IT@Intel Brief

Intel Information Technology

Computer Manufacturing

Data Centers

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Data Center Heat Recovery Helps Intel Create Green Facility

To support Intel's first planned certified green building, Intel IT has designed a system that saves energy by recovering data center heat and using it to heat the rest of the building. Figure 1 shows a typical water-cooled refrigeration system.

The system employs heat recovery (HR) chillers, shown in Figure 2, to capture heat produced by data center servers and other equipment. This heat warms the rest of the building in winter and provides year-round hot water for bathroom and kitchen use.

Profile: Heat Recovery

- Reuses data center heat to warm offices
- Accumulates points toward green certification
- Yields USD 235,000 estimated annual savings

Reusing data center heat eliminates the need to add boilers for heating the rest of the building. This energy-saving approach accumulates points towards environmental certification and is highly cost-effective. We project savings of approximately USD 235,000 annually due to reduced fuel consumption, resulting in an ROI of about 1.7 months.

We expect that the system will go online in 2008. We have already successfully retrofitted a heat recovery system at an existing facility.

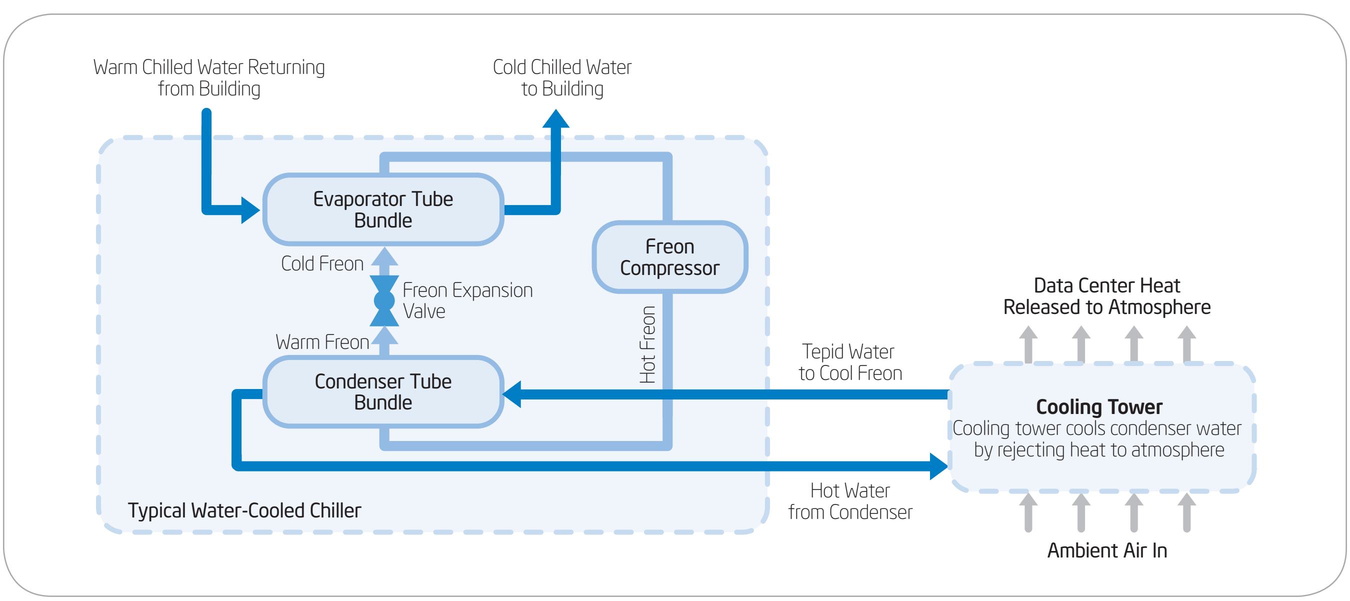

Figure 1. Typical Water-Cooled Refrigeration Chiller. This chiller rejects condenser water heat to the atmosphere via a cooling tower. This type of system can be modified into a heat recovery system by finding uses for the hot condenser water.

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Background

In 2008, Intel is planning to open its first "green" certified building: a new development center in Israel.

The facility will have six floors above ground, with an additional five floors below ground. It will include a high-density, air-cooled data center occupying approximately 10,000 square feet, with total power consumption up to 3.7 megawatts (MW) when operating at full capacity.

Energy-efficient design helps buildings accumulate points towards certification under the Leadership in Energy and Environmental Design (LEED) Green Building Rating System. We made energy efficiency, including heat reuse, a primary goal during the building's design and engineering phases.

We looked for an energy-efficient way to heat the offices during the winter and to provide hot water for the bathrooms and kitchen year round. We wanted to avoid using energy-consuming gas or fuel oil boilers, while reducing the total operational cost of the HVAC systems that cooled the facility and data center. The best overall value appeared to be offered by HR chillers. They recover data center waste heat, producing hot water for building heating systems by modifying a chilled water system, like the one shown in Figure 1 into a heat recovery system like the one shown in Figure 2. This system uses the hot condenser water instead of directly releasing it to the atmosphere via the cooling towers.

Retrofit Heat Recovery System

We gained experience with heat recovery systems and validated the benefits by retrofitting a system at an existing facility. We installed a single HR chiller, enabling us to avoid using the existing boilers. This retrofit system cost approximately USD 168,000, which was more expensive than including HR chillers in a new building design. Even so, we achieved substantial estimated annual operational savings of USD 250,000 by reducing fuel consumption. This retrofit also reduced greenhouse gas emissions.

Heat Recovery System

Our system is shown in Figure 2. The building will use two chilled water loops. A high-temperature loop producing water at 55° F supplies the data center air handlers, and a low-temperature loop producing chilled water at 41° F supplies the rest of the building.

We initially considered attaching HR chillers directly to the high-temperature loop in order to capture heat from data center IT equipment. However, our facility presented an interesting challenge that required a more complex piping arrangement.

We need to provide office heating, as well as hot water for kitchens and showers, from the first day the building opens. The building will require about 1.5 MW of heat energy. However, only a small amount of IT equipment will be installed in the data center on day one. Initially, this equipment will use only about 0.3 MW power, so it cannot generate enough heat to supply the facility's heating needs.

We expect this IT equipment will increase by about 500 kilowatts (kW) per year, reaching a maximum of about 1.3 MW after two years at the completion of Phase 1 of the building. Additional sources of heat include uninterrupted power supply (UPS), electrical rooms, and electrical motors that drive the HR chillers and the data center air handler fans. By the end of Phase 1, these sources will result in a total of about 1.6 MW of data center heat energy that we can recover and reuse—enough to provide the heating and hot water that we need for the rest of the facility.

However, we needed to find a way to produce enough heat to warm offices and heat water before Phase 1 is completed, during the period that the IT equipment will not generate enough heat for all our needs.

In our design, we solved this problem by connecting the heat recovery chillers to the low-temperature loop that supplies most of the facility, rather than directly to the high-temperature loop that supplies the data center.

This solution allows HR chillers to function as part of the overall facility cooling system and makes it possible to recover heat from offices, communication rooms, and meeting rooms. The system is linked via a heat exchanger to the high-temperature data center loop, so the HR chillers also cool and recover heat from the data center equipment. Combined, the facility and data center loads will enable the HR chiller to recover enough heat, even on the first day, to provide heat for the rest of the building.

The HR chiller condensers in our system are designed to produce hot water at 104 degrees F, hot enough to use for warming offices, produce hot water for bathrooms, and pre-heat water for kitchen use.

Our design uses two 350 tons of refrigeration (TR) HR screw chillers. These chillers will act as the primary chillers for the data center during Phase 1. Additional centrifugal chillers on the low-temperature loop will provide cooling for the rest of the facility.

Linking the high-temperature and low-temperature chilled water systems offers several additional advantages:

- A single centrifugal chiller on the low-temperature loop can provide backup cooling for both the data center and the offices. Thus, we avoid the need for an additional backup chiller potentially costing as much as USD 500,000.
- The HR chillers can contribute to the total facility cooling capacity, providing up to 350 TR of cooling to help cool offices during peak summer loads.
- We can use the most effective chillers for each season. In winter, the heat recovery chillers are the primary source of cooling, so they also

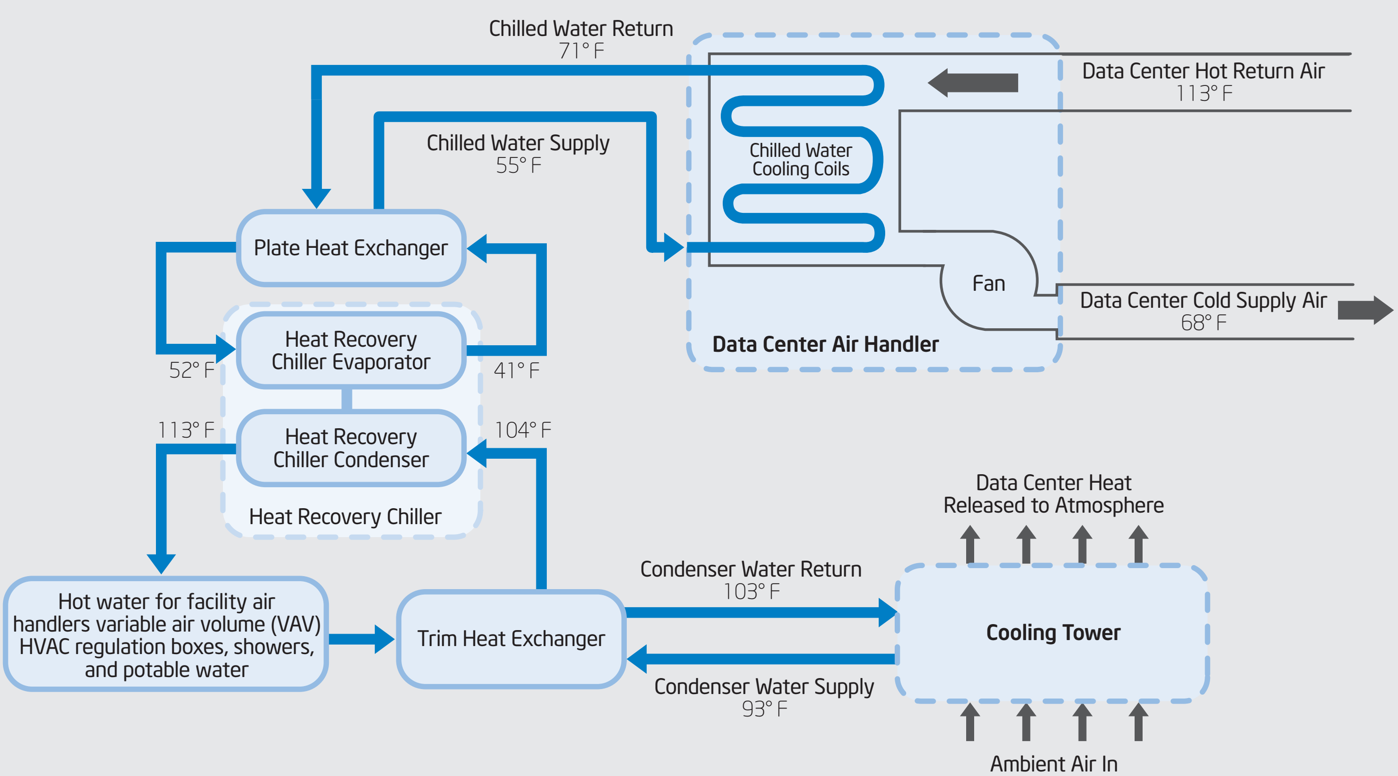

Figure 2. Our heat recovery system.

capture heat and add it to the water heating system. In the summer months when heating load is reduced, the more energy-efficient centrifugal chillers provide most of the cooling.

Benefits

We project substantial savings using our HR system. Installing HR chillers rather than non-HR chillers will require an additional initial capital expenditure estimated at approximately USD 84,000, based on a cost difference of about USD 120 per TR of capacity. However, we do not need to install boilers and associated pumps, tanks, and piping, so we will save about USD 50,000 through cost avoidance. The result is a net installation capital cost of about USD 34,000.

HR chillers are slightly less energy-efficient than non-HR chillers, resulting in projected additional annual chiller operating costs of approximately USD 15,000. However we expect to save approximately USD 250,000 in annual boiler fuel costs, resulting in a net annual savings of approximately USD 235,000 and an ROI of about 1.7 months.

Our system makes it possible to supply chilled and hot water to the building by using the same system and eliminates the need to add boilers. By reducing fuel consumption, this system reduces emissions of CO2 and nitrogen oxides (NOx) and saves money. In addition, this system will help Intel achieve green certification for this facility, which in turn will support Intel's environmental profile.

Acronyms

HR	heat recovery
kW	kilowatt
MW	megawatt
TR	tons of refrigeration
UPS	uninterrupted power supply

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