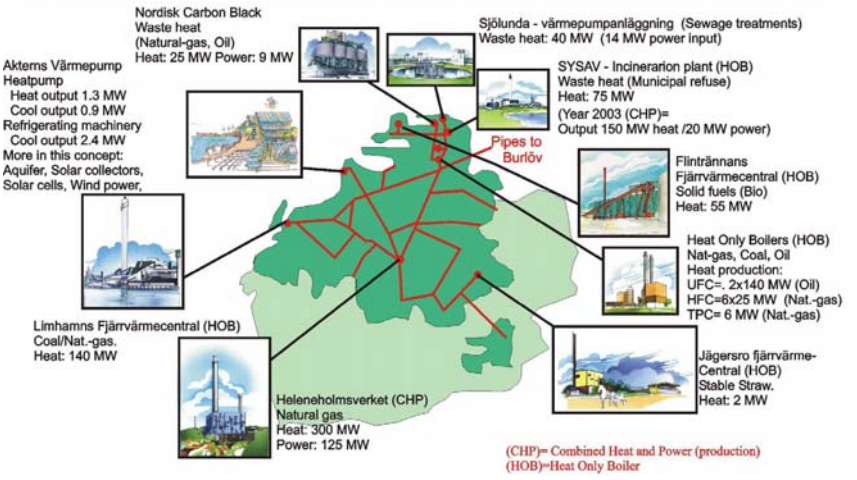
Solutions at a Glance:

DISTRICT ENERGY SYSTEMS – DON'T LET THAT HEAT GO TO WASTE!

"The chief function of the city is to convert power into form, energy into culture, dead matter into the living symbols of art, biological reproduction into social creativity." – Lewis Mumford, social philosopher



The district energy system of Malmö gathers heat from nine plants and distributes it to homes and offices throughout the city.

The Challenge

A typical home or office relies on several forms of energy to fulfill different needs: high quality electricity for lighting and appliances, medium temperature heat for hot water, and low temperature heat for space heating. Electricity is the most versatile of these, and also the most expensive on a per unit basis. This is largely due to the fact that up to 60% of the energy content of fuels used for producing electricity is lost the moment the electricity is generated, expelled though cooling towers as waste heat.

Energy expert Amory Lovins points out that it is inherently wasteful to heat water to 1,000 degrees F for use in a turbine generator, only to make electricity for warming household water to 140 degrees. Wouldn't it make more sense if some of this heat could instead be distributed directly to homes and offices where it can meet all of our low and medium temperature heating needs?

The Solution

A district energy system takes thermal energy (heating or cooling) from one or more sources and distributes it to multiple customers through a piping distribution network. This heat is produced as a natural by-product of electrical generation or industrial processes, but it is typically just exhausted as waste. With a district energy system in place the waste heat can be captured and transported to homes and offices, eliminating the need for on-site furnaces and boilers. Although industrial plants may be connected to the system as well, in Scandinavia the systems are primarily designed to provide heating and cooling for residential and commercial customers.

District energy systems have a number of benefits, such as being able to accept energy from a wide variety of fuels and sources. For example, the system in Malmö, Sweden, which provides heating and cooling for about 200,000 households, receives surplus heat from a carbon black industrial plant, a sewage treatment facility, solar collectors, a municipal waste incineration plant, and a CHP (Combined Heat and Power) electrical generating plant. Several straw and gas-fired boilers are also available to help meet peak demands, and some of the gas is biogas from kitchen wastes.

The district energy system provides a ready market for waste heat, creating a new revenue opportunity that can make clean waste incineration or CHP plants burning wood wastes and

other fuels economically viable. Because CHP is much more efficient than a typical generation plant, less CO2 is created for the same amount of energy generation. Finally, by eliminating the need for individual boilers and furnaces, buildings connected to the system benefit from increased effective interior space, and reduced construction and operating costs.

Background

Energy use planning in Scandinavia centers around two fundamental questions: "What can we do to make buildings as energy efficient as possible" and "How can we fulfill the remaining energy requirements as efficiently as possible?" District energy systems have proven to be the most efficient model for generation and distribution of electrical and thermal energy in urban environments.

Although district energy proliferated in urban areas in the U.S. in the early 1900s, most of these systems fell into disrepair as low fuel prices made in-building systems the preferred approach to space heating. In northern European countries district energy systems are still in widespread use, and adoption has actually grown substantially over the past 20 years. In Denmark there are now over 450 district heating companies, supplying more than half of the country's space heating needs – six out of ten residences are supplied with district heating today. Because of the climate these systems have primarily taken the form of district heating systems, though in recent years interest in district cooling has grown and combined district heating and cooling systems have begun to appear.

Infrastructure

In addition to electrical, water and gas lines, almost every city and village in Denmark and Sweden has a network of "heat" lines distributing hot water throughout the area. The system creates a robust heat grid, linking consumers to heat generators such as electrical generation plants or nearby industrial plants.

A modern Scandinavian district energy system can be quite large, serving the greater part of a large metropolitan area such as Copenhagen, or limited to a small village of a few thousand people. Because of the heavily insulated piping that is used, systems can serve loads over a wide geographic area. For example, the district energy system for Helsingør, Denmark serves several small villages and industrial facilities, some located as far as 14 miles from the primary heat generation plant. The hot water is transported at temperatures of 203 to 230 degrees F, and loses only about 7 degrees F from end to end. The system is a closed loop system; typically every large customer or block of housing served has a local heat exchanger to connect to their internal system. Industrial facilities can either generate or extract heat from the system, depending on their internal demands at the time.

In larger systems, the district heating system can include multiple levels of distribution, similar to modern electrical transmission and distribution systems. For example, the district heating system in the Municipality of Rødovre, a suburb of Copenhagen, serves about 37,000 people. This distribution system is fed via five heat exchange stations by the Copenhagen district heat system, which carries heat from a number of plants to the central area and surrounding suburbs.

So why aren't these systems more prevalent in the United States? For starters, the systems are not inexpensive – in Europe planners anticipate pay back horizons of 20 to 40 years. In addition, costs of energy tend to be higher in Europe (often because of taxes, not because of production costs), making alternative solutions more attractive. However, Scandinavian governments view district energy systems as a necessary public infrastructure, similar to roads and water, because of the many societal benefits they provide. The key to adopting these in the United States is to think beyond solutions for single buildings, and begin incorporating district heating and cooling systems into new development projects on a neighborhood or even a regional level, to achieve the necessary economies of scale.

The 2004 Urban Sustainability Study Group to Sweden and Denmark

In March 2004, a group of architects, engineers, developers and others from Seattle, Washington and Portland, Oregon went to Sweden and Denmark to look at advanced urban sustainability projects. A key component of this trip was a visit to several CHP plants and to Western Harbor in Malmö, Sweden, where they were able to experience the implementation of a 100% renewable energy district, and learn more about the components of Malmö's district energy system.

Produced by Jayson Antonoff, International Sustainable Solutions (www.i-sustain.com). International Sustainable Solutions encourages the implementation of sustainability practices and products by facilitating the sharing of knowledge and the creation of market opportunities.

Education sponsorship provided by Catapult Community Developers, CH2M Hill, Gregory Broderick Smith Real Estate, Magnusson Klemencic Associates, Nitze Stagen, ZGF Partnership and Vulcan Inc.