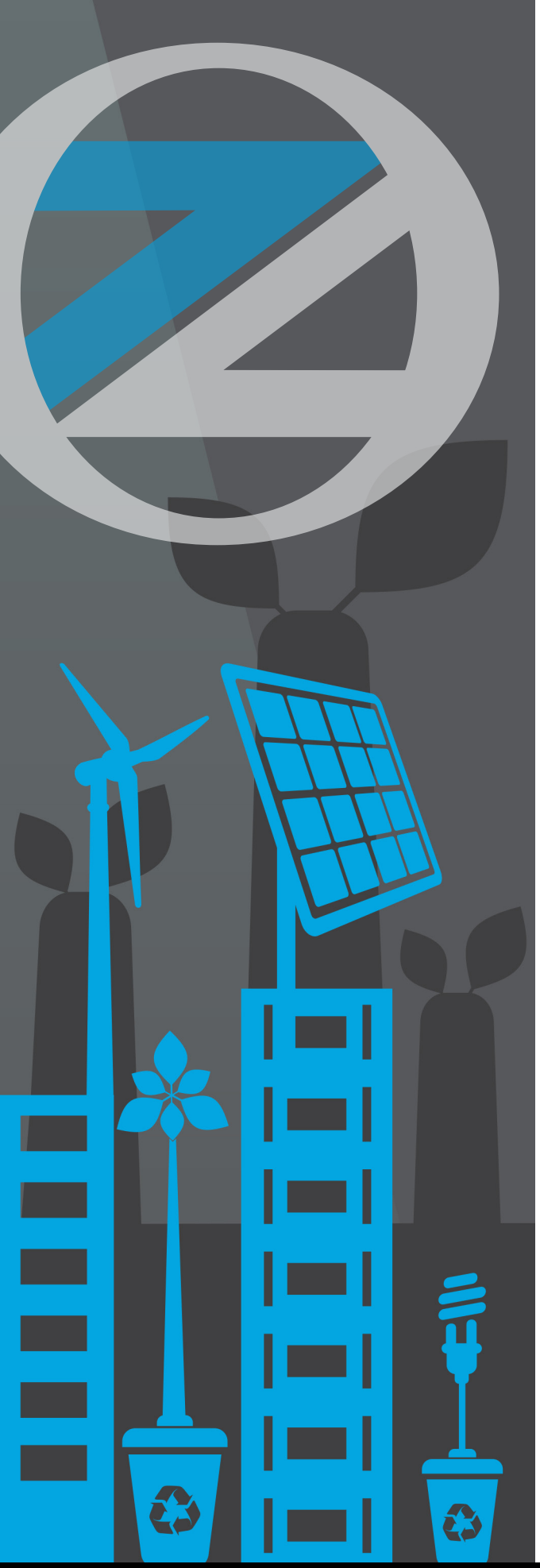


Containment Helps Data Centers Go Green

SUBZERO / WHITE PAPER

By Gordon Johnson

INTRODUCTION

Data centers are a huge part of today's economy, with both businesses and people connected 24/7. However, along with this usage comes a huge drain on our energy resources. Recent studies show that energy consumed by data centers in the U.S. alone has doubled over the last five years. With the growth of cloud computing and High Performance Computing (HPC) and the energy required to operate them, this trend is not disappearing anytime soon. Fortunately, many realize that this high level of energy consumption cannot continue indefinitely, and the push for greener and more environmentally friendly data centers is being taken seriously.

What can data center and facility managers do to stop this runaway train? While there are several options to get greener and thus lower the overall cost to operate a data center, this paper specifically focuses on containment. Why? Containment is the fastest, easiest, and most cost effective strategy to going green while simultaneously lowering operating costs without adding additional CapEx to the data center. In addition, containment makes other options either possible or economically feasible. This paper will show why this is true, while discussing the following topics:

- Why Being Green Matters
- Containment is the Smallest Action with the Greatest Outcome
- Containment = High Efficiency = Green Data Center
- Containment's Role in HPC
- Efficiency: Full Containment Versus Partial Containment
- Efficiency: Cold Aisle Containment Versus Hot Aisle Containment
- CFD Predicts Energy Savings & Environmental Footprint

WHY BEING GREEN MATTERS

Many organizations face escalating data center energy costs. Driven by an increase in computing demand, IT equipment power density, along with the availability of power to meet computing demands, many will soon need to retrofit existing facilities, build new ones, or risk running out capacity for growth. Data center power consumption has become a growing global concern on both a business and environmental level, with resulting heat generated and power consumed having a dramatic effect on both the environment and the cost of running a data center.[1]

Already it's estimated that data centers consume approximately 3% of the global electrical energy supply and account for 2% of total greenhouse emissions, meaning data centers currently have the same carbon footprint as the airline industry. We need to realize that this level of energy consumption cannot continue to rise indefinitely. It's time to stop just talking about saving energy, we need to do it!

We must be committed to sustainability. We need to offset the impact data centers are having on the environment by reducing CO2 emissions and our carbon footprint. We need to take steps now to make our data centers and our industry more environmentally friendly. It's our responsibility to create green, energy-efficient data centers with minimal impact on the environment.

CONTAINMENT IS THE SMALLEST ACTION WITH THE GREATEST OUTCOME

Containment has often been described as a "no brainer" decision when it comes to data centers. Why is this true? Simply put, containment is the smallest action with the greatest outcome. It's the easiest way to save money and increase efficiency in the data center. Containment also makes the data center an environmentally conscious place, because instead of consuming energy, containment saves energy.

Because containment prevents cold supply air from mixing with hot exhaust air, the supply temperatures at server inlets can be increased and kept at the desired level throughout the data center. Since today's servers are recommended to operate at temperatures as high as 80.6°F (27°C), containment allows for lowering fan speeds, higher chilled water temperatures, decommissioning of redundant cooling units and increased use of free cooling, all important factors for improving efficiency and lowering the carbon footprint.

An environmental friendly data center is always a cost effective data center. How cost effective? With containment installation projects, most data centers have an ROI between 6 and 18 months. Containment can save a data center approximately 30% of its annual utility bill.[2] This makes the ROI from containment faster than other changes in a data center. The cost of containment and going green to an organization is recouped very quickly, after that it's money in the bank, a win-win situation for everybody.

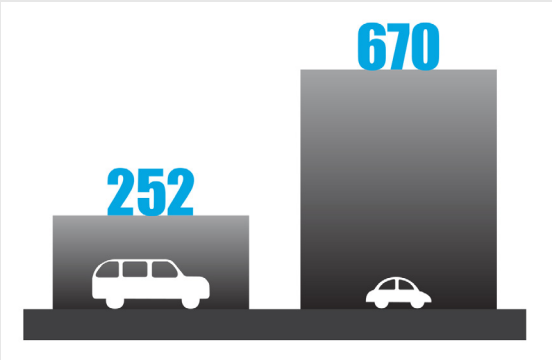
A data center with containment is energy-conscious because it consumes less power than without containment. This, in turn, means less overhead since data center cooling requirements are reduced. Green data centers offer the same amount of power, cooling, bandwidth, etc., as facilities not operating in "green mode". The big difference is they are able to do so without leaving a hefty impact on the environment.[3]

CONTAINMENT = HIGH EFFICIENCY = GREEN DATA CENTER

Data center efficiency and its carbon footprint are directly related to each other since an efficient data center should be capable of using energy to its best potential. Today's data centers are taking various steps towards a more environment friendly future. Some simple steps are turning out to be very effective towards greater efficiency and greener results.[4]

For example, how much does containment help towards going green and reducing CO2 emissions? Since containment separates the cold supply and the hot exhaust air, the temperature in the data center can be increased, while often lowering fan speeds or turning off unnecessary cooling units. The result is a reduction of kW and thus kWh on the utility bill.

For example, a 1MW data center could easily see a 288 kW reduction after containment, which is an annual reduction of 2,522,820 kWh on its utility bill. This results in an annual CO2 reduction of approximately 2,372 Tons. How did this help the environment? A useful ballpark number is about 5 to 6 trees need to be planted and exist over a period of 30 years to sufficiently offset 1 Ton of CO2 emissions.[5]



In this example, 13,043 trees would've had to been planted and lived for 30 years to offset the annual CO2 had containment not been installed. Another way to look at this is that containment helped remove 252 SUVs (15 mpg) or 670 compact cars (40 mpg) traveling approximately 12,000 miles per year.

Going green definitely helps the environment, but how much does containment lower operating costs? With the above reduction of 2,522,820 kWh and assuming the cost of electricity to be $0.10 kWh, the annual savings after containment would be $252,288. Again, a win-win for everybody!

In addition to saving energy, other benefits of containment include higher energy density per rack, longer Mean Time Between Failures (MTBF) of the IT equipment, lower PUE, and more. The net effect of containment is a high efficiency data center, lower carbon footprint, and a greener data center.

CONTAINMENT'S ROLE IN HPC

With HPC becoming the norm rather than the exception, containment's role in the data center becomes even more crucial. Where just a few years ago 5 kW per rack was considered pushing the limits, today 15 kW to 25 kW racks are becoming more and more common in data centers. Some predict power densities of 52 kW per rack by 2025.[6] Whether the industry will climb to such levels is still unknown, but data center density is definitely on the rise.

What's behind rising rack power densities? Artificial Intelligence (AI) and machine learning technologies, cloud computing, large high-density data centers, smaller more compact high-density data centers, blade servers, virtualization, just to name a few. Both hardware and software are finally hitting their technological stride, and thanks to Building Controls Systems and other intelligence (DCIM, etc.), data centers are running smarter and more efficiently. HPC is just beginning, and data centers will likely look very different 5 years from now.

What role does containment play in HPC? Since containment reduces the amount of air conditioning or cold supply air (CFM) needed to cool the IT equipment, it should be an integral part of any HPC deployment or hyperscale data center. If you're not planning on containment in your data center, don't even consider HPC or high density racks. Without containment, you'll need to continue to flood the room with an excess of cold supply air, and data center managers will need to be content with 5 kW or less at each rack and potential hot spots.

EFFICIENCY: FULL CONTAINMENT VERSUS PARTIAL CONTAINMENT

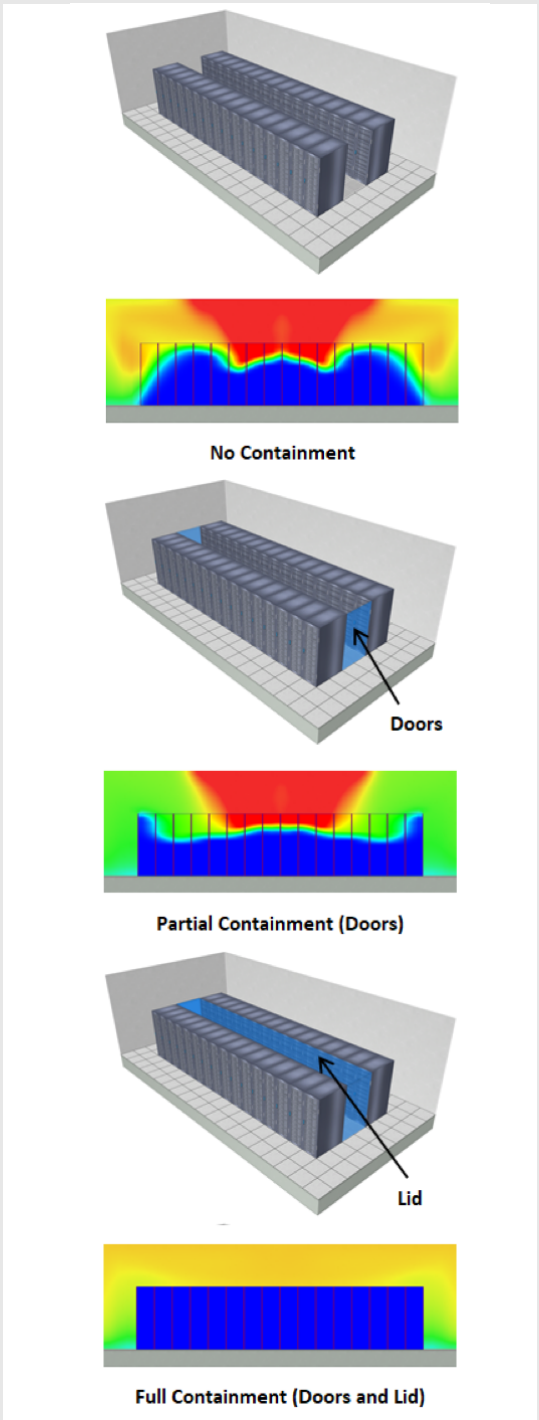


FIGURE 1: FULL CONTAINMENT VERSUS PARTIAL CONTAINMENT

What about employing partial aisle containment in a data centers to improve efficiency? For example, is just adding doors to the end of aisles sufficient versus additionally adding a lid across the top of the cold aisle or running containment to the top of the ceiling?

Partial containment such as end of aisle doors will prevent hot air from recirculating around the end of the aisles, but will not have a large impact on improving any existing issues of hot exhaust air recirculating over the racks and back into the cold aisles (see Figure 1). If possible, full containment should be installed since this is the best way to improve efficiency in the data center.

What if overhead obstructions or even the fire suppression system make it difficult or impossible to install full containment? Even containment 18" below the ceiling will have a substantial impact in preventing the mixing of the cold supply and hot exhaust air, thus improving efficiency.

As a side note, both full cold aisle containment and hot aisle containment have been successfully installed and approved with sprinklers and gaseous-agent suppression systems. However, it is always recommended that the Authority Having Jurisdiction (AHJ) be contacted for specific requirements well before any containment project is started.

EFFICIENCY: COLD AISLE CONTAINMENT VERSUS HOT AISLE CONTAINMENT

We know that containment increases efficiency, but is one type of containment better than the other? Which is more efficient, cold aisle containment or hot aisle containment?

From a thermodynamics point of view, both will improve efficiency and lower data center operating costs. Recent energy efficiency studies also show that the savings between the two are negligible. If given the choice, such as during a new data center design, a close look at some of the advantages and disadvantages between the two will help make the choice easier.

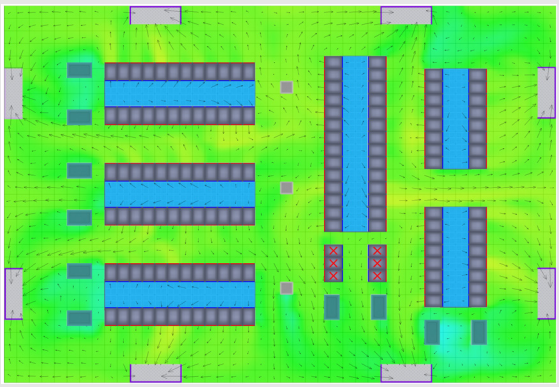


FIGURE 2: 6' HORIZONTAL XY PLANE WITH CAC

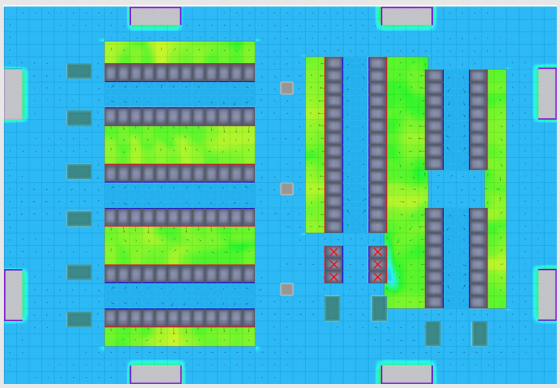


FIGURE 3 6' HORIZONTAL XY PLANE WITH HAC

The cold aisle containment system (See Figure 2) separates the cold supply and hot exhaust air from each other, often with simple modifications to the room. The down side is that employees must work in the open warm space as cold supply air only cools the IT equipment.

The hot aisle containment system (See Figure 3) also separates the cold supply and hot exhaust air from each other, but one advantage to this type of system is for data center personnel. Hot aisle containment creates a pleasant working atmosphere for personnel as they walk into a cool room. Some feel they can increase the temperatures higher than they could with cold aisle containment and thus see larger energy savings. However, when taking the human element out of the equation, both systems are equally effective at providing optimized and well-managed airflow to the IT equipment.[7]

CFD PREDICTS ENERGY SAVINGS AND ENVIRONMENTAL FOOTPRINT

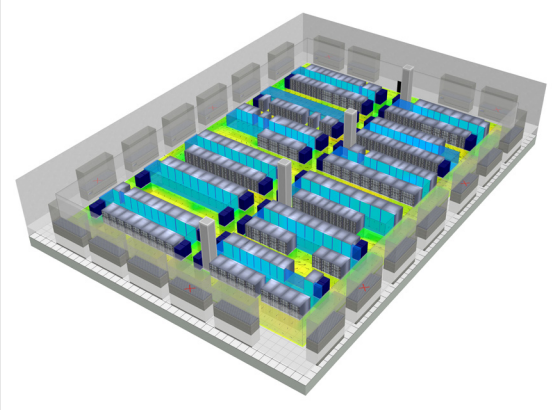


FIGURE 4: CFD MODELING SHOWING RACK INLET TEMPERATURES WITH CAC

What is CFD and how does it assist in predicting energy savings and environmental footprint? CFD is an acronym for Computational Fluid Dynamics, and many data centers use it for planning, construction, and maintenance solutions. CFD provides a detailed 3D analysis that shows the flow of both cold supply and hot exhaust air through the data center. CFD modeling also enables easy identification of potential overheating of IT equipment.

Most important, CFD modeling shows how to reduce energy costs by reducing instead of wasting valuable data center cooling. CFD is a tool to virtually test both new and legacy data center environments for active temperature, pressure, and airflow. CFD also helps optimize and fine-tune the mechanical system directly to server heat loads (kW).

Since containment is already recognized as an integral piece of any data center, CFD further drives this point home. For example, CFD modeling accurately answers the following questions:

1) What impact will CAC have versus HAC in a specific data center layout?
2) Which saves more energy, full or partial containment?
3) After containment is installed, how many CRACs can be turned OFF and/or how low can fan speeds be reduced on CRAH units?
4) How high can supply temperature be increased while still following the thermal guidelines from SLAs and ASHRAE (see Figure 4)?

CFD answers the above and more. By helping data center managers make informed decisions regarding cooling without having to move or add new equipment and devices, energy savings can be predicted. When provided with accurate data, CFD can provide the following expected results from containment:

1) Updated PUE
2) Annual energy savings and annual total operating cost
3) Annual kWh and kW reduction
4) Annual CO2 reduction (Tons) and annual CO2 offset reduction
5) ROI of containment project

A good containment company will offer complimentary CFD modeling so customers can have a clear picture of how containment will immediately impact their energy cost and lower their environmental footprint. If available, it's recommended to always take advantage of such environmental impact evaluations.

CONCLUSION

Improving energy efficiency and lowering the carbon footprint is easily attained by using containment in the data center. Regardless of which type of containment is used, large energy savings can be achieved by raising the supply air temperature and optimizing the airflow in the data center. With containment, other options such as Digital Scroll Compressors, EC or Variable Frequency/Speed Drives, DCIM, Building Controls, etc., become more efficient and economically feasible. But it still starts with separating the cold supply air from the hot exhaust air via containment. As described above, instead of consuming energy containment saves energy, thus reducing operating costs. Since the best energy saved is the energy you don't consume in the first place, containment makes the data center greener and a more environmentally conscious place.

Whenever possible, existing data centers should be retrofitted with either cold or hot aisle containment, with containment always automatically included as part of any new data center design.

ABOUT THE AUTHOR

Gordon Johnson is the Senior CFD Engineer at Subzero Engineering, and is responsible for planning and managing all CFD related jobs in the U.S. and worldwide. He has over 25 years of experience in the data center industry which includes data center energy efficiency assessments, CFD modeling, and disaster recovery. He is a certified U.S. Department of Energy Data Center Energy Practitioner (DCEP), a certified Data Centre Design Professional (CDCDP), and holds a Bachelor of Science in Electrical Engineering from New Jersey Institute of Technology. Gordon also brings his knowledge and ability to teach the fundamentals of data center energy efficiency to numerous public speaking events annually.

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