# Waste Heat to Power
# The Baseload Renewable You Already Have

August 2017

# Waste Heat to Power

**Highlights**

–Founded in 2005

–Patented & Patent-Pending Technology

–50+ Operational Machines

–Acquired by BITZER in 2017


**ElectraTherm's Power+ Generator™**

Commercial Release August 2011

–Up to 110 kWe Power Output

–More than 700,000 Hours Run Time

THIS IS SMART POWER®

# BITZER Integration

June 2017: ElectraTherm headquarters relocated to the BITZER production facility in Flowery Branch, Georgia.

# GLOBAL INSTALLATIONS











**Austria**
**Canada**
**Czech Republic**
**France**
**Germany**
**Italy**
**Japan**
**Romania**
**Slovakia**
**United Kingdom**
**United States**

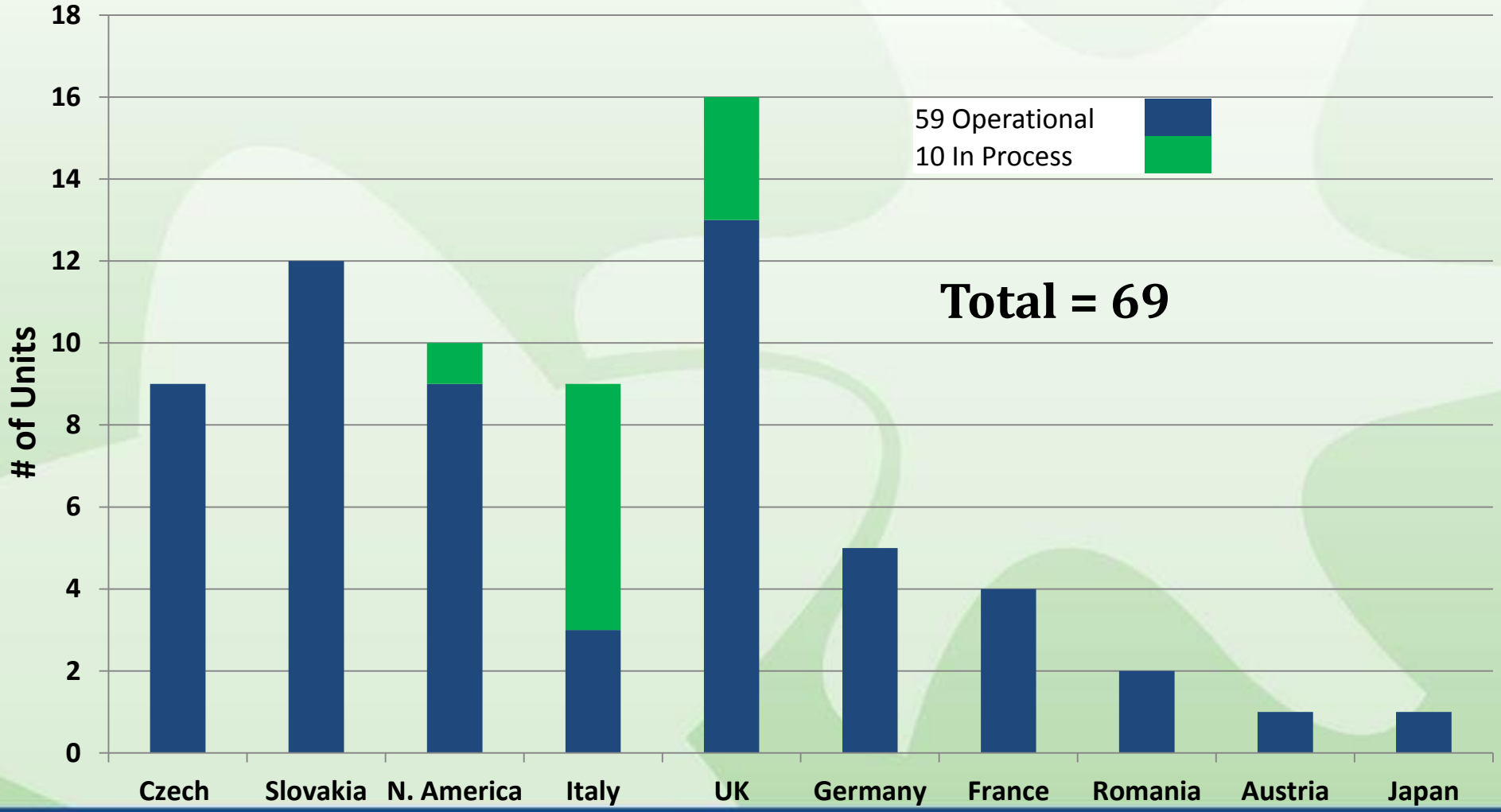
# DIVERSE APPLICATIONS

**Clean, distributed power** from low temperature water (90-122C)

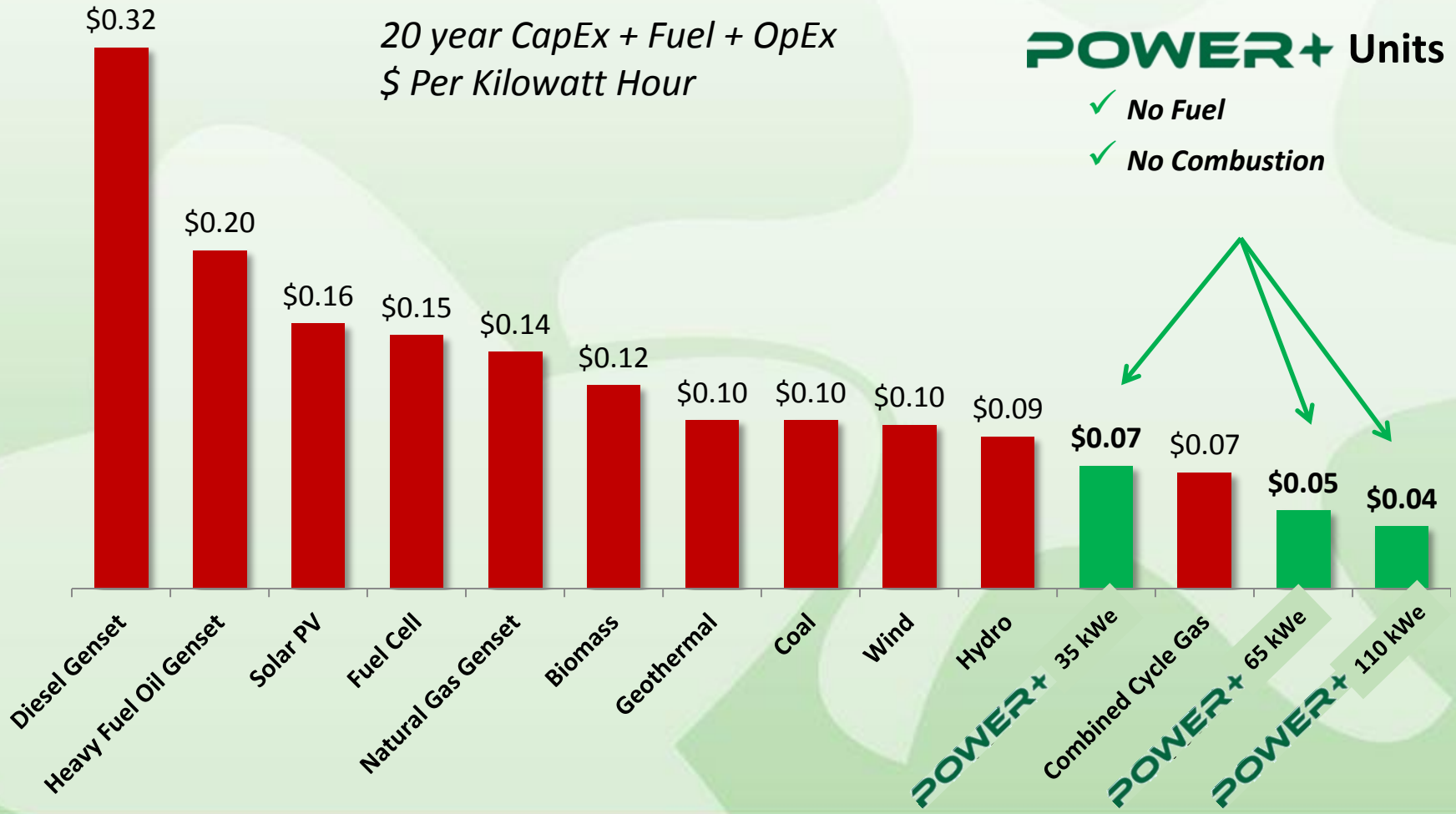
- **Biomass Boilers**
- **Reciprocating Engines**
- **Methane Utilization**
- **Geothermal/Oil & Gas Wells**
- **Solar Thermal**
- **Process Heat**


# FLEET PROFILE BY GEOGRAPHY

*(**Operational** is the running Fleet, **In Process** is pending commissioning, production and backlog)*



# LEVELIZED COST OF ELECTRICITY GENERATION

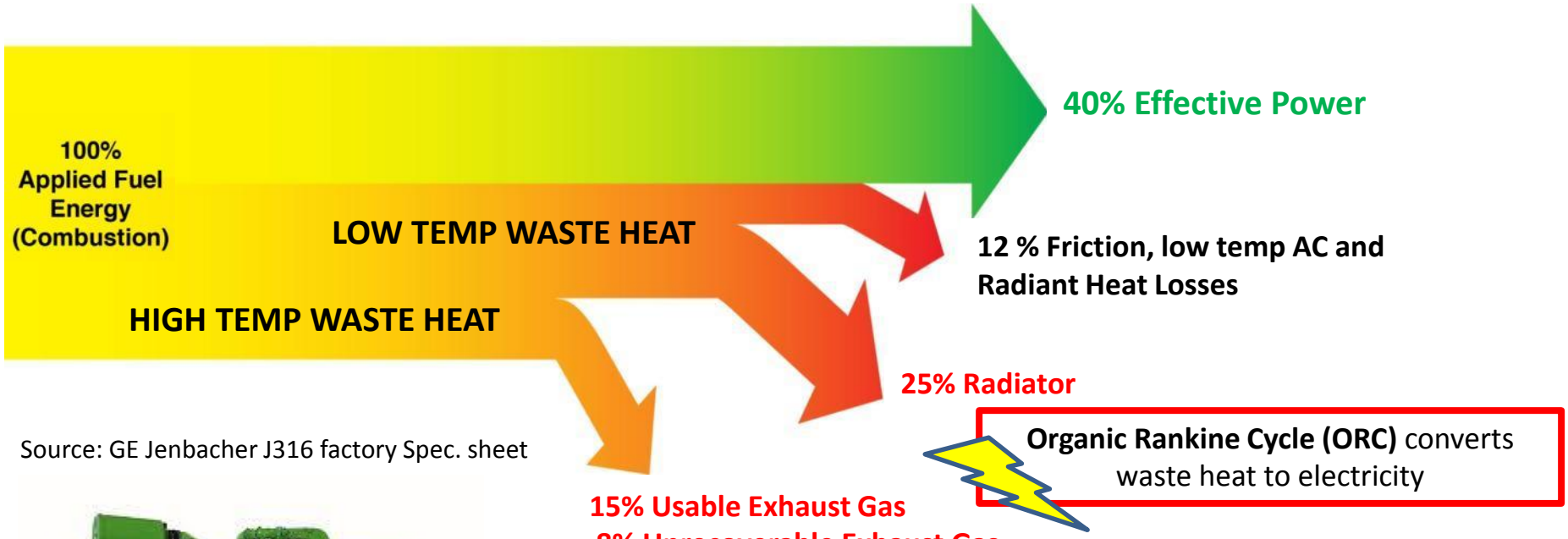



*Source: US EIA's Annual Energy Outlook 2012; Cadmus Group 2012 Report, ElectraTherm, Caterpillar*

# WASTE HEAT FROM STATIONARY ENGINES

*Engines used for prime power ,landfill gas, waste water treatment plants, CHP*

**Ex. Jenbacher 316 (834 kWe)**




Source: GE Jenbacher J316 factory Spec. sheet

**100,000+ Stationary Engines Installed Worldwide**

.5-2 MW, Continuous Duty

# US DEPT OF DEFENSE DEMONSTRATION

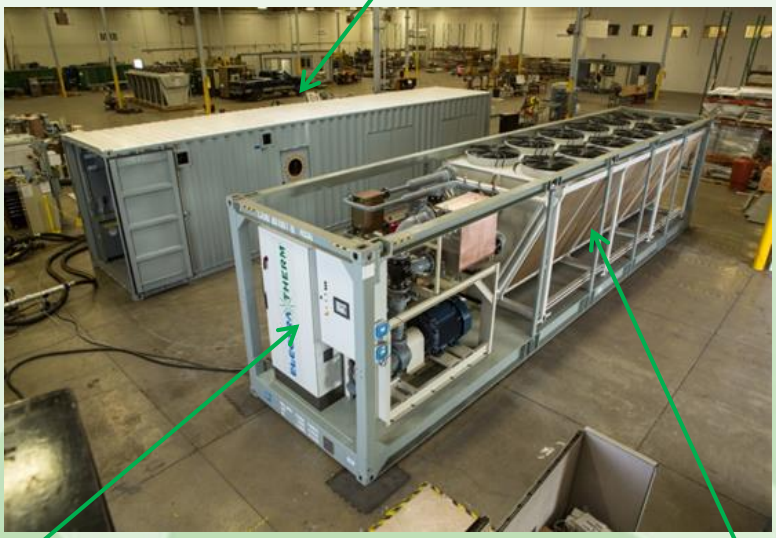
**ElectraTherm has 23 installs on engines**
In 2015, ElectraTherm demonstrated the "radiator replacement" system shown here with US DoD

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

## Benefits:

- Complete Engine Radiator Replacement
- Engine Cooling Independent of ORC Operation
- ORC Provides Hot Ambient Cooling Benefits
- 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*

# BIOGAS FLAGSHIP SITES

Trechwitz, Germany

Trebova, Czech Rep.

Bratcice, Czech Rep.

Inning, Austria

Drahobudice, Czech Rep.

Slapanov, Czech Rep.

Kosova Hora, Czech Rep.

Grabsleben, Germany

Kaarssen, Germany

Valovice, Czech Rep.

Straznice, Czech Rep.

Lapouyade, France

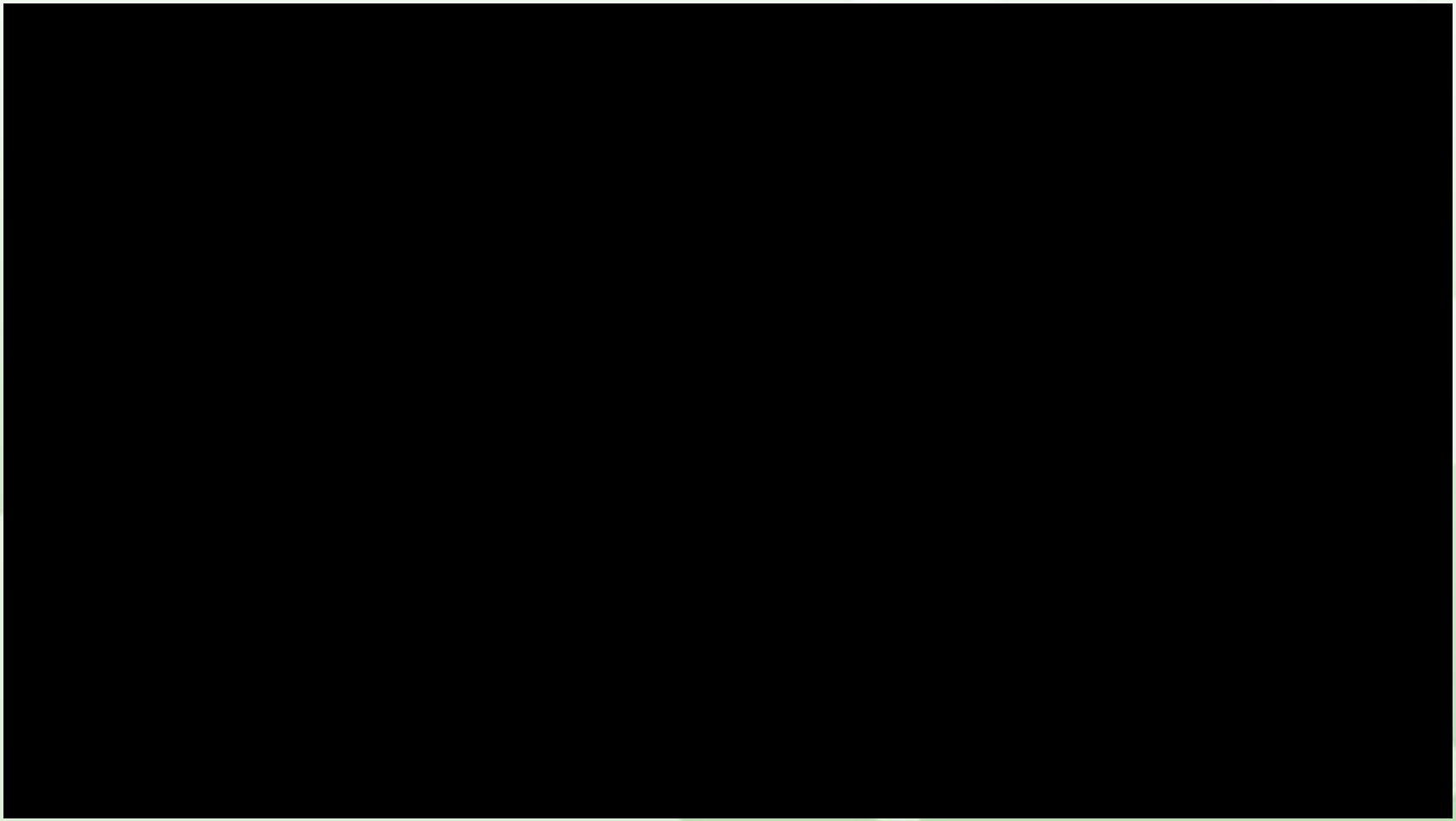
# REMOTE DIESEL FLAGSHIP SITE



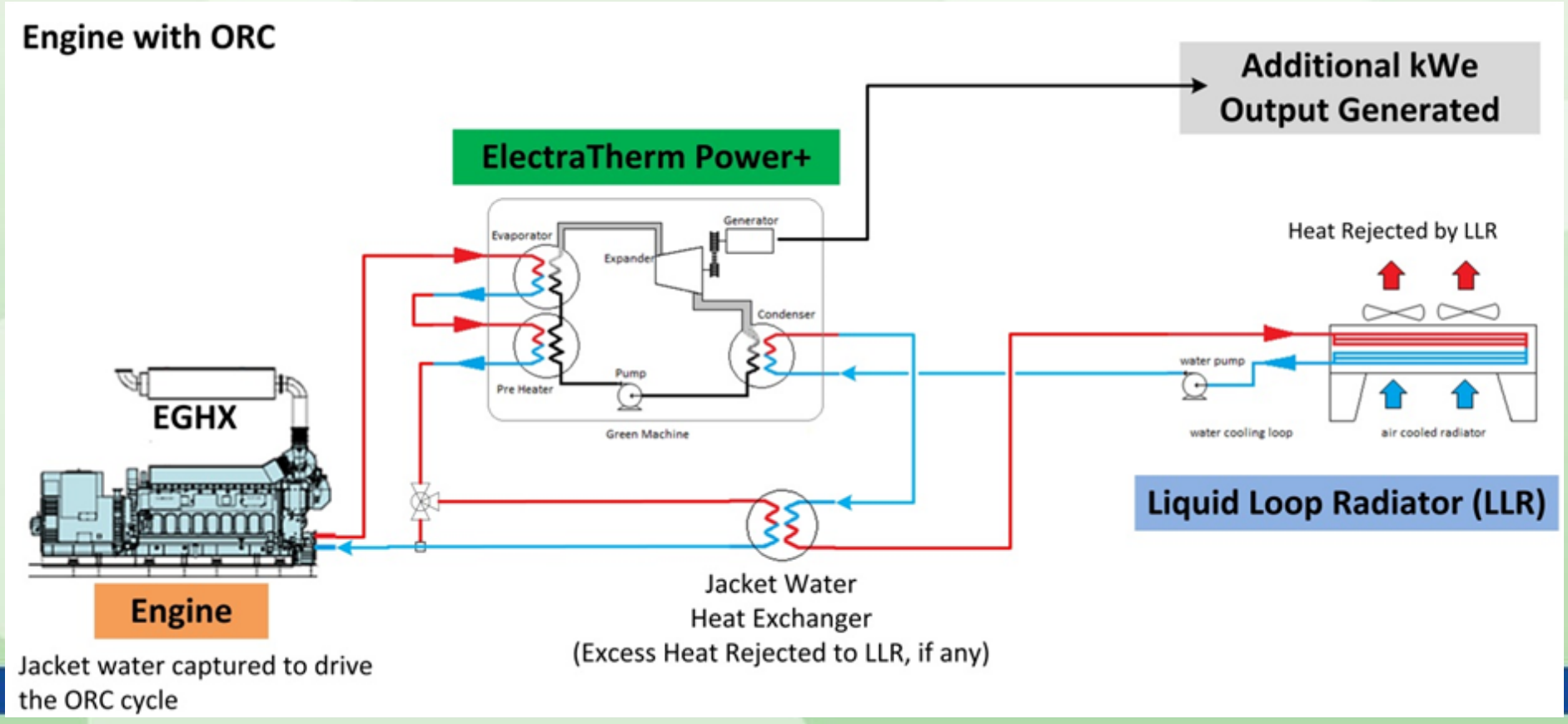
**Dutch Harbor, Unalasksa**

**20,000+ hours of run time**

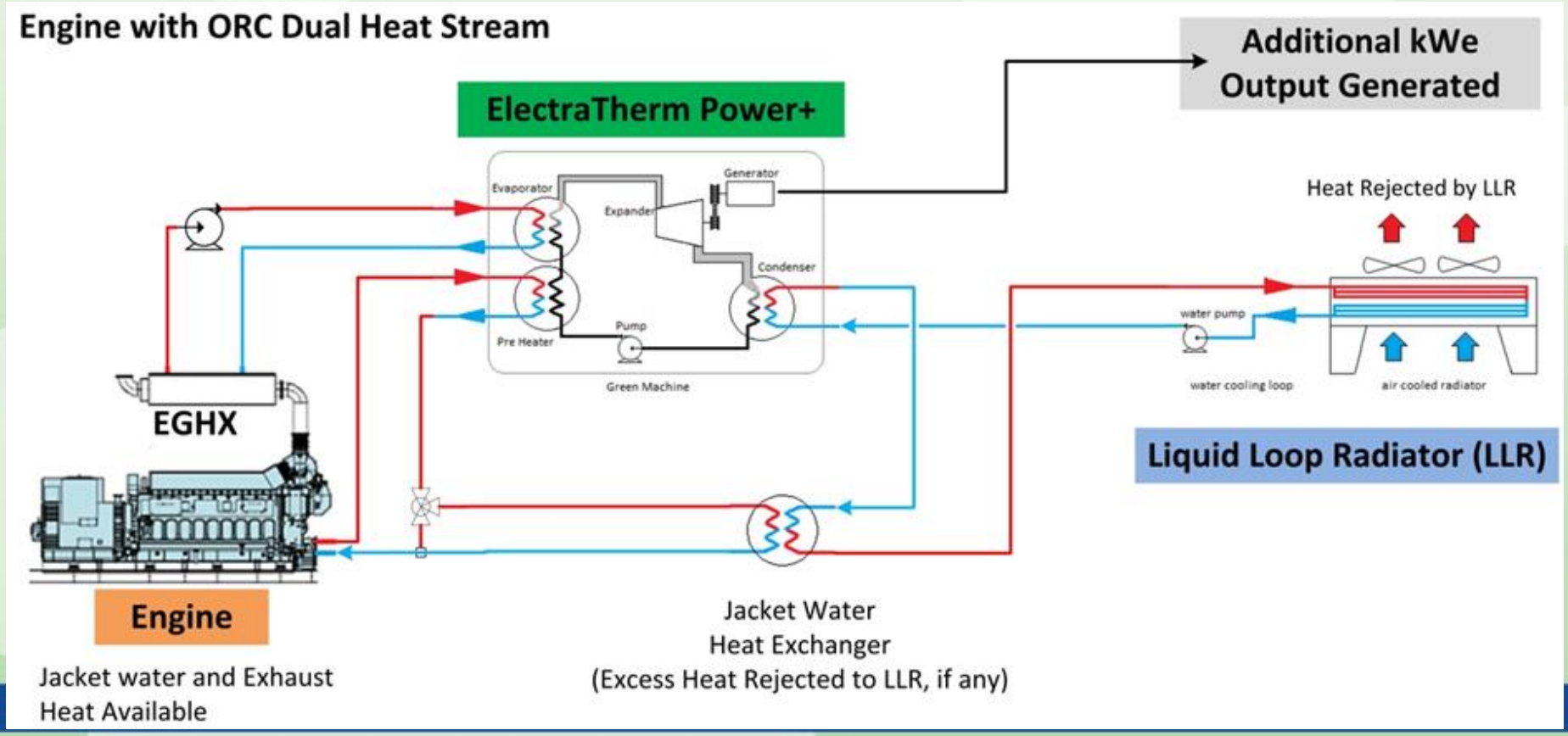
Referral and introductions upon request



# Engine/ORC combination running only on the jacket water



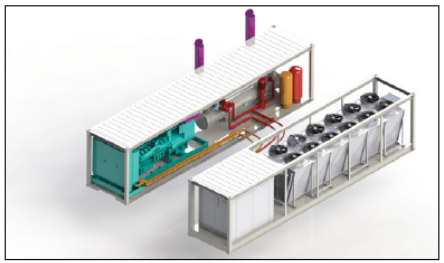
# Engine/ORC combination running in a dual heat stream configuration



# DIESEL & GAS TURBINE WORLDWIDE
## *Magazine Article Features ElectraTherm*

ELECTRA THERM BY BITZER GROUP





The DOD-funded ORC integration and replacement project that will deploy later this year is comprised of two 40 ft. (12 m) ISO shipping containers.

### Utilizing Waste Heat For Power

**Advanced engine cooling with economic payback; DOD project demonstrates up to 12% increase in fuel efficiency**

Continuous duty gen-sets provide base-load power generation in diverse applications around the globe. However, high fuel costs and engine maintenance are pain points felt by operators. A low-maintenance path to significant fuel savings and lower emissions is what the U.S. Department of Defense (DOD) had in mind when they approached ElectraTherm to integrate the company's Green Machine waste heat to power (WHP) generator with a 1.1 MW Cummins KTA-50 generator.

ElectraTherm specializes in small-scale, distributed power generation from waste heat, utilizing Organic Rankine Cycle (ORC) and proprietary technologies to generate power from low temperature heat ranging from 77° to 116°C. The company's WHP technology converts various sources of heat into power, including internal combustion engines, small geothermal, biomass, concentrated solar and process heat. To date, ElectraTherm said it has deployed 42 units worldwide, with a cumulative 250 000 operating hours and over 97% availability.

ElectraTherm's primary market is waste heat from stationary internal combustion engines. Typical sites for these engines include prime power production in remote areas, island and developing nations, biogas gen-sets including landfill and waste water treatment plants, natural gas compression stations and renewable biofuels. With the typical engine running at about 35% efficiency, there is considerable waste heat between the jacket water and the exhaust that ElectraTherm converts into emissions-free/fuel-free electricity.

ElectraTherm's Green Machine generator operates using a closed-loop ORC, where hot water is the fuel. Hot water from the engine enters a heat exchanger to excite (pressurize) the non-flammable, nontoxic working fluid, driving the twin-screw expander and generator to create electricity. The company said its twin-screw expander is unique in its configuration, lubrication and specifications, but the core technology is based on decades of proven compressor technology.

The twin-screw expander has a rotational speed of 1800 to 4900 r/min, considerably less than turboexpanders, according to ElectraTherm. Unlike high-speed turboexpanders, screw expanders are robust units that tolerate "wet" dual-phase flow.

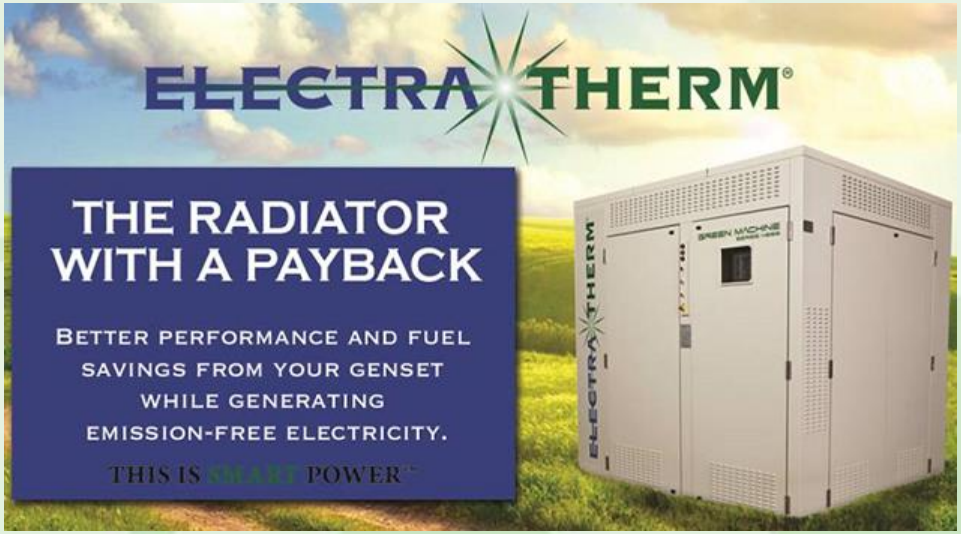
"This allows a very robust and cost-effective design for the Green Machine that can tolerate perturbations in both temperature and flow with turn down ratios of 6:1 available on demand," said John Fox, CEO of ElectraTherm, Inc. "This is particularly advantageous in low temperature waste heat streams such as engine jacket water. Our Green Machine design is simplified and eliminates lubrication reservoirs, oil coolers, pumps and land filters, creating a simple, robust and efficient system with fewer parasitic loads and maintenance requirements."

The Green Machine acts as the engine's radiator, so the engine-driven radiator fans can actually be disconnected (or eliminated completely for a new installation), allowing more work to be performed by the engine to generate additional electricity. In effect, the engine's waste heat becomes a source of cost savings by displacing the radiator's capital cost and parasitic load.

Between the DOD project and the machines currently running in the field, ElectraTherm said it increases fuel efficiency up to 12%, depending on engine size and configuration, and site conditions while featuring simple installation, mobility and low maintenance.

There are multiple benefits to integrating an ORC heat to power generator with an engine gen-set: the additional electrical output from the conversion of the waste heat to electricity with no additional fuel consumption or emissions, and the reduction or elimination of the parasitic load from the engine cooling fans. In hot climates or seasonally high ambient conditions, which often coincide with peak demand, the engine's derate can be reduced due to the added cooling effect of the ORC, thereby increasing the power output of the engine. "The additional benefits from





# AVAILABLE MODELS

**Power+ 4200**
*Up to 35kW*
Low Cost Packaged Solution

**Power+ 4400**
*Up to 65kW*
ElectraTherm's Standard ORC Model

**Power+ 6500**
*Up to 110kW*
Largest Output Model

# ECONOMICS RUNNING 95% OF THE TIME

ELECTRA THERM BY BITZER GROUP

| ELECTRA THERM | $ | Single Currency | Expand Null Values | Collapse Null Values |
|---|---|---|---|---|
| | $ x 1 = $ | CONFIDENTIAL | | |
| | 1.00 | Payback Estimator | | |
| Series 6000 Power+ Generator | $ 410,000 | Power+ Generator | | |
| Water plumbing | $ 20,000 | Plumbing, piping, connections, valves and assembly | | |
| Electrical components and hookup | $ 15,000 | Electrical conduit, wiring, and component installation | | |
| Exhaust gas heat exchanger | $ 125,000 | Exhaust gas heat exchanger, pump, and plumbing if required | | |
| Radiator with a payback option | $ 15,000 | Additional HX / Pump / BOP | | |
| misc expense | $ 10,000 | misc. | | |
| Commissioning and startup of P+ | $ 8,000 | Technicians with travel expenses for two days | | |
| Shipping Power+ Generator | $ 25,000 | Estimated shipping of P+ to site | | |
| **Estimated Total Capital Expenditure (CapEx)** | **$ 628,000** | **Estimated Total CapEx for this Project** | | |
| **CapEx including Incentives** | **$ 628,000** | **CapEx including Incentives** | | |
| Total value of power per kWh | $ 0.28 | Average value of kWh produced | | |
| Percentage of uptime hours (100% max/8760hrs) | 95% | 95% uptime is equal to 8322 hrs. | | |
| Estimated net power output in kWe | 65.0 | P+ net output in kWe | | |
| Fan radiator offset | 25.0 | Power savings from fan radiator | | |
| **Average Total Net Power Output in kWe** | **90.0** | **Average Total Net Annual Power Output in kWe** | | |
| Annual value of power produced by P+ | $ 209,714 | 1st year annual revenue from P+ Generator [$17476 Gross per month] | | |
| AVG annual P+ O&M expense based on $0.015 per kWh | $ 8,291 | Operation and maintenance expenses based on projected lifetime | | |
| **Simple Payback in Years** | **3.12** | **Years (this does account for 0% increase $/kWh for electricity** | | |
| Projected lifetime | 20 | Years | | |
| Estimated % annual increase in $/kWh | 0.00% | Estimated percentage per year in increased power costs | | |
| **Projected Lifetime Net Revenue** | **$ 3,400,473** | **Based on 0.00% increase in power costs per year** | | |
| Total cost per kWh over lifetime | $ 0.0573 | Total cost over lifetime including O&M costs of $0.015 per kWh | | |
| IRR for projected lifetime | 32.22% | Internal Rate of Return for 20.0 years | | |
| | | | | |
| **Net Present Value of Investment over 20 Years** | **$ 3,400,473** | **Based on inflation rate of 0.00%** | | |

# ECONOMICS RUNNING 6000 HOURS OF RUNTIME ANNUALLY

ELECTRA THERM

| | $ | Single Currency |
|---|---|---|
| | $ x 1 = $ | CONFIDENTIAL |
| | 1.00 | Payback Estimator |
| Series 6000 Power+ Generator | $ 410,000 | Power+ Generator |
| Water plumbing | $ 20,000 | Plumbing, piping, connections, valves and assembly |
| Electrical components and hookup | $ 15,000 | Electrical conduit, wiring, and component installation |
| Exhaust gas heat exchanger | $ 125,000 | Exhaust gas heat exchanger, pump, and plumbing if required |
| Radiator with a payback option | $ 15,000 | Additional HX / Pump / BOP |
| misc expense | $ 10,000 | misc. |
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| Shipping Power+ Generator | $ 25,000 | Estimated shipping of P+ to site |
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| **CapEx including Incentives** | **$ 628,000** | **CapEx including Incentives** |
| Total value of power per kWh | $ 0.28 | Average value of kWh produced |
| Percentage of uptime hours (100% max/8760hrs) | 68% | 68% uptime is equal to 5957 hrs. |
| Estimated net power output in kWe | 65.0 | P+ net output in kWe |
| Fan radiator offset | 25.0 | Power savings from fan radiator |
| **Average Total Net Power Output in kWe** | **90.0** | **Average Total Net Annual Power Output in kWe** |
| Annual value of power produced by P+ | $ 150,111 | 1st year annual revenue from P+ Generator [$12509 Gross per month] |
| AVG annual P+ O&M expense based on $0.014 per kWh | $ 5,606 | Operation and maintenance expenses based on projected lifetime |
| **Simple Payback in Years** | **4.36** | **Years (this does account for 0% increase $/kWh for electricity** |
| Projected lifetime | 20 | Years |
| Estimated % annual increase in $/kWh | 0.00% | Estimated percentage per year in increased power costs |
| **Projected Lifetime Net Revenue** | **$ 2,262,106** | **Based on 0.00% increase in power costs per year** |
| Total cost per kWh over lifetime | $ 0.0730 | Total cost over lifetime including O&M costs of $0.014 per kWh |
| IRR for projected lifetime | 22.80% | Internal Rate of Return for 20.0 years |
| | | |
| **Net Present Value of Investment over 20 Years** | **$ 2,262,106** | **Based on inflation rate of 0.00%** |

Expand Null Values | Collapse Null Values

# WHAT WE WILL DO

1. Site visit and then send you a Preliminary Engineering Proposal for your engines
2. Offer to have our technicians come to site and measure mass flow
3. After measurement give an installation proposal
4. Offer you an ongoing service contract to be included with the purchase

Upon contract approval:

- Come to site and install all equipment
- Train your team on preventative maintenance upon request
- Station our technician in Oceania for ongoing service and support
- Remotely monitor the running of the ORC with service contract

# IN SUMMARY

***ElectraTherm's Heat to Power Generator Delivers the Following Benefits:***

- Generate Fuel-Free Emission-Free Renewable Energy
- For each 3.5 kW of electricity provided by the Power+Generator 1 liter of diesel fuel will be offset. For a typical installation with an output of 85kWh this would result in a saving of 17,300 liters of diesel fuel per month
- Improve Efficiency of Generating Asset
- Achieve Emission Reduction Targets

  Each liter of fuel saved provides an offset of 3.5kgs in environmental emissions. In one month this would relate to 61 tones of carbon offsets
- Distributed Renewable Power in a Scalable Modular Package - Proven Robust Design - Ease of Installation with Low Operating and Maintenance Costs - Strong Company R & D Supported by Worldwide Bitzer Group

**Thank you!**

**Rob Emrich, Director Sales and Market Development**

**ElectraTherm**
**remrich@electratherm.com**