Investor Brief: Critical Point Energy, LLC, (CPE) --A Hydraulic Modified Stirling Engine for Low-Temperature Power Generation and Other Work

Executive Summary:

Critical Point Energy (CPE) is developing a breakthrough hydraulic modified Stirling engine which will exploit the largely untapped opportunity of low temperature energy conversion in the temperature range of 160°F to 210°F (70°C to 99°C - hereafter referred to as "Sub-boiling"). Presently, there is a great unfulfilled need for an engine capable of economically converting Sub-boiling heat sources into electricity. The CPE engine is poised to profitably monetize extensive low-grade heat from geothermal and industrial waste heat resources and is projected to perform where other conversion engines cannot.

Heat represents the most abundant untapped energy resource on Earth, primarily consisting of industrial waste heat and geothermal energy. In the United States the industrial sector accounts for about one-third of the total energy consumed. According to the US Department of Energy, up to 50% of industrial energy input is lost as waste heat. An engine capable of Sub-boiling energy conversion is necessary.

The CPE engine is configured to use multiple slow-speed, high-pressure piston assemblies, operating quietly with a benign proprietary working fluid in a super critical state. This heat engine is expected to be uniquely effective at harnessing Sub-boiling temperatures. Additionally, the anticipated CPE slow-speed piston configuration will result in minimal wear, enjoying a predicted lifespan of over 40 years; beyond existing and proposed theoretical heat conversion engines.

CPE's approach could significantly improve industrial energy efficiency and utilize Sub-boiling geothermal resources that current engine technologies cannot access.

The following sections provide a detailed look at the technology, market potential, and investment requirements for realizing the full potential of this solution.

The Challenge: Unlocking Low–Temperature Heat

Despite being abundant, low-temperature heat has been underutilized due to limitations in current energy conversion technologies. Industrial processes across different sectors produce significant amounts of waste heat, which is often released into the atmosphere without being utilized. Additionally, shallow (under 1500 ft), low temperature geothermal aquafers remain a mostly untapped source of steady and renewable energy.

CPE recognizes that focusing on Sub-boiling heat resources and using its proposed unique design, including robust piston driven technology, it could dramatically expand the range of viable low-temperature power projects. The result should be not only more power output at Sub-boiling temperatures, but also a simpler, turbine-free design that maximizes uptime and reduces total lifecycle costs.

Technology Overview: A Breakthrough in Energy Conversion

CPE's innovation begins with the modification of a classic gas Stirling heat engine into a hydraulic version that uses a benign working fluid in a supercritical state. CPE's conversion engine will use several slow-moving piston assemblies driven by a highly expansive working fluid. Unlike conventional ORC engines, the CPE engine's working fluid **does not change phase** during the engine cycle thus conserving energy. This design can produce very high pressures. Here is how it functions:

1. Heat Source Activation: A Sub-boiling thermal source fluid enters a heat exchanger, transferring its energy to the primary working fluid. In certain applications, an intermediate closed-loop working fluid can be used which then transfers heat to the primary working fluid *i.e.* a 2-stage system.

2. Pressurization of Working Fluid: The highly expansive working fluid then drives a piston which pressurizes hydraulic fluid typically between 2,000 - 5,000 psi (13.5 – 34.5 MPa). The engine operates without exhaust, odor, vibration or noise.

3. Energy Conversion: Pressurized hydraulic fluid from multiple pistons is combined to create a steady flow, which directly drives a hydraulic motor to spin a generator and produce electricity.

4. Cooling and Reset: At the end of the power stroke, a cooling cycle reduces the working fluid temperature and resets the piston, allowing the process to repeat seamlessly, approximately one to three cycles per minute.

Key Innovations:

Elimination of Turbines, Screw Expanders and Mechanical Transmissions: It's simplicity reduces maintenance costs, increases lifespan (projected 40 plus years) and reduces total cost of operation.

Slow, Powerful Piston Strokes: The individual piston assembly design, at ~ 8 ft (2.5 m) in length, moves slowly while producing very high pressures. The expected cycle time ranges from one to three cycles per minute, resulting in low wear and tear on piston components.

Hydraulic, Mechanical Solution: The CPE engine design will use common industry standard mechanical / hydraulic / electrical systems lowering complexity and allowing easily sourced components anywhere globally. This will allow for easy commercial standardization.

Special Working Fluid: a key to the engine's efficiency is a proven benign special working fluid which is maintained in a high-pressure, supercritical state to enhance its thermal expansion rate in the Sub-boiling temperature range without changing its phase.

Rapid On/Off Capability: The CPE engine can be designed to cease operation immediately and restart within a few minutes. This would make it ideal for stabilizing power grids using intermittent renewables.

Efficient Cooling: CPE's engine should operate efficiently with much less water consumed than is required for conventional ORC and other alternative engine types.

Modular Design: As designed, individual heat exchanger and piston assemblies could be isolated enabling easy component maintenance or even replacement during continuous operation of the remaining engine cylinders; a unique feature.

Anticipated Unique Value Proposition:

Low Operating Temperature: CPE's engines are projected to operate effectively and economically at Sub-boiling temperatures starting at 160°F (70°C) up to 210°F (99°C), beyond the reach of current ORC technologies.

Longer Equipment Lifespan: Slow piston cycles will mean long maintenance internals and lower mechanical wear, extending the engine's expected operational life to 40 years or more.

Low Op-Ex: Robust engine components, modular design, and long maintenance intervals equate to low labor requirements to operate the power plant.

Low-Cost Geothermal Drilling: Sub-boiling shallow geothermal wells under 1500 feet (450m) deep, can be accomplished with truck mounted drilling equipment used primarily for agricultural irrigation wells. Drilling equipment capable of reaching beyond 5,000 feet (1500m) in depth for high temperature power plants, is immensely more expensive. This possibility makes geothermal power production economically viable.

Market Applications:

Geothermal Power Production: Unlocks the power potential of Sub-boiling geothermal resources in shallow wells that were previously uneconomical for conventional geothermal projects. Power can be sold into the grid or used directly.

Data Centers: Often privately owned, data centers could be powered on site, and off grid, with the planned CPE conversion engine using low grade geothermal resources. In many locations with geothermal resources, fiber optic connectivity is more readily available than power grid connectivity, making them ideal sites for low-cost data center development.

Abandoned Oil Wells: In regions where oil extraction activities have ceased, residual geothermal well heat can be utilized for power generation. This approach leverages existing infrastructure, thereby avoiding or postponing the costly requirements of well abandonment.

Maritime Industry: Ships run on fossil fuel engines which produce corresponding amounts of waste heat. The CPE engines could convert this heat to electricity for onboard uses to reduce shipping costs and carbon footprints. There are mandated annual carbon footprint reductions in much of the maritime industry which the CPE engines can help meet.

Heavy Industries: Steel and aluminum production, chemical production, and oil refining all generate significant waste heat; most of which is too low to be economically useful and is vented into the atmosphere. By recovering a portion of this waste heat, plant efficiencies can be increased and carbon footprints reduced.

Food Processing: Offering a clean, effective solution for turning low-grade process heat into electricity or mechanical power for pumping, and other work.

Off-Grid and Decentralized Power: Localized power distribution, referred to as microgrids, and grids in remote locations could be powered quietly, with a small footprint, using focused solar energy or nearby low heat geothermal resources.

Reverse Osmosis: The CPE engine's projected capacity to create a high volume of high-pressure fluid makes it valuable for powering large-scale water purification systems in regions with scarce freshwater resources. The engine is well suited for reverse osmosis applications.

Combined Cycle Applications: High heat organic Rankin cycle or Binary power plants and natural gas power plants have wasted heat that could be captured by the CPE engine and produce more power.

Preferred Revenue Strategy:

Instead of selling engines outright, CPE will retain ownership of deployed units and offer a Power-as-a-Service model to maximize revenue over the anticipated lengthy duration of the engine lifespan. The CPE team possesses extensive experience in project development, which will facilitate expedited deployments and engine credibility. Benefits of this model include:

1. Technology Protection: Avoids replication risks and protects intellectual property.

2. <u>Overcomes Risk Aversion:</u> Clients avoid the uncertainty of purchasing unfamiliar technology. They can reap the benefits of the engine without bearing the risks linked to ownership and maintenance.

3. <u>Flexible Pricing</u>: Rates may be adjusted according to use cases and regional energy prices, either upward or downward.

4.<u>Continual Preventive Maintenance:</u> Modularity will allow for proper maintenance and component replacement for ensured longevity.

5. <u>Continual Upgrades</u>: Swappable engines and major components allow for efficiency improvements over time.

6. <u>Long-Term Profitability:</u> Estimated long engine lifespan will ensure sustained financial returns.

Global demand for efficient, low-temperature power generation continues to grow. Past and present discussions in the European Union, Japan, Taiwan, Greece and elsewhere provide strong evidence of a large addressable market. These discussions highlight a long-standing unmet need for dependable, low-temperature heat engines.

Investment Opportunity: Scaling a Breakthrough Technology

$4,018,000.00

This is the initial capital requirement to bring a 250 kW CPE engine to a full scale, market ready and field deployable state. The following breakdown shows the steps, time frames, and capital expenditure required.

ITEM	DESCRIPTION	DURATION (MONTHS)	CAPITAL (USD)
1	Machine shop overhead	24	$270,000
2	Machine shop Mechanical Engineer	24	$170,000
3	Machine shop skilled mechanic	24	$130,000
4	LLC management fees at four Managers	24	$576,000
5	Fees, Commissions, Marketing	24	$364,000
DEVELOPMENT TASKS:			
A	Single-piston assembly: full scale testing, cycling, sensor integration, automation, test efficiency scenarios	2-4	$125,000
B	Four-piston (30 kW) engine:	4-6	$151,000

	design, build, test, refine, deploy and test efficiency		
C	Optimize heat exchanger design: collaborate with 3rd party engineering; concurrent with 'B' (four piston fabrication)	5-6	$120,000
D	250 kW engine: design, build, test, refine, deploy, make ready for manufacturing	6-9	$2,112,000

Conclusion

Summary of Key Anticipated Benefits:

1. Profitable efficiency at Sub-boiling temperatures, with no viable competition in this temperature range.

2. Robust, slow-piston design, with long service life.

3. Scalable and modular, suitable for a wide range of applications.

4. Large and diverse market including geothermal power plants, data centers, waste heat recovery in numerous industries.

Why Now Is the Time to Invest:

Global energy demand continues to rise, accompanied by heightened attention to sustainability, efficiency and resiliency in power generation. Governments and private industries alike are seeking cleaner, more cost-effective ways to harness waste heat and tap abundant underused low-grade geothermal resources. CPE's innovative conversion technology will be uniquely positioned to capitalize on these trends and to significantly expand the market for low-temperature power generation.

Next Steps for Potential Investors:

Technical Validation: CPE welcomes visits to our premises in Long Beach, CA for on-site demonstrations of the technology.

Investment Discussions: We are available to discuss investment terms, equity and revenue sharing scenarios.

By joining forces with Critical Point Energy, LLC a California limited liability company, investors have the opportunity to support a truly innovative energy technology that stands to redefine the low-temperature power generation and mechanical work landscape.

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