Case Study

Wake Tech East Central Energy Plant

AquaEdge® 19DV Heat Pump Chillers Contribute to Innovative Low Carbon Solution and Achieve Several Sustainability Awards

Photo: Courtesy Wake Tech Community College

Project Objectives

From its inception, it was clear that the design and operating criteria for Wake Tech East's new central energy plant would need to incorporate an innovative integration of leading-edge energy and HVAC equipment technologies. The final solution would have to maximize efficiency and also meet the demand for decarbonized heating and cooling.

Unlike typical central plants which distribute hot water from boilers and chilled water from chillers independently, Wake Tech East's facility called for an integrated central heat pump plant with a common set of water source heat pumps to provide the distribution of hot and chilled water to the entire campus.

The plant's systems would have to execute strategies which would achieve the notably high degree of sustainability and energy efficiency. And, as additional campus buildings were going to be phased in, system expandability was a critical requirement.

With Wake Tech East's enviable reputation of providing education and training in the very latest technologies and protocols, the facility would also need to serve as a 'hands-on' classroom to build talent capable of excelling in high-tech fields and advanced sustainability practices.

EDUCATION

Project Solution

To help the Wake Tech East Central Energy Plant achieve its operational, energy efficiency, and sustainability goals, Carrier recommended installing two 500-ton AquaEdge® 19DV centrifugal chillers to serve as both chiller and heat pump.

The system design consists of three main water loops; chilled water, hot water and heat source/sink water—all served by the two 19DVs and a modular heat pump for base loading. The primary means of heat rejection and absorption is via a geothermal bore field tied to the heat source/sink water loop.

The advanced geoexchange system includes 297 closed-loop wells, each 500 feet deep. This system is designed to consume one-third less energy and produce 50% fewer carbon emissions compared to conventional boiler/chiller configurations.*

For future build-outs, the system has been designed to be expandable and flexible.

*Source: Skanska - April 26, 2024: *Skanska completes geothermal central energy plant at Wake Tech Community College* https://www.usa.skanska.com/who-we-are/media/press-releases/280522/Skanska-completes-geothermal-central-energy-plant-at-Wake-Tech-Community-College-/

"By selecting the higher efficiency chillers, we got better long-term energy performance, were able to lower our electric bills and get better operating life out of the equipment. We've seen a wide variety of savings... anywhere from five to ten percent on our energy use, up to over 40% on our energy consumption for our buildings."

John L. Majernik, EI, PEM, CEM
Director, Energy, Sustainability & Transportation
Wake Technical Community College

A showcase for teaching innovative HVAC system design and sustainable practices.

Photo: Keith Isaacs / Architect: HH Architecture

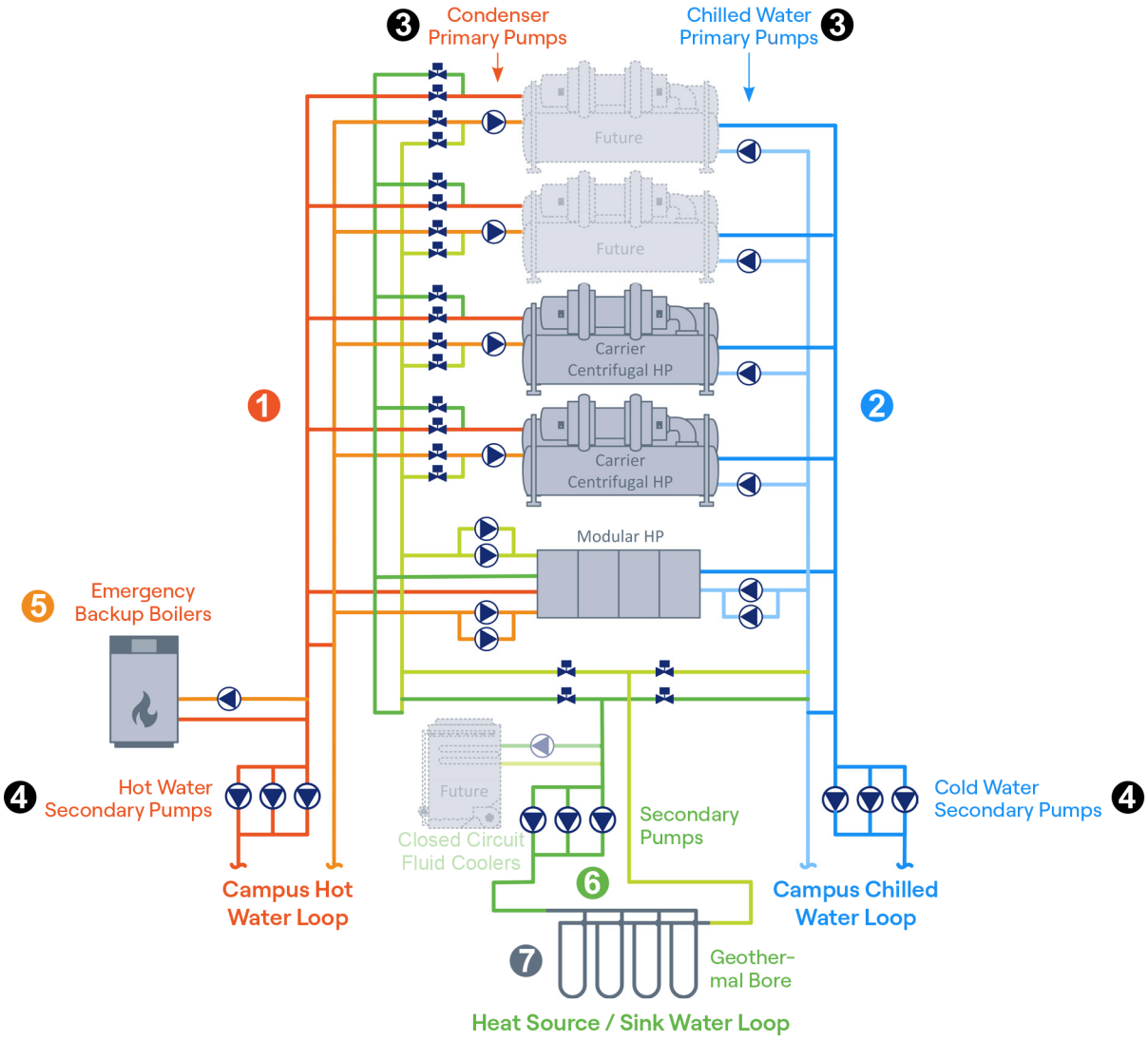
The Renewable Energy Training Center at Wake Tech East not only supplies heating and cooling to the campus, it serves as an immersive educational experience for its students.

Housed beyond its glass-walled classroom is an advanced central plant which reflects the most innovative strategies for experiencing and learning sustainable HVAC and energy practices hands-on.

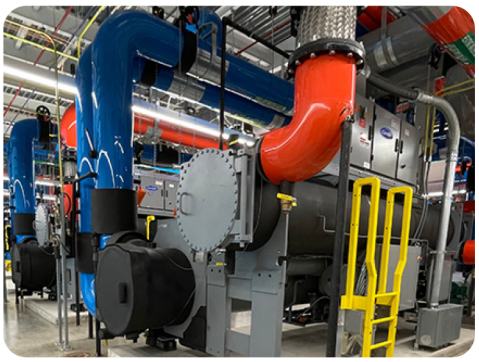
The selection of two AquaEdge 19DV centrifugal heat pump chillers were integral to help Wake Tech East meet their sustainability, energy and growth goals.

EDUCATION

The System



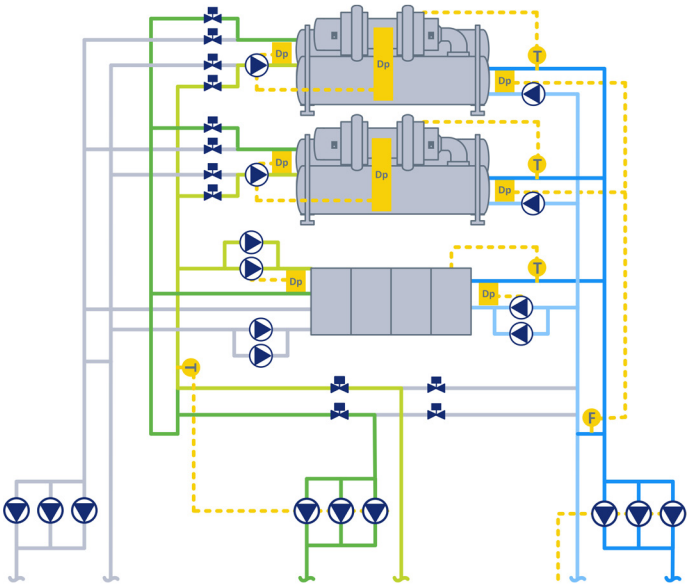
The hot ❶ and chilled ❷ water loops are arranged in a primary/secondary manner with primary pumps ❸ providing circulation through the heat pumps and secondary ❹ pumps providing circulation in the campus distribution loops.



The AquaEdge 19DV units utilize a common primary pump for both the hot water loop and the heat source/sink loop. The secondary side of the hot water loop also includes one 3000 MBH condensing hot water boiler ❺ for use as an emergency/backup heat source.

Similarly, the heat source/sink loop ❻ is arranged in a primary secondary manner. The secondary side of the system is also linked to the primary side of the chilled water loop and can transition between the heat source/sink primary system and the chilled water system based on the mode of operation (heat rejection or heat absorption).

The primary means of heat rejection and absorption is via a geothermal bore field ❼ tied to the heat source/sink water loop. Future phases of the project will include two 500-ton closed circuit fluid coolers to balance the heating and cooling loads on the geothermal field.



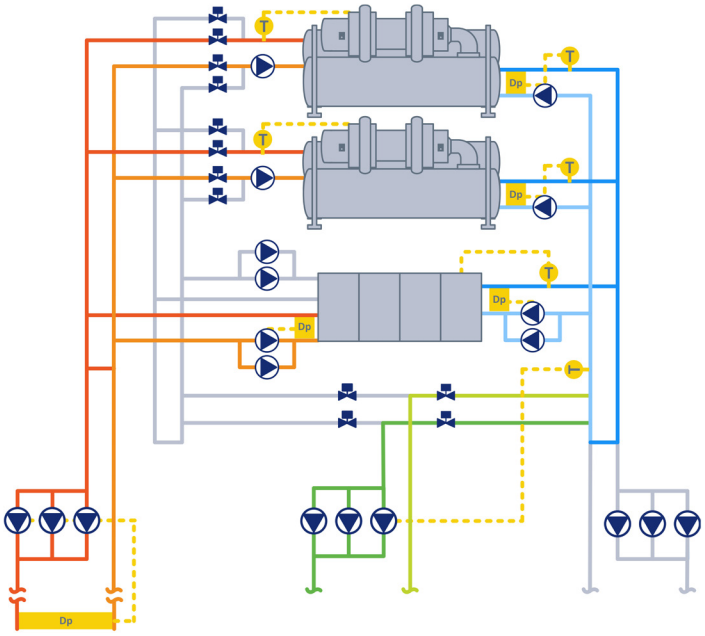
Cooling Only

When the Wake Tech East campus demand calls for the cooling only mode, the AquaEdge 19DVs will control to maintain the chilled water supply setpoint temperature of 44°F (6.7°C) design and the primary chilled water pumps will vary speed to maintain zero to slightly positive flow in the primary secondary decoupler within the flow limits of the heat pump.

The secondary pumps will vary flow based on resetting differential pressure setpoint as building valves open and close.

On the condenser side of the 19DVs, the motorized valves will isolate the hot water loop and open to the heat source/sink water loop. The primary condenser pumps on the 19DV units vary speed to maintain set refrigerant head pressure within the flow limits of the heat pump. The primary pump on the modular unit will vary flow based on differential pressure.

Heat rejection is controlled by varying the speed of the heat source/sink water loop secondary pumps to maintain a set heat pump entering condenser water temperature.



Heating Only

When the Wake Tech East campus demand calls for the heating only mode, the AquaEdge 19DVs are varying capacity to maintain the set hot water supply temperature of 105°F (40.5°C) design and the primary condenser water pumps run at a constant speed while the secondary pumps will vary flow based on resetting differential pressure setpoint as building valves open and close.

On the chilled water side, the pumps are varying flow to maintain the chilled water supply temperature setpoint. As the return water drops below 54°F (12.2°C) this setpoint is reset to as low as 39°F (3.9°C) from 44°F (6.7°C).

Heat absorption is controlled by varying the speed of the heat source/sink water loop secondary pumps to maintain the heat pump entering evaporator temperature.

Simultaneous Modes

As North Carolina doesn't have equal cooling and heating seasons, the innovative design of the Wake Tech East Central Energy Plant needed the flexibility for the system to operate in simultaneous modes. To meet this demand, the AquaEdge 19DV chillers can operate with cold condenser water during periods of free cooling one day, and at 105°F (40.5°C) condenser water for heat recovery the next. To achieve this, the 19DV has a variable orifice to ensure robust refrigerant metering and proper refrigerant levels during variable lift and load conditions, keeping operation not only possible, but efficient.

During the cooling dominate simultaneous mode, the 19DV units operate in the same manner as cooling only mode. The modular heat pump operates like a dedicated heat recovery chiller in that it's operating in parallel to the chillers on the evaporator side and supplying hot water to the hot water loop on the condenser side. The remaining excess heat from the cooling load is rejected through the 19DV units and to the heat source/sink water loop where the geothermal field and/or fluid coolers are acting as a heat sink.

The heating-dominate simultaneous mode is also like the heating-only mode, with all heat pumps controlling a leaving hot water supply temperature. All heat from cooling loads is recovered to meet heating loads and the remainder of the heat needed to satisfy the heating load is made up via the heat source/sink water loop. This loop is now acting as heat source in heat absorption mode maintaining the heat pump entering evaporator water temperature.

The Wake Tech East Central Energy Plant is a very unique application with very specific requirements. In order to meet these challenges, Carrier worked closely with the various engineering groups on the project. As a result, two AquaEdge® 19DV centrifugal heat pump chillers help achieve the facility's operational, sustainability and decarbonization goals.

Innovation + Collaboration = Recognition

The Wake Tech East Central Energy Plant represents a paradigm shift in how educational institutions can successfully integrate advanced technologies into their infrastructure and educational programs. It has set new standards in sustainable design and represents the successful collaboration of world-class HVAC equipment manufacturers, design/build contractors, architects, and engineers.

Designed and constructed by HH Architecture and Skanska USA Building for Wake Tech East Technical Community College, the building showcases mechanical systems with easily accessible and daylit spaces.

As a result, it has not only captured the attention of the industry's professional community, it has earned formal industry recognition with the following awards:

- Green Building Initiative (GBI) 2023 Green Globes Project of the Year. The first project in North Carolina to achieve Green Globes' highest certification level of four Green Globes. (Click here) The ultra-low GWP refrigerant* and exceptional efficiencies of the AquaEdge® 19DV units were a contributing factor. (Click here)
- Design-Build Institute of America (DBIA) Southeast Region Project of the Year (Click here)
- City of Raleigh 2023 Climate Action Award (Click here)
- ENR Southeast Regional Best Projects Winner in the Energy/Industrial category (Click here)

**Refrigerant R-1233zd(E) has a ~1 GWP according to the Intergovernmental Panel on Climate Change Fourth Assessment Report. GWP is a measure of a substance's climate warming impact compared to CO_2*

Project Summary

LOCATION: Raleigh, North Carolina

PROJECT TYPE: New Construction - High-Efficiency Chiller Plant

BUILDING SIZE: CEP: 15,700 f² / Future Total Conditioned Space: 600,000 f²

FACILITY USAGE: Education - multi-building campus

OBJECTIVES: The Wake Tech East Central Energy Plant called for an integrated central heat pump plant with a common set of water source heat pumps to provide the distribution of hot and chilled water to the entire campus.

EQUIPMENT: Two 500-ton AquaEdge® 19DV centrifugal heat pump chillers equipped with the unique EquiDrive™ two-stage back-to-back compressor which utilizes lift optimization technology.

MAJOR DECISION DRIVERS: The 19DV chillers, with their leading efficiencies helped the campus meet its decarbonization goals and were able to accommodate a wide range of entering and leaving condenser water temperatures.

UNIQUE FEATURES: The AquaEdge 19DV centrifugal heat pump chillers double as both a chiller (controlling to a constant leaving chilled water temperature), or as a heat pump (controlling to a constant hot water temperature). Along with external motorized valves, this allows for the units to be applied similar to a packaged 6-pipe heat pump in which the 4-pipe unit can switch the condenser between a heating hot water loop or a source/sink water loop.

TAX INCENTIVES: U.S. Federal tax incentives available for geothermal systems via the internal revenue code's investment tax credit (Elective Pay or Direct Pay) may be available to offset costs. These incentives may pay for a portion of both the geothermal system as well as the AquaEdge 19DV units. Further information on commercial geothermal heat pumps incentives can be found here.

DESIGN/BUILD FIRM: Skanska / HH Architecture

GENERAL CONTRACTOR: Skanska

ARCHITECT: HH Architecture

ENGINEERS: Salas O'Brien; TransSystems (formerly SEPI, Inc.); Surface678

INSTALLATION DATE: 2023

For more information, contact your Carrier Representative, call 1.800.CARRIER or visit carrier.com/commercial

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