BY WINSTON HUFF, CPD, LEED AP

What You Can Learn During a Long, Cold Night in Denmark

With a district energy system, the type of fuel can be changed in the central energy plants, while the heating and water distribution systems remain the same at the points of use.

While tapping my fingers impatiently on the steering wheel of my MG Midget, stuck in a long line for gas, I was reminded of the oil embargo of the early 1970s. If you thought the United States was in bad shape back then, imagine living in Denmark. At that time, 92 percent of Danish energy came from oil, and overnight, prices doubled or tripled. In extreme cases, oil wasn't available at all, and people shivered in their homes. Forty years later, that experience is still shaping Danish energy policies.

I recently spoke at the High Performance Buildings Summit at the Grundfos Center in Bjerringbro, Denmark and had the chance to talk to some Danes who had lived through the embargo, as well as some younger people who had only heard about it. Everyone was equally dedicated to Denmark's energy independence.

Soon after the oil embargo, Denmark made the change to coal, which was an improvement over oil, but still not the best option. Then they switched to natural gas, which came from the country's north shore wells. This has been a much better solution, but the gas supply is predicted to last only 20 more years. The Danes could buy gas from Russia, but that would make them vulnerable to another country's politics again.

Today, oil is only about 5 percent of Denmark's energy source—more than 40 percent is from renewable sources, while coal and natural gas make up the rest. It is a matter of national pride to remain energy independent, and the search is on for new technologies such as district energy, carbon-neutral buildings, and decentralized waste.

DISTRICT ENERGY

Since the 1970s, the Danes have increased the capacity and coverage of their district energy systems. These district systems heat water and distribute it via a piping network to businesses, factories, and homes. As a result, buildings do not have expensive boilers, furnaces, and water heaters on site. Rather, they have heat exchangers for domestic hot water and piping systems that distribute the hot water in radiant heating systems.

Due to this type of centralized system, the fuel source can be changed in the central energy plants, while the heating and water distribution systems remain the same at the points of use. In contrast, in most U.S. cities, changing the energy type would necessitate changing the water heaters, furnaces, boilers, piping, and electrical distribution systems in each building.

Several central energy plants in Denmark use natural gas, coal, and sustainable fuels that feed the system. Some of these plants can generate either electrical power or thermal heat for the district energy system. Many wind turbines in the country generate electricity, and in the near future these turbines may be upgraded to either generate electricity or heat water for the district energy systems.

District energy has not been used in the United States as it has been in Denmark. Some cities such as Madison, Wisconsin, New York City, and Nashville, Tennessee have invested in systems, but they are rare. Making the sell in the United States is always hard, and one reason is due to our short-term perspective of payback. However, if the United States had invested in these systems in the 1970s, we would be reaping the rewards now.

DECENTRALIZED SEWERS

Centralized heating systems can reduce cost, but this is not always the case with wastewater systems. Centralized wastewater and drinking water facilities use a lot of energy. *Evaluation of Energy Conservation Measures for Wastewater Treatment Facilities* by the U.S. Environmental Protection Agency reported in September 2010 on the energy usage in these facilities:

"Providing reliable wastewater services and safe drinking water is a highly energy-intensive activity in the United States. A report prepared for the Electric Power Research Institute (EPRI) in 1996 estimated that by the end of that year, the energy demand for the water and wastewater industry would be approximately 75 billion kilowatt hours (kWh) per year, or about 3 percent of the electricity consumed in the U.S. (Burton 1996). The Consortium for Energy Efficiency (CEE) now estimates the annual energy usage at approximately 100 billion kWh per

Figure 1 This compact wastewater treatment plant, which can pretreat waste from approximately 1,000 homes, is installed in shipping containers for ease of transport. Photos courtesy of Grundfos

year (Burton 1996, extrapolated by CEE). At an average energy cost of $0.075 per kWh, the cost for providing safe drinking water and providing effective wastewater treatment is approximately $7.5 billion per year."

Municipal systems pose other problems as well. Outdated combined storm water and wastewater systems often overflow untreated wastewater into natural water sources during rain events. Large wastewater systems take up significant areas of land and require complex and costly facilities, and many municipal wastewater facilities cannot add new customers to the distribution system due to infrastructure and economic limitations. As a result, buildings owners have been forced to install their own wastewater systems on site.

These problems have created interest in decentralized wastewater systems, or portable systems that can be upgraded and moved when the demand changes. These systems could be installed in buildings or be accessible to clusters of buildings to treat wastewater on site.

In Denmark, a BioBooster system is being developed that will be available in the United States in the near future. This system was installed in the Viborg municipality in Bjerregrav, Denmark to replace a small-scale municipal wastewater treatment plant that handled the waste of approximately 1,000 homes. The unit utilizes an efficient biofilm biological wastewater treatment system, constructed in a reactor called a PBR (pressurized biofilm reactor), which reduces the biological load in the process wastewater. This system can be used in buildings to pretreat waste before it flows into the municipal system. For full water treatment, an MBR (membrane bioreactor) can be added to the system. It is installed in shipping containers for ease of installation and removal to other sites.

CARBON NEUTRAL HOTEL

In Copenhagen you can find what some consider the No. 1 green hotel in the world. The 366-room Crowne Plaza Copenhagen Towers is the first hotel in Denmark to meet the standards of the EU Green Building Programme and the Danish Building Regulations for Low Class 2 buildings. It also is the first carbon-neutral hotel building.

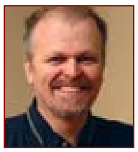
The largest facade of the hotel has an integrated solar panel park—the largest privately owned solar park in northern Europe—that provides electricity for the building. The unique heating and cooling system uses two sets of wells connected to an underground aquifer, one to store hot water and the other to store chilled water. When the building needs cooling, it pulls water from the chilled water wells and transfers heat to water that is stored in the heated water wells. When heating is needed, the heated water wells provide heat to the building, while the chilled water is sent to the chilled water wells.

The hotel gets guests involved in energy reduction by taking efficient energy production one step further with electricity-producing bicycles in the fitness center. Any guest who produces 10 watt-hours of electricity or more for the hotel is given a locally produced complimentary meal, encouraging guests not only to get fit, but also to reduce their carbon footprint and save electricity and money.

Crowne Plaza's other energy-saving initiatives include the following:

- From the fifth to the 25th floors, the hotel facades are covered with solar panels that produce more than 170,000 kWh a year—equivalent to the energy consumption of 55 private households.
- The groundwater-based cooling and heating system, which also heats the domestic hot water, is expected to reduce the energy used to heat and cool the hotel by almost 90 percent.

The overall result of all energy-saving initiatives is a 53 percent reduction in the hotel's energy consumption and an estimated reduction of 1.4 tons yearly in the hotel's carbon emissions. PSD



Winston Huff, CPD, LEED AP, is a project manager, plumbing fire protection designer, and sustainable coordinator with Smith Seckman Reid Consulting Engineers in Nashville, Tenn. He is on the U.S. Green Building Council's Water Efficiency (WE) Technical Advisory Group (TAG). He was the founding editor of Life Support and Biosphere Science and has served as its editor-in-chief. He is editor of Me Green You Green (megreenyougreen.com), a LEED credit data bank. For more information or to comment on this article, e-mail **articles@psdmagazine.org**.