WHITE PAPER

NOT YOUR FATHER'S DATA CENTER

The Need for More Flexible and Sustainable Data Center Design—Now and Into the Future

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15 minutes

The demand for computing power will inevitably increase as companies in all industries take advantage of emerging technologies to provide the experiences their customers crave and achieve their most critical IT and business goals. This trend is already changing how we all think about traditional multi-tenant data centers and highlights specific needs for more flexible and sustainable design, construction, and operation.

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Executive Summary

Many different factors are driving significant demand in the data center industry today. Examples include cloud computing (both hybrid cloud and multi-cloud solutions), edge computing, the increased popularity of digital content, network upgrades to support 5G, and companies taking advantage of the latest technologies, such as artificial intelligence and machine learning. This exploding demand means companies must now store staggering amounts of data, secure it, and use powerful, computing-intensive resources to uncover valuable business insights.

It all represents a rising tide that lifts all boats in the entire data center industry. According to recent research, the data center market size is expected to grow by $615 billion from 2021 to 2026, growing at a compound adjusted growth rate of 21.98%, and 35% of the market's total growth will occur in North America.[1]

Yet, as companies look to find the right data center facility or colocation partner, many aren't aware of how this growth in demand—as well changing dynamics and climate-based concerns—are shaping data center design. The entire industry is already evolving beyond traditional elements and once-accepted norms to now offer more flexible design elements to help their customers achieve a wide variety of computing-related goals. This white paper examines these topics and shows how they're shaping the evolution of data center design, now and into the future.

[1] Technavio, "The Data Center Market Report," May 2022.

Introduction:

One thing is clear: The demand for computing power will continue to increase as companies in all industries look to take advantage of digital technology, manage explosive data growth, and meet their customers' expectations. This has real implications, not just for the technology in use, but for the physical aspects of the data centers where IT infrastructure resides.

The entire data center industry is quickly changing to keep pace. Many providers are already rethinking past approaches and accepted norms to implement more flexible aspects of data center design and use. Examples of these shifting considerations include factors such as density, cooling, energy efficiency, and sustainability—all affecting how data centers are designed and operated.

INCREASING POWER DEMANDS AND DENSITY

In our experience, when executives of enterprises are asked what they want to know about their data centers, chances are good that they focus on whether applications are available, whether they'll perform as advertised, and the total cost. However, they often don't ask about another important factor, which has a direct impact on cost, performance, and availability: density

Density is generally measured as the amount of power consumed by all the gear within a single cabinet. This includes compute, storage, networking, and everything else needed to support the application. Higher densities enable more resources within the same physical space to support larger, faster, more complex applications and workloads.

The drive for better performance—combined with the drop in price for multi-processor blades—has moved many IT departments to denser server systems. Whether these are 1U servers, blade servers, or even hyperconverged systems, it's now normal to see cabinet densities at 10kW or more (up from 3-5kW per rack).

On top of this, the extreme growth of data and the demand for analysis of Big Data has increased dramatically. Just think of all the modern services performed on the vast amounts of data that users currently store: contextual searches of their photos, scrubbing of real-time videos for offensive content, analysis of shopping patterns, and targeted marketing to name a few.

These services and many others all run extremely compute-intensive artificial intelligence, which demands high power consumption hardware. This has led to special High Performance Computing (HPC), hardware that can drive power consumption at the rack level to 20kW, 50kW, or even 100kW and above.

Data centers consume approximately 3% of the global electric supply and account for nearly 2% of total greenhouse gas emissions worldwide—roughly as much CO2 as the airline industry. Data centers are already turning to clean energy and sustainable energy sources and will continue to do more in the future.

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UNIVERSAL DATA HALL DESIGN

As power consumption demands increase, it leads to larger and heavier equipment, a trend that is already changing data hall construction. This is especially true with hyperscale cloud providers, although we're starting to see enterprise-level companies move in this direction, too. In the not-so-distant past, the standard requirement was that data hall floors had to support 2,000 pound cabinets. This quickly changed to 3,000 pounds and even 5,000 pounds as equipment manufacturers are packing more and more resources into the same footprint to meet the demands of a new generation. These numbers would have been unthinkable just a short time ago.

All of this has a connection to flooring options in the data center. For years, the majority of data center customers wanted raised floors because they made it easy to configure and control the air flow under each cabinet or data hall. Yet, raised floors may not be able to support the increased weight, causing many companies to pivot to concrete slab flooring, or better yet, a concept we at DataBank are calling Universal Data Hall Design because it accommodates IT infrastructures at all stages of evolution. (See diagram on page 6)

In our Universal Data Hall Design, the base design is slab floor with perimeter cooling, great for large full hall deployments typical to hyperscalers. If there is demand for even higher density, technologies like rear door heat exchangers or direct chip cooling infrastructure can be piped in with minimal effort. In the other direction, if there is still a need for more traditional enterprise deployments, the data center owner can easily add raised flooring to accommodate multiple customer requests of varying cabinet sizes, layouts, and other options. This universal approach provides the flexibility needed to accommodate pioneering customers while still supporting the late adopters during this transitional period.

COOLING

Packing a lot of power into less space can lead to cooling issues. Virtually every data center can provide the power needed for high density, but it still must cool the generated heat. It doesn't do any good to provide 2MW of power into a data hall if the supporting infrastructure can cool only 1MW. The same is true if there's not enough airflow to properly cool the equipment in individual racks.

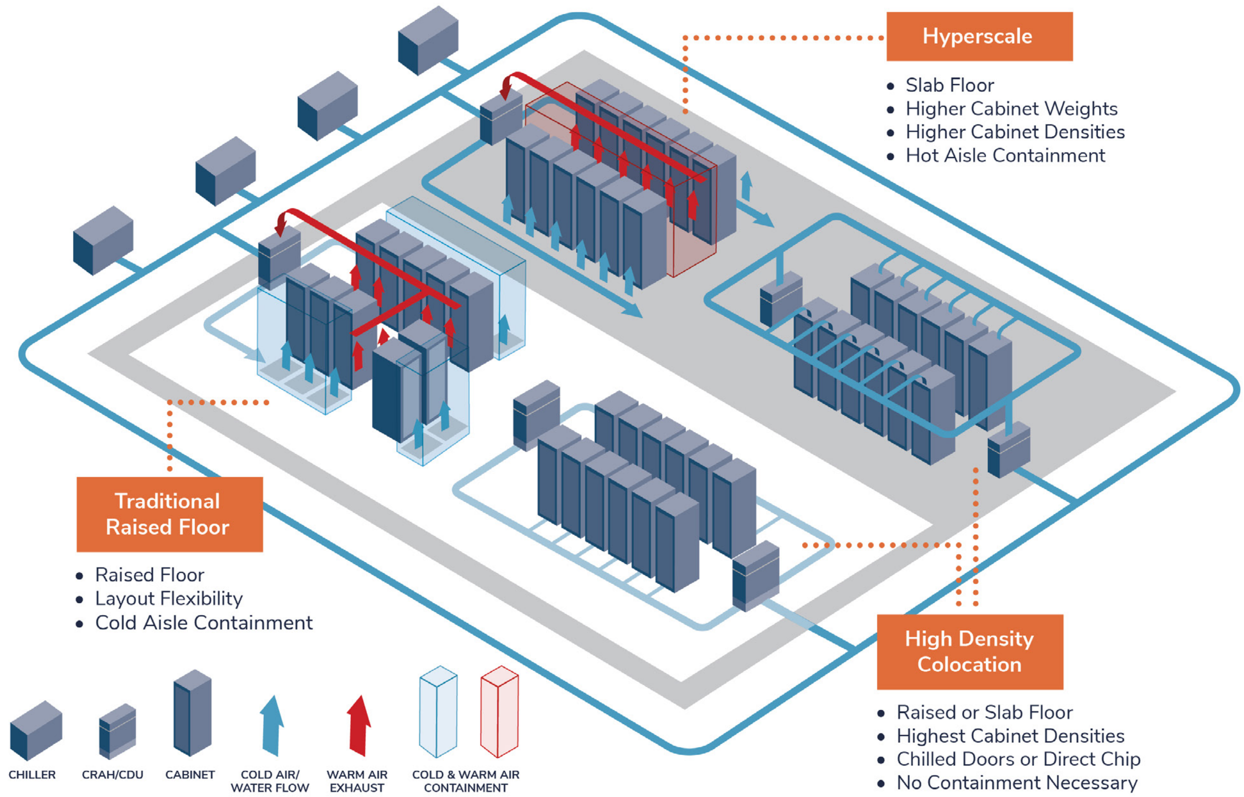
The industry is likely to evolve away from perimeter cooling and will adopt technologies like rear door heat exchangers, direct chip cooling, and immersion cooling as density continues to climb. However, with customers at different stages of density evolution and no real high density standard in play, design of multi-tenant data centers must be flexible enough to accommodate the varying needs of a broad customer base.

As the industry continues to look for more energy-efficient alternatives, it should invest in equipment that offers more competitive energy performance and proven reliability. Some manufacturers now offer advanced chiller equipment that uses better compressor design with variable speed controls in conjunction with free air economization optimized to significantly reduce average annual electricity consumption. For example, the latest air-cooled chilling systems can now enhance uptime and reliability as well as energy performance, without the need for traditional water-based evaporative systems.

The industry could also benefit from new ways of thinking, especially the expectation that data centers must be cold (usually 68-71°F). While some customers applying traditional thinking still profess a preference for colder temperatures—*"I want to feel cold"*— modern IT equipment can easily run at higher temperatures than they do currently—for example, eight to 10 degrees hotter—without any significant sacrifices in system reliability. This alone could deliver significant savings on power consumption of the chillers.

Universal Data Hall Design

Flexibility to accommodate all types of customer needs



CLEAN ENERGY SOURCES

It is estimated that data centers consume 3% of the global electric supply and account for nearly 2% of total greenhouse gas emissions worldwide—roughly as much CO2 as the airline industry.[2] Clearly, data centers must do more to improve energy efficiency and embrace clean energy sources to reduce these emissions, and DataBank has committed to a Net Zero target by 2030.

[2] Yale Environment 360: "Can the World's Huge Data Centers Be Made More Efficient?" April 2018.

There's a bit of a catch-22 in the data center industry today. Customers want more power, but they want it to come from the greenest energy sources possible. "Give me more power but make it clean," they seem to say. Many are even requesting detailed information about the data center's energy consumption and overall carbon footprint.

Many of the larger, more forward-thinking companies are now demonstrating leadership by being vocal proponents of efforts to address and mitigate climate change. When it comes to data centers, many people involved—including C-suite executives and customers alike—are concerned that the power demands of our digital infrastructure are having a major, detrimental impact on the environment.

As a result, there is a movement to transition away from power sources such as coal and natural gas toward electricity generated from renewable energy sources such as wind and solar. For example, Singapore recently announced plans to quadruple its solar deployment by 2025 and is now working toward deploying at least two gigawatt-peak (GWp) of solar – approximately three percent of the country's total projected energy consumption by 2030. Among other highlights, this effort includes a massive floating solar farm that covers the size of 45 football fields and includes 122,000 panels.[3]

DataBank is also committed to using renewable energy sources. Currently, we have 11 renewably powered data centers. Our two Indianapolis data centers are 100% powered by renewable sources through a voluntary green power program with the local utility, Indianapolis Power and Light. Through the Indianapolis Power and Light program, DataBank will offset the carbon dioxide emissions by the equivalent of 3,321 passenger cars driven in one year or 84 railroad cars of coal burned. Participants in the Indianapolis program now help support the development of additional renewable energy sources, further helping reduce reliance on fossil-fueled power. In addition, many of our largest customers, including hyperscale cloud providers and major content providers, are making strides to use energy from renewable vs. non-renewable sources.

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[3] Reuters, "Singapore Unveils One of the World's Biggest Floating Solar Panel Farms."

ECONOMIZER COOLING STRATEGIES

In the past, massive air conditioning systems were the primary mechanism for cooling data centers, but they consume significant amounts of power. In colder climates and cooler seasons, the use of naturally cold external air helps reduce the overall reliance on air conditioning compressor units and reduces power consumption, a process called economization.

One approach is to use sensors that measure the outside air temperature and humidity, and if conditions are appropriate, they open air dampers to allow outside air to cool the facility. The system closes those air dampers when the conditions require a return to mechanical cooling. The whole process is like opening a window at your house on a nice day, but it also offers fully autonomous capabilities with sophisticated sensing and control sequences that maintain temperature and humidity parameters. While this method is extremely efficient, it is very challenging to maintain the often strict parameters required for mixed multi-tenant deployments (specifically humidity and air quality). It is why we generally see this in single tenant or self-managed datacenters where the customer/user is more likely to assume the calculated risk. For instance, the customer may have back-up systems in other nearby data centers.

Another approach, while less efficient but much more controllable, is to use the cold outside air to reject heat from the cooling system instead of compressors. Using an air cooled chiller as an example, when the temperature outside is cold enough, the chiller can divert building loop water from the power hungry compressors into a large coil where high-efficiency fans blow air and pull away the heat. This allows for precise control of the data center environment, avoiding the humidity and air quality challenges of direct air economization, while still benefiting from some level of economization. This is a great compromise for multi-tenant data centers to accommodate a range of customers with varying computing needs.

Today, data centers consume tremendous amounts of electricity to power their servers, storage equipment, back-ups, and power-cooling infrastructure. U.S.-based data centers use more than 90 billion kilowatt-hours of electricity a year, a number that is expected to double every four years.[4]

[4] *Forbes*, "Why Energy is a Big and Rapidly Growing Problem for Data Centers."

ON THE PATH TO ENVIRONMENTALLY FRIENDLY REFRIGERANTS

Air conditioning systems require refrigerant chemicals that can have a negative impact on our atmosphere by depleting ozone and further contributing to global warming. A refrigerant's Global Warming Potential (GWP) is a measurement of a chemical's contribution to global warming and enables comparison between different refrigerant options. Fortunately, the industry is seeing an iterative improvement in refrigerants. Specifically, in the past, a refrigerant called R22 had been the most used chemical in air conditioning systems and had both a high GWP as well as a destructive impact on ozone. Consequently, it has largely been replaced by at least a dozen–friendlier refrigerants, but with the understanding that they, too, are not perfect and would also eventually need to be replaced. So the industry is constantly exploring other refrigerants with lower ozone impact and GWP. In other words, although a refrigerant with zero environmental impact might not be available in our lifetimes, we can expect to see newer, better refrigerants with less negative impact over time.

HEAT RECYCLING

While venting data center waste heat into the atmosphere may be efficient, data centers soon realized that this heat had value in other infrastructures.

For example, DataBank's ATL1 data center hosts the Georgia Tech liquid-cooled supercomputer, which offers High Performance Computing to the institution's faculty, research scientists, graduate students, and academic and government affiliates. A water-cooled door chilling system in this data center gives DataBank the ability to scale up to 100kW per cabinet without having to take up additional space for cooling. The heat and waste energy from the supercomputer is transferred to the chilled water, which, when it reaches a specified temperature, is supplied to the building's boilers for use by other tenants.

GREENER BACKUP SYSTEMS

Back-up power systems are a critical component of any data center operation and keep mission-critical systems and applications running, even when there is an interruption to utility-provided power. These backup systems need to be reliable, scalable, efficient, and use as little space as possible.

Advanced, three-phase UPS battery systems provide the most popular option, delivering smart, dependable power in a compact format. However, their use of lead-acid chemicals is not environmentally friendly, and they need to be replaced periodically.

To minimize this impact, many data centers have turned to smarter battery systems. Lithium Ion (Li-Ion) batteries, for instance, have become a viable alternative to Lead Acid batteries because of their reduced footprint, longer lifecycle, lighter weight, and faster self-charging. Still, even Li-Ion batters can have a negative environmental impact and carry a risk of explosion during transport. For these reasons, DataBank is looking to leap-frog Li-Ion systems toward a better option, such as Nickel Zinc (NiZn). These provide many of the same benefits of Li-Ion batteries but are smaller, lighter, and safer to transport. Plus, they are made with readily available materials and are greater than 90% recyclable – using existing recycling equipment and processes.

ONSITE POWER GENERATION

Relying exclusively on utility power means a data center's power costs will rise as overall demand rises. Being able to offset those costs at peak times with onsite power generation is a way to reduce total costs while improving overall efficiency.

At DataBank, we recently accomplished this in one of our Atlanta data centers. We partnered with a local utility (Georgia Power) to deploy a 1.5 microgrid to support Georgia Tech's High Performance Computing Center (HPC), which is housed in the Atlanta data center. The microgrid runs in parallel to Georgia Power's grid as an additional power source. It senses power consumption and can export power to the facility in an emergency or simply at peak times to save costs.

The installation includes fuel cells, battery storage, diesel generators, and a natural gas generator, but it is also adaptive to new and additional distributed energy sources. It will be able to accommodate microturbines, solar panels, and electric vehicle chargers in the future.

Conclusion:

Many factors are changing our perceptions and approaches to data center design and use, especially when it comes to meeting customers' changing requirements with clean energy sources. Understanding these trends and their implications can help data center operators anticipate the future to design much more intelligent data centers today.

Next Steps

To learn more about DataBank, and how our flexible data center design is helping customers at all stages of their technological evolution, please visit www.databank.com today.

About DataBank

DataBank enables the world's largest enterprises, technology, and content providers to consistently deploy and manage their infrastructure, applications, and data on the right platform, at the right time, in the right place. Our colocation and edge infrastructure footprint consists of 65+ data centers and 20 interconnection hubs in 27+ markets, on-ramps to an ecosystem of cloud providers, and a modular edge data center platform with virtually unlimited reach.

We combine these platforms with contract portability, managed security, compliance enablement, hands-on support, and a guarantee of 100% uptime availability, to give our customers absolute confidence in their IT infrastructure and the power to create a limitless digital future for their business.

About The Authors

Eric Swartz, DataBank's senior director of infrastructure engineering, has 19 years of experience in data center operations and infrastructure.

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