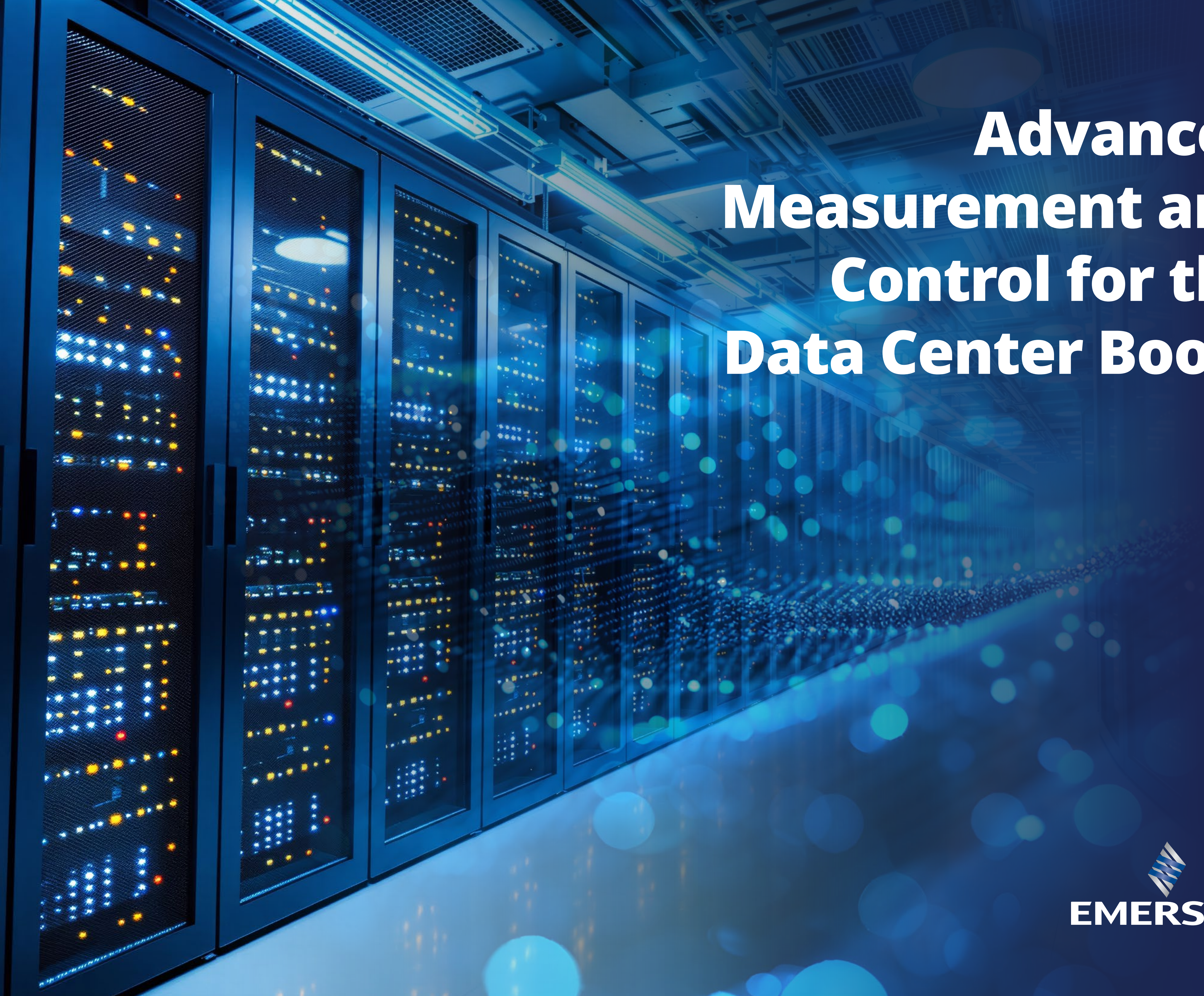
Advanced Measurement and Control for the Data Center Boom



EMERSON

As cloud computing and artificial intelligence continue to advance, data centers have become indispensable to the global digital economy. These facilities provide the critical infrastructure to store, process, and move massive volumes of data across increasingly complex campuses supporting everything from e-commerce and telecom to IoT, advanced analytics, and GPU-dense AI clusters. Far from their origins as small server rooms, modern sites are engineered as repeatable MW blocks with stringent requirements for power quality, redundancy, and thermal stability across liquid and air-assisted cooling topologies.

The pace of digital transformation has accelerated dramatically in recent years. Enterprise adoption of cloud platforms-combined with rapid growth in AI and machine learning-has driven unprecedented demand for data center capacity and power. In the U.S., federal analysis estimates data centers used 176 TWh in 2023 and could rise to roughly 325–580 TWh by 2028. Looking toward 2030, credible projections vary by scenario, but a reasonable, defensible planning range is ~400–600+ TWh/year-equivalent to ~45–70+ GW average load (with peak/connected demand potentially far higher in high-growth cases). For perspective, Hoover Dam's nameplate capacity is 2.08 GW (with average long-run hydro output of ~480 MW). This growth underscores why efficiency, reliability, and speed-to-deploy have become board-level imperatives.

Meeting this demand requires proactive energy and thermal management strategies. Data centers are among the most power-intensive facilities in operation today, with IT equipment and cooling representing the majority of electricity use; cooling alone is commonly cited in the ~38–40% range, depending on design, climate, and PUE (Figure 1). Because compute hardware generates substantial heat and can throttle under thermal stress, precise control of cooling water/airflow, differential pressure, supply/return temperatures, and fluid quality is essential to protect IT assets and maintain uptime across CRAH/CRAC systems, CDUs, pumping skids, heat exchangers, and condenser/chiller plants.

Operational efficiency is mission-critical for data centers. Even incremental gains in thermal performance and power utilization can significantly improve PUE and reduce operating costs. Achieving this level of optimization depends on accurate, resilient measurement and closed-loop control across the full stack-electrical distribution and backup power, chilled water and condenser loops, liquid cooling distribution, and campus monitoring. Robust instrumentation and automation enable operators to maximize uptime, minimize energy waste, and scale repeatable deployments with confidence.

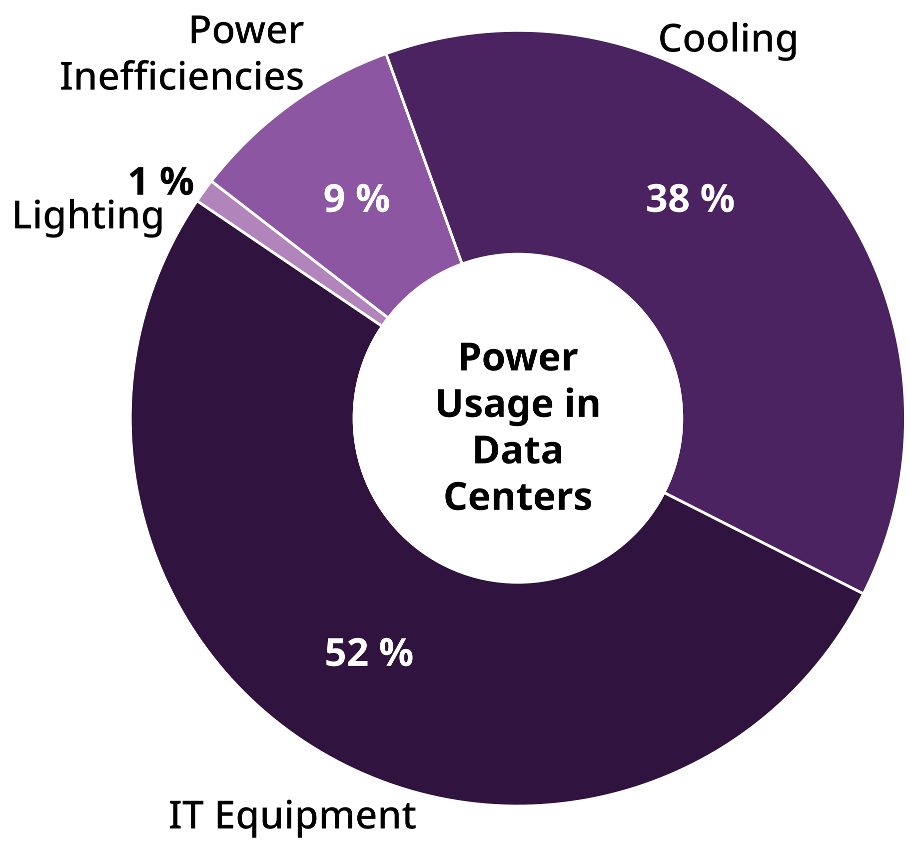


FIGURE 1

Breakdown of energy consumption in a data center, highlighting the dominant impact of IT equipment and cooling loads.

Liquid Versus Air Cooling

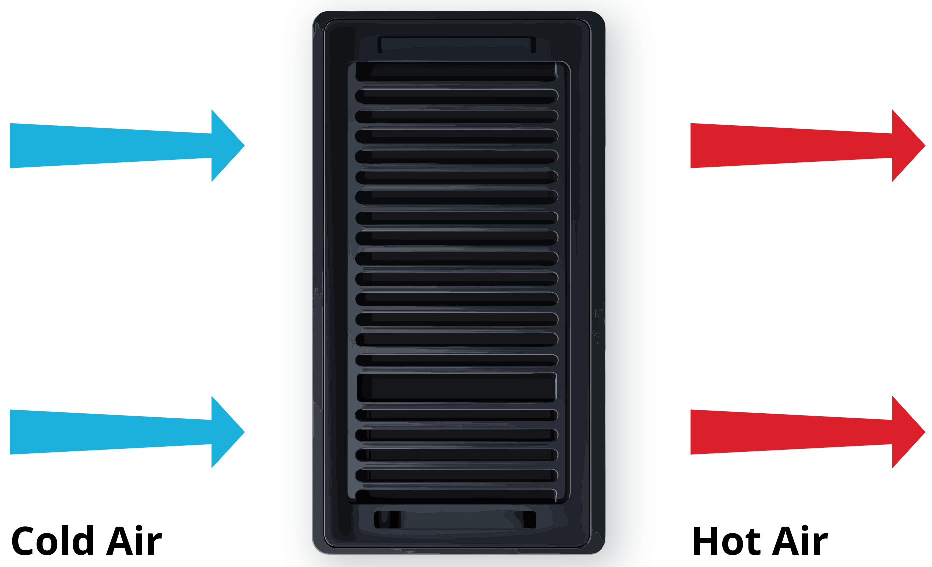
One of the primary functions of a data center's mechanical systems is to remove heat generated by servers. Traditionally, this has been accomplished through air cooling. In this approach, cold air is directed into a server rack, where it flows across components, absorbs heat, and exits as hot air on the opposite side (Figure 2).

However, substantial increases in computing (CPU) and graphics processing unit (GPU) power capable of handling artificial intelligence and high-performance computing workloads have increased server rack cooling demand considerably. While a conventional rack might draw around 5 kilowatts of power, modern AI racks can exceed 80 kilowatts, with future designs expected to push even higher. This level of heat cannot be managed efficiently with air cooling alone, leading to widespread adoption of liquid cooling.

Typical rack power density Air-cooled: ~1-10 kW/rack | Liquid-cooled: ~10-100+ kW/rack

Air-Cooled

- Front-to-back airflow moves heat away (cold-aisle/hot aisle)
- Higher density needs containment and higher fan power
- Example heat load: 5 kW (≈17,000 BTU/hour)



Liquid-Cooled

- Removes heat at/near GPU chip (cold plates, rear door HX)
- Lower fan power and more predictable thermal control
- Liquid immersion (direct-to-chip); next-gen GPU density
- Example heat load: 30 kW (≈100,000 BTU/hour)

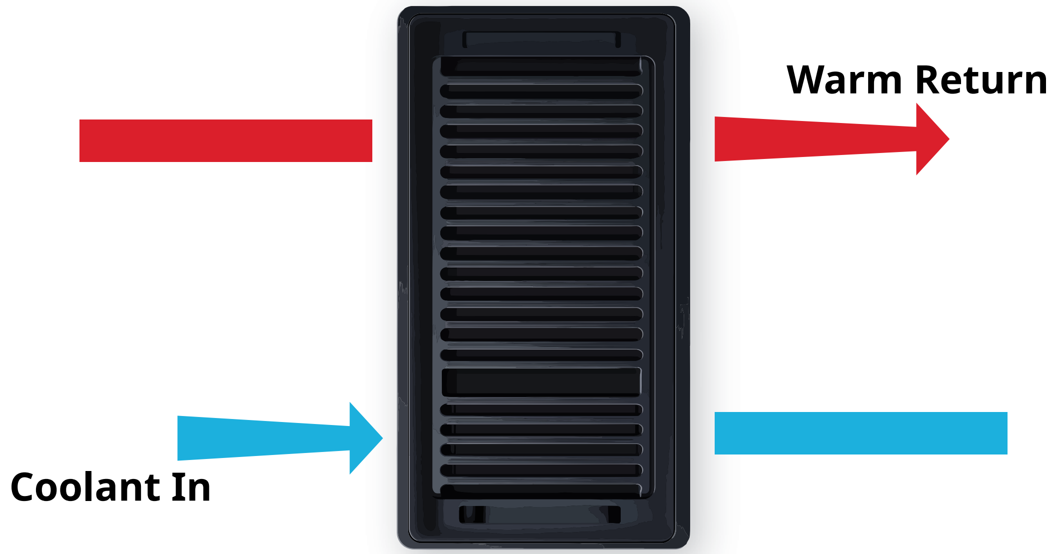


FIGURE 2
Liquid cooling is significantly more effective at removing heat, making it essential for high-density AI and high-performance computing workloads.

Liquid cooling uses water or other fluids to absorb heat much closer to the source, often directly at the chips. Because liquids are more effective at transferring heat than air, this method is ideal for removing heat from tightly packed and powerful modern IT hardware.

The transition from air to liquid cooling introduces greater complexity and requires precise control. System efficiency depends on accurate monitoring of flow, temperature, pressure, and coolant quality within the cooling loops (Figure 3).

Data center efficiency is measured by PUE, which is the ratio of total facility energy to IT equipment energy. A lower PUE indicates a more efficient data center. Advanced liquid cooling, supported by precise measurement and control, is essential for achieving the ultra-low PUE targets required by hyperscale operators and high-density computing environments.

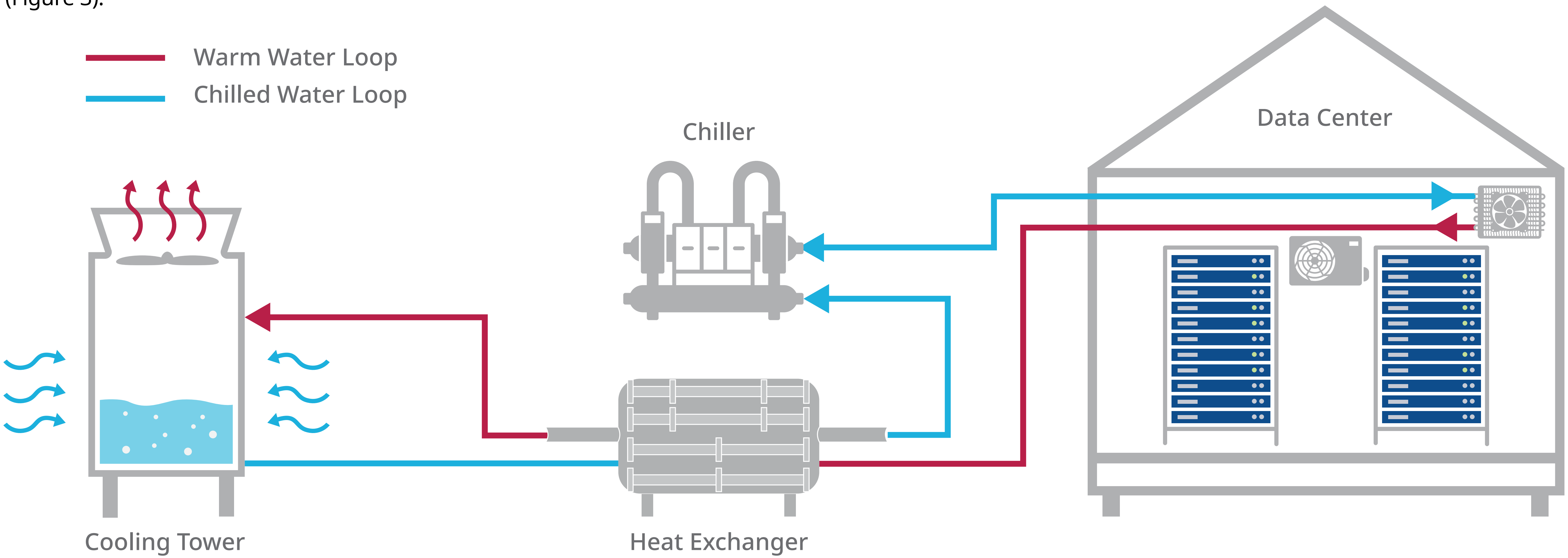


FIGURE 3
Cooling loop efficiency depends on accurate instrumentation for process measurement.

Turning Data Center Challenges into Competitive Advantages

Data center operators face a wide range of challenges, including rising energy costs, aggressive construction timelines, the need for high-density cooling, and supply chain constraints, all while maintaining uptime and meeting scalability demands.

Advanced measurement instrumentation provides the foundation for overcoming these challenges by delivering real-time visibility and precise control across critical systems. This capability empowers operators to optimize performance, reduce risk, and achieve the operational resilience and efficiency required to support today's data-driven world.

Speed to Revenue

- Pre-integrated systems accelerate deployment and minimize schedule risk
- Factory-tested solutions ensure a smoother, more predictable go live
- Standardized, repeatable designs streamline rollout across sites

Energy Efficiency and Sustainability

- Optimize cooling and power performance with real-time insight to improve PUE
- Reduce energy and water consumption to meet sustainability targets
- Streamline ESG tracking with simplified monitoring and reporting

High-Density Cooling

- AI/HPC-ready liquid-cooling controls ensure stable, high-density performance
- Identify issues early to avoid cooling instability failures, and downtime
- Streamline cooling operations to support sustained high-density loads

Scalability & Repeatability

- Scale faster with modular expansion that adds capacity without redesign
- Ensure consistency and reliability with unified global standards
- Accelerate deployment with configuration templates that cut commissioning time

Reliability & Safety

- Automated controls stabilize critical power and cooling to protect uptime
- Predictive maintenance prevents failures, maximizing availability and reducing costly downtime
- Safety features support compliance and reduce operational risk

Integration & Visibility

- Bring OT and IT together for a clearer, more confident operational view
- Act sooner with remote monitoring that delivers meaningful, prioritized alerts
- Accelerate outcomes with integrated data that drives faster decision making

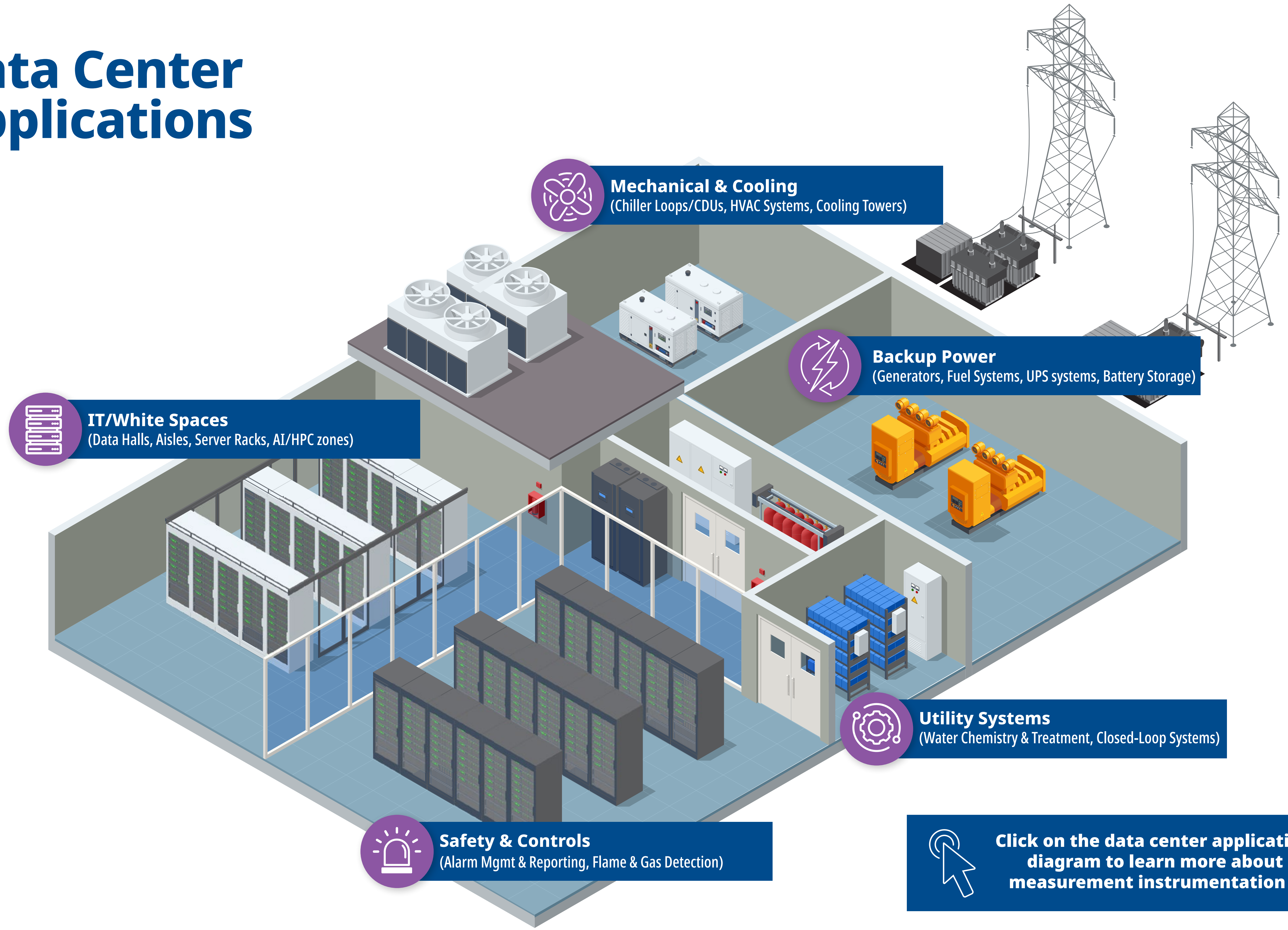
Measurement Instrumentation Built for Today's Data Center Demands

Every data center relies on a series of interconnected applications that must work together seamlessly to deliver reliability, efficiency, and scalability. These applications include mechanical and cooling systems that maintain thermal performance, IT spaces that enable high-density AI-ready operations, backup power systems that ensure resiliency, safety and control systems that reduce risk, and utility systems that support compliance and chemical management. Each of these areas has unique requirements, and success depends on accurate measurement and control.

Advanced instrumentation provides the foundation for optimizing these applications. Emerson provides a comprehensive portfolio of measurement solutions designed to help operators reduce energy consumption, maintain operational continuity, and meet the demands of modern computing environments.

The following sections will examine each of these critical data center applications shown below and demonstrate how advanced measurement technologies solve the most pressing challenges faced by data center operators.

Data Center Applications



Click on the data center applications in the diagram to learn more about Emerson's measurement instrumentation solutions.

Mechanical & Cooling

MECHANICAL & COOLING

Manage Thermal Capacity and Efficiency as Loads Scale

Mechanical and cooling systems are the backbone of thermal management in data centers. These systems ensure servers and IT equipment operate within safe temperature ranges, preventing downtime and protecting critical infrastructure. As AI and high-performance computing workloads drive power densities higher, cooling efficiency and reliability have become essential for maintaining uptime and optimizing energy use. Success in this application depends on accurate measurement of flow, temperature, and fluid quality throughout chilled water and glycol loops.

AMBIENT TEMPERATURE MONITORING FOR OPTIMAL COOLING AND HEAT EXCHANGER MONITORING

Accurate ambient temperature monitoring is essential for maintaining efficiency and equipment safety in applications such as heat exchangers, server racks (hot/cold aisle), electrical rooms, computer rooms, and more. In particular, heat exchangers play a critical role in removing heat from liquid cooling loops and transferring it to ambient air. If the air temperature across heat exchanger coils is not properly monitored, cooling efficiency can drop, leading to thermal stress on servers and increased energy consumption.

The Rosemount™ Synchros™ Temperature Monitor (Figure 4) delivers precise air temperature readings throughout server halls to ensure predictable cooling performance and prevent hot spots, as well as provides a simple and reliable way to measure air temperature across heat exchanger coils to ensure efficient heat transfer, helping operators maintain cooling performance and prevent thermal disruptions that could compromise uptime. These measurements also help data centers avoid overcooling, reduce operational costs, and sustain higher IT loads without compromising equipment safety.

FIGURE 4

Emerson's Rosemount Synchros Temperature Monitor reliably measures surface or ambient temperature using *Wireless*HART® technology, empowering plant managers to schedule maintenance more proactively and reduce operator manual rounds.

OPTIMIZE FLOW FOR ENERGY EFFICIENCY AND LEAK DETECTION

Maintaining proper flow rates in chilled water and glycol loops is critical for heat transfer efficiency and overall system reliability in data centers. Over-pumping increases energy consumption and operating costs, while leaks or blockages can lead to thermal disruptions and unplanned downtime. Accurate flow measurement enables operators to maintain optimal cooling performance, reduce energy waste, and detect issues before they escalate. Emerson's magnetic flow meters provide high-accuracy measurement of conductive fluids, helping ensure balanced cooling loops and energy-efficient operation across the facility (Figure 5).

FIGURE 5

Rosemount Magnetic Flow Meters are engineered for precise, energy-efficient cooling performance in data center applications.

EFFORTLESS FLOW AND THERMAL ENERGY MONITORING OF LARGE, MAIN COOLING PIPES

To ensure reliability and availability, the monitoring of large cooling water mainlines is essential to maintain optimal performance and prevent overheating of IT equipment. Implementing ultrasonic clamp-on flow meters such as the FLUXUS F731 WD and F731 TE for these large pipelines offers significant advantages (Figure 6). Ultrasonic clamp-on technology can be easily applied to pipe sizes like 15" and larger, which can be found especially in hyperscale data centers. Unlike traditional inline flow meters, these ultrasonic clamp-on meters are installed without any shutdown or pipe modification. The non-intrusive technology reduces the need for extensive engineering and planning, bypasses, and isolation valves. Additionally, the FLUXUS models provide highly accurate and reliable measurements of flow rates, crucial for monitoring and controlling the efficiency of cooling in large-scale water systems. This solution enhances energy efficiency, minimizes maintenance costs, and ensures greater system reliability, proving invaluable in the operations of modern data centers.

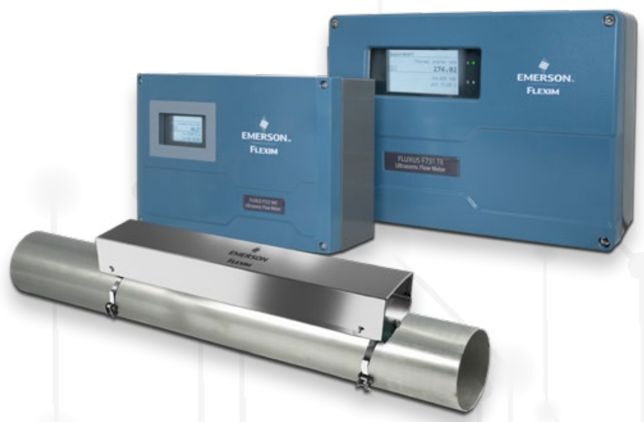


FIGURE 6

Flexim™ FLUXUS non-intrusive ultrasonic flow and thermal energy meters offer significant advantages when it comes to large pipelines in hyperscale data centers.

VALIDATE COOLING PERFORMANCE WITH TEMPERATURE DEVICES

Within chilled water and glycol loops, precise temperature measurement is essential for validating cooling performance and optimizing energy use. Emerson temperature transmitters monitor supply and return temperatures to confirm that heat is being effectively removed from servers. These measurements help identify fouling in heat exchangers, chiller inefficiencies, and other issues before they escalate into costly failures. The Rosemount 3144S Temperature Transmitter (Figure 7) provides diagnostic coverage from process to control room to help ensure you do not lose your measurement on your critical temperature measurement loops. These diagnostic capabilities include RTD Measurement Protection, which automatically converts your sensor from a 4-wire to a 3-wire if a wire is broken or damaged to help avoid measurement loss and downtime. Continuous temperature trends also support proactive maintenance and PUE optimization, ensuring that cooling systems operate at peak efficiency.

Another solution for accurate and reliable process temperature measurements that is uniquely suited for chilled water loops is Rosemount X-well™ Technology (Figure 8). This solution is non-intrusive, which means it eliminates the need for thermowells, process penetrations and modifications related to the measurement. This significantly reduces installation time and complexity while allowing for additional project schedule flexibility, as well as removes potential leak paths and helps preserve system integrity. Flush and fill risk is minimized because there is no potential for contamination from welding slag, debris, or installation-related particulates entering the system. When specifying Rosemount X-well with the Universal Pipe Mount, you can standardize on a single solution across a variety of applications and pipe sizes.

FIGURE 7

The Rosemount 3144S Temperature Transmitter provides the most accurate and reliable temperature data, which supports uptime by ensuring servers operate within safe ranges.

FIGURE 8

Rosemount X-well Technology provides an easy to install, non-intrusive solution to support accurate temperature control on the primary chilled water flow loops.

SUSTAIN FLUID QUALITY FOR MAXIMUM COOLING PERFORMANCE

Cooling loops rely on water or glycol mixtures, and maintaining proper chemical balance helps drive efficiency and protect equipment. Contaminants or incorrect ratios can reduce heat transfer performance and damage sensitive components. Emerson's process analytical instruments monitor pH, conductivity, turbidity, and other fluid properties to ensure optimal cooling performance and prevent corrosion, scaling, and other issues that lead to costly downtime (Figure 9). These measurements help operators maintain fluid cleanliness, protect critical assets, and extend the life of cooling systems.

FIGURE 9

Fluid cleanliness, measured by process analytical instruments, helps optimize cooling efficiency and system uptime.

IT/ White Spaces

Maintain Optimal Rack-Level Conditions Across the Data Hall

Inside the extensive halls of server racks, environmental conditions must be carefully managed to operate equipment safely and efficiently. These spaces require precise monitoring of airflow, pressure, and temperature to prevent contamination, optimize cooling, and avoid unnecessary energy consumption.

MANAGE PRESSURE FOR CONTAMINATION PREVENTION AND CONTROL

Advanced pressure measurement is essential for protecting sensitive IT equipment from airborne contaminants. Emerson pressure transmitters provide accurate differential pressure readings to maintain positive pressure in server halls, reducing the risk of contamination and costly equipment damage (Figure 10). These transmitters also offer local real-time control through configurable relay switches, eliminating the need for separate control devices on OEM process skids. This capability enhances modularity and speeds up construction for facilities deploying skid-based systems.

In addition to control functions, these instruments detect abnormal conditions, such as plugged impulse lines and pump cavitation using built-in diagnostics. Bluetooth® connectivity enables increased productivity and reliability by simplifying operator rounds with fast and easy device connection.

FIGURE 10
Emerson's Rosemount 4051S Pressure Transmitter provides a 20-year warranty for stability and performance, along with flexibility for data center applications with local real-time control, which eliminates the need for a separate loop controlling device.

IT/WHITE SPACES

PROTECT AGAINST CORROSION IN COOLING PROCESSES

Immersion cooling and direct-to-chip cooling systems can experience corrosion-related issues due to chemical, electrochemical, and environmental factors, such as galvanic corrosion from mixed metal components and fluid chemistry upsets, pH imbalance or poor fluid quality, moisture or oxygen ingress, thermal breakdown causing acid formation, high fluid velocities, and more. Emerson's Rosemount Wireless Corrosion and Erosion Transmitters continuously monitor the health of cooling loops and related assets through direct wall-thickness measurements to help quantify corrosion/erosion rates and enable more informed decisions about maintenance, replacement, and optimization--without the need for frequent manual inspections or expensive cabling (Figure 11).

FIGURE 11

Emerson's Rosemount Wireless Corrosion and Erosion Transmitters obtain continual direct thickness measurements to track corrosion and erosion impact over time, helping operators optimize cooling-system reliability and avoid unexpected downtime.

Safety & Controls

Gain Early Visibility Into Critical Infrastructure

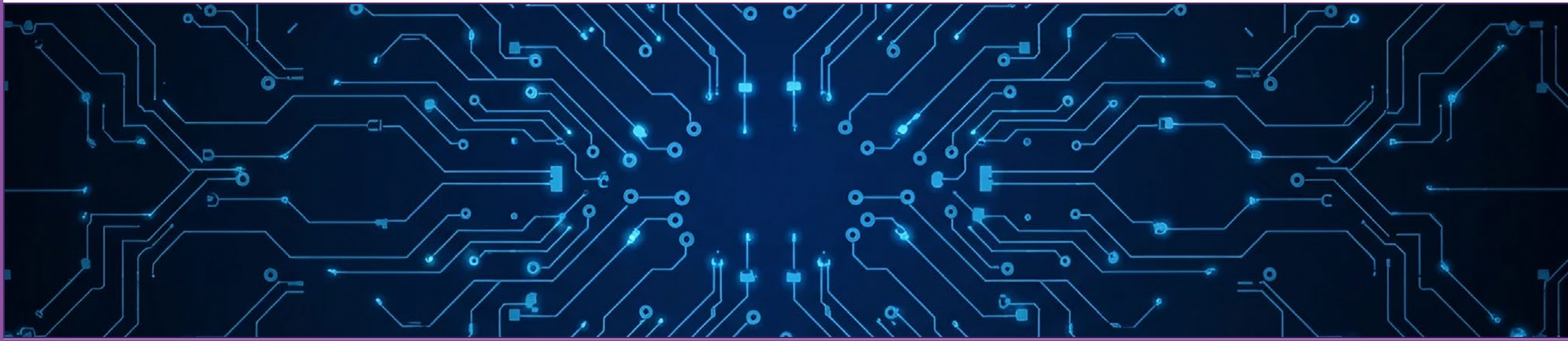
This domain encompasses the foundational systems that ensure operational visibility and safety, including the building management system (BMS), energy management system (EMS), and fire suppression system. Integrated controls, combined with advanced gas and flame detection technologies, help operators maintain compliance with applicable codes while protecting personnel and equipment.

FLAME DETECTION FOR PROTECTING CRITICAL INFRASTRUCTURE

While gas detection helps prevent incidents, flame detection provides early warning when ignition occurs (Figure 12). In data centers, where equipment operates continuously and cooling systems run at full capacity, rapid fire detection is essential.

Traditional heat or smoke sensors require a fire to burn long enough to reach a measurement threshold, delaying response. Advanced flame detection technology eliminates this delay by sensing specific wavelengths of ultraviolet (UV) or infrared (IR) radiation produced during combustion. As soon as a fire breaks out, the sensor recognizes the change within seconds and initiates the appropriate response. These systems function like cameras, requiring a clear line of sight, which is an important consideration when determining placement in dense server environments.

FIGURE 12
Radiant energy sensors, such as Emerson's Rosemount 975 Flame Detector family, respond to specific wavelengths produced by hydrogen or carbon-based fuels. They are effectively cameras, requiring a clear line of sight, which is important to consider when determining placement.



GAS CHROMATOGRAPHY FOR DETAILED ANALYSIS

Gas chromatograph data is used in data centers to monitor energy value and custody transfers via BTU and support compliance with safety regulations. Their advanced analysis capabilities help ensure safe, reliable, and efficient operations, especially in mission-critical environments.

For example, Emerson's Rosemount 470XA Gas Chromatograph provides a compact, economical, and reliable solution, delivering accurate measurement that is fully traceable to international standards. Furthermore, this sensor does not require a shelter in most environments, lowering total cost of ownership (Figure 13).

FIGURE 13
Emerson's Rosemount 470XA Gas Chromatograph provides a compact, economical, and reliable solution for gas analysis in data center and other environments.

Backup Power

Ensure System Availability Through Power Disturbances and Outages

Uninterrupted power is essential for data centers to meet high-availability service-level agreements and maintain customer trust. Backup power systems ensure critical operations continue even during grid failures or unexpected outages. Emerson provides solutions for monitoring and controlling every element of the power infrastructure, from primary power sources and microgrids to diesel generators and uninterruptible power supply (UPS) systems. These solutions include fuel consumption monitoring, flame detection in generator rooms, and surge protection to safeguard sensitive equipment.

Primary energy for data centers typically comes from a combination of sources, such as the utility grid, combined cycle gas turbines, small modular nuclear reactors, and renewable energy technologies, including solar and wind. Emerson delivers the automation and instrumentation required to manage these diverse energy sources, although a detailed discussion of these technologies is beyond the scope of this eBook.

When one or more primary sources fail, battery backup is generally reserved for the most critical loads due to its high cost, while the majority of backup power is provided by diesel generators. Automatic transfer switches enable a seamless transition between power sources, ensuring continuity without manual intervention.

GAS DETECTION FOR LEAK PREVENTION AND OPERATIONAL SAFETY

Reliable power is a critical requirement for data centers. Many data centers rely on battery backups and/or standby generators to ensure reliable power and avoid shutdowns in the event of a power outage. However, battery backups and standby generators could be sources of combustible gas leaks. Battery backups are at risk of combustible hydrogen gas releases due to charging issues, while backup generators are at risk of fuel leaks. Many leading data centers use fixed point gas detectors to warn of gas leaks.

Point gas detectors are located near the potential leak source, detecting combustible gases before they spread and dilute. The Rosemount 928 Wireless Gas Detector with the 628MP-F41 combustible gas sensor can detect combustible hydrocarbons and hydrogen (Figure 14). The Rosemount 628 sensor works by measuring thermal properties of the air, allowing it to classify the gas detected and measure its concentration without the need for manually-applied calibration factors. As a solid-state sensor that does not use consumables, the 628 sensor will not drift which means customers can avoid the frequent calibrations other sensor technologies require.

Open path detection operates differently by creating a monitoring zone across open spaces (Figure 15). A focused beam of light is transmitted from a source to a sensor, forming a detection fence that can span up to 20 meters. If gas enters the beam at any point, the system responds immediately. These detectors are designed to function in full sunlight and complete darkness, using optical components to minimize interference from ambient light. This approach is ideal for areas with multiple potential leak sources, offering broad coverage and rapid detection.

FIGURE 14
The Rosemount 928 Wireless Gas Detector provides continuous, wireless LEL monitoring within high density server rooms—enabling early detection of combustible gases without adding load to existing cabling infrastructure.

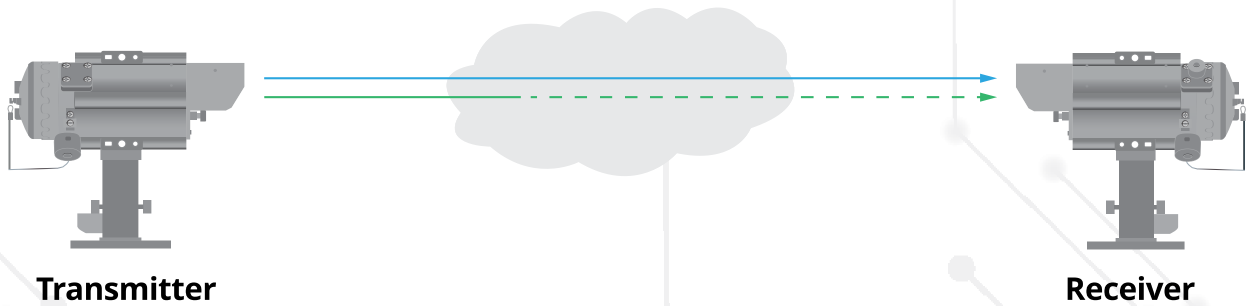


FIGURE 15
Emerson's Rosemount 935 Open Path Combustible Gas Detector consists of a source and detector pair to detect combustible hydrocarbon gases in the path of the beam between the two.

LEVEL MEASUREMENT TO ENSURE FUEL AVAILABILITY AND OPERATIONAL CONTINUITY

Diesel generators require a dependable fuel supply, making accurate fuel level monitoring essential for reliability. Continuous and precise measurement enables operators to maintain regulatory compliance, enhance reporting accuracy, and optimize fuel inventory and process control. Emerson's non-contacting radar-based level measurement technology provides an easy-to-install, reliable solution for monitoring fuel levels in storage tanks, ensuring generators have the fuel required to power critical operations for extended periods during grid failures (Figure 16). Remote configuration via Bluetooth® wireless technology enables quick, safe installation, helping data centers meet uptime requirements without interruption. On-board Smart Meter Verification with printable reports provides automatic device health checks, supporting regulatory compliance requirements.

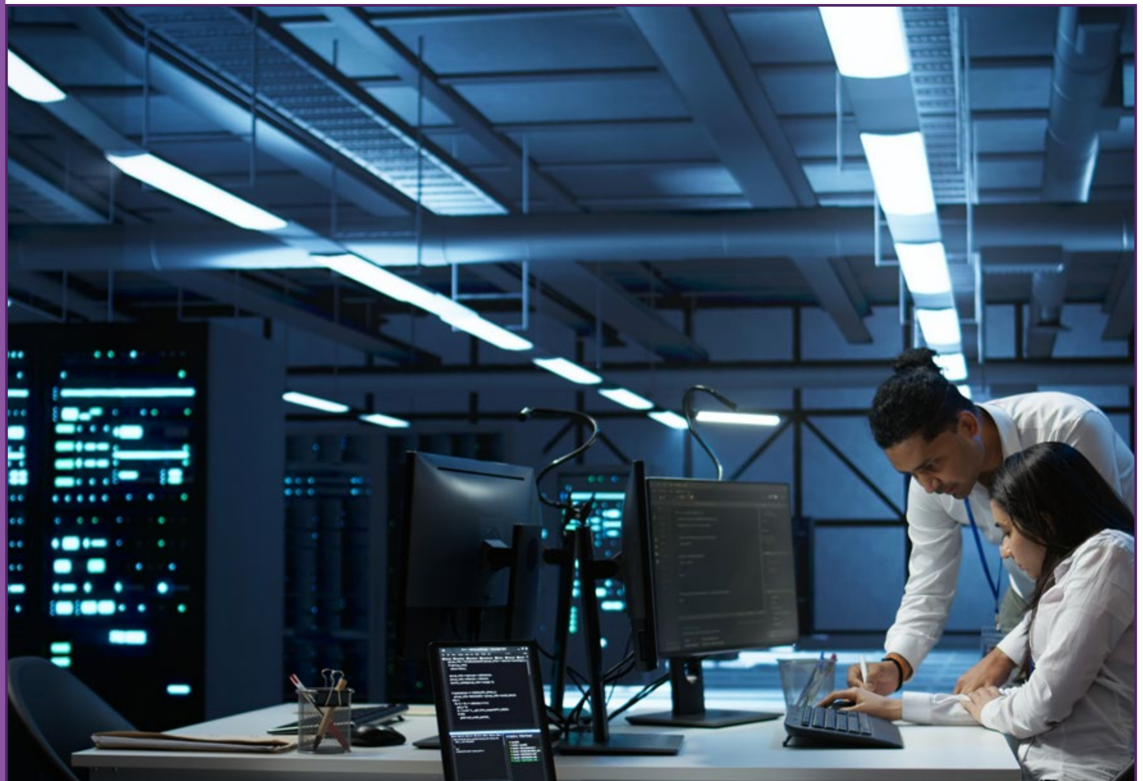
FIGURE 16

The Rosemount 3408 Non-Contacting Radar Level Transmitter ensures that backup generators have the fuel required to power critical operations for several hours in case of grid failure. For control of multiple tanks, install the Rosemount 2405 Monitoring Hub.

Utility Systems

Improve Power Island Emissions and Water Monitoring

Data centers depend on robust utility systems to maintain continuous operations and meet strict uptime requirements. Cooling water is a critical component of these systems, and its quality must be carefully managed to prevent corrosion, scaling, and microbial growth in cooling loops. These issues can degrade heat transfer, reduce cooling efficiency, and shorten equipment life. Because utilities represent one of the largest operating costs for data centers, operators focus on strategies that minimize water and energy consumption while ensuring optimal conditions for IT equipment and personnel.



CONTINUOUS EMISSIONS MONITORING ENHANCES DATA CENTER COMPLIANCE

An increasing number of hyperscalers' utilities are subject to CEMS requirements, demanding multicomponent gas analysis for accurate monitoring, reporting, and optimization.

Power island gas turbines and other combustion sources require EPA-approved continuous measurements of NOx, CO, and sometimes NH3. For applications without NH3, the Rosemount QX1000 Continuous Gas Analyzer delivers precise, continuous monitoring by combining laser absorption spectroscopy with paramagnetic oxygen measurement. For applications requiring NH3, the Rosemount CT5100 Continuous Gas Analyzer provides reliable, high-performance gas analysis (Figure 17).

FIGURE 17

The Rosemount QX1000 (left) and CT5100 (right) deliver high-performance, multi-component gas analysis for NOx, CO, NH_3, and O_2. The QX1000 is ideal for non-NH_3 applications, while the CT5100 supports both NH_3 and non-NH_3 needs, offering greater flexibility for emissions monitoring.

WATER LEVEL MEASUREMENT IMPROVES COOLING PERFORMANCE

Accurate water level measurement in storage tanks is essential for stable cooling operations. Maintaining proper levels ensures cooling towers operate at peak efficiency and prevents pump failures that can lead to costly downtime. Reliable level control reduces the risk of dry-run conditions and overflow, minimizing water waste and lowering treatment and consumption costs. Stable tank levels also support consistent heat transfer, reduce energy usage, and limit conditions that cause scaling, corrosion, and biological growth (Figure 18).

By ensuring consistent water levels, data centers can reduce maintenance costs, improve efficiency, and protect critical infrastructure from process upsets that compromise reliability. Cost-effective, compact non-contacting radar technology provides easy-to-install, precise and stable utility water level control through accurate, continuous level measurement. For applications where continuous measurement is not required, point level switches offer a simple, economical solution for high- and low-level monitoring only, allowing operators to balance performance requirements with budget considerations (Figure 19).

FIGURE 18

The Rosemount 1208 Level and Flow Transmitter with Rosemount 3490 Controller provides continuous utility water level control, helping data centers run more efficiently and reducing conditions that can cause process upsets and drive-up maintenance costs, such as scaling, corrosion, and biological growth.

FIGURE 19

The Rosemount 2120 Vibrating Fork Level Switch provides a reliable yet simple means of high and low level monitoring for control or alarming.

Lifecycle Services

LIFECYCLE SERVICES

Sustaining Performance Beyond System Delivery

Engineered utility systems and solutions do not end at commissioning. As data centers are delivered through EPCs and scaled in repeatable blocks, long-term performance depends on how those systems are supported once they are operational. Lifecycle services span from startup and commissioning through ongoing operation, providing the structure needed to sustain reliability, measurement integrity, and availability across complex utility infrastructures—ensuring engineered systems and solutions continue to perform as designed over time.

FROM STARTUP AND COMMISSIONING TO CONTINUOUS SYSTEM PERFORMANCE

As data center operators deploy engineered utility systems and solutions to support higher loads and stricter performance targets, lifecycle services play a critical role in sustaining reliable, system-level operations. While engineered systems and solutions deliver integrated capability at startup, long-term value is realized through service contracts that focus on keeping capital equipment and integrated systems in proper working order throughout their expected lifespan. Structured long-term service agreements enable standardized inspections, calibration, and diagnostics across complete utility systems once they are in operation—rather than at the component level—helping identify degradation early and reduce operational risk. This contract-based approach improves uptime, stabilizes operating costs, and extends asset life while preserving the measurement accuracy required for cooling performance, water management, and regulatory compliance. By embedding lifecycle services into day-to-day utility operations, data center teams move beyond reactive maintenance toward predictable, data-driven system performance management as infrastructure complexity grows.

Case Studies: From Design to Operation

Critical Cooling Water and Thermal Energy Metering

CASE STUDY

Since data centers convert nearly all electrical power into heat, uninterrupted cooling is essential to avoid equipment shutdowns and significant financial losses.

A major data center provider was planning a safe, reliable, and energy-efficient operation of the critical cooling infrastructure for one of its new large projects.

The project required precise thermal energy and water flow metering across multiple cooling lines (8-16” diameter) carrying water and water-glycol mixtures. A non-intrusive clamp-on flow metering solution was selected to avoid process interruptions, reduce installation costs, and enable easy deployment of the measurement points. For some applications, the provider requires multiple layers of redundancy including triple redundant metering configurations - these can be added easily thanks to the clamp-on design and the ease of installation. In total, 83 advanced ultrasonic meters were installed, supporting accurate monitoring of cooling system health and optimizing overall energy efficiency (Figure 20).

FIGURE 20
Emerson’s Flexim non-intrusive measurement technology enabled a data center provider to avoid process interruptions, reduce installation costs, and enable easy deployment of the measurement points.

The solution delivered strong operational value, aligning with strict safety needs while providing an extremely flexible, user-friendly, and reliable metering approach for a high-power, mission-critical environment. It also reduces planning and engineering efforts for a flow metering point, as no bypasses like for in-line meters are needed.

CASE STUDY

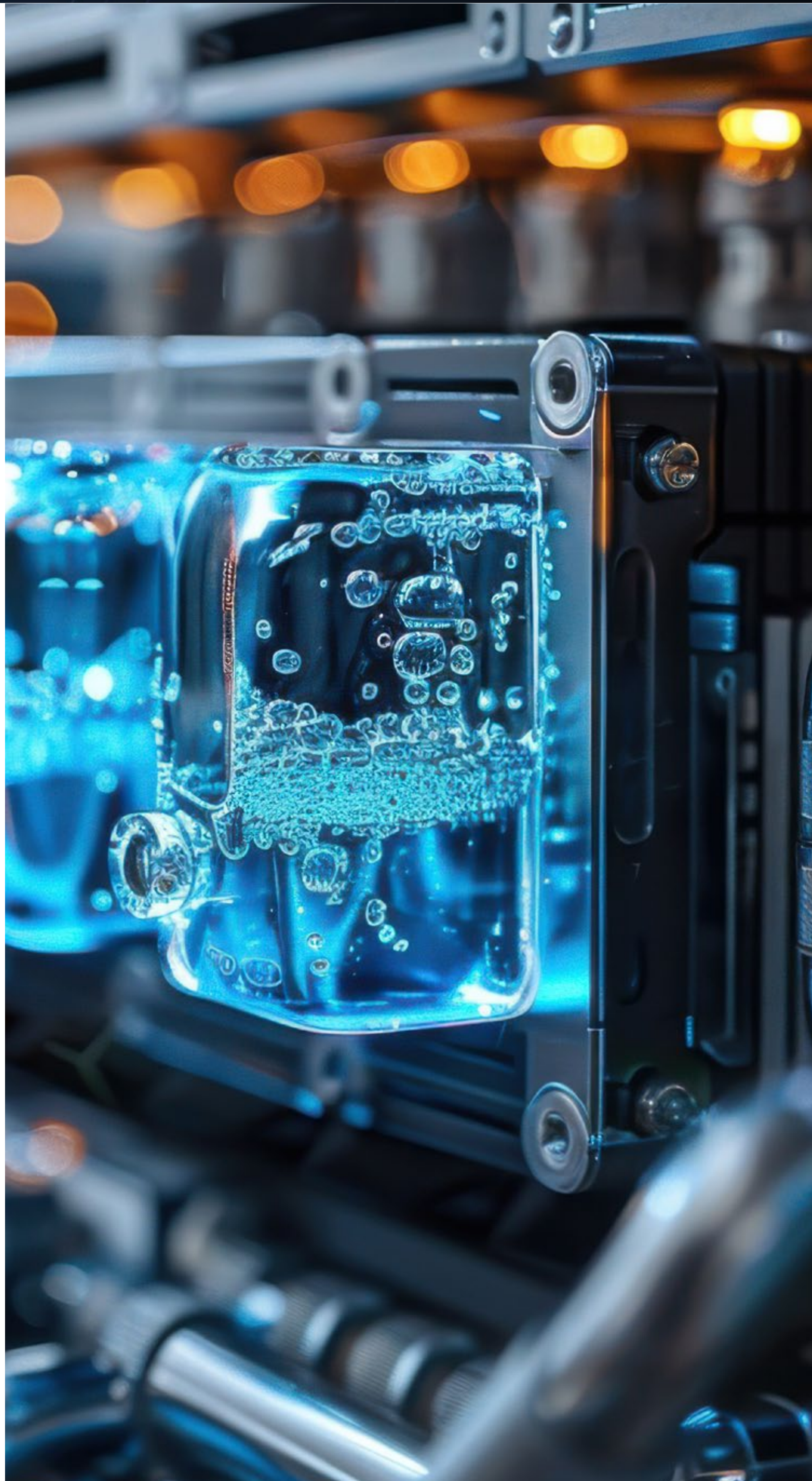
Real-Time Monitoring of PG25 Mixtures

As data centers increasingly adopt liquid cooling with propylene glycol (PG)-water mixtures (typically 25% PG, or PG25), maintaining fluid integrity and purity becomes even more critical.

An OEM building a data center infrastructure monitoring process skid required measurement of pH, turbidity, conductivity, dissolved oxygen, and refractive index to track glycol concentration and quality in real-time.

The OEM engaged Emerson for a suite of Rosemount retractable analytical sensors to measure these key fluid quality parameters in the PG25 cooling loops. These inline sensors are validated for glycol applications and fitted with retractable assemblies that enable servicing without process shutdowns. For glycol concentration, the Flexim PIOX R refractometer was used for its precise, real-time monitoring.

These measurements provided data centers with precise real-time measurements, eliminating the need for manual sampling and reducing the risk of corrosion, scaling, or microbial growth. This improved cooling efficiency and uptime, with automated trending and alerts provided through BMS integration.



Helping Data Centers Build, Operate, and Scale with Confidence

Short Lead Times

Data center build schedules are highly compressed, and delays in critical instrumentation can slow commissioning and postpone time to revenue. Emerson supports accelerated schedules through a robust, resilient supply chain, strong manufacturing capacity, factory-configured solutions, and expedited delivery.

Simplified Procurement

Large data center projects move quickly and involve many stakeholders, making specification, approvals, and supplier coordination challenging. Emerson simplifies procurement by enabling customers to work with a single supplier, reducing specification effort and streamlining ordering across phased projects and facilities.

Complete Instrumentation Portfolio

Data centers depend on accurate measurement across interconnected systems including cooling, power, safety, IT spaces, and utilities. Emerson offers a comprehensive instrumentation portfolio spanning flow, pressure, temperature, level, and liquid analysis to support consistent designs that scale across sites and regions.

Global Manufacturing & Support

Modern data center programs are often executed across multiple regions and require consistent product availability and dependable support. With manufacturing facilities around the world and scalable production capacity, Emerson delivers consistent availability and supply continuity backed by local engineering and service teams.

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