Advanced Low-Temperature Heat Recovery Absorption Chiller Module

Efficient, Secure Combined Power and Cooling for Distributed Data Centers

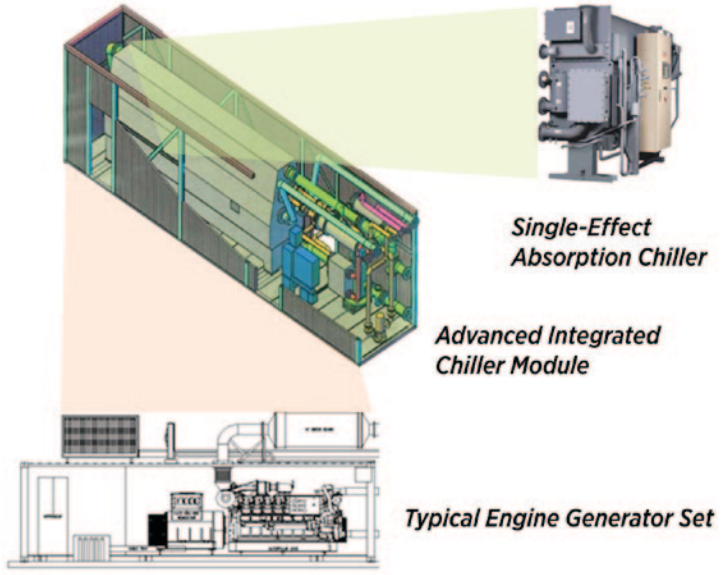
This project will develop an advanced single-stage lithium bromide absorption chiller module to utilize low-temperature waste heat from natural gas engines.

Introduction

Data center operation is energy intensive, requiring significant amounts of electricity and refrigeration to power and cool hundreds or even thousands of servers. Reliable and efficient combined heat and power (CHP) distributed generation systems are an excellent means for supplying data center power and cooling needs. For this project, power is generated by a natural gas reciprocating engine. The engine's jacket water and exhaust heat is recovered and then used to drive an absorption chiller that produces cold water for data center cooling.

Research will focus on expanding the range of absorption chiller performance data and optimizing the system configuration specifically for CHP applications. The project will develop an absorption chiller test data protocol to match the thermal energy profile of newer high-efficient natural gas engines in data center applications. Absorption chillers have not been fully performance tested with respect to thermal bottoming cycles as required to quantifiably match them with modern reciprocating engines in CHP system applications. Testing and verifying performance of an absorption chiller will be conducted, and algorithms to scale the chiller product line to match larger frame sizes will be developed. The results of this modeling will be analyzed and reviewed for market effectiveness in terms of energy efficiency improvement, reduction in temperature requirements, economic impact, system reliability, and customer appeal with specific reference to the data center market.

A second and important research step will modularize the absorption chiller, piping, valves, and controls. Modularization of the chiller plant will reduce the installed cost; reduce the installation schedule; and improve reliability, operability, and energy savings. A low-temperature absorber module, based on the results of prototype testing, will include the absorber, condenser pump, power distribution, heat exchangers, automated valves, pipe, and fittings in a skid mounted outdoor enclosure. The module will also include an integrated controller that operates the entire thermal system and provides data acquisition as well as integration with the engine and building controllers through a single open protocol connection. The completed test module will be commissioned at a data center, and performance data will be collected and evaluated to determine the results.



Conceptualization of Heat Recovery Absorption Chiller Module/CHP Solution

Illustration courtesy of EXERGY Partners Corp./Integrated CHP Systems Corp./Carrier Corporation

Benefits for Our Industry and Our Nation

Data centers can consume up to 100 to 200 times as much electricity as standard office spaces. The critical nature of data center loads elevates many design criteria (e.g., reliability and high power density capacity) far above energy efficiency. CHP systems can provide reliability and power density with significantly increased energy efficiency if power and thermal systems are properly integrated and benchmarked.

Applying just 100 megawatts (MW) of advanced CHP power and cooling modules to new data centers would result in 17.3 billion British thermal units (Btu) of primary energy savings and 2.3 million tons of carbon dioxide equivalent (CO_{2e}) reduction per year.

In its initial commercial deployment, modularized CHP systems with the new low-temperature absorption chiller modules will be marketed to high-reliability data centers.

Applications in Our Nation's Industry

Demonstrating the technology at the Great Lakes Center for Energy Smart Communities, which is the nation's first carbon neutral all-digital community, will provide a high profile platform for modularized CHP systems. Modular CHP systems providing heating, cooling, and power will have broader appeal beyond high reliability data processing and storage as prices reduce with scale. The low-temperature absorption chiller technology can also utilize waste heat from other sources beyond engine generators, such as low-pressure steam and process heat.

Project Description

This project will develop and demonstrate an advanced single-stage lithium bromide absorption chiller module designed to use low-temperature waste heat from clean and efficient natural gas engines in data center applications.

Barriers

- Chiller performance at actual CHP/data center conditions has yet to be tested
- Module cost is too high for scalable market entry
- Design and construction schedule for site-built CHP systems is too long
- Siting the CHP systems is problematic

Pathways

The team assembled for this project has notable expertise in delivering technology to the market. Carrier Corporation will develop the advanced low-temperature absorption chiller. HP's EYP Mission Critical Facilities, Inc. will develop the power, cooling, and electrical support infrastructure and design. General Electric will provide the engine-generator, uninterruptible power supply (UPS) and switchgear systems.

This project will encompass four distinct phases:

1. Develop a comprehensive project plan
2. Research, develop, and test an absorber to define the range of possible operating parameters for the absorption chiller with multiple engine scenarios
3. Develop a CHP-specific heat recovery/absorption chiller module for tight integration with a reciprocating engine
4. Field test the module within a CHP system at a high-reliability data center in Park Forrest, Illinois

Milestones

- Completion of project plan
- Testing of advanced low-temperature heat recovery chiller
- Development of chiller scaling algorithms and engine/chiller calculator
- Development of heat recovery/chiller module
- Field demonstration of module

Commercialization

After successful demonstration, D.E.N.T. LLC intends to move forward in the data center space with aggressive marketing of modular CHP systems for data centers. D.E.N.T. LLC will have strategic allies, in particular Hewlett-Packard Co.'s (HP) EYP Mission Critical Facilities, Inc., Carrier Corporation, and General Electric to assist in these efforts.

Project Partners

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