

# Two for One

Although a mature technology, combined heat and power (CHP) is in demand more than ever, thanks to its ability to cut costs, energy consumption, and greenhouse gas emissions.

By Eric Johnson

During the Soviet era, when Russian art and architecture were ruled by socialist realism, the Moscow City project would have been unthinkable. This €10 billion forest of gleaming skyscrapers both looks and feels like better-known bastions of capitalism at

London's Canary Wharf or La Défense in Paris. Today, the Moscow International Business Center, as it is officially named, is set only 4 kilometers west of the Kremlin. Still, deep beneath its glass-and-steel skin beats the heart of an energy

## Combined Applications – Many Uses for CHP

As a world leader in power technology, Siemens is a major player in both industrial and communal CHP, primarily as a turbine supplier. Some of its success stories are:

**Moscow City, Russian Federation:** The 226-MW cogeneration plant consists of two combined-cycle blocks, type SCC-800 2 x 1, both in operation. Each block is based on two Siemens 45-MW SGT-800 gas turbines and one 30-MW SST-700 district heating condensing steam turbine. The plant provides district heating and power to the new international business center. The gas turbines are the heart of the CHP power plant and the key element of its efficiency. The hot exhaust gases from the gas turbines generate steam in the heat recovery steam generator (HRSG). The steam produced by the HRSG is fed to the steam turbine, which is connected to a two-stage district heating condenser system.

**River Bay, New York City, USA:** In temperatures that often top 30 °C in summer, yet frequently dip well below freezing in winter, 60,000 residents of a housing development

here opted for a 40-MW unit that delivers power, heat, and cooling at 76 percent total efficiency. The combined-cycle trigeneration plant consists of two Siemens SGT-400 gas turbines of 13 MW each, and one SST-300 steam turbine. The 2007 changeover from conventional supply saves the residents US\$15–25 million per year in fuel charges, which is expected to pay back capital costs in less than five years.

**Hannover, Germany:** In an existing cogen plant operated by City of Hannover Municipal Utility, Siemens is providing a 96-MW dual-casing re-heat steam turbine plus a state-of-the-art process control system. The revamp should be up and running for the start of the 2011–12 heating season.

**Igelsta, Sweden:** In 2007, Siemens supplied a 90-MW SST-800 steam turbine to Söderenergi's CHP plant that is fired by peat and residue from paper production. The complex – which was started in 1982 and now encompasses four boilers that supply up to 190 MW heat to 200,000 locals – was originally fueled by coal, but has since switched entirely to a mix of biofuels and waste.

Established energy for a new era:  
The Moscow City complex is powered  
by CHP technology.

Photo: Siemens



The HRSG-fed cogen turbines provide heating and power to the business district of Russia's capital.

system that harkens back to the communist era: a combined heat and power (CHP) unit that provides electricity and warmth to 300,000 office workers and residents (see sidebar 1). Also called cogeneration (cogen), CHP was a pillar of Soviet energy policy, and Russia ranks third in CHP penetration behind Finland and Denmark. Most of the leading countries (Figure 1) have a traditional commitment to CHP. Indeed, the idea of combining heat and power generation is as old as the origins of the electricity industry; this is a mature technology (see sidebar 2). In recent years, however, it has met with revived interest – especially from policy makers. Cogeneration offers a crucial counterpoint to the triple threat of high oil prices, energy inse-

curity, and global warming. Moreover, growth is there for the taking: According to a report by the International Energy Agency (IEA) on the benefits of greater investment in CHP, cogen today accounts for only 9 percent of global power, a figure that experts say could double over the next two decades.

### Good to the Last Drop

CHP's appeal is due to efficiency. Rather than converting 40 percent of incoming energy to electricity and ejecting the remaining 60 percent as waste – which, according to the IEA, are the global averages for the power industry – cogen makes use of the heat as well. Typically, the average efficiency is doubled, reaching maxi-

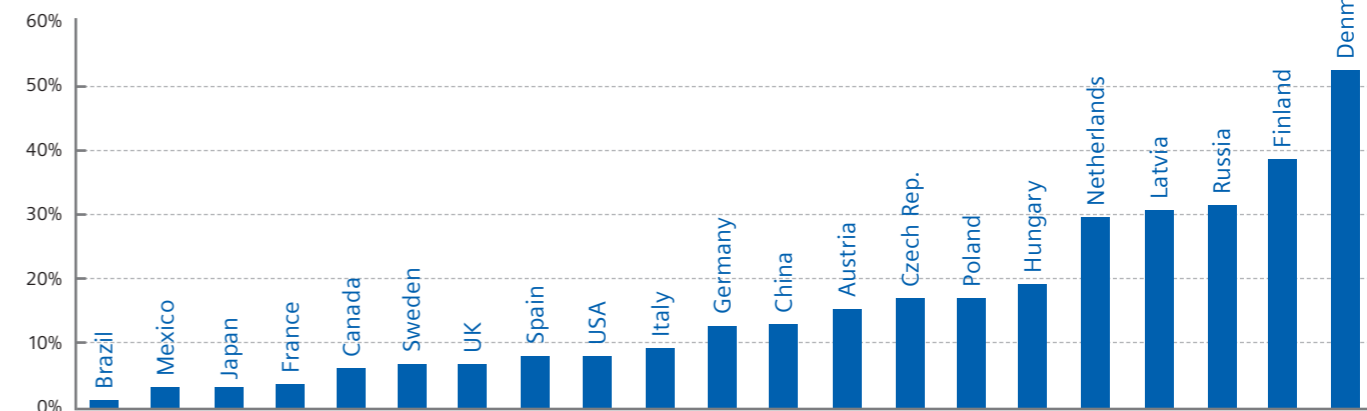
mum ranges of up to 80 to 90 percent. Further savings can be realized in terms of a generator's key performance indicators. Capital costs (per MW of total capacity), operating costs, and pollutant emissions all fall by up to one-half. Even better, as a greenhouse gas mitigation method, CHP in industrial plants and commercial buildings is one of the few “negative cost” methods of cutting carbon, according to a study by the US Oak Ridge National Laboratory (ORNL). In other words, rather than subsidizing biofuels or solar power to reduce the carbon dioxide being pumped into the atmosphere, cogeneration delivers substantial cost savings up front, with carbon reductions as a bonus.

A further advantage is the possibility of lowering dependence on fuel imports. Energy security naturally rises with CHP, because the same amount of energy can be wrung out of less fuel. The political and economic benefits of efficiency are obvious. Just ask motorists who have watched the price of gasoline and diesel climb more than 100 percent over the past decade whether they would welcome a doubling of their car's fuel economy.

### What's Not to Like?

All of which brings us to the cogen conundrum. If this technology is so attractive, why is CHP not more widely employed? One reason is that while most everybody uses electricity, not everyone needs heat. While industrial cogen uses process steam all year round, CHP for commercial or residential heating tends to dump a large part of its load in the summertime. The solution is a technical fix known as trigeneration. In developments such as the River Bay Power Plant (see sidebar 1), a combined cooling, heating, and power (CCHP) plant supplies electricity all year, plus heat in the cold months and cooling in the warm ones. However, the biggest stumbling block to CHP's expansion is not so much technical as political. Three barriers, says the IEA, are most prominent:

## CHP Penetration: an International Comparison



Source: IEA, *Combined Heat and Power: Evaluating the Benefits of Greater Global Investment* (2008).

- Planning disconnect – supply networks such as in Helsinki, Finland, where 92 percent of homes are connected to CHP-fired district heating, tend to be the exception. More integrated heating and cooling systems are needed.
- Grid disconnect – cogenerators need to have certainty that they can profitably sell excess electricity to their regional grid.
- Knowledge disconnect – even in expert circles, CHP is overlooked as a key solution to the ongoing energy and carbon crises. Moreover, a clear method to calculate its energy-saving and environmental benefits is lacking.

Encouragingly, the IEA and other experts report that governments are beginning to tackle these barriers in earnest, using tools such as accelerated planning consents, price guarantees for cogenerated power, tax credits, and capital grants. Leading the pack is Germany's federal government, which has legislated a program to double the share of CHP in national power generation to 25 percent by 2020. Other governments – the USA, the EU, and the Russian Federation – have been weighing in with similar schemes. Admittedly, these structural changes are fundamental and time-consuming. Progress will be measured in

## Cogent Cogen – a Bit of the Basics

Fuel goes in, is burnt, and releases power, delivered by the rotation of the turbine rotor. In a conventional generating plant, this is converted to electricity, end of story. A CHP plant goes one step further, also converting the turbine's waste heat to usable heat. This can be linked to combined-cycle generation; there can be supplemental firing if extra heat is needed; and cooling (instead of heat) can be supplied by absorption chilling (an established technology used on a much smaller scale in camping refrigerators, for instance).

An estimated 80 percent of the world's existing CHP capacity is found at industrial sites, typically in the chemicals, metals, oil refining, and pulp sectors. These need a steady supply of process heat, which conveniently can be piped over the fence from the generator. They are also equipped with switchgear and connections to pump excess electricity production into the power grid.

CHP's greatest growth potential lies in the commercial, institutional, and residential sectors – for instance, in developments such as Moscow City (see sidebar 1). Office buildings, hotels, and hospitals have significant energy costs as well as balanced, constant electric and thermal loads, yet many owners are unaware of the benefits of CHP.

years and decades. But the goal is similar to that of the developers of Moscow City: to make the unthinkable thinkable and the impossible possible, to make CHP and CCHP a major part of the world's future energy mix.

*Eric Johnson writes about technology, business, and the environment from Zurich.*

### Further Information

[www.siemens.com/energy/chp](http://www.siemens.com/energy/chp)

#### The following literature can be found on the Internet:

IEA, *Combined Heat and Power: Evaluating the Benefits of Greater Global Investment*. February 2008.

ORNL, *Combined Heat and Power: Effective Energy Solutions for a Sustainable Future*. December 2008.

Deutsche Bank, *Combined Heat and Power: A Pillar of Germany's Integrated Energy and Climate Programme*. May 14, 2008.

Photo: Siemens, Graphic: independent