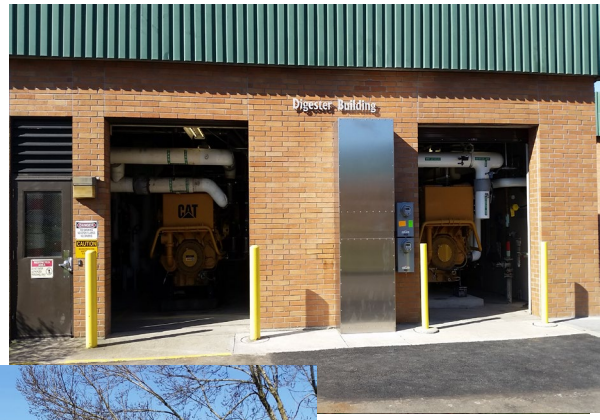
COLLABORATIVE PRACTICAL INVENTIVE NIMBLE EQUITABLE



Case Study – Gresham's FOG Program

From FSEs to Renewable Energy

CITY OF GRESHAM

Overview

HISTORICAL BACKGROUND

- Gresham WWTP's Renewable Energy Past
- The Road to the FOG Receiving Station and Cogeneration Improvements

CO-DIGESTION OF FOG

- Current Operation of Gresham's Digesters
- Current Status of the WWTP's FOG Program

FOG SCREENING IMPROVEMENTS CIP

- FOG Screenings Improvements

FUTURE OF FOG IN GRESHAM

- Anaerobic Digestion and Cogeneration Expansion

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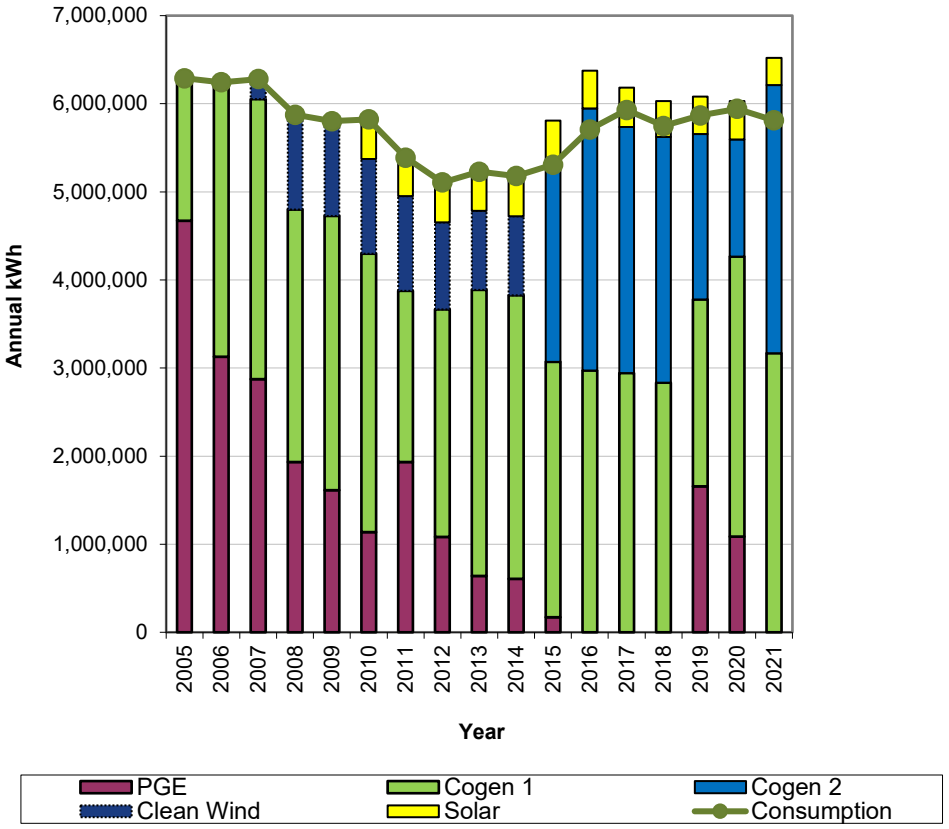
History of Sustainability at Gresham WWTP

Renewable Energy

- Waukesha 250kW CHP Engine online in 1991.
  - Produced an average 3,040kWh/day
- Cogen Replacement in 2005 with CAT 3508 400kW Engine
  - Produces ~50% of annual power consumption with full-year runtimes
- Purchased Clean Wind from 2007 to 2014
  - Purchased 17-20% of annual power consumption in respective years
- Solar Power Purchase Agreement in 2010
  - Produces between 5-9% annual power consumption

Figure 1
2005-2021 Consumption/Production Summary



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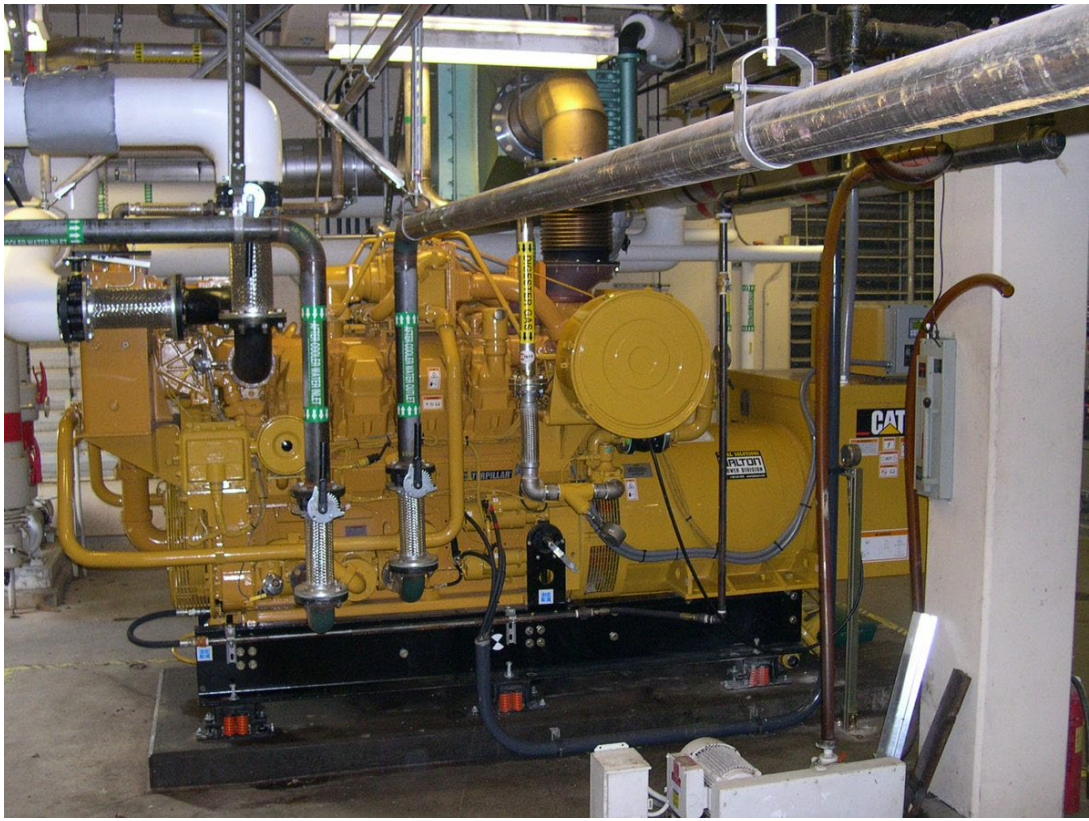
History of Sustainability at Gresham WWTP

Drivers: Evaluation/Implementation of FOG Co-Digestion

- Success of co-gen 1 providing ~50% annual power consumption
  - Second co-gen would provide path to electrical net-zero by doubling power production.
  - Each cogen needs 140,000 SCFD Biogas, with 180,000 SCFD typical production, Pre-FOG
    - Need 280,000 SCFD
- 2008 City Council Sustainability Policy
  - 80% GHG reduction by 2050
  - 100% renewable energy by 2030
- Partnership with Oregon Business Development Department
  - Grant funding for the City of Gresham's FOG Feasibility Study in 2009
    - Feasibility Study of Digester Grease/Food Waste Injection System Wastewater Treatment Plant Process Improvements Pre-Design prepared by CH2M-Hill.



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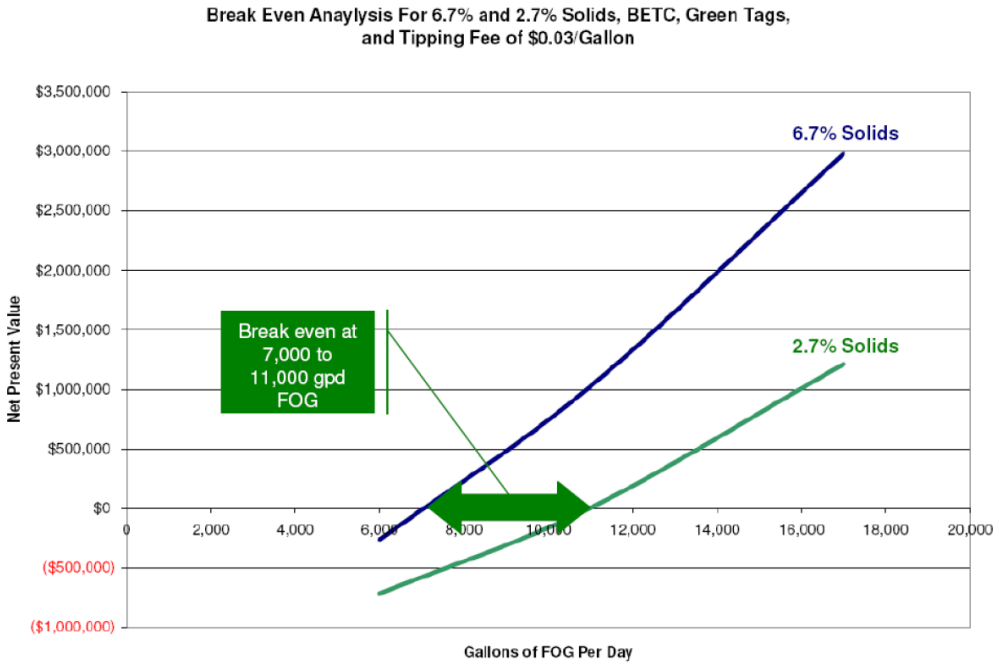
History of Sustainability at Gresham WWTP

FOG Feasibility Study

- Study Findings
  - 2nd co-gen is economically viable if:
    - 7,000 to 11,000 gallons of FOG codigested per day &
    - tipping fees >$0.03/gallon
    - TS between 2.7%-6.7%
  - Simple payback estimate of 7 years based on:
    - avoided power costs,
    - Business Energy Tax Credit (BETC), and
    - Energy Trust incentive payments



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Phased Approach

FOG System Development

FOG Phase 1

- 12,000 gallon tank
- Pumping, heating, and odor control provisions

FOG Phase 2

- Phase 2A
  - FOG Station Expansion
- Phase 2B
  - Cogeneration Expansion

Additional Drivers

- Grants/Tax Credits
  - Energy Trust of Oregon (ETO)
    - $40,000 for FOG Ph1
    - $40,000 for FOG Ph2A
    - $330,000 for FOG Ph2B
  - Oregon DOE
    - ~$1M Pass-through Tax Certificates

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Phased Approach

FOG System Development

- FOG Phase 1
  - FOG Tank 1
    - 12,000 gallon feed tank
  - FOG Offload/Recirculation Pump 1
    - 350 gpm Rotary Lobe pump
  - FOG Feed Pump
    - 50 gpm Rotary Lobe pump
  - Plant and Cutter Grinder/Rock Trap
  - FOG Heat Exchanger
    - 1.2M BTU
  - Odor Control Unit
    - Carbon media canister
  - Road Improvements for Hauler Access
  - EI&C Systems
  - Total Cost $897,440 in 2011 Dollars
    - Design/SDCs $136,800
    - Construction $760,640

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Phased Approach

FOG System Development

- FOG Phase 2A
  - FOG Tank 2
    - 18,000 gallon offload/transfer tank
  - FOG Recirculation Pump 2
    - 350 gpm Rotary Lobe
  - 2nd Odor Control Unit
    - Carbon media canister
  - Road Improvements for Hauler Access
    - Road widening
  - EI&C Systems
  - Total Cost $610,727 in 2014 Dollars
    - Design covered in Ph1
    - Construction $610,727

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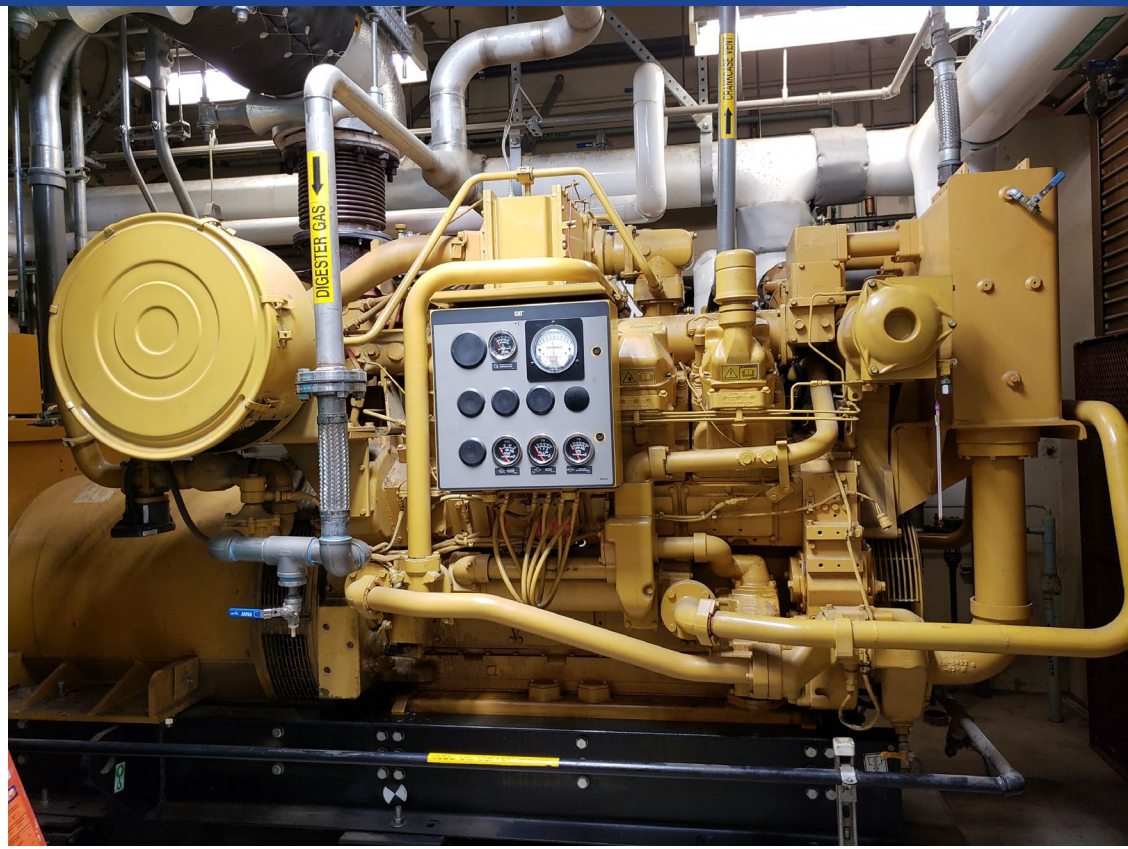
Phased Approach

Biogas/Cogen System Expansion

- FOG Phase 2B
  - Co-generator 2
    - 395KW CAT 3508 CHP Engine
    - Pre-purchased unit to ensure same model as Co-gen 1
  - Air-Fuel Ratio Controller (AFRC)
  - Boiler Improvements
  - Fuel Treatment Improvements
  - EI&C Systems
    - Co-gen controls
    - Switchgear addition
    - PGE Net-metering
  - Total Cost $2.53M in 2015 Dollars
    - Design/SDCs $342,746
    - Equipment Procurement $835,677
    - Construction $1,352,271



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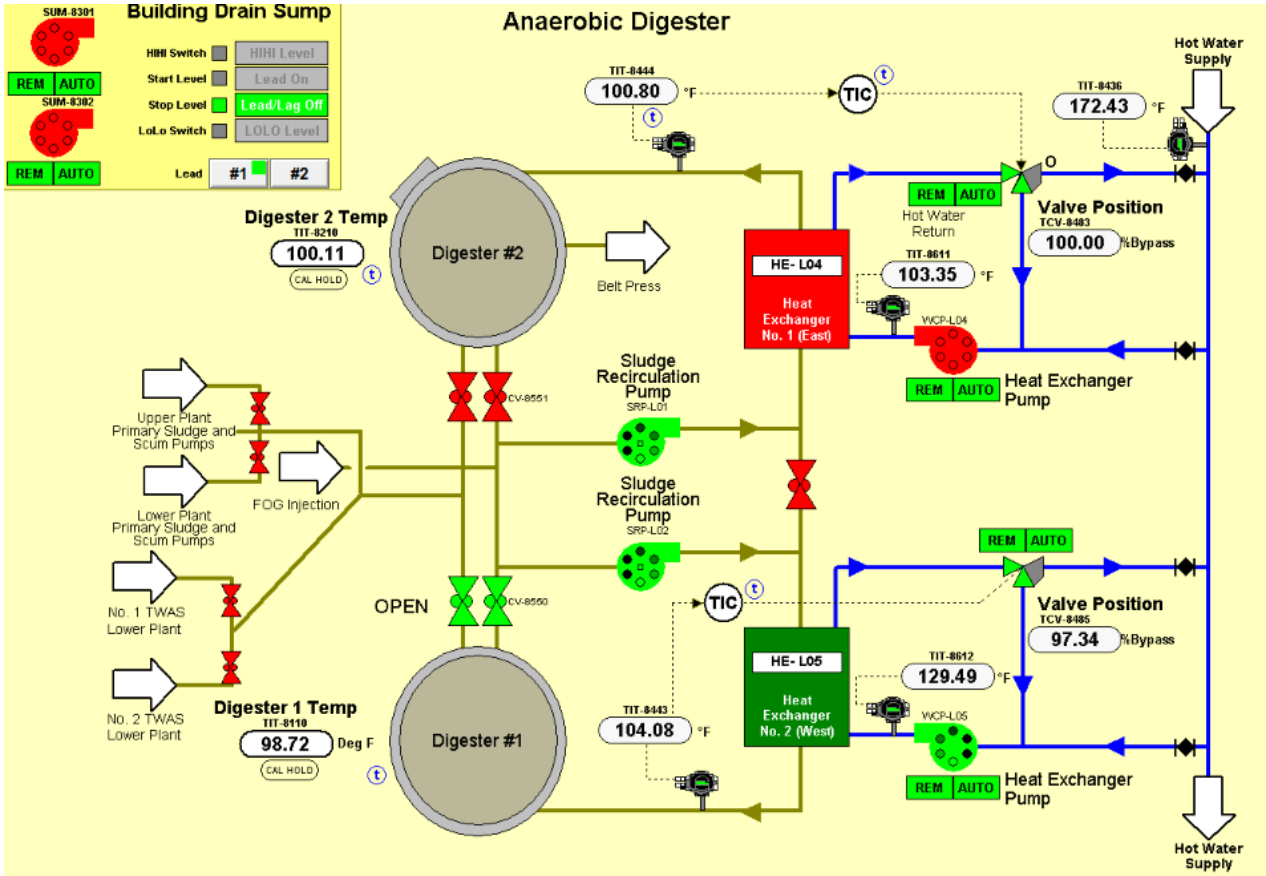
Gresham's Digestion Process

Gresham's Digesters

Two Anaerobic Digesters

- Mesophilic
  - Typically run between 96–100°F
- Ran in series
  - Primary (Digester 1) and
  - Secondary (Digester 2)
- Feed ratios
  - 30% Primary Sludge
  - 55% Waste Activated Sludge (WAS)
  - 15% FOG
- Solids Treatment
  - Provide 25 days Solids Retention Time
  - Produces 2,500 – 3,000 dry tons of Class B Biosolids per year
- Biogas Production
  - Produces 109,500,000 SCF Biogas per year



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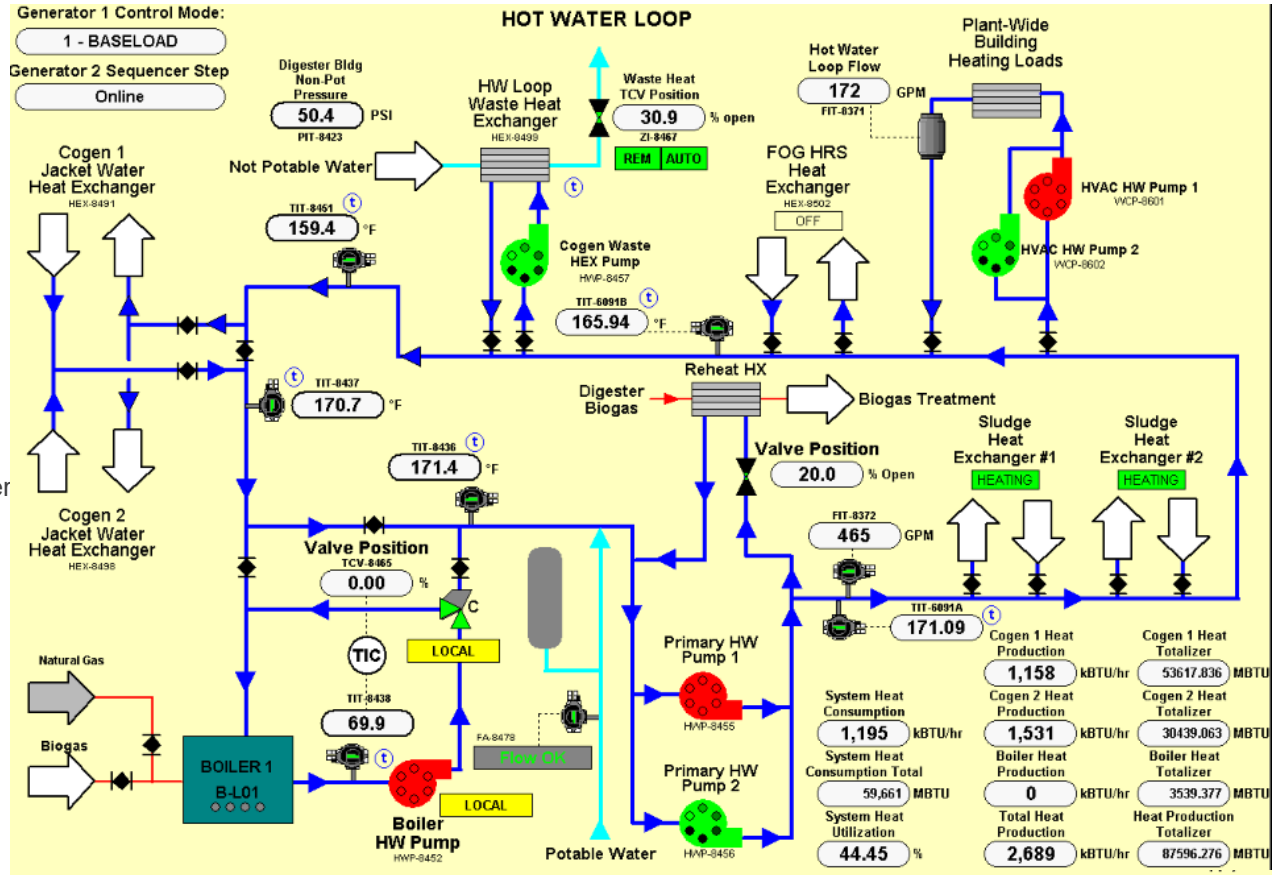
Gresham's Cogeneration Process

Gresham's Co-gens

Two 395kW CAT Engines

- Combined Heat & Power (CHP)
  - Produces 395kW per unit
  - Produces 25 MBTU heat per day per unit
- Heat Utilization
  - The co-gens transfer 16 MBTU heat per day per unit to the Hot Water Loop
  - Several projects to utilize heat around the WWTP
    - Heating digesters
    - Heating buildings
    - Heating FOG



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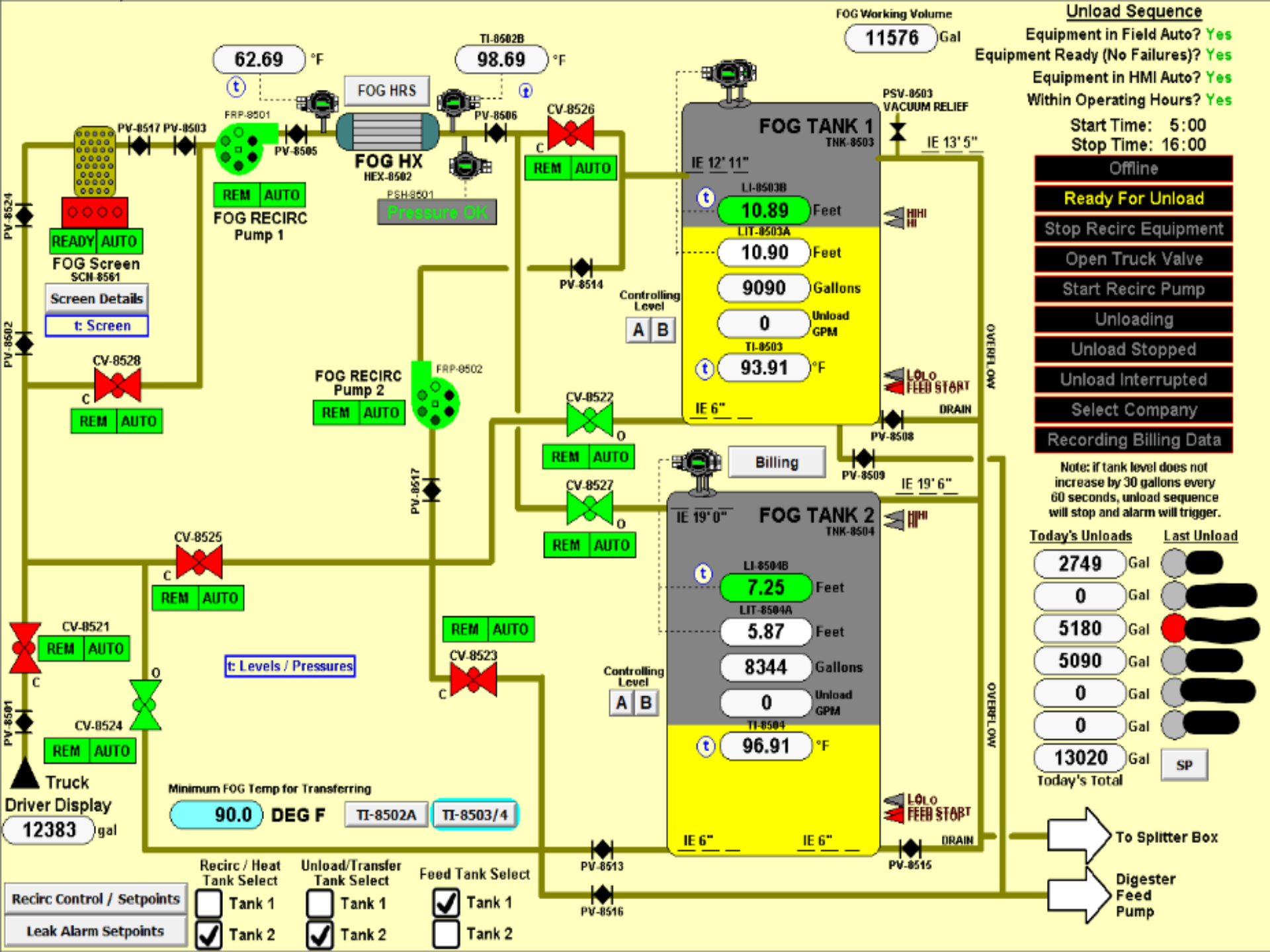
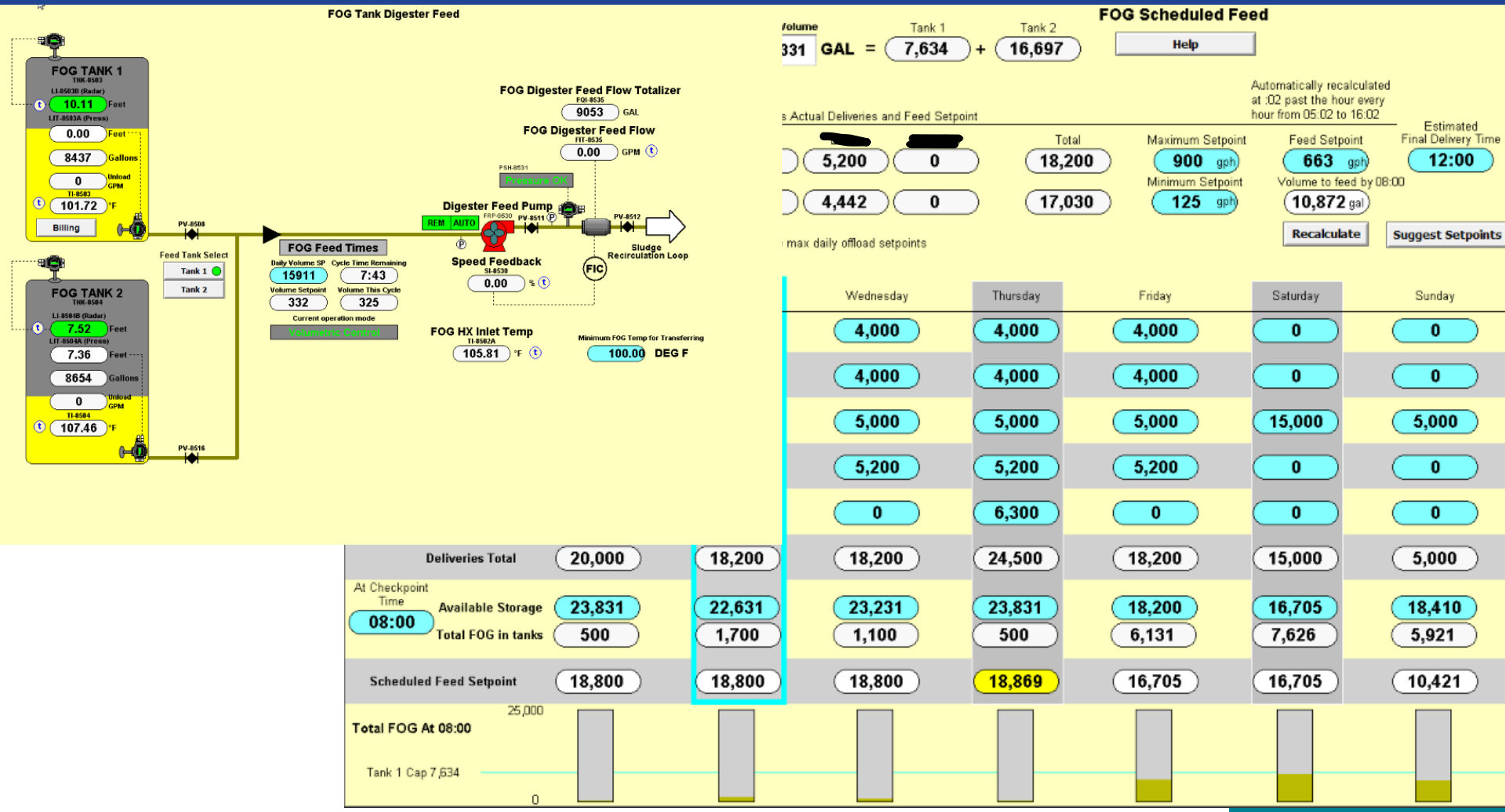

FOG Working Volume
11576 Gal
Unload Sequence
Equipment in Field Auto? Yes
Equipment Ready (No Failures)? Yes
Equipment in HMI Auto? Yes
Within Operating Hours? Yes
Start Time: 5:00
Stop Time: 16:00
Offline
Ready For Unload
Stop Recirc Equipment
Open Truck Valve
Start Recirc Pump
Unloading
Unload Stopped
Unload Interrupted
Select Company
Recording Billing Data
Note: if tank level does not increase by 30 gallons every 60 seconds, unload sequence will stop and alarm will trigger.
62.69 °F
TI-8502B
98.69 °F
FOG HRS
FRP-8501
PV-8517 PV-8503
PV-8505
FOG HX
HEX-8502
PV-8506
CV-8526
PSV-8503
VACUUM RELIEF
FOG TANK 1
TNK-8503
IE 12' 11"
IE 13' 5"
LI-8503B
10.89 Feet
LIT-8503A
10.90 Feet
9090 Gallons
0 Unload GPM
TI-8503
93.91 °F
HIHI
LOLO
FEED START
OVERFLOW
DRAIN
PV-8508
PV-8509
IE 19' 6"
IE 6"
PV-8514
PSH-8501
Pressure OK
REM AUTO
FOG RECIRC
Pump 1
READY AUTO
FOG Screen
SCN-8561
Screen Details
t: Screen
PV-8524
PV-8502
CV-8528
FOG RECIRC
Pump 2
FRP-8502
CV-8522
CV-8527
Billing
PV-8517
CV-8525
CV-8521
CV-8523
CV-8524
PV-8501
t: Levels / Pressures
Controlling Level
A B
FOG TANK 2
TNK-8504
IE 19' 0"
LI-8504B
7.25 Feet
LIT-8504A
5.87 Feet
8344 Gallons
0 Unload GPM
TI-8504
96.91 °F
Today's Unloads
Last Unload
2749 Gal
0 Gal
5180 Gal
5090 Gal
0 Gal
0 Gal
13020 Gal
Today's Total
SP
Truck
Driver Display
12383 gal
Minimum FOG Temp for Transferring
90.0 DEG F
TI-8502A
TI-8503/4
PV-8513
PV-8516
PV-8515
To Splitter Box
Digester Feed Pump
Recirc / Heat Tank Select
Unload/Transfer Tank Select
Feed Tank Select
Tank 1
Tank 2
Recirc Control / Setpoints
Leak Alarm Setpoints

FOG Program



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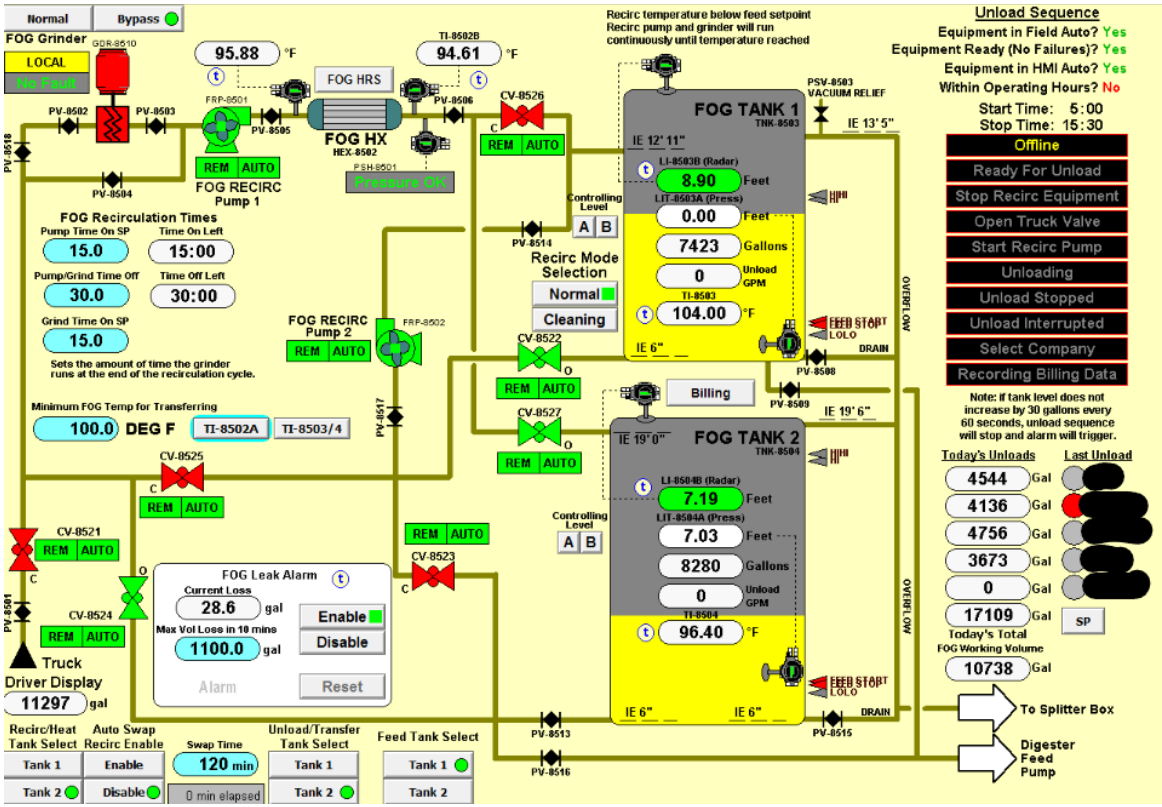
FOG Program

Hauler Contracting

- Request for Proposals
  - FOG Haulers provided proposed tipping fee with minimum set at $0.05/gal
  - 3 Haulers selected at $0.08/gal
    - Primary & Secondary @ 2,000 – 6.000 gpd
    - Tertiary On-call
  - Increased contracted haulers to 5 in 2015
    - Began Accepting additional volume with increased capacity (30,000 gallons)
    - Reached 11,000 gpd average in 2015
  - Increased tipping fee in 2021
    - Increased tipping fee to $0.09/gal in 2021
  - Collected $3.1M in tipping fees through March 2023



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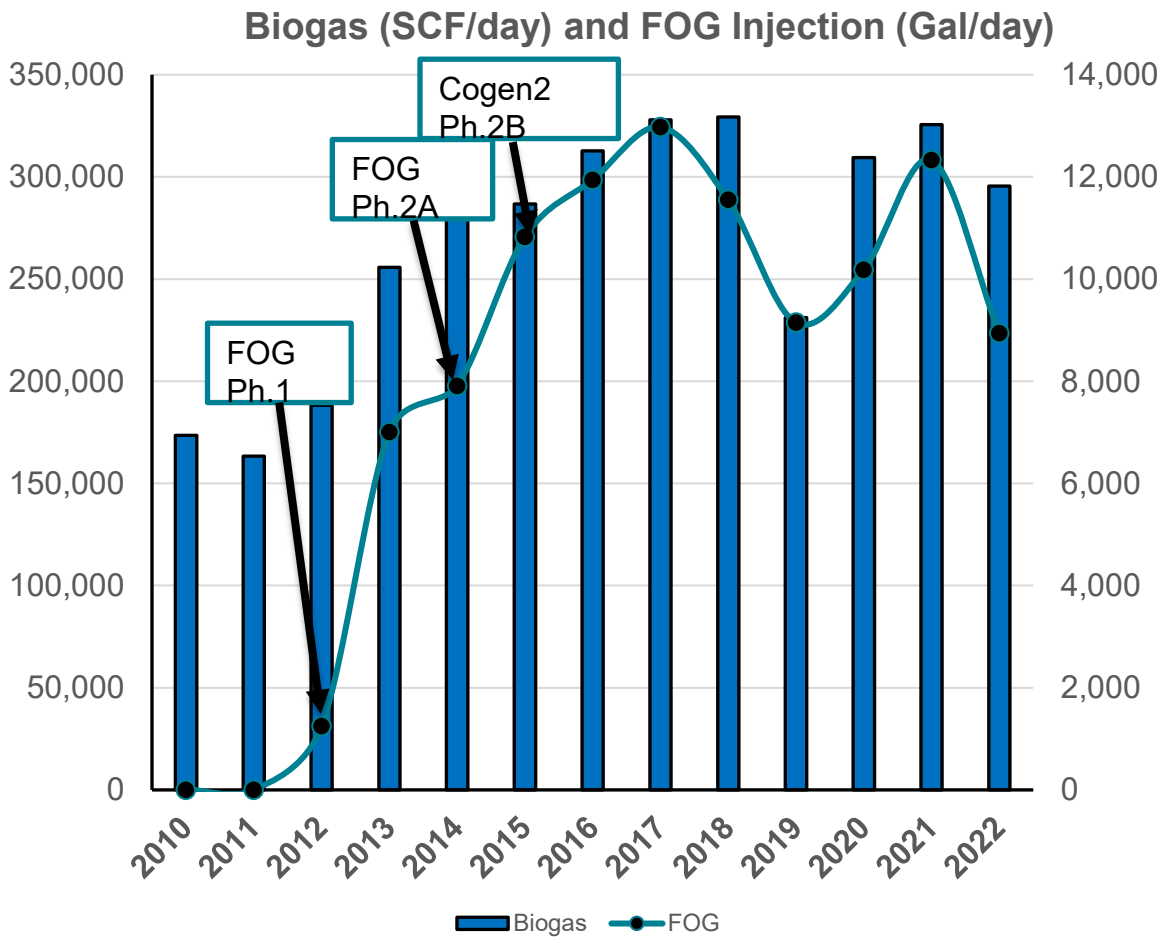
FOG Program

Beneficial Outcomes

Increases in Biogas Production and Utilization

- Baseline at 180,000 SCFD
- Increased to >250,000 SCFD with FOG Program in full effect
- Reached Electrical Net-Zero in 2015
- Maintained net-zero through 2018
  - Digester Cleaning, Biogas Treatment Improvements, and Cogen Overhauls in 2019-20



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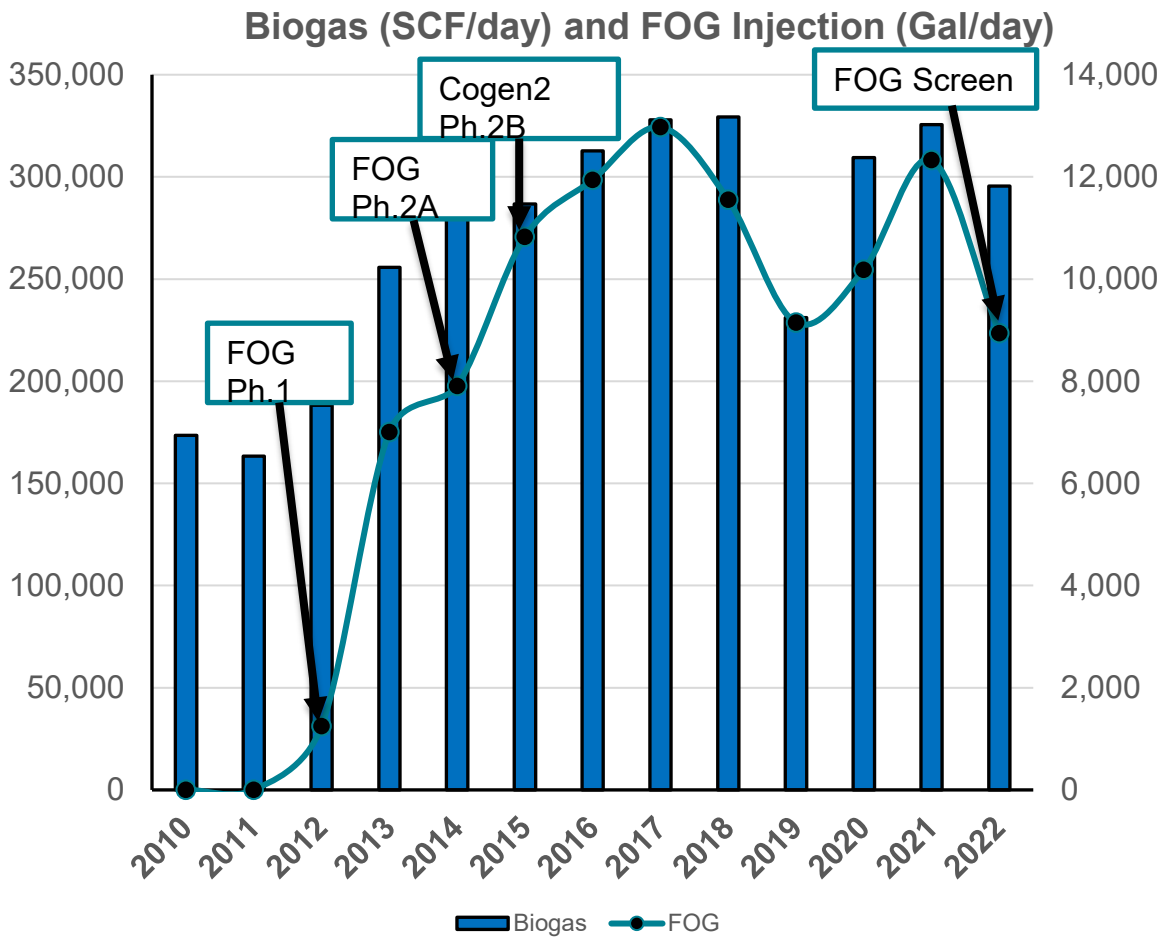
FOG Program

Current Status

- Trending to Baseline Average of 12,000 gpd
- Produce >300,000 SCFD Biogas
- Produce >16,000 kWh/day average



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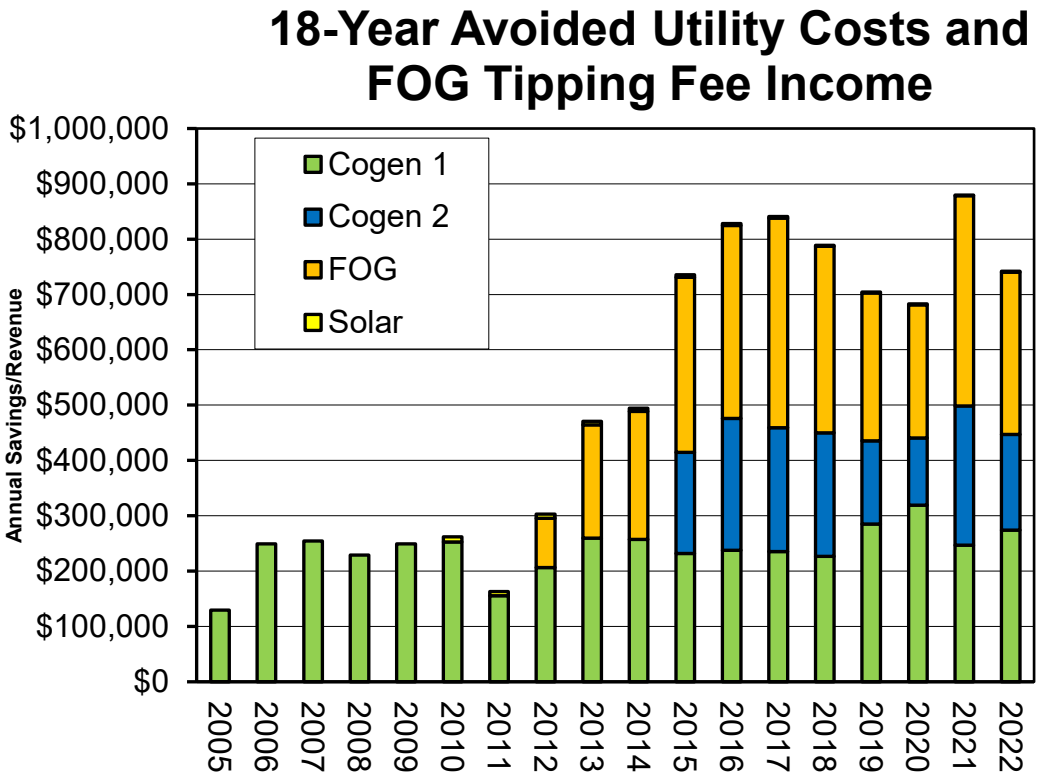
Energy Management Program

Pros: FOG Injection for Biogas Increase

- Avoided Utility costs average >$450,000/year since 2015
- Tipping Fees average $26,500/month since 2015

Trade-offs

- Large Capital Expenditures
  - Several Improvement Projects
    - Biogas Treatment Improvements (2019)
    - Solids Improvements (2019)
      - Level and Pressure Indicators added
      - Second, larger Waste Gas Flare
      - Digester Cleaning
      - FOG Injection improvements
    - FOG Screening Improvements (2022)



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FOG System

History

- Maintenance Struggles
  - Low pH and abrasives issues for piping, pumps, and instrumentation
  - Cleaning 1 Tank/month with assistance from Collections
    - Takes several hours and 2-3 Vactor loads
    - Large amounts of trash, debris, and grit
  - ~$500K in equipment repairs, not including tank cleanings

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FOG Screenings Improvements CIP

Project Aims

Better Screening of FOG

- Reduce tank cleaning efforts
  - Duration
  - Frequency?
- Protect Equipment
  - Low pH, abrasives, trash and debris destroys equipment
  - New Rock Trap and StrainPress with 5mm screen to remove majority of trash & debris
- Better Monitoring of Tank Levels
  - Replaced unreliable pressure transmitters with secondary radars
- Stainless Steel Rotary Lobe Pumps
  - Rubber lobes replaced frequently

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FOG Screenings Improvements CIP

Current Status

Screening

- Huber SP 430
  - 5mm Drum Screen
  - Convey screenings with auger
  - Pressure zone with cone to dewater and squeeze screenings into dumpster.

95% Complete

- FOG Improvements
  - FOG Receiving online
  - System tuning ongoing

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FOG Screenings Improvements CIP

Before

After

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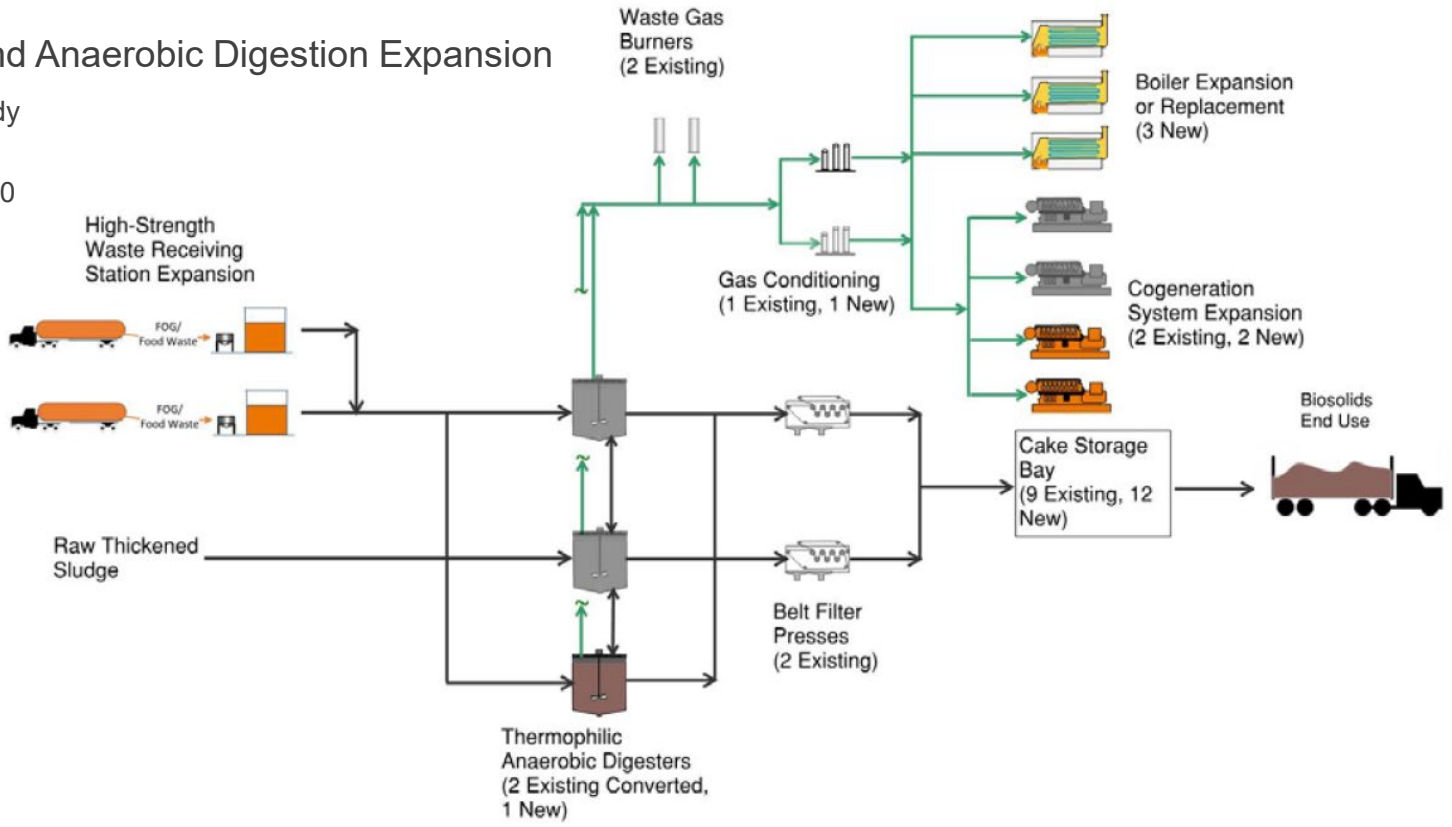
Future of Energy Management at Gresham WWTP

Capital Projects

- Cogeneration and Anaerobic Digestion Expansion
  - Feasibility Study completed in November 2020
  - Currently in Pre-design



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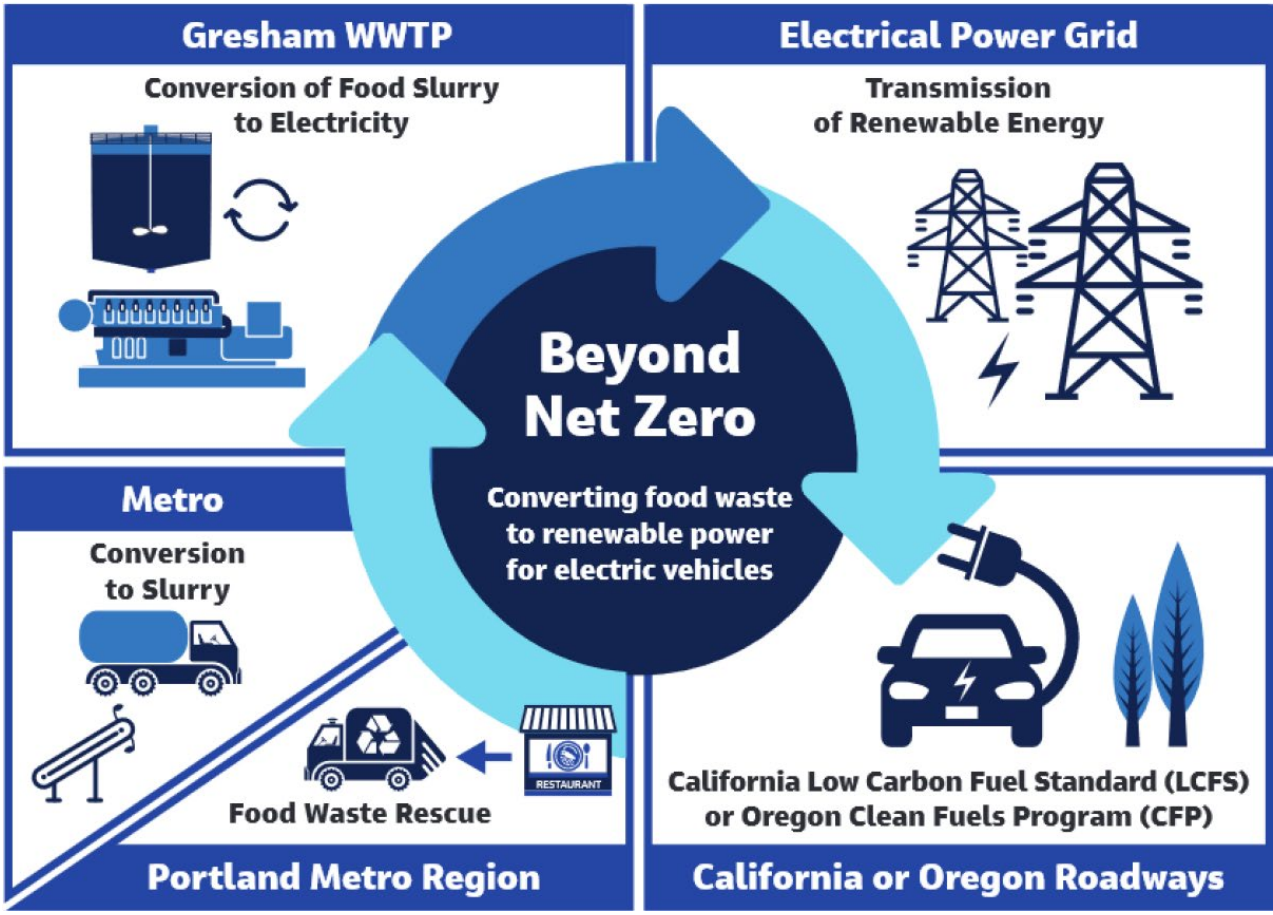
Conclusions

- FOG is a resource that can be leveraged for sustainability
- Sustainability pathways can be long and step-wise, but with consistent effort and dedication will pay dividends



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Questions?

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