

## Federspiel Controls' Data Center Energy Efficient Cooling Control System

Combining artificial intelligence with variable flow control, direct temperature measurement, and best practices can reduce cooling energy use by up to 50%.

### Introduction

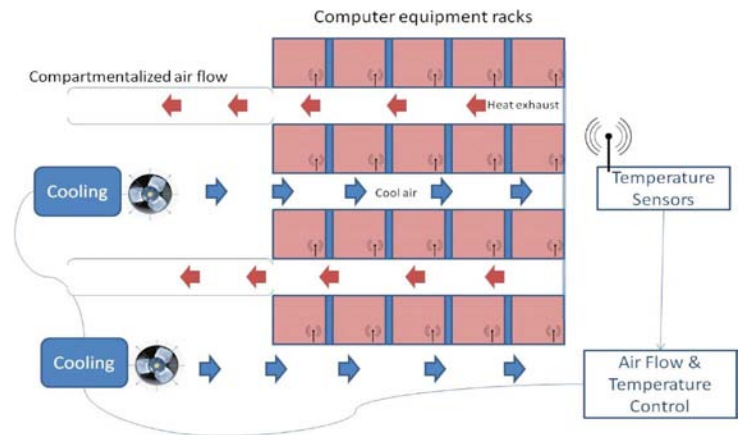
Typical data centers use equipment that cannot operate in high temperatures, resulting in extensive use of energy-consuming air cooling infrastructure. This infrastructure consists of cooling and computing components that typically use low-efficiency, single-speed fans and do not allow for dynamic shifting of cool air to where it is needed most.

This project integrates variable frequency drive (VFD), perforated tiles, and wireless temperature sensors to continuously adjust the volume and targets for cooled air according to temperature. This can significantly reduce the cooling requirements for a data center, which typically consumes 25% or more of the facility's electrical energy. In addition, the use of best practices in airflow management and containment strategies adds to the potential savings.

### Benefits for Our Industry and Our Nation

The technology developed in this project—combined with best practices like VFDs, hot aisle/cold aisle containment, blanking panels, and floor tile optimization—provides the framework for a comprehensive energy-management program. With data center energy consumption doubling every five years, there is an immediate and evident need for such an approach. A 25% savings in energy use can easily save a data center \$8–\$16 per square foot in total annual energy costs, while delivering a power usage effectiveness (PUE or total facility power/information technology [IT] equipment power) rating of 1.25, a dramatic improvement over the 1.7 or higher rating for most data centers (a rating closer to 1 is preferred).

A previous pilot project improved PUE from 1.78 to 1.37 while eliminating 60% of the energy required to move air in the data center.



Dynamically managed cooling systems.

*Illustration courtesy of U.S. Department of Energy's Industrial Technologies Program.*

### Applications in Our Nation's Industry

Conventional telecommunications facilities and data centers design cooling infrastructure for worst-case scenarios. The air cooling systems are run in response to the environmental conditions of entire zones or entire facilities, making them very inefficient. This project is implementing systems that control air distribution, temperature, and air velocity according to the environmental conditions of individual server equipment racks, reducing the amount of energy wasted on overcooling. The control systems identified in this project will be used by or require the services of many industries, the most significant being the following:

- Data center and telecommunication facility owners, operators, rack equipment manufacturers, and construction and development companies
- Developers and distributors of building and data centers and IT management software
- Manufacturers and resellers of facility cooling and refrigeration equipment

### Project Description

The primary goal of this project is to show that the intelligent supervisory control and wireless mesh network sensing system demonstrated at the California Franchise Tax Board's Sacramento Data Center can scale to a wide range of localized, mid-tier, and enterprise data centers. The technology includes intelligent control software and a network of wireless mesh sensors and controllers that provide feedback on server inlet air temperature and direct control of the VFDs on the fans of the computer room air conditioners.

The project includes the best practices of retrofitting computer room air-handling units with VFDs to modulate fan operation, rack blanking, hot/cold aisle containment, and perforated floor tile arrangement. Combined, these measures can improve

air distribution, resulting in better temperature control while achieving good energy savings. These savings are dramatically increased when feedback from the wireless mesh network is used as input to an artificial intelligence engine that automatically and constantly determines which cooling units to operate and adjusts the set points of the units not in use.

Cooling units are normally controlled in a standalone, decentralized mode based on return air temperature to the unit, rather than inlet air temperature of the servers. This often results in overcooling, and wasted energy. The technology provided as part of this project resolves these problems and also improves data center reliability by increasing thermal ride-through, improving resilience, and maintaining equipment inlet temperatures within the limits recommended by the American Society of Heating, Refrigeration and Air-Conditioning Engineers.

## Barriers

Data center operators will be reluctant to adopt new methods of modulating fan control and automating air handling without hard evidence of energy savings and acceptable performance. By demonstrating the energy savings achievable along with performance benefits at eight variously sized California government sites, prospective buyers will have increased confidence in the proposed control systems.

## Pathways

- To demonstrate technology performance, Federspiel Controls Datacenter Automation Software and Hardware (DASH) systems will be installed along with other data center best-practice measures at the eight sites.
- Monitoring tools will be installed followed by the implementation of control systems and measurements, as well as the verification of energy savings, at each site.

## Milestones

- Determination of energy-use baseline at all eight sites
- Installation of DASH monitoring technology
- Monitoring and measuring of performance
- Validation and evaluation of control systems

## Commercialization

The final phase of this project is the creation of technology transfer materials that can be used to inform data center operators of the benefits of this solution.

For ease of commercialization, the creation of a shared-savings financing contract model would allow for more interest during the current economic climate. This business model enables facilities that lack the funds for a standard purchase to acquire a system and immediately achieve energy savings, which are then used to pay for the project. This is most feasible at data centers that submeter IT loads and cooling equipment energy consumption, allowing the impact of DASH to be measured accurately over time.

## Project Partners

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