8 CONSIDERATIONS IN DESIGNING MORE EFFICIENT DATA CENTERS

Honeywell

The demand for data storage and processing is increasing seemingly every day as businesses rely on data to drive decision making and to help improve operational efficiency. This is impacting both the volume of data that data centers must handle as well as the volume of data centers needed. One challenge to this growth in the data center industry is managing its energy impact. It's estimated that data centers could account for up to 10% of global electricity demand growth by 2030.[1]

In this document, Honeywell will explore ways to manage data center energy use through more sustainable lifecycle design and deploying specific types of solutions.

1 DESIGN FOR MORE EFFICIENT THERMAL MANAGEMENT

Managing energy use in a data center starts at the design and strategic planning phase. It's important to consider all options for efficiency throughout the facility design and operations. This includes considering the thermal management lifecycle of a data center including waste heat recovery and reduce to lessen overall operating costs and carbon impact. Taking a narrow focus on just minimizing power usage efficiency (PUE) may miss opportunities for waste heat use that can defray operating costs and substantially reduce the overall carbon footprint of the data center and its surrounding community. Depending on the technologies deployed, there is a future potential for carbon-negative data center operations.

[1] The Oxford Institute for Energy Studies, "Global electricity demand: what's driving growth and why it matters?" Rahmatallah Poudineh, January 2025. [Accessed April 1, 2025]

2 USE LOW GLOBAL WARMING REFRIGERANTS

Most air- and liquid-cooled facilities use vapor-compressions cycle chillers that use a refrigerant to chill the air or liquid that is used to cool the data center. Chillers need to have high efficiency and use refrigerants that have low global warming potential (GWP). The Honeywell Solstice® 1234ze refrigerant is an energy efficient alternative to traditional, legacy refrigerants in air-cooled and water-cooled chillers that provides a >90% reduction in GWP and 3-4% energy savings versus R-134a. Honeywell's liquid cooling technologies offer an efficient alternative, providing superior heat dissipation while minimizing energy consumption. As these systems require less energy to operate compared to traditional cooling methods, they represent a pivotal advancement in creating more energy efficient data centers.

There are two other important considerations when selecting a refrigerant-based cooling system over a water-based cooling system. Refrigerant-based cooling systems (dual exchange air-cooled or liquid-cooled) avoid the use of cooling water and eliminate the resulting environmental impact on water-distressed regions. Additionally, all refrigerants and refrigerant blends used in rack cooling, HVAC and chillers can be recovered at end of system life and reprocessed into either pure refrigerant components or raw materials to make similar molecules, usually referred to as "reclaiming" the refrigerant.

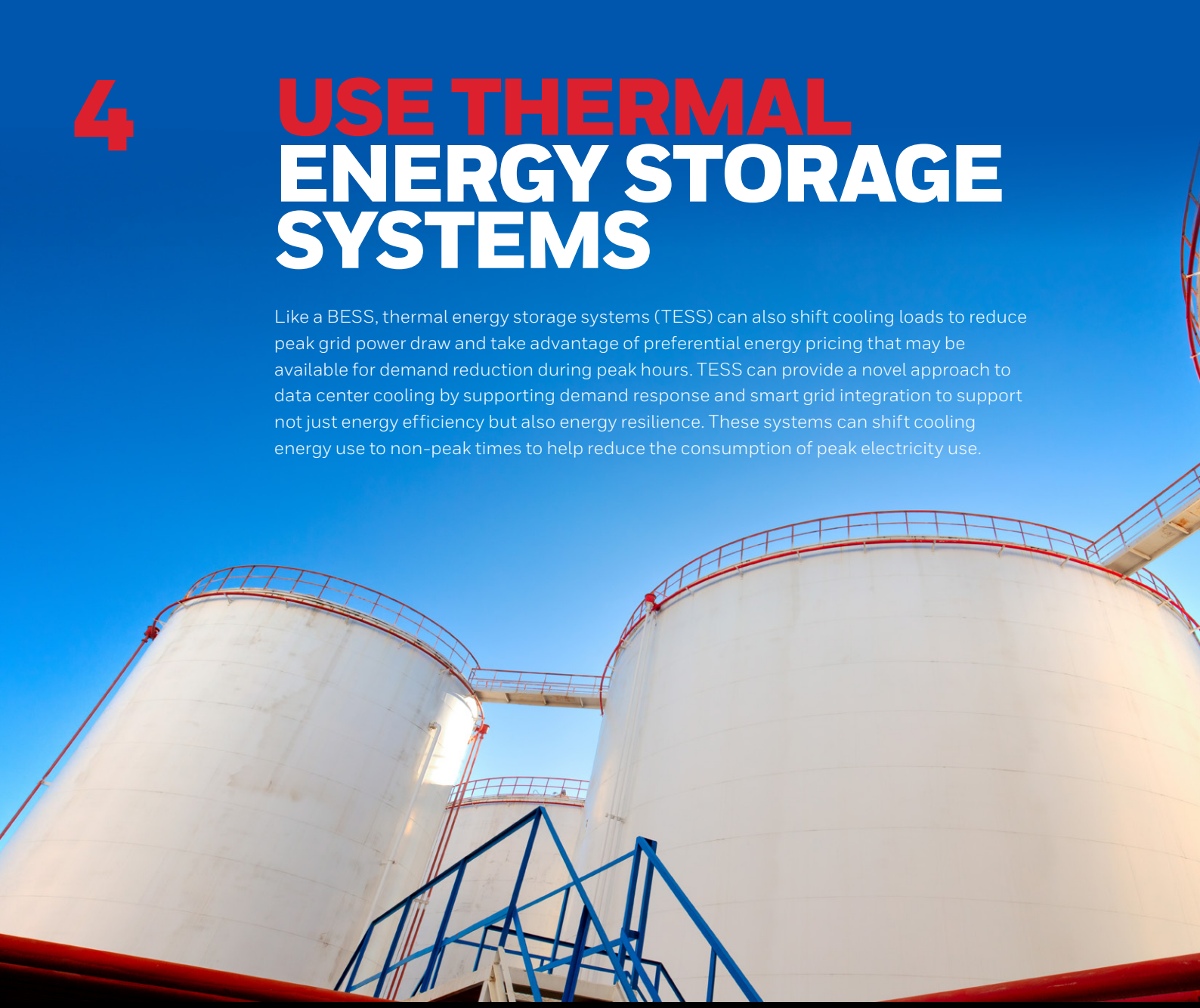
3 INTEGRATE BATTERY ENERGY STORAGE

Most data centers have a form of redundant power supply systems to enable continuity of critical operations in the event of grid outages. Low carbon footprint backup power can be supplied by using diesel generators powered by renewable fuel or by storing electricity using a battery energy storage system (BESS). A BESS – as compared to a backup generator – can be used for daily energy arbitrage and price management, allowing the data center operator to charge the BESS overnight (with wind power) or during the middle of the day (with solar power) and use part of the charge to offset power demand during the evening peak times when prices are at their highest, while still meeting system availability and performance requirements. This price arbitrage can offset the higher initial cost of a BESS and make a BESS a more economical solution.

Honeywell Ionic™ Modular is a compact, liquid cooled modular and scalable battery energy storage system (BESS) with an advanced energy management system that can help reduce installation costs and commissioning times while providing an end-to-end, holistic approach to supporting energy security. It can help optimize energy outcomes, improve uptime and allow energy market participation to help data centers increase the use of renewable energy. This means they can aim to meet corporate emissions reduction goals and generate revenue while doing so.

4 USE THERMAL ENERGY STORAGE SYSTEMS

Like a BESS, thermal energy storage systems (TESS) can also shift cooling loads to reduce peak grid power draw and take advantage of preferential energy pricing that may be available for demand reduction during peak hours. TESS can provide a novel approach to data center cooling by supporting demand response and smart grid integration to support not just energy efficiency but also energy resilience. These systems can shift cooling energy use to non-peak times to help reduce the consumption of peak electricity use.



5 USE RENEWABLE DIESEL TECHNOLOGIES

For data centers with a diesel generator, it's important to be mindful of the type of fuel it uses and consider renewable diesel technologies. While Honeywell does not directly produce any renewable fuels, licensees of our technology are able to supply diesel fuel (hydrotreated vegetable oil or HVO) with lifecycle GHG impact 60-80% lower than fossil fuel-based diesel, depending on the feedstock used to make the renewable fuel. Honeywell has licensed over 70 renewable fuels plants globally since commercially demonstrating this technology in 2007.

6 OPTIMIZE DEMAND SCHEDULING AND LOAD MANAGEMENT

Every region experiences seasonal, weekly and even daily variation in power demand with different daily patterns during heating and cooling seasons. The highest peaks, which set grid capacity needs, are typically seen during hot summer afternoons when demand for air conditioning and industrial cooling is highest.

Peak power demands typically require electric utility companies to generate power using dispatchable assets. Since the daily peak usually occurs from 6:00 -10:00 p.m., the problem of meeting peak demand is exacerbated by the fact that solar power is not available during peak hours, so the utility either needs to deploy large-scale energy storage to balance the grid or else fall back on dispatchable assets such as pumped-storage hydropower and gas turbine engines to meet peak needs. This can be expensive and can produce electricity with a higher carbon footprint than the grid average. As a result, utilities often incentivize large-scale consumers to practice demand reduction during peak hours to reduce strain on the grid through a combination of incentives for load shedding and time variable pricing (TVP) or punitive pricing for exceeding demand thresholds.

The high price and carbon footprint of peak power may encourage a data center operator to shift as much power demand as possible away from peak hours and to deploy a BESS or TESS to further reduce peak grid power draws and take advantage of preferential electricity pricing that may be available for demand reduction during peak hours.

Electrical power monitoring systems (EPMS) record and provide data about power systems and power-related events. That information is used to manage power generation efficiencies, batteries and capacitor banks, gas or steam turbine relays and other systems in power generation stations and power substations. EPMS can visually display real-time or historical data. Many data centers are moving to using EMPS to further the ability to find and implement tighter tolerances in the overall facility operations to gain efficiencies not previously found with building management systems (BMS) alone.

7 EXPLORE USING HEAT PUMPS TO SUPPORT DISTRICT HEATING

Recently, there is increased interest in using data center waste heat for district heating of nearby communities, particularly in regions like Europe where district heating is widespread.[2] District heating schemes, while dependent on the downstream community's district heating radius, typically require hot water to be supplied at 95°C, so a heat pump is needed to boost the temperature of a data center's waste heat to allow energy reuse for other low- to medium-grade heat applications.

While the heat pump replaces the conventional data center chiller, both capital and operating costs can increase and the additional cost for the data center must be recovered from the district heat customers. Heat pumps allow the waste heat from a chilled water system, or two-phase liquid coolant system, to be rejected at a higher temperature for use in district heating or other energy reuse applications. Honeywell has experience in the design and operation of heat pumps over a wide range of temperatures and works with heat pump original equipment manufacturers (OEMs) to customize the refrigerant, or refrigerant blend, to optimize thermodynamic performance while meeting other safety and cost objectives.

8 UPGRADE IT AND OT HARDWARE THROUGHOUT DATA CENTER LIFECYCLE

Once a data center is operational, it's important to consider the overall lifecycle of not just the overall facility but also the equipment used inside. Throughout the data center lifecycle, consider replacing existing IT and OT hardware with the latest versions to gain improvements in energy efficiency due to advancements in chip design, power management and power-saving features such as dynamic frequency scaling, and even product designs that support better airflow.

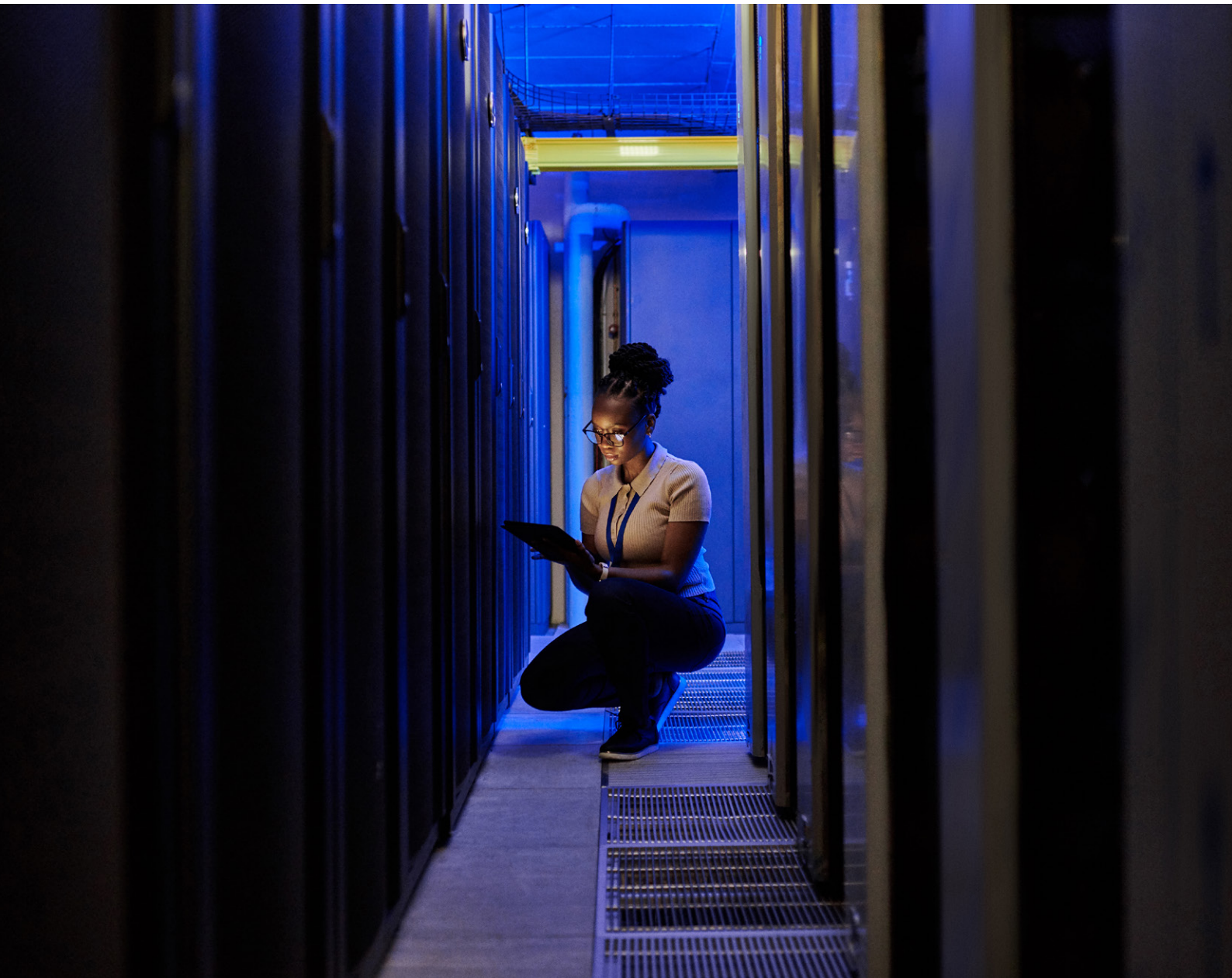
The Honeywell Advance Control for Buildings platform of building management systems (BMS) controllers can simplify integration, routing and plant control for existing facilities and offers Hand-Off-Auto (HOA) display that can manage local I/O channels and overrides, with or without a controller. It is designed to make upgrades easy and has ISA 62443 cybersecurity certification.

[2] European Commission, "2020 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency," Acton M., Bertoldi P., Booth J, January 29, 2021. [Accessed April 1, 2025]

CONCLUSION

Data centers are – and will continue to be – an enabler of our connected society. As the proliferation of data centers continues, it's critical that data center owners and operators identify ways to better manage energy use and resilience.

By taking a more sustainable approach to data center lifecycle design and management, there is opportunity to reduce the overall environmental impact of the industry. It will take a collection of actions – not just one action – to make this happen. By embracing these principles and leveraging advanced technologies to better enable energy management and by choosing a partner that can support your goals now and in the long term, data center owners and operators can better meet the challenges of today and be more future ready tomorrow.



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