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Boosting Data Center Efficiency:

UV-C TECH'S POWER PLAY FOR SUSTAINABILITY

As the global data center market surges, driven by cloud computing and AI, sustainability and energy efficiency have become top priorities. UV-C technology is emerging as a game-changer in enhancing HVAC systems, improving cooling efficiency, and reducing energy consumption. This article explores how UV-C innovations align with ASHRAE standards to optimize data center operations. Discover how UV-C is shaping the future of data center sustainability.

GLOBAL DATA CENTER GROWTH TRENDS AND THE DRIVE FOR SUSTAINABILITY

Over the past decade, the global data center market has experienced **unprecedented growth**, driven by **cloud computing**, **artificial intelligence**, **5G**, and the surge in **digital services**. Between 2014 and 2024, **hyperscale data centers increased more than fivefold**, with over **900 hyperscale facilities** worldwide as of 2024.

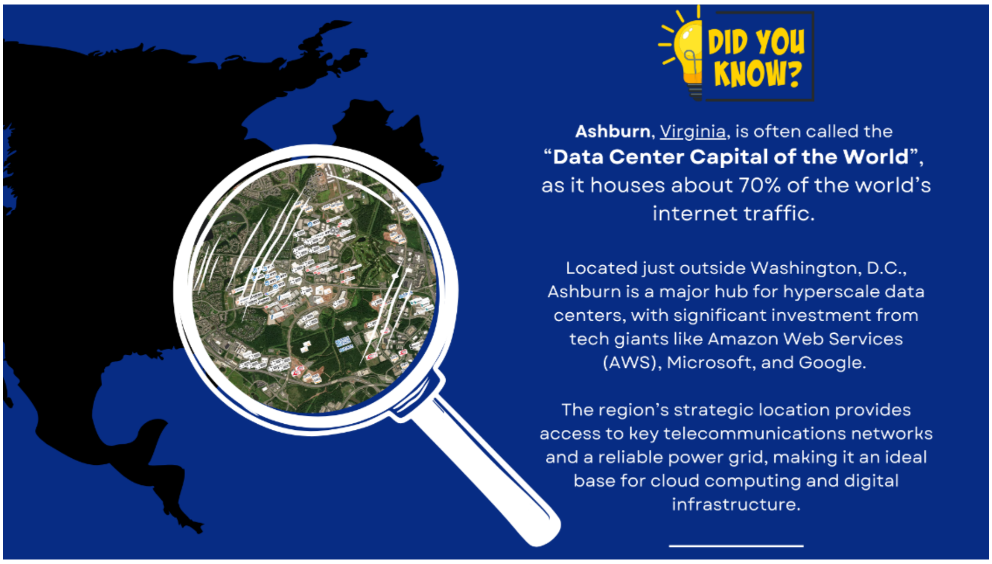
North America, particularly the **United States**, remains the largest data center market, accounting for over **40% of global capacity**. Key hubs like **Northern Virginia**, **Dallas**, **Phoenix**, and **Silicon Valley** have expanded rapidly, fueled by cloud giants such as **AWS**, **Microsoft**, **Google**, and **Meta**. The adoption of **edge computing** and **AI-driven workloads** has further accelerated demand for **energy-efficient infrastructure**.
The **European Union** estimates that data centres account for almost **3% of the EU's electricity demand**, a percentage that is likely to increase in the coming years, so operators will need to focus on new projects and developments in **data centre efficiency** for sustainability, i.e. effective use of water, **energy reuse** or use of **renewable energy**, reuse of **waste heat** in nearby structures and networks.

As **regulations tighten** on energy consumption and carbon footprints, **ASHRAE standards**, including **90.4 for energy efficiency** and **TC 9.9 for thermal management**, are playing a critical role in shaping the future of **data center design**.

DATA CENTERS ARE “COOL” – BUT THEY NEED TO STAY COOL.

The market has shifted towards **sustainable** and **high-density computing**, with innovations in **liquid cooling**, **AI-driven optimization**, and **renewable energy integration**.

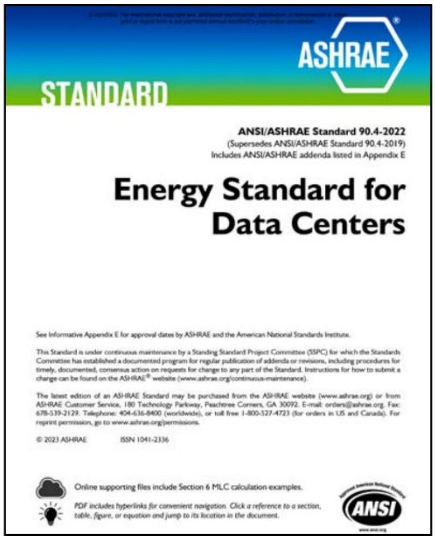
In data centers, **HVAC (Heating, Ventilation, and Air Conditioning)** systems represent a significant portion of overall energy consumption, often accounting for **30% to 50%** of the total energy used. This high energy consumption is due to the need to maintain optimal temperatures and humidity levels for the servers and equipment, which must be kept cool to prevent overheating and ensure reliable performance.



Energy use in HVAC systems is driven by factors such as the size of the data center, the density of equipment, the cooling technology employed (e.g., traditional air conditioning vs. **liquid cooling**), and the local climate. Innovations like **AI-driven optimization**, **liquid cooling systems**, and the integration of **UV-C technology** in HVAC systems are helping reduce energy consumption by improving cooling efficiency, maintaining clean equipment surfaces, and reducing the need for excessive cooling power.

Additionally, utilizing **free cooling** strategies (such as taking advantage of cooler external air) and **renewable energy** sources is becoming more common in data center HVAC design to further minimize the environmental impact.

As the demand for computing power continues to rise, **energy efficiency** and **reliability** have become critical challenges for data centers. To address these issues, **ASHRAE** has developed standards such as **90.4 (Energy Standard for Data Centers)**, **127 (Testing for CRAC/CRAH Units)**, and **TC 9.9 (Mission Critical Facilities)** to optimize **thermal management**, reduce **power consumption**, and ensure system resilience.



HVAC IN DATA CENTERS.

HVAC systems are crucial for maintaining the **proper temperature**, **humidity** *(ASHRAE's recommended temperature and humidity range for data centers (18-27°C or 64-80°F, and 45-60% relative humidity),* and **air quality** in data centers.

Depending on the data center's size, design, and operational requirements, different types of HVAC systems are used.

- **CRAC (Computer Room Air Conditioning) Units** are the most common cooling systems in traditional data centers. They are designed to cool the air directly around the IT equipment.

- **In-Row Cooling** systems place cooling units directly between server racks, helping reduce the distance cool air must travel to reach the equipment. This method is energy efficient as it focuses cooling where it's most needed.

- **Free Cooling (Air Side and Water Side)** leverages the outside air or water to cool the data center instead of using mechanical refrigeration. This can significantly reduce energy usage in cooler climates.
  - → Air-side free cooling: Uses outdoor air to cool the data center, often through dampers or heat exchangers.
  - → Water-side free cooling: Uses cool water from a nearby source (like a lake or river) to cool the air within the facility.

- **Chilled Beam Systems** use water-cooled beams to cool the air in the data center. These beams absorb heat through conduction and convection, providing highly efficient cooling with less air movement.

- **Geothermal Cooling** use the stable temperature of the earth to cool the data center. They are typically used in larger facilities where long-term energy savings are a priority.

- **Evaporative Cooling** systems use the evaporation of water to cool the air. These are highly efficient in dry climates and can be used in conjunction with other cooling systems.

- **Direct Liquid Cooling** cools IT equipment directly by circulating liquid coolant through specialized pipes in contact with the equipment, such as server racks or processors. It's often used in high-performance computing environments where air cooling is insufficient.

ALIGNING WITH ASHRAE STANDARDS: UV-C AS AN OPPORTUNITY

In this context, **UV-C technology** is emerging as a valuable tool for enhancing **HVAC efficiency**, improving airflow, and maintaining clean cooling surfaces, all of which contribute to **reducing energy costs** and preventing equipment failures.

By integrating **UV-C** into data center cooling systems, operators can achieve **higher sustainability**, better **indoor air quality**, and improved compliance with **ASHRAE efficiency guidelines**.

Ultraviolet-C (UV-C) technology has been extensively studied for its effectiveness in cleaning **HVAC coils** and reducing energy consumption. Research indicates that **UV-C** can lead to substantial **energy savings** by maintaining clean coil surfaces, which enhances **heat transfer efficiency** and reduces the workload on **HVAC systems**. A field study conducted at **St. Clare's Denville Hospital** in New Jersey demonstrated that implementing **UV-C treatment** on cooling coils resulted in energy savings of approximately **79,324 kWh**.

Further research by **Penn State University** showed that **UV-C light** effectively cleans away microorganisms, improving **heat transfer capacity** and reducing energy consumption.

Industry reports suggest that **UV-C installations** are cost-effective, with many users experiencing **payback periods** of less than six months based on energy savings alone. The initial investment for a **UV-C system** is often comparable to or less than the cost of a single professional coil-cleaning procedure, making it a financially viable option for maintaining **HVAC efficiency**. In summary, integrating **UV-C technology** into HVAC systems for coil cleaning has been shown to yield significant **energy savings**, improve **system performance**, and provide a rapid **return on investment**.

1. ASHRAE 90.4 – Energy Standard for Data Centers

ASHRAE 90.4 focuses on energy efficiency in mechanical and electrical systems. UV-C contributes to compliance and efficiency improvements in the following ways:

✅ **Improved Cooling Efficiency** – UV-C prevents biofilm buildup on cooling coils, improving heat exchange and reducing fan and compressor energy consumption. This supports lower Mechanical Load Component (MLC) values, helping data centers meet 90.4 efficiency requirements.

✅ **Reduced Airflow Resistance** – Clean coils reduce pressure drops, allowing lower fan speeds and reduced power consumption, aligning with ASHRAE's energy-saving goals.

✅ **Extended Equipment Life** – By maintaining clean cooling surfaces, UV-C helps prevent overworking of HVAC components, reducing maintenance and extending lifespan, supporting sustainability goals in data centers.

2. ASHRAE 127 – Method of Testing for Air Conditioning Units in Data Centers

ASHRAE 127 establishes standardized testing methods for computer room air conditioners (CRACs) and air handlers (CRAHs). UV-C benefits include:

✅ **Consistent Performance** – UV-C prevents coil fouling, which can degrade cooling capacity and cause units to fail efficiency tests under ASHRAE 127 guidelines.

✅ **Lower Airborne Contaminants** – Reducing microbial growth in cooling units helps maintain ASHRAE-recommended airflow and temperature performance, preventing operational inefficiencies.

✅ **Minimized Downtime & Maintenance** – CRAC/CRAH units require less frequent cleaning, leading to higher uptime and reduced operational costs.

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3. ASHRAE TC 9.9 – Mission Critical Facilities, Data Centers, Technology Spaces

TC 9.9 focuses on best practices for reliable and efficient data center operation, where UV-C contributes by:

✅ **Preventing Contamination on IT Equipment** – UV-C reduces microbial and particulate accumulation on heat sinks, circuit boards, and filters, minimizing overheating risks and failure rates.

✅ **Enhancing Air Quality in High-Density Environments** – Data centers with on-site personnel can benefit from UV-C-based air disinfection, supporting worker health and ASHRAE 241 IAQ recommendations.

IT MEETS UV-C: POWERING SUSTAINABLE DATA CENTERS

As data center demand continues to rise, **UV-C's role in optimizing HVAC performance is increasingly vital**, offering a cost-effective, efficient solution for maintaining operational reliability while reducing the environmental impact.

This innovation marks a significant step forward in shaping the future of data center sustainability. UV-C technology is **particularly advantageous**, as it **thrives in any climate**. It ensures effective air purification and optimal performance **regardless of external temperature or humidity conditions**, making it a **versatile and reliable choice** for **global data center operations**.

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