



# Case Study: Lawrence Berkeley National Laboratory Air Flow Management

As part of Pacific Gas and Electric's Data Center Emerging Technologies Program, Lawrence Berkeley National Laboratory, and its subcontractor, Rumsey Engineers conducted an air management demonstration and monitoring project in an operating data center. The goal was to show data center designers and operators the operational and energy benefits of more efficient data center air management techniques. Data centers that do not optimize air distribution use considerably more energy.

## Project Case

The demonstration took place in a small section of the National Energy Research Scientific Computing (NERSC) Center in Oakland, California from June 12-16, 2006.

A baseline air distribution configuration, representative of typical data centers today, is compared with two alternate configurations.

In the baseline configuration, supply air entered the cold aisle through perforated tiles in a raised floor, passed through the server intakes, and was discharged into the hot aisle where, through return airflow and stratification, it returned to the cooling unit. The 'Alternate 1' configuration was similar, except that the cold aisle was sealed at the top and ends of the racks to prevent hot air re-circulating back into the cold aisle. In the 'Alternate 2' configuration, plastic partitions sealed the hot aisles off from the cold aisle, and the interstitial ceiling space was used as a return air plenum.

Each configuration was monitored for energy use, computer inlet and aisle temperatures, and air flow volume. These values were then compared to determine cooling effectiveness and efficiency.



## Project Outcome

Alternate 1 provided the most effective hot and cold air separation, and therefore, the greatest cooling efficiency. The project found:

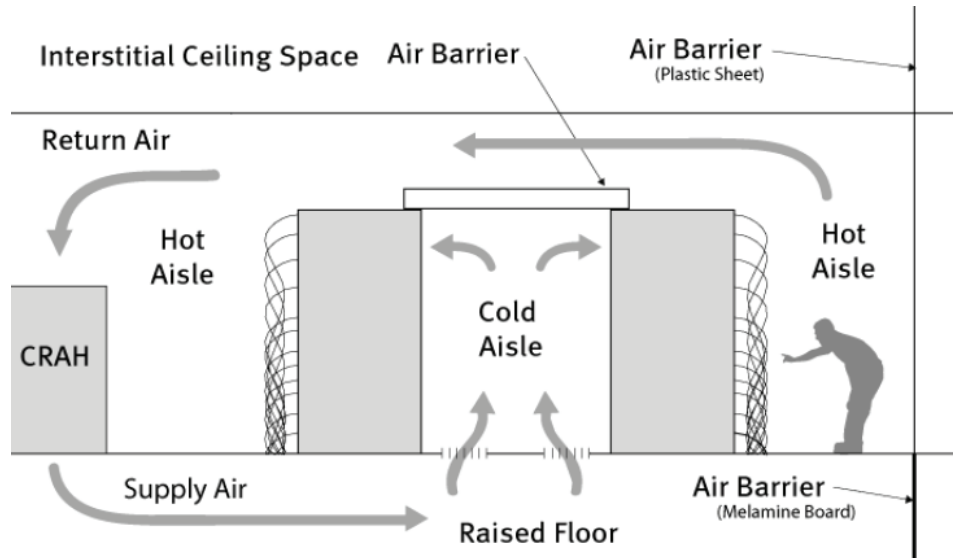
- Carefully separating hot and cold aisles allowed for better uniformity of the supply air temperature at the inlets to the servers. The variation in supply air temperature decreased from 26°F to 18.5°F between Baseline and Alternate 1. That is, the homogeneity of supply air temperatures improved as a result of better air management.
- By minimizing air mixing, and allowing the temperature difference between the supply and return air to increase, LBNL was able to reduce fan power by 75% without adversely affecting the server environmental conditions.
- Higher return air temperatures increased the capacity of the computer room air handling (CRAH) units by 30% - 49%.
- Temperature difference between the chilled water supply and return increased, which could allow for reduced chilled water flow, and save pumping energy. Alternatively, a chilled water temperature differential of 20°F increases piping capacity 43% (but not chiller capacity) without modifying the chilled water system (compared to the as-found differential of 14°F).
- When using variable speed server fans, power savings can be offset or decline to zero if the CRAH fan speed is reduced too low. The server fans speed up in response to the increased supply air temperature, which can increase power consumption overall.
- By minimizing the mixing of supply and return air, the supply air and chilled water supply temperatures can be raised. Raising the chilled water supply temperature to 50°F can save 4% in chiller energy.

7. Raising the chilled water supply temperature to 50°F and utilizing integrated water-side economizing can save 21% in chiller energy and result in increased chiller capacity.

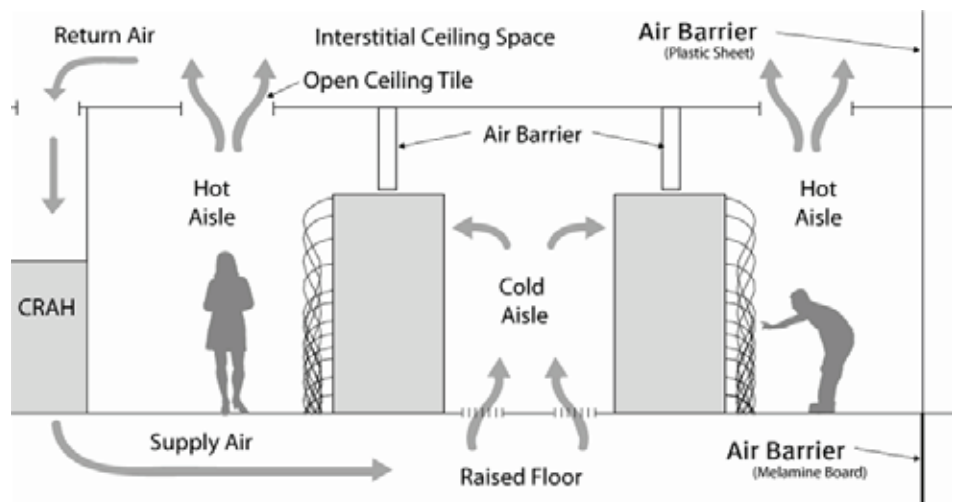
Calculated energy savings and/or equipment capacity increases in the test area are set out below. These values have also been extrapolated to estimate the savings possible in applying the techniques presented here to the entire data center. The extrapolation was performed by multiplying the computer heat load density in the test area to the entire floor area of the data center. This load was then used to estimate cooling plant energy use.

Interestingly, the electrical load of the computing equipment in the data center far outweighs the electrical load of the cooling equipment. The ratio of cooling power to the total electrical power in a facility is a commonly-used metric in data centers. The test area, as found, was using approximately 63 kW of cooling power to cool about 270 kW of computing load. Thus, the ratio of cooling power to total power is about 20%. So dramatically reducing cooling power required will not have significantly affect the facility's power use overall.

Alternate 1—Cold Aisle Isolation



Alternate 2—Hot Aisle Isolation



## Summary of Potential Energy Savings for Data Center

Finding	Annual Energy Savings (kWh)	Demand Reduction (kW)	% Reduction in Cooling Energy	% Reduction in Total Energy
1			N/A	
2	740,000	84.2	12%	1.8%
3			N/A	
4	110,000	12.2	3.2%	0.3%
5			N/A	
6	210,000	24.5	3.3%	0.5%
7	1,140,000	24.5	18%	2.8%

Findings marked with “N/A” either increase capacity rather than save energy or are qualitative observations.

## About the Energy Efficient Data Center Demonstration Project

The project’s goal is to identify key technology, policy and implementation experts and partners to engage in creating a series of demonstration projects that show emerging technologies and best available energy efficiency technologies and practices associated with operating, equipping and constructing data centers. The project aimed to identify demonstrations for each of the three main categories that impact data center energy utilization:

- operation & capital efficiency
- equipment (server, storage & networking equipment)
- data center design & construction (power distribution & transformation, cooling systems, configuration, and energy sources, etc.).

The project also identified member organizations that have retrofitted existing data centers and/or built new ones where some or all of these practices and technologies are being incorporated into their designs, construction and operations.

## About The Silicon Valley Leadership Group (SVLG)

The SVLG comprises principal officers and senior managers of member companies who work with local, regional, state, and federal government officials to address major public policy issues affecting the economic health and quality of life in Silicon Valley. The Leadership Group’s vision is to ensure the economic health and a high quality of life in Silicon Valley for its entire community by advocating for adequate affordable housing, comprehensive regional transportation, reliable energy, a quality K-12 and higher education system, a prepared workforce, a sustainable environment, affordable and available health care, and business and tax policies that keep California and Silicon Valley competitive.