Kennedy/Jenks Consultants

Energy & Emissions Strategic Plan

Executive Summary

April 2011

Prepared for

Encina Wastewater Authority

Executive Summary

Section 1: Introduction

The Encina Wastewater Authority (EWA) is a Joint Powers Authority (JPA) owned by the City of Carlsbad, City of Vista, City of Encinitas, Leucadia Wastewater District, Vallecitos Water District and Buena Sanitation District. EWA operates the Encina Water Pollution Control Facility (EWPCF) located in Carlsbad, California.

EWA's 2013 Business Plan (adopted in 2008) addresses nine (9) key issues. Key Issue No. 5 (Additional resource recovery and investment creates the opportunity for energy independence) recognizes the economic value of increased self generation of energy. This study pursues the concepts of increased self generation by evaluating alternative technologies and the development of a recommended energy strategic plan focused on optimizing self generation of energy.

The objectives of this Energy and Emissions Strategic Plan study are to:

- Project energy usage
- Identify opportunities for energy demand reduction
- Identify technologies for increasing energy production
- Evaluate air emissions compliance in conjunction with production technologies
- Recommend improvements that will work toward achieving energy independence

To accomplish these objectives, an approach was developed summarized as follows:

- Develop baseline (current and projected) EWPCF energy needs based on current operations and permit limitations
- Identify efficiency measures that could reduce energy consumption as initial action items
- Provide a comprehensive analysis of technologies available that offer the opportunity to reduce electrical power and natural gas purchases
- Rank available technologies using evaluation criteria
- Evaluate air emissions regulations and identify required permit modifications associated with alternative technologies
- Proceed with the comparison of alternatives, ranking and identification of the preferred alternative and develop an implementation plan

Current levels of self generation are obtained by utilizing biogas produced to self produce electricity with existing internal combustion engines recently replaced as a part of the Phase V upgrades. Air emissions permits act as a constraint to increase such production and are addressed in this study. Opportunities to enhance biogas production are also investigated.

The introduction of new technologies to either better utilize biogas or take advantage of solar and wind power generation systems is also evaluated.

Section 2: Baseline Energy Profiles and Projections

EWA's demand for energy and the ability to self generate energy (in the form of electricity, gas and waste heat) under baseline conditions is defined as operation of current processes and equipment within current permit limitations, is addressed. A 12 month operating period is used to define current conditions, including seasonal variations.

The impacts of projected wastewater flow increases on existing facilities operation is considered in the development of a baseline "business as usual" energy profile through year 2030.

Baseline Energy Profiles

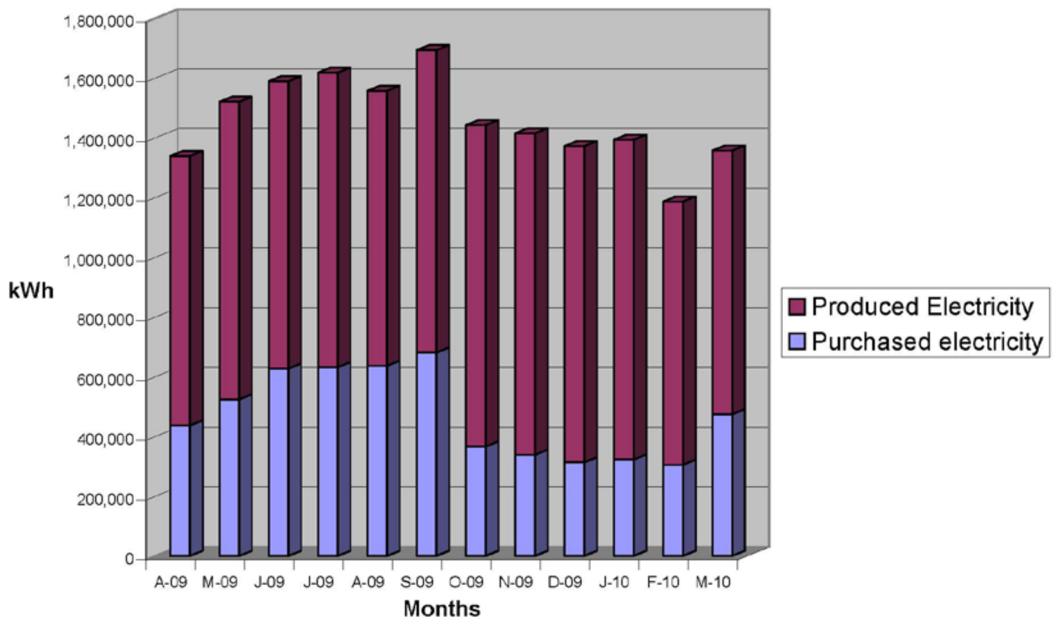
Two 12 month baseline periods were utilized in this study to determine current baseline energy conditions. Data utilized from the period April 2009 through March 2010 served as the primary source of baseline operating data. Monthly totals for electrical energy purchases and use, biogas production, natural gas purchases and heat production and use were obtained from this period. The electrical energy use breakdown within the plant for each process area was developed from EWA recorded data over the January through December 2010 operating period.

EWPCF influent flows ranged from 21.5 mgd (October 2009) to 24.5 mgd (January 2010) with a 12 month average flow rate of 22.6 mgd. Average flows during calendar year 2010 were similar.

Total annual power consumption was 17,480,000 kWh, with a monthly average of 1,456,700 kWh. Total annual electrical power production was 11,823,700 kWh, with a monthly average of 985,300 kWh. EWA purchased 5,657,000 kWh of electricity over the 12 month baseline period. Approximately 68% of the EWPCF electricity demand was produced on-site.

Monthly self produced and purchased electrical energy is shown graphically in the following graph, Figure E-1

Figure E-1: Baseline Electrical Power Purchases and Projection



Small quantities of biogas (55,500 therms) were flared resulting from brief operating conditions that prevented operators from utilizing 100% of the produced gas.

Biogas use is limited to the IC engines and solids dryer. Natural gas is required in the dryer RTO and buildings support equipment.

The use of biogas within the dryer was being initiated during the latter part of the baseline period. Larger quantities of biogas could be used in the dryer if more was available from the digesters. The baseline use of biogas in the IC engines was at the maximum allowed by the current air emissions permits.

Table E-1: Baseline 12-Month Natural Gas and Biogas Usage (Therms)

Process/Facility	***Natural Gas***	***Biogas***	***Total***
Internal Combustion Engines 1)	85,700	1,350,000	1,435,700
Solids Dryer	541,800	16,700	558,500
Dryer RTO	41,300	0	41,300
Administration Building	24,300	0	24,300
Maintenance Building	1,300	0	1,300
Flared	0	55,500	55,500
Totals	**694,400**	**1,422,200**	**2,116,600**

1) Including indirect use and blending

Heat is produced at EWPCF with the operation of the IC engines and solids dryer process units. A portion of the produced heat from the IC engines (in the form of hot water) is utilized in the anaerobic digesters and an absorption chiller serving the energy building. Excess hot water is wasted to EWPCF effluent. 100% of the dryer system heat (in the form of hot air) is wasted to the atmosphere.

A summary of the baseline heat balance, recorded as MMBtu/hr (million Btu's per hour), in Table E-2:

Table E-2: Baseline Heat Projection and Utilization (MM BTu/hr)

Heat Source	***Produced***	***Utilized***	***Wasted***
IC Engines a)	6.8		3.6
Dryer/RTO b)	1.4		1.4
Digesters		1.2	
Chiller		2.0	
Total	**8.2**	**3.2**	**5.0**

a) Heat produced in hot water circulation system
b) Exhausted hot air

Purchased and EWPCF self generated and EWPCF energy during the baseline period is summarized in the following table E-3:

Table E-3: Baseline Energy Project Summary

	Electricity		***Gas***		***Heat*** [a)]	
	kWh/yr	% Total	therms	% Total	MMBtu/hr	% Total
Self Generation	11,824,000	74%	1,422,200	66%	6.8	100
Purchased	5,656,000	26%	694,400	34%	0	0
Total	17,480,000		2,116,600		6.8	

a) 47% of the IC engine produced hot water was utilized by the EWPCF digesters and power building absorption chiller

Baseline Energy Projection

An energy profile was developed assuming no process changes and the planned increase in wastewater flows from 22.6 mgd in 2010 to 40.6 mgd by the year 2030.

Annual electricity demand is projected to increase from 17. 5 million kWh in 2010 to 27.9 million kWh in 2030. Self generation would remain constant at 11.8 million kWh due to the current air emissions permits restrictions. Self generation would therefore decrease from 74% to 46% by 2030.

Annual biogas production would increase from 1.4 million therms in 2010 to 2.3 million therms in 2030. Since the air emissions permit limits engine run time, additional biogas projection would be used in the dryer. This provides an opportunity to reduce natural gas demand in the dryer from 0.55 million therms to 0.20 million therms by 2030. Total natural gas purchases would be reduced from 0.69 million therms in 2010 to 0.36 million therms in 2030. Self generation of gas required for EWPCF fuel demands would increase from 66% to 87% by 2030.

Flaring of excess biogas would be required beginning in approximately 2022 when the maximum dryer biogas fuel demand is reached.

Heat utilization would increase to meet higher digester heat demands although wasted hot water heat would remain relatively high at 3.2 MMBtu/hr.

Projected “business as usual” energy demands and self generation capabilities would be as summarized in the following table E-4:

Table E-4: Projected Energy Demand and Production[1)]

	Average Flow	Total Electricity Demand	Electricity Self Generation	Total Gas Use	Gas Self Generation	Heat Balance[2)] (MMBtu/hr)	
Year	**MGD**	**kWh**		**Therms**		**Utilized**	**Waste**
2010	22.6	17,368,000	74%	1,896,000	66%	3.2	3.6
2015	28.1	20,659,000	62%	2,141,000	73%	3.5	3.3
2020	33.7	23,951,000	54%	2,291,000	82%	3.7	3.2
2030	40.6	27,916,000	46%	2,591,000	87%	3.9	2.9

1) Business as Usual.
2) Hot air heat produced and used is not included.

EWPCF electricity and gas usage is projected to increase between years 2010 and 2030. A baseline energy profile was developed to quantify projected increases. The baseline profile is based on the “business as usual” condition with no major changes to processes (except capacity expansions as needed) and no changes to air emissions permits. With air emissions rates for internal combustion engines being fixed, additional biogas projected would be used in the dryers(s). Additional electrical energy demand would be met through purchased electricity. Therefore, self generation of gas demand would increase from 66% in 2010 to 82% in 2020 and self generation of electricity would be reduced from 74% to 54% considering both gas and electricity measured in therms, self generation of energy demand would be reduced from 70% to 67%.

Section 3: Energy Efficiency and Process Improvements

A baseline EWPCF energy demand profile was developed along with potential Energy Efficiency Measures (EEM) that could reduce electrical energy demand Payback periods for EEHs were calculated. A process audit was also completed that concluded with a list of potential energy savings process changes.

The analysis and results include the following:

- The baseline annual electricity energy demand was 17,368,000 kWh.
- Blowers operating to provide air for the flow equalization, aeration basins and agitation air resulted in the greatest demand (6,110,000 kWh, 35% of total demand)

- Dewatering, secondary treatment support facilities, the new dryer and effluent pumping facilities incurred similar significant electrical demands each over the 12 month baseline period:
  - Dewatering (2,015,000 kWh – 11%)
  - New Dryer (1,846,000 kWh – 10.4%)
  - Secondary support Facilities (1,435,000 kWh – 8.1%)
  - Effluent Pumping (1,581,000 – 8.9%)
- Nine (9) potential EEM's where identified ranging in electrical demands savings from 76,000 kWh to 2,000,000 kWh.
- The recommended EEM target of electrical demand savings is 2,000,000 kWh, 12% of the baseline demand and 36% of total purchased electricity.
- Potential process changes were divided into two projects groups; major projects (greater than $10,000 cost) and minor projects (less than $10,000).

The EEMs and process changes with the greatest potential for energy cost scenarios are presented in Table E-5.

Table E-5: Energy Demand Reduction Opportunities

Category	Name	Potential Annual Savings
EEM	Turbo Blowers Technology	$380,000
Process Change	Reduce Sludge Return Rate	$250,000
Process Change	Anaerobic Selectors	$200,000
EEM	Variable Speed Ventilation Fans	$150,000
EEM	Variable Speed Digester Mix Pumps	$140,000
EEM	Repair Aeration Air Main	$120,000

Some of these investments may be eligible for local energy projection incentives.

Summary

There are opportunities for investment in improvements that would reduce electric power demand and purchased energy cost. Some opportunities are process changes and some are efficiency measures. These opportunities should be further investigated.

Section 4: Technology Evaluations – Biogas Production

Technologies considered in the development of a recommended Energy and Emissions Strategic Plan is divided into three groups, biogas production, alternative power and waste heat. Several conventional and alternative technologies within each group have been evaluated by considering environmental, operational, technology maturity and cost factors.

The technology evaluations objective was to provide a basis for selecting appropriate technologies for inclusion in alternative project scenarios considered in the development of a recommended project.

Biogas Production

Biogas production enhancement technology evaluations included opportunities to increase biogas production (Waste to Energy, cell lysis and digester train enhancements). Waste to Energy (WTE) and cell lysis were selected as technologies suitable for consideration in the development of project scenarios as each would increase biogas production contributing to increased self generation with acceptable environmental, operations and cost impacts.

WTE would include the introduction of grease to EWPCF digester facilities by haulers serving businesses in North San Diego County. Increased biogas production from grease organic solids reduction would be directly proportional to the volume of grease received and likely would require development of a grease receiving market over time. Food waste is an alternate organics source as well. The estimated biogas production developed in the analysis was 533,000 therms per year, a 39% increase in biogas production.

Cell Lysis is an emerging technology that would increase biogas production by conditioning waste activated sludge prior to discharge into digesters. The technology is utilized in Europe now and is recently being installed in the United States. Experience indicates biogas production could be increased by approximately 10%.

Digester train modifications were not retained due to their higher capital cost, operating difficulty and only small increase in gas production.

Other evaluated support facilities technologies include biogas treatment, sludge heating preconditioning and biogas storage. Biogas Treatment was retained as a selected technology to be included with several other technologies to provide required biogas pre-treatment.

Section 5: Technology Evaluations - Alternative Power

Alternative power technologies would provide EWA the ability to increase self generated electricity. Continued use of internal combustion (IC) engines, fuel cells, solar photovoltaic (PV), small wind turbines and microturbines were evaluated.

Technologies retained for development of alternative project scenarios Include:

- IC engines, with and without emissions reduction equipment
- Fuel cells fueled by biogas or natural gas

- Solar PV

Retained technologies offer cost savings, preservation of recent investments (IC engines), increased self generation due to higher gas use efficiency (fuel cells) and reduction of greenhouse gas emissions (IC engines fueled by biogas, fuel cells and Solar PV).

Technologies dropped from consideration and the reason for that finding includes:

- Small wind turbines limited wind source at EWPCF site as documented by nationally published wind data.

- Microturbines limited benefits due to availability of existing IC engines, higher costs due to smaller units, increased operating complexity.

Section 6: Technology Evaluations - Waste Heat

Waste heat technologies evaluated in the analysis include those capable of converting currently produced waste heat into chilled water for space cooling (absorption and adsorption systems) and processes able to produce electricity (organic rankine cycle ORC power and steam turbine systems). Gasification of biosolids that could increase produced heat supply was evaluated. Produced heat could be used either directly to offset gas fuel needs currently met by purchase of natural gas, or used to produce mechanical energy or electricity thereby offsetting power purchases.

The absorption/adsorption and organic rankine cycle (ORC) technologies are selected for consideration in the alternative scenario development process. Either would reduce power purchases and allow EWA to improve use of currently wasted produced heat.

Steam turbines were not selected due to high costs and limited available systems that could effectively use waste EWPCF produced heat. Gasification of biosolids was determined to be an emerging technology with limited operating experience and high cost and space requirements.

Section 7: Air Emissions

This section reviewed constraints on cogeneration operation due to air emissions. Opportunities to relieve those constraints and optimize the use of existing and future cogeneration equipment were evaluated. Air emissions from other technologies were also evaluated.

One IC engine serves as a standby unit and the remaining 3 are available for production of electricity. Based on carbon monoxide (CO) emissions limits contained in current SDAPCD air emission permits, the use of the IC engines is limited to an equivalent of approximately 1.8 IC engines full-time use. The current air emissions permit results in an unused IC engine capacity equal to 1.2 IC engines preventing EWA from increasing self generated electricity (beyond current operation) unless an alternative air emissions strategy is adopted.

CO emissions from IC engines, fuel cells and the existing dryer technologies are presented in Table E-6.

Table E-6: CO Emissions from Key Technologies

Technology	Fuel	Capacity Annual CO (kW)	Emissions (tons/yr)
IC Engine without Catalyst	Biogas	750	51
IC Engine with Catalyst	Biogas	750	5.1
Fuel Cell	Biogas	1,400	0.6
Dryer	40% Biogas[1)]	---	4.6
Dryer	82% Biogas [1)]	---	6.3

1) The remaining fuel demand would be met by natural gas

Greenhouse gas baseline emissions were reviewed in this section. For reporting year 2009, emissions expressed in metric tons per year of CO_2 equivalents were 22,000 tons of which 17,000 were classified as biogenic and 5,000 as non-biogenic.

Alternative project scenarios were evaluated in Section 8 using a model developed for that purpose. That model treated CO and CO_2 emissions for each technology and each scenario.

Section 8: Alternative Scenarios Development, Evaluation and Selection

The purpose of this section is to develop practical alternative scenarios that would achieve energy independence in accordance with the Business Plan. Energy independence is defined initially as self generating 95% of EWPCF's required electrical power.

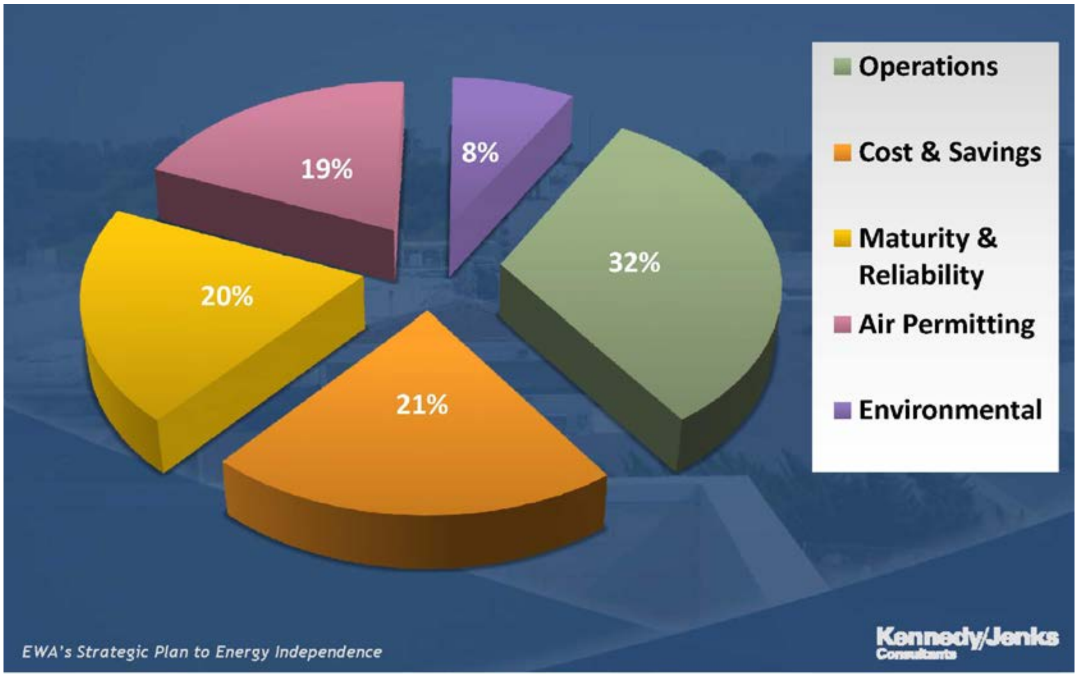
This section includes the development of preliminary scenarios, ranking scenarios by completing scoring process, preliminary screening of scenarios and ultimately recommending the most favorable scenario. The scoring and preliminary screening resulted in a short list of scenarios from which the recommended scenario was selected. The recommended scenario was then further developed into a prioritized plan for implementing technologies comprising the scenario.

Evaluation Criteria and Weighting Factors

Kennedy/Jenks and EWA staff developed evaluation criteria for use in comparing alternative technologies. An alternative scenario was evaluated by evaluating each technology included in the scenario. Five criteria were developed that include various factors considered important in the ranking process. Weighting was developed using the paired wise technique by EWA staff.

The selected evaluation criteria include operations impact, cost and savings, technology maturity and reliability, air permitting and environmental considerations. The criteria weighting developed by the paired wise comparison are shown in Figure E-2.

Figure E-2: Evaluation Criteria with Weighting



Technologies Retained for Projects Development

Sixteen (16) candidate technologies divided into three (3) general categories were considered in the analysis. From this list, seven (8) were selected for inclusion in the development of alternative scenarios.

The technologies surviving the screening process were as follows:

- Electricity Production
  - Internal combustion engines with emissions reduction
  - Internal combustion engines without emissions reduction
  - Fuel cells
  - Solar photovoltaic (PV)
- Biogas enhancements
  - Waste to energy (WTE)
  - Cell lysis
  -

- Waste heat utilization
    - Organic rankine cycle engine (ORC)
    - Adsorption/absorption chiller

Technologies considered and dropped in the technology screening process were as follows:

- Electricity production
    - Microturbines
    - Small wind turbines
- Biogas enhancements
    - Digester train modification
    - Other support facilities
        - Sludge heating
        - Biogas storage
- Waste heat utilization
    - Biosolids gasification

Energy Self Generation Goals

A primary objective of the Energy and Emissions Strategic Plan is to provide EWA with a plan for achieving targeted energy self generation goals. The development of alternative scenarios provides the opportunity to identify combinations of the selected technologies that could achieve such goals.

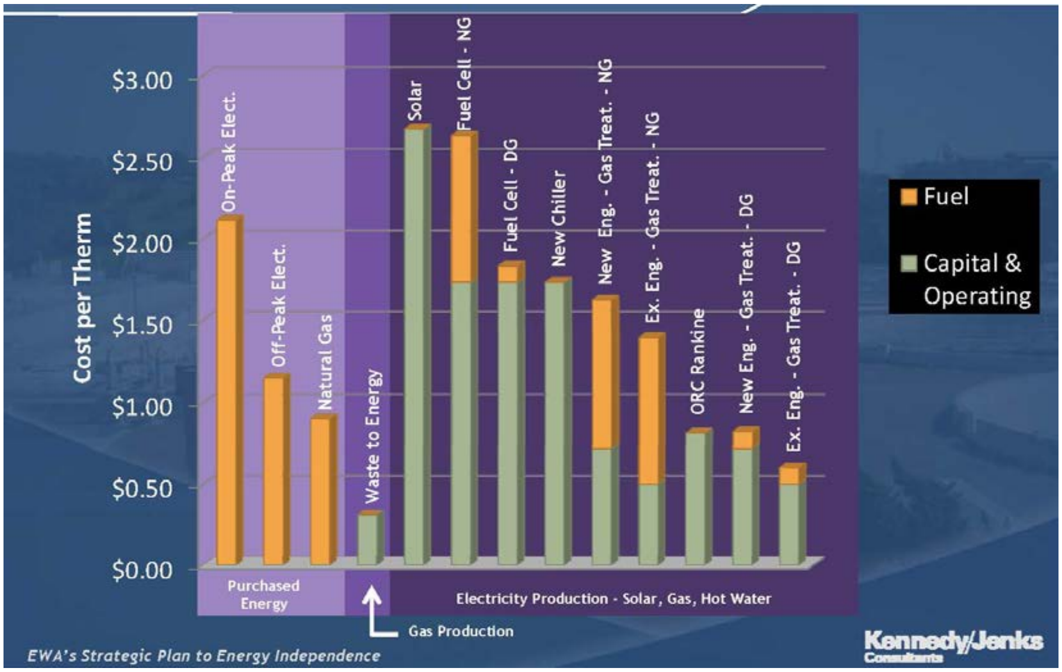
The alternative scenarios developed in the study were configured to enable EWA to self generate 95% of the total EWPCF electrical needs in the year 2020. The 95% self generation goal included an allowance for implementation of EEM's (estimated to reduce electrical energy use by 2.0 MM kW/hr per year). Natural gas purchases are also considered in the development and opportunities to reduce such purchases to the maximum extend possible is identified. However, the 95% 2020 self generation target is the metric used to select the mix of technologies included in each of the alternative scenarios.

Approach to Identifying Alternative Scenarios

The selected technologies offer EWA the opportunity to reduce dependence on purchased electricity and natural gas. The value of incorporating each within the EWPCF operation can be initially viewed by considering unit costs expressed on a common basis.

The following figure provides a comparison of energy cost from various sources expressed in a common unit of energy (therms).

Figure E-3: Energy Cost for Various Sources



The comparison demonstrates the economic value of waste to energy, the use of existing IC engines fueled by biogas and the organic rankine cycle generator (ORC) units. Solar PV and fuel cells operating on natural gas are shown to have the highest cost. Fuel cells fuel by biogas and a new adsorption chiller have unit costs between the off-peak and on-peak purchased power costs.

Combining technologies into multiple scenarios was identified as the next step for subsequent comparison.

An Excel-based model was utilized to facilitate the development of alternative scenarios. Based on a “building blocks” concept, the model allows the selection of technologies tracking the following key factors.

- Capital Cost
- Annual Operation and Maintenance Cost
- Net Present Value
- Annual Carbon Monoxide (CO) Emissions
- Annual Power and Production/Purchase

- Annual Biogas Utilization
- Annual Natural Gas Purchases
- Waste Heat Balance (production and utilization)
- Greenhouse Gas Emissions (carbon dioxide - CO_2)

Total energy requirements and onsite energy production are tabulated in 5-year increments to allow selection of combinations of technologies meeting selected goals. The annual CO emissions are tabulated and notification is provided by the model when the total exceeds the current synthetic minor limitation of 100 tons per year.

Electricity generation is tracked and compared to demand. Using this model feature, various combinations of technologies were identified that could achieve the 2020 95% self generation goal.

By tracking biogas production and utilization as technologies are selected, the availability of sufficient biogas is verified. Technologies that would increase biogas production (waste to energy and cell lysis) were incorporated into some of the identified scenarios.

Preliminary Project Scenarios

Using the scenario model, seventeen (17) scenarios were initially developed. Each scenario was configured with alternative combinations of technologies for comparison purposes. The combinations were designed to evaluate all practical combinations of variables (technologies). As noted previously, all of the scenarios (with one exception) would allow EWA to achieve 95% electrical energy self generation in the year 2020. One scenario would be limited to 90% self generation in 2020.

Each scenario included combinations of technologies from the following list:

- **IC Engines**: Identified scenarios including continuing with four (4) existing engines, adding a 5^{th} engine or installing engines with greater capacity than current 750 kW units
- **IC Engines gas treatment and catalysts**: Several scenarios include the addition of air emissions reduction equipment (biogas treatment and catalysts) allowing increased IC engine use within the current SDAPCD permit emissions limits.
- **Dryer Facilities**: fueled with one of two possible combinations of biogas and natural gas (40% biogas/60% natural gas or 82% biogas/18% natural gas)
- **Fuel cell**: 0.3 mW or 1.4 mW units (compared to 0.75 kW for each current IC engine)
- **Solar:** 1.0m mW, 3.0 mW or 4.0 mW (larger capacity installations would utilize net metering)

- **Organic Rankine Cycle Generator (ORC):** utilizing waste heat from IC engines or fuel cell producing 0.23 mW electricity

- **Second Absorption Chiller:** 110 ton unit installed in Administration Building (without this technology, existing administration equipment utilizes electricity)

- **Cell Lysis:** increasing biogas production

- **Waste to Energy:** increasing biogas production

A detailed table listing technologies included in each of the 17 scenarios is provided in Table 52, page 8-8. A summary of the variations between the scenarios is as follows:

- Three scenarios would exceed the current SDAPCD air emissions permit creating the need to obtain a Title V major emissions permit

- Nine scenarios would maintain current four IC engines operation

- Seven scenarios include air emissions reduction equipment for all IC engines

- Eight scenarios include a fuel cell

- Five scenarios include solar PV equipment

- Thirteen scenarios include an adsorption chiller serving the Administration Building

- Five scenarios include an Organic Rankine Cycle (ORC) unit

- Twelve scenarios include waste to energy (WTE)

Preliminary Project Scenarios Scoring

The seventeen scenarios were ranked by completing a scoring process utilizing the evaluation criteria and the weightings developed in the study. A matrix analysis approach was used assigning scores derived from the weighted criteria applied to each technology included within each scenario.

The scoring was completed by assigning the highest possible score to each technology included within a scenario. Scores were then adjusted downward based on technology limitations for each of the technologies included in the scenario. With 12 technologies and 100 possible points for the 5 evaluation criteria, the maximum possible score was 1200. Those technologies that were not included in a scenario received the maximum score.

The scores ranged from 712 to 975 as detailed in Table E-7, below.

Table E-7: Preliminary Scenarios Scoring Results

Rank	Scenario	Score	2020 Electrical Self Generation
1	4d	975	90%
2	4f-1	958	95%
3	4e	933	95%
4-5	4	919	95%
4-5	1(Business as Usual)	919	54%
6	12	915	95%
7-8	6	902	95%
7-8	4b	902	95%
9	2	901	95%
10	11	887	95%
11	13	885	95%
12	3	876	95%
13	7	810	95%
14	10	810	95%
15	8	732	95%
16	5	715	95%
17	9	712	95%

A review of the scoring resulted in the following findings:

- The "business as usual" scenario received a score of 919 and was tied for 4th highest.
- The highest ranked scenario (receiving a score of 975) would not enable EWA to achieve the 2020 95% electricity self production goal

- The 2nd highest ranked scenario (receiving a score of 958) includes additional IC engines and emissions reduction on all engines

- The highest ranked scenario including fuel cells technology was tied for 4th with a score of 919

- The highest ranked scenario including solar PV technology was ranked 6th with a score of 915

- The highest scenario requiring a Title V emissions permit (major emissions designation) received a score of 901 (ranked 9th)

Top Ranked Scenarios Considerations

The top ranked scenarios were compared by completing a detailed review of each to verify the scoring for each and identification of features that might influence a final selection.

For screening purposes, projects scoring less than 900 were screened out. In addition, Scenario 2 was dropped because the CO emissions would require operating under a Title V permit. This was deemed inconsistent with EWA's "Mission" of being an environmental leader. Scenario 4b was also dropped because it did not equip all engines with exhaust catalysts. This would dictate assigning an engine to natural gas fuel only and would reduce equipment redundancy and hamper efficient operations.

The highest ranked remaining scenario would take advantage of the recent EWA investment in new IC engines utilizing the remaining power Building space by including the addition of a 5th engine. Gas treatment and catalysts are included thereby allowing greater use of the IC engines and reducing CO emissions well below SDAPCD threshold for a synthetic minor emissions permit. With the addition of a 5th engine, up to 4 engines would be operated maintaining one engine as a standby unit as required to meet EWPCF reliability requirements.

Operating 4 engines as described above would limit self generation to 90% of the projected 2020 demand. Each of the remaining 16 scenarios would allow EWA to provide 95% self generation capacity. Because of the 2020 self generation limitation, this scenario was dropped from further consideration.

The remaining top 6 ranked scenarios were assigned Strategic Plan Scenario designations to simplify the final comparison and selection of a recommended scenario, see Table E-8.

Strategic Plan Scenario B is similar to the dismissed scenario but includes a 6th engine (that would allow EWA to achieve 95% self generation in 2020) and was scored highest among the remaining scenarios. This scenario has a high score even when considering the added cost of adding a 6th engine. The estimated capital cost includes an expansion of the building. As in the case of the dismissed scenario, Scenario B would take advantage of the current investment in four new IC engines providing a competitive capital and operating cost when compared to other scenarios.

Table E-8: Highest Ranked Scenarios

Final Designation	Scenario	Comparison					Features						
		Score	**Annual Cost ($ mil)**	**Capital Cost ($ mil)**	**Net Present Value ($ mil)**	**2020 Self Generation**	**No. of Engines**	**Biogas Treatment**	**No. Engines with Catalyst**	**Fuel Cell (mW)**	**ORC Generation (mW)**	**Solar PV (mW)**	**2030 Self Generation**
B	4f-1	958	$2.5	$11.7	$29.2	95%	6	Full	6	-	-	-	83%
C	4e	933	$2.2	$10.0	$27.6	95%	5	Full	5	-	0.23	-	83%
D	4	919	$2.4	$13.0	$30.5	95%	4	For 3	3	1.4	-	-	83%
A	1 (Business as Usual)	919	$3.2	$ -	$26.8	54%	4	-	-	-	-	-	38%
E	12	915	$2.4	$17.5	$33.0	95%	5	Full	5	-	-	1.0	83%
F	4b	902	$2.3	$13.5	$30.0	95%	4	For 2	2	1	0.23	-	83%

Strategic Plan Scenario A (Business as Usual) would maintain the current operational scheme (with no required capital investment) and was scored in a tie for 4th highest among the 6 remaining. Self generation would be considerably lower in 2020 (43%), much lower in 2030 and would not allow EWA to achieve self generation goals.
Table E-8 provides a comparison of the remaining 6 highest scored Strategic Plan Scenarios A through F. Features of each Strategic Plan Scenario are listed including electricity producing technologies contributing to self generation capacity.

The six top ranked Strategic Plan Scenarios have several common features:

- Each would maximize use of biogas in the dryer up to the maximum design blend of 82% biogas and 18% natural gas.

- Waste to energy (WTE) increasing biogas production is required to achieve self generation goals and dryer gas demand in five of the six scenarios (WTE is not included in Scenario C).

- Each includes the installation of an adsorption chiller utilizing available waste heat reducing existing administration building equipment natural gas demand.

Selected Project and Implementation Plan

The review of the highest ranked Strategic Plan Scenarios resulted in the following important findings:

- The ranking process was developed with careful consideration of the five weighted criteria.

- The resulting scores were judged to be appropriate based on the weighting and scoring process developed in the study.

- Each of the remaining 6 top highest ranked scenarios would allow EWA to achieve the energy independence goals included in the adopted business plan with one exception, Strategic Plan Scenario A (Business as Usual).

Of particular note was the final scoring with respect to the capital and net present value cost estimates. Scenario A (Business as Usual) was estimated to have the lowest of both. It would not, however, allow EWA to achieve its goals. Also, the estimated present value is dependent on a state-wide published energy inflation rate of 1.75% per year. The rate of energy price increase is controlled by others and higher purchased energy prices would increase Scenario A costs.

Scenario B (the highest ranked scenario) has the third lowest net present value and the second lowest capital cost. It maximizes the use of the recently installed IC engines and continues with the same mix of existing technologies (technologies EWA staff are familiar with and have available staff to support) with the exception of gas treatment and catalysts.

With these factors in mind, the final recommendation is to rely on the evaluation criteria, weighting and scoring developed during the study and select the highest ranked scenario, Strategic Plan Scenario B.

Description of Recommended Project

The recommended Strategic Plan Scenario B includes the following technologies and features:

- Utilize IC Engines fueled with biogas to produce electricity thereby reducing commercial power purchases to 5% of electricity demands in 2020.

- Increase total IC Engine capacity to maintain current level of redundancy and meet electrical energy demands by installing 5th and 6th engines. Increasing the size of one or more of the existing 750 kW engines and installing a larger 6th engine would likely be superior to expanding the existing energy building to accommodate a 6th engine.

- Install biogas treatment and catalysts on all engines to substantially reduce carbon monoxide and other pollutant emissions thereby complying with current emissions limitations.

- Increase biogas production (beyond production available from wastewater solids) by implementing a waste to energy (WTE) project.

- Utilize biogas as a fuel source for the dryer up to a maximum blend of 82% biogas and 18% natural gas as biogas production increases and exceeds IC engine biogas demand for self generation of electricity.

- Supplement existing Administration Building chiller with new adsorption chiller and hot water loop utilizing available waste heat from IC engines hot water recovery system.

A comparison of "business as usual" and the recommended scenario is provided in the following Table E-9. Electricity and total energy self generation would be significantly increased with implementation of Scenario B. Total energy accounts for electrical energy production and use of biogas offsetting purchases of natural gas. The comparison of energy self production includes implementation of the recommended Energy Efficiency Measures (EEMs) identified in the study.

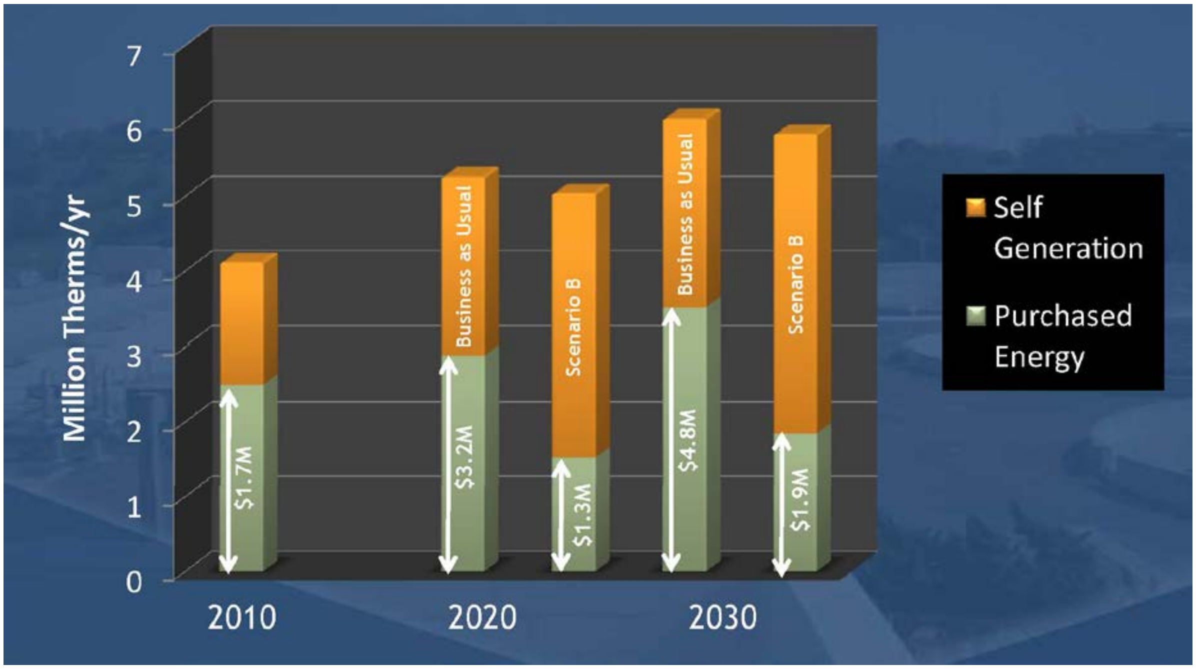
Table E-9: Scenarios A and B Comparison

Factors (2020)	Scenario A (Business as Usual)	Scenario B (Recommended)
Electricity Self Generated	54%	95%
Total Energy Self Generated	65%	73%
Capital Cost	$0	$11,700,000
O&M Cost	$3,210,000	$2,510,000
Self Generation (kwh/yr)	14,133,000	23,623,000
Power Purchase	$2,700,000	$239,000
CO Emissions (t/yr)	97	27
GHG Emissions (t/yr)	6,500	6,100
Net Present Value	$26,800,000	$29,200,000

Scenario B would require a capital investment of $11,700,000 to achieve the self generation levels indicated. A portion of that investment would be recovered by reduced operating costs.

Energy purchases and self generation for Scenarios A and B are compared graphically in the figure E-4.

Figure E-4: Scenarios A and B Energy Sources Comparison

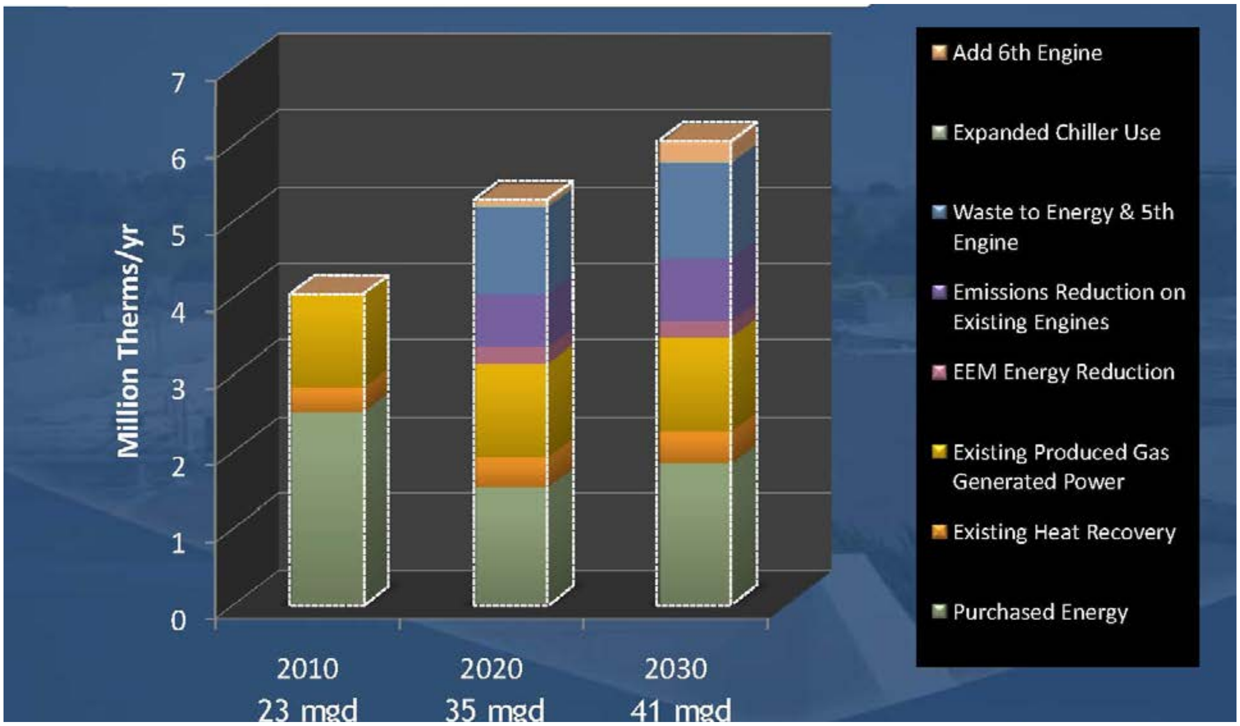


Implementing Scenario B would allow EWA to move forward with increased levels of self generation. Figure 5 provides a breakdown of energy elements of Scenario B in 2010, 2020 and 2030 in common units (millions of therms per year) and grouped into categories as follows:

- **Purchased Electricity:** Electricity and natural gas purchases
- **Existing Heat Recovery:** Heat utilization for digesters and the existing chiller
- **Existing Produced Gas:** Electrical Energy production from IC engines limited by current APCD permit (prior to installation of gas treatment and catalysts
- **EEM Energy Reduction:** Energy savings associated with Energy Efficiency Measures
- **Emissions Reduction on Existing Engines:** Increased electricity production with installation of gas treatment and catalysts
- **Waste to Energy and 5th Engine:** Increased electricity production with installation of waste to energy technology and 5th IC engine
- **Expanded Chiller Use:** Increased recovery of waste heat with installation of new chiller serving administration building

- **Add 6th Engine:** Increased electricity with installation of 6th IC engine (or increased size of existing engine)

Figure E-5: Scenario B Energy Elements



Implementation Plan

Scenario B includes several technology components that could be implemented in a phased manner. A recommended phasing plan is developed by setting priorities for each technology.

The opportunity to increase self generation is directly related to increased biogas production that is dependent on two factors, increased wastewater (and solids) flows and implementation of the recommended waste to energy (WTE) project. Increased wastewater flows are dependent on the local economy and associated new development. The WTE project provides an opportunity to increase biogas production immediately and potentially has a higher degree of certainty for increasing biogas production.

Considering these factors, the recommended priority for implementing Scenario B elements is provided in Table E-10.

Table E-10: Priorities for implementing Scenario B

Plan Element	Investment - $ Million	Payback Period - Years	Priority	Basis for Setting Priority
Waste to Energy	3.0	--	1	Near term biogas increased production with high level of EWA control; immediately reduces natural gas purchases
IC Engine Gas Treatment & Catalysts	3.2	--	2	Reduces emissions; ability to increase electricity self generation
Administration Building Chiller	1.4	--	3	Reduces natural gas purchases; utilizes waste heat
5th IC engine	1.0	--	4	Scheduling dependent on increased wastewater flows
6th IC engine	3.1	--	5	Scheduling dependent on increased wastewater increased flows

The E-CAMP process should be used to schedule, fund and implement the recommended plan elements

Summary and Findings

Benefits of Recommended Scenario

The recommended plan, Strategic Plan Scenario B, has the following benefits:

1. Reduce the requirements for purchased energy. Under Scenario B the cost of purchased energy is projected to fall between years 2010 and 2020 and then rise between 2020 and 2030.
2. Reduce air CO emissions and remove operating constraints imposed by air emissions permits.
3. Reduce reliance on outside energy providers.
4. Leverages the previous investments made in internal combustion engine generators.
5. Insulate EWA energy budgets from the uncertainty of energy markets.

Energy Independence

The Energy & Emissions Strategic Plan Update has shown that energy independence is indeed achievable for EWPCF. The Plan, compared to Business as Usual, is projected to:

- Increase self generated electricity from 54% currently to 95% in 2020.
- Increase self generated total energy from 65% currently to 73% in 2020.

Additional Recommendations

Beyond implementing the recommended Scenario, other actions should be taken to support the objectives of this plan:

1. Energy asset management: Update and improve programs for energy assets condition assessment and maintenance. Improve operability and control of existing cogeneration system.
2. Energy funding strategies: As part of the Comprehensive Asset Management Program (CAMP) and the budget process, support energy strategic initiatives that focus on continuous improvement related to energy efficiency and energy annual cost. While current budget pressures may slow the implementation of energy related initiatives, they should be evaluated in the context of facility wide need through the established CAMP process.
3. Energy initiatives awareness: Utilize EWA's website and other communications to make the public aware of the "energy cost" of accomplishing our work and of initiatives underway to reduce the amount of energy and cost devoted to providing our services.
4. Waste to energy implementation: Explore cooperative ventures between EWA and Member Agencies related to grease and food waste derived fuel production.

Future Work

EWPCF's culture of energy efficiency and optimization should be maintained. Additional effort will contribute to this. These efforts should consider and include the following future studies, analysis and improvements.

1. Energy procurement management: The effort includes conducting tariff analysis, consideration of long term energy purchase contracts and new strategies for energy procurement.
2. Energy sub-metering: Expand and automate the system of monitoring and reporting electrical power use by plant area and equipment. This type of date supports energy use projections, management and conservation.
3. Purchased energy quality and reliability: Evaluate the quality and reliability of electrical power being delivered to us. Determine if purchased power quality and reliability could be improved, and if so, how. Consider actions to reduce our risk of not being able to provide serves due to electrical power delivery shortcomings.

4. Energy asset security and internal reliability: Evaluate the security and reliability of assets related to distribution of self produced energy. Identify strategies for maintaining service in the event of natural disasters, component failure and human error.
5. Energy and use model: Explore expanding our energy use predictive model to include feedback from our metering and real time status of energy use and generation. Design the model to best support the staff resources of EWA.
6. Energy use and efficiency metrics: Establish metrics to measure improvements in the efficient generation and use of energy.
7. Energy conservation: Expand initial work related to demand reduction and search for additional energy conservation measures.

Section 9: Grant and Incentive Programs Summary

The available funding is in the form of incentives managed by the local supplier of energy (SDG&E) and state and federal grants and are primarily technology based.

Fuel Cells

In California, the Self Generation Incentive Program (SGIP) governed by the California Public Utility Commission offers an incentive for fuel cells using a renewable fuel, such as digester gas, of $4500 per kW up to 1 MW. For projects greater than 1MW, incentives of $2250 per kW are available for the energy generated between 1 MW and 2 MW. Projects larger than 2 MW receive $1125 per KW above 2 MW and up to 3 MW. Systems must be new, UL listed, and in compliance with all applicable performance and safety standards. Wind systems, fuel cells and advanced energy storage systems must be covered by a minimum five year warranty. The warranty must protect against the breakdown or degradation in electrical output of more than ten percent from the originally rated electrical output. The warranty should cover all replacement and labor costs. The incentive can go to the project if owned or leased. The SGIP might not receive additional funding beyond December 31, 2011.

Net metering is also available as described in the following paragraph.

Solar PV

California's Net Energy Metering (NEM): Net energy metering applies to solar PV projects as long as the project is behind the meter. Eligible renewable resources are photovoltaic, wind, fuel cells and dairy biogas. System capacities are limited to a maximum of 1 MW in size. SDG&E is obligated by state law to provide a net metering agreement to all their customers. Net metering is a method of metering the energy consumed and produced by a customer that has a renewable resource generator, and credits the customer with the retail value of the generated electricity.

The California Solar Initiative (CSI): This is part of the Go Solar California campaign which builds on 10 years of state solar rebates offered to customers in California's investor-owned utility territories. CSI rebates vary according to system size, customer class, and performance and installation factors. The subsidies automatically decline in "steps" based on the volume of solar megawatts confirmed within each utility service territory.

Federal rebates and incentives are available in the form of tax credits and rebates. Unfortunately, tax-exempt entities such as EWA are not eligible unless developed through a third party agreement.

Microturbines

Federal rebates and incentives are available in the form of tax credits and rebates. Unfortunately, tax-exempt entities such as EWA are not eligible. However, a tax exempt entity could take advantage of these incentives through a third-party lease arrangement.

Waste to Energy (WTE)

The funding incentives for installing a waste receiving facility are geared to the ultimate use of the digester gas that is produced. Energy production incentives could be used to help fund a combined heat and power system. The improvements directly associated with waste receiving (i.e. pumps, tanks, and site improvements) are not eligible for incentives. However, energy efficiency incentives could be used to lower the cost of project components such as premium efficiency pumps and motors.