

Yahoo! Compute Coop Next Generation Passive Cooling Design for Data Centers

Using outside air to cool data center equipment.

Introduction

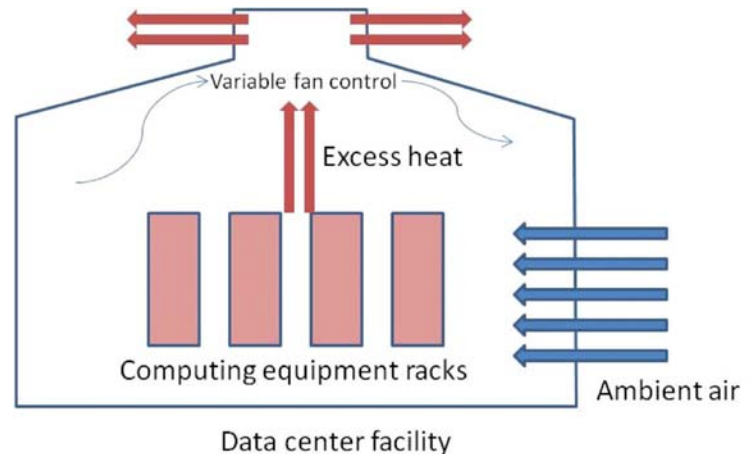
This project has contributed to the creation of a novel design data center for a major internet company. The integrated building design, including the building's shape and orientation and the alignment of the servers within the building, allows the data center to use outside ambient air for cooling 99% of the year. Relatively low initial building costs, compatibility with current server and network models, and efficient use of power and water are all features that make this data center a highly compatible and replicable design innovation for the data center industry.

This 120,000 square foot data center facility in Lockport, New York is an innovative, high-efficiency structure. By eliminating the need for conventional chiller and air handling units, this project will validate the successful use of outside air to cool data center equipment. Called the Yahoo Compute Coop (YCC), this data center is designed to work with readily available, common computing hardware, including servers, storage devices, and network equipment. YCC is designed to work within recommended temperature and humidity specifications for popular data center equipment.

Benefits for Our Industry and Our Nation

This project will validate the concept of "free cooling," which uses outside air to cool data center equipment. The project will improve cooling efficiency to achieve a design Power Usage Effectiveness (PUE or Total Facility Power/IT Equipment Power) of 1.08 as compared to an industry average of 1.7 or more. Specifically, this data center will do the following:

- Use only ambient-air cooling 99% of the time, capitalizing upon prevailing winds and local weather conditions
- Maintain temperature and humidity requirements for servers according to equipment specifications
- Withstand 100-year temperature and humidity conditions and extremely low winter temperatures while maintaining server room environmental requirements



Use of ambient air and variable fans for data center cooling.

Illustration courtesy of U.S. Department of Energy Industrial Technologies Program.

- The YCC design is estimated to save over 90% of the cooling energy used in conventional data center designs. Cooling currently accounts for an estimated 25% of total data center energy use; this design is expected to reduce that percentage down to about 1%.

Applications in Our Nation's Industry

This project will also reduce risk aversion within the data center industry for innovations that relate to outside and ambient-air cooling, chiller-free data centers, and higher-temperature interior environments. It will also serve as a catalyst for experimenting with data center designs that maximize the use of local climate conditions and geography. Much of the new data center capacity in the United States would be a good candidate for YCC implementation, with the Southeast being a less likely candidate market since temperature and humidity are not appropriate.

Project Description

The YCC design emulates a chicken-coop building where hot air rises through a cupola in the roof. Cool air is drawn in through the side of the building which is strategically placed to take advantage of prevailing winds. This new data center design directly addresses the considerable inefficiencies in server cooling that are present in current common practices for data center design. By eliminating the need for expensive, energy-intensive chiller systems and most air handling equipment, and by reducing the power draw of fans, the YCC design ensures that the majority of power is allocated to useful computing work rather than to supporting cooling infrastructure. Using outside-air cooling and/or evaporative cooling for extreme summer conditions translates into fewer moving parts, lower water consumption, and reductions in both capital and operating expenses.

The YCC design addresses a major challenge to reducing electricity consumption from data centers by significantly reducing cooling load. It offers a simplified, whole-building approach to data center design as opposed to a conventional systems approach. The YCC design has a lower initial building cost compared to many high-efficiency systems (e.g., cooling towers, piping for water cooling, etc.). The initial capital cost advantage relies primarily upon use of a pre-engineered steel building and the elimination of raised floors. These two elements yield an estimated capital cost reduction of 32% compared to Yahoo!'s most recently completed data center (built in 2007).

Lower capital cost means faster payback and consequently improved return on initial investments and will likely accelerate adoption of this design compared to other, more expensive, chiller-free design solutions.

Barriers

The data center market has been slow to adopt cooling-system innovations due to the perception of increased risk to equipment performance. The usual concerns are that equipment performance will be jeopardized by the following:

- Use of outside air for cooling, thereby introducing humidity and environmental problems
- Exceeding American Society of Heating and Refrigeration Engineers (ASHRAE) temperature standards for servers
- Eliminating large, mechanical cooling systems from the design entirely

The lack of successful, publicly available examples of design innovations has limited any experimentation or aggressive adoption of such innovations. This project addresses the barriers identified above and will provide evidence to prove the effectiveness of the design.

Pathways

Having already begun the project design and site selection, this project targets the construction and evaluation of the energy- and water-saving innovations described herein.

Milestones

- Completion of construction (Completed)
- Evaluations of energy and performance (Completed)
- Conduction of final reporting and commercialization activities

Commercialization

Yahoo! is ready to utilize the patent-pending YCC concept in its data center designs that are slated for deployment at sites around the globe. The willingness to accept the research and development risks and recognize the technology's operational advantages provides the seed for subsequent commercial opportunities. The reduced construction costs and improved operational efficiencies of the YCC design provides a range of inherent commercial advantages for a broader market of designers, builders, owners and operators. Introducing the technology to the data center industry can lead to further licensing agreements and operational deployments following the Lockport, NY YCC facility build-out. The Lockport, NY facility was officially opened in September of 2010 and evaluation of energy and water savings are in progress.

Project Partners

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