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for a greener tomorrow

CASCADE SYSTEMS I: CENTRAL PLANT AIR-TO-WATER HEAT PUMP

APPLIED HVAC

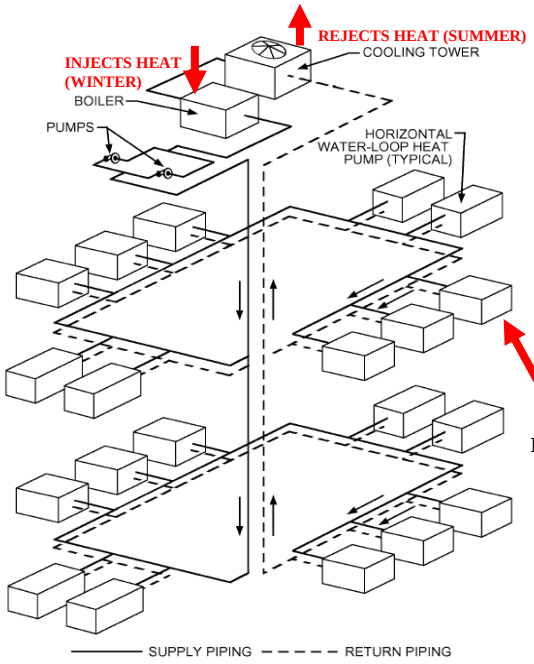
HOW IT WORKS

MITSUBISHI ELECTRIC Heating and Cooling

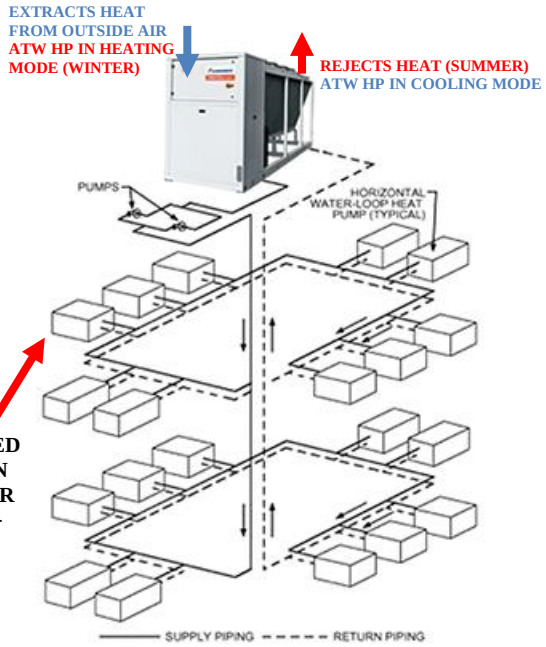
Air-to-Water Heat Pumps are often dismissed in the early design process because of the "operating envelope" constraint, which defines the supply water temperature available from the heat pump, which varies depending on the outside air temperature (OAT). A simple and effective way to workaround these constraints are **cascade systems**. A cascade system means that two or more vapour-compression refrigeration cycles are combined to move heat throughout the system. This simplifies the overall design and achieves higher overall efficiencies –all while electrifying the HVAC design using low-carbon alternatives to traditional gas-fired boilers. **Water Loop Heat Pump Systems (WLHP)** provide the comfort and flexibility of a 4-pipe system with a 2-pipe distribution loop – saving installation time and costs.

In **WLHP Systems**, the central plant supplies low-temperature water to **Water-to-Air (WTA)** Heat Pumps that heat or cool individual zones by pulling or rejecting heat from the water-loop, respectively. These systems often use a **Cooling Tower-Boiler** central plant, which provides a means to inject or reject heat to or from the HVAC system. **Air-to-Water (ATW) Heat Pumps** make the perfect substitute for the cooling tower and boiler and are an excellent choice for low-carbon designs and can be used in both new-construction or retrofits.

COOLING TOWER-BOILER CENTRAL PLANT



AIR-TO-WATER HP CENTRAL PLANT



INDIVIDUAL ZONED WLHP UNITS CAN BE IN HEATING OR COOLING YEAR-ROUND FOR PERFECT COMFORT

Image Courtesy of ASHRAE Handbook: 2020 HVAC Systems and Equipment, Ch. 9 Fig. 30

The advantage with using an ATW Heat Pump central plant in a cascade configuration is that the designer need not worry about a supply temperature that varies according to the OAT. This is because the NX-N ATW Heat pump can provide low-grade heat that is compatible with the requirements of the WTA Heat Pumps throughout the heating season. Because the NX-N is a **reversible** heat pump, it has the added benefit of operating in cooling mode in the summer. Therefore, the cooling tower-boiler central plant can be simplified to a single machine that performs the same function as the cooling tower-boiler central plant, without the carbon emissions.

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