EthosGen

Waste Heat to Electrical Power System

Shale Gas Innovation Contest

Contact:
jamesabrams@ethosgen.com
570.371.9390
www.EthosGen.com
The Problem

$8 Billion Market of Commercial, industrial and defense end-users experience escalating energy costs and most critical energy resiliency challenges including storage and demand response. They also are largest generators of waste heat.
The EthosGen Solution
Leverage the abundant resource of waste heat currently produced by commercial, industrial and defense end-users to generate on-site, renewable and scalable electric power.

Currently in most energy and industrial processes nearly 55% of energy produced is lost as waste heat. No two waste heat streams have same temperature and outputs, therefore this emerging market requires a standardized commercially produced market solution....EthosGen

- Provides a “NO” fuel solution for distributed power generation with the highest energy surety and resiliency.
- Users already produce waste heat 24/7 providing higher energy surety and quicker payback than other renewables.

“Sun isn’t always shining for solar power and wind isn’t always blowing. ...”
- Waste heat is produced on-site and waste heat can be STORED today using well-established commercial systems providing extremely high energy resiliency.

DOE Waste Heat Industry Study
EthosGen Technology
Patent Piston-Base Organic Rankine Cycle Engine

**FUNCTIONAL DESCRIPTION**

- Injector
- Internal Heater
- External Heater
- Condenser
- Pump

**KEY FEATURES**

- Product is based on the Organic Rankine Cycle Engine technology
- Proven capability to capture and convert low grade heat to electrical power in a small package
- No internal combustion required for the generation of electrical power
- Utilizes a low cost “piston” design approach
- Incorporates off the shelf heat exchanger technology
- Fuel or heat source flexible
- Extremely low noise operation due to low friction
- Significant increase in reliability in harsh environments from the closed cycle operation
- 10 year life expectancy with minimal maintenance due to low temperature operation
- Self adjusting to changing load conditions

**ENABLING TECHNOLOGY:**
Innovative Heat Engine
CraftEngine captures waste heat from a variety of sources to produce scalable and renewable electric power.

Waste Heat from Exhaust Gases from Manufacturing, Energy, industrial Sources

Waste Heat from Liquids - Hot Water, Steam and Geothermal
Market: Utilities
Natural Gas Compressor Stations $ 1 Billion

1,200 Hundred Natural Gas Compressor Stations Interstate Pipeline only with ability to deploy SIX 40kW Powerpacks per Station Average (Market size 7,000 Units = $ 1 Billion USD)

D2PA Shale Gas Innovation in partnership with:

EthosGen will deploy Waste Heat to Electric System in tandem with current Caterpillar compressor/generator set to produce electricity from waste heat.
### Electric Power Production

<table>
<thead>
<tr>
<th>Model</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 3606</td>
<td>90 kWe per hour Output</td>
</tr>
<tr>
<td>Model 3608</td>
<td>120 kWe per hour Output</td>
</tr>
<tr>
<td>Model 3612</td>
<td>180 kWe per hour Output</td>
</tr>
<tr>
<td>Model 3616</td>
<td>240 kWe per hour Output</td>
</tr>
<tr>
<td>Taurus 60 Turbine</td>
<td>720 kWe per hour Output</td>
</tr>
</tbody>
</table>

@ 8200 operating hours per year and 10 year useful life system provides at .06 cents per kW a 240kW system provides nearly $118,080 in energy production per year ($1,180,800 over useful life) in addition to environmental and tax credits.
Benefits

Operational Benefits
• Provides an on-site source of resilient power from the grid
• Decreased cooling requirements for the engine

Economic Benefits
• Reduces and possibly eliminate the existing plant’s retail electric requirements
• Increases the existing plant’s revenue through power production
• Increased engine efficiency through decreased cooling load = fuel savings

Environmental Benefits
• Emission free and fuel free production of electricity
• Firms deploying product increase power production with no increase in emissions for enhanced environmental profile and credits

Projects can be up to 700 kW depending on engine size, waste heat capture scheme and ambient conditions.

Applications:
Natural gas pipelines, crude oil processing, industrial gas compression, CO₂ flooding, power generation using internal combustion engines, co-produced fluids associated with oil and gas production.
Competitive Advantage
Piston-Based Engines are the most economical and widely deployed engine design in the world.

Strong Intellectual Property

Lower Cost. HIGH Scalbility 10-240kW System as waste heat output and temperature are not uniform. Operability opens HUGE untapped market.

BE Aerospace is global leader in heat exchangers. VDG AVL Schrick largest private engine design firm in the world.

Recent Thermoelectric Waste Heat Startups Series A Funding
Silicon Cost High, High Fouling in Exhaust, Scaling Issues


Management, Strategic Partners & Milestones

- Strategic manufacturing teaming agreement with BE Aerospace ($5B USD)
  BE Aerospace Tooling and Manufacturing Investment of over $3 million USD
- Over $1.2 million USD Funding From United States Department of Defense
- 2014 Top 25 out of 2500 Firms Globally for Sir Richard Branson’s Xtreme Tech Challenge
- Department of Energy Accelerated Clean Energy Awardee
- 2015 Ben Franklin Technology Partnership of NEPA Innovative Application of Technology Awardee
- 2015 Pacific Northwest National Laboratory ARPA-E Awardee
ANNUAL FORECAST & Go To Market Strategy

<table>
<thead>
<tr>
<th></th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td>8,200,000</td>
<td>32,000,000</td>
<td>128,000,000</td>
</tr>
<tr>
<td><strong>Expenses</strong></td>
<td>6,000,000</td>
<td>22,400,000</td>
<td>89,600,000</td>
</tr>
<tr>
<td><strong>EBITDA</strong></td>
<td>2,200,000</td>
<td>9,600,000</td>
<td>38,400,000</td>
</tr>
</tbody>
</table>

Direct Sales of Waste Heat to Power Systems and Utilization Power Purchase Agreements (PPAs) & Energy Savings Performance Contracts (ESPCs)

- PPAs and ESPCs allow market customers to fund waste heat to electrical power system with no up-front capital costs while locking in preferable cost of electricity over next 10 -20 years as well as value-added marketing benefits of on-site *sustainable energy production*.

- Leverage available Energy Production Insurance. Warranty provides a “backstop” performance guarantee to energy production of PPA. Warranty provides security on future energy production and removes contingent liabilities on balance sheet.
Current Traction with Best of Breed Global Firms in Industrial, Defense and Renewable Market Segments

Current status of deployment