

LMOP Webinar

Don't Waste the Heat!

September 28, 2021



Welcome and Agenda

Agenda

Beneficially Using Engine Exhaust for Onsite Leachate Treatment

Steve Gabrielle, Partner, Energy Power Partners

and

Casey Cammann, Chief Marketing Officer, Heartland Water Technology

Sustainable and Energy-Efficient Solutions Turn Landfill Gas and Waste Heat into Profitable Power

Jessie Howell, Sales Manager North America, ElectraTherm

Questions and Answers

Wrap Up

Mention of any company, association, or product in this presentation is for information purposes only and does not constitute a recommendation of any such company, association, or product, either express or implied, by the EPA.



Steve Gabrielle
Energy Power Partners

Casey Cammann
Heartland Water Technology

Beneficially Using Engine Exhaust for Onsite Leachate Treatment

Cumberland County Improvement Authority



- Location: Cumberland County, NJ Landfill
- 275 acres permitted
- Over 6M tons of waste in place
- Receiving 540 tons solid waste per day



Early 2018 ..The Situation

- Landfill generating highly concentrated Reverse Osmosis (RO) concentrate
- Hauling leachate over 40 miles to Delaware
- Over 25 truck trips per week
- Opportunity to utilize waste heat from 3 CAT 3520 landfill gas engines

Team worked together to optimize asset utilization



Concentrated Leachate from the RO Plant requires treatment



Waste heat available from onsite landfill gas to energy plant

Concept: CoVAP™

Beneficial Use of Engine Exhaust For Onsite Leachate Treatment

- CoVAP™ = Cogeneration for industrial wastewater evaporation
- 900° F engine exhaust
- Exhaust from three engines ducted together and transferred to Heartland Concentrator
- Concentrated leachate is evaporated
- Jacket water from the engines is used to heat bio tanks that feed the evaporator
- Improve efficiency of the plant and reduced the carbon footprint for the authority



(1) Hot generator exhaust gas is ducted together to provide thermal energy for evaporation in the Heartland Concentrator™ (2)

On site pilot

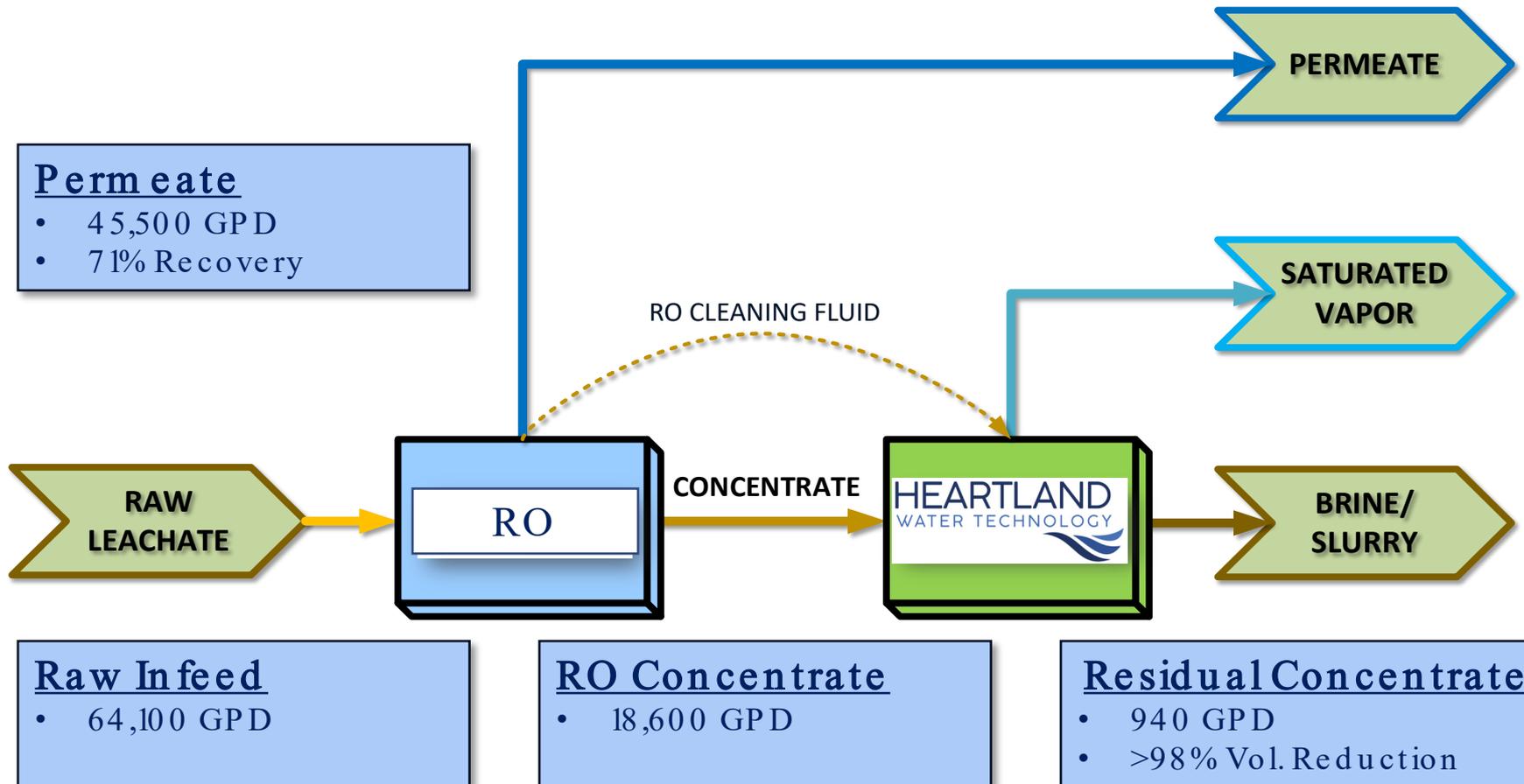
To prove concept the team completed a successful 15-day pilot

- Processed over 5,050 gallons of The Authority's RO Concentrate, using Heartland's 1,000 GPD pilot Concentrator.
- The trial achieved volume reduction targets, yielding 332 gallons of residual slurry
- During the trial, the Concentrator did not shutdown and required no maintenance. It was automatically self-controlling, which included overnight unattended operation.
- The concentration, precipitation, and management of solids through the Concentrator to the final residual tote were performed successfully; no degradation of performance was observed.



The Project

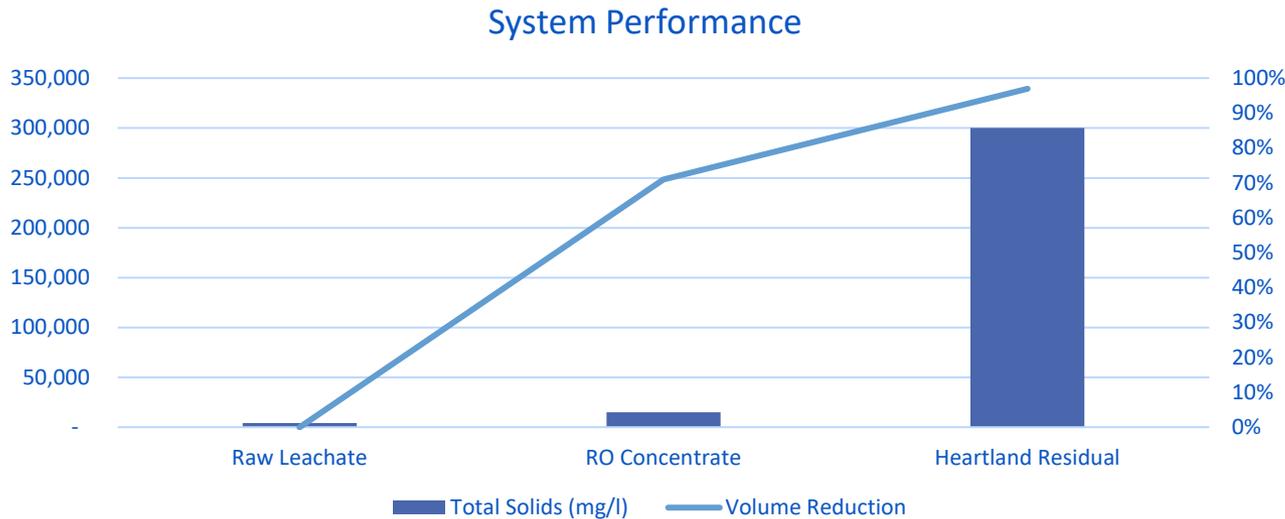
Combined 98% Volume Reduction



Integration of the Landfill Gas Engine Exhaust



System Performance



- >98% system volume reduction
- Generates concentrated residual with over 300,000 mg/l TS
- Engine Thermal Efficiency improvement from 36% to 76%

Engine Thermal Efficiency

	Exhaust Loss	Jacket/Other Loss	Electric Output	Recovered Jacket	Heartland Concentrator	Thermal Efficiency
Prior to Project	36%	28%	36%			36%
After Project	0	24%	36%	4%	36%	76%

Financial and ESG Benefits for the Authority



- Thermal efficiency increased
- Beneficial reuse of waste heat
- Removed trucks from the road
- Reduced Carbon Footprint
- Positive Community Relations
- Significant leachate volume reduction
- Annual cost savings 20-25%



Thank you!

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SUSTAINABLE AND ENERGY EFFICIENT SOLUTIONS TURN LANDFILL GAS AND WASTE HEAT INTO PROFITABLE POWER

Engineering world-class ORC heat to power generation systems since 2005.

 **ElectraTherm**
BY BITZER GROUP

Established in 2005, we are a global leader in low temperature waste heat recovery, providing simple and effective solutions that **boost efficiency while reducing energy costs and emissions.**

By using utilizing an Organic Rankine Cycle (ORC) along with proprietary technologies, our heat recovery systems generate up to **125 kW of clean electricity from heat sources as low as 70°C.**

There are no additional emissions or fuel consumption and the power generated is ready immediately.

ElectraTherm's heat recovery solutions are modular, scalable, and robust so you can use them however, whenever, and wherever you need to.

ABOUT BITZER GROUP

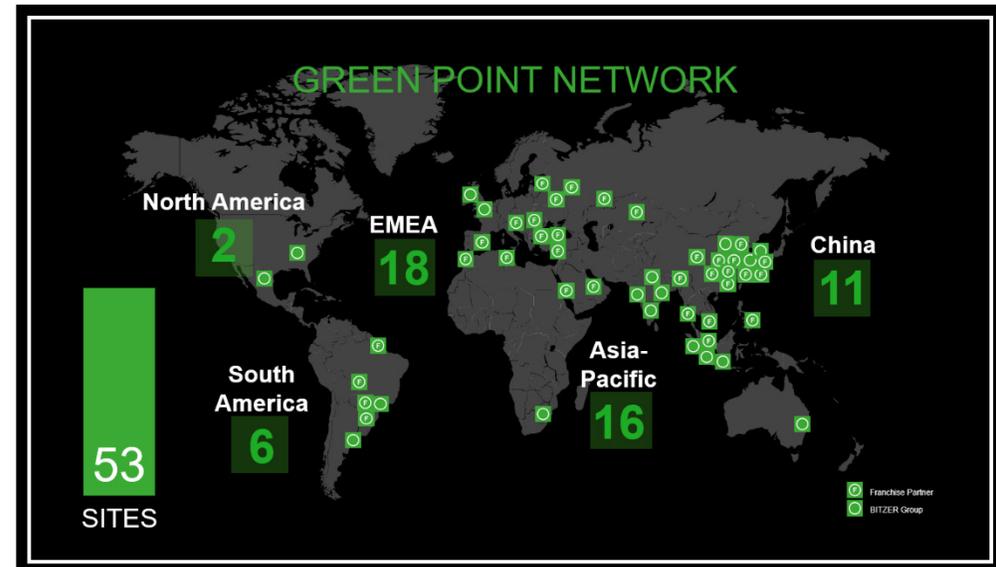
In 2016 ElectraTherm was acquired by BITZER, the world's largest manufacturer of refrigeration compressors, the centerpiece of our waste heat recovery technology.

BITZER is represented across the globe, with 3,400+ employees generating sales approaching \$1 Billion.

The combined advantage of ElectraTherm's engineering along with the value of being supported by such a reputable company allows us to dedicate all our energy to the advancement of our technology in the marketplace. With BITZER's support, we can keep the bigger picture in mind.



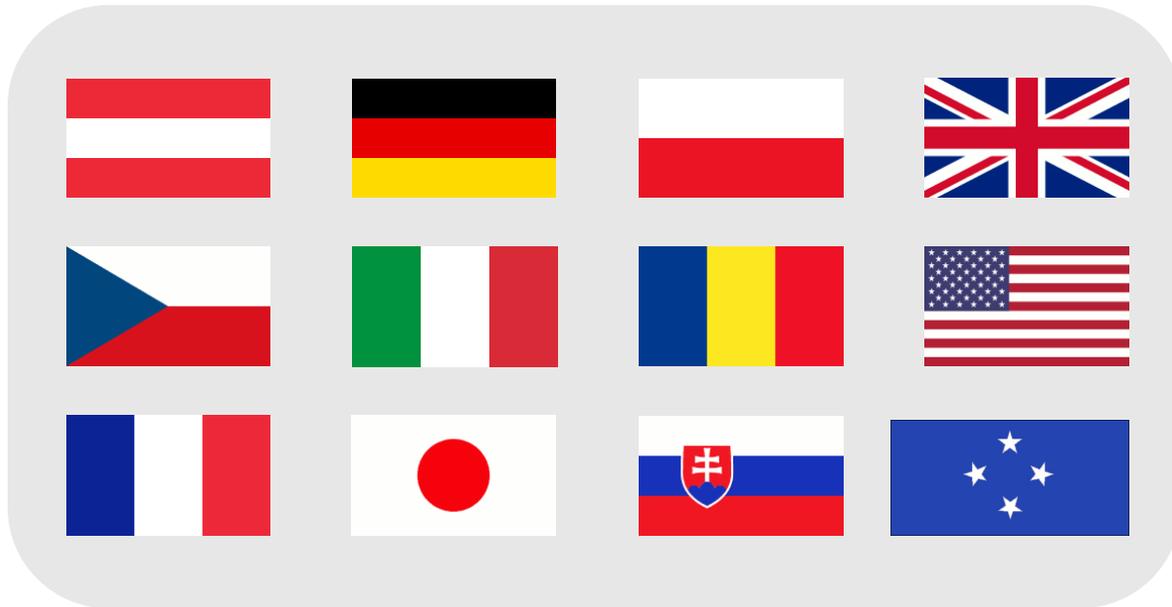
BITZER's semi-hermetic twin screw expander, centerpiece of the ElectraTherm ORC system.



FLEET OVERVIEW

After years of research and development the Power+ Generator saw a successful commercial release in 2011.

- // **100+** applications worldwide
- // Operating in **13** countries
- // **1,700,000+** operating hours
- // Fully supported worldwide by **BITZER Greenpoint**



For industries dealing with natural gases – landfill or wastewater treatment gases – integrating an ORC heat recovery system provides a reliable baseload power supply that boosts engine efficiency, decreases energy / fuel costs, and could even eliminate flaring.

HOW IT WORKS

// Engines and boilers are extensively used to provide power to landfills and heat to wastewater treatment plants.

// Typically, the boilers only work for a small portion of the time, when the site calls for heat.

// An ORC heat recovery system, such as the Power+ or Active Cooler, produces power and consumes hot water 24/7.

// By increasing hot water production, power output can be maximized and flares can be 100% eliminated.

// This not only reduces emissions but creates a sustainable baseload power supply.



FLARE ELIMINATION

THE PROBLEM

Flaring is the open-air burning of natural gases – commonly occurring in biogas production, landfills, wastewater treatment, and during oil extraction.

// Flaring releases large amounts of greenhouse gases that are major contributors to global warming.

// Flaring is a waste of a natural resource. Due to the difficulty associated with storing and transporting natural gases at oil plays, the easiest choice is to burn it off.

// Recent government programs incentivize the reduction of flaring while beginning to impose fees for those in violation.

// Flaring has a negative impact on the environment and health of those nearby. Prolonged exposure can cause headaches, dizziness, weakness, nausea, and vomiting.



FLARE ELIMINATION

SOLUTION & RESULTS

Working in tandem with a boiler, the ElectraTherm Power+ Generator is fueled by gas that would otherwise be flared. This results in the combined output of both power and heat with no additional fuel consumption or emissions.

After completing a 2,000-hour product demonstration at a HESS oil well in the Bakken, the Power+ Generator showed to have an on-stream reliability greater than 98% and showed to be effective in reducing emissions of **carbon monoxide by 98%, nitrogen oxide by 48%, and VOCs by 93%**.



- // Reduce or eliminate flaring, lowering emissions
- // Exceed air quality and EPA emission standards
- // Generate power for pumpjack, controls, wellhead
- // Generate heat for heater/treater and oil flow

PORT RICHMOND FIRST WWTP INSTALLATION



PORT RICHMOND, STATEN ISLAND, NY

New boilers use a combination of biogas and natural gas, and replace equipment dating to the 1970s that ran on heating oil.

By capturing the flared biogas and using it in the plant's operations and lowering the reliance on fossil fuels, greenhouse gas emissions will be significantly reduced.



*Location site: on rooftop,
above boiler room*

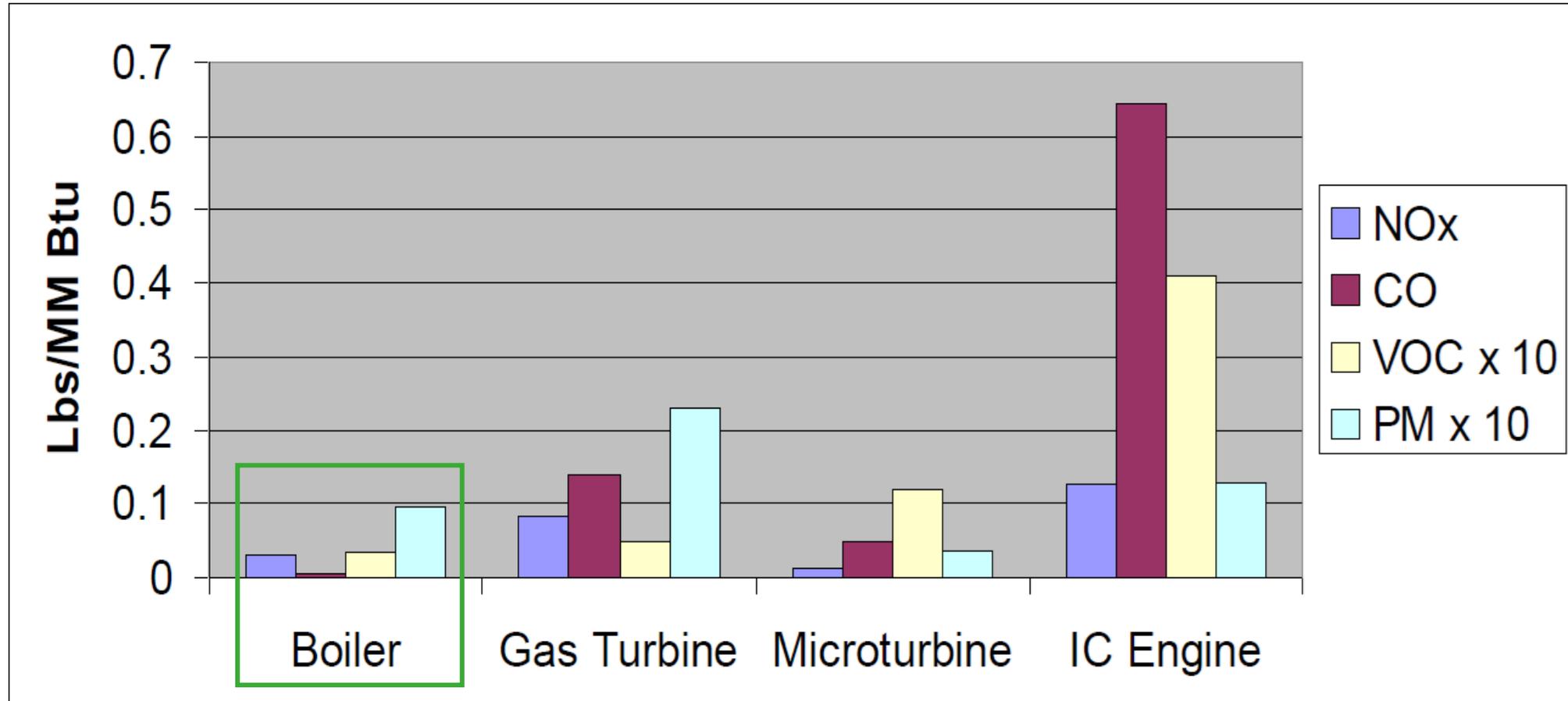
HOW IT WORKS

SIMILAR TO STEAM CYCLE BUT **HOT WATER** DRIVES THE SYSTEM

WWTP/Landfill Gas Example:

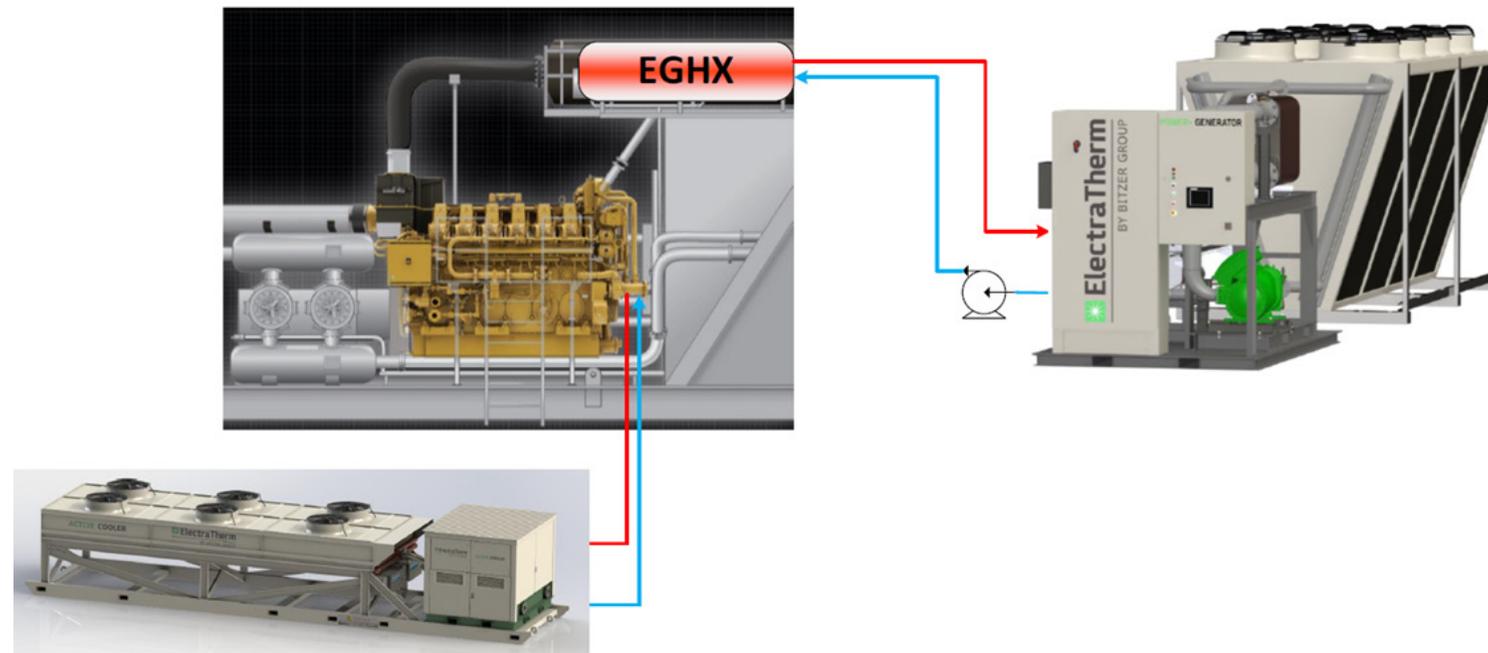


EMISSIONS COMPARISON AMONG BIOGAS ELECTRICAL GENERATION TECHNOLOGIES



Source: http://ocacs.sites.acs.org/resources/OrellanaPresentn_BiogasEngines.pdf

Heat from the jacket water in reciprocating engines can be used for power production, exhaust heat from engines and turbines can act as a great heat source as well.



Simple solution for immediate action

ACTIVE COOLER

COOLING TO POWER

All engines produce heat. All radiators consume power. Having to cool your system results in losses of efficiency, increased energy costs, and increased emissions.

By using the excess heat produced instead of expelling it, the Active Cooler generates clean electricity while providing 100% full-load cooling capabilities for the site – with no additional energy costs. It's the radiator with a payback.

800 KW ENGINE APPLICATION

- 8,500 operating hours per year
- Parasitic Cooling Load (Eliminated): **8 kW (68 MWh per annum)**
- Newly Available Power (Net): **43 kW (365 MWh per annum)**
 - Efficiency Increase: **~5.4%**
 - Radiator Cost: **\$6,800** per year at \$0.10/kWh
 - Active Cooler Savings: **\$36,500** per year at \$0.10/kWh
 - Total Annual Savings: **\$43,300**



ElectraTherm's heat recovery system uses a closed-loop Organic Rankine Cycle (ORC), taking advantage of the change in temperature in order to generate electricity.

- 1) Surplus heat is used to boil refrigerant in the evaporator.
- 2) Under pressure, the vapor is forced through a twin-screw expander, spinning an electric generator which then produces power.
- 3) The vapor is then cooled and condensed back into a liquid in the condenser.
- 4) The refrigerant is pumped to higher pressure and returned to the evaporator.



Unlike most other ORC technologies, our method utilizes a twin-screw expander instead of a turbine. This leads to numerous benefits such as higher turndown ratios and transient operations.

// Turbines typically have rotational speeds close to 10,000 rpm. Our twin-screw expanders have rotational speeds between 1,800 and 4,900 rpm – leading to significantly less wear and tear as well as noise reduction.

// Unlike high-speed turbo expanders, our twin-screw expander can tolerate “wet” dual phase flow. This means our system can accept disruptions in both temperature and flow, while even allowing for a turbine’s worst nightmare – *moisture*.

// Our ORC solutions are simple and compact, much less labor intensive than the leading turbine technologies. This translates to less maintenance and less down time, making for a smoother power generation experience.





POWER+ GENERATOR

6500B / 6500 B+
Up to *150 kWe



ACTIVE COOLER

AC-800 (800 kWth)
// Up to 75 kWe

AC-1800 (1800 kWth)
// Up to 125 kWe

POWER+ GENERATOR

4400B / 4400 B+
Up to 75 kWe



*60 Hz grid system only; 50 Hz is 125 kWe maximum

LMOP data Flare Elimination examples

Virginia Landfill

Approx. 502cfm @ 39.5% CH4= enough gas for 214kW NET= approx. 4 year ROI

Units

Metric Imperial

Cooling Method

Water Radiator

ElectraTherm

BY BITZER GROUP

Cooling Load Calculation

Automatic Manual

10 Jun 2021 (150 kW at 60Hz)

Inputs

0 % GLY 158 - 302 °F 295.0 F Hot Water Inlet Temperature

95.1 - 364.5 gpm 130.8 gpm Hot Water Flow Rate

Use All Thermal Power? 1342 kW Thermal Power Available

Show Negative TP? 0 kW Additional Thermal Power

Auto CW In 53.6 - 176 °F 75.4 F Cold Water Inlet Temperature

142.7 - 412.1 gpm 350.0 gpm Cold Water Flow Rate

0 % GLY 33.8 - 113 °F 52.0 F Ambient Air Temperature

Reset

Power+ Evaluation

Series **6500B+**

System Type: Type L, Type M, Type I, Type H, All Types

Grid: 60 Hz, 50 Hz

Working Fluid: **R245fa**

Calculate Optimize

Average Estimated Outputs 1.3.13

143.8 kWe	P+ Gross Power Output	10.7 %
122.9 kWe	P+ Net Power Output	9.2 %
1341 kW	Thermal Power Into P+	
1 kW	Remaining Thermal Power	
1199 kW	Thermal Power Rejected	
221.0 F	Hot Water Exit Temperature	
98.8 F	Cold Water Exit Temperature	
3.5 kWe	Estimated Load from Cold Water Pump	
12.0 kWe	Estimated Load from Radiator Fans	
107.4 kWe	Estimated System Net Power Output	8.0 %

Estimate assumes pure water (0% propylene glycol by volume.)

295.0 F

130.8 gpm

1 kW

221.0 F

Power + Generator

Gross Power Generated: 143.8 kWe

LLR Approach: 23.4 F

Ambient Air Temperature: 52.0 F

Thermal Power Rejected: 1199 kW

98.8 F

350.0 gpm

75.4 F

3.5 kWe

Liquid Loop Radiator

1.3.13

Input History

LMOP data Flare Elimination examples Maryland Landfill

Approx. 405.9cfm @ 47.9% CH4= enough gas for 94kW NET

Units

Metric Imperial

Cooling Method

Water Radiator

ElectraTherm
BY BITZER GROUP

Cooling Load Calculation

Automatic Manual

10 May 2021

Inputs

0 % GLY 158 - 302 °F 280.0 F Hot Water Inlet Temperature

95.1 - 364.5 gpm 247.5 gpm Hot Water Flow Rate

2654 kW Thermal Power Available

0 kW Additional Thermal Power

Auto CW In 12 - 80 °C 31.3 C Cold Water Inlet Temperature

9 - 26 L/s 20.0 L/s Cold Water Flow Rate

0 % GLY 33.8 - 113 °F 65.0 F Ambient Air Temperature

Power+ Evaluation

Series **6500B+**

System Type

Type L
 Type M
 Type I
 Type H
 All Types

Grid

60 Hz
 50 Hz

Working Fluid R245fa

[Click Here to Calculate](#) [Click Here to Reset](#)

Average Estimated Outputs 1.3.12

125.0 kWe	P+ Gross Power Output
108.6 kWe	P+ Net Power Output
1273 kW	Thermal Power Into P+
1381 kW	Remaining Thermal Power
1152 kW	Thermal Power Rejected
243.0 F	Hot Water Exit Temperature
45.1 C	Cold Water Exit Temperature
3.0 kWe	Estimated Load from Cold Water Pump
11.5 kWe	Estimated Load from Radiator Fans
94.0 kWe	Estimated System Net Power Output

Estimate assumes pure water (0% propylene glycol by volume.)

Power + Generator

Gross Power Generated 125.0 kWe

LLR Approach 13.0 C

Ambient Air Temperature 65.0 F

Thermal Power Rejected 1152 kW

45.1 C

20.0 L/s

31.3 C

Water Pump 3.0 kWe

Liquid Loop Radiator 11.5 kWe

1.3.12

LMOP data Flare Elimination examples Hawaii Landfill

Approx. 941cfm @ 53.2% CH4= enough gas for over 500kW NET

Units
Metric Imperial

Cooling Method
Water Radiator

Cooling Load Calculation
Automatic Manual

30 Jun 2

Inputs

0 % GLY 158 - 302 °F 295.0 F Hot Water Inlet Temperature

95.1 - 364.5 gpm 200.0 gpm Hot Water Flow Rate

6780 kW Thermal Power Available

0 kW Additional Thermal Power

Auto CW In 12 - 80 °C 31.9 C Cold Water Inlet Temperature

142.7 - 412.1 gpm 350.0 gpm Cold Water Flow Rate

0 % GLY 33.8 - 113 °F 66.0 F Ambient Air Temperature

Reset

Estimate assumes pure water (0% propylene glycol by volume.)

Power+ Evaluation

Series **6500B+**

System Type

Type L
 Type M
 Type I
 Type H
 All Types

Working Fluid R245fa

Grid

60 Hz
 50 Hz

Calculate **Optimize**

Jessie Howell / ET

Average Estimated Outputs

150.0 kWe	P+ Gross Power Output
127.4 kWe	P+ Net Power Output
1473 kW	Thermal Power Into P+
5307 kW	Remaining Thermal Power
1329 kW	Thermal Power Rejected
241.9 F	Hot Water Exit Temperature
46.4 C	Cold Water Exit Temperature
3.5 kWe	Estimated Load from Cold Water Pump
13.3 kWe	Estimated Load from Radiator Fans
110.7 kWe	Estimated System Net Power Output

1.3.13

CAT 3520C Jacket Water Example Pennsylvania

Gain over 50kW NET by replacing the radiator

The screenshot displays the ElectraTherm software interface, divided into several sections:

- Inputs:** A form for entering system parameters. It includes:
 - Hot Water Inlet Temperature: 230.0 F (range 158 - 240.8 °F)
 - Hot Water Flow Rate: 297.7 gpm (range 50 %GLY)
 - Hot Water Outlet Temperature: 210 F
 - Thermal Power Available: 42553 BTU/min
 - Number of Machines: 1
 - Ambient Air Temperature: 68.0 F (range 32 - 113 °F)
 - Control Mode: Manual (toggle switch)
 - System Efficiency: Added Efficiency (radio button selected)
 - System Type: Type I (radio button selected)
- Grid Hz:** A section with a lightbulb icon and radio buttons for 60 Hz (selected) and 50 Hz.
- Calculate:** A large cyan button to execute the calculation.
- Reset:** A blue button to reset the inputs.
- Active Cooler Performance:** A green panel displaying the results of the calculation:
 - 50.3 kWe: Estimated System Net Power Output
 - 1.0: Number of Machines Used
 - 65.5 kWe: Estimated Gross Power Output
 - 265.6 gpm: Hot Water Flow Rate of Each Machine
 - 6.8 kW: Radiator Power Consumption
 - 2.6 kW: Cold Water Pump Work
 - 42519.8 BTU/min: Thermal Power Utilized
 - 19.8 F: Radiator Approach Temperature

CAT 3520C Exhaust Example Pennsylvania

Gain over 93kW NET by replacing the radiator

Units
: Imperial Metric

Cooling Method
Water Radiator



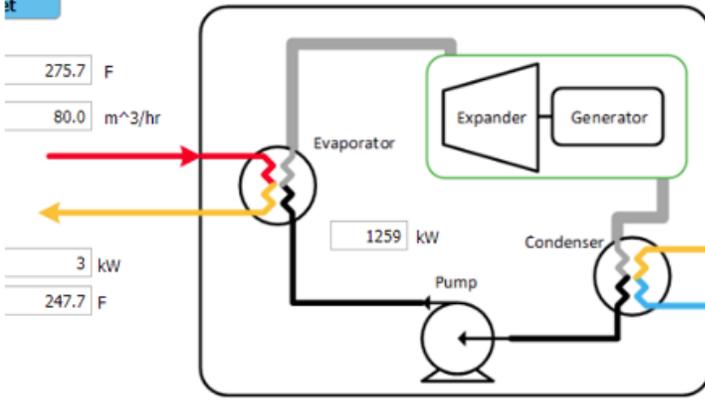
ElectraTherm
BY BITZER GROUP

Cooling Load Calculation
Automatic Manual

10 Jun 2021 (150 kW at 60Hz)

Inputs	Power+ Evaluation	Average Estimated Outputs
<p>Hot Water Inlet Temperature: 275.7 F</p> <p>Hot Water Flow Rate: 80.0 m³/hr</p> <p>Thermal Power Available: 1262 kW</p> <p>Additional Thermal Power: 0 kW</p> <p>Cold Water Inlet Temperature: 32.4 C</p> <p>Cold Water Flow Rate: 20.0 L/s</p> <p>Ambient Air Temperature: 67.0 F</p>	<p>Series: 6500B+</p> <p>System Type: <input checked="" type="radio"/> Type H</p> <p>Grid: <input checked="" type="radio"/> 60 Hz</p> <p>Working Fluid: R245fa</p> <p>Calculate Optimize</p>	<p>124.1 kWe P+ Gross Power Output</p> <p>108.1 kWe P+ Net Power Output</p> <p>1259 kW Thermal Power Into P+</p> <p>3 kW Remaining Thermal Power</p> <p>1141 kW Thermal Power Rejected</p> <p>247.7 F Hot Water Exit Temperature</p> <p>46.1 C Cold Water Exit Temperature</p> <p>3.0 kWe Estimated Load from Cold Water Pump</p> <p>11.4 kWe Estimated Load from Radiator Fans</p> <p>93.7 kWe Estimated System Net Power Output</p>

Estimate assumes pure water (0% propylene glycol by volume.)



Power + Generator

Gross Power Generated: 124.1 kWe

LLR Approach: 13.0 C

Ambient Air Temperature: 67.0 F

Thermal Power Rejected: 1141 kW

Water Pump Load: 3.0 kWe

Radiator Fan Load: 11.4 kWe

Liquid Loop Radiator

Thank you!

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ElectraTherm
www.electratherm.com



ElectraTherm
BY BITZER GROUP

Questions

Q&A

Wrap Up

Contact Information

Wrap Up

- The slides and recording from today's webinar will be posted on the LMOP website
- To learn more about LMOP or LFG energy, visit our website at epa.gov/lmop
- Have a webinar idea? Drop us a note with your email in the Q&A box or email lmop@epa.gov



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Landfill Methane Outreach Program (LMOP)



Upcoming LMOP Webinar

September 28, 2021 – Join us as three LMOP Partners discuss [waste heat applications](#) for LFG energy projects. Free to attend but [online registration](#) is required.

LMOP is a voluntary program that works cooperatively with industry stakeholders and waste officials to reduce or avoid methane emissions from landfills. LMOP encourages the recovery and beneficial use of biogas generated from organic municipal solid waste. [Learn more about LMOP](#) or [join the LMOP listserv](#).

Key Information



Data and Partners



Tools & Resources



Thank You

Please reach out with any questions or comments

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