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Microturbines for Combined Heat & Power Generation at Hotels

By

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U.S. government statistics show that on average, America's 48,000 hotels annually spend nearly $2,200 per guestroom on energy – about 6 percent of all operating costs (energystart.gov). With this built-in overhead, it is clearly time for hotels to reenergize. Hotel managers know that increasing the number of returning guests requires a high level of service, comfort, and a commitment to high levels of energy consumption. Fortunately, energy consumption can now be tempered by advances in combined heat and power (CHP) generation. Executives quickly are learning alternative energy systems achieve greater energy efficiency and can dramatically reduce energy consumption – thus lowering both operating costs and greenhouse gas emissions.

Combined Heat and Power with MicroTurbines

CHP is the simultaneous production of onsite electricity and thermal power from a single fuel source, which also is known as cogeneration.

Three natural gas microturbines provide electrical and thermal power at the Four Seasons Hotel Philadelphia.

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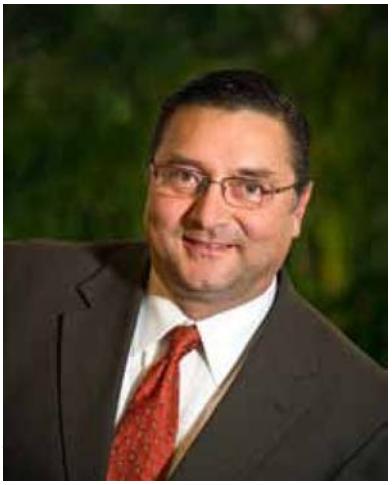

An Interview with

Marvin Dixon

Director of Engineering

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By

Robert Elliott

TO GET US STARTED, COULD YOU TELL OUR READERS A LITTLE ABOUT YOURSELF AND YOUR PROPERTY?

"As Director of Engineering at Four Seasons Hotel Philadelphia, I am responsible for overseeing the engineering functions of a 330,000 square foot luxury hotel. The Four Seasons Hotel, Philadelphia was built in 1982, is an 8 story property with 364 guestrooms and approximately 10,000 square feet of meeting space. The building is a sub-meter to the adjacent office building for the chilled, hydronic heat and electric services. We have a dedicated gas and district steam service feeding the hotel."

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INTERVIEW WITH Marvin Dixon

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Marvin Dixon joined Four Seasons Hotel, Philadelphia as Director of Engineering in February 2004. Prior to joining Four Seasons Hotel Philadelphia, Mr. Dixon served as the Regional Chief Engineer at GF Management in Philadelphia. While with GF Management, Mr. Dixon was responsible for overseeing the engineering functions for the Valley Forge Convention Center, Hilton at University Place, Holiday Inn Center City, Airport Hilton, Sheraton Baltimore North, and Four Points Hotel by Sheraton Rochester Riverside. As Director of Engineering, Mr. Dixon worked with each property to oversee engineering functions, energy controls, preparation and approval of capital projects and renovations.

In addition, Mr. Dixon has worked as the Director of Engineering at Pocono World Hotels and Omni Richmond Hotel, and was the Chief Engineer at Radisson Suite Hotel in New Orleans, Louisiana.

A native of Kentucky, Mr. Dixon attended Lexington Technical Institute where he studied Mechanical Engineering. He has also attended Rheem Heat Pump School in Lexington, KY; Servidyne in New Orleans, LA; and South Side Vocational School in Lexington, KY.

Mr. Dixon resides with his wife and children in Chester County, PA where he enjoys riding horses and spending time on his farm.

I SUSPECT YOU WILL BE THE ENVY OF MANY OF OUR READERS WITH THE ABILITY TO RIDE HORSES ON A DAILY BASIS, NOT WHAT YOU WOULD EXPECT FOR A LARGE METROPOLITAN BASED PROPERTY. WOULD YOU TELL US A LITTLE ABOUT YOUR STAFF? I UNDERSTAND THEY ARE RESPONSIBLE FOR A GREENING PROGRAM THAT HAS BEEN QUITE SUCCESSFUL.

"I am directly responsible for implementation and maintenance of the engineering department's procedures, and work with my staff to ensure that the department confirms with the brand's quality system procedures. Since joining Four Seasons Hotel Philadelphia, I have been instrumental in assembling the staff "Green Team," a group of employees committed to ensuring that the hotel strives to be eco-friendly in their day-to-day operations." Under his guidance, Four Seasons Hotel Philadelphia instituted a comprehensive recycling and composting program, achieving an overall 33% waste stream diversion and reducing landfill waste by 47% from 2006 to 2009.

Additionally, Mr. Dixon's staff consists of himself, Director of Engineering (DOE), 1 Assistant DOE (Bob Siuta), 1 Administrative Support (Dawn Montaque), 2 Painters, 1 carpenter, 1 wood/furniture refinisher, 7 shift engineers, and 1 room PM.

YOUR PROPERTY HAS BEEN VERY PROACTIVE IN MANAGING ENERGY. CAN YOU TELL OUR READERS A LITTLE BIT ABOUT SOME OF YOUR INITIATIVES AND THE CHALLENGES OF USING MICRO-TURBINES?

The installation of the Combined Heat and Power (CHP Micro-Turbines) has really launched the department into new ways of managing and how we look at energy. Instead of trying to count kwhrs, ccf, mcf, mlbs of steam, tons of chilled water or therms, we convert it all over to btu's of heat by metering. And the approach we have, is to look at how we can better control the heat, because, it does not matter what source of energy you have entering your building, when you consume energy it turns into HEAT. And, then you either remove it through the A/C system, dump it down the drain, or exhaust it out a ventilation system. This means you use it once and then throw it away. Our new approach is that we now recycle the same heat that we used to be so quick to discard. We have been able to do this by reconfiguring our existing hydronic heating piping as a storage cell for heat. This opens up new opportunities for use to capture the waste heat from laundry, kitchen exhaust, refrigeration condenser loops and other sources that we use to remove heat. I am very proud of department staff and how well they manage the heat from the turbine. It has opened up new ideas in the ways we think and operate.

I UNDERSTAND YOU DID YOUR HOMEWORK BEFORE SETTLING ON A HEAT RECOVERY SYSTEM. CAN YOU TALK TO THE SYSTEMS YOU HAVE CHOSEN FOR YOUR PROPERTY TO HELP CONTROL UTILITY COSTS AND ENERGY CONSUMPTION?

Here at the Four Seasons we were challenged with finding a better solution for controlling our utility costs. After our due diligence in searching for a CHP system was complete, we settled on Capstone CHP systems here at our property. Their units technologically meet all of our needs

Instead of trying to count kwhrs, ccf, mcf, mlbs of steam, tons of chilled water or therms, we convert it all over to btu's of heat by metering.

with regard to sound, vibration, maintenance, and performance. The system cost was hard to budget and forecast because our utility costs were changing monthly with the fluctuating cost of a barrel of oil. Prior to installing the Micro-Turbines, the Hotel heated all of its domestic water with steam from the local District Steam Company, which was the operation's most expensive source of energy.

SO WHAT DID YOU FIND? DID THE CHP SYSTEM MEET YOUR EXPECTATIONS?

The entire project cost $1.1 million and included (3) 65kW units, new high pressure gas service to building, hot water piping and heat exchangers. In the first full year of operation the impact of the Turbines was significant. Had the facility not had the Micro Turbines installed, they would have seen a $376 thousand increase in energy cost.

ARE YOU CONTINUING TO SEE SUCH POSITIVE SAVINGS?

Today the Hotel is self generating 30% of all it's electrical needs, and the waste heat that is rejected from the Turbines meets the amount of heat needed to heat all of the hot water for the laundry, Guest tower, Kitchen operation and 10%-15% of the building's space heating needs. The Hotel is also able to more accurately forecast our energy cost and insulate itself from any market fluctuations by purchasing 1-2 year supplies of natural gas while the market price is low.

SO WOULD YOU DO IT ALL OVER AGAIN KNOWING WHAT YOU KNOW NOW?

As a five-star luxury hotel, the world-renowned Four Seasons Hotel in Philadelphia uses a tremendous amount of energy each day for cooking, heating, lights, laundry, showers, swimming pools and more. So, with management wanting to gain control of energy costs and reduce greenhouse-gas emissions, we decided to generate the hotel's own onsite power. In October 2009, the 8-story hotel had three natural-gas microturbines installed on its roof at One Logan Square in downtown Philadelphia.

The microturbines' combined heat and power (CHP) technology allows the hotel to generate nearly 200-kilowatts of electric power, which is about 30 percent of the hotel's overall electricity needs. Exhaust heat from the microturbines is captured and used to heat water for laundry and other hotel operations. In fact, the energy-efficient CHP application provides 100 percent of the building's day-to-day domestic hot water and 15 percent of its heating needs.

Before installing the microturbines, the hotel relied heavily on the City of Philadelphia's steam loop and the local electric grid to meet its energy needs. Today, the hotel uses natural gas to produce its own electrical and thermal power

CAN YOU TELL US ABOUT THE SAVINGS IN BOTH DOLLARS AND BTUS?

"There is a great link: buy cheap gas, own your own turbine and produce your own electricity. We buy third-party transportation gas and we shop around for the best rate. This has made electricity from the microturbines 20 percent cheaper than what we could get from utility."

The hotel reconfigured its hydronic heating loop into a system that captures heat from the microturbines and distributes it throughout the building. "With such a highly efficient process, the hotel is able squeeze every dollar out of each BTU. Instead of dumping rejected heat into the atmosphere, we can reuse it," Dixon reports. "During the first 27 days of operation we saw a cost avoidance of over $27,000."

ARE THESE SYSTEMS LOUD?

Aesthetically the system is quiet and takes up minimal space, which was a key reason microturbines were selected over reciprocating technology. With a noise output of only 65 decibels at 10 meters, the microturbines are not a nuisance to the Presidential Suite guests directly below. "Reciprocating engines have to be rebuilt at 22,000-23,000 hours, have oil replaced regularly, consist of lots of moving parts, and have high vibration and noise. We can't have noise at a hotel – that would be a disaster," he added.

DOESN'T NATURAL GAS HAVE LESS CARBON EMISSIONS THAN COAL PRODUCED ELECTRICITY?

The rooftop microturbines, which sit amid prime metropolitan real estate, are also ultra-low in emissions (less than 9 parts per million) — making this onsite power generation system a clean-and-green, environmentally friendly option.

Marvin expects more hotels will utilize the proven technology. In fact, the Philadelphia Four Seasons itself plans for a 2nd phase installation to occur that will include two additional microturbines and an absorption chiller which will meet the growing hotel's future energy and air-conditioning needs.

"Four Seasons is a leader in the community and accustomed to setting the standard for future generations," Dixon said. "The microturbine installation is a step in the right direction in helping Philadelphia become a more sustainable city."

For all of their efforts in lessening their carbon footprint, under Mr. Dixon's guidance Four Seasons Hotel Philadelphia received the 2007 Philadelphia Commercial Recycling Award and 2008 Corporate Energy Management Award. Mr. Dixon's efforts in establishing and implementing green initiatives has also resulted in Four Seasons Hotel Philadelphia being recognized by the Environmental Protection Agency (EPA) as a case study on composting in the hospitality industry. Mr. Dixon was recently named 2009 Energy Manager of the Year by the American Energy Engineers Association.■

Microturbines for Combined Heat & Power Generation at Hotels

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In addition, CCHP (combined cooling, heating, and power or trigeneration) provides the ability to power heat and cool a facility from a single fuel source. Hotels, hospitals, data centers, office buildings, and even wastewater treatment plants are among the growing number of industries installing microturbine-powered CHP and CCHP systems to increase operational efficiency, ensure energy reliability, and lower emissions and energy bills.

In a CHP or CCHP application, microturbines produce reliable electricity and thermal power onsite from a single fuel. CHP and CCHP systems have the ability to run on such alternative fuel sources as natural gas, propane and biogas. As microturbines generate this low-emion electricity, their exhaust heat is captured and recycled for direct heating, hot water, steam, and process heating and/or cooling, thus greatly increasing system efficiencies and significantly lowering energy costs.

According to the United States Clean Heat & Power Association, CHP systems currently:

- Produce almost 8 percent of U.S. electric power;
- Save building and industry owners over $5 billion/year in energy costs;
- Decrease energy use by almost 1.3 trillion BTUs/year;
- Reduce NOx emissions by nearly half a million tons/year;
- Reduce SO2 emissions by nearly 1 million tons/year;
- Prevent release of over 35 million metric tons of carbon equivalent into the atmosphere.

By generating electricity and thermal power onsite, microturbines eliminate or reduce the need to produce electricity from such high-emission and expensive sources as large electric utility plants. When coupled with heat recovery systems that capture exhaust thermal energy to heat spaces and/or water, microturbines also reduce the need to use conventional heating technologies such as boilers and furnaces, which emit significant quantities of carbon dioxide, nitrogen oxide, and carbon monoxide, and require additional fuel.

In a CHP or CCHP application, microturbines produce reliable electricity and thermal power onsite from a single fuel.

In a CCHP application, an absorption chiller is added to the system, which turns the heat into a cooling source that often is used for low-cost and highly-efficient air conditioning.

Microturbines are optimal for providing electricity in CHP or CCHP applications because they are compact, flexible in connection methods, have the ability to be arrayed in parallel to serve larger loads, provide reliable energy, and emit ultra-low emissions.

What is a microturbine?

Microturbines are small, clean-and-green gas turbine systems manufactured with "jet engine" technology. Rotating speeds of microturbines are extremely high ranging from 45,000 revolutions per minute (RPM) to 96,000 RPM. This high RPM results in generator outputs that are high frequency alternating current (AC). These sophisticated distributed energy sources can operate in parallel with or independent from the utility grid.

On average, microturbines operate at 99 percent availability. This equates to 25 more operating days per year than a reciprocating engine, which averages 92 percent availability. Microturbines operate on a number of different fuels, including propane, diesel, bio-diesel, digester gas, landfill gas, jet fuel, and compressed natural gas, making them flexible for a variety of applications. These highly reliable alternative energy sources produce 30 kilowatts (kW) to 5 megawatts (MW) of power with energy efficiencies often nearing 80 percent when used in a CHP or CCHP application.

Advances in technology have produced air-cooled microturbines that operate with only one moving part. This makes the system completely dry and void of such maintenance-heavy components as water pumps, oil pumps, oil filters, radiators, and fan belts. Microturbines can run for extended periods at full power output and require minimal scheduled maintenance when compared to reciprocating engines, making them ideal for stationary prime power applications.

Microturbines help preserve the environment with their near-zero emissions profile. Installing a highly efficient microturbine is equivalent to removing up to 700 average U.S. passenger vehicles off the road, or the equivalent carbon dioxide reduction of planting 730 acres of pine and fir forest. According to the U.S. Environmental Protection Agency (EPA), microturbine systems – with or without heat recovery – can reduce emissions of carbon dioxide, methane, and pollutants including nitrogen oxides, sulfur dioxide, carbon monoxide, particulate matter, ammonia, and total hydrocarbons.

National and state governments recognize the environmental and economic value of microturbine CHP systems and often provide incentives to offset the costs of new installations.

Microturbine CHP Trends in Hospitality

According to the EPA, hotels and casinos are opportune – yet underutilized – markets for CHP and CCHP. "Of the nearly 48,000 hotels in the United States, about 10,000 have the energy characteristics suitable for current CHP technology," an EPA report states (www.epa.gov/chp/markets/casinos.html) . "More than 1,000 of these sites are likely to meet a simple payback on their investment within five years or less."

Microturbine CHP and CCHP systems in hotels and casinos:

- Reduce operating costs
- Improve energy efficiency and overall environmental performance
- Ensure guest comfort as hot water is available at all times
- Provide reliable electricity for gaming venues, even during utility blackouts
- Limit cost uncertainties by creating a

hedge against future fluctuating energy prices

The Ritz-Carlton in San Francisco, Igora Ski Resort in Russia, Four Seasons Hotel Philadelphia, and a five-star resort in Italy are among the many hotels and resorts that have turned to microturbines for reliable, efficient, clean-and-green power.

Four Seasons Case Study

To gain control of energy costs and reduce greenhouse gas emissions, the luxurious Four Seasons Hotel Philadelphia installed three Capstone C65 ICHP MicroTurbines® in 2009. Within the first two months of operation, the hotel reduced its energy cost by more than $80,000. The microturbines' CHP installation allows the hotel to generate nearly 200kW of electric power onsite, which fulfills 30 percent of the hotel's overall electricity needs.

The energy-efficient CHP system provides 100 percent of the heat needed for the building's domestic hot water used for laundry, the kitchen, and guest rooms, and satisfies 10-15 percent of the hotel's heating needs.

Before installing the C65 microturbines, the hotel relied on the City of Philadelphia's steam loop and the local electric grid to meet its energy needs. Today, Four Seasons Hotel Philadelphia uses natural gas to fuel the microturbines on the hotel's roof to produce its own electricity and thermal energy.

With such a highly efficient process, the hotel is able to squeeze every dollar out of each BTU because now we have a way to capture the heat, store it, and use it when we need it.

"Because we buy third- party transportation gas, we can shop around for the best rate," said Marvin Dixon, director of engineering at Four Seasons Hotel Philadelphia. "This has made electricity from the microturbines 20 percent cheaper than what we could get from the local utility."

Aesthetically, the system is quiet and takes up minimal space on the roof, a key reason the C65 microturbines were selected over reciprocating technology. With a noise output of only 65 decibels at 10 meters, the microturbines are not a nuisance to the Presidential Suite guests directly below.

"This new process with microturbines allows for more control over heat distribution and BTUs (British Thermal Unit)," Dixon said. "With such a highly efficient process, the hotel is able to squeeze every dollar out of each BTU because now we have a way to capture the heat, store it, and use it when we need it. This has opened new opportunities for the hotel to use the heat storage for other processes."

Dixon expects more hotels will use the proven CHP technology. In fact, Four Seasons Hotel Philadelphia plans for a Phase II installation that will include two additional microturbines and an absorption chiller to meet the growing hotel's future energy and air-conditioning needs.

"Four Seasons is a leader in the community and accustomed to setting the standard for future generations," Dixon said. "The microturbine installation is a step in the right direction in helping the hospitality industry become more sustainable." ■