VERTIV WHITE PAPER

Zeroing in on Sustainability

Enhancing Efficiency While Maintaining Resiliency

Executive Summary

Within data centers and similar critical facilities, there are recent developments driving enhanced data center power usage effectiveness (PUE), water usage effectiveness (WUE), and carbon reduction. Efforts to improve these metrics aren't new to the industry; however, there is a new urgency around them today as accelerating demand for data has been met with maturing technologies.

This urgency is evident in the ambitious carbon and water-reduction goals, and the innovations being developed to support them, established by hyperscale operators such as Google and Microsoft. While these operators may lead the way, we anticipate that all data centers — whether cloud, colocation, or on-premises — will eventually make changes as operators start to take a serious and multi-faceted approach to data center sustainability that could include:

- Increasing the efficiency and utilization of power systems
- Replacing water-intensive systems with water-efficient technologies
- Supporting high-density racks with liquid cooling
- Reducing dependence on carbon-based fuels by transitioning to locally generated renewable energy

This white paper draws on Vertiv's industry expertise and delves into current developments related to each of these strategies.

We all have a part to play in shaping the future of the data center industry, and the solutions of the past are not expected to be able to deliver the efficiency and resiliency required to meet the demand for data in the coming years.

The information shared in this white paper aims to inspire innovation and collaboration and guide us all to new methodologies.

Enhancing Power Utilization and Efficiency

In the report, The Road to a Net Zero Data Center, Gartner recommends that operators, "Actively implement a radical energy efficiency and emissions reduction plan that falls in line with the enterprise net zero target or similar science-based targets."

That plan could include identifying stranded capacity and optimizing efficiency within the critical power system. Stranded capacity in the power system can exist due to excessive derating of power components by equipment manufacturers compensating for variances in manufacturing. With equipment from vendors, such as Vertiv, capable of operating at 100% of rated capacity, we believe that companies can avoid derating and the stranded capacity that comes with it.

Oversizing based on infrequently experienced peaks can also create stranded capacity. Today's UPS systems are rated to allow the UPS to safely handle short-term out-of-norm conditions, minimizing the need for oversizing. For example, the Vertiv™ Liebert® Trinergy™ Cube can operate at 110% of rated capacity continuously, 125% for 10 minutes, and 150% for one minute.

Stranded capacity from oversizing can also extend to the backup generator system. In a blog post from Gartner analyst Tiny Haynes, he notes that monthly diesel generator checks contribute 9.2 kilograms per kilowatt-hour of carbon dioxide (CO_2) into the atmosphere, assuming 2 liters of diesel is consumed.

Reducing the size of generators by eliminating the need for oversizing has the potential to reduce the emissions from carbon-based generators. This can be achieved through controls that compensate for frequency changes during the transition to generator power, eliminating the need to oversize generators to enhance stability during the transition.

Power equipment utilization and efficiency can also be enhanced through the adoption of more sophisticated UPS architectures and new intelligent operating modes. With efficiency up to 99%, the Vertiv™ Liebert® EXL S1 operating in Dynamic Online mode offers operational energy savings over legacy UPS systems that average 94% efficiency, and modern UPS systems that approach 97% efficiency.

As operators consider investments in these technologies, we believe they should keep in mind the guidance Gartner provides in The Road to a Net Zero Data Center: "The alternatives are either elderly, less efficient data centers or ones that cannot consume any form of renewable energy, thus becoming a liability for business should emission taxations be introduced."

Case in Point: Increasing Power System Efficiency

Background

The University of Southampton, UK, enables its exceptional research and development capabilities and entrepreneurial culture with a forward-thinking IT team and a proactive approach to data center infrastructure.

With computing demands continuing to increase, the university identified the need for a new data center that could achieve the dual goals of enabling high performance computing (HPC) while ensuring environmental accountability.

Critical Need

The challenge the university faced during the data center design process was enabling HPC alongside more repetitive processing tasks while optimizing efficiency across the various load profiles.

Solution

The university chose the modular Vertiv™ Liebert® Trinergy™ Cube UPS system to meet its current needs for a high-efficiency power system while maintaining the flexibility to adapt to future requirements.

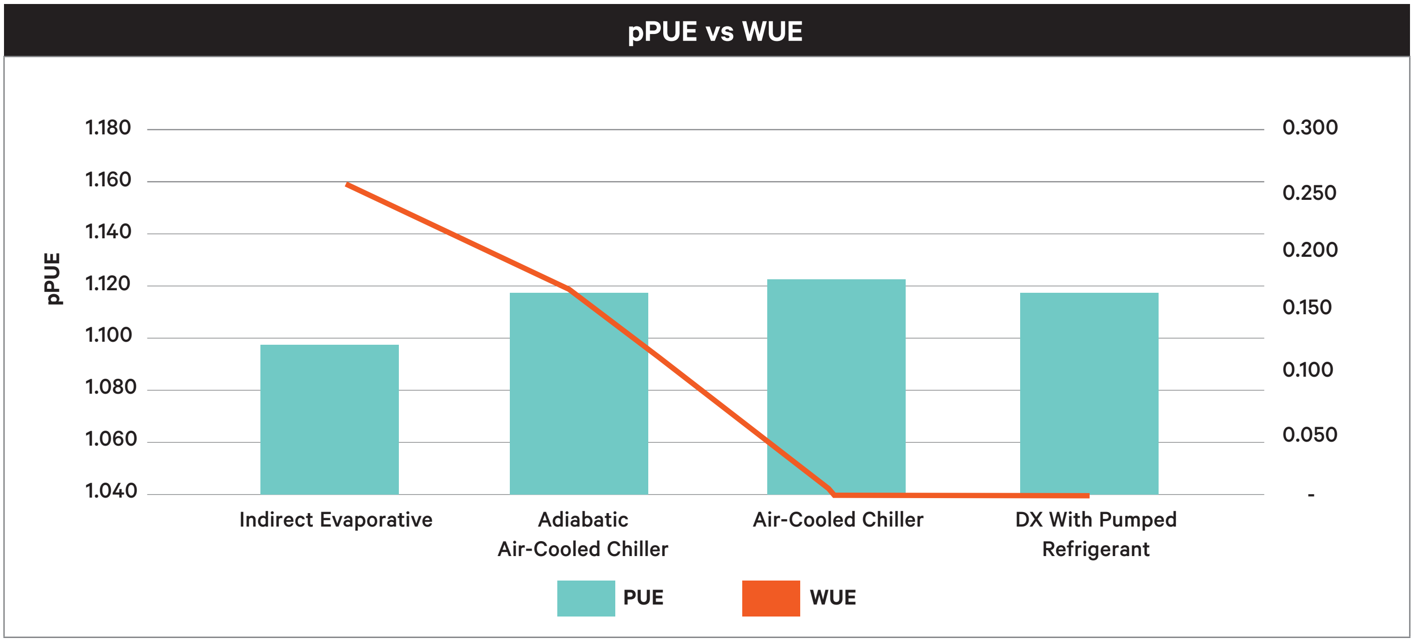
The Liebert Trinergy Cube is the first high-power UPS with an adaptive algorithm that continually monitors the power supply and load and automatically selects the most efficient operating mode. With the new facility, the university reduced its data center energy requirements by 300 megawatt-hours per year and annual CO_2 production by 160 tons compared to the previous, less efficient facility.

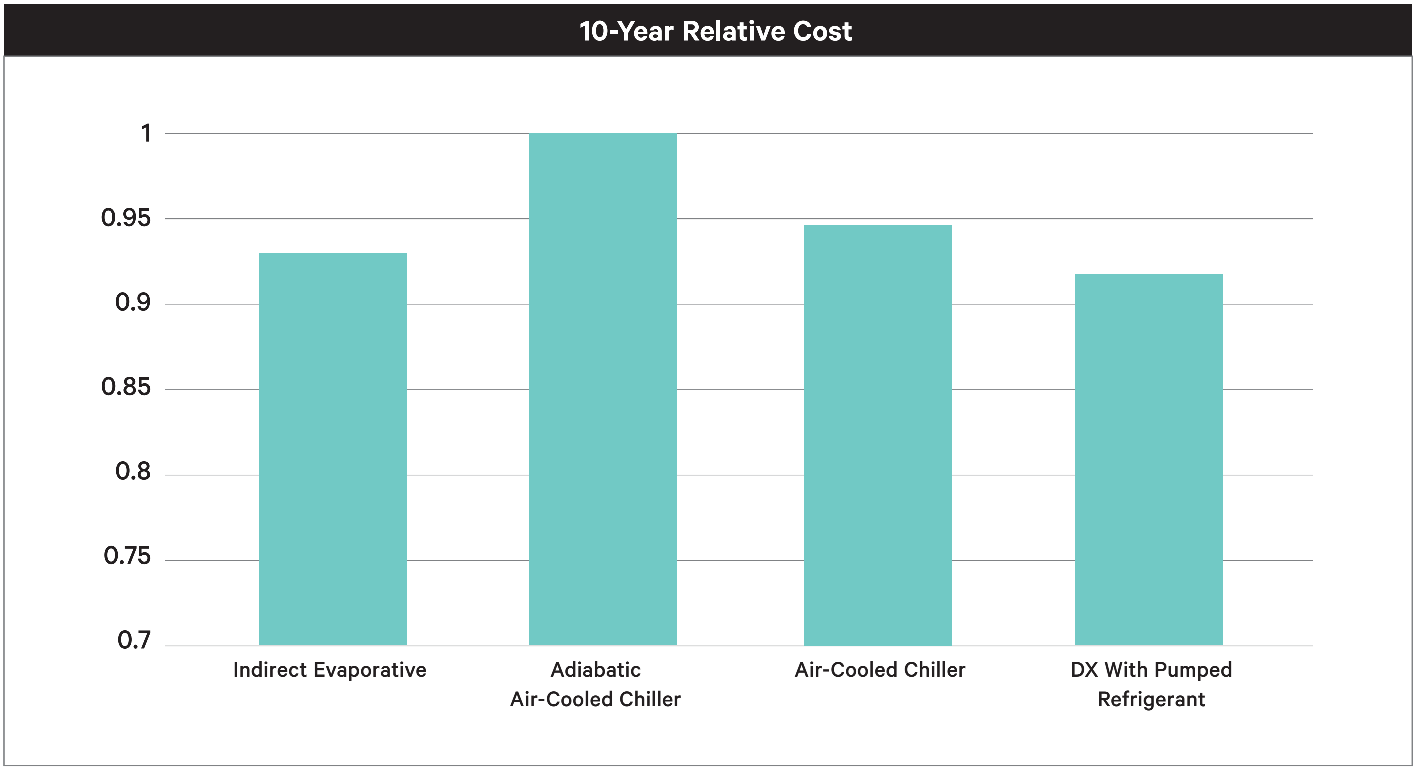
Reducing Water Consumption

According to Gartner, "water consumption can be a material issue for a data center, particularly in areas of existing or growing water stress."

The use of water in data center cooling has been driven by the desire to increase thermal management energy efficiency by effectively expanding the number of hours the cooling system can operate in free-cooling mode. This approach sacrifices water consumption for energy efficiency and could prove unsustainable in water-scarce areas. The challenge, then, for thermal management design in those areas becomes not simply to maximize energy efficiency but optimizing both energy efficiency and water usage.

Chilled water free-cooling systems achieve a balance between water utilization and energy efficiency. Energy efficiency can be optimization through strategies such as increasing air and water temperatures, system-level control, and the addition of adiabatic technologies. A chilled water system also simplifies the implementation of energy-efficient liquid cooling to support high-density racks and can enable heat recovery to enhance building efficiency. These systems can use onboard controllers to enable the use of water strictly when needed based on redundancy, efficiency, or cooling demand, enabling water-efficient operation.





Statistical comparison of data center cooling systems using a standardized data center model

For areas where water availability is limited, water-free direct expansion (DX) systems, such as the Vertiv™ Liebert® DSE free-cooling economization system, can be employed. DX systems come close to delivering the energy efficiency of indirect evaporative water systems while conserving the water used by those systems.

In a direct comparison of the two systems, the DX system with pumped refrigerant delivered a partial power usage effectiveness (pPUE) of about .01 higher than the indirect evaporative system while reducing water usage effectiveness (WUE) from .25 for the indirect evaporative system to zero for the DX system with pumped refrigerant.

Managing Higher Densitites

As data center operators tackle the challenge of reducing their environmental impact, they are faced with a competing challenge: meeting increased capacity demands and supporting more high-density equipment racks. One of the recommendations in the Gartner report, The Road to a Net Zero Data Center, is to "use higher efficiency cooling techniques such as liquid cooling."

Liquid cooling offers the cooling capacity required to protect high-density equipment racks and is typically more efficient than air cooling due to the higher thermal transfer property of fluids compared to air. Organizations considering liquid cooling should work with vendors capable of helping them navigate the introduction of liquid cooling into existing data centers.

This includes identifying the specific liquid cooling technology that is the best fit for the application, the type of fluid that will be used, and the heat load-to-liquid ratio. The variables of heat load, liquid flow rates, and pressure work together to contribute to the overall liquid cooling solution and should be considered early in the process. The type of fluid used will also impact the selection of plumbing materials, as it is essential to ensure wetted material compatibility between the plumbing material and the specific fluid being used.

Commonly used methods of liquid cooling, such as rear-door heat exchangers and direct-to-chip cold plates, work with air cooling systems rather than independently. When planning for liquid cooling, you need to determine how much of the total heat load each system will handle, how much air-cooling capacity the liquid system will displace, and where the liquid cooling system may be introducing new demands on air-cooling systems. Working with vendors with domain knowledge that extends across both liquid and air-cooling technologies can help ensure proper balance between the two systems.

How fluids are distributed within the data center can also impact the success of a liquid cooling deployment. Establishing a secondary cooling loop for the liquid cooling system enables more precise control of the liquid being distributed to the rack. The key component in this loop is the coolant distribution unit (CDU). In most cases, the CDU will use a liquid-to-liquid heat exchanger to capture the heat returned from the racks and reject it through the facility water system.

Finally, risk mitigation must be included in every phase of a liquid cooling project, even when dielectric fluids that don't pose a risk to IT systems are used. The Open Compute Project has released a paper on leak detection technologies and strategies, Leak Detection and Intervention, which can be helpful in developing risk mitigation strategies.

Case in Point: Managing Higher Densities

Background

Silicon Valley-based Colovore delivers a colocation data center environment designed to support next-generation HPC for applications that include artificial intelligence, virtual reality, and big data.

Colovore's high-density solutions are ideal for these applications because they allow customers to deploy servers in a highly compact footprint that requires much less space and far fewer cabinets than traditional colocation facilities.

Critical Need

The increase in power usage from HPC coupled with the high operating temperatures of high-density environments required Colovore to implement a robust thermal management solution that would enable compact server footprints that maximize power, cooling, and operating efficiency.

Solution

Colovore chose the Vertiv™ Liebert® DCD rear-door heat exchangers to deliver efficient and effective high-density cooling. The Liebert DCD liquid cooling modules manage efficient heat removal of up to 35 kW per rack across the entire data center floor.

This solution enabled fully packed, top-to-bottom rack deployments with no wasted or unusable rack unit slots and increased operating and capital efficiency due to significant reductions in required cabinets, data center floor space, and energy consumption. The high-density facility also relies on Vertiv™ UPS systems, power distribution units, and supplemental air-cooling systems.

Moving to Locally Generated Renewable Power

There are multiple strategies being deployed by data center operators to meet their emissions objectives, including purchasing renewable energy credits and migrating loads to cloud or colocation facilities that have made the commitment to net zero operation. Some operators are now seeking to move beyond those measures and exploring the feasibility of powering data centers with locally generated renewable power.

As Gartner points out, "Data centers running on carbon-intensive electricity grids, with little provision for renewable energy, could become a stranded asset or will carry a financial liability if they are subject to carbon taxes or pricing."

Integrated renewable energy solutions are already being used to support telecommunications network access sites, and locally generated renewable energy could present a long-term solution for data centers seeking net-zero operations.

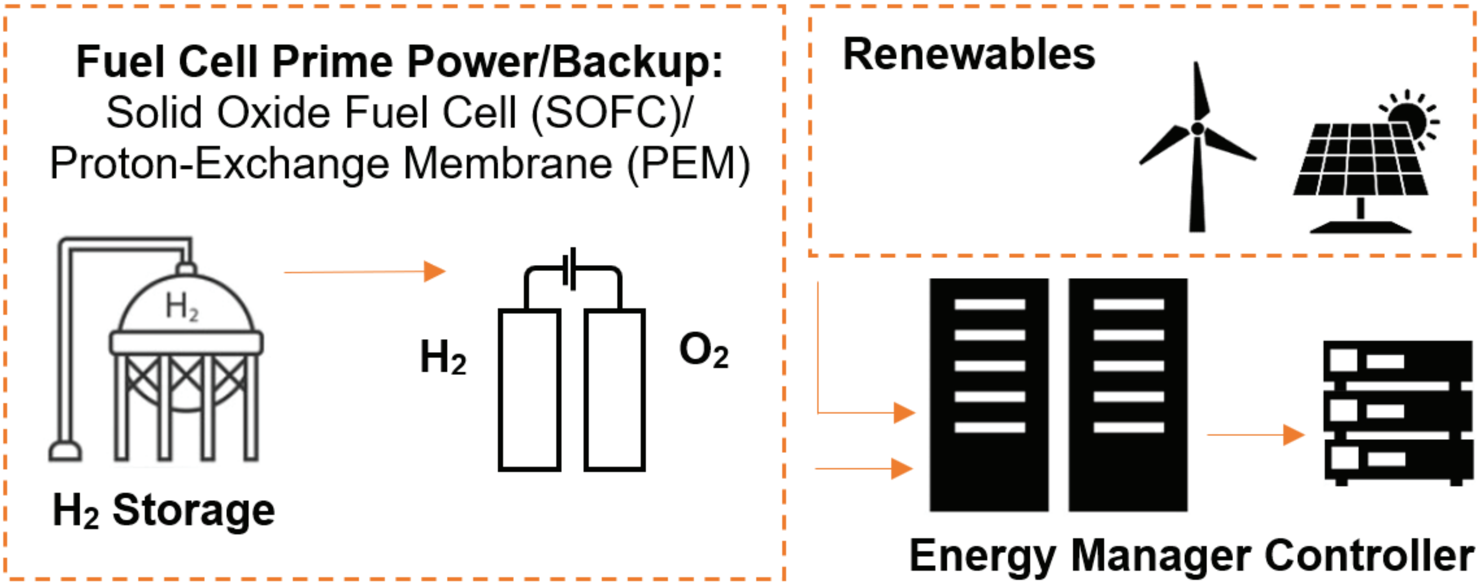
The continued advancement of fuel cell technology has the potential to make the transition to locally generated renewable power possible. In the short-term, fuel cells could create the opportunity to replace carbon-fueled generators as a source of backup power. Proton-exchange membrane (PEM) fuel cells have excellent power density and can start quickly even in low temperatures, making them ideal for backup power applications.

The key obstacles restraining the use of fuel cells as a backup power source today are the cost of hydrogen, which could come down as adoption of fuel cells increases across various industries, and the challenge of transporting and storing the quantities of hydrogen required to ensure 24 or 48 hours of backup power.

Ultimately, this second obstacle could be addressed by implementing on-site hydrolyzation that, when powered by renewable sources, creates enough green hydrogen to enable fuel cells to serve as the backup power source and as the primary source of power when renewables are not producing energy.

Excess wind or solar energy generated on site could be used to power hydrolyzers that generate clean hydrogen that supports fuel cells. This hydrogen can be stored on site and when the sun stops shining or the wind is not blowing, the fuel cells can power the data center. When the hydrogen fuel is depleted, the UPS switches the data center to the grid to maintain continuous operations.

In this scenario, the UPS provides key energy management capabilities in addition to its power conditioning and backup power functions. For example, operators that make the investments in renewable energy and fuel cells may want the ability to save excess energy for later use or use it within their campus to offset existing base loads. Future generations of UPS systems will require smart energy management capabilities to orchestrate these activities.



Conclusion

Energy efficiency has been a focus for data center owners and operators for years. However, there is now a renewed focus on it and other sustainability-related metrics as the demand for data continues to grow while the technologies used to meet that demand are maturing.

Fortunately, there are solutions available today from data center equipment manufacturers, such as Vertiv, that allow operators to improve utilization, minimize water consumption, and reduce emissions, while the technologies required to support local renewable power generation continue to advance.

By partnering with your infrastructure provider, you'll be able to more closely evaluate your critical system needs and develop an asset management plan that supports your energy efficiency and other sustainability goals.

Vertiv.com | Vertiv Headquarters, 1050 Dearborn Drive, Columbus, OH, 43085, USA

SL-70993 (R09/22)