

TURBINE TALK

Taken from the Top: The Next Generation of Microturbines

On behalf of Capstone Turbine Corporation, I would like to wish all Capstone staff and distributors a very prosperous and happy new year! As we wrap-up one of the biggest product announcements in our company's history – the C1000S Signature series microturbine – we wanted to reflect on some of the many improvements we've made to the new system that help to solidify our company as the world's leading clean technology manufacturer of microturbine energy systems.

New Enclosure

The new doors feature a double-walled, box-construction design with bulb seals and acoustic foam that is embedded between the walls of the doors. Continuous gear hinges and slam-style, keyed-alike door latches allow the doors to open/close with little effort. These combined changes enhance door strength and improve door sealing.

Enhanced Air Filtration System

Each microturbine now utilizes a two-stage air filtration system. The first stage offers pre-filtering without the need to open the enclosure door to perform pre-filter inspection and service. The internal, second stage offers improved engine filter longevity and pressure drop monitoring to assist with scheduling service intervals.

Redesigned Air Inlet Hood

The air inlet hood has been redesigned to provide a uniform flow profile using a series of vertically oriented hooked vanes. The vanes impose several direction changes to the incoming air, thereby minimizing water and dust intrusion into the filter system. The hood is hinged to allow easy access to the pre-filters.

Redesigned Discharge for Enclosure Cooling Air

The enclosure incorporates a new rear louver design allowing package cooling air to discharge without the need for a rain hood. This updated approach reduces the installed footprint of the enclosure without compromising rain protection.

Improved Electrical Distribution

Higher gage power cables and improved cooling increase the current handling capability of the microturbine system.

Redesigned Frame and Roof

The strengthened enclosure frame and integrated forklift pockets eliminate the need for lifting braces when transporting the enclosure. The addition of an H-frame in the roof increases its load carrying capacity for auxiliary equipment. The roof is now flush to the upper frame and corner castings to reduce water collection.

Relocated Engine Exhaust Stack

The combustion exhaust port has been relocated to the roof of the enclosure. This mirrors the design of our popular C65 and C200 Microturbine systems and increases exhaust ducting flexibility.

Engine Serviceability

The straight exhaust assembly simplifies the engine removal process and reduces the time required to overhaul an engine.

Higher Inlet Fuel Temperature

Gaseous systems are now capable of handling inlet fuel temperatures of 80°C (176°F).

Recessed Fuel Inlet

Fuel header inlet flange has been recessed so that it is contained within the corner castings. This reduces potential interference with and damage from transportation equipment.

Updated Aesthetics

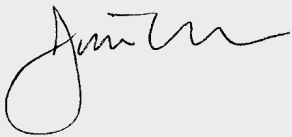
New color scheme for a brighter, fresher look. New decals to align with Capstone's new branding scheme. Marine-grade paint increases corrosion resistance.

Heat Recovery Module [HRM]

Capstone's new roof-mounted Heat Recovery Module dramatically simplifies installation, serviceability, and operation of CHP projects without increasing footprint. By providing an integrated solution, distributors can offer improved part load performance and eliminate the need for common exhaust ducting and backflow dampers.

These changes represent only a few of the many improvements that have been implemented into the new Signature series microturbines. As we work to strengthen Capstone's market position and overall value proposition, we continue to look for and evaluate further opportunities to enhance the value of our products. Shipments will begin soon, and we are excited to see what 2016 has in store!

Sincerely,



Jim Crouse
Executive Vice President, Sales and Marketing
Capstone Turbine Corporation



Capstone C1000S Microturbine

The C1000S microturbine is the smartest one-megawatt turbine energy system available. With a redesigned enclosure, enhanced filtration and improved exhaust routing, the powerful C1000S generates clean and reliable energy onsite. The highly efficient C1000S also features an optional fully integrated heat recovery solution for CHP and CCHP applications.

Distributor Spotlight: IBT Group

15 Years of Technological Leadership, Sustainability and Customized Energy Solutions

IBT Group, Capstone's Italian distributor, was founded by Ilario Vigani, a nuclear engineer who in 2000 decided to pursue his own business venture by starting a company that would develop high efficiency energy solutions based on the latest and greatest technologies available. A graduate of the University of Pisa in Italy, Vigani had a goal of bringing distributed generation to mainstream, with the intent of reducing the carbon footprint of Italian industries. Crucial to the launch of the company was IBT's meeting with Capstone Turbine, the only company to design and manufacture oil-free gas microturbines. The technology fascinated Vigani and he soon realized the great market potential for Capstone's products. In 2001, IBT Group would become the exclusive distributor for the Italian market and the first company to "introduce" the innovative technology to companies in Italy.

In 2002, IBT Group installed their very first energy cogeneration plant with Capstone microturbine technology, in Italy. Now in its 15th year of operation, IBT has offices in Klagenfurt (Austria) and Treviso (Italy), and is a major player in the development, marketing and service of green energy solutions for businesses looking to become energy independent. IBT specializes in cogeneration and trigeneration applications and sustains all of the skills necessary for the proper development of customized energy solutions. IBT also maintains strategic agreements with top international technology partners, with who consolidate long-term relationships in order to develop applications and customized solutions to protect their customers' investments. From consulting and custom-build services, to system installation and maintenance, IBT Group stands as a valuable partner to Capstone.

"One of Capstone's first distributors in Europe, Ilario and his team have supported the entire Capstone product portfolio in Italy and promoted our brand, to an effect that we are a known and respected technology. IBT has very strong marketing tactics, continuously identifying and assessing the market segments where our products give the maximum advantage to our customers. Their total satisfaction oriented service ensures that our brand stays well regarded in this market," commented Radu Anghel, Director of Sales for Europe at Capstone Turbine.

IBT Group has already distinguished itself as a top player in the unique energy solutions space. In particular, IBT has gained market share by developing applications that ensure maximum energy efficiency for specific industries, such as:

- Those that require thermal energy such as steam for their production processes (e.g. Food and Beverage, Textile, Pharmaceutical, Paper production, Drying processes, etc.)
- The hospitality industry (Hotels, Swimming pools, Hospitals, Nursing homes, etc.)
- Wastewater treatment (Powered by biogas containing low percentages of methane)

It wasn't until recently that IBT Group started to develop applications for industries that require thermal energy for



>> A Capstone C600 microturbine produces steam via post combustor for Aba Foods company in Italy

production processes. IBT has two outstanding applications that are worth highlighting.

- IBT Group's latest application allows a customer to utilize all of the thermal energy from their microturbines to maximize the production of steam. With some of the lowest levels of NOx and carbon emissions, the microturbine exhaust carries an oxygen content level of about 17%, which makes it combustible enough to use in air vein burners to raise the temperature from 300°C (572°F) to a maximum of 700°C (1292°F). The exhaust gases are then used in a heat recovery steam generator for the production of saturated steam. This sort of application provides an advantage to those industrial end users that are without a need for hot water.
- Another recent application was developed for major Italian food retailer, Conad, which is set for commissioning by the end of the calendar year, and will serve as one of the first Italian retailers to implement Capstone microturbines. According to IBT Group, the customer will be able to achieve energy efficiency peaks of over 85% by combining the microturbine with an ammonia chiller. Unlike a CHP piston engine, high quantities of water or steam can be produced in a short amount of time. Since the food retailer maintains a temperature-controlled facility, this can be done at a fraction of the cost.

IBT Group continues to make significant progress with the distribution of Capstone microturbines across multiple industries in Italy. The IBT fleet has reached over 184 running microturbines in 2015, mainly providing turn-key solutions for various sectors. IBT Group is dedicated to reducing energy costs for its customers as well as reducing global emissions. ■

For more information on IBT Group, visit: www.ibtgroup.it or follow them on Twitter [@IBTEuropeGmbH](https://twitter.com/IBTEuropeGmbH)

Capstone and the Trade Winds Mission to Africa

In September 2015, Capstone President and CEO Darren Jamison, and Director of Sales in the Middle East and Africa Augusto Farro, had the opportunity through the United States Commercial Service to attend a business conference and trade mission in Africa, called Trade Winds Africa. The program offered U.S. companies the opportunity to explore individual markets in Africa and develop commercial ties between Sub-Saharan Africa and the U.S. Of all the participating countries, Capstone chose to visit the countries of Angola (third largest economy in Sub-Saharan Africa driven primarily by the Oil & Gas industry) and South Africa (second largest economy in Africa).

Africa is a region where access to electricity is largely restricted. It is estimated that around 500 million people in Africa do not have access to an advanced source of energy. For example, lights during the night are often fueled by kerosene, and cooking is done with wood or similar materials. In underdeveloped environments, the methods of powering everyday needs can cause collateral damages as the fumes can negatively affect the people. The potential of the power generation market in Africa is promising and several U.S. companies, such as Cummins and APR, are trying to further develop their presence.

To put this into context, the power consumption of Sub-Saharan Africa is only 1.3% of what the U.S. consumes, yet the population is 2.5 times greater than that in the U.S. Electricity is directly related to the development of a country, so there is great reason (and urgency) for Africa to address the power of power.

As part of Capstone's commercial development and strategy for the associated market potential, we are focusing our efforts on countries with large economies and/or Oil and Gas producers, which is the case in Angola and South Africa. Both countries present to Capstone markets that can be developed in several areas. Rural electrification in Africa is poor and several of Capstone applications can help to fill this gap. "With the potential economic growth for Sub-Saharan countries such as Angola and South Africa, Capstone is well situated to begin making strides into these dynamic markets for future sales growth and further acceptance of our products worldwide," commented Darren Jamison, Capstone's President and Chief Executive Officer.

Capstone provided presentations for and participated in one-on-one meetings with the Ministry of Energy, major Oil and Gas companies in Angola such as BP and Luxervisa (gas to electricity provider), large agricultural and animal farms, utility providers ESKOM (South Africa) and industrial estates that are looking to fulfill the lack of reliable electricity. The main themes discussed with these entities included, flare reduction, offshore applications, small-scale power plants that use natural gas, rural electrification with Biogas, and displacing diesel power generation applications for a more clean and economic solution.

In this case we have the support of our newly established distributor for Angola, Tomas Oliveira (formerly Must Capital) and Acrona South Africa. Rodrigo Oliveira (Sales Director) and Matthew Hayden (Owner of Acrona South Africa) were the attending representatives from Capstone's distribution network for these regions. The presence of Capstone's President and CEO also provided distributors the opportunity to discuss the mission in-person and better collaborate on business objectives. Our attending distributors were thrilled to see such large opportunities, like an agricultural company in Angola interested in Biogas technology with their monthly spend exceeding \$500,000 USD in fuel costs alone. Acrona South Africa and Tomas de Oliveira were very supportive and appreciative of having Mr. Jamison present and available in this growing market.

In South Africa, Capstone has over 20 commercial advisers from Sub-Saharan Africa helping the company to understand the market and their needs, and providing information about the suitability of our products. Capstone representatives had the opportunity to attend a panel session with the CEO of Ford Motor Company, Mark Fields, explaining the importance and challenges behind finding good distribution partners in these territories. Mr. Fields explained that even a large company like Ford has challenges within their distribution network.

The power of the U.S. Embassy and the quality of their commercial advisors were vital to the success of the meetings, and a quick and easy way to meet with relevant local companies in the region. Capstone and the attending distributors also had the opportunity to discuss the ways in which these local companies could access loans from the U.S. Government under the U.S. Agency for International Development initiative, or USAID. This enabled Capstone to better understand how we can benefit from U.S. born programs. Programs like this are very important to the company as one of the biggest difficulties with developing business in Sub-Saharan Africa is the large set of economic limitations African countries have.

"It was noted at the Africa Progress Panel in August that Africa will need to invest \$55 billion over 15 years to meet the electricity needs of the region. With so much potential in Africa, and with the proper amount of dedication and distributor support, Capstone can capitalize on the opportunities that will come, and I am optimistic about the future of our success in this region," noted Augusto Farro, Capstone Director of Sales in the Middle East and Africa. "The support of Jen Derstine was fundamental to the success of this trade mission and we will be working diligently with her and her team in the future to accelerate the market penetration through this initiative," added Farro. ■

How does it Work?

CHP in Cap-and-Trade Systems

By Jen Derstine, Director of Strategy, Policy and Capstone Development

Cap-and-trade emissions trading systems are becoming an increasingly popular policy tool for meeting emissions reductions goals. In the United States, the U.S. Environmental Protection Agency (EPA) launched the first cap-and-trade system with the U.S. Acid Rain Program, which capped emissions of SO₂ gases beginning in 1995. In 2003, the EPA added the NO_x Budget Trading Program to reduce emissions of NO_x. Individual states and groups of states launched additional cap-and-trade programs, including the Regional Greenhouse Gas Initiative and California's AB-32 statewide trading system. Elsewhere, regional or nationwide trading systems have been launched in the European Union, New Zealand, and South Korea. China is expected to launch a carbon cap-and-trade system nationwide in 2017.¹

Emissions trading systems limit emissions at a certain level to create scarcity, which then puts a price on emissions and supports an emissions-trading market. Permitted emissions may be allocated through allowances either freely distributed based on historical emissions levels, purchased at a flat price or sold through an auction (or a combination of both of these methods). Sites that reduce emissions may sell any surplus (or unused) allowances to those sites that will emit more than their allowances permit. The total emissions cap is then lowered over time to achieve reduced emissions. (e.g. 20% by 2020).

Combined heat and power (CHP) systems do not fit neatly into many cap-and-trade programs since onsite emissions at a CHP system generally increase though global emissions decrease. Program design can inadvertently penalize CHP since onsite emissions increase, which would generally result in compliance costs. However, by combining generation of

heat and electricity from a single fuel source and displacing a site's current use of grid electricity, CHP systems offset the emissions that would have been generated by the grid to supply electricity to the site, decreasing overall emissions (unless the grid generation is cleaner than CHP). In the U.S., average grid emissions of carbon dioxide equivalent are 1,142 lb/MWh.² For Capstone, CO₂ emissions of our CARB-certified CHP microturbines are as low as 700 lb/MWh, and for some applications, even lower.

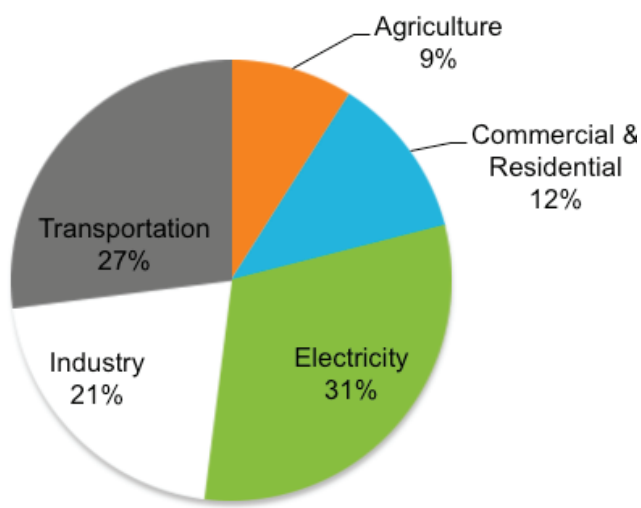
Behind-the-meter CHP is an important option for states to consider in developing compliance plans to meet emissions targets under the proposed U.S. Clean Power Plan.³ In the plan, the EPA aims to reduce U.S. carbon pollution to 30% below 2005 levels by 2030 focusing on new and existing power plants in the electricity sector. EPA set rate-based (lb/MWh) and mass-based (short tons of CO₂) emissions goals for each state based on the best system of emission reduction (BSER) for fossil fuel-fired electricity generating units (EGUs) and the specific power sector conditions in each state. States must choose one of these options – rate-based or mass-based – as well as whether to enable trading with other states as their compliance pathway.

In order to take advantage of customer-sited CHP for compliance, states must take a statewide approach, allowing outside measures to be used to support compliance of affected electric generating units (EGU), instead of a source-based approach that limits compliance options to measures at the EGUs themselves.⁴ States may also choose to trade individually or with other states. A statewide or multi-state approach will allow CHP in the commercial, institutional and industrial sectors to reduce the need for generation from grid resources. CHP systems can also deliver additional benefits including improved environmental performance, reduced congestion on the electric grid, reduced line losses, embedded resiliency for emergency response and preparedness, and high quality jobs.⁵

Under a rate-based compliance plan, states have specific emissions rate targets. A CHP system that generates electricity at a lower effective emissions rate (accounting for thermal output) could generate emission reduction credits (ERCs) that can be used by EGUs to meet emissions targets. CHP system owners/investors could then sell the ERCs directly to EGUs or trade them through an organized emissions trading registry.

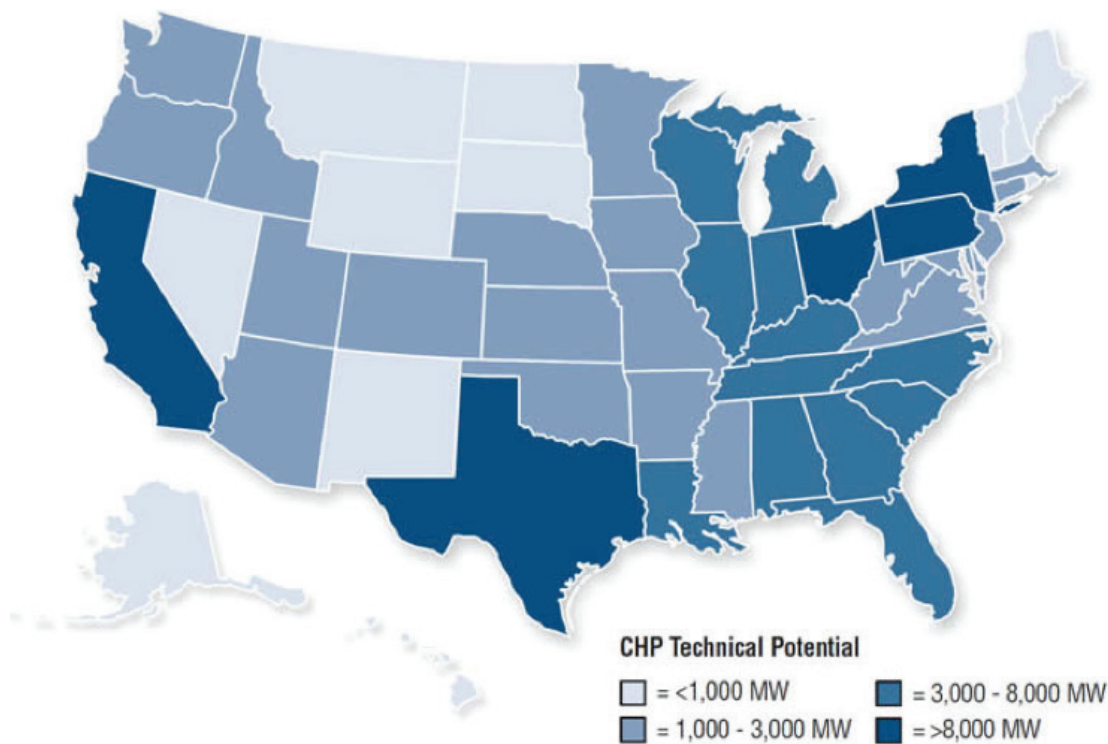
Under a mass-based compliance plan, states convert the rate-based emissions targets to overall limits on tons of CO₂ emitted. Grid-connected CHP systems that reduce power purchased from the grid would lower the emissions from affected EGUs. While CHP owners/investors may not be able to directly derive value for emissions reductions through sales of ERCs, states could incentivize CHP deployment to achieve these lower emissions through allowance set-asides for CHP in a state or regional cap and trade program or through other state or rate-payer programs.

Total U.S. Greenhouse Gas Emissions by Economic Sector in 2013



Source: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013

CHP Technical Potential



Source: DOE. "Combined Heat and Power: A Decade of Progress." August 2009.

As cap-and-trade systems and other emissions reduction approaches gain adoption in a growing number of markets around the world, customer-sited CHP systems should be considered an important option for compliance. Policies

must be designed to ensure emissions reductions are fairly calculated across CHP systems' thermal and electric output. ■

¹ The White House. "The United States and China Issue Joint Presidential Statement on Climate Change with New Domestic Policy Commitments and A Common Vision for an Ambitious Global Climate Agreement in Paris." Fact Sheet. September 25, 2015.

² EPA. Emissions & Generation Resource Integrated Database (eGRID2012). October 2015.

³ The information in this article is based on the unofficial Final Clean Power Plan Rule released by the EPA on August 3, 2015. The rule is not official (and thus may be changed) until it is published in the Federal Register.

⁴ CCAP. "Expanding the Solution Set: How Combined Heat and Power Can Support Compliance with 111(d) Standards for Existing Power Plants." May 2014.

⁵ NACAA. "Implementing EPA's Clean Power Plan: A Menu of Options." May 2015.

Do you have a topic or article idea for the next edition of Turbine Talk?

Please send any article suggestions or newsletter feedback to marketing@capstoneturbine.com. The Turbine Talk newsletter is produced solely by the Capstone Marketing team and exclusively for Capstone distributors, partners and employees. We ask that all newsletter recipients not share the newsletter with any customers or outside parties.

Did you know?

Capstone Microturbines powered the 2015 U.S. Republican Presidential Debate at the Ronald Reagan Library

As U.S. President Barack Obama closes in on the end of his second term in office, the race for the 2016 U.S. presidency is rapidly underway. On September 16, the Ronald Reagan Presidential Library, located 30 minutes northwest of Capstone Headquarters, in Simi Valley, California, held its fourth ever presidential debate, the second on the 2015 U.S. Republican Presidential Debate schedule. This year, 15 of the 16 Republican Party candidates attended the debate, with the top 10 candidates facing off on a live, prime time TV airing. The Republican primary presidential debate was moderated by Jake Tapper of CNN and drew about 23 million television viewers, making it the most watched event in the 35-year history of the cable news channel. With the most candidates of any presidential race in U.S. history, there is more interest in the debates than ever before, making it the biggest debate ever held at the Library.

The first televised presidential debate aired in 1960, featuring candidates John F. Kennedy and Richard M. Nixon. About 58% of voting age Americans tuned in, according to a report aimed at improving the quality and reach of presidential debates, "Democratizing the Debates." This number dipped all the way down to a nationwide low of 25 percent for the Mitt Romney and President Barack Obama debate in 2012. According to a Pew Research Center poll from 2012, about two-thirds of those surveyed said presidential debates were helpful in learning about the candidates. With record numbers of Americans following the 2016 presidential race, this could shape up to be one of the most important presidential elections to date. That said, one could say that Capstone had a small, small part in it.

Ten years prior to the September 16 debate, the Ronald Reagan Presidential Library turned to Capstone Turbine for an energy solution that would meet their trigeneration needs. Sixteen natural-gas-fueled C60 microturbines, commissioned in October 2005, produce 960kW of electricity as well as heating and cooling for the Library through a CCHP application. Today, the 100,000-square-foot Library uses the same Capstone microturbines to generate about 95% of its energy. Most notably, the microturbines provide electricity to the Air Force One Pavilion, home to Air Force One (tail number 27000), which served seven U.S. presidents. The debate, which was held specifically in the Air Force One Pavilion, utilized the power generated by the Library's Capstone microturbines. "Overall we are pleased with the performance of the turbines, the efficiency of their electricity-generating capabilities, and the hot water they provide to the facility," commented John Lehne, Facilities Manager for the Library. Since the system was commissioned, the Ronald Reagan Presidential Library has maintained 24/7 availability.

Capstone microturbines will continue to produce clean and reliable energy in support of all future debates and events at the Ronald Reagan Presidential Library. ■



>> Sixteen natural-gas-fueled C60 microturbines running on natural gas provide electricity for the Air Force One Pavilion.

At a Glance

Location

Harrisburg, Pennsylvania, USA

Commissioned

October 2013

Fuel

- High Pressure Natural Gas

Technologies

- Capstone C800 Dual Mode Power Package
- Hot Water Heat Exchanger
- 250-ton Exhaust-Fired Absorption Chiller
- (mTim) PLC Control System

Customer

- Pennsylvania State Employees Credit Union (PSECU), one of the largest credit unions in Pennsylvania.
- Building: A 239,000-square-foot (22,203-square-meter), three-story LEED Gold-certified building on a 47-acre campus.

Results

- Reduce carbon emissions by 1,468 tons per year
- Standalone clean power for data center UPS
- 24/7 remote monitoring of site through (mTIM) PLC control system
- Provide backup power to site's data center
- Factory protection plan with 24/7 remote monitoring
- Thermal priority site
- Virtual electric metering

Case Study: Pennsylvania State Employees Credit Union



Over 75 years ago, Pennsylvania State Employees Credit Union (PSECU) was started as a member-owned, not-for-profit credit union. Today it serves hundreds of thousands of members and is one of the largest credit unions in the state of Pennsylvania. In 2013, PSECU realized it was time to invest in natural gas power generation to reduce their overall cost of operation and become more environmentally friendly. With time and budget in mind, PSECU turned to E-Finity Distributed Generation, the exclusive Capstone Turbine distributor in the area, to develop a trigeneration combined cooling, heating and power (CCHP) solution.

As part of a major construction project, PSECU required a clean and energy efficient power generator system to power its 239,000-squarefoot (22,203-square-meter) LEED Gold-certified facility and data center, while also providing space heating, space cooling and cold water. With the construction effort rapidly underway, PSECU teamed up with the local energy service provider to install an onsite power generation system site plan that would allow for the natural gas powered microturbine power plant.

The trigeneration installation, which was completed in October 2013, includes the Capstone C800 Power Package, four MMBTU heat exchangers and a 250-ton flue-gas fired absorption chiller—a system that now reduces carbon emissions by 1,468 tons per year, which is equivalent to removing 243 cars from the road. The package also operates in dual mode, meaning it is able to communicate with and work independently from the local utility grid to maximize efficiency.

The C800 system is not the only piece of equipment that is contributing to the success of PSECU. The credit union is controlled by E-Finity's PLC-based control system (mTIM) with remote monitoring, which exchanges key energy production data between the power plant and PSECU's building automation system to maximize thermal priority performance. The mTIM monitors, diagnoses, and troubleshoots the Capstone system 24/7 and allows E-Finity's customer service department to fix the unit remotely, minimizing downtime and maximizing uptime for the end user. Energy and performance data is then made available to the customer in real time. ■

Clean Fuel Impacts on Microturbine Operation, Maintenance and Life Cycle

Besides being one of the Big Three (air, fuel, ignition source) fundamentals for combustion, high quality, clean fuel has a significant positive impact on both environmental and economic aspects of generator operation and system life. Power generation system owners and operators expect long system life and low operating cost. Let's look at how fuel, and fuel maintenance, play major roles in meeting those expectations.

Rarely will a fuel be perfect as it occurs naturally. Chemicals harmful to finely machined microturbine components can be dissolved in both gaseous and liquid fuels. Most of these contaminants don't provide any combustion energy and we don't want them inside a microturbine engine. Fuel contaminants can cause:

- Fouled and clogged precision fuel flow control valve components. They can also plug fuel injectors, and cause hot and cold spots in the combustor liner.
- Contaminant residue may collect on turbine blades causing imbalances and eventual turbine and bearing failure.
- Liquid contaminants, including water, can cause flameouts which quench the combustion process.
- Other liquid contaminants such as higher hydrocarbon liquids (oil) can cause engine overheating and damage the turbine rotor, turbine nozzle, and combustor liner.

Gaseous fuel composition varies depending on the source. Pipeline-quality gas is regarded as a suitably clean fuel. Associated gas or gas derived from waste streams from industrial processes may contain many harmful contaminants. Liquid fuels – specifically diesel – can also contain potentially harmful contaminants. Contaminants found in fuels include:

- Higher Hydrocarbons (oil)
- Water and Water-soluble Compounds
- Inert Gases (nitrogen and carbon dioxide)
- Sulfur
- Carbon Monoxide
- Hydrogen
- Alkali Metals (sodium and potassium) and Heavy Metals (vanadium, nickel, and lead)
- Solids (dirt, plant residue, bugs)

In most cases, these contaminants are transported with the fuel. The end-user is responsible for cleaning it up before consuming it.

Some fuels come to the site in generally good and usable condition. However, in some cases, even processed natural gas can pick up pipe scale debris and condensable water along the way. Depending on site configuration, liquefied propane gas (LPG), as well as diesel, may pick up water, dirt or other particulate matter during transport and delivery.

So, what is clean fuel? It is fuel, whether gaseous or liquid, with as many harmful compounds as possible removed.

Clean fuel at the end-user site is simple: FILTRATION. Simple – but not always easy. Filtration systems can be as complex as the contaminants requiring removal. Whether simple or complex, all filters need regular attention.

For full system life, inspect and replace fuel filters according to Capstone's Scheduled Maintenance guide for each product family to ensure clean fuel is provided to the microturbine.

Fuel storage

Fuel gases delivered through a pipe do not present an unusual storage challenge, although some sites may use pressure and/or storage vessels. In all cases, routine inspection, cleaning, and replacement of damaged or deteriorated components are primary maintenance tasks for ensuring clean fuel.

For sites dependent on liquid fuels, storage and maintenance may be the difference between optimal microturbine operation and extensive and seemingly unending site maintenance. Some fuel storage best practices will help prevent expense and downtime caused by contaminated liquid fuel:

- Source fuel from suppliers who will maintain fuel specs set by Capstone. It is reasonable to ask the fuel vendor to certify that the fuel meets or exceeds Capstone's requirements.
- Monitor fuel samples routinely or get regular analysis reports from the fuel vendor.
- Receive, unload, store, and transfer liquid fuels to avoid contamination from airborne particles, invisible corrosion in tanks and piping, and foreign object debris (FOD). Prevent FOD ingress through inspection ports, or other storage tank openings. Maintain seals to protect fuel from all sources of water. Install and maintain desiccant/air filters on breather pipes to minimize drawn in dirt and moisture as fuel is consumed.
- Use and maintain filters at each storage tank.
- Maintain storage tank drain valves and drain water regularly.
- Turn over the fuel as quickly as possible – at least every 90 days. Avoid storing diesel longer than 12 months.

Service and Maintenance Benefits

Clean fuel, properly handled and maintained, is fundamental to long and efficient microturbine operation. The appropriate quality fuel, correctly transported, handled and stored, can

result in optimal operation and reduced downtime, and deliver the full potential built into Capstone microturbines.

The downside of dirty fuel:

- Increased planned maintenance intervals.
- Additional unplanned maintenance costs in parts and labor, which also adds a level of uncertainty and lack of confidence in the equipment.
- Lower customer satisfaction levels due to increased down time and costs.
- Shutoff valve and manifold valve failures due to buildup of particulates, chemical corrosion, rust, and surface depletion. Sticking valve seats can also lead to dangerous conditions where the valve is held open when it should be closed. Similarly the fuel control valve can lose calibration due to contaminant build up.
- Increased personnel exposure to possible hazardous or unknown compounds.

The upside of clean fuel:

- Clean, efficient operation meeting system specifications
- Increased end-user satisfaction
- Component life meeting or exceeding specifications.
- Environmental impact meeting or exceeding design specifications.

Understanding fuels used in Capstone's high-performance, high-efficiency microturbines is critical to achieving high availability and reliability, while ensuring compliance with environmental requirements. Capstone provides detailed specifications covering the fuel quality permitted for use in all microturbine products. The "**Capstone Microturbine Fuel Requirements Technical Reference**" (document number 410002H) is the comprehensive resource detailing all microturbine fuel requirements. ■

News from the Globe



Capstone Receives 4.6MW Order from Horizon Power Systems for Flare Gas Project

Capstone received an order for three C800 systems and two C1000 systems for a total of 4.6 Megawatts for a large flare gas energy project in North America from Horizon Power Systems. The Capstone product was chosen because of its superior overall value proposition. No other microturbine manufacturer provides the combination of presales and aftersales support that the Capstone distributor network provides.



Capstone and Multichill Announce Strategic Partnership to Deliver Air-Cooled Absorption Chillers and Water Making Systems

Capstone announces a strategic partnership with MultiChill Technologies, Inc. ("MultiChill"). The partnership will allow Capstone to deliver air-cooled absorption chillers and water making systems to end users in conjunction with its flagship C30 and C65 microturbines.



Capstone Unveils New Signature Series Microturbine at 2015 Power-Gen International Show in Las Vegas

Capstone unveiled the Capstone C1000S microturbine, as part of the company's new Signature series microturbine energy systems. The one-megawatt C1000S microturbine incorporates numerous system and design upgrades intended to improve overall product quality and enhance the microturbine ownership experience in all applications but specifically for CHP and CCHP applications.



Capstone Secures First Microturbine Order for Industrial Application in Peru

Capstone received an order for a C200 microturbine to provide combined heat and power (CHP) for an industrial application in Peru. ISI Mustang, Capstone's distributor in Peru, secured the order, which is expected to be commissioned in early 2016. The C200 microturbine will be installed in a grid connect configuration to provide electricity and heating to the customer's facility.



This document contains "forward-looking statements," as that term is used in the federal securities laws, about expanded market opportunities and the environmental advantages, reliability, cost and energy efficiency of Capstone products. These forward-looking statements are subject to numerous assumptions, risks and uncertainties described in Capstone's filings with the Securities and Exchange Commission that may cause Capstone's actual results to be materially different from any future results expressed or implied in such statements. Capstone cautions readers not to place undue reliance on these forward-looking statements, which speak only as of the date of this report. Capstone undertakes no obligation, and specifically disclaims any obligation, to release any revisions to any forward-looking statements to reflect events or circumstances after the date of the release of this document or to reflect the occurrence of unanticipated events.

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