

Turbine Talk

Capstone Turbine Corporation's Quarterly Newsletter

Spring/Summer 2009

At a glance

Jonah Field, Wyoming, USA

First Microturbine Commissioned

August 2007

Fuel

Dry and wet natural gas

Technologies

Four Capstone C30 MicroTurbines™ drive well-site production equipment. The microturbines use "wet" flash gas to generate 20kW of power each. Electricity produced by the microturbines power triethylene glycol (TEG) dehydration and glycol heat tracing pumps, eliminating the need for the environmentally unfriendly gas-driven and pneumatic-type pumps.

Results

- The initial microturbine has run since August 2007 with no operational problems.
- Significant reduction of greenhouse-gas emissions.
- Savings of nearly 12 million standard cubic feet of natural gas each year that once had been used to fuel pumps.
- The Jonah Field microturbine project was a commended entry in the competitive BP Helios Awards in 2008.

Looking Forward

- BP is considering installing Capstone microturbines at five more Jonah Field sites.
- In addition, BP hopes to power automation, chemical injection and cathodic protection systems with microturbine-produced electricity and is investigating the use of a VRU (Vapor Recovery Unit) to capture flash gas from the onsite.

Case Study: Jonah Field

Fueling Themselves First, BP Taps into Its Own Resources

In the Jonah Field of Wyoming, BP America no longer siphons its own product to get more out of the ground.

One of the largest on-shore natural gas discoveries in the U.S., the expansive Jonah Field is estimated to contain 297 billion cubic meters of natural gas. But to tap into that vast resource, BP had to waste environmentally unfriendly gas to fuel pneumatic pumps that support well-site equipment.

"We recognized an opportunity to eliminate gas-driven pumps, increase revenue by keeping gas in the system and reduce the impact on the environment," said Will Burton of British Petroleum.

In 2007, a forward-thinking Burton agreed to install a microturbine that runs on natural gas produced at the well site. In addition to being fueled by raw natural gas, the clean-and-green microturbine emits extremely low greenhouse-gas emissions and requires little maintenance.



The remote Jonah Field wellsite uses a Capstone C30 microturbine to generate electricity to run the site's pumps.

In August 2007, Capstone Turbine Corporation installed a C30 microturbine to drive well-site production equipment. The microturbine uses a small amount of clean natural gas (also referred to as "dry gas") to generate 20kW of power.

Electricity produced by the microturbine powers TEG dehydration and glycol heat tracing pumps, eliminating the need for the environmentally unfriendly gas-driven and pneumatic-type pumps typically found throughout the Jonah Field.



The original C30 unit is housed in a small building to protect it from low winter temperatures on the harsh Wyoming plains. The building is outfitted with forced ventilation, catalytic heating, gas detection and a small fuel-gas delivery system. After temperatures sank to -35 degrees Fahrenheit in 2007, BP insulated the building to protect the system.

"The system has two fuel types coming in and we had to be able to switch between fuels on the fly," Pumps and Service's Hensley said. "Burton told us what he'd like the system to do, together we figured out how to do it and it worked."

BP, which has a strong focus on the environment, has experimented with other forms of alternative energy, but has decided to stick with microturbines.

"We're looking at replacing solar panels with microturbines on some of our large sites due to reliability," Burton said. "There are days when it's cloudy or snowy and you can't count on solar power. Regardless of the weather, the microturbines always run."

Four months after the first microturbine installation, BP's Jonah team tested the use of "wet" flash gas to drive the microturbine. The test was a success.

"Wet gas is usually wasted – put in a combustor and burned away," Burton said. "We weren't getting any benefit from it. Now we have a free fuel source."

"The turbines had never been used in this application before, but Will (Burton) was looking for an innovative way to utilize the power on site," said Bryan Hensley of Pumps and Service, the Capstone distributor that co-designed the Jonah Field application. "He was willing to bet on this opportunity and BP has a success story because of it."

Today, Capstone microturbines operate at four separate BP well sites. Each turbine generates 20kW of electricity that runs pumps typically driven with gas. The initial microturbine has run for 18 months with no operational problems.

The result for BP is significantly reduced greenhouse-gas emissions and savings of nearly 12 million standard cubic feet of natural gas each year that once had been used to fuel pumps.

The Jonah microturbine project was a commended entry in the competitive BP Helios Awards in 2008. Only 160 of the nearly 1,400 submissions from around the world receive commendation.

"What this commendation says to me is that BP is very pleased with the performance of the microturbines," Burton said.

Looking ahead, BP hopes to power automation, chemical injection and cathodic protection systems with microturbine-produced electricity and is investigating the use of a VRU (Vapor Recovery Unit) to capture flash gas from the onsite condensate storage tanks. Plans are in place to implement those changes in 2009.

BP officials are so pleased with the performance of the Capstone microturbines they want to expand use of the turbines in the field.

"Given their reliability, financial savings and reduced emissions, we're looking at five additional sites this year," Burton said. "The more we build our knowledge base about microturbines, the more we want to increase their use." ■

Capstone's Service Capability

Capstone Factory Protection Plan: A Factory Protection Plan from Capstone Turbine Corporation minimizes downtime and fixes maintenance costs, ensuring your system will operate when needed and perform as intended at the lowest total cost of ownership.

Authorized Service Providers: Factory trained professionals provide full service capability when needed.

Capstone Service Network (CSN): Monitors and records key data on the operation and performance of your microturbine(s) on a 24 x7 basis.

Capstone Power Electronics Package

Developed In-House to Produce High Efficiency and Low Costs

By Mark Gilbreth, Executive Vice President Operations and Chief Technology Officer

Capstone microturbines are the microturbine-of-choice because of their low-maintenance air-bearing technology; ultra-clean, CARB-compliant combustion; and compact high-speed rotating machinery. A highly efficient, state-of-the-art power electronics package – designed and manufactured by Capstone – is the key to converting the generator's high frequency AC into usable power for consumers.

Just as the microturbine's air bearings require no lubricants or coolant, the same is true for the system's power electronics components. Because Capstone power electronics are highly efficient, they greatly reduce the amount of heat dissipation required. Any residual heat is air cooled with fans.

Based on IGBT Technology

Capstone's power electronics conversion is based on Integrated Gate Bipolar Transistor (IGBT) technology, which is similar to millions of industrial motor drives sold worldwide. Each IGBT connects to the positive and negative terminals of a central DC bus. Switches from each terminal then connect to a single AC output. The IGBT increases the AC output voltage by turning on the switch connected to the positive DC terminal and reduces the AC output by turning on the switch connected to the negative DC terminal. The ability of IGBTs to perform high-speed switching means fast connections to the high-speed turbine generator and clean sinusoidal AC power for the customer.

So why doesn't Capstone use off-the-shelf motor drives for its power electronics package? Capstone continues to search for lower cost, third party suppliers. The challenge is finding

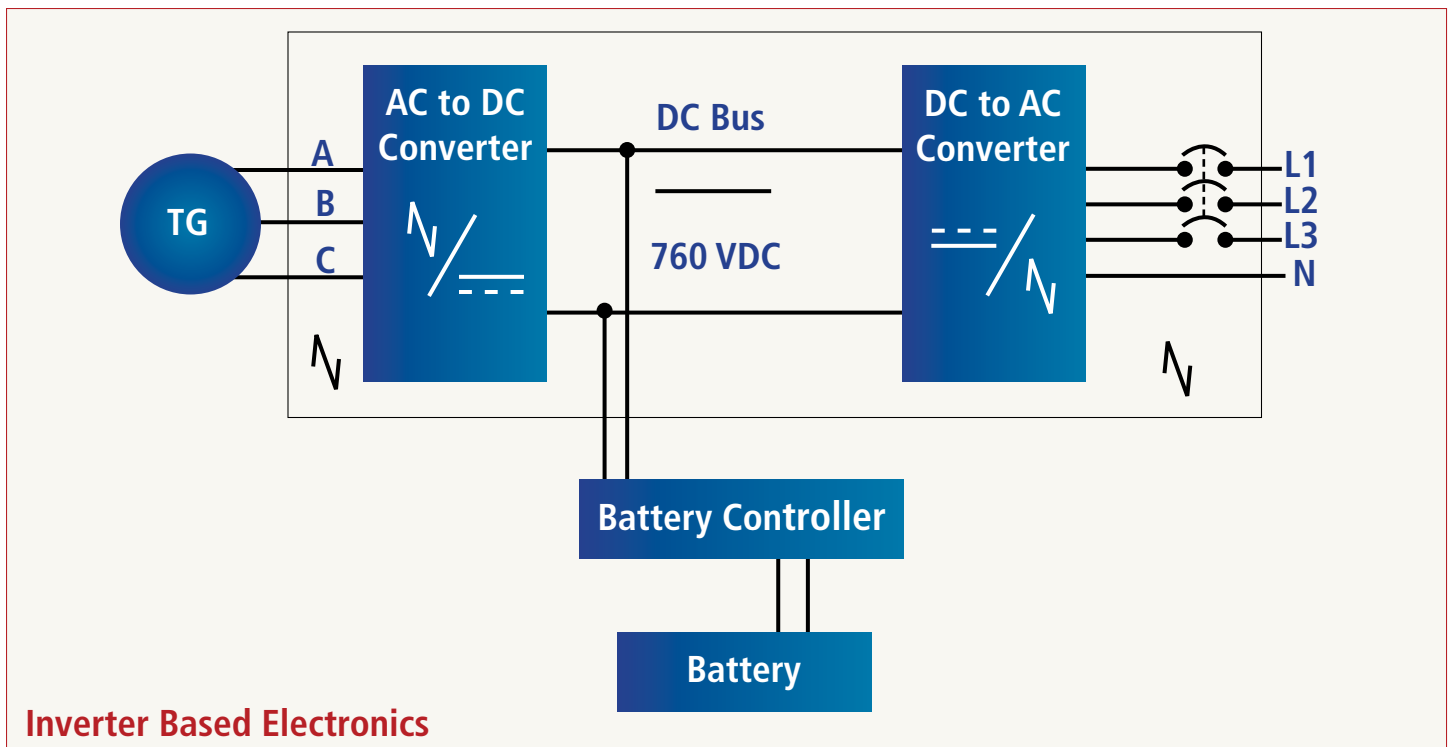
a highly efficient and cost-effective power electronics package that meets Capstone's requirements. Today, Capstone uses higher switching frequencies and state-of-the-art magnetic filtering components to produce high efficiency and low costs. Off the shelf motor drive controls are limited for the microturbine power generation system.

More Innovations

Capstone power electronics offer a wide variety of digital control functions typically not found in motor drives, but well suited for Capstone power generation systems. Air bearings allow the turbine generator to operate at high speeds, which makes the engine small, compact and low cost. Generator controls synchronize with the permanent magnet motor up to 96,000 RPM, which far exceeds the capability of motor drives. These controls also allow the engine to operate at variable speeds and at rated temperatures for load efficiency and low emissions.

The central DC bus is isolated from the package ground to create more efficient IGBT switching schemes with common low-cost devices. Battery management controls provide energy from the battery to support customer step load changes and charge the battery to maintain long life for reduced maintenance.

Inverter controls incorporate high-speed switching schemes to provide AC-power output that meets IEEE, UL and CE standards for clean power with lower-cost components. Inverter controls synchronize the AC output at typically 50-60 Hz with a utility or other alternative power generation



Inverter Based Electronics

source, or control the AC output voltage 10-60 Hz for stand-alone power generation applications. Inverter controls also parallel the AC output between multiple generators to provide n+1 redundancy, protective relay functions compliant with IEEE1547 and UL1741, elimination of additional onsite equipment costs, and DC output for Hybrid Electric Vehicle (HEV) applications.

Capstone power electronics and controls technology provide new market opportunities for future growth. Our dual-mode products offer grid-connect and stand-alone operation using:

- a generator control module (GCM) to convert high frequency AC from the turbine to DC;
- a battery control module (BCM) to provide transient response; and
- a load control module (LCM) to convert DC to AC output for the customer.

Hybrid UPS

Incorporating two LCMs, one permanently connected to the grid and the other connected to the customer's critical load, will allow Capstone to create a hybrid Uninterruptible Power Supply (UPS) system for the Secure Power market. Capstone's Hybrid UPS product operates as a UPS for critical load support, provides high efficiency combined heat and power (CHP) or combined cooling heat and power (CCHP) to reduce

electricity costs and meet thermal loads, or operates as a back-up generator that provides long-term power during grid outages. The Hybrid UPS product offers all these features at a fraction of the cost of traditional UPS and back-up generation systems.

Power Electronics for HEVs

As the HEV market grows, Capstone will need to reduce its power electronics footprint. Larger vehicles, such as buses, have more space to integrate existing air-cooled electronics design. For passenger vehicles, however, the power-electronics system must be smaller due to space constraints. This can be accomplished by replacing the fin air heat exchanger with a water cooling plate fed by the vehicles existing water cooling system. More critical to this change is the packaging requirements for the specific OEM vehicle.

Capstone power generation products benefit from in-house technologies that drive high reliability, low maintenance, low cost, low emissions, small footprint and an integrated solution. Capstone produces 30kW and 65kW microturbines, along with 200kW turbines, for applications between 20kW and 10MW. All products operate on a variety of gaseous and liquid fuels. Capstone microturbines and turbines serve markets including CHP, CCHP, landfills, digesters, secure power, offshore and onshore pipeline, and HEV. ■

Capstone Microturbine Installed in 7-Passenger Car that Gets 80+ MPG

In June 2009, a Capstone Model C30 liquid fueled microturbine was successfully integrated into a Ford S-Max people carrier in the United Kingdom.

Langford Performance Engineering, headquartered in Wellingborough, England, designed and modified the Ford S-Max seven seat crossover vehicle into a series hybrid plug-in vehicle with a C30 under the hood as an electric range extender. Langford reports that the "Whisper Eco-Logic" car gets up to 80 miles per gallon in early stage demonstration testing.

The design characteristics of Capstone's turbine permits ultra-low emissions, high-fuel economy, multi-fuel capability, no coolants or lubricating oil, and little to no maintenance in hybrid electric vehicle applications.

The Whisper Eco-Logic vehicle is a plug-in electric car with an on board turbine generator to keep the batteries charged and extend the range of the car beyond that of a typical electric vehicle. This sets it apart from the hybrids now available such as the Lexus and Toyota which use conventional 4 stroke engines to provide both vehicle drive and battery charging. In early demonstration testing, the car achieved up to 80 miles per gallon and

traveled 40 miles on electric power before the Capstone turbine generator started up and charged the lithium ion batteries.

Langford did an exceptional job integrating the turbine, power electronics and batteries into the vehicle without impacting any of the seven seats or increasing the overall vehicle weight. ■



Distributor Spotlight

Aquatec Introduces Product Specialist, More Training to Boost Sales

How can a distributor inspire passion for Capstone products among its employees? Create eagerness that results in increased sales? Incite gusto that leads to distributor comments like, "You'd think Capstone was gold. Our employees love it. If given the opportunity, they'd work 16 hours a day playing around with the technology."

For Capstone's Australian distributor, Aquatec-Maxcon, it's a combination of clear roles among its employees, regular staff training and constant communication that has created a "Capstone-centric" culture.

The result is strong Aquatec orders and sales of Capstone products, including C1000s, C30s and C65s last year. In fact, Aquatec is so successful that the company received the "Most C30 Orders Award" at Capstone's 2008 Global Distributor Conference.

"Our sales team members all are engineers," said Ron Howick, Aquatec manager. "They can talk the talk, but they don't get to the skill level of our Capstone product specialist. This person is quite savvy in all aspects of Capstone technologies."

He continued, "By using one person as a product specialist, our sales team is now completely focused on generating inquiries."

He explained that the Capstone specialist provides in-depth detail about all Capstone products and is great at working with people. "It's unusual to have those two qualities in such a technical role," Howick said. "He can ask the hard questions in a way that's not offensive to clients."

Howick explains that while the salesmen are all engineers they are also hired for their strong sales skills—the ability to open doors, perform cold calls, analyze markets, get 2-3 additional names from clients to contact and much more.

Training is also a key factor in Aquatec's sales success. The company holds quarterly sales training classes that focus on the fundamentals of selling. In addition, all staff get Capstone product training at least three times each year.

"The bottom line is that our salespeople have to have a presence, be confident and demonstrate the ability and willingness to ask questions that help guide the client," Howick said. "Their job is to educate potential clients on the features and benefits of Capstone technologies, and at the appropriate time, get the product special involved. This model has worked well for us since Day 1."

Visit Aquatec's website at www.aquatecmaxcon.com.au/. Ron can be reached via email at ronh@aquatecmaxcon.com.au. ■

Aquatec's Sales Beliefs

- **Illuminate** – use all available marketing tools to get Capstone products exposed to the widest possible community.
- **Educate** – from undergraduate lectures to lunch and learns, do whatever it takes to get the story told at a technical level for clients of today and tomorrow.
- **Penetrate** – consider no market out of bounds, too big, too small or too impossible until tested and an informed judgment is made based on facts – not assumptions.
- **Deliberate** – take time to qualify the client, application, risks and benefits. Develop a "best-for project," which is a project best for the client and best for ourselves.
- **Create** – an order. Also create a partnership and a long-term relationship with the client. Word-of-mouth via a happy client is still the best sales aid.

Ron's Sales Tips

- **Respond to all inquiries** within 24 hours, whether big or small, realistic or ridiculous.
- **Use questionnaires to qualify prospects** wherever possible. This is essential. Only work with facts, not assumptions.
- **Arrange to meet face-to-face** with clients as soon as possible after any formal submittal.
- **Follow up** and then follow up again. By the time you've submitted your proposal, two other competitors have made their approach. Stay on top of the pile – hence the need to follow up.
- **Ask for an order** – be viewed as serious. We're in business to make money, provide a service, meet a need, and ensure client satisfaction. We expect when we make an investment in time and energy (dollars) we have the right to ask for a return if we meet the necessary criteria – hence there is no shame in letting the client know early in discussions we will expect an order once having worked through the iterations.

News from the Globe

California amends Rule 1110.2 – Good for Capstone. The amended rule sets limits on the amount of NOx, volatile organic compounds (VOCs) and CO₂ from engines over 50 horsepower. This is good news for Capstone, since reciprocating engines are not currently able to meet the required NOx emission value for Non-natural gas projects in Southern California.

EPA expected to begin regulating greenhouse gases. In mid-March, the *New York Times* reported that the Environmental Protection Agency intends to begin the process in which greenhouse gases would be regulated under the Clean Air Act. This ruling would mark a reversal for the EPA. Under the previous administration, the EPA had claimed the Clean Air Act was not the appropriate vehicle to regulate these gases. In addition, it was reported that the EPA plans to issue an endangerment finding that greenhouse gases do affect public health and welfare.

EPA signs proposed mandatory greenhouse gas reporting rule. In mid-March, the EPA administrator signed the proposed rule to develop mandatory greenhouse gas reporting. According to the EPA, the proposed rule will collect accurate and comprehensive emissions data to inform future policy decisions. Landfills and waste-to-energy facilities will be covered under this ruling. Sources emitting 25,000 tons of CO₂ equivalent or more will be required to report the six primary greenhouse gases.

Solid waste operations impacted by Stimulus Act. Renewable energy operations now have three options for how to receive a tax credit.

- **Tax Credit Extensions** – Landfill gas and waste-to-energy received a three-year extension of tax credits, making the placed-in-service date Dec. 31, 2013. Credit that facilities receive is not capped at 35% of the facility's capital cost. LFG and WTE operations will continue to receive 1¢ per kilowatt.

- **Investment Tax Credit** – A provision temporarily allows facilities to claim an investment tax credit instead of a production tax credit (PTC). Facilities placed online by Dec. 31, 2013 may, in lieu of the PTC, elect to claim an investment tax credit equivalent to 30% of capital invested in the facility. Previously, this provision applied only to solar operations.

- **U.S. Department of Treasury grant program** – allows LFG and WTE renewables to receive a grant worth 30% of the capital cost of the operation within 60 days after the facility goes online. Applicable to projects brought online in 2009 or 2010, or for projects that began construction in 2010.

Stimulus Package - Good for Capstone – The American Recovery and Reinvestment Act contains measures that promote clean energy and energy efficiency. Many of the measures could be beneficial to deployment of Capstone's products and continued development of our technology. For example,

- microturbine and CHP tax credits can now be taken as grants;
- approximately \$11 billion will be spent to make federal government buildings more energy efficient;
- money also will flow to states to fund energy programs.

New Sales and Applications Training – Capstone has developed new training courses for distributors. Courses are designed to help distributors to effectively sell, design, install, operate and maintain Capstone products and services. The program rolled out this spring.

CHP Carbon Credit Program – Capstone and partner Blue Source are developing a methodology to calculate and monetize carbon dioxide emissions reductions from natural gas-fired CHP projects. No such methodology currently exists. Distributors and customers can use the methodology after expected completion this summer.

Training in Bolivia – In December, Capstone provided on-site training at Transredes, a Bolivian company that has installed C65 systems in compression power plants for natural-gas pipelines since 2006. Led by Capstone trainer David Pastrana Hernandez, the sessions included complete ASP and FTI training for 12 technicians.

Upcoming Events

5-9 October
World Gas Conference
Booth A32
La Rual Convention Center
Buenos Aires, Argentina

7-9 October
Power-Gen Asia
Booth H24
Impact Exhibition & Conference Center
Bangkok, Thailand

10-14 October
WEFTEC
Booth 2831
Orange County Convention Center
Orlando, Florida

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Capstone Turbine Corporation® is the world's leading producer of low-emission microturbine systems, and was first to market with commercially viable air bearing turbine technology. The company has shipped thousands of Capstone MicroTurbines to customers worldwide. These award-winning systems have logged millions of documented runtime operating hours.

Capstone is a member of the U.S. Environmental Protection Agency's Combined Heat and Power Partnership which is committed to improving the efficiency of the nation's energy infrastructure and reducing emissions of pollutants and greenhouse gases.

A UL-Certified ISO 9001:2000 and 14001:2004 certified company, Capstone is headquartered in the Los Angeles area with sales and/or service centers in the New York metro area, Mexico City, Milan, Nottingham, Shanghai, Singapore and Tokyo.

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