



Flare Reduction Field Trial

Cost Effective Flare Gas & VOC Reduction

May 9, 2017

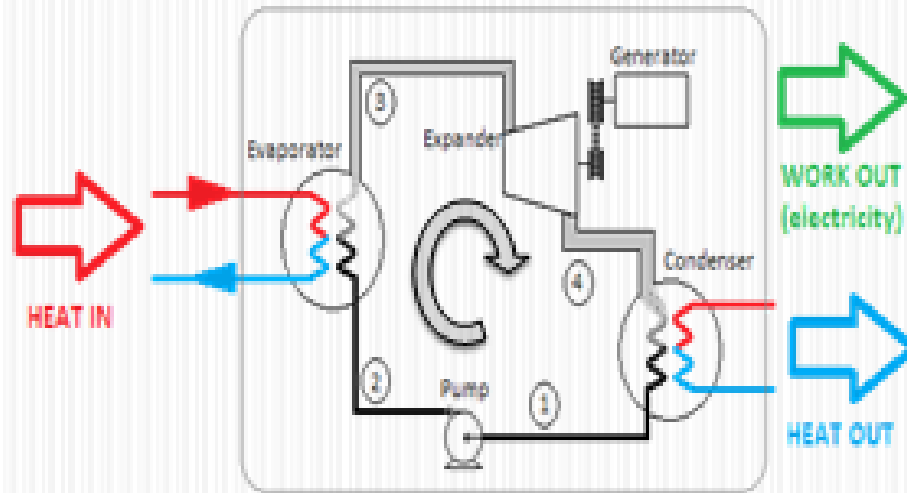


HEAT IS POWER
LET'S CAPTURE IT



The 15,000 MW Opportunity

ORC SYSTEM OVERVIEW



- ① Low pressure liquid
- ② High pressure liquid
- ③ Heated, pressurized vapor
- ④ Low Pressure Vapor

THE ORC CYCLE

-HEAT IN: Heat enters ORC via hot water stream, transferred into system through evaporator where working fluid changed from liquid to vapor.

-HEAT OUT: Heat leaves ORC via cooling water stream, heat transferred through the cooling water stream changing vapor back to liquid

-WORK OUT: Work is provided via shaft output from expander, and converted to electricity by a generator.

-IMPORTANT: 90% of the heat input into the ORC passes through the machine to the cooling side.

Flare to Power

Reduce Flaring, Generate Power



- ✓ Reduce or eliminate flare
- ✓ Much lower capital and maintenance than other power generation technologies
- ✓ Significantly reduced emissions



Waste Water Treatment



For WWTPs under pressure to reduce flaring and lower emissions, the **POWER+** membrane bioreactors and anaerobic digesters for a cost-effective solution.

Oil & Gas Wells



In the fall of 2015, ElectraTherm demonstrated a **POWER+** paired with a boiler to reduce flaring on a Hess oil well in the Bakken.

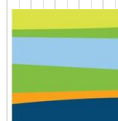
**Increased Efficiencies
and
Reduced Emissions**

Flare and Emission Reduction Trial

Sponsored By:

Environmentally Friendly Drilling Systems Program
and

Houston Advanced Research Center, HARC



HARC





Field Test – Flaring Mitigation



Location

- Field trials ongoing in the Bakken

Objectives

Identify & test simple/robust technologies to reduce flaring

Status

- ORC equipment installed, commissioned, successfully operated. Data compiled and submitted.

Our Solution:

Provide Beneficial Use for Flare Gas



Gas to Boiler



kW Output



Reduced Flaring



Well Site Pre-Commissioning



Day 1

Equipment Lands



Installation

Day 1-2



Day 2

Hot Water Boiler Commissioned



Hot Water Boiler – **NO** operator required

Day 2

Power+ Generator Commissioned



Day 3

System Successfully Commissioned



**Flare Emissions Study:
ElectraTherm Power+ Generator
Texas A&M/Institute of Renewable Natural Resources
Under the
Houston Advanced Research Center/ Environmentally Friendly Drilling Program**



“The real benefit is the power generated by raw gas or fuel gas which would otherwise be wasted by open flaring. Furthermore, this new technology would meet the goals of the US EPA and North Dakota Department of Health – Air Quality by reducing emissions and providing energy by reuse of the produced raw gas or fuel gas.” p.10

Results



Total Run Time: 1857 HR

Total kWh Produced: 99,000

Emission Reduction

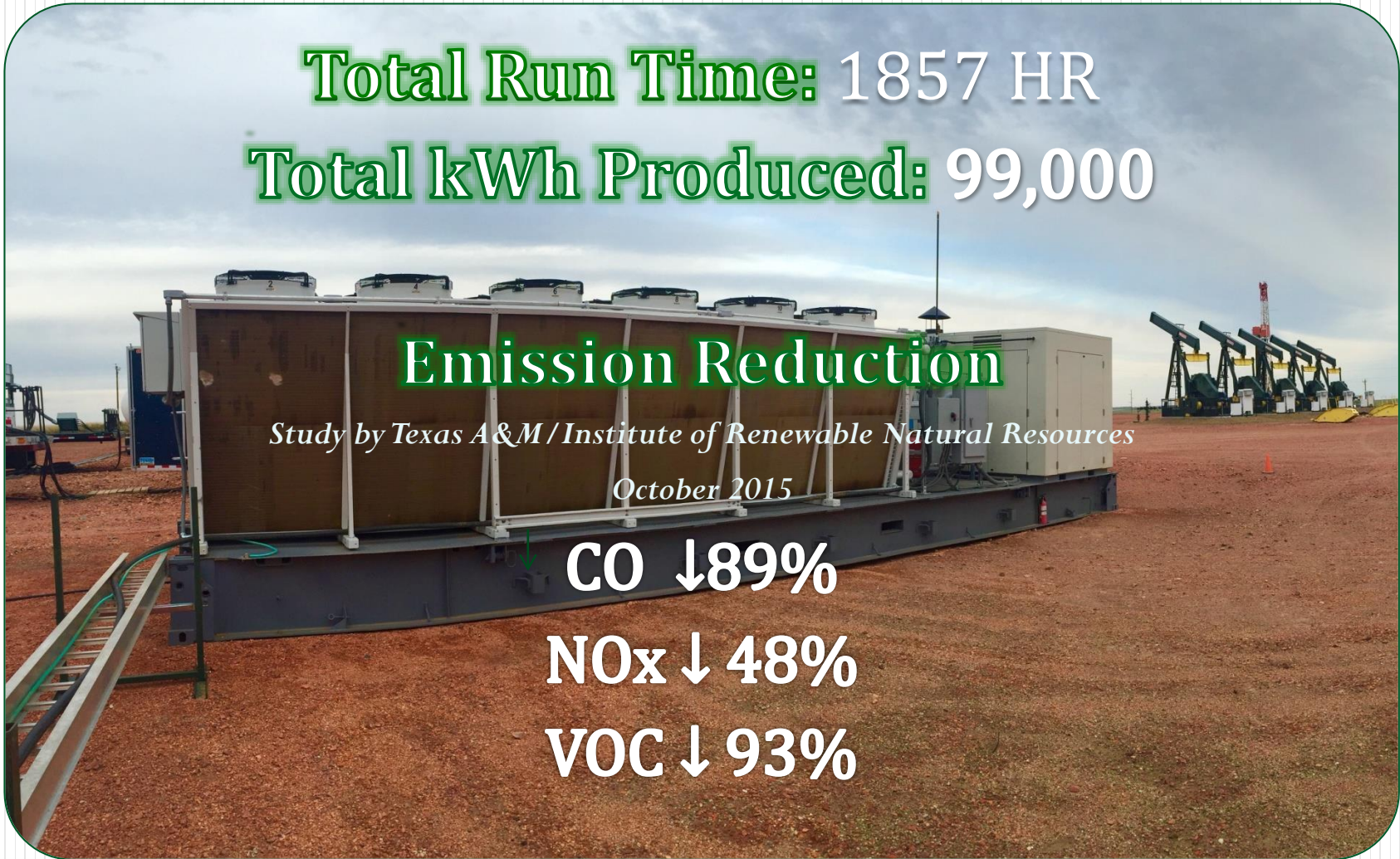
Study by Texas A&M/Institute of Renewable Natural Resources

October 2015

CO ↓ 89%

NOx ↓ 48%

VOC ↓ 93%



COA FM 812 Landfill Flare



Austin Landfill

Anticipated Emissions Reductions and Values

- Values for TCEQ Credits for HGM Area

lb/hr	Calculated Reductions #/yr.			#/yr Reduction	Price/ton*	Value
	Flare	Pwr+ Boiler	% Decrease			
VOC	14,541	438	97	14,103	\$200,000/ton	\$ 1,410,000
CO	38,368	11,388	70	26,980		
NOx	6,291	3,591	42	2,700	\$5,200/ton	\$ 14,040

**Note: Price/ton from TCEQ Emissions Banking Division
6/1/2016*

CALCULATION METHODS

Landfill Emissions Calculation: Average Flow (SCFM or ft³/min) 414.05 ft³/min x 60 min/hr x 476 Btu/ft³ x MMBtu/10⁶ Btu x Emission Factor (lb pollutant/MMBtu)

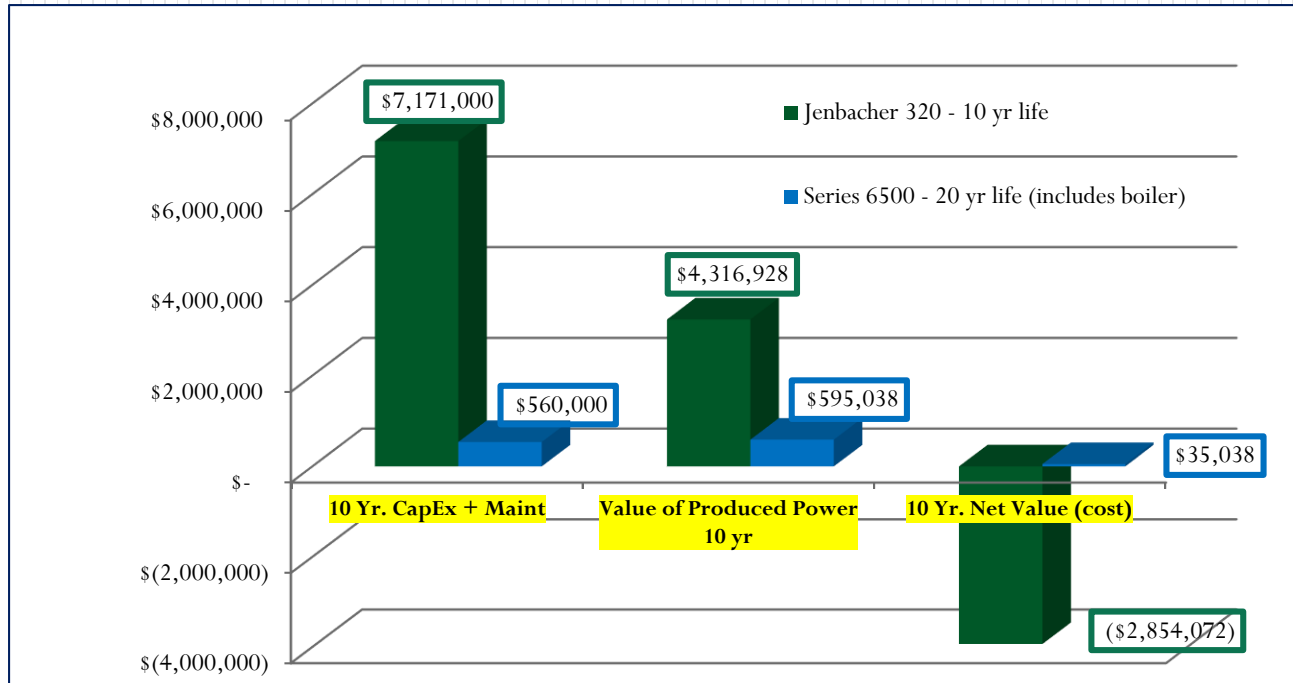
Existing Landfill Flare City of Austin*

- **VOC reduction: 7 tons/yr.**
(Equivalent of taking 512 cars off Austin streets)
- **NO_x reduction: 1.2 tons/yr.**
(Equivalent of taking 108 cars off Austin streets)
- **CO reduction: 13 tons/yr.**
(Equivalent of taking 104 cars off Austin streets)

**Applies IRNR Hess/HARC Project research results*

Power+ Generator vs. Engine Economic Comparison

- 92% reduction in Costs – CapEx + Maintenance
- \$2.8 Million savings over engine over 10 years
- Power+ provides a positive ROI + Dramatic Emissions Reductions



Notes:
 *Installed cost for Genset is calculated including Gas Cleanup (4.4M) + Genset/Switchgear (1.5M)
 ** Genset Uptime and Maintenance based on Jenbacher 320 –
Truckee Meadows WWT report
 Value of Power Based on \$.08/kWh

Hess Project – Fall 2015

In October 2015, ElectraTherm completed a flare reduction demonstration at a Hess oil well in the Bakken

POWER+ Series 4000 -- 65 kW

- Total Run Time: 1,857 Hours
- Total kWh Produced: 99,000
- Positive Hess Feedback
- Iraq delegation/DOE visit to site
- “Beneficial Use” Approval from North Dakota
- Visibility to all producers in Bakken

Media Highlights:

Cover story in Oil, Gas & Petrochem Equipment

Bakken Magazine feature story

Addl. coverage in: Exploration & Development

Magazine, Power Engineering, Penn Energy, more.

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OGPE.COM

OIL, GAS

& petrochem equipment®

WHAT'S NEW FOR ONSHORE & OFFSHORE: UPSTREAM, MIDSTREAM, DOWNSTREAM OPERATIONS

What's New In Equipment, Products, Systems & Services For:
Upstream, Midstream & Downstream



Design avoids flaring — converts well's natural gas into clean energy
Power+Generator is on the market to convert waste heat into clean energy.
At a well, the design captures natural gas otherwise flared — to generate electricity plus reduce or eliminate onsite flaring.
The system applies Organic Rankine Cycle (ORC) and proprietary technologies to generate power from 170° to 252°F. At one site, natural gas otherwise flared, is instead used to fuel an industrial boiler via clean energy as low as 9 ppm NOx.
ElectraTherm: Reno NV
For FREE information, select #1 at ogpe.hotims.com

Technical aspects: Enclosures
Thirty-six free pages in this free brochure present technical aspects of enclosures for broad applications including oil and gas.
It addresses, illustrates, and diagrams answers to common recurring day-to-day questions on planning and assembly of electrical systems. These include electrical output, cables labeling, or selection of an enclosure climate solution.
Rittal: Schaumburg IL
For FREE Literature, select #250 at ogpe.hotims.com

Intelligent, safe motor management
Power Xpert C445 intelligent motor management and protection



The BAKKEN

MAGAZINE

Technology Comparison

ORCs for raw flare gas



	POWER+ and Boiler	Engine	Micro Turbine	Fuel Cell
Lowest LCOE per kWh	✓			
Lowest O&M	✓			
No Costly Gas Conditioning	✓			
No Costly Gas Storage	✓			
Low Emissions	✓		✓	
Ease of Installation	✓			
Accepts Varying Gas Flows	✓			
Smallest Footprint	✓			
MW Output for Grid Export		✓		✓
kW Output for Local Loads	✓		✓	

POWER+ Family of Products

Model

Product

High

POWER+ 6500

Up to 110kW



Power Output (kW/h)

POWER+ 4400

Up to 65kW



Low

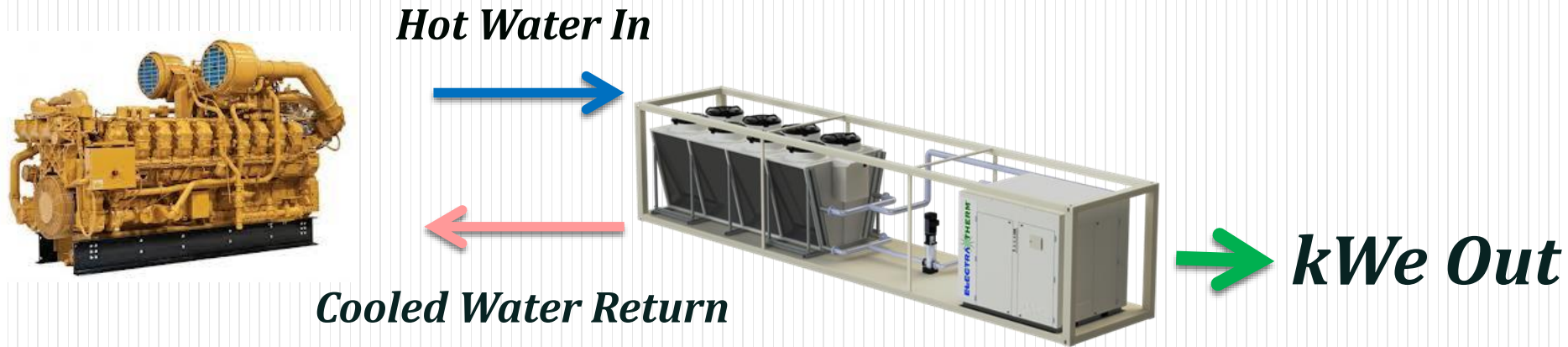
POWER+ 4200

Up to 35kW



We offer 3 output levels packaged with cooling circuit or standalone

Stationary Engines



Produce More Power & Reduce Cooling Fan Load

Waste heat from engine jacket water or combination exhaust & jacket water

Radiator Replacement for Stationary Engines



Avoid Radiator Expense on a Greenfield Project
Offset ORC Capex by 20-30%

**Containerized 1.1MW Cummins Genset +
ORC Packaged in two 40-foot containers**



Benefits:

- *Complete Engine Radiator Replacement*
- *10% - 12%+ Improved Fuel Efficiency*
- Easily Transportable
- Limited Site Construction
- Payback 2-3 years (diesel)

*1.1 MW Cummins Genset and
Exhaust Gas Heat Exchanger*



POWER+ ORC

*Combined Engine
and ORC Radiator*

“The Radiator with a Payback”

Video at <https://youtu.be/fca0faX8R84>

For More Information Contact:

For:



Loy Sneary, President/CEO
Gulf Coast Green Energy
979.240.3512
loy@gcgenergy.com

www.gulfcoastgreenenergy.com