Adaptive Environmentally Contained Power and Cooling Information Technology (IT) Infrastructure for Data Centers

Power and cooling solution for data centers to reduce energy use by 38%.

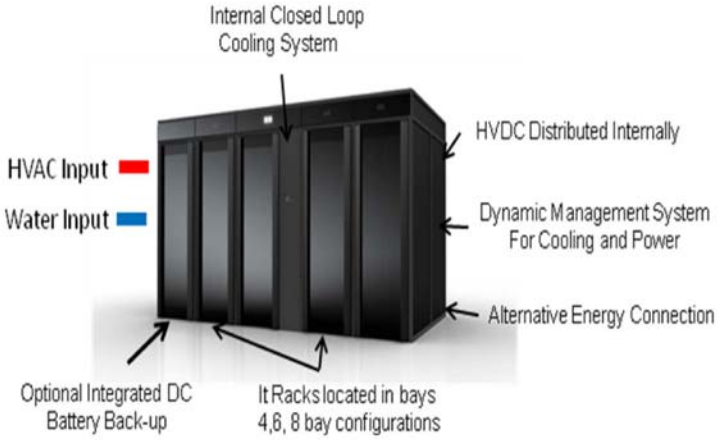
Introduction

This project is the result of an examination of the total energy conversion process required by today's data centers. A large share of utility-provided electricity is converted into heat or reserved as backup power within the data center. Reducing losses from end-to-end power conversion and increasing cooling efficiency will improve overall data center efficiency and reduce greenhouse gas emissions. For the power train, this means reducing the total number of conversions to as few as possible and making those that remain as efficient as possible. For cooling, this means distributing the appropriate amount of air at the required temperature as close to heat-intolerant equipment as possible and removing the heat generated as efficiently as possible. Dynamic control of air delivery and heat removal is also integral to a solution.

This project addresses all of these power conversion and cooling requirements. Through research and development (R&D), testing, manufacturing, market analysis, and commercialization, a complete end-to-end power train and cooling solution for information and communications technology (ICT) facilities will be made available. Each unit will be sized for an electrical supply of about 100 kilowatts (kW).

Benefits for Our Industry and Our Nation

While this contained, closed-loop infrastructure for data centers is targeted at small to medium businesses, the biggest segment of the U.S. data center market, larger data centers seeking modularity and scalability at the 100 kilowatt (kW) building block level are also viable target markets. This project will reduce energy use in a 100 kW data center by 38% and will mitigate roughly 400 tons of carbon dioxide (CO_2) emissions annually. The 100 kW data center will have a Power Utilization Effectiveness (PUE, the total power used divided by the power used by the IT equipment) value of 1.25.



Adaptive environmentally contained power and cooling IT infrastructure.

Illustration courtesy of Hewlett-Packard.

Applications in Our Nation's Industry

The adaptive, environmentally contained power and cooling IT infrastructure will allow high-density IT rack instances to be deployed at up to 100 kW per contained system. The customer will have the ability to deploy this solution in any type of compute environment.

This solution will increase the energy efficiency of small and medium-sized data center installations. Those benefiting from or participating in this industry development will include the following:

- IT, internet applications, and service providers
- ICT facility owners, operators, rack equipment manufacturers, and construction and development companies
- Developers and distributors of building and data center/IT management software
- Utilities with renewable energy or demand-side management programs

Project Description

This project is conducting research and development to produce a fully enclosed IT rack system that will be designed to have its own internal power distribution system and cooling. It will use high voltage Alternating Current (AC) and chilled water as the system's primary input. The system will also allow the use of alternative energy Direct Current (DC) power sources. To maximize efficiency, the system will use internally distributed high voltage DC power from the power source to the IT loads. The system will manage the optimal use of available power and cooling resources based on factors such as grid demand signals, peak-demand usage times, and the strength and availability of alternative energy sources.

The technology aims to yield a 38% reduction in the amount of energy needed to support a 100 kW IT load, compared to current data center designs. Power conversions will be minimized and energy waste reduced. For cooling, the appropriate amount of air will match the cooling needs at the temperature required to be distributed at the load's closest proximity.

Barriers

There is a lack of information in the market as to which systems truly are more energy efficient than others. Computing system energy efficiency has been expressed at the data center level, the system component level, and various other measures, but few data center offerings are accompanied by a whole-system evaluation of energy efficiency.

The contained and closed-loop system tested in this project will provide a true indication of the energy efficiency of the entire information technology infrastructure contained within it. This will allow for a simplified decision path for customers of the technology and those who would expand upon it with further R&D.

Pathways

This novel system will incorporate active management controls to optimize its own environment under various IT loads and changing system conditions, and to interface with data center management systems for a complete end-to-end view of the power and cooling chain.

This project includes further research, development, and testing of the following:

- High-efficiency power distribution paths from the utility to the servers
- High-efficiency cooling systems
- Distributed power generation at the system-unit level
- Dynamic power and cooling monitoring and control software for total system optimization.

Milestones

- Completion of two prototypes
- Completion and evaluation of two pilot deployments
- Confirmation of manufacturability and completion of marketing plan

Commercialization

HP and Eaton's partnership in this joint initiative will lead to the R&D, testing, manufacturing, market analysis, and commercialization of a novel solution for an adaptive, environmentally contained power and cooling IT infrastructure technology. These developments will result in an end-to-end power and cooling solution for data centers in the target size of 100 kW.

Project Partners

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