

STM POWER THE **CLEAN** ENERGY CHOICE



THE FUTURE OF ENERGY

STM Power, the world's leading developer of external combustion engine technology, harnesses energy from virtually any heat source, and turns it into valuable electrical power and hot water for commercial and industrial applications.

Established on the principles of the Stirling cycle, STM Power has developed an innovative engine that is revolutionizing the way energy is produced, distributed and consumed.

Leading the Way

STM Power has been leading the process of commercializing external combustion engines for more than a decade, and has made technological breakthroughs allowing it to design and produce

Stirling cycle engines that are versatile, reliable, efficient, and competitively priced.

Increasing demand for clean, affordable distributed generation technologies, combined with the advantages offered by engines based on the Stirling cycle have generated renewed commercial interest in Stirling engines.

STM Power's solution, the PowerUnit, provides our customers with the most cost-effective, low emission and low maintenance distributed generation technology on the market today. Our integrated engine/generator unit provides 55 kilowatts (kWe) of continuous electric power, yet with a fraction of the emissions and maintenance requirements of comparable internal combustion engines.

STM PRODUCTS

Fuel Fired Units Electricity On-Site

The STM combustor mounted to the engine is capable of burning a wide variety of conventional fuels including diesel, kerosene, alcohol, natural gas, hydrogen and propane, resource recovery fuels such as flare gas and coal-bed methane, or renewable biogas fuels from landfills or digesters (sewage or agricultural waste).

Because the products of combustion never come into contact with any precision moving parts or lubricants due to the use of an external combustion configuration, the STM PowerUnits are able to burn low BTU, dirty gases that are otherwise flared or vented off, while reducing the maintenance required on the engine and extending its life.

And the continuous external combustion process allows precise control of emissions, making the STM PowerUnit not only extremely fuel-flexible, but environmentally friendly as well.

Heat Powered Units Waste Not. Generate More.

The STM Powerunit is capable of converting otherwise wasted heat, such as the exhaust from an incinerator, kiln, furnace, thermal oxidizer, or other process producing a heat stream above 1400° F (760° C) directly into electricity without producing any incremental emissions.

The heat source could also be an external combustor separate from the PowerUnit, which is designed to burn a number of materials specifically for the purpose of supplying heat to an STM engine. This option is most advantageous when the fuel is a renewable resource or material which would otherwise be wasted or require disposal at some cost. Examples include solid waste, biomass or various liquids. The external heat could also be exhaust from other energy generation devices such as reciprocating engines, gas turbines or fuel cells.

Finally, the external heat source could be concentrated solar power from an array of mirrors focused on the STM engine. The solar PowerUnit can even be combined with an STM combustor, so that the unit can produce power even when the sun is not available.

THE ADVANTAGES

STM Power has refined external combustion technology to become a world leader in industrial and commercial distributed generation applications of Stirling cycle engines. Here are some of the reasons why:

- Scalable solutions** Systems are scalable using competitively priced, environmentally friendly 55 kW modules, which can be equipped with low cost integral heat exchangers for combined heat and power (CHP) applications.
- Fuel versatility** Fuel-fired PowerUnits can accept a broad range of liquid and gaseous fuels, including renewables and biogas. Heat-fired PowerUnits can convert any good quality heat source, including solar heat, directly into electricity.
- Ultra-low emissions** STM PowerUnits are designed to meet the most stringent mandated emissions requirements, including 2003 CARB limits, without after-treatment.
- High fuel efficiency** The STM PowerUnit provides levels of efficiency equal or superior to other energy conversion technologies. It has a 30% electrical efficiency and 80% total system efficiency in CHP applications delivering 310,000 BTU/hr in the form of hot water.
- No fuel compression** The STM PowerUnits are designed for fuel pressures as low as 0.25 psig, so they do not require costly fuel compressors and their associated parasitic losses and maintenance.
- Quiet and low vibration** The STM engine is extremely smooth and quiet and produces negligible vibration, making it possible to install the PowerUnit without vibration isolation devices or external sound attenuation, thereby lowering installation costs.
- Low maintenance** The STM engine has less than half the number of moving parts as a reciprocating internal combustion engine, and these parts never come into contact with any products of combustion. The result is a reliable product that requires very little fuel treatment and generally requires maintenance only once a year in full-time operation. All of this means low maintenance costs.
- Predictable, low power costs** STM Power can help manage your energy costs. Fuel flexibility, high energy efficiency, easy installation with minimal fuel compression or fuel treatment expense, and low maintenance all translate into low and stable energy costs for you.



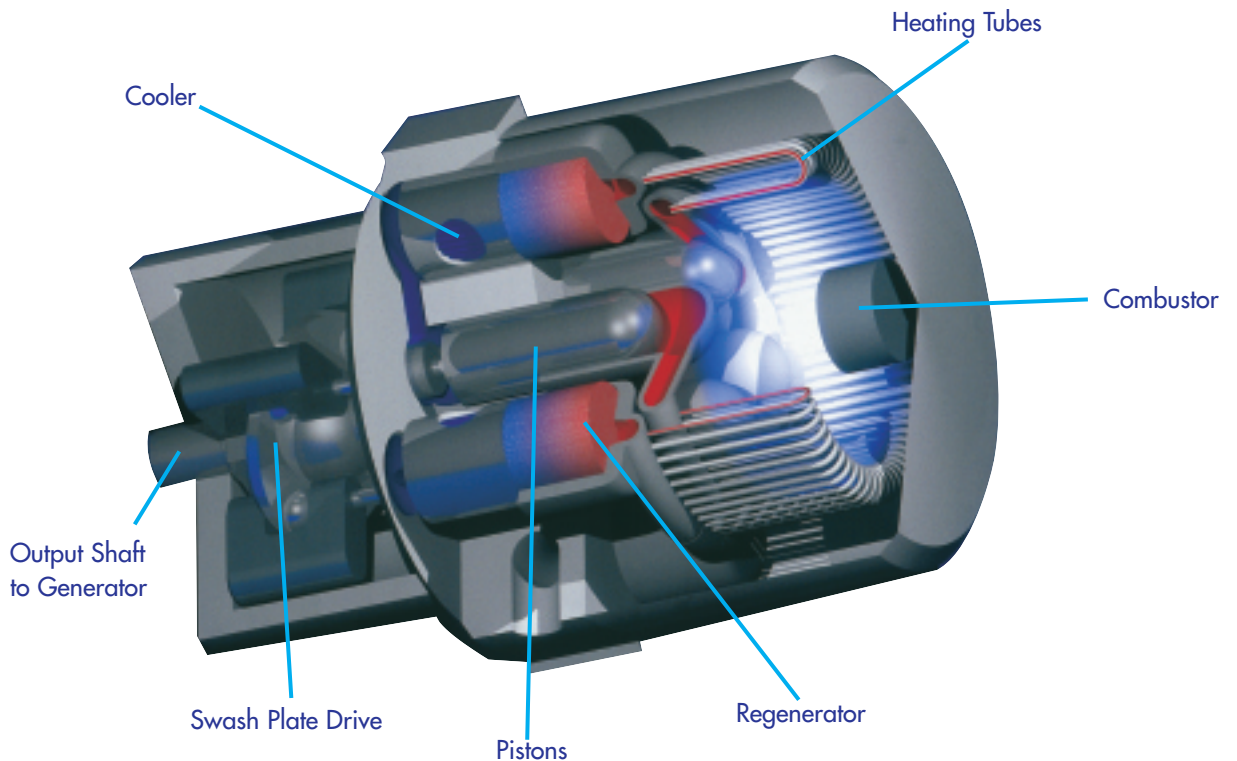
THE TECHNOLOGY

Stirling Cycle Technology – How It Works

STM's Stirling engine is a heat engine in which a gaseous working medium, in this case hydrogen, is sealed within the machine. A portion of the engine is maintained at a constant high temperature by burning fuel in the combustor or from an external heat stream and another portion at a constant low temperature. The working gas is transferred back and forth between the hot and cold portions of the machine by the movement of the engine's pistons. Expansion at the hot end pushes on the top of each of four pistons to produce power and also compresses the cold gas below each

piston. The reciprocating motion of the pistons is converted to rotary motion via a swash plate drive, which powers the generator. A regenerator is used between the hot and cold portions of the engine to increase efficiency.

The STM engine is capable of utilizing any heat source, provided that it contains sufficient energy at a high enough temperature and at a sufficient flow rate. This heat can be provided either from a heat source external to the STM engine or be produced by the combustion of a wide variety of fuels within STM's combustor, which is mounted directly to the engine.



STM 4-Piston Stirling Engine

STM POWER'S VERSATILE ENERGY SOLUTIONS



CHP

- All STM PowerUnits can be operated in the CHP (combined heat and power) mode, in which waste heat produced as a byproduct of the electrical generation process is recovered and utilized.
- STM PowerUnits can achieve up to 80% total system efficiencies with low-cost heat exchangers integral to the unit.
- Recovered heat in the form of hot water can be used for space heating or in commercial or industrial processes.



Biogas

- Uses low BTU gas (down to 250 BTU per SCF) from landfill sites, wastewater treatment plants, and agricultural digesters.
- No fuel compression required. Requires only 0.25 to 2.0 psig gas pressure.
- Minimal fuel treatment required; external combustion process is insensitive to siloxanes and to fluctuations in the heating value of the fuel.



Waste Heat and Biomass

- Operates directly on industrial waste heat, generating electricity using no incremental fuel and producing no incremental emissions.
- Improves energy economics and protects against process disruption in the event of a power loss when operated in grid-independent mode.
- Converts heat from an external biomass combustor directly to electricity without the need to produce syngas or steam.
- Can burn most syngas in a fuel-fired PowerUnit or use the heat from an external burner.



Solar

- Operates on concentrated solar energy.
- Hybrid solar units can also burn conventional or biogas fuels at night to maximize asset utilization.
- Smaller, more efficient and lower cost than photovoltaics.

STM PowerUnit Specifications*

Renewing the Environment

- **Electric output**
55 kWe continuous duty
277/480 VAC, 3-Phase, 60 Hz
220/380 VAC, 3-Phase, 50 Hz
Grid parallel or grid independent modes
- **Heat output at 55 kWe**
91 kWth, 310,000 BTU/hr
e.g. 10 GPM @ 72°F temp rise
- **Fuel requirements**
0.25-2.0 psig inlet gas pressure
11,375 BTU/kWh
- **Efficiency**
30% net electric efficiency
80% CHP efficiency
- **Noise level**
58 dBA at 7 meters
- **Dimensions**
Length 102" (259 cm), Width 34" (86 cm)
Without Radiator: Height 43" (110 cm)
Weight 3200 lbs (1455 kg)
With Radiator: Height 68" (173 cm)
Weight 3500 lbs (1591 kg)
- **Codes and Standards**
Compliant with UL 2200, CE, CSA,
UL 1741, IEEE 1547, CARB
- **Warranty**
One year, parts and labor, no limitation
on operating hours or starts.
Extended service agreements available.

Company Profile

STM Power, Inc. is a privately held Ann Arbor, Michigan based company that designs, develops, assembles, and sells ultra-low emissions, external combustion (Stirling cycle) engine products. With 34 active patents and 57 worldwide patents and patent pending applications, we are the world leader in using Stirling-cycle engines as industrial prime movers, in renewable and distributed power generation ("DG") applications worldwide.

STM is in the process of growing its distribution network with quality companies and partners capable of creating total power generation solutions for our customers.

STM Power, Inc.

Corporate Office/Sales and Service
275 Metty Drive
Ann Arbor, MI 48103
Tel: 734-995-1755 • Fax: 734-995-0610

Finance and Business Development
1655 North Fort Myer Drive • Suite 825
Arlington, VA 22209
Tel: 703-248-0454 • Fax: 703-248-8124

www.stmpower.com

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* Note, all specifications are in CHP configuration.
Specifications subject to change without notification.