Purchasing district energy services

by Richard Damecour

A case for life-cycle analysis

THE CONCEPT OF district energy in North America has been around for over 100 years. (The first commercial district energy system was started in Lockport, NY in 1877 by American hydraulic engineer Birdsill Holly, considered the founder of district heating.) However, the concept has really only started to become popular in the last 15 years.

So how can a procurement professional properly evaluate a district energy proposal? The answer is through life-cycle analysis. That is to evaluate all of the costs associated with producing space heating, domestic hot water and cooling on-site (commodities, operation and maintenance and capital) over a 20 to 40 year period and compare it to the district energy proposal.

Figure 1 displays the proportional values of the various life cycle costs that a building owner would need to consider in order to produce heating and cooling on-site.

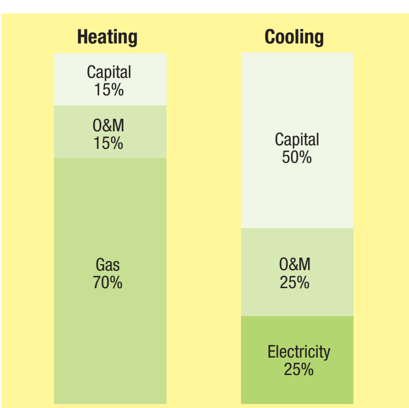
From figure 1, a building owner's cost to produce heating and cooling on-site is made up of three main components:

1. natural gas or electricity
2. operation and maintenance
3. capital

Natural gas or electricity

Natural gas does not produce space heating and domestic hot water (DHW) directly. It first must go to a boiler where it is transformed into hot water that in turn is used to produce space heating and DHW. The ability of a boiler to transform natural gas into hot water is known as boiler efficiency. Boiler efficiency is a very misunderstood number and often building owners will assume that the efficiency of a boiler is what the theoretical value that the boiler manufacturer specifies (typically in the 80 to 90 percent range).

Figure 1. Proportional values of life cycle cost



In actual fact, the efficiency of a boiler is in the 60 to 70 percent range. This efficiency is usually referred to as "real world" or "seasonal efficiency." There are a number of reasons why the real world or seasonal efficiency is lower than the theoretical boiler efficiency:

- **Full load vs. part load** – Boilers rarely (if ever) run at full load and normally spend most of their lives running at very low load conditions (poor boiler loading = poor efficiency).
- **Over-estimation of building thermal loads** – Designers are conservative by nature and it is typical to see boiler plants that are double to triple the size that the actual building's thermal load is (poor boiler loading = poor efficiency).
- **Lower heating value (LHV) vs. higher heating value (HHV)** – Boiler manufacturers sometimes quote boiler efficiencies in LHV; this overstates the boilers actual efficiency by 11 percent.

Just like boilers, chillers also have similar issues. Electricity must be transformed into chilled water that in turn is used to produce space cooling. The ability of a chiller to transform electricity into chilled water is known as the "coefficient of performance (COP)." Again, building owners will assume that the chiller COP is the theoretical value that the chiller manufacturer specifies (typically in the 5.5 to 6.5 range).

In actual fact, the COP of a chilled water plant (chiller + cooling tower + condensing pump) is in the 3.0 to 3.5 range. There are a number of reasons why the real world or seasonal efficiency is lower than the theoretical chiller efficiency quoted by the manufacturer and they can be summarized as follows:

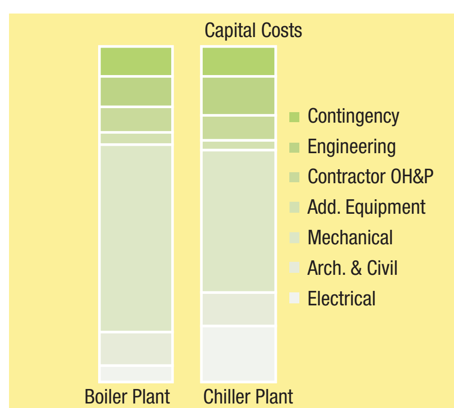
- **Chilled water plant vs. chiller** – Manufacturers quote the efficiency of the chillers alone; it's important to note that there are additional components required to transform electricity into chilled water and they are cooling towers, condensing pumps, and chiller pumps.
- **Full load vs. part load** – Chillers rarely (if ever) run at full load and normally spend most of their lives running at very low load conditions (poor chiller loading = poor efficiency).
- **Over-estimation of building thermal loads** – Designers are conservative by nature and it is typical to see chiller plants that are double the size that the actual building's thermal load is (poor chiller loading = poor efficiency).

Operation and maintenance

Boilers, chillers and cooling towers do not operate themselves – they require dedicated staff and maintenance budgets. When examining the production costs of producing heating and cooling on-site, it's important to include the following line items:

- **Water, chemicals, parts** – Boilers and chillers require makeup water and chemicals to keep them working properly. Cooling towers consume significant amounts of water and chemicals as well.
- **Equipment insurance** – Building owner's need to carry insurance for major equipment like boilers, chillers and cooling towers.
- **Equipment maintenance, including reserve** – Boilers, chillers and cooling towers normally have annual maintenance contracts to keep them operational. Included in this is also a reserve fund to replace major equipment over time (especially important for condos).
- **Labour** – Boiler and chiller plants require professional operators to ensure

Figure 2: Capital costs of boiler and chiller plants



that they run efficiently and don't prematurely fail (boilers and chillers have lifetimes in the 20 to 25 year range).

- **Administration and management** – Every extra staff position in an organization adds additional administration and management costs.

Capital

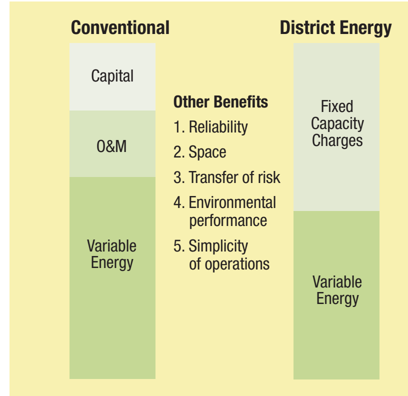
When determining how much capital can be avoided by connecting to a district energy system, it is important to first realize that the actual equipment makes up a small portion of the total install costs. In the case of a boiler plant, the actual space heating and domestic hot water boilers only make up about 25 percent of the total install cost. In the case of a chiller plant**,** the chillers and cooling towers only make up 25 percent of the total install cost (see figure 2).

Comparing district energy to your on-site costs

Now that you have determined your alternative cost to produce heating and cooling on-site (figure 3) you can then compare that to the district energy provider's proposal. Typically district energy providers have a fixed capacity charge that is based on the actual heating and cooling needs of the building. **Important – this is not the boiler or chiller capacity that you would have otherwise installed in the building.** The actual heating and cooling capacity that a building needs is a much lower number than the installed boiler and chiller capacity. The capacity charge is generally fixed and is the same cost month to month and normally increases by CPI on an annual basis. The variable energy rate varies by the actual energy utilized by the building and is often tied to actual natural gas or electricity prices.

While it is important for the procurement professional to quantify if the district energy proposal is competitive with the alternative on-site boiler and chiller plant costs, it is equally important to realize that the district energy service provides several qualitative benefits such as those listed in figure 3.

Figure 3. Conventional heating/cooling vs. district energy



Richard Damecour is a registered professional engineer in the Province of Ontario and has an MBA from the University of Alberta. He has over 27 years experience in the energy industry, including 12 years in oil and gas. For the past 15 years, he has helped to develop at least 25 new district energy systems successfully brought into service in North America and the Middle East. Richard is currently the elected vice-chair of the Canadian District Energy Association and a former marketing chair of the International District Energy Association.