# Data Center Sustainability... Searching for the Oasis

"When the well's dry, we know the worth of water."

— Benjamin Franklin

*Integrating Dry Cooler Technology to Address Water Usage Effectiveness (WUE) Concerns*

Throughout time—regardless of geographic location— water has always been held as a precious resource. However, the current combination of global warming, drought and ever-increasing consumption are not only creating previously non-existent water-stressed areas but have made uninterrupted access to water a community-based 'call-to-arms' to restrict many commercial developments. And nowhere has this been more apparent than in data centers that provide shared access to applications and data using complex networking, computing, and storage infrastructures.

There is little argument that data centers play a critical role in the future of our world's economic growth. Of the approximately 8,000 data centers currently in the world, 33% are located in the United States.[1] Whether it's an Enterprise, Managed Services, Cloud-based, Colocation, Edge or Hyperscale data center, two of the major operational certainties they all share are extremely high demand for power and cooling. Carrier is providing both advanced-technology equipment and digital lifecycle solutions to support the unprecedented growth and criticality of data centers. More than 300 data center

owners and operators with over one million racks, spanning enterprise, colocation and edge benefit from Carrier's optimization solutions across their portfolios.

Data centers are one of the most energy-intensive building types, consuming 10 to 50 times the energy per floor space of a typical commercial office building. Collectively, data centers account for approximately 2% of the total U.S. electricity usage.[2] The current trend towards server consolidation (rack vs. blade servers) and virtualization may help reduce hardware within data centers but does not always reduce energy consumption. As for water usage, a large data center can consume anywhere between 1 and 5 million gallons a day—as much as a town of 10,000 to 50,000 people.[3] Water is used for a data center's cooling system, which ensures that the heat produced by thousands of servers within these massive facilities is precisely controlled so that their internal servers can run uninterrupted 24 hours a day, 7 days a week. Additionally, data centers indirectly consume large amounts of water off-site at a power generation plant to supply the data center with electricity.

As data networking, computing and storage demands continue to surge—and as water becomes scarcer due to climate change—the development of data centers is attracting greater scrutiny and resistance by both local residents, municipalities and governments throughout the US. Additionally, addressing environmental issues such as Power Usage Effectiveness (PUE), Carbon Usage Effectiveness (CUE) and Water Usage Effectiveness (WUE) are becoming mission-critical for all data center owners and operators.

## Technical References
### Historical
- **PUE** has been used extensively in data center research, development and evaluation as one of the most crucial indicators to gauge system effectiveness. It is defined as
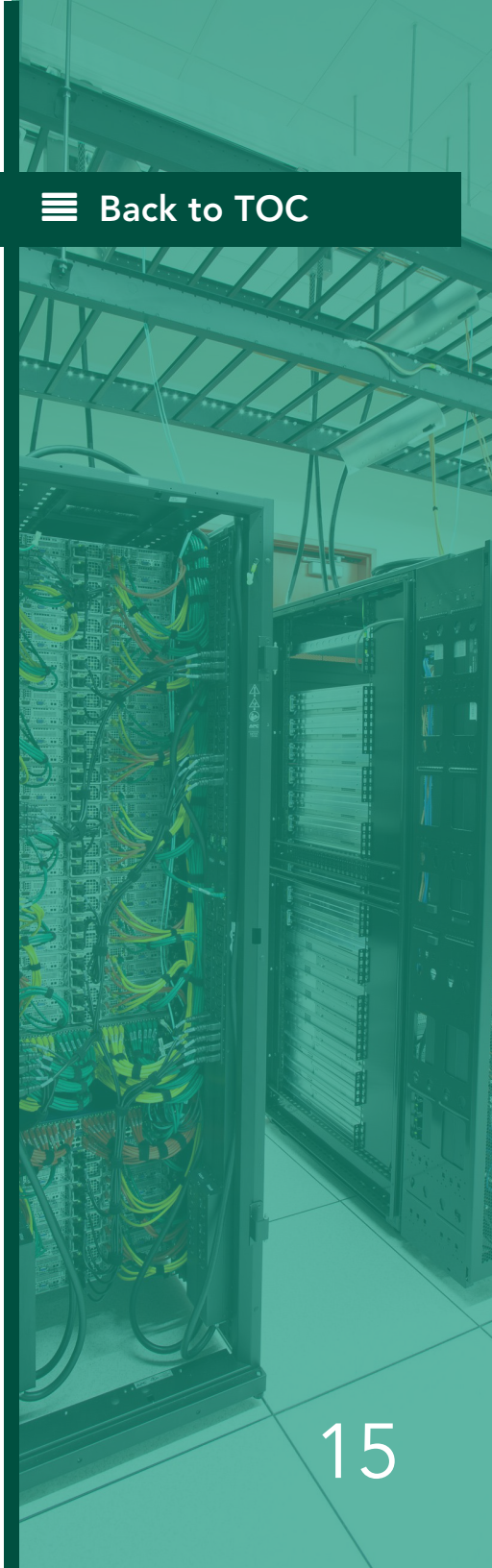
the ratio of a data center's overall energy consumption to the energy used just by its IT equipment.[4]

## Driven by New Sustainable Efforts

• **WUE** in recent years has become an important focus for data center operations due to the continued advancement of sustainability efforts. It is a value identified as the ratio between the use of water in a data center system that consists of water loops, adiabatic towers, humidification, water-driven energy production, etc. and the energy usage of the IT equipment.[4]

• **CUE** aims to gauge its sustainability by means of pollutant emissions as an outcome. It is the relationship between the $CO_2$ emissions generated by the data center and the energy usage of IT components.[4]

## Traditional Data Center Cooling

Maintaining and managing precise temperatures within data centers is crucial to maintaining the functionality and life of IT equipment. IT equipment temperatures which rise above set parameters can result in expensive downtime or equipment failure.

Traditionally, **water-cooled chillers** are paired with cooling towers that evaporate water to reject the heat generated by servers, IT equipment and mechanical infrastructure found within the data center. This type of cooling system removes and releases heat produced inside a data center into the outside environment, through a cooling tower that uses a water evaporative process. Cooling towers are heat exchangers that use water and air to transfer heat from a data center's cooling system to the outdoor environment. Most commonly, they are used to remove heat from the condenser water leaving a chiller.

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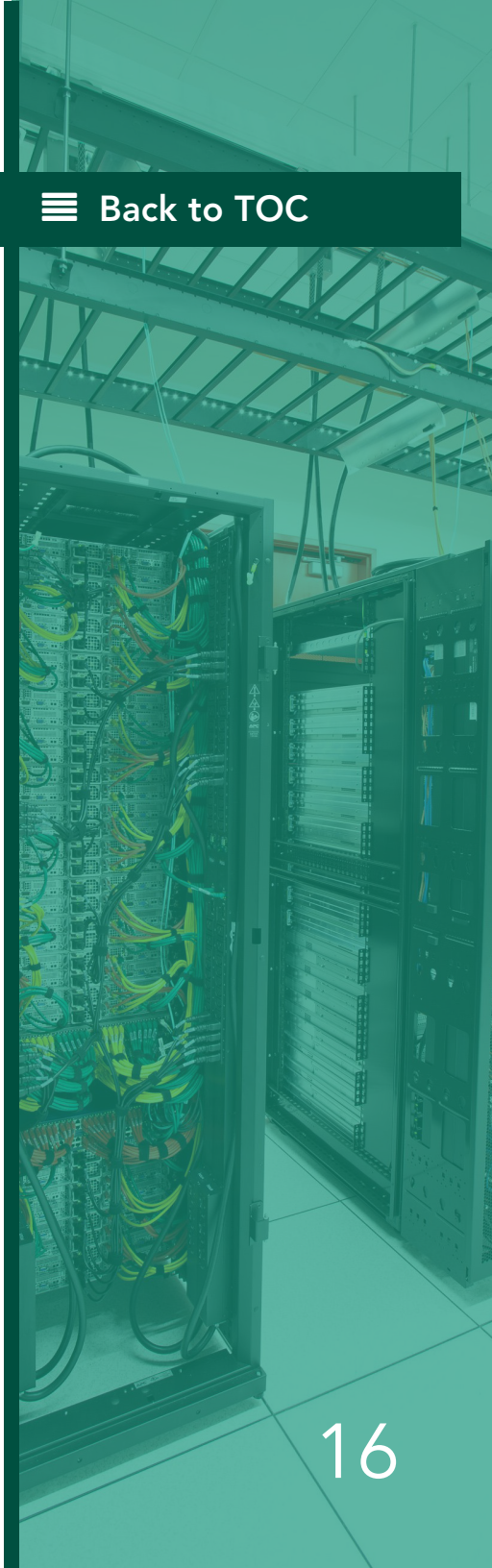
As an alternative to water-cooled chillers, stand-alone **air-cooled chillers** are often used to eliminate water loss from cooling towers. With limited cooling tonnage capacity, this equipment is often found in either smaller data center facilities or large data centers that utilize 100+ air-cooled chillers to meet the load. Air-cooled chillers are a lower-cost packaged product where as water-cooled chillers are available in larger capacities (4000+ tons with a single compressor), resulting in fewer units to maintain.
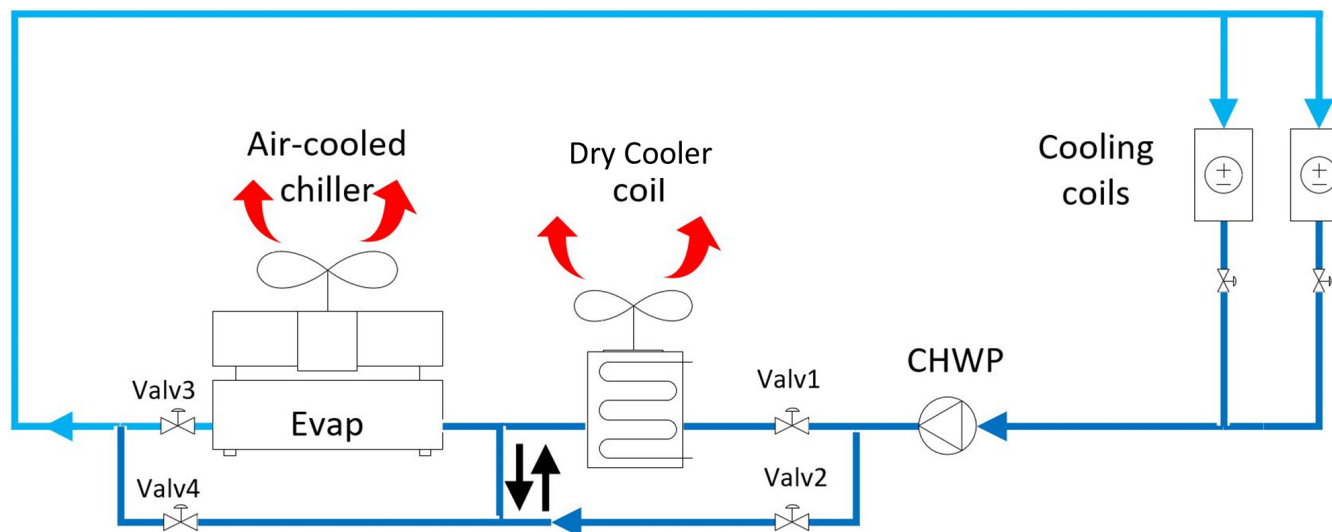


## Dry Cooler Technology – Helping Meet ESG and Sustainability Goals

Environmental, social and corporate governance (ESG) is a business framework for considering environmental issues and social issues in the context of corporate governance. Data center owners and operators are acutely aware of the importance of creating and meeting ESG/Sustainability goals within their facilities, and continually explore innovative technologies to accomplish them. As climate change and diminishing natural resources gain importance, solutions to help reduce water and power consumption are of paramount concern.

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"Data center operators have made great strides in power usage effectiveness over the past 15 years," said Michel Grabon, Director of Data Center Solutions, Carrier. "Continual technology advances with higher powered server processors present power-consumption and cooling challenges requiring specialized solutions that Carrier provides."

To help meet the cooling challenges relative to water usage reduction, **Carrier Dry Coolers** are a closed-loop system that does not evaporate water. They remove excessive heat from the cooling liquid and reject it directly into the atmosphere. Fans blow air over a heat exchanger which then cools down the liquid. Additionally, Carrier Dry Coolers eliminate water treatment requirements and Legionella concerns since they don't use any water or evaporative cooling. Hence, water conservation and lower maintenance are the key considerations for using Carrier Dry Coolers.

Unlike cooling towers, Carrier Dry Coolers do not evaporate any water which is key for data center owners and operators due to public scrutiny. They also positively impact corporate sustainability goals such as Water Usage Effectiveness (WUE) which data centers are aiming to get as low as possible. Dry Coolers, compared to air-cooled chillers, have the same WUE but better PUE. Data centers have a constant heat load from the servers and evaporate enormous amounts of water with cooling towers. Installing Carrier Dry Coolers in conjunction with a water-cooled chiller is more efficient and doesn't utilize water.

A very real concern in many parts of the US today is the future availability of water. Data center owners and operators who are considering water-cooled chillers with evaporative cooling towers in dryer areas may run the risk of water availability. For example, if the life of a data center's cooling plant is 20 years, the concern for data center operators in
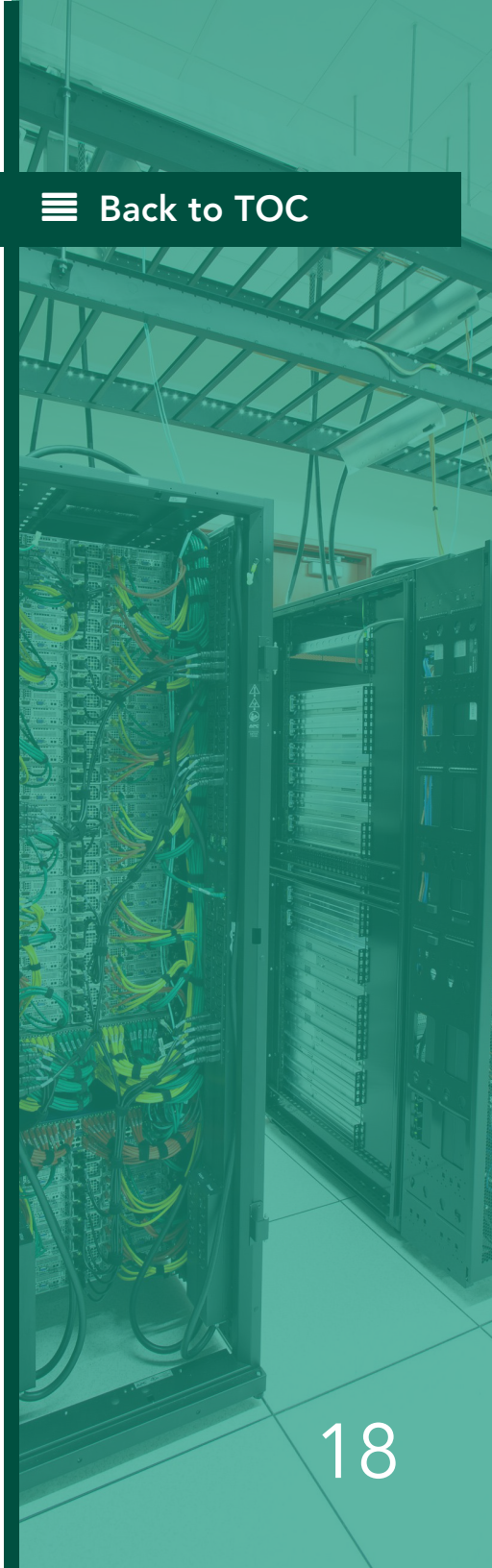
those areas is if they'll be able to get water, and in 10 years' time, what the price will be for that water to be able to continue to operate their type of system.
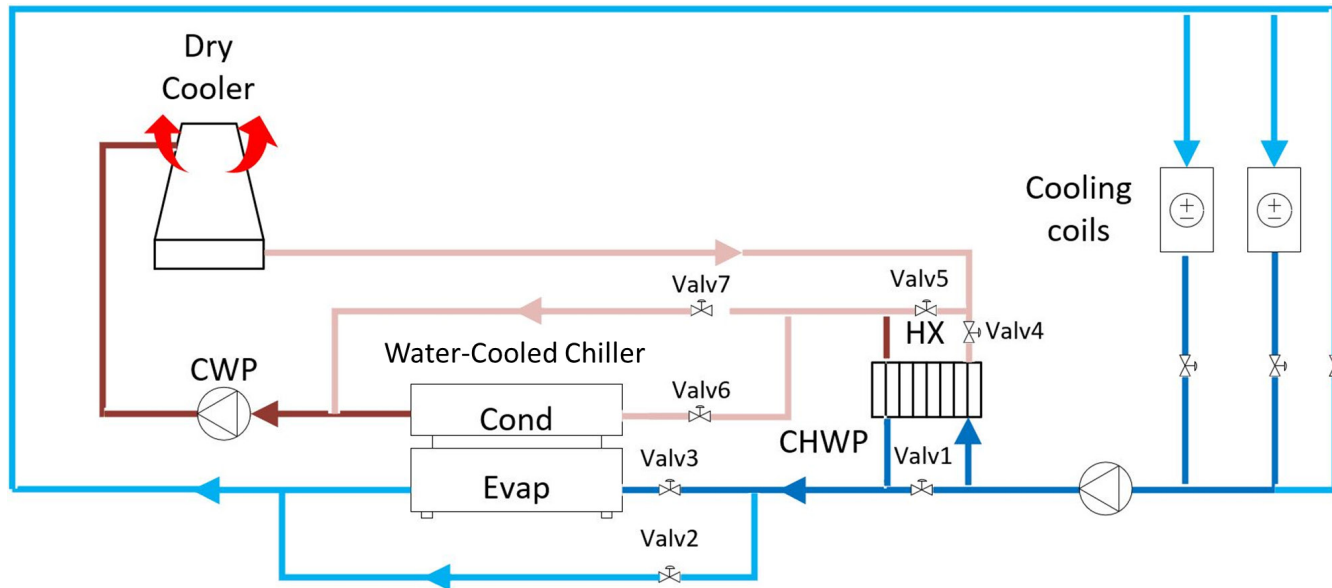


## Sustainability / ESG Issues

Cooling/evaporative towers use chemical treatment for water and have 'blow-down,' which is the result of evaporating so much water that you get sludge which is then blown down the drain. Over time, correcting this requires time-consuming maintenance costs. The treated water is also emitting contaminants into the air when the evaporator is running.

In a cooling/evaporative tower, the condenser water loop is open to ambient air, so any airborne contaminants can ultimately end up back in chiller tubes. Over time, this condition can reduce a chiller's efficiency. Add to this the downtime, maintenance and cleaning costs to remove the built-up scale and grime on the tubes. Conversely, a dry

cooler is a closed loop system designed to eliminate water loss. This feature proves critical when addressing concerns often found in water-stressed areas. Additionally, a dry cooler's fresh water remains clean which contributes to less chiller maintenance required.

## Features and Benefits of Carrier Dry Coolers

Dry Coolers remove excessive heat from the liquid and reject it directly to the atmosphere. Unlike evaporative cooling towers, Carrier Dry Coolers do not require water. Instead, fans blow air over heat exchangers and thus, cool down the liquid.

- As a closed loop system, Dry Coolers eliminate water treatment requirements and Legionella concerns since they don't use any water for evaporative cooling. Hence, water conservation and lower maintenance are the key advantages of using Dry Coolers.

- Dry Coolers installed in conjunction with water-cooled chillers allow for fewer chillers due to capacities up to 4000+ tons being available in a single compressor versus an average of 300 tons being available in a single compressor of an air-cooled chiller.

- Carrier Dry Coolers utilize a unique fan design that allows for a smaller footprint that delivers significant cooling tons per square foot when compared to competing technologies.

- When using a Dry Cooler, the owner is able to operate in both full and partial economization mode without the efficiency loss of a secondary heat exchanger due to both loops being closed loops versus an open evaporation cooling tower loop.

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## Smaller Footprint

With available square footage on data center roofs at a premium, Carrier Dry Coolers incorporate a unique modular design to facilitate stacking over water-cooled chillers to better utilize space. This convenient separation of components allows operators to save vital roof space for other equipment.
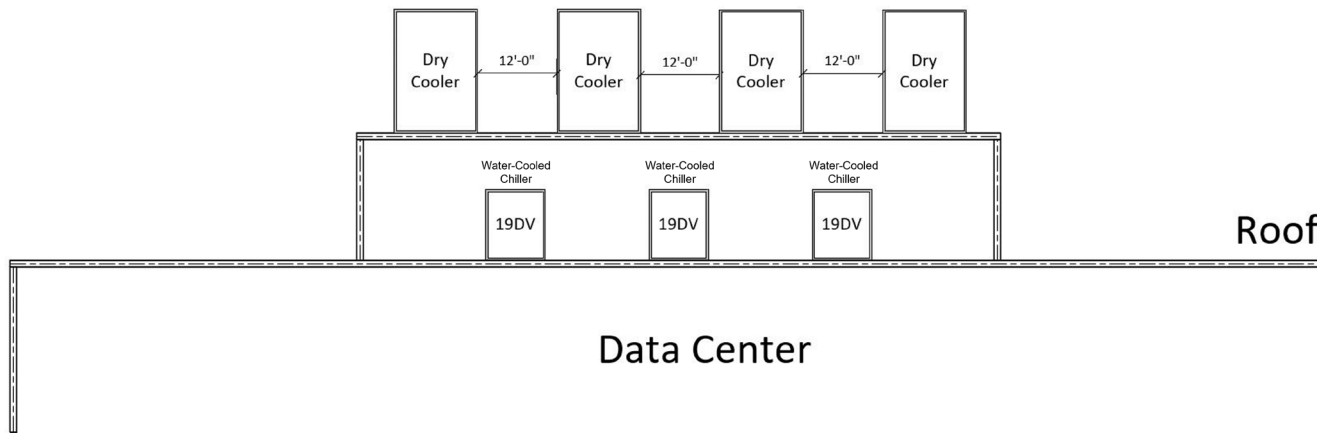


## Supports Water-Positive Initiatives

Carrier Dry Coolers do not require a constant water supply as opposed to evaporative cooling towers. This feature eliminates water supply, disposal and maintenance issues. When compared to air-cooled chillers the water-cooled chiller with Dry Coolers can support a reduction in PUE that can reduce the amount of water utilized in the production of electricity at the power plant serving the data center.

## Design Flexibility

Carrier Dry Coolers can be custom designed for any size data center. In addition, due to the custom design, additional sound attenuation is available to meet the overall community sound pollution levels.

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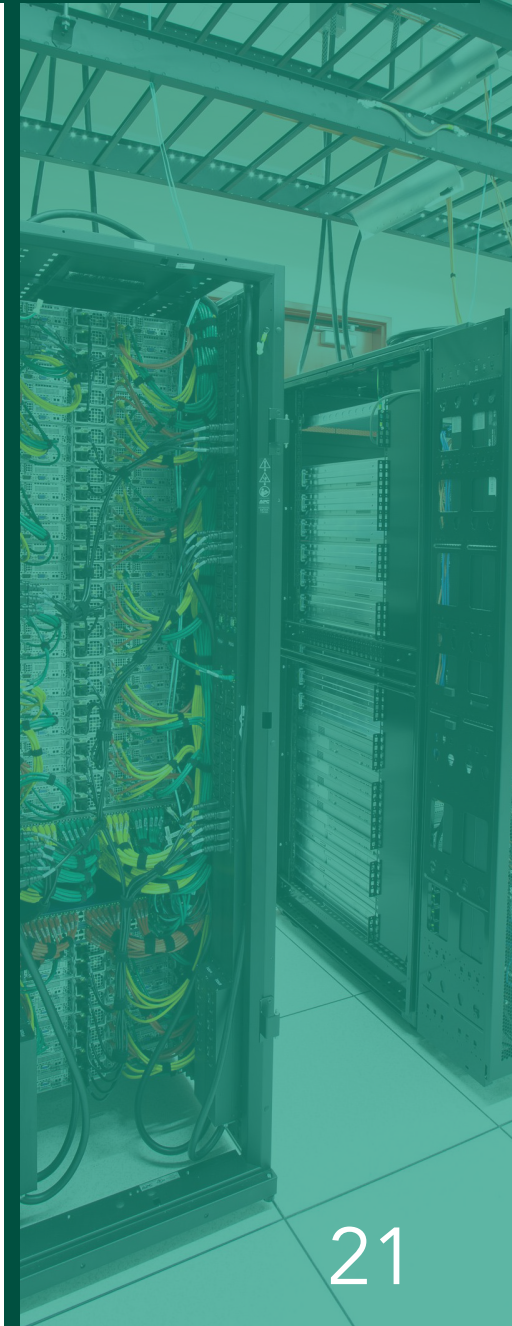
## Easy Installation and Start-up

Carrier Dry Coolers arrive on site 'installation ready' and are wired with product-integrated controls for quick connection to any building automation system.

## Controls

Carrier Dry Coolers can be easily programmed to operate efficiently year-round, even in geographical regions that experience lower temperatures.

## Efficiency

The fan technology utilized allows for a smaller footprint and delivers the most industry-leading cooling tons per square foot. This feature also contributes to low operating costs after initial installation. In addition, the heat sent to the Dry Cooler can easily be used as a low-grade heat source for building heating, district heating and other process needs to improve the overall system efficiency.

## LEED and Local Utility Rebates

In certain installations, Carrier Dry Coolers positively impact data centers that are applying for LEED certification. Additionally, there may be opportunities to receive local utility rebates.

## Life Cycle

As demonstrated in the above discussion utilizing Dry Coolers with water-cooled chillers can have distinct benefits when compared to the other common design methods used today.
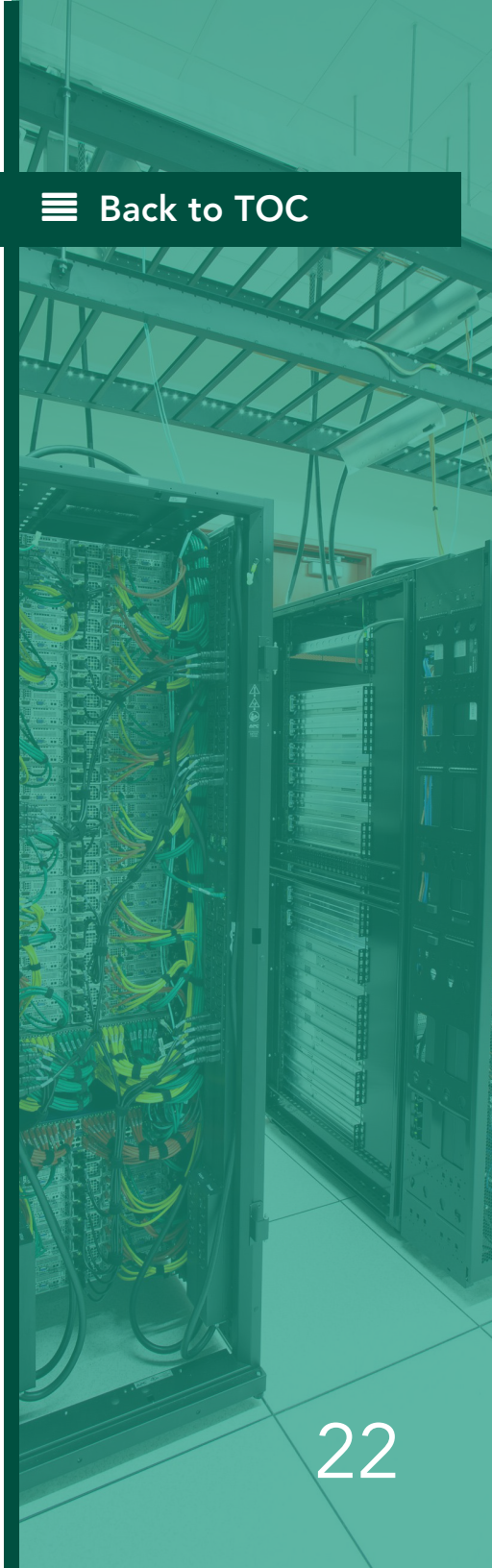
- When compared to using direct evaporative air handling units, this solution eliminates water usage and the introduction of particulate in the airstream serving the data hall.

- Larger capacity water cooled centrifugal compressors available up to 4000+ tons can significantly reduce the number of compressors utilized, compared to air-cooled chillers, and can also reduce the PUE.

- The elimination of evaporative cooling towers in a traditional water-cooled chiller design eliminates the water usage (improved WUE), chemical treatment and tube cleaning.

For future data center designs, the design team should investigate whether utilizing Dry Coolers with water-cooled chillers would provide a preferable solution versus the traditional designs used in the past. Newer, centrifugal compressor designs that allow for the higher condensing temperatures required for dry-cooler operation, have only recently become common in the market, allowing for this new design concept to become a reality.

## Lifecycle Solutions for Complete Data Center Optimization

Data centers have never been more strategic or critical than they are today. They have also never faced greater scrutiny regarding sustainability, efficiency and flexibility. To help address these issues, Carrier delivers purpose-built solutions and expertise to help face all data center challenges with confidence.

Carrier Dry Coolers and our full breadth of HVAC equipment deliver essential cooling while reducing both energy consumption and carbon footprint. Our

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building management systems integrate building and IT infrastructure to provide greater visibility and optimization. Our service and support ensure peace of mind and enable continuous operations. And as a truly global partner, we're there wherever and whenever you need us. It all adds up to the confidence needed to operate with optimized performance at every stage of the data center lifecycle— and at Carrier, it's delivered by design.

Carrier's range of smart and connected solutions deliver upstream data from the data center ecosystem to cool, monitor, maintain, analyze and protect the facility to meet green building standards, sustainability goals and comply with local greenhouse gas emission regulations. Carrier's Nlyte data center infrastructure management (DCIM) tools share detailed information between the HVAC equipment, power systems and servers/workloads that run within data centers, providing unprecedented transparency and control of the infrastructure for improved uptime.

Carrier's purpose-built solutions are integrated across its solutions portfolio with efficient and high-performing HVAC equipment, DCIM tools and building management system to help data center operators use less power and improve operating costs and profitability for many years.

## Complete Lifecycle Service and Support Specifically Designed for Data Centers

## BluEdge® Service Solutions

The BluEdge service platform delivers expertise, service, and greater peace of mind throughout the lifecycle of your HVAC equipment. Our service tiers offer a range of

options, all powered by Abound™ HVAC Performance—your source for actionable insights that can reduce operating costs, increase efficiency and improve uptime.

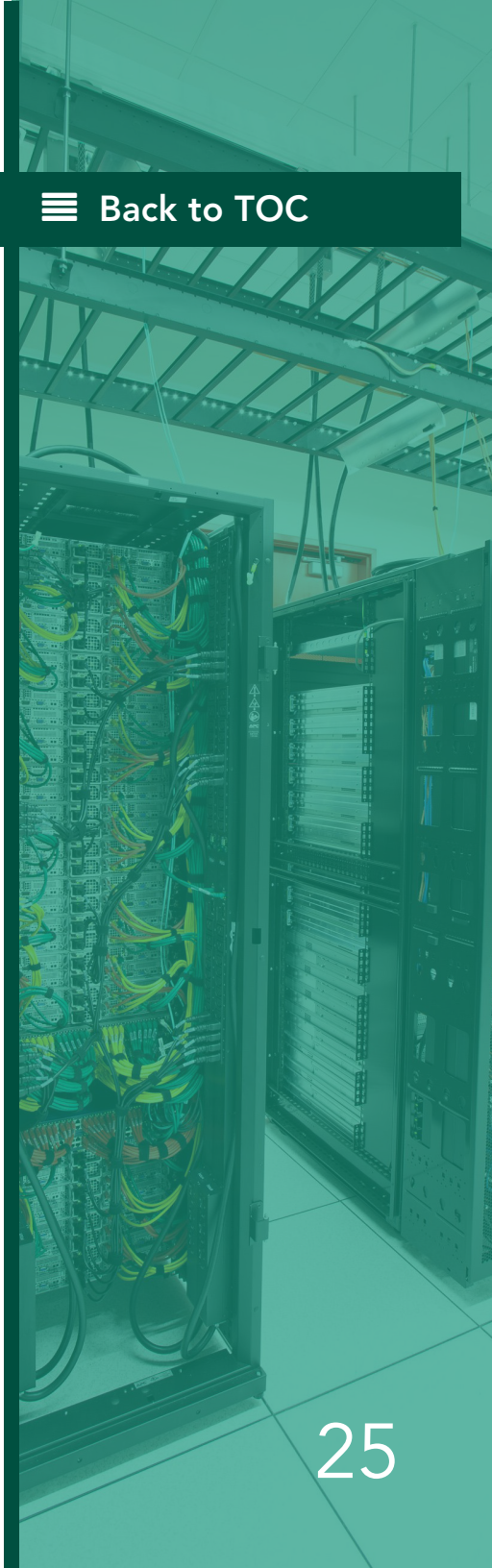## Advanced Analytics Solution for Predictive Maintenance

Abound Predictive Insights™ solution provides improved asset management across your building portfolio. This enables a simpler, smarter way to analyze your building operations and optimize efficiency, comfort and performance. The Abound technology is based our award-winning CORTIX™ artificial intelligence (AI) platform. This advanced AI platform can predict failures and maintenance issues long before they manifest into breakdowns, while also helping pinpoint efficiency improvements.

## Data Center Infrastructure Management (DCIM)

Carrier's Nlyte® Asset Lifecycle Management and Capacity Planning software provides automation and efficiency to asset lifecycle management, capacity planning, audit and compliance tracking. It simplifies space and energy planning, easily connecting to an IT service management system and all types of business intelligence applications.

## Carrier Rental Systems

Carrier Rental Systems can help you maintain data center uptime when temperature control is interrupted by scheduled upgrades or unforeseen events. With customized plans according to your timeline, budget and available space, you can use our readily available rental units to ensure continuous operations while you select, order, and receive new equipment.

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