Gresham's Energy Independence Challenges and Successes

Alan Johnston, Senior Engineer, Wastewater Services Division

- 114,000 service population *(Gresham, Fairview, Wood Village)*
- 20 mgd annual average capacity; 13 mgd current flowrate
- Secondary, Activated Sludge, Anaerobic Digestion, BFP, Chlorination/ Dechlorination.
- Discharges to Columbia River
- WWTP and PS O&M provided under contract with Veolia Water
- 16 FTE in Operations & Maintenance (Veolia Water)
- 3 FTE in WWTP and PS Engineering (Gresham)

Energy Discussion Items

- Gresham's Sustainability Policy (carbon footprint reduction)
- 400 kw Cogeneration
- 420 kw Peak DC Solar plant
- MicroHydro in our Outfall Pipeline
- FOG Receiving Station (under construction)
- Energy Conservation (Linear Motion Mixers, Neuros Blowers)
- WWTP Energy Consumption and Production Data
- Energy Management Plan (Keep it simple)
- Power Monitoring
- Lofty Goal: Energy Independence by FY 2015/16?

Gresham's Sustainability Policy

Adopted by Gresham City Council in 2009.

"The City of Gresham will strive to design and deliver services that:

- Support a stable, diverse and equitable economy.
- Promote community health and well-being, outdoor recreation, cultural awareness, and encourage learning.
- Protect and improve the quality of the air, water, land and other natural resources by reducing human impacts and increasing public awareness of the valuable services the environment provides."

Gresham's Sustainability Policy
Key Goals

- 1) 80% Reduction in City Greenhouse Gas Emissions by 2050
- 2) 100% Renewable Energy by 2030
- 3) Zero Waste in City Operations by 2020
- 4) Ongoing Protection of Natural Resources (including water quality and availability, and habitat)
- 5) Toxin Reduction and Eventual Elimination

This discussion involves Goals 1 and 2 at the WWTP.

Gresham Cogeneration History

- 250 kw Waukesha cogenerator installed 1987 with digesters
- No biogas treatment over its lifetime
- Turned off 2003/04 due to sudden continued internal corrosion
- 400 kw Lean Burn Caterpillar cogenerator started 2005
- Installed in same footprint as Waukesha
- H2S/Siloxane/moisture removal system incorporated

400 kw CAT Cogenerator

Cogeneration by the Numbers

- 93% Runtime since 2005 (off about 48 hours per month)
- Produces power and heats buildings with jacket water heat
- Haven't put a number to the financial benefits of the heat
- 50,000+ Operating Hours (no engine overhaul yet)
- 17,000,000+ **kwh** of power production
- 2.6 cents per kwh operation/maintenance expenses
- An oil change and spark plugs is $3,200 bimonthly, or so
- Sample your oil starting at 1000 hrs runtime.
- 50% of WWTP Power needs
- $1.5 million in avoided electrical costs.
- 3.5 year payback

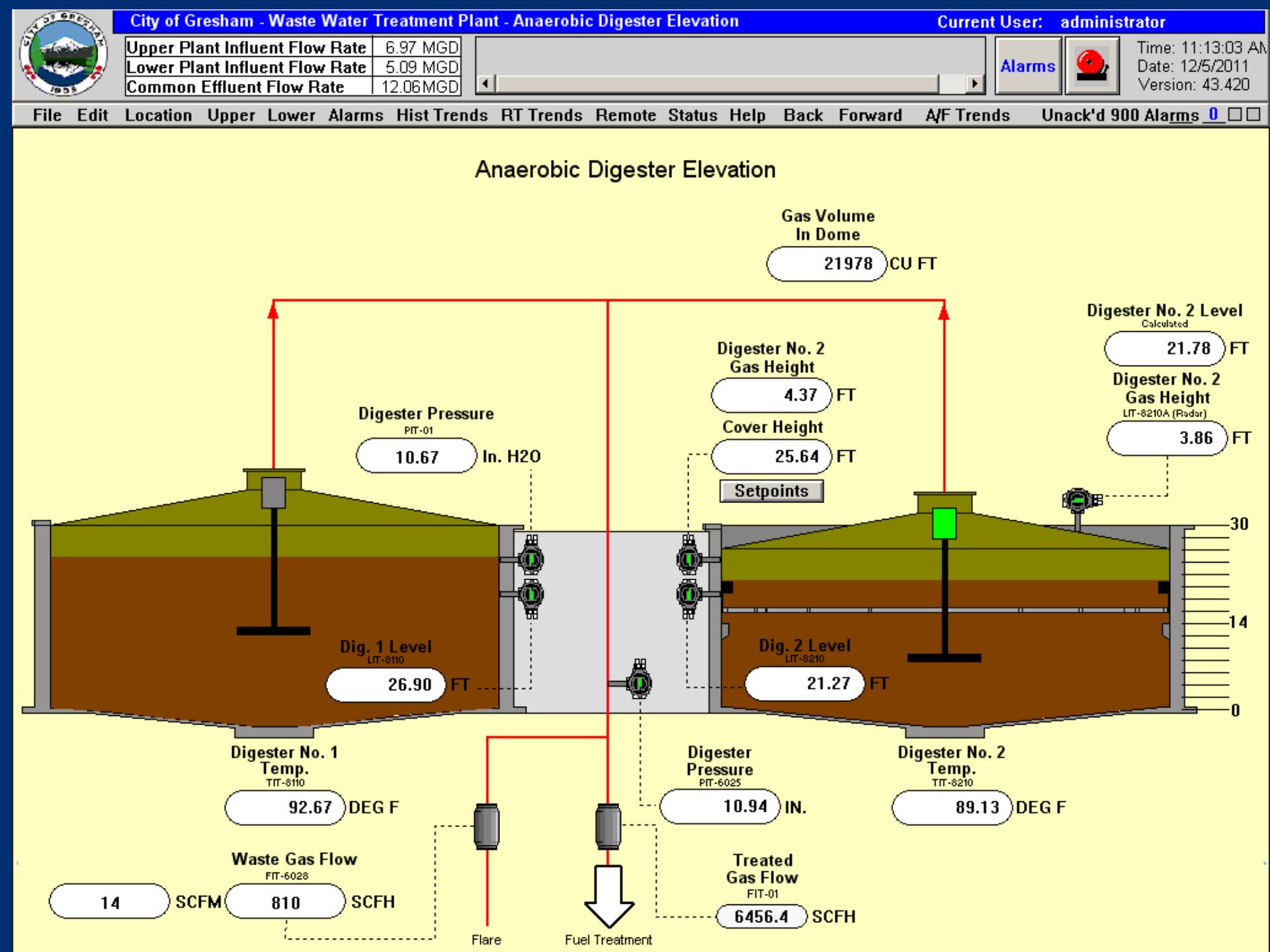
Cogeneration Financing

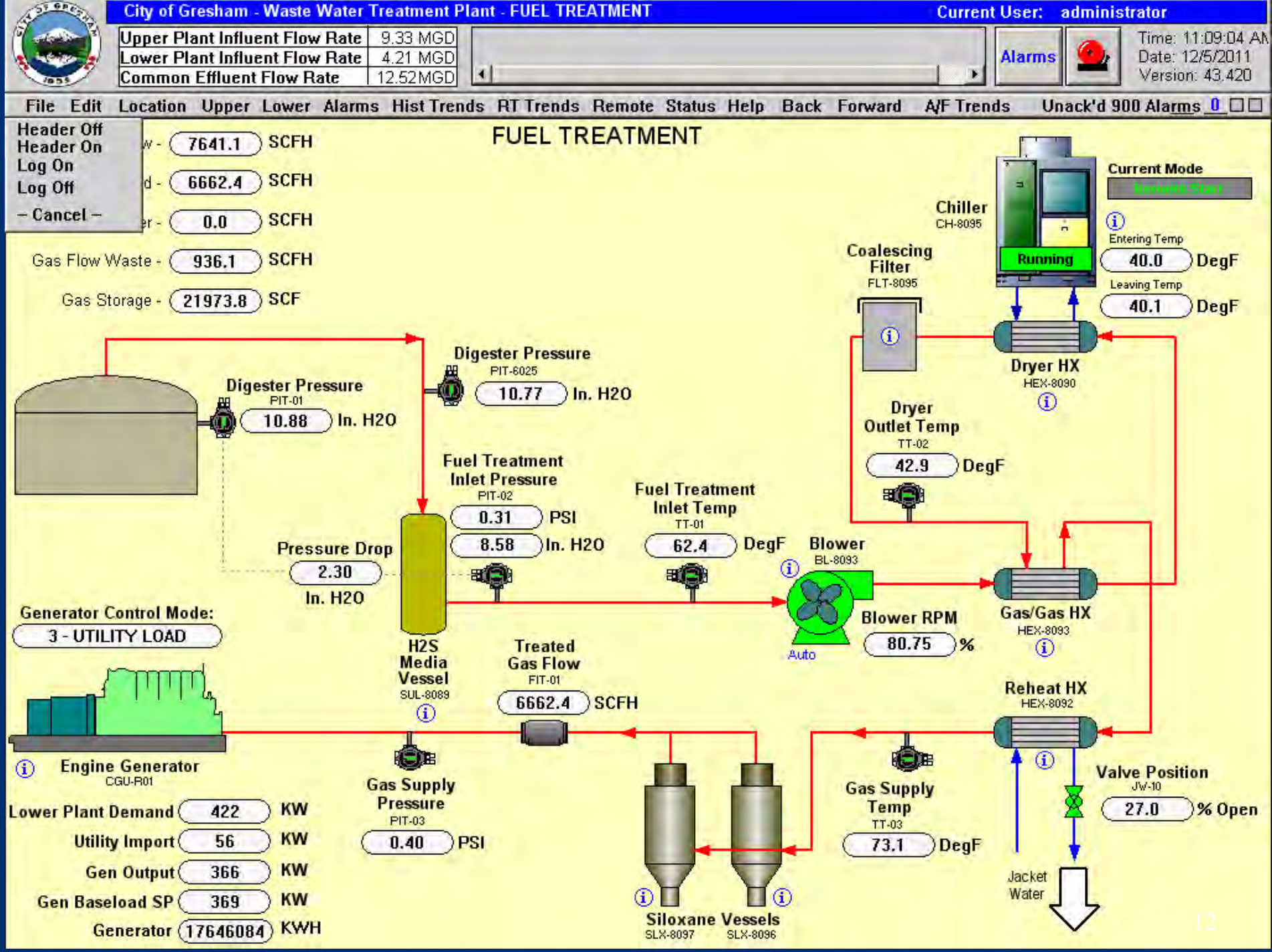
- City's first Design-Build contract
- Engine ordered during schematic design phase.
- Allowed start-up 6-8 months earlier than possible with conventional design-bid-build (resulting in >$100k in energy production and savings)
- ODOE BETC Grant, Energy Trust Grant

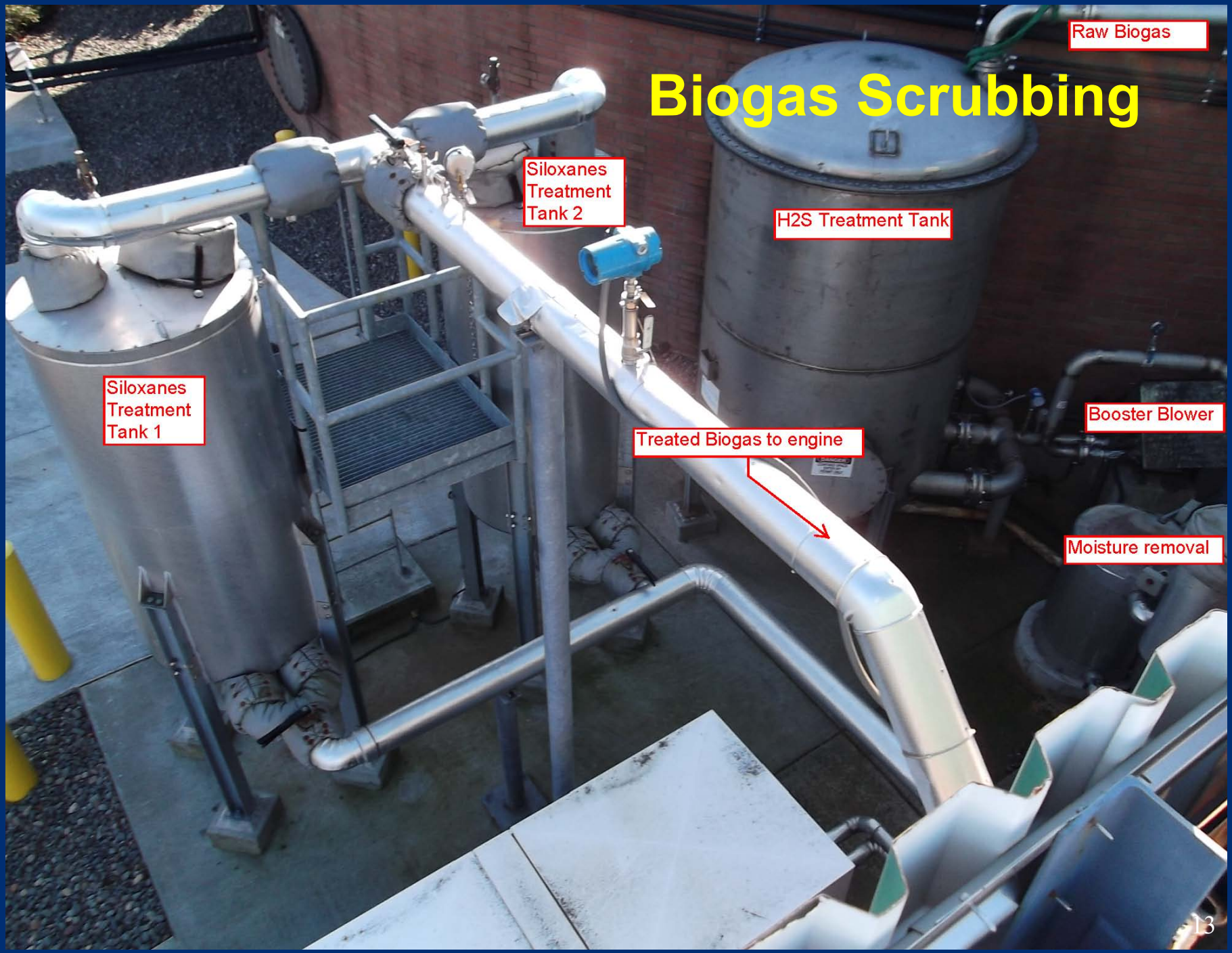
Certified Capital Cost	$1,128,633
less BETC Partner	$287,801
less Energy Trust Grant	$82,379
Total Capital Cost	*$758,453*
Annual Power Savings	$275,000
Annual O&M	$40,000
Payback	3.5 years

Biogas Scrubbing

- 9000 scfh Design Flow (7000 scfh at 400 kw engine output)
- H2S Scrubbing Tank (Change media as needed)
- Booster Blower (Design in redundancy)
- Heat exchanger (Chill gas to 40 F)
- Moisture Removal
- Heat Exchanger (Heat gas to 70 F)
- Siloxane Tank (Change media once per year)
- Treated Biogas to Engine or boiler


City of Gresham - Waste Water Treatment Plant - Anaerobic Digester Elevation
Current User: administrator
Upper Plant Influent Flow Rate 6.97 MGD
Lower Plant Influent Flow Rate 5.09 MGD
Common Effluent Flow Rate 12.06 MGD
Alarms
Time: 11:13:03 AM
Date: 12/5/2011
Version: 43.420
File Edit Location Upper Lower Alarms Hist Trends RT Trends Remote Status Help Back Forward A/F Trends Unack'd 900 Alarms 0
Anaerobic Digester Elevation
Gas Volume In Dome
21978 CU FT
Digester No. 2 Level
Calculated
21.78 FT
Digester No. 2 Gas Height
4.37 FT
Digester No. 2 Gas Height
LIT-8210A (Radar)
3.86 FT
Digester Pressure
PIT-01
10.67 In. H2O
Cover Height
25.64 FT
Setpoints
30
14
0
Dig. 1 Level
LIT-8110
26.90 FT
Dig. 2 Level
LIT-8210
21.27 FT
Digester No. 1 Temp.
TIT-8110
92.67 DEG F
Digester Pressure
PIT-6025
10.94 IN.
Digester No. 2 Temp.
TIT-8210
89.13 DEG F
Waste Gas Flow
FIT-6028
14 SCFM
810 SCFH
Flare
Fuel Treatment
Treated Gas Flow
FIT-01
6456.4 SCFH

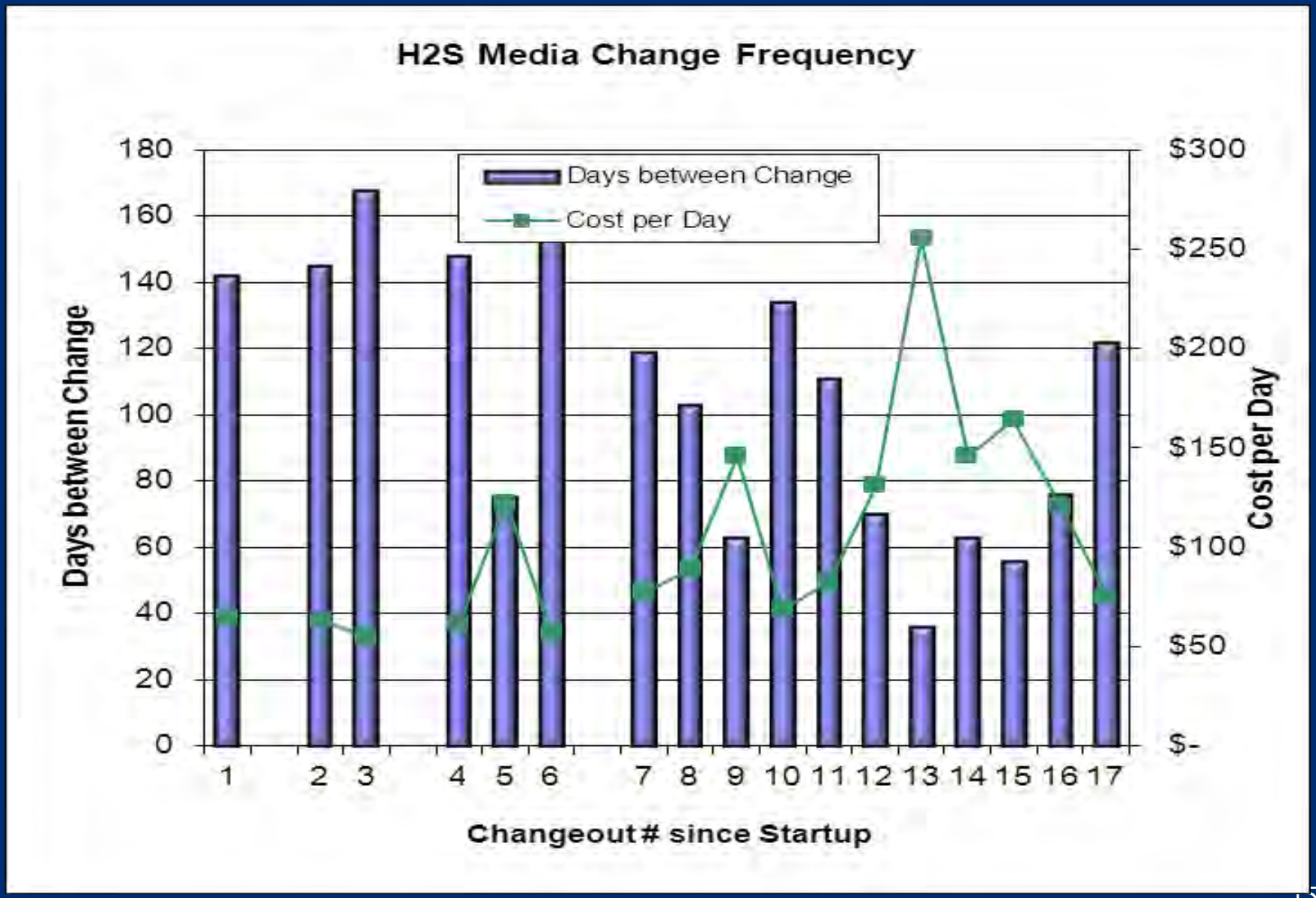

City of Gresham - Waste Water Treatment Plant - FUEL TREATMENT
Current User: administrator
Upper Plant Influent Flow Rate 9.33 MGD
Lower Plant Influent Flow Rate 4.21 MGD
Common Effluent Flow Rate 12.52MGD
Alarms
Time: 11:09:04 AM
Date: 12/5/2011
Version: 43.420
File Edit Location Upper Lower Alarms Hist Trends RT Trends Remote Status Help Back Forward A/F Trends Unack'd 900 Alarms 0
Header Off
Header On
Log On
Log Off
– Cancel –
FUEL TREATMENT
7641.1 SCFH
6662.4 SCFH
0.0 SCFH
Gas Flow Waste - 936.1 SCFH
Gas Storage - 21973.8 SCF
Chiller
CH-8095
Running
Current Mode
Remote Start
Entering Temp
40.0 DegF
Leaving Temp
40.1 DegF
Coalescing Filter
FLT-8095
Dryer HX
HEX-8090
Digester Pressure
PIT-6025
10.77 In. H2O
Digester Pressure
PIT-01
10.88 In. H2O
Dryer Outlet Temp
TT-02
42.9 DegF
Fuel Treatment Inlet Pressure
PIT-02
0.31 PSI
8.58 In. H2O
Fuel Treatment Inlet Temp
TT-01
62.4 DegF
Pressure Drop
2.30 In. H2O
Blower
BL-8093
Auto
Blower RPM
80.75 %
Gas/Gas HX
HEX-8093
Generator Control Mode:
3 - UTILITY LOAD
H2S Media Vessel
SUL-8089
Treated Gas Flow
FIT-01
6662.4 SCFH
Reheat HX
HEX-8092
Engine Generator
CGU-R01
Gas Supply Pressure
PIT-03
0.40 PSI
Gas Supply Temp
TT-03
73.1 DegF
Valve Position
JW-10
27.0 % Open
Lower Plant Demand 422 KW
Utility Import 56 KW
Gen Output 366 KW
Gen Baseload SP 369 KW
Generator 17646084 KWH
Siloxane Vessels
SLX-8097 SLX-8096
Jacket Water


Raw Biogas
Biogas Scrubbing
Siloxanes Treatment Tank 2
H2S Treatment Tank
Siloxanes Treatment Tank 1
Booster Blower
Treated Biogas to engine
Moisture removal

Biogas Scrubber Media

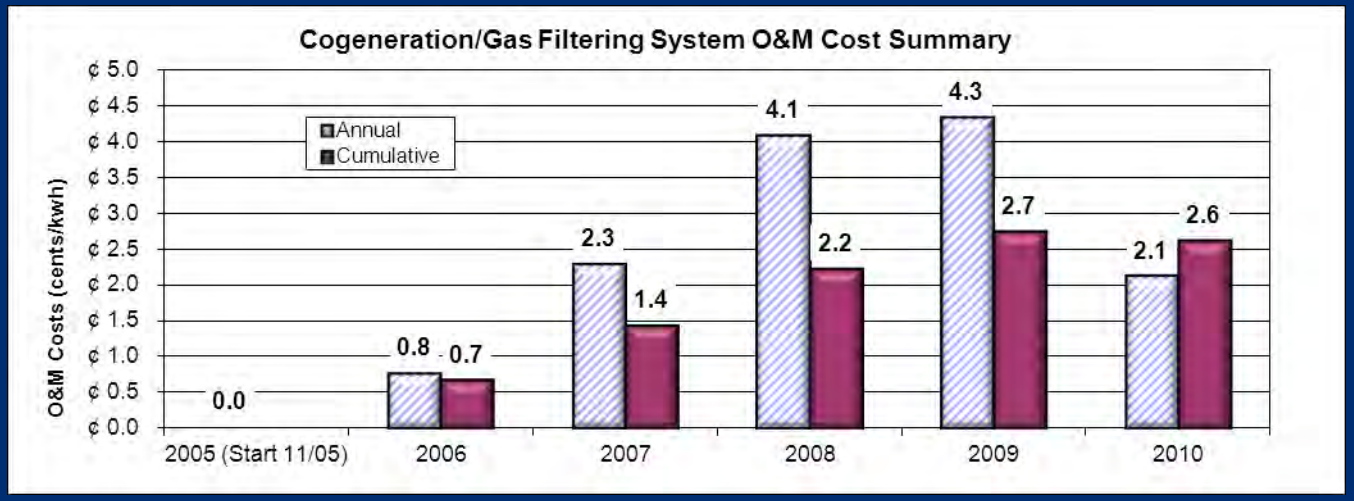
- Largest Cost of the treatment system
- H2S Media replaced every 60-120 days, varies widely.
- H2S media changed when treated biogas > 100 ppm H2S
- Siloxane media Changed every year (switch tanks 6 months)
- 1 per year siloxanes testing, unreliable and expensive
- Storage required for media so it is ready to go
- Change oil (if needed) when media is replaced for ½ day outage.
- $10,000 per H2S Media Changeout (3 per year)
- $6,000 per Siloxane Media Changeout (1 per year)

Biogas Scrubber Media



Cogen/Gas Scrubber Maintenance Cost Summary

Summary of Costs:	Total Maintenance	City Labor Media	Uptime	Total	Cumul.	Cost	Cumul. Cost
Period (calendar year)	Costs	Costs	Incentive	Costs	Costs	¢/kwh	¢/kwh
2005 (Start 11/05)	$ 131.25	$ -	$ -	$ 131.25	$131.25	0.03	
2006	$ 24,138.83	$ -	$0.00	$ 24,138.83	$24,270.08	0.77	0.68
2007	$ 59,271.45	$ 5,644.00	$8,061.55	$ 72,977.00	$97,247.08	2.30	1.44
2008	$ 98,542.27	$ 7,953.00	$10,822.81	$ 117,318.08	$214,565.16	4.09	2.23
2009	$ 117,073.31	$ 10,262.00	$8,036.77	$ 135,372.08	$349,937.24	4.35	2.75
2010	$ 52,481.72	$ 10,262.00	$4,566.55	$ 67,310.27	$417,247.51	2.13	2.62
Total:	$ 351,638.83	$ 34,121.00	$ 31,487.68	$ 417,247.51			
Average:	$ 58,606.47	$ 5,686.83	$ 5,247.95	$ 69,541.25		2.62	



Audience Poll Question

If you have a cogen system, do you have a biogas scrubber?

Solar Update

- 420 kW peak capacity
- 1 acre ground-mounted system
- RFP issued in April 2008
- Power Purchase Agreement signed with Tioga in Oct. 2008
- Transferred to SunEdison in July 2009
- Installation completed in Dec. 2009
- PGE net metering agreement
- No capital cost to City
- First year kwh charge 2/3 PGE
- Fixed annual escalation

Solar Layout

Solar Highlights

- City's first design, build, own, operate project
- Power Purchase Agreement (PPA) negotiated (yes, 60 pages)
- Essentially leasing the land (make sure you don't need it later)
- No upfront cost from ratepayers
- SunEdison owns, operates and maintains
- COG purchases energy produced for 20 years
- Solar system purchase options after year 6
- Constructed through partnership with SunEdison, REC Solar
- Incentives provided by BETC and ETO
- REC Solar designed & installed the system

Solar Website

- System monitoring website required of PPA
- Realtime kw, Kwh, insolation, temperature
- Monthly Invoice generation
- Calculates CO2, NOX, SO2 avoided
- www.my.sunedison.com
- Public login, UN: gresham.kiosk, PW: Gresham@wwtp1
- Show website!

Solar By The Numbers

- 420 kw Peak DC Capacity
- Payback in years = 0
- Capital Cost to City = $0
- O&M Costs to City = $0
- COG purchases energy produced for 20 years
- 2010 Power Production 450,181 kwh
- 2011 Power Production 437,116 kwh
- Average Monthly Solar Invoice $2,200
- Average Monthly avoided utility cost $1,100
- Produced 8% of WWTP demand in 2011

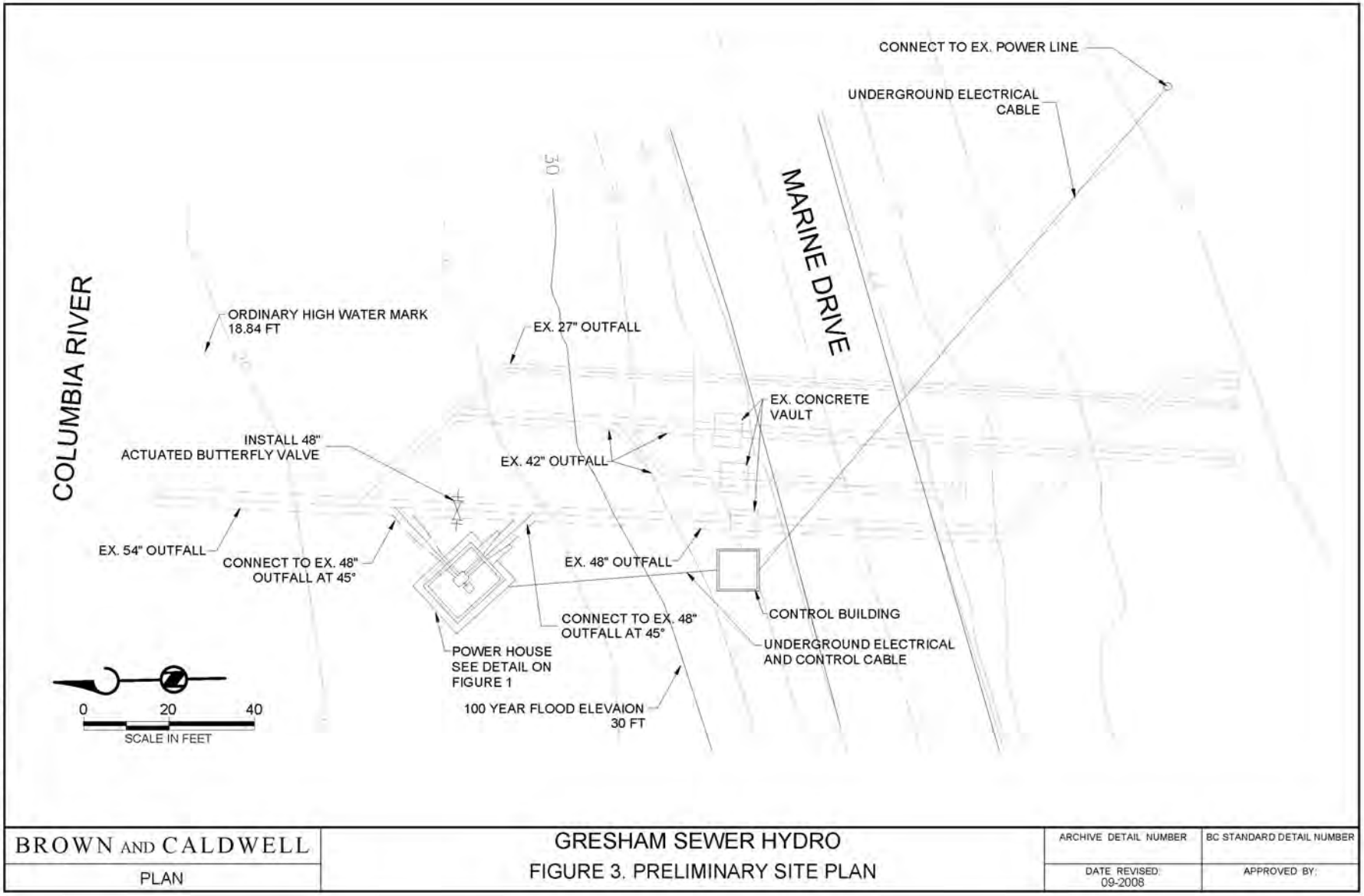
Audience Poll Question

Is your organization interested in solar power?

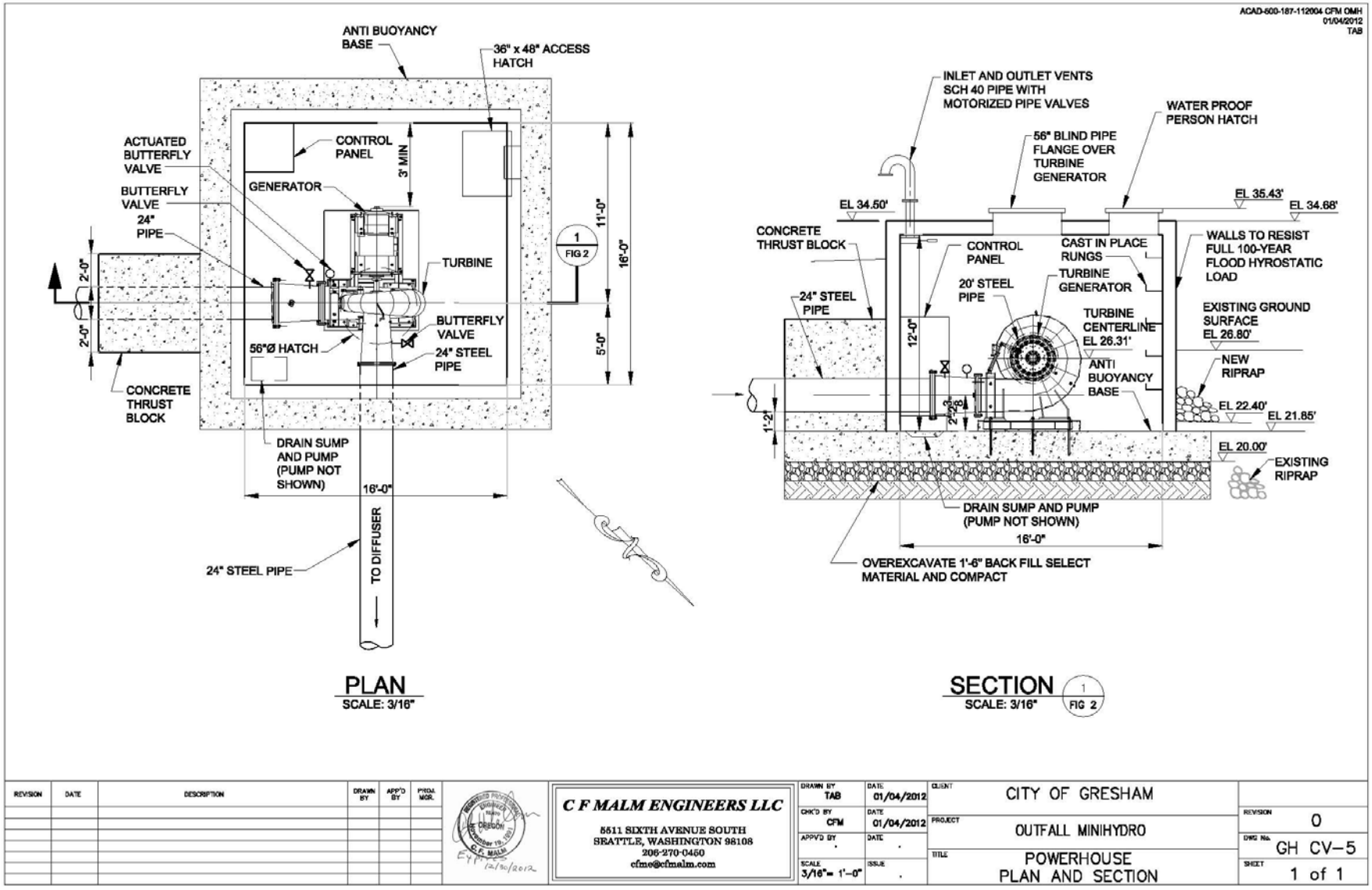
MicroHydroPower

- Produce power from a 36 foot (annual average) gravity fall
- 60 kw Frances Turbine, 600 rpm, 480 v
- Install Powerhouse near shore of Columbia River
- Permitting has been and still is lengthy
- Water Rights permit from State (Done)
- FERC Permit (conduit exemption) for powerhouse (Done, took about 2 years)
- Flood Plain Development Permit for flood plain construction (pending)
- Levee encroachment permit with Drainage District (pending)
- Still evaluating grant options and feasibility of project
- Looking at public/private ownership options

MicroHydroPower



MicroHydroPower



MicroHydroPower Funding

- Annual power production 450,000 kwh
- Revenues from PGE Schedule 201
- Kwh purchase varies linearly from $.04 in 2012 to $.11 in 2032, 20 year contract.
- Annual O&M estimated at $7,500
- Frances Turbine Cost $385,000
- Expected Turbine Life 25 years

Estimated Capital Cost	$905,477
less BETC Partner	$153,000
less Energy Trust Grant	$360,000
Net Capital Cost	$392,477
Annual Power Income	$41,000
Annual O&M	$7,500
Payback	12 years

Audience Poll Question

Would you go forward with the MicroHydro project?

Small Wind Power

- Quite windy in Gresham (near Columbia River gorge)
- Prefeasibility Study Completed (100% ETO)
- Feasibility Study Underway $18,000 (50% ETO)
- Early Paybacks aren't promising
- Technology always changing
- Public/private partnership?
- More to Come!

2 Energy Efficiency Projects

- Energy Efficiency Study financed by ETO

- Replace gas mixing system (3 - 40 hp compressors)
- Install Linear Motion Mixers (LMM) for both digesters
- Each LMM has 20 hp motor and VFD
- Currently operating at 75% speed or 15 hp.
- Essentially trading 80 hp 24 hrs/day for 30 hp 24 hrs/day

- Replace 2 Hoffman mutistage blowers (100 hp each)
- Install 2 Neuros Turbo blowers (100 hp each)
- Operating curves are much more efficient
- 50% variable speed turndown
- Air bearings

2 Energy Efficiency Projects

1.3 Economic Summary

Table 1: Savings and Cost Summary

Utility Rate Schedule			
Cost of Energy:	$0.07	/kWh	
Cost of Demand:	$4.82	/kW/mo	

EEM No.	Description	Include in Package?	Billing Demand Savings (kW/mo)	On Peak Demand Reduction (kW/mo)	Annual Energy Savings (kWh/yr)	Annual Cost Savings			EEM Cost ($)	Pre-Incentive Payback (Years)
						Demand Charges ($)	Energy Charges ($)	Total Savings ($)		
1	Anaerobic Digester Mixing System	Yes	94	94	412,375	$454	$27,914	$28,367	$297,000	10.5
2	Upper Plant AB Mixing System	Yes	27	27	237,671	$131	$16,088	$16,219	$528,000	32.6
3	Lower Plant AB Improvements	Yes	53	53	437,983	$256	$29,647	$29,903	$319,000	10.7
4	Chiller Upgrade	No	0	0	0	$0	$0	$0	$0	0
			174	174.311754	1,088,029	$840	$73,649	$74,489	$1,144,000	15.4

Table 2: Incentive Summary

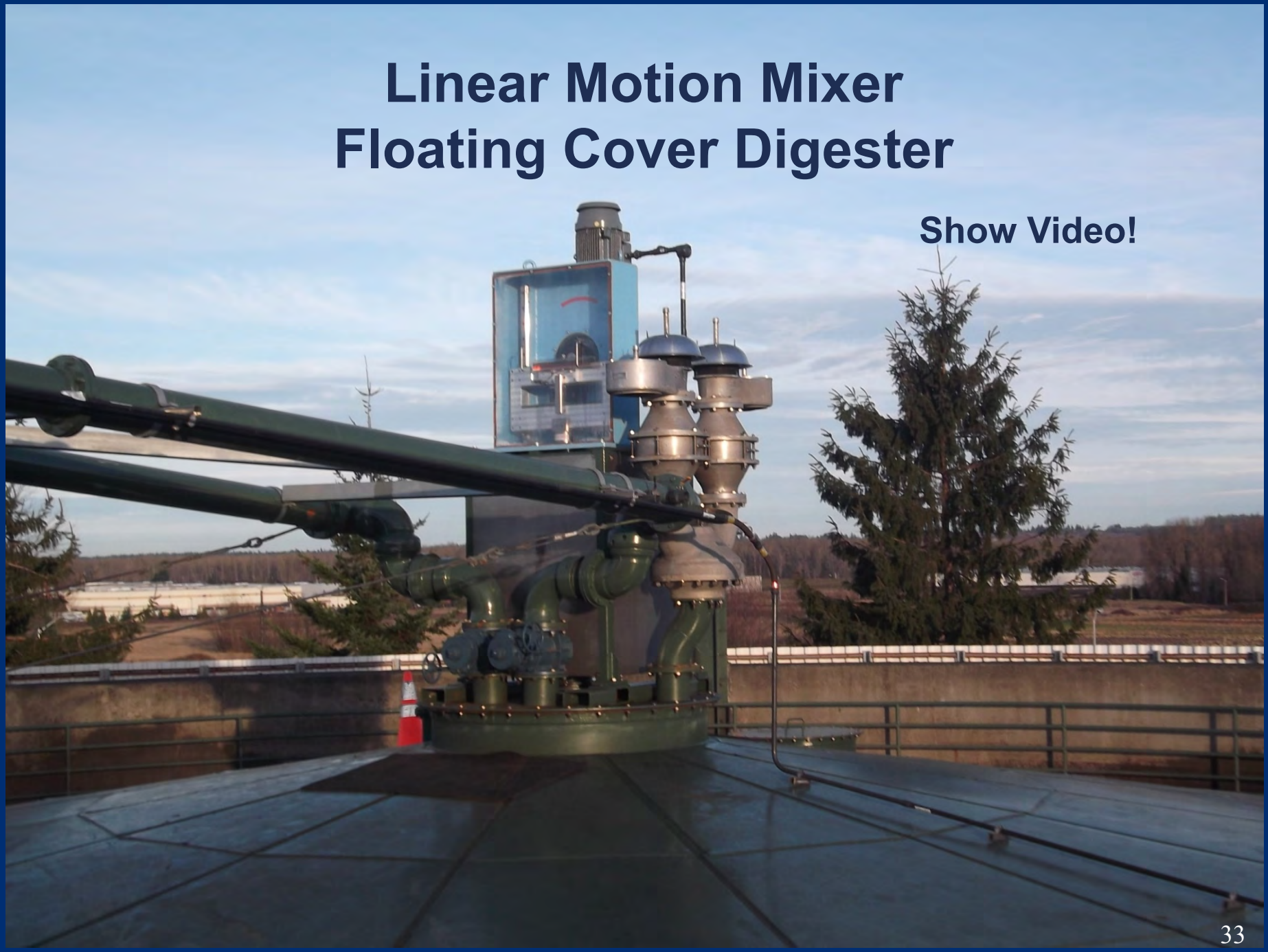
Incentive Cap, % of Project Cost	50%	
Energy Incentive Rate	0.32	kWh

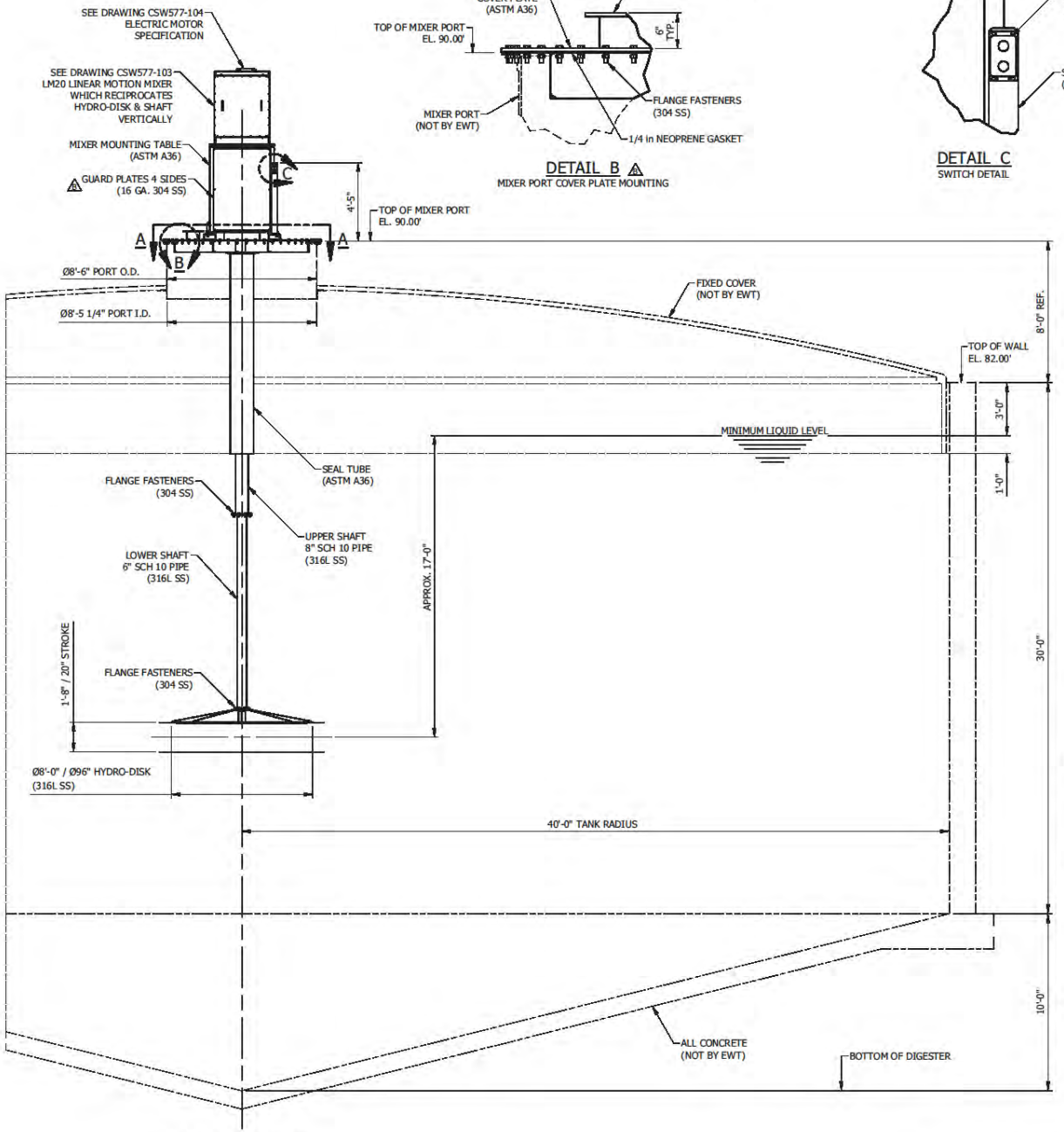
EEM No.	Description	EEM Life Expectancy (Years)	Energy Trust Incentive Calculation			Cost After Incentive	Customer Final Payback (Years)
			Incentive Cap (50%)	Energy Incentive ($)	Final Incentive ($)		
1	Anaerobic Digester Mixing System	20	$148,500	$131,960	$131,960	$165,000	5.8
2	Upper Plant AB Mixing System	20	$264,000	$76,055	$76,055	$452,000	27.9
3	Lower Plant AB Improvements	20	$159,500	$140,154	$140,154	$179,000	6.0
4	Chiller Upgrade	20	$0	$0	$0	$0	0.0
			$572,000	$348,169	$348,169	$796,000	10.7

Fraction of Package Cost Covered by Energy Trust Incentive: 30%

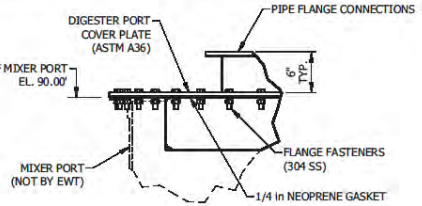

100 hp Neuros Blowers

Linear Motion Mixer
Floating Cover Digester

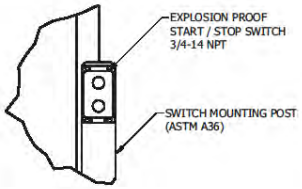




ELEVATION VIEW



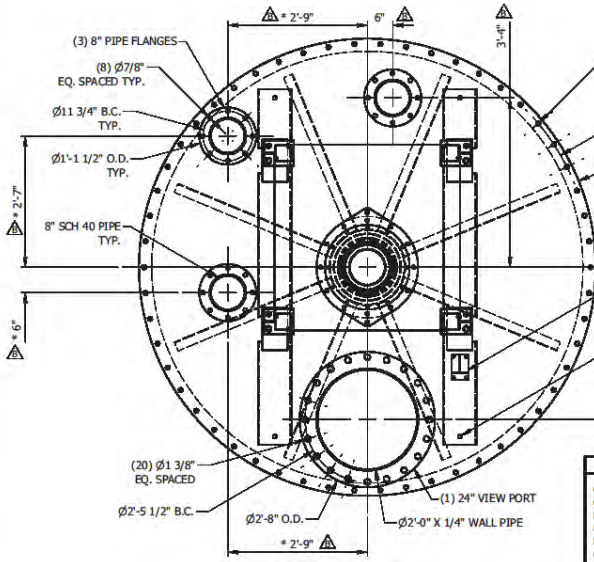
DETAIL B ⚠
MIXER PORT COVER PLATE MOUNTING



DETAIL C
SWITCH DETAIL

NOTES:

1. EIMCO WATER TECHNOLOGIES (EWT) WILL SUPPLY ONE (1 MOTION SLUDGE MIXER MECHANISM FOR MOUNTING ON A TANK. THE LM20 SLUDGE MIXER SHALL BE SUPPORTED FR AND SHALL BE CAPABLE OF MIXING SLUDGE WITHIN THE T
2. EWT WILL SUPPLY ONE (1) ONE HYDRO-DISK PER LINEAR A MINIMUM OF 96" OUTSIDE DIAMETER MOUNTED AT THE THE DESIGN SHALL CREATE A VERTICAL "UP AND DOWN", PRODUCING A TURBULENT "LIQUID-CORE" OF MICRO AND EXTEND THROUGH ITS RANGE OF MOTION AND THE TANK BE CONSTRUCTED OF 316L SS.
3. THE SHAFT AND HYDRO-DISK WILL RECIPROCATE AT APPR WITH A STROKE LENGTH OF 20".
4. THE MIXER SHAFT TO BE CONSTRUCTED FROM 316L SS SCH
5. AN ASTERISK (*) WHERE SHOWN DENOTES A VARIANCE FR AND SHOULD BE PARTICULARLY NOTED OR ADDRESSED. D MARKED WITH "CLOUDS" REQUIRE VERIFICATION BEFORE
6. DAMAGE TO THE MIXER MAY OCCUR IF IT IS OPERATED WH BY AT LEAST FOUR (4) FEET OF LIQUID. EWT WILL NOT BE INCURRED IN THIS SITUATION.
7. ALL STRUCTURAL STEEL IS TO BE ASTM A36 OR A53 UNLES SHOP WELDING IS TO CONFORM TO THE LATEST EDITION STANDARDS D1.1.
8. FOR SURFACE PREPARATION AND SHOP PAINTING SEE CSW
9. APPROXIMATE MAXIMUM DYNAMIC LOAD CREATED BY MIXE
10. COMBINED WEIGHT OF LM MIXER W/ GEARBOX & MOTOR, PORT COVER PLATE, MIXER SHAFTS AND HYDRO-DISK IS
11. ALL MIXER FLANGE FASTENERS TO BE 304 SS.
12. GEARBOX TO BE SUPPLIED DRY.
13. EWT DOES NOT FURNISH ELECTRICAL OR WIRING, CONDU LUBRICATING OIL OR GREASE, INSULATING SEALANT; FI ERECTION; DEMOLITION, EXCAVATION, BACKFILL OR GR (EXCEPT AS SPECIFICALLY NOTED).



⚠ SECTION A-A
DIGESTER PORT COVER PLATE

REVISED PER RETURN SUBMITTAL (9/8/10) COMMENTS	S-001649	HCC	JAG	10/11/10	B	
INITIAL RELEASE					A	

EIMCO WATER TECHNOLOGIES

ORIGINAL S.O.	
CSW0000577-01	
DATE	8/12/2010
DRAWN	HCC

GEN
LM20
MIX

Linear Motion Mixer (Inside Digester)

Energy Efficiency By the Numbers

Project Cost	$1,000,000 (estimated at $600k)
Energy Trust Incentive	$272,115
BETC	$220,000
Capital Cost	$507,885

Energy Savings

Linear Motion Mixing	412,375
Neuros Blowers/Diffusers	437,983
	850,358 kwh per year
	$58,270 per year

Approximate payback 8 years

FOG Receiving Station

- 12,000 gallon receiving tank
- Tank Mixing Pump and FOG injection pump
- Projected 30 - 50% increase in gas production

FOG Receiving Station Financing

- FOG Feasibility Study Completed with OECDD grant
- $1,000,000 Phase 1 Construction under way
- $40,000 Energy Trust Grant
- FOG Hauler RFP advertising this week
- Anticipated $20,000 per month tipping fee revenue
- $3,000,000 Phase 2 Cogeneration under design
- Anticipated 2-3 mil kwh per year additional production
- $20,000 per month avoided utility costs
- Anticipated 7 year payback

Energy Management Plan

- Keep it simple
- Select Energy Team Members (Ops, engineering, maintenance, etc)
- Meet Monthly for 1 hour and talk only energy
- Update Monthly energy production and consumption numbers every month
- Look and discuss trends
- Select and evaluate projects
- Stay on track!
- Assign projects to team members
- Keep Running agenda in EMP
- Update plan monthly (keep it alive!)

City of Gresham WWTP
Energy Management Plan
Updated January, 2012

Brief Description of Utility and Scope (Fenceline):

Gresham WWTP physical fenceline and all WWTP facilities fed by main PGE utility meter.

Goals: *Continue to increase renewable energy production as a % of energy used at site. These production and energy efficiency decisions need to have clear cost and pay back analysis completed to justify project. In 2009, we averaged 72% renewable energy use on site. The goal is to become 100% energy independent within 5 year timeline. Construct digester mixing improvements and lower plant blower improvements in 2010/2011. Design FOG receiving facilities 2010, Construct 2011/12. Continue to try and get funding for Microhydro project. Design/Construct additional 400 kw cogeneration system with Cogen Phase 2 CIP by 2015/16. Complete Predesign FY 2012.*

Targets: *100% Energy Independent by 2015/2016, 10% reduction in consumption by 2012/2013 with 2009 baseline. 12 month running average consumption of 450,000 kwh/month or less. Maximize cogen output and runtime at 390 kw average and 95% runtime.*

Energy Management Team:

Alan Johnston, Paul proctor, Rich Ludlow, Jeff Maag

Energy Management Team Meetings (*Meet Second Monday of each month***):**

Running Agenda:
Portfolio Manager Review of previous months kwh usage (Alan J)
E-manager review of data and improvements (Alan J)
Energy Management SOP status (Paul P)
Cogeneration Update (Rich L)
- *H2S testing, Media Replacement History and next change out*
- *Oil Change Summary and Oil analysis results and trending*
- *Engine valve recession trending.*

Cogenerator Life Cycle Costs (Alan J)
Top End or Major Overhaul Discussion. (Rich L)
Runtime Analysis and Veolia Runtime Incentive. (Paul P)
Operations and Control Issues (suggested improvements) (Group)
Capital Project Updates (Digester Mixing, Lower Turbo Blowers, Aeration Diffusers) (Jeff M)

Goal Reporting:

Energy Summary

Benchmark from *Portfolio Manager*

Energy Efficiency

Electricity

Column	*1*	*2*	*3*	*4*	*5*	*6*
Time	Average kWh/month (1 Month)	Average kWh/year E-Manager	Average kWh/month (Column 2/ 12)	Total Flow: Million Gallons /year (influent)	Average kWh/million gallons (Column 2/ Column 4)	Portfolio Manager Score
Goals	***450,000***		***450,000***		***1,308***	***95***
1-12/2007	523,317	6,279,813	523,317	12.557 mgd, 4,583 Mg	1,468	
1-12/2008	489,643	5,875,720	489,643	11.808 mgd, 4,309 Mg	1,363	
1-12/2009- Baseline	483,599	5,803,190	483,049	11.492 mgd, 4,195 Mg	1,375	97
1-12/2010	485,273	5,823,282	485,273	12.491 mgd, 4,559 Mg	1,277	97
1-12/2011	488,554	5,128,775	427,398	12.127 mgd, 4,426 Mg	1,159	96
	2011 met goal					
% improvement		None	None	8.7% increase	7.1%	0%
Goal Met?	***No***		***Yes***		***Yes***	***Yes***

Lower plant Meter Installed 2/1/2011.

Column	*1*	*2*	*3*		*4*	*5*	*6*
Time	Lower Plant Average kWh/month (1 Month)	Lower Plant Average kWh/year	Lower Plant Average kWh/month (Column 2/ 12)	Lower Plant % kwh of entire Plant	Upper Plant Average kWh/month (1 Month)	Upper Plant Average kWh/year	Upper Plant Average kWh/month (Column 2/ 12)
1-12/2010	-	-	-	-	-	-	-
2-12/2011	291,324	3,181,029	289,184	67%		1,799,051	
% improvement		None	None			None	None

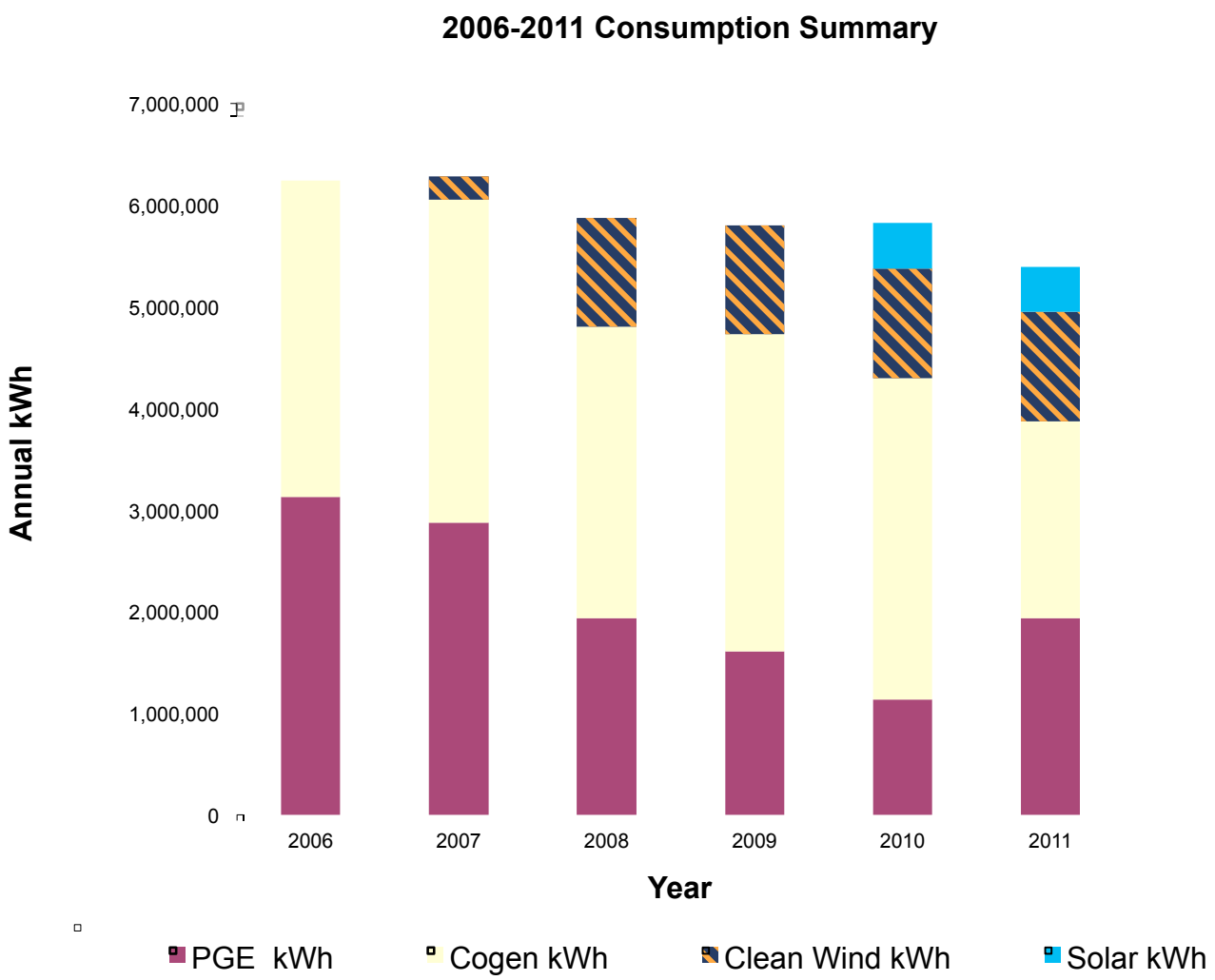
Power Monitoring

- Monitor, store and evaluate power consumption
- PGE meter, lower plant, cogen, solar
- Data sent by cell to PGE E-manager website
- http://www.portlandgeneral.com, search “E-manager”
- About $60/month per unit

Energy Accomplishments Since 2005

- 18,000,000 Kwh produced by cogeneration
- 1,000,000 kwh produced by Solar
- 55% of WWTP power needs generated on site
- Over 26 billion gallons treated without a permit violation
- Approximately $10,000,000 in Capital Projects built
- 6.2 mil kwh 2006, 5.4 mil kwh 2011
- 13% reduction in energy consumption
- 50% increase in energy production
- 76% of energy from sustainable sources
  - Cogeneration 50%
  - Solar 8% since 2010
  - Clean Wind program through PGE 18% since 2008
- Completed ACWA Sustainable Energy Training in 2011

Energy Accomplishments Since 2005



Next Steps

1.	Energy Management Team Meetings	Monthly
2.	FOG Receiving Facilities, Complete	June, 2012
3.	FOG Hauler Contract	May, 2012
4.	Cogeneration expansion, Complete	May 2014
5.	Evaluate Future Energy Projects	Ongoing
6.	Energy Independent	2015 ?

Questions & Answers

Alan Johnston, Senior Engineer, Wastewater Services Division