

# Turbine Talk

Capstone Turbine Corporation's Quarterly Newsletter

Fall 2008

## Case Study: 1350 Avenue of the Americas

It's easy to locate 1350 Avenue of the Americas during a blackout in New York City – it's the place with the lights on.

The building is a beacon in the darkness because it doesn't fully rely on Consolidated Edison for its power – thanks to natural-gas turbines from Capstone Turbine that generate electricity onsite.

On the 16th floor set-back roof of the 35-story building sit 12 Capstone C60 High Pressure Dual Mode ICHP units that create an individual power plant generating 720 kW of clean and secure electricity – about 35 percent of the building's day-to-day electricity needs – regardless of the status of the aging electric grid surrounding it.

The power plant of Capstone turbines is owned and operated by OfficePower Inc., a Connecticut-based company that offers multi-tenant office building owners an option that once was impossible: Energy independence and financial competitiveness.

OfficePower is teaming with Capstone Turbine to increase the facility's power reliability and overall asset value by reducing 1350 AOA's consumption of grid power during high-cost peak periods. In addition, the Capstone turbines provide thermal energy that carry up to 80 percent of the building's heating load during colder months. A Capstone Heat Recovery Module is installed on the top of each turbine, capturing exhaust heat energy normally unused and sent into the atmosphere.

"In the office space real-estate market, the newest amenity that is rapidly becoming a necessity is a building's ability to deliver power," said Joel Wilson, CEO of OfficePower. "Energy is the raw material for production of financial services, legal, accounting and other similar enterprises."

Combined heat-and-power is an essential feature of Mayor Michael Bloomberg's energy road map for the future – PlaNYC 2030. Capstone Turbine provides a path to that future with its clean and advanced turbines.

Beginning operation in August 2006, the 1350 AOA Capstone installation has experienced 99.4 percent availability – an almost unheard of figure for a distributed generation system.

"Installing Capstone Turbines is a way for building owners to differentiate their buildings in the marketplace so they can attract higher level tenants – and increase the value of their building at the same time. Because of their outstanding

### At a glance

#### 1350 Avenue of the Americas

#### Technologies

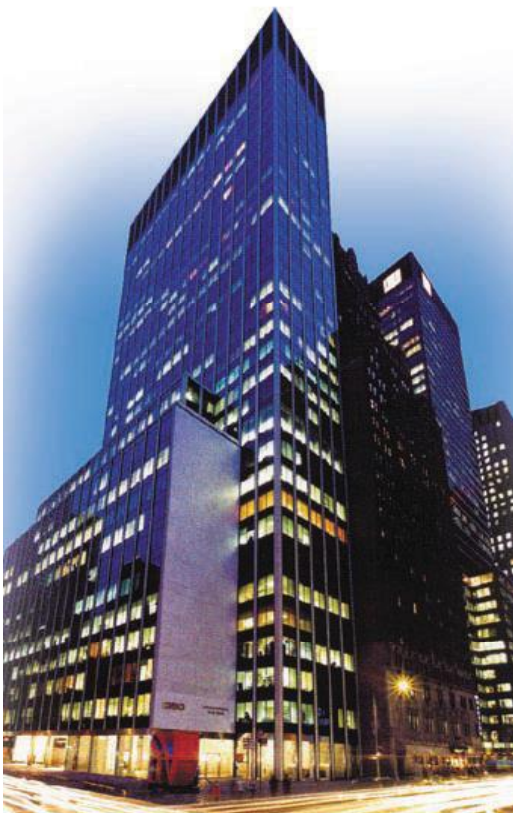
- 12 Capstone C60 High Pressure Dual Mode ICHP units generating 720 kW of clean and secure electricity.
- Capstone Heat Recovery Module on each turbine captures exhaust heat energy.

#### Customer

- OfficePower Inc., a Connecticut-based company that offers multi-tenant office building owners energy independence and financial competitiveness.
- Building: 1350 Avenue of the Americas, a 35-story office tower in Manhattan.

#### Results

- Capstone Turbines provide 35% of building's day-to-day electricity needs and up to 80% of heating needs.
- The turbines are 2 to 2.5 times more efficient than a central fire plant.
- Turbines cut the CO2 footprint in half, or better.
- During a "grid event" the turbines reconfigure near-seamlessly to provide back up power to designated "protected" loads.
- Building's total power costs are never more than the cost of remaining tied to the grid.





efficiency, reliability, almost complete lack of vibration, and super-green emission levels, Capstones are the right power generator for virtually all urban buildings," Wilson said.

OfficePower owns and operates the power plant in a long-term arrangement with the building owner. Under terms of the agreement, OfficePower ensures a building's total power costs are not more than the cost of remaining completely tied to the grid.

"Our economic business model aside, this is also about what we're bringing to the market by relieving the grid of some of its problems and how that, in turn, benefits the environment," Wilson said. "If we're twice as efficient as the grid, then we cut in half the CO<sub>2</sub> footprint of buildings on the grid. We partnered with Capstone because they share our vision of an energy option that not only serves building owners, but also is environmentally responsible."

OfficePower soon will have more Capstone-based installations in prime locations in New York City, including 200 Park Ave., 220 E. 42nd St., 230 Park Ave. and 666 5th Ave. ■

## How Does It Work? Air Bearing

By Marc Rouse, Capstone Product Manager

Perhaps the most intriguing Capstone innovation is our patented air bearing – a technological innovation that provides a lubrication solution superior to previously existing technologies. The use of air bearings in Capstone turbines provides longer engine life, requires no maintenance and reduces the unit's ecological footprint.

When two contacting bodies move past each other, no matter how smooth their surfaces, friction results in a resisting force. This resisting force and the heat it generates creates energy loss and leads to material breakdown and premature component wear. Lubricants are typically used to reduce friction between bodies and can help transfer heat generated by their relative motion against one another.

Lubricating oils are used in most systems to alleviate the many problems caused by friction. However, the introduction of a wet, environmentally unfriendly lubricating oil has severe drawbacks. In most traditional oil-lubricated systems, moving parts are separated by a thin oil film. This oil film is created and maintained through a complex series of pumps, switches and tubing. The oil is typically cooled with a radiator and kept particulate-free with a filter. The introduction of all these subsystems makes a failure to deliver clean, cool lubricating oil more likely, which will result in equipment



failure. These systems need regular maintenance to ensure their integrity. In addition, inspections, oil changes and filter replacements are required. The costs of maintaining a complex lube-oil system is high, both economically and environmentally.

Capstone's air bearings side-step many of these concerns by using ordinary air as a lubricating medium instead of oil. The principles of air-bearing operation are similar to those behind the operation of an air-hockey table – the turbine shaft rides on a cushion of air just as the puck in air hockey rides on a cushion of air over the table.

The unique aerodynamic shape of the Capstone air bearing pulls a very thin layer of air into space between

the rotating parts, which creates a near frictionless cushion of air. The two parts are no longer in contact and what little heat is generated within the bearing is dissipated as air flows through the bearing. The air-bearing system eliminates external lubrication systems; provides longer engine life; and requires no maintenance, no oil changes, no oil filter replacements and no inspections.

Every Capstone MicroTurbine uses air bearings and has only one moving part in the turbine generator. Traditional problems associated with turbine lubrication are greatly reduced with the use of air-bearing technologies. In short, Capstone offers the highest reliability and lowest maintenance electrical generators in the industry because of its air-bearing technology. ■

# Growing Interest in Propane Fuel

By Rene Flores, Capstone Applications Manager

Capstone-manufactured turbines always have operated on a variety of liquid and gaseous fuels; often in a straightforward fashion, and occasionally after the implantation of a fuel-conditioning process. As a result, Capstone now has turbines operating in an ever increasing array of unique applications worldwide.

Many potential Capstone customers are interested in propane, as it is a fuel that makes projects viable where natural gas is not available. Propane is relatively easy to store locally. In addition, the environmental (emissions) benefits of propane over traditional diesel systems allow turbines to operate continuously in locations that otherwise would be prohibitive with a diesel-fired engine.

With growing interest in propane, Capstone Distributors and Customers must consider several items when propane is selected as the fuel for a specific application. These items, when properly understood and planned for, will promote the reliable operation of a Capstone Turbine.

## Must remain in vapor form

Propane fuel, defined by Capstone as meeting ASTM D1835 (similar to HD-5 Special Duty propane), must remain in vapor form throughout the turbine fuel system at all times and for all operating conditions. Though propane is stored locally as a liquid, it must be consumed by the turbine as a gas. Failure to maintain the vapor form of the fuel poses considerable risk to the life of the turbine engine. Condensed propane constituents entering the engine lead to a sudden and

unexpected release of an enormous amount of energy; which in turn can trigger over-speed events, over-temperature events, engine shutdowns and potential engine damage.

Given the consequences of condensed propane constituents entering the engine, the Capstone Distributor and/or Customer must take various measures to ensure fuel remains in vapor form when delivered to the turbine. Such measures usually include the following:

- Consuming propane from the bottom of storage tanks
- Use of a pump
- Use of a vaporizer
- Proper selection of vaporizer type
- Installing a demister between vaporizer and turbine
- Heat trace and insulation of fuel lines after the vaporizer
- Maintaining turbine fuel system above fuel dew point temperature

Figure 1 is a generic representation of a propane fuel-delivery train featuring these items.

Drawing fuel from a tank's bottom as a liquid and using a vaporizer based fuel-delivery system helps ensure the turbine receives fuel at required pressure levels. If propane fuel is taken from the top of the tank, then fuel-delivery pressure is primarily dictated by local ambient conditions. If ambient conditions do not support the required rate of vaporization of liquid fuel within the tank, then delivery pressures to the turbine will drop, resulting in unreliable operation.

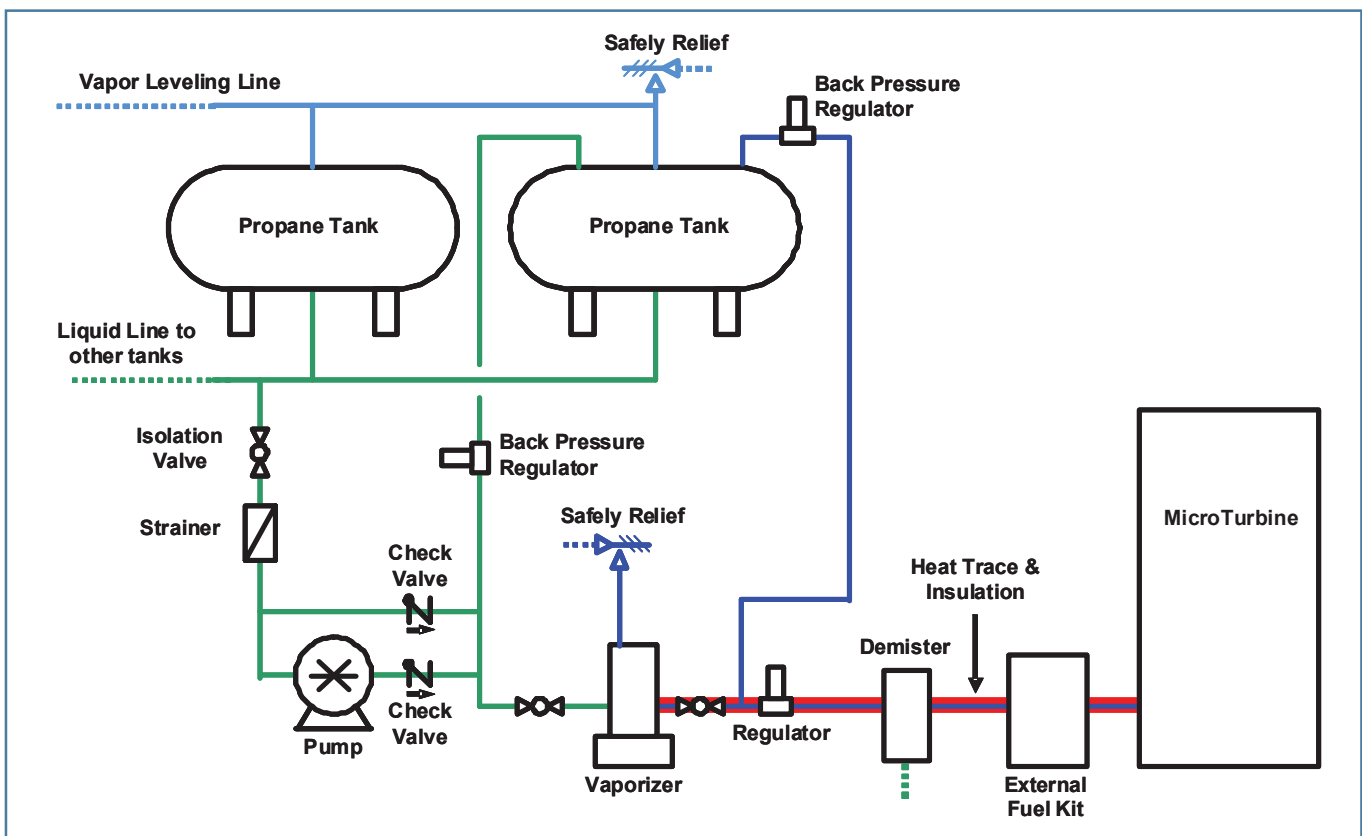


Figure 1: Generic Representation of a Propane Fuel-Delivery Train

### Type of vaporizer critical

Since propane-fired turbine applications tend to be stand-alone applications, vaporizer type also is critical to the turbine's reliable operation. A direct-fired vaporizer, for example, uses some fuel to vaporize the fuel; and as such, does not require power from the turbine for black-start conditions. However, code and safety considerations (e.g., NFPA 58) may dictate that such a vaporizer be located a minimum distance (usually 25 feet) from the turbine, which increases the need for heat tracing and insulation to maintain the fuel's vapor form after it has passed through the vaporizer.

Alternatively, electric vaporizers may be used (often rated for hazardous locations), allowing placement of the vaporizer near the turbine. Such vaporizers reduce the amount of fuel line heat tracing and insulation required for operation. But an external power source (e.g., a large battery bank) is required for black start conditions.

### Fuel settings, fuel inlet pressures & fuel system temps

Other items to consider are specific to the turbine itself and include turbine fuel settings, fuel inlet pressures and turbine fuel-system temperature. A Capstone C65, for example, requires a steady fuel pressure of 75-80 psig (517-552 kPa gage) at the fuel inlet for full power operation on natural gas.

In a propane application, however, the required inlet pressure is reduced to approximately 60 psig (414 kPa gage). Likewise, the required inlet pressure for full power operation of a C30 turbine is reduced to 45-50 psig (310-345 kPa gage). Under part-load conditions, the required fuel inlet pressures



Propane tank fueling microturbines at Ramon Station.

for the C30 and C65 may require further reduction to achieve stable and reliable turbine operation.

Turbine fuel settings also require adjustment for propane use. The fuel index value, used with turbines operating a smart proportional valve (SPV), require an adjustment to approximately 0.2 - 0.3 from the default value of 1.0 used with natural gas. Likewise, turbines operating with a Woodward fuel valve, such as the high-pressure C65, may require adjustments to the Wobbe Adjustment (wobadj) fuel parameter and/or the fuel type designation. **Note that adjusting the fuel-type designation from the default natural gas value to a propane designation currently requires assistance from a service provider certified as an advanced ASP, or a direct Capstone support representative.**

Just as the fuel-delivery system *after* the fuel vaporizer to the turbine must be heated and insulated, there may be need to maintain the fuel system *within* the turbine to temperatures above the fuel's dew point. While not always necessary, turbines operating in cold environments will experience a significant drop in fuel temperature within the turbine due to air passing through the enclosure for electronics and engine cooling purposes. Consult the Capstone Applications Engineering team for further information on various options available to keep the fuel system's temperature above the fuel dew point temperature.

Capstone Distributors who take these crucial items into consideration will offer reliable propane-based solutions to customers. With a growing number of propane-fueled turbine applications operating successfully, new customers now are able to reliably gain the benefits of a Capstone Turbine energy solution fueled with propane. ■



Fifteen 65 kW Capstone microturbines running on propane provide primary power for a booster station on an oil pipeline at Ramon Station in New Mexico, US.

## 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.

# Distributor Spotlight

## Sweet-Spot Analysis from E-Finity Distributed Generation



Capstone Distributor E-Finity Distributed Generation in Wayne, Penn., has developed an innovative – and effective – system to analyze a potential-customer's site, review data and determine if the site is a candidate for Capstone turbines.

"We call it a sweet-spot analysis," said Jeff Beiter, Managing Partner of E-Finity, "because the sweet spot is the minimum

BTU load the site requires, which then tells us how many turbines the site can utilize at 100% output. The analysis allows us to quickly and efficiently qualify a client site. Everything is done via computer, which saves us from driving to various sites and wasting fossil fuels. The analysis is an easy way to identify a customer's minimum thermal and electric requirements, and then know how much Capstone Turbine power the site can utilize."

Beiter and the E-Finity team target potential customers they meet at trade shows, via referrals from reps and "credible leads from our Mid-Atlantic dealer network," he said. The next steps are as follows:

1. Potential customers get a short introductory letter from E-Finity, an easy-to-complete 2-page questionnaire titled "Site Survey Form" (see Figure 1) and Capstone product data sheets.
2. The Site Survey asks quick questions about the customer's utility, base load (kW), peak load (kW), average monthly usage (kWh), if natural gas is available onsite and at what pressure, types of heating sources onsite and 12 months of gas/oil/steam bills for accurate sizing.
3. E-Finity analyzes the data, plugs figures into its Sizing Array Calculator (see Figure 2) and within 3 days, sends a 1-page proposal letter that identifies immediate energy savings and site benefits.
4. E-Finity follows up with a phone call within 2 days to set a face-to-face meeting.

"It's been successful for us," Beiter said. "We're sending out at least 2-3 of these a week and getting great response."

Capstone Distributors interested in learning more about E-Finity's Sweet-Spot Analysis can contact Jeff Beiter directly at (610) 688-6212 x 111 or [jbeiter@e-finity.com](mailto:jbeiter@e-finity.com).

E-Finity Distributed Generation LLC  
"The Power Take Independent"  
610-688-6212

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### Site Survey Form

**Note** This document is used to aid E-Finity with preliminary design of potential projects. It will help E-Finity to better understand the intended application of the MicroTurbine, as well as how the MicroTurbine will be installed.

**Note** The information contained in this document is intended solely for the individual or entity to whom it is addressed. You, the recipient, acknowledge and agree that implementation of any information contained in this document and/or compliance with Capstone specifications does not guarantee proper installation, commissioning or performance of any particular Capstone MicroTurbine or any particular application. Furthermore, you acknowledge and agree that you bear all liability for the implementation of any information contained in this document and that the information contained herein does not change, modify or impact the allocation of liability contained in any agreement between you and E-Finity or Capstone.

**Note** This information is proprietary to Capstone Turbine Corporation. Neither this document nor the information contained herein shall be copied, disclosed to others, or used for any purposes other than the specific purpose for which this document was delivered. Capstone/E-Finity reserves the right to change or modify without notice, the design, the product specifications, and/or the contents of this document without incurring any obligation either with respect to equipment previously sold or in the process of construction.

<b>E-Finity Dealer</b>	<b>Sales Person</b>
<b>E-Finity Contact</b>	
<b>Project Name</b>	
<b>Company Name</b>	
<b>Primary Contact</b>	Contact Name: _____ Phone No.: _____ Email Address: _____ Fax No.: _____
<b>Technical Contact</b>	Contact Name: _____ Phone No.: _____ Email Address: _____ Fax No.: _____
<b>Project Location</b>	City: _____ State / Province: _____

**General**

Project Timeline: \_\_\_\_\_  
 Building Use: \_\_\_\_\_

Does Facility Have Use for Standby Power in the event of a utility failure?  Yes  No

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**Electrical**

Utility: \_\_\_\_\_ Other: \_\_\_\_\_

Tariff: \_\_\_\_\_

Base Load (KW) _____ KW	Does Building Have Multiple Meters? <input type="radio"/> Yes <input checked="" type="radio"/> No
Peak Load (KW) _____ KW	
Avg Mo. Usage kwh _____ kwh	

**Note:** Please include 12 Months of Electric bills for economic analysis

Figure 1: Page 1 of the Site Survey Form E-Finity Distributed Generation sends to all potential customers.

Calculator By: Jim Bondi

### Sizing Array from Gas Bills

Note: Use month with a history of least usage for hydronic heating or hydronic & domestic  
Use 12 month average for domestic HW only

Amount	Units	
2000	Dekatherm	

Cost	Billing Days	Ccf/hour	Boiler Efficiency	Months Run/yr	Basin Run/yr Output
19512.2	30	27.10	75.00%	1031	2,095,528.98

Based on Monthly Average

# of Turbines	# of Turbines
5.14	2.51

\*Note: Using SS Heat Exchanger

**Step 1:** E-Finity inputs data from the month with least hydronic heating.

**Step 2:** Calculations determine number of turbines needed.

Figure 2: E-Finity's Sizing Array Calculator determines number of Capstone turbines needed.

# News from the Globe

**Tax Credit for Turbines & CHP Through 2016:** On Oct. 3, the U.S. Congress passed a bill extending the 10% investment tax credit for turbines through 2016 (up to \$200 per kW). The same bill contained a new 10% investment tax credit on CHP systems through 2016. You should seek advice from your tax professional on how to apply the credits.

**California Climate Change:** California is implementing its landmark bill – the Global Warming Solutions Act of 2006 – to reduce greenhouse gas emissions. Capstone is a member of the combined-heat-and-power group California established to provide input to the policy making process. Our goal is to ensure that climate regulation promotes the deployment of Capstone's low-emission turbines in the fight against climate change.

**Self Generation Incentive Program:** A recent bill to reinstate combustion technologies, including turbine CHP, into California's Self Generation Incentive Program rebate program failed its final step to become law before the close of the legislative session. Capstone is working with partners to reintroduce the bill in the next session, and is contributing input for a cost-benefit analysis underway that will impact SGIP going forward.

**U.S. Clean Heat and Power Association Annual Meeting:** On Oct. 2, President and CEO Darren Jamison and Director of Policy and Business Development, Justin Rathke spoke at USCHPA's annual meeting. USCHPA is the trade association for the clean distributed generation industry.

**PowerGen Asia:** Capstone presented a paper titled "A Japanese Biogas Microturbine Plant: Using Free Fuel to Generate Electricity, Heat and a Model for Carbon Revenue Streams" at the PowerGen Asia Conference in Kuala Lumpur, Malaysia, on Oct. 22. The paper was co-authored by Justin Rathke and Sohra Yatani and was selected as a runner-up paper for the Best Paper Award.

**FMA Congress:** To spread Capstone's message to high-level individuals in the building management, construction and commercial industries, Capstone will sponsor and deliver a presentation on its low-emission CHP systems at the FMA Congress in late October. Distributor E-Finity will present a case study on its successful Masonic Homes project.

**New 100% Biodiesel Installation in England:** Capstone recently installed one of its first microturbines running on 100 percent biodiesel in the luxurious 17th Century-built Ponsbourne Park Hotel in Newgate Street, England. The installation by Capstone Distributor Cogenco is located outside of the main building in a purpose built enclosure embedded in the well established gardens close to the main house.

**Capstone Joins the U.S. Green Building Council (USGBC):** The U.S. Green Building Council ([www.usgbc.org](http://www.usgbc.org)) is a non-profit organization committed to expanding sustainable building practices. USGBC is composed of more than 15,000 organizations from across the building industry that are working to advance structures that are environmentally responsible, profitable, and healthy places to live and work. As a National Corporate Member of USGBC, Capstone is now part of the nation's foremost coalition of leaders working to transform the way buildings and communities are designed. ■



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 infrastructures and reducing emissions of pollutants and greenhouse gases.

A UL Certified ISO 9001:2000 and 14001:2004 certified company, Capstone is headquartered in Chatsworth, California and has offices in New York, Mexico City, Milan, Nottingham, Shanghai and Singapore.

## Upcoming Events

29-31 October  
FMA Congress  
Hyatt Regency Inner Harbor  
Baltimore, Maryland

11-14 November  
2008 Global Distributor Conference  
Ritz-Carlton  
Cancun, Mexico

17-19 November  
Saudi Oil & Gas (SAOGE)  
Booth 622  
Dhahran, Saudi Arabia

2-4 December  
PowerGen International  
Booth 1646  
Orange County Convention Center  
Orlando, Florida

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