. The Gresham WWTP is a shining example of the new way of looking at wastewater treatment and blazing a trail to be emulated nation-wide. It's not just about treating waste, it's about recovering resources - in this case generating renewable energy worth over $500,000 annually.

A key element to this success was the installation of the Fats Oils and Grease (FOG) Station at the WWTP. Codigestion of FOG (a waste product from restaurant grease traps) with ordinary wastewater sludge in the anaerobic digesters has doubled biogas production, which in turn allowed electrical production to double. With a tip fee of 8 cents per gallon, receiving FOG also brings in approximately $250,000 annually.

As the Pacific Northwest's first energy net zero WWTP and one of only a handful in the U.S. the WWTP is getting national and international attention. As such, it is helping to promote the use of this reproducible technology. It is estimated that only eight percent of WWTPs in the United States with anaerobic digestion generate electricity or hot water as a renewable energy resource. According to the U.S. EPA up to 400 MW of additional renewable electrical power could be generated with the installation of cogen units (or other combined heat and power systems) at facilities where it is currently feasible. 400 MW of biogas-based renewable energy would prevent approximately three million metric tons of carbon dioxide emissions annually, equivalent to the emissions of approximately 596,000 passenger vehicles (U.S. EPA Combined Heat and Power Partnership, 2011)

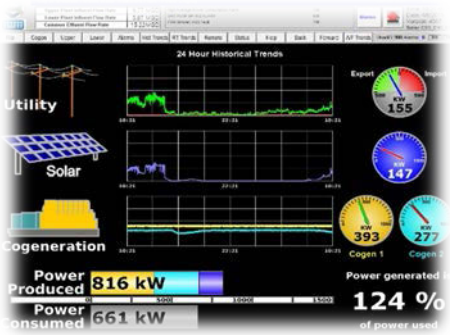
Project Background

The City of Gresham Wastewater Treatment Plant (WWTP) became energy net zero on February 12, 2015 with the completion of the Cogen Expansion Project. The plant now produces more energy than it consumes. All months since February 2015 have been energy net zero months. It is the first energy net zero WWTP in the Pacific Northwest, and one of a handful in the United States. The plant utilizes biogas from the two plant anaerobic digesters to fuel two 400 kW cogen combined heat and power engines which generate electricity and hot water. Veolia North America is the contract operator of the plant.

The WWTP has used cogen on site since the 1990's. Between 1990 and 2004, a 250 kW Waukesha cogen was operated. In 2005, it was replaced by a 400 kW CAT cogen that produced approximately 55 percent of WWTP power needs. The hot water produced by cogen is used by the WWTP to keep the sludge in the two 1,000,000 gallon digesters at 98 degrees, and also to heat five campus buildings.

With the Cogen Expansion Project, a second 400 kW CAT cogen unit was installed which enabled the WWTP to generate all the energy needed to operate the plant. The WWTP's first energy net zero day was February 12, 2015 and each month since has been energy net zero. Trends indicate that 2015, and all future years will be energy net zero for the plant.

The new cogen engine, the heart of the Cogen Expansion Project



SCADA screen shot from April 6 at 10:21 a.m. - at this particular time, 155 kW of WWTP plant power production (about 20 percent) is being exported to grid

The WWTP has a net metering agreement with Portland General Electric (PGE). The net metering agreement with PGE allows the City to put power on the grid during periods of high production or low consumption. The City receives credit for the power put on the grid, which in turn, can be used during periods of low production or high demand. The WWTP will only rely on grid power when one or both cogen units are down for maintenance. During those times, the plant will not be billed for grid power because the WWTP will be able to use credit for excess power that was previously exported to the grid. The annual net metering cycle restarts every March 1 – at that time, the net meter credit total (for excess power exported to the grid) is reset to zero.

The predesign for the Cogen Expansion project was completed in 2013 by Carollo Engineers. During this process, it was determined that another 400 kW cogen would meet current WWTP needs while allowing for future growth.

The design effort for the Cogen Expansion Project started in 2013 and was completed in early 2014 by Carollo Engineers. The design process was complicated by the fact this was not a “green field” design, rather it retained the existing building and adapted the existing cogen system which included complex controls, the plant heat loop, electrical elements, the biogas fuel train including biogas scrubbing. The final design called for very limited work shut downs for the existing cogen system and the power distribution center. The scheduled shutdowns went well and plant operations (a major concern) were never adversely affected in an unscheduled way.

The basic work sequence was designed as follows to minimize downtime:

1) Install new electrical ductbank. Install new standby genset outside of the digester control building and complete switchgear modifications in the lower blower building Power Distribution Center to accommodate new standby genset. Install hot water loop cogen bypass valves, new digester gas blower and digester gas filter during 24 hour shutdown;
2) Remove existing standby genset from digester control building to make room for new cogen;
3) Make boiler and sludge heat exchanger modifications;
4) Relocate existing hot water loop equipment and make modifications to the existing cogen system;
5) Install new hot water loop and jacket water loop components;
6) Install new cogen unit and jacket water piping;
7) Startup, testing and controls.
8)

Pouring electrical ductbank

Route of new ductbank was complicated by presence of existing operational plant lines and electrical duct bank

Lower portion of new electrical ductbank linking lower blower building power distribution center with cogen engine switchgear in digester control building

Removing old standby genset from digester control building to make room for new, second cogen unit

Removing old standby genset. Notice cut out (right) for new garage door in Digester Control Building to accommodate second cogen unit

Load testing new outdoor standby genset

Preparing spot for new cogen unit

Working on the foundation for new cogen unit

Moving in switchgear

Moving the exhaust heat exchanger into the building

Small forklift brought in to help move the exhaust heat exchanger

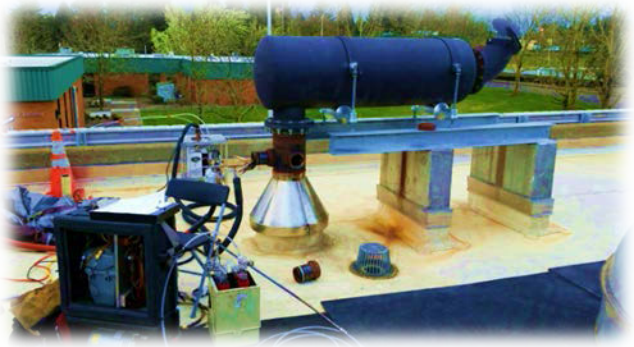
Moving new Cogen unit into digester control building

New cogen unit in place on foundation

Pipefitter at work on hot water loop

Electrician working on CAT switchgear

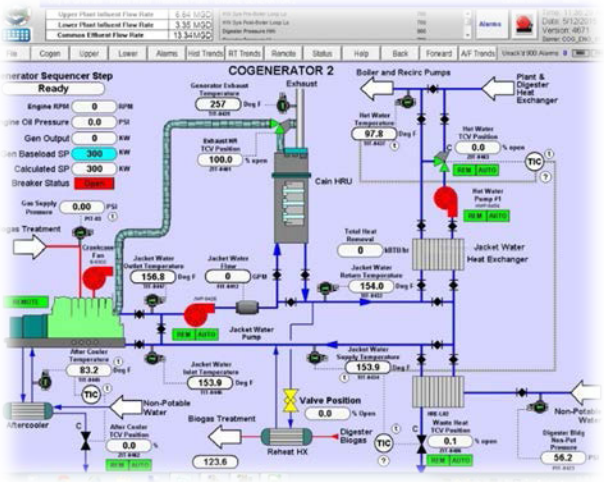
CAT technicians using laptops to program and test system during startup, January 2015



Emissions testing new cogen unit at exhaust pipe on roof

Deif paralleling controller matches cogen output with grid power

The entire WWTP is highly automated – operational and maintenance staff are on site for just one shift a day. The expanded Cogen system is also highly automated. It is designed to ramp up and ramp down with varying biogas production.



Cogen 2 SCADA screen shot – system is highly automated

Two cogen engines producing approximately 800 kW from FOG enhanced biogas production

Construction Schedule, Management and Control Techniques

The contractor (JRT Mechanical, Incorporated of Battle Ground, Washington) was the lowest qualified bidder on the project, chosen using the typical public design-bid-build process.

Weekly on-site construction meetings were held by the City which involved the contractor and their sub-contractors and representative staff for plant operation and maintenance. The design engineers and equipment supplier participated on an as-needed basis. The project schedule was reviewed at each meeting with adjustments made in an effort to keep the project on schedule. Construction inspection was performed by City personnel with special inspections done by specialized firms on an as-needed basis. The team worked well together on the common goal of getting the project done well and on time, with the end goal of making the plant energy net zero. Plant operators and maintenance staff were essential to the process.

EADOC construction management software was operated by the City for all project documentation. Virtually all documentation except for plans in the field were handled electronically which expedited the project management process, minimized waste and maximized transparency.

In order to enhance control of the schedule as well as control the selection of equipment, the City chose to obtain major equipment using the owner-supplied equipment approach. The CAT equipment was purchased under a National Joint Powers Alliance joint purchasing agreement, a competitive process that satisfied City of Gresham and State of Oregon purchasing rules while providing a 17 percent discount off list price. Equipment purchased this way included the cogen engine, switchgear and heat exchangers. This complex equipment order was fine-tuned as the design evolved and was finalized, so that as soon as bids from contractors were received and it was determined that the project was in budget, the order with CAT was placed. The 43 week project length outlined in the contract was designed to accommodate CAT's lead time and the delivery of equipment occurred right on schedule.

JRT completed the project on schedule, the equipment was ready for the CAT startup January 19, 2015. They were able to adjust tasks to make up for any schedule delays that occurred throughout the project. The contract included a provision for liquidated damages if the completion date were exceeded. The contractor was informed that the value of daily electricity generation was over $1,000, so any delays or extended downtimes were of serious financial consequence to the City.

Safety Performance Measure

Safety was emphasized throughout the project. The JRT foreman conducted a daily accident hazard analysis and discussed hazards with the project team prior to the beginning of work. JRT also held once per week tailgate safety meetings. Site control was used were appropriate to keep plant personnel away from project areas. Unfortunately one accident occurred during construction – there were .126 lost time injuries per 1000 hours worked.

Community Need

The cogen expansion project was a good value for the community, with a payback period expected to be approximately seven years. By adopting this technology and becoming more energy efficient, the City is saving approximately $500,000 per year on electricity. This savings, coupled with annual FOG tip fees of approximately $250,000 per year results in substantial long term savings which has a positive effect on the Wastewater Fund. There are two major winners with this formula: rate payers and the environment.

Under the terms of the net metering agreement with PGE, any excess power that the WWTP generates each year will be donated to the PGE energy assistance program which provides bill payment assistance to low income customers.

Sustainable Practices

At with many WWTP, biogas is simply flared. Using it to generate renewable energy is a great example of sustainable practice. By displacing utility grid power emissions of greenhouse gases and other air pollutants are reduced.

With a low tip fee of .08 cents per gallon, the FOG Receiving Station encourages the "upcycling" of what was once considered a waste product – fats, oils and grease from restaurant grease traps and food manufacturers. Frequently the end disposal site for FOG is landfills. Through implementation of state and local regulations and inspection requirements, more FOG is being captured prior to entering the sewer system.

Because of this, there are less FOG related maintenance and overflows which lowers the City's maintenance costs, conserves energy and reduces environmental damage to basements, streets and surface water.

This project will help the City meet two key goals of its sustainability policy implemented in 2009: the intention to have an 80 percent reduction in City greenhouse gas emissions by 2050, and the intention to use 100 percent renewable energy for City facilities by 2030.

The contractor maintained a field office on site to minimize job-related travel. All scrap steel was recycled and scrap concrete used for fill at a nearby construction site. Anything of value that had potential for reuse was retained by maintenance staff at the WWTP. The old standby genset that was removed was sold by the electrical subcontractor for reuse.

City support for going Energy Net Zero demonstrates City commitment to sustainability

Environmental Considerations

The project was designed to reuse existing facilities and equipment where ever possible in order to conserve resources and keep expenditures low. Need for a new building to house the new cogen unit was avoided by removing the existing backup genset that was nearing the end of its expected life and replacing with an all-weather unit that was located outside, which freed up space inside the building for the new cogen unit.

Avoiding the construction of a new building also conserved green space on the WWTP campus. The WWTP campus is approximately 25 acres, with an estimated nine acres being green space. The combination of the green space with water basins means that the WWTP attracts a lot of wildlife including waterfowl, owls, hawks and squirrels however no endangered species or critical habitat have been identified at the WWTP so special measures to protect them were not necessary for this project. Silt fences were used where necessary to prevent any potential stormwater pollution.

Community Relations

The WWTP maintains an educational connection to the general public by conducting public tours. Each year many school groups visit the plant and receive a personal tour of the entire facility. Educational handouts about the water cycle have been developed and there are interpretive panels describing the treatment process scattered throughout the plant. The plant has hosted delegations from all over the world interested in learning more about the facility, and very frequently plant personnel participate in industry meetings regarding Cogen, FOG and energy conservation.

WWTP monitors odors throughout the plant and around the perimeter as well as in adjacent neighborhoods and is proactive in informing neighbors if a particular operation or maintenance procedure will results in changes.

International delegation and
Portland State University

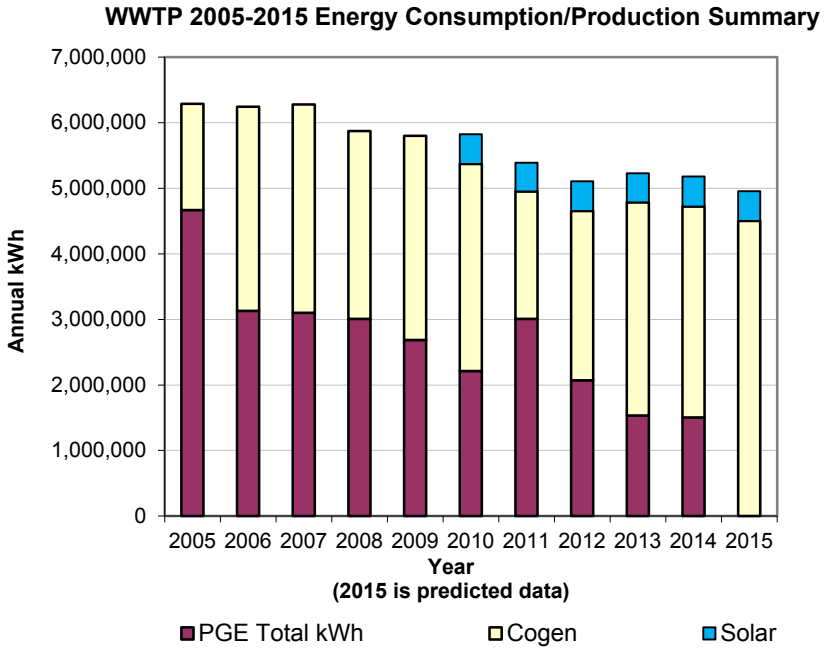
Local and national dignitaries along
With local school groups

On April 22, 2015, Earth Day, the WWTP held a Net Zero Celebration to recognize the fact that the WWTP was now a net zero energy facility, one of the few in the entire nation. Project partners with Oregon Department of Energy, the Energy Trust of Oregon, and Veolia North America and Mayor Shane T. Bemis gave speeches to the project partners, plant staff, media, and 80 fourth graders studying energy from Reynolds School District celebrating this historic occasion for the City of Gresham and the Pacific Northwest.

April 22, 2015 Net Zero Celebration

Additional Information

JOURNEY TO NET ZERO



The journey to become energy net zero first began with the 2008 "Energy Independence Project" study of two Oregon WWTPs conducted by Oregon Association of Clean Water Agencies (ACWA). The study pointed out that the City of Gresham WWTP could probably become energy net zero through conservation efforts and the addition of digestion of Fats, Oils, and Grease (FOG) and an additional cogen engine. FOG is a waste product that is removed regularly from grease traps at restaurants and grocery stores. Injection of FOG into anaerobic digesters has the effect of dramatically increasing biogas production. Traditional disposal of FOG is time consuming and expensive and quite often the final disposal site is a landfill.

In 2009, a $40,000 grant from the Oregon Economic Development Department paid for a feasibility study to determine the potential payback of installing a FOG Receiving Station and Cogen Expansion at the WWTP. With the potential payback time determined to be approximately seven years, the City chose to move forward with the project. The first step was the phased installation of the FOG Receiving Station – Phase 1 with a 10,000 gallon tank was completed in 2012 and biogas production immediately increased. In 2014, Phase 2 (FOG Receiving Expansion) with an additional 20,000 gallons of storage, was completed. The Gresham FOG Receiving Station was the first installed at a WWTP in the Pacific Northwest.

Expanded FOG Receiving Station

With a tipping fee of .08 cents per gallon, the FOG Receiving Station has brought in $645,000 of revenue since completion. As expected, receiving approximately 10,000 to 12,000 gallons of FOG per day has caused WWTP biogas production to double, which made cogen expansion, and energy net zero status feasible.

FOG hauling truck unloading at FOG Receiving Station. (Anaerobic digester in background)

In 2009, a 420 kW solar array was installed at the WWTP. It provides approximately five percent of WWTP power. Under a 20 year agreement, the system was provided at no cost to the City by Sun Edison, who provides electricity at two-thirds the cost of the Portland General Electric (PGE) rate.

420 kW solar array installed in 2009, at the time of installation, the largest in the NW

Since 2010, WWTP power consumption has been reduced 15 percent through a combination of operational changes and equipment replacement. In 2010, the plant Energy Management Team was formed and began meeting once a month to focus on energy consumption and the most effective ways to reduce consumption. The 2011, the Process Improvements Project (PIP) replaced older equipment in need of replacement with more energy efficient new equipment. Equipment replaced included the old digester mixing system (120 HP) with new vertical linear motion "pancake" mixers (10 HP) and 30 year old blowers with modern "air bearing" turbo blowers coupled with modern air diffusers in the aeration basins. The digester mixing improvements reduced plant energy consumption by 8.5 percent and the aeration improvements yielded a 6.5 percent reduction in plant energy consumption.

New high speed turbo blower (foreground)

Linear motion mixers efficient mix sludge in anaerobic digesters

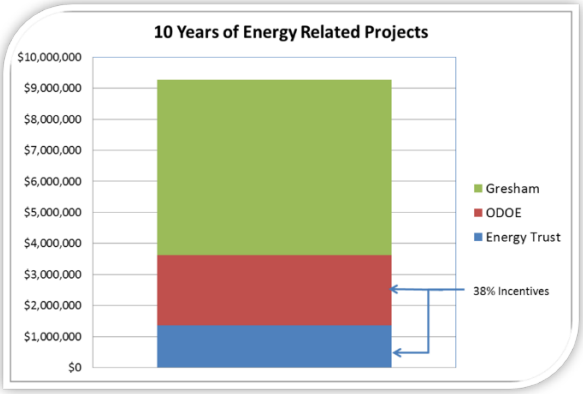
GRANTS, INCENTIVES, AND TAX CREDITS

For the predesign effort on the Cogen Expansion Project, the City received a $40,000 Technical Assistance grant from the Energy Trust of Oregon to help pay for the study.

For actual implementation of the Cogen Expansion Project, the City received a $330,000 cash incentive from the Energy Trust of Oregon in exchange for Green Tags associated with the renewable energy being produced by the new cogen engine. Under the agreement with The Energy Trust of Oregon, the City agrees to transfer 29,400 Green Tags (Transferable 1 MWh Renewable Energy Credits) to The Energy Trust over the next 12-15 years in exchange for the $330,000 cash incentive. Following the transfer of the 29,400 Green Tags, the City of Gresham will then be able to claim future Green Tags for itself, or transfer them to another entity.

The Oregon Department of Energy will award the City a $1,011,749 Combined Heat and Power tax credit incentive for the Cogen Expansion Project and the FOG Receiving Station Expansion Project (design and construction cost of $716,393).

In total, the City received incentives totaling approximately 40 percent of the project cost for the Cogen Expansion Project and the FOG Receiving Expansion Project. This closely matches the percentage of incentives the City has consistently received on energy project over the last 10 years. In the past ten years the City has spent over $9,000,000 on energy related projects since the installation of the first modern CAT cogen engine in 2005. Of that $9,000,000, approximately 38 percent has been paid for by Energy Trust and ODOE incentives and tax credits.



PAYBACK PERIOD

The payback period for the Cogen Expansion Project was calculated to be approximately seven years in several planning documents and grant applications. Now that it is operational, the City will continue to track its payback using actual maintenance cost data, tip fee revenue and electrical savings. Tracking this data helps to point out where cost savings could occur, to reduce payback time.

The first CAT cogen installed in 2005 was found to have an actual payback period of 3.5 years. It has an average runtime of 93 percent, and was found to have an operation and maintenance cost of 2.6 cents per kwH.

GATHERING AND SHARING INFORMATION

The WWTP frequently hosts meetings put on by ACWA, ODOE, and the Oregon Energy Trust regarding energy conservation, FOG and renewable energy production. Being a leader in the field, the plant frequently receives inquiries about cogen and FOG, by disseminating information the City is helping spread this technology throughout the U.S. City engineers frequently give presentations at local energy and wastewater conferences outlining the plant's path to becoming energy net zero.

The WWTP also logs real time data on plant operations which is occasionally used by researchers or engineering firms planning new similar projects.

ADDITONAL INFORMATION ON THE WWTP

The City of Gresham WWTP has a service population of 114,000 people including the cities of Fairview and Wood Village. It is a basic secondary activated sludge facility with a capacity of 20 million gallons per day. Average flows are around 13 million gallons per day, with the plant discharging to the Columbia River. The plant has two 1,000,000 gallon anaerobic digesters. Class B biosolids produced at the plant are applied to agricultural fields. Veolia North America is the contract operator of the plant. There are three City of Gresham engineers at the plant, and 16 Veolia operation and maintenance staff.

Aerial view of WWTP with Fairview Lake, the Columbia River and Washington state in the background