Testimony to the House Subcommittee on Water Resources and Environment
February 4, 2009
By Alan Zelenka
Energy Services Leader for Kennedy/Jenks Consultants
On the Oregon ACWA Energy Independence Project

My name is Alan Zelenka and I am the Energy Services Leader for Kennedy/Jenks Consultants. Kennedy/Jenks is an engineering and science consulting company for water and wastewater agencies; as well as ports, railroads, airports and other industries.

The Oregon Association of Clean Water Agencies (ACWA) is trade association for all the wastewater treatment plants in Oregon, and the Energy Trust of Oregon (ETO) uses the public purposes money collected from Oregon electric utility ratepayers to do energy efficiency and renewable resource projects.

I was the project manager for the Energy Independence Project for ACWA which was funded predominantly by ETO.

This project is a ground-breaking project that was recently awarded the American Council of Engineering Companies (ACEC) 2008 Project of the Year Award for Oregon. The goal of the project was to see what it would take for waste treatment plants (WTP) to become energy independent using energy efficiency and renewable resources. In essence, how would they end their addiction to grid electricity.

The 2008 study evaluated two wastewater treatment facilities, in the cities of Gresham and Corvallis, Oregon both using anaerobic digesters and advanced secondary treatment. The study showed that the Gresham and Corvallis plants could achieve energy independence by using energy efficiency, maximizing the use of digester gas, and installing micro-hydropower and solar photovoltaic systems (solar PV).

Kennedy/Jenks developed a broadly applicable systematic methodology to evaluate and recommend which energy efficiency measures (EEMs) and which renewable resources would work best to have these plants become energy independent. We created a six step program to end their addiction to grid electricity.

Step 1 – Identify energy-efficiency measures. In the study's first step, Kennedy/Jenks performed an energy audit with plant personnel and reviewed previous energy audits. Then we identified already-implemented EEMs and recommended others, considering installation cost, energy and financial savings, incentives, net cost, and simple payback. We also created a list of EEMs that treatment plants should consider to become more energy-efficient.

Step 2 – Determine plant energy profile. Next, we analyzed the two plants' utility bills, determining purchased energy, deducting the energy saved by new EEMs, and yielding their net energy requirements, which is the amount of energy each plant must offset to become energy-independent.

Step 3 – Assess renewable resources to use. The study's Technical Advisory Committee (TAC) had approved seven renewable resources to be assessed:

1. Fuel cells using digester gas
2. Internal combustion (IC) engines using digester gas
3. Microturbines using digester gas
4. Micro-hydropower turbines with plant outfall to a river
5. Solar PV
6. On-site small wind turbines
7. Fats, oil, and grease (FOG) and green waste to increase digester gas production

The Kennedy/Jenks team assessed and profiled each resource's history, technical description, vendors, size and kWh production, project examples, funding sources, and cost, along with political, community, environmental, greenhouse gas, and operational impacts. The cost of each resource was analyzed using levelized cost that puts them on equal financial footings. The lowest-cost resource was found to be FOG, followed by IC engines.

Step 4 – Evaluate renewable resources. To evaluate the data, the Kennedy/Jenks team created criteria that were approved by the TAC: levelized cost, environmental impacts, technical maturity and reliability, greenhouse gas impacts, political and community impacts, operational impacts, and adequate size. The criteria were weighted by the TAC and, using a point scoring system, the resources were ranked.

Step 5 – Rank the resources. The resources were ranked as follows:
1. FOG and green waste – 88 points
2. IC engines (385 kW) – 82 points
3. Microturbines (65 kW) – 81 points
4. Fuel cells (400 kW) – 70 points
5. Micro-hydropower turbines (35 kW) – 68 points
6. Small wind turbines (100 kW) – 60 points
7. Small wind turbines (10 kW) – 55 points
8. Solar PV (100 kW) – 52 points
9. Micro-hydropower turbines (5 kW) – 46 points

Step 6 – Develop recommendations to become energy-independent.

Gresham Plant: The Gresham plant already uses nearly all its available digester gas in a Caterpillar IC engine and has no significant wind resource. Hence, Gresham will need to rely on a combination of energy efficiency, micro-hydropower, and solar PV. The Kennedy/Jenks team recommended three EEMs (replace four motors with premium efficiency motors; reduce non-potable-water pressure; and replace the aeration diffusers with newer, more efficient fine-bubble diffusers) and recommended installation of a micro-hydropower 35-kW unit. Finally, the plant should meet the balance of its net energy requirement with 22 solar PV units of 100 kW each if sufficient land is available. The estimated total net capital cost (including incentives) to become energy-independent: approximately $9.6 million.

Corvallis plant: The Corvallis plant had already implemented all the cost-effective EEMs available to them and also lacks a significant wind resource. The Kennedy/Jenks team recommended a combination of two microturbines to use the plant's existing digester gas supply (the plant has insufficient digester gas to operate an IC engine), plus solar PV. The plant should consider a lease option for the microturbines and the solar PV. The plant should install 28 solar PV units of 100 kW each if sufficient land is available. The estimated total net capital cost (including incentives) for the Corvallis plant to become energy-independent: about $12.1 million.

Highly recommended: FOG and green waste program. The study found that both plants have excess digester capacity, which they could access to generate more digester gas using FOG and green waste. The additional digester gas in turn would power other renewable resource options. The upfront capital cost would be $1.1 million to process 3,000 gallons of grease and 20 tons of food scrap per day, which would create approximately 107,000 cubic feet/day of digester gas, which could run three microturbines (1.6 million kWh/year), one fuel cell at 80 percent capacity (1.4 million kWh/year), or one Caterpillar IC engine at approximately two-thirds capacity (0.9 million kWh/year). The substantial tipping fees could cover the capital cost in a relatively low number of years, making a FOG and Green Waste program a very cost-effective option.

Recommended path toward energy independence:

- Apply energy-efficiency measures (EEMs) first! They are the most cost-effective way to reduce energy needs and to save money. To accomplish this, a plant must have an energy audit conducted to identify EEMs, then seek incentives, and then install the EEMs.
- The evaluation methodologies developed in this study are broadly applicable to any WTP across the nation.
- IC engines are the most cost-effective and overall best generation option, and should be the first generation resource considered.
- Investigate a FOG and Green Waste program to create more digester gas if excess digester gas is available. This additional biogas can then power IC engines, microturbines, and fuel cells.
- After using all available digester gas, consider micro-hydro, small wind, and finally solar PV systems to become energy independent.
- Because these resources have high capital costs, public WTPs should consider third-party lease options to avoid upfront capital costs, to stabilize O&M costs, and to take advantage of tax credits.

Conclusions

WTPs use a great deal of energy. Many have already done a great deal of energy efficiency, but by no means have all of them implemented all cost-effective EEMs. There is an enormous potential across the country to mine much more energy efficiency out of WTPs.

Our study included a check-list of potential EEMs that each and every WTP across the country could use to make their plants more energy efficient. EEMs should be the first thing that they do because they are the most cost-effective option. We often see EEMs that have very short simple paybacks; as short as 0.3 to 3 years. What is needed is targeted programs, adequate funds available to do energy audits, and incentives to get the WTPs to act. Energy efficiency has multiple benefits such as lower operating costs which means lower rates for rate-payers, new equipment that increases reliability, lower environmental impacts, and reduced GHG emissions.

Excess digester gas at WTPs can use generators to cost-effectively create electricity and is considered a renewable resource. One recent survey showed that only about 15 percent of WTPs with the potential to generate electricity are actually doing so. What is needed is programs directed at WTPs, access to capital at favorable rates, and incentives to lower the cost. The benefits of generating electricity from digester gas are: lower environmental impacts, reduced GHGs, WTPs gaining control over their energy future, and in some cases depending on the existing cost of electricity, plants can lower their operating costs which means lower bills for rate-payers.

Other renewable resources like wind, micro-hydro, and especially solar photovoltaics (PV) are feasible and can contribute greatly to making WTPs energy independent. But it will take targeted programs, access to capital, and financial incentives to entice WTP to act. Incentives such as: investment tax credits, accelerated depreciation and production incentives. However, we need to create mechanisms so that public agencies can also take advantage of these tax incentives. For example, in Oregon, the Business Energy Tax Credit (BETC) has a pass-through provision that allows public agencies to transfer these tax credits to approved private entities and reap 35 percent of the 50 percent tax credit in an up-front payment.

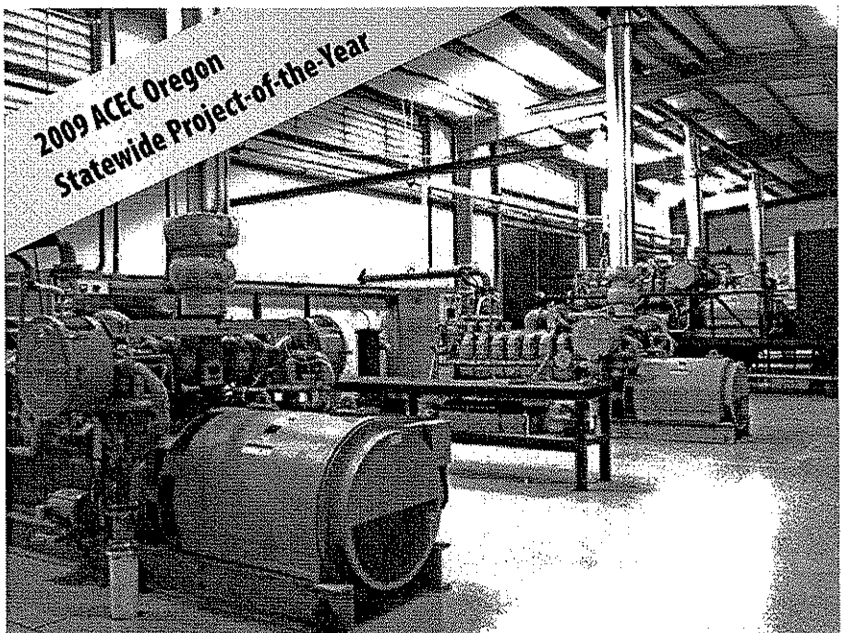
Being creative and putting the right programs and incentives in-place can allow WTPs to maximize their energy efficiency and optimize their use of renewables.

Attached are the Project Summary Sheet for the ACWA Energy Independence Project, and the executive summary of the full report.

Thank you for your time, and I very much appreciate the opportunity to testify today.

Energy Independence Project

Oregon Association of Clean Water Agencies, in partnership with Energy Trust of Oregon



The 2008 energy independence study showed that IC engines are the most cost-effective and overall best generation option.

Achieving energy independence. For the Oregon Association of Clean Water Agencies and Energy Trust of Oregon, Kennedy/Jenks Consultants investigated how domestic wastewater treatment plants could most effectively eliminate the purchase of electricity, using energy-efficiency measures (EEMs) and renewable resources to become energy-independent.

The 2008 study evaluated two wastewater treatment facilities, in Gresham and Corvallis, both using anaerobic digesters and advanced secondary treatment. The study showed that the Gresham and Corvallis plants could achieve energy independence by using energy efficiency, maximizing the use of digester gas, and installing micro-hydropower and solar photovoltaic systems (solar PV).

Step 1 – Identify energy-efficiency measures. In the study's first step, Kennedy/Jenks performed an energy audit with plant personnel and reviewed previous energy audits. Then we identified already-implemented EEMs and recommended others, considering installation cost, energy and financial savings, incentives, net cost, and simple payback. We also created a list of EEMs that treatment plants should consider to become more energy-efficient (see box).

Step 2 – Determine plant energy profile. Next, we analyzed the two plants' utility bills, determining purchased energy, deducting the energy saved by new EEMs, and yielding their net energy requirements, which is the amount of energy each plant must offset to become energy-independent.

Step 3 – Assess renewable resources to use. The study Technical Advisory Committee (TAC) had approved seven renewable resources to be assessed:

1. Fuel cells using digester gas
2. Internal combustion (IC) engines using digester gas
3. Microturbines using digester gas
4. Micro-hydropower turbines with plant outfall to a river
5. Solar PV
6. On-site small wind turbines
7. Fats, oil, and grease (FOG) and green waste to increase digester gas production

The Kennedy/Jenks team assessed and profiled each resource's history, technical description, vendors, size and kWh production, project examples, funding sources, and cost, along with political, community, environmental, greenhouse gas, and operational impacts. The cost of each resource was analyzed using levelized cost that

Energy-efficiency measures for WWTPs >>

- Optimize pump station wet-well set points to decrease pumping head
- Add variable-frequency drives to motors of pumps and blowers
- Install premium-efficiency motors on pumps, blowers, and process equipment
- Automate aeration blower operation to maintain dissolved oxygen level and sequence blower operation
- Upgrade aeration systems with fine-bubble diffusers
- Replace aeration mechanical mixers with submersible mixers
- Maximize cogeneration operating time
- Reduce odor control fan operating time to minimum required
- Upgrade digester gas mixing to hydraulic mixing
- Reduce digester mixing time
- Reduce non-potable water pressure
- Recover exhaust heat to supplement supply heat
- Upgrade to more energy-efficient lighting

Levelized Costs of Assessed Renewable Resources	
Resource Option	Levelized Cost (cents/kWh)
FOG & Green Waste	-9.5*
IC Engines (385 kW)	2.9
Utility Power – Pacific Power	4.4
Microturbines (65 kW)	4.9
Utility Power – Portland General Electric	6.8
Fuel Cells (400 kW)	7.9
Micro-Hydropower #1 (35 kW)	15.4
Small Wind Turbine #2 (100 kW)	16.5
Small Wind Turbine #1 (10 kW)	19.0
Solar PV (100 kW)	36.5
Micro-Hydropower #2 (5 kW)	111.8

** The negative cost is due to the revenue from tipping fees, which, over time, outweighs the capital cost.*

puts them on equal financial footings. (The lowest-cost resource was found to be FOG, followed by IC engines.)

Step 4 – Evaluate renewable resources. To evaluate the data, the Kennedy/Jenks team created criteria that were approved by the TAC: levelized cost, environmental impacts, technical maturity and reliability, greenhouse gas impacts, political and community impacts, operational impacts, and adequate size. The criteria were weighted by the TAC and, using a point scoring system, the resources were ranked.

Step 5 – Rank the resources. The resources were ranked as follows:

1. FOG and green waste – 88 points
2. IC engines (385 kW) – 82 points
3. Microturbines (65 kW) – 81 points
4. Fuel cells (400 kW) – 70 points
5. Micro-hydropower turbines (35 kW) – 68 points
6. Small wind turbines (100 kW) – 60 points
7. Small wind turbines (10 kW) – 55 points
8. Solar PV (100 kW) – 52 points
9. Micro-hydropower turbines (5 kW) – 46 points

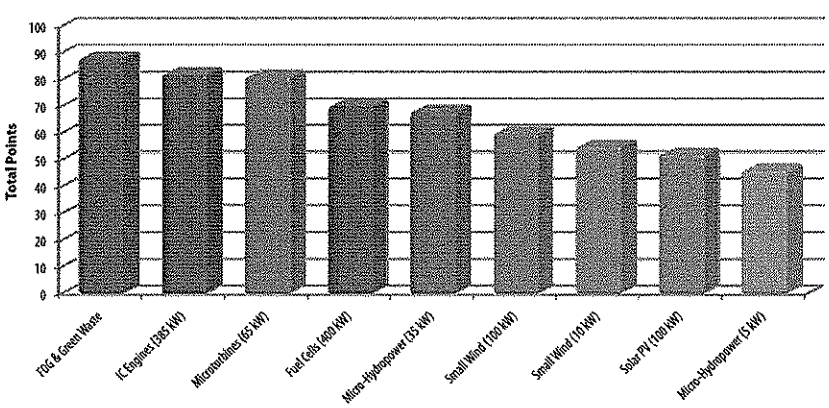
Step 6 – Develop recommendations to become energy-independent.

Gresham Plant: The Gresham plant already uses nearly all its available digester gas in a Caterpillar IC engine and has no significant wind resource. Hence, Gresham will need to rely on a combination of energy efficiency, micro-hydropower, and solar PV. The Kennedy/Jenks team recommended three EEMs (replace four motors with premium-efficiency motors; reduce non-potable-water pressure; and replace the aeration diffusers with newer, more efficient fine-bubble diffusers) and recommended installation of a micro-hydropower 35-kW unit. Finally, the plant should meet the balance of its net energy requirement with 22 solar PV units of 100 kW each if sufficient land is available. The estimated total net capital cost (including incentives) to become energy-independent: approximately $9.6 million.

Corvallis plant: The Corvallis plant had already implemented all the cost-effective EEMs available to them and also lacks a significant wind resource. The Kennedy/Jenks team recommended a combination of two microturbines to use the plant's existing digester gas supply (the plant has insufficient digester gas to operate an IC engine), plus solar PV. The plant should consider a lease option for the microturbines and the solar PV. The plant should install 28 solar PV units of 100 kW each if sufficient land is available. The estimated total net capital cost (including incentives) for the Corvallis plant to become energy-independent: about $12.1 million.

Highly recommended: FOG and Green Waste program. The study found that both plants have excess digester capacity, which they could access to generate more digester gas using FOG and green waste. The additional digester gas in turn would power other renewable resource options. The upfront capital cost would be $1.1 million to process 3,000 gallons of grease and 20 tons of food scrap per day, which would create approximately 107,000 cubic feet/day of digester gas, which could run three microturbines (1.6 million kWh/year), one fuel cell at 80 percent capacity (1.4 million kWh/year), or one Caterpillar IC engine at approximately two-thirds capacity (0.9 million kWh/year). The substantial tipping fees could cover the capital cost in a relatively low number of years, making a FOG and Green Waste program a very cost-effective option.

Ranking of Renewable Resources



Kennedy/Jenks' recommended path toward energy independence >>

- Apply energy-efficiency measures (EEMs) first – the most cost-effective way to reduce energy needs and save money. Conduct energy audits to identify EEMs, then seek incentives.
- IC engines are the most cost-effective and overall best generation option.
- Investigate a FOG and Green Waste program to create more digester gas, which can then power microturbines, fuel cells, and IC engines.
- After using all available digester gas, consider solar PV systems.
- Because these resources have high capital costs, consider third-party lease options to avoid upfront capital costs, fix O&M costs, and take advantage of tax credits.

Kennedy/Jenks Consultants

240 Country Club Road, Suite A
Eugene, OR 97401
(541) 338-8135
(541) 338-8180 (Fax)

Final Energy Independence Project

03 July 2008
Revised

Prepared for

Oregon Association of Clean Water Agencies (ACWA)
537 SE Ash Street, Suite 12
Portland, OR 97214
and
Energy Trust of Oregon
851 SW Sixth Avenue, Suite 1200
Portland, OR 97204

K/J Project No. 0876003

Executive Summary

Oregon's domestic wastewater treatment facilities are leaders in the protection of public health and the environment by providing water quality services to our urban areas. Some of the valuable services they provide include: sewerage collection and treatment, regulation of industries to prevent toxic substance discharges into treatment plants, leadership in promoting innovative water quality policies, and partnerships with other members of their community to restore local bodies of water. These facilities are often use energy efficient processes and frequently implement sustainable practices such as recycled water and biosolids recycling. Nonetheless, there is opportunity for these facilities to build upon their leadership in environmental stewardship by further reducing their need for energy.

This report is an investigation into what it would take for Oregon domestic wastewater treatment plants to become energy independent by optimizing plant energy efficiency and using renewable resource opportunities. For the purposes of this report the term "energy independence" means to use digester gas and renewable resources to eliminate the need for purchased electricity. This report provides valuable information for plant operators and managers, and policy-makers, and will be a valuable tool in directing significant investment in wastewater treatment plants. The report estimates the benefits and costs of implementing recommended energy efficiency measures while describing the cost, the operational impacts, and the environmental impacts of developing selected renewable resources. The project was conducted for the Oregon Association of Clean Water Agencies (ACWA) in partnership with the Energy Trust of Oregon (Energy Trust).

The analysis was based on an evaluation of two demonstration facilities at the Gresham Wastewater Treatment Plant and Corvallis Wastewater Reclamation Plant in Oregon. Energy audits were initially conducted at the two demonstration sites including the review of prior energy audits and installed energy efficiency measures (EEMs) were reviewed to identify opportunities for additional energy efficiency improvements. Following the facility analysis, the project team researched and analyzed seven renewable resource options for consideration in seeking energy independence. The seven renewable resources included in this investigation were:

1. fuel cells using digester gas
2. internal combustion (IC) engines using digester gas
3. micro-hydro using a treatment plants outfall to a river
4. microturbines using digester gas
5. solar photovoltaic (PV) systems
6. on-site small wind turbines, and
7. using fats-oils-and-grease (FOG) and green waste to increase digester gas production and related energy production).

The resources were assessed using a common template that was developed using with standardized criteria to assess each of the facilities. Costs were determined using a standardized spreadsheet with consistent assumptions and formulas to facilitate in comparing the various renewable options. The resource assessments described a brief history of the resource, how the resource works, and its size and kilowatt-hour (kWh) production. The resources assessment also included potential funding and incentives, its cost, the political and community impacts, as well as the environmental, greenhouse gas and operational impacts of each resource option.

Seven evaluation criteria were developed by the Project Team and approved by the Association of Clean Water Agencies (ACWA) Energy Independence Project Technical Advisory Committee (TAC). To simplify the evaluation process, the evaluation criteria were prioritized and given a weighted score that reflects their importance to the TAC as decision-making criteria. The weighted scoring system allowed a maximum of 100 total points to be assigned to each resource option. The weighted scoring of the evaluation criteria was:

Evaluation Criteria	Possible Points
Cost	50
Environmental Impacts	20
Technology Maturity & Reliability	10
Political and Community Impacts	5
Adequate Size	5
Greenhouse Gas Impacts	5
Operational Impacts	5
TOTAL =	**100**

Based on the criteria and weighting described above, the evaluation team analyzed each of the seven resource options for the report. A score was then developed for each of the resources to provide a basis for comparison. The resource scoring is summarizes as:

1. FOG & Green Waste – 88 points
2. IC Engines (385 kW) – 82 points
3. Microturbines (35 kW) – 81 points
4. Fuel Cells (400 kW) – 70 points
5. Micro-Hydro Turbines (35 kW) – 68 points
6. Small Wind (10 kW) – 55 points
7. Solar PV (100 kW) – 52 points
8. Small Wind (100 kW) – 60 points
9. Micro-Hydro Turbines (5 kW) – 46 points.

Summary of Recommendations for the Gresham Wastewater Treatment Plant

Since the Gresham Wastewater Treatment Plant (WWTP) already uses nearly all of the available digester gas in its Caterpillar IC Engine, none of the resource options that use digester gas as a fuel (IC engines, microturbines, or fuel cells) would be available for this facility to become energy independent. In addition, the plant site does not appear to have a significant wind resource eliminating the use of the small wind resource at this site.

To achieve energy independence the Gresham WWTP would need to rely on a combination of energy efficiency, micro-hydro and solar PV. The first recommendation is to install the three cost-effective energy efficiency measures identified in this study: replacing four existing motors with premium efficiency motors, reducing the system's pressure, and replacing the aeration diffusers with newer more efficient fine bubble diffusers. This facility could also investigate and implement potential energy efficiency savings associated with changes to their process. The second recommendation would be to install one of the micro-hydro 35 kW units. The final recommendation would be to meet the balance of the plant's energy needs (kWh) with 22 solar PV units of 100 kW each for a total of 2.2 MW of energy if sufficient land is available. The estimated total net cost to become energy independent would be approximately $9.6 million.

Summary of Recommendations for the Corvallis Wastewater Reclamation Plant

The Corvallis Wastewater Reclamation Plant (WWRP) has commendably already implemented all the cost-effective EEMs available to them. Since the Corvallis WWRP site does not appear to have a significant wind resource, small wind is not available to help achieve energy independence. Additionally, the micro-hydro option is not recommended because of the cost of the micro-hydro option and its lowest overall score; the micro-hydro option is not recommended. Since the Corvallis WWRP has commendably already implemented all the available cost-effective EEMs in their facility, they could also investigate potential energy efficiency savings associated with changes to their treatment process.

To achieve energy independence the Corvallis WWRP would need to rely on a combination of microturbines using their existing digester gas supply and solar PV. The first recommendation is to install two microturbines, to make use of the available digester gas. While IC Engines are a more cost-effective option, the Corvallis plant only has a limited amount of available digester gas which is insufficient to operate an IC Engine. Two microturbines use roughly one-third the digester gas that an IC Engine would use making them a much better fit for the Corvallis plant given their limited digester gas.

Serious consideration should be given to a lease option for the microturbines that would not require up-front capital from the plant. It could result in some of the savings available to the leasor from tax credits being passed along to the municipality while requiring no additional staff for operations and maintenance (O&M) and potentially lower operating costs. The second recommendation would be to meet the balance of the plant's energy needs (kWh) with 28 solar PV units of 100 kW each to produce a total of 2.8 MW of energy if sufficient land is available. The estimated total net cost for the Corvallis WWRP to become energy independent would be about $12.1 million.

Summary of Recommendations to Further Investigate a FOG and Green Waste Program

It is recommendation that Gresham and Corvallis further investigate the development of FOG and Green Waste to energy projects. Both the Corvallis and Gresham wastewater treatment plants currently have excess digester capacity for which they could use FOG and Green Waste to generate more digester gas to run renewable resource options. A FOG and Green Waste project would cost about $1.1 million to process 3,000 gallons of grease and 20 tons of food scrap per day; would create approximately 107,000 CFD of digester gas, and could generate enough digester gas to run three microturbines (1.6 million kWh/year), one fuel cell at 80 percent capacity (1.4 million kWh/year), or one Caterpillar IC Engine at approximately two-thirds capacity (0.9 million kWh/year)..