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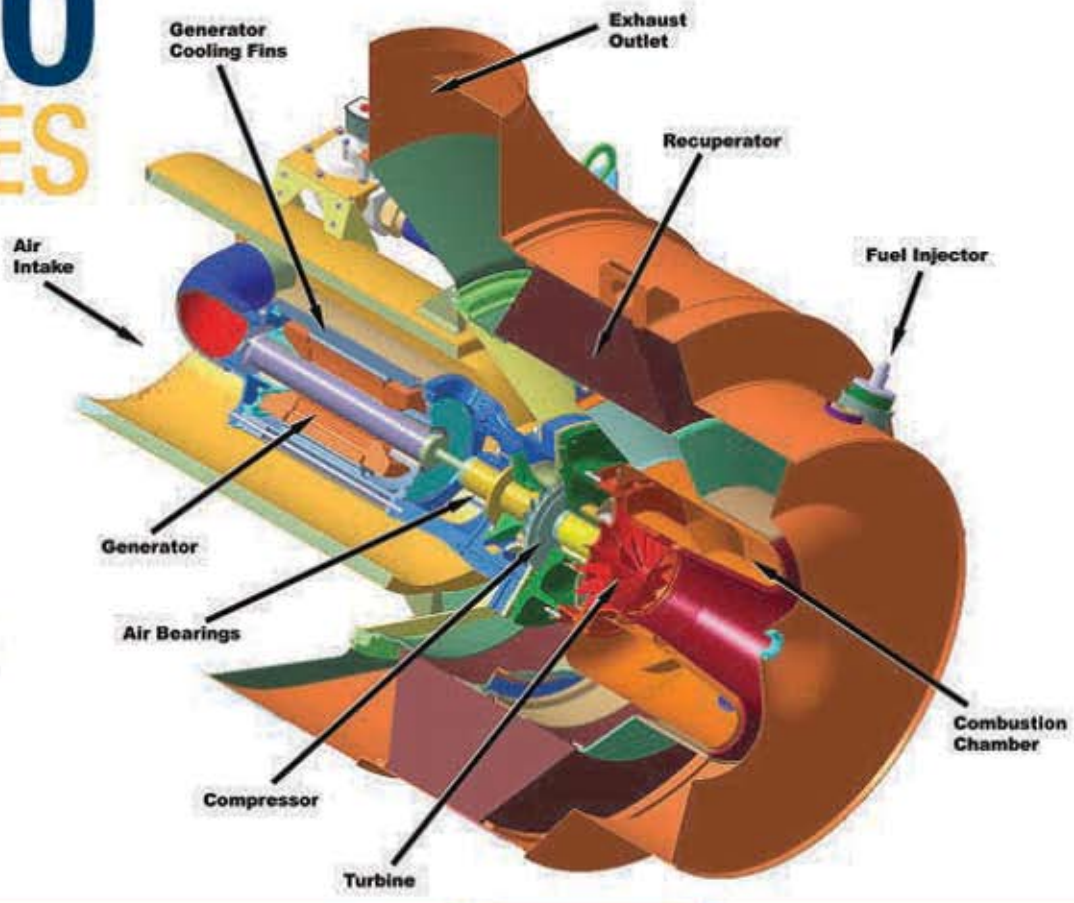
MICRO TURBINES



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One-on-one with Darren Jamison, president and CEO of Capstone Turbine Corp

More than ever, global companies of all sizes are increasingly focused on reducing costs through energy efficiency, while the widespread implementation of increasingly stringent emissions standards is being driven by customer, government and societal mandates.

Darren Jamison, president and CEO of Capstone, said, "microturbines are the answer for organizations concerned about high energy costs, power quality and reliability, and reduced carbon footprint."

Scalable from 30 kW to 10 MW+, Capstone microturbines are used in distributed power generation applications including oil and gas, energy efficiency, renewable energy, critical power supply and mobile products.

Designed with just one moving part supported by maintenance-free air bearings, no gearbox and the ability to maintain operations without liquid lubricants or coolants, the Capstone microturbine integrates an aero-based turbine engine, a magnetic generator and power electronics into a case roughly the size of a refrigerator. These units all operate continuously or on demand, individually or in a multi-pack array, and in stand-alone or grid connect mode, the company said. The microturbines produce both alternating current (AC) and direct current (DC), with an AC output of 480 V.

Because the turbines use no oil, lubricants, coolants or other hazardous materials — even water — this eliminates transportation, storage and costly hazmat spill/leakage issues associated with engine gen-sets, said Jamison.

Capstone currently manufactures 30 kW (C30), 65 kW (C65) and 200 kW (C200) turbines. The product range also includes the C65 and C65 ICHP microturbines, both producing up to 65 kW of power with the UL-certified C65 ICHP adding 150 kW of thermal energy for CHP applications. The C65 CARB natural-gas microturbine emits

Darren Jamison

less than 4 ppm volume NO_x emissions at 15% CO_2 — among the industry's lowest, the company said.

Capstone also produces hazardous locations microturbines for oil platform power solutions, fueled entirely by wellhead gas. The C30 and C65 microturbines for hazardous locations are UL-Certified for Class 1, Division 2. The hazardous location C200 is Atex Certified for Class 1, Zone 2.

The C200 turbine can be bundled — all within a single ISO-type container — to produce 600, 800 and 1000 kW solutions. Five C200s make up the 1 MW power package known as the C1000. These larger modules can be piggybacked to provide even more power, although the company sets 10 MW as the practical limit.

"The customer doesn't care if it's one turbine or five inside as long as it's reliable, easy to maintain and has low life-cycle costs," Jamison said

"Lower costs, reliability and efficiency are the major factors driving a growing number of customers to switch from reciprocating engines to microturbines," Jamison said. "Most engines experience a big drop in efficiency as load goes down. With the C1000, power can be graded down without loss. One MW reciprocating engines want to run at near capacity. Emissions worsen and there is wasted energy as you ramp them down."

Jamison stressed the redundancy and reliability of the C1000 microturbine package. "If one C200 inside requires service, the module can continue with 800 kW while the service is completed," Jamison said. "If you lose one spark plug on a reciprocating engine, you've lost your entire 1 MW."

Oil and gas companies — particularly American firms cashing in on the glut of domestic oil and gas reserves — have begun exploring the benefits of microturbines. According to a U.S. energy sector report from the Energy Industries Council Consult, the market research and consultancy arm of the EIC, U.S. shale gas production is projected to reach almost 900 MNm^3/d by 2020.

Capstone, which estimates it has more than an 80% share of the domestic microturbine market, said its solutions are often installed at remote oil and gas exploration, production, compression and transmission sites both onshore and offshore. Typically, these oil and gas or mining operations have no electric utility grid and rely solely on the microturbines as a reliable source of critical, low-emissions power generation.

For example, Capstone recently secured another 7 MW order from an existing customer. The latest order is for eight C600, one C800 and 17 C65 units for installation at several remote central gathering sites in the midwest. This follow-on order was from the same major oil and gas producer that purchased two C600 and 10 C65 power packages in June 2012.

The microturbines, fueled by pipeline quality gas, will produce electricity to

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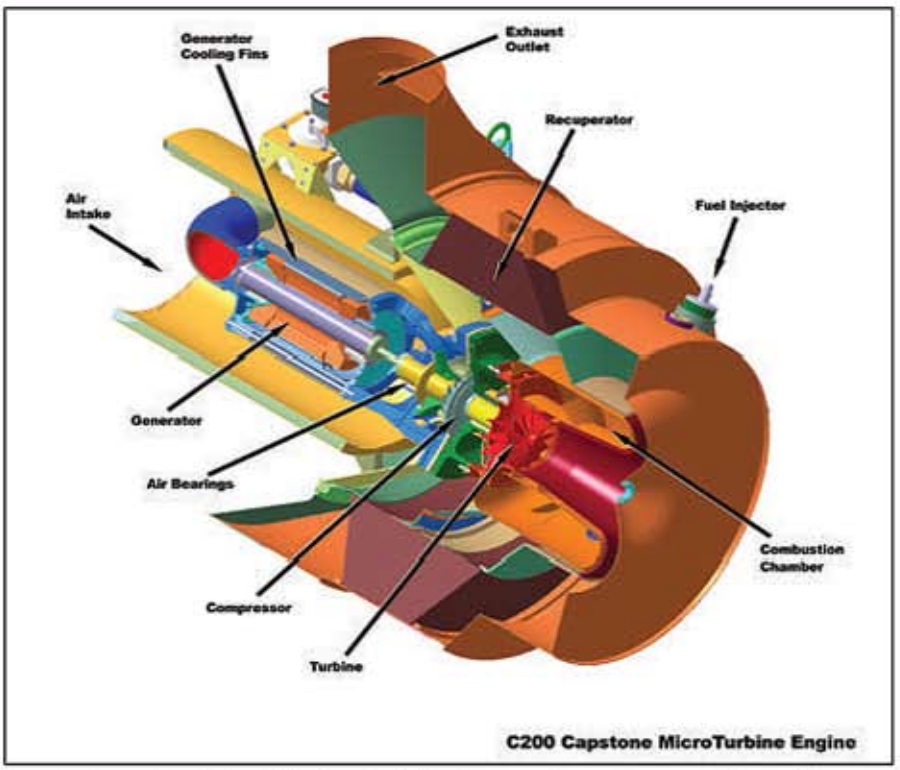

The Capstone microturbine is designed with just one moving part supported by maintenance-free air bearings, no gearbox and the ability to maintain operations without liquid lubricants or coolants.

provide all power to the on-site equipment including heaters, pump motors, compressors and distribution panels.

The oil and gas market isn't a new one for the company, but Jamison said that it now accounts for over 60% of the company's product revenue. "For a clean and green company, our biggest market is oil and gas, which is a little ironic," Jamison said. "Shale has been a huge boon for us. We had almost zero penetration in that market 20 months ago."

Jamison said that orders with Pioneer Natural Resources helped them break into the shale plays. "Once we began working with them, it became a landslide," he said. "Pioneer got us Chesapeake, Anadarko, Talisman, Marathon, Shell, and we can just keep going down the line."

Jamison said customer education has been the primary challenge for the Chatsworth, California, U.S.A.-based company.

"Once customers try our technology they like it, but getting to them and getting them to try it is another thing," Jamison said. "In this economy, people don't like to take risks. Oil and gas operators tend to be very loyal — they've been buying the same engines for 50 years and they tend to continue to do that. It's vital for us to educate them about the technology, explain what a microturbine is and what the benefits are. The operators need to understand it's a different animal; it's more of an electrical product than a mechanical one."

Jamison described Capstone's microturbines as "somewhat fuel agnostic" since they are capable of running on low-pressure, high-pressure and compressed natural gas; liquid fuels including diesel, gaseous propane and kerosene; and renewable methane gases from landfills, wastewater treatment facilities and other biogas applications such as food processing, agricultural waste (green waste) and cow, pig and chicken manure.

The microturbines can operate on casinghead gas (19.8 to 73.6 Btu/m^3) with up to 7% sour content, providing electric power for the on-site needs of a remote oil or gas development site. They can be used for compressor stations and manned/unmanned offshore platforms, also running on unprocessed wellhead gas to generate continuous power.

Jamison said that Capstone's oil and gas customers can reconfigure the microturbines for different fuels depending on whatever is economical and locally available. "During the process of completing and hooking up natural gas wells, they can run their microturbines on diesel while they are building the pipeline, and once that pipeline is operational, they can begin taking gas off the pipeline and running the machines with that," Jamison said.

The Capstone microturbine can transform low-grade, unprocessed waste biogas with methane content as low as 35% (9.9 Btu/m^3) into usable electricity. The company said this is proving a practical and cost-effective technology that can eliminate flaring at landfills, wastewater treatment plants and agricultural or livestock facilities.

Capstone said that its microturbine's use of flare gas has increased sales abroad, where foreign governments are starting to push oil and gas producers to use flare gas as a fuel instead of burning it into the atmosphere. Moscow-based Lukoil OAO purchased 17 Capstone turbines for its Siberian fields (either to run a substation or send it into the grid).

The microturbine design achieves near complete combustion of flare and vent gases, virtually eliminating hydrocarbon emissions, the company said. When used in combined heat and power (CHP) applications, efficiencies of 70 to 90% reduce greenhouse gas emissions, produce oxygen-rich exhaust with less than 5 ppm NO_x — compared to approximately 50 ppm NO_x for a typical reciprocating engine — and emit low levels of carbon monoxide (CO), volatile organic compounds and particulate matter. The company said its emissions are less than 10% that of internal combustion engines.

The company also sees potential growth in its four other areas of focus: mobile products, critical power supply, renewables and energy efficiency.

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Five C200s (200 kW) make up the 1 MW power package known as the C1000. These larger modules can be piggybacked to provide even more power, all connected through a centralized control and monitoring system.

Capstone believes that bringing in a microturbine solution can reduce reliance on grid power and find other uses for it when it's not needed for backup power.

Jamison cited Syracuse University's 1115 m^2 Green Data Center, designed to use 50% less energy and produce fewer greenhouse gasses than traditional data centers, as a prime example. Capstone said it integrated the design of the combined cooling, heating and power (CCHP) system so that 12 Hybrid UPS microturbines produce electricity and supply heat and cooling power to the facility and a nearby building.

"They have 12 machines — six run continuously while six are in standby," Jamison said. "They would have to lose the first six, and then the second six, and then have the utility not be there to go dark. With a normal system, you have a room full of batteries — which may or may not be charged – and a backup generator, all of which you hope to never use. So, it's a sunk cost."

A study conducted for the U.S. Department of Energy calculated the total potential energy efficiency CHP market in the United States to be more than 35.5 GW through 2020 — a tremendous domestic market opportunity the company acknowledged.

Within energy efficiency — CHP, industrial and commercial applications — Jamison said, "We're changing the perspective of businesses out there, helping them understand they don't have to buy power the way their father and grandfather did. They have a choice. They can put in a distributed generation asset, lower their cost of energy, produce thermal load for steam, hot water, chilled water or air conditioning, and benefit from the green part of it. They can work directly with the gas companies, which tend to be more flexible and easier to do business with, as opposed to the utility companies."

In CHP applications, captured exhaust heat can be used in three ways: porting exhaust straight from the microturbine and into the heating load; using an air-to-liquid heat exchanger to create hot water or steam for circulating through the heating load; and using an absorption chiller or other thermally activated cooling technology, creating chilled water for circulating through the cooling load.

Jamison said that another advantage of its microturbines is a substantially lower total cost of ownership relative to internal combustion engines, with 25% lower maintenance costs on average. The Capstone systems require 6 hr/yr of planned maintenance, with scheduled and unscheduled maintenance costs of US$0.015 per kWh. Measured against an average of 120 hr/yr of planned maintenance, with scheduled and unscheduled maintenance costs of US$0.018 to US$0.022 per kWh for standard internal combustion engines, the company said its systems are a more cost-effective clean power choice.

"A reciprocating engine is a concert of moving parts," Jamison said. "While the availability of those parts is fairly good, as they wear down the scheduled and unscheduled maintenance costs and subsequent downtime can be extremely costly, especially if there isn't an operator on-site. With us, you have one moving part running on air bearings, with no oil and no cooling system, so it's very reliable.

"With remote monitoring, when a unit goes down, we can know if it's a fuel fault, clogged air cleaner, software issue or something else. We can remotely dial in for more diagnostics."

Capstone said its turbines are designed to run for extended periods with minimal maintenance. An air filter change is recommended after the first 8000 hours of operation, with routine maintenance typically following every 8000 hours. Factory engine servicing is recommended after 40 000 hours of intermittent or continuous use. Typical uptime for a Capstone system is 99% versus 84% for a standard internal combustion engine, and the average time between Capstone failures exceeds 15 000 hours of operation, the company said.

"If you're getting 80 to 85% runtime, what's that 15% downtime worth to you?" Jamison asked. "Forget the maintenance costs. Sometimes it's just the lost opportunities of not having power."