

Future-Ready Data Centers

8 TRENDS SHAPING DESIGN, PERFORMANCE AND GROWTH

TRANE TECHNOLOGIES

Dear Industry Leader,

Whether you're building a new data center or expanding an existing one, you need to bring capacity online quickly. Yet AI is driving higher thermal loads at a time when access to power constrains growth. **How can you meet these demands without compromising uptime? The cooling decisions you make today will play a critical role in your ability to grow and adapt tomorrow.**

Data center environments require more from their thermal management systems than perhaps any other type of facility, but these are the challenges Trane solves every day. With more than a century of engineering experience, we work with customers and technology partners to help design systems around each facility's requirements.

We bring cooling and controls together as one coordinated system, helping create more efficient cooling that can help free up power for compute. Plus, our flexible architecture helps protect your investment as workloads scale. Trane data center experts work alongside your team from early design through commissioning and into everyday operation. As your facility grows, local service expertise and digital insights help keep the system performing as intended.

In this report, we examine **eight trends shaping the data center market** and share Trane's perspective on what they mean for your infrastructure decisions. You'll find practical examples and insights from our specialists to help you address today's pressures and prepare for tomorrow's requirements.



Oakley Roberts

Oakley Roberts
President, Data Centers
Trane Technologies

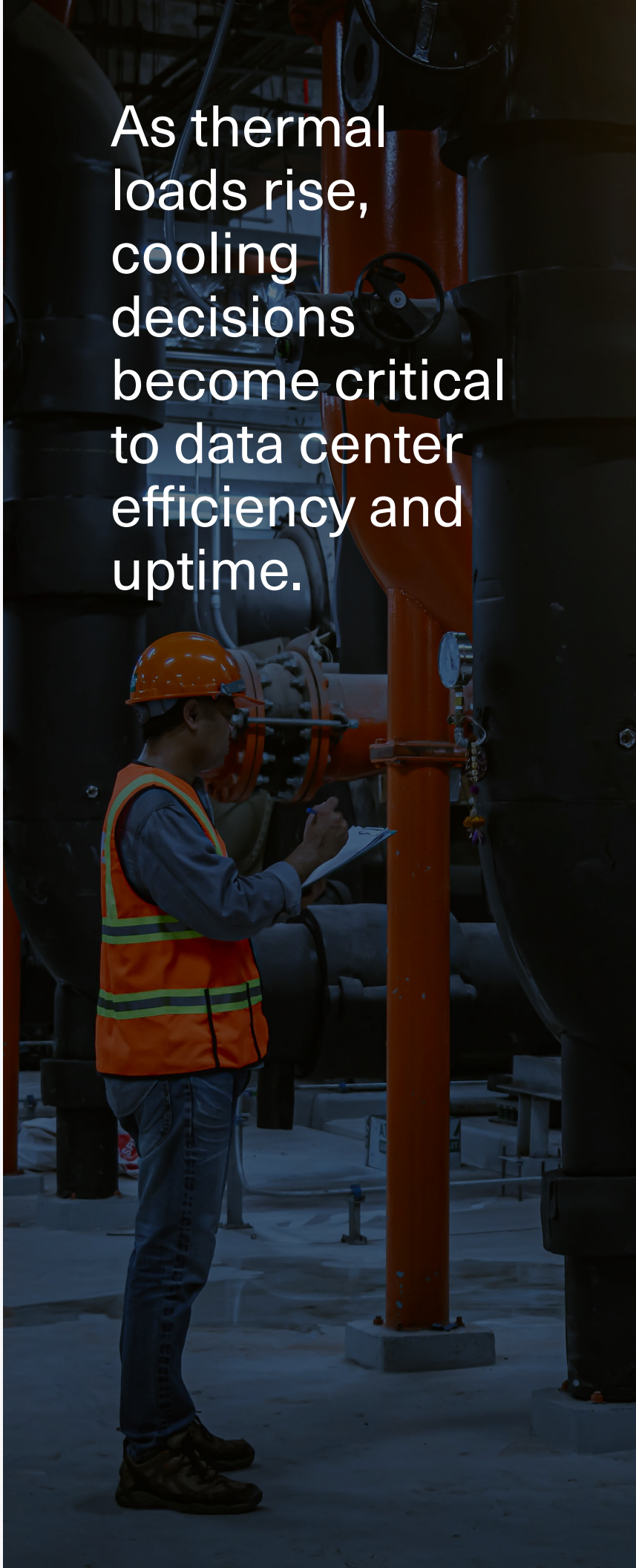


Eight Trends Shaping the Future of Data Centers

1. Thermal Management Is Now the Foundation
2. Growth Depends on Power
3. Uptime, the Ultimate KPI
4. Rise of Operational Intelligence
5. Deployment Speed Matters
6. Performance Defines Value
7. Sustainability Shapes Operations
8. Flexibility Drives Design

TREND 1

As thermal loads rise, cooling decisions become critical to data center efficiency and uptime.



1 Thermal Management Is Now the Foundation

AI workloads are asking more of data center cooling. As rack densities rise, thermal management directly affects how much compute a facility can support and how reliably it operates. Your cooling strategy needs to help shape the infrastructure from the beginning.

120kw

Cooling capacity required for a single NVIDIA GB200 NVL72 AI rack.[1]

7% to 30%+



Approximate share of facility electricity used for cooling, ranging from efficient hyperscalers to less efficient enterprise data centers.[2]

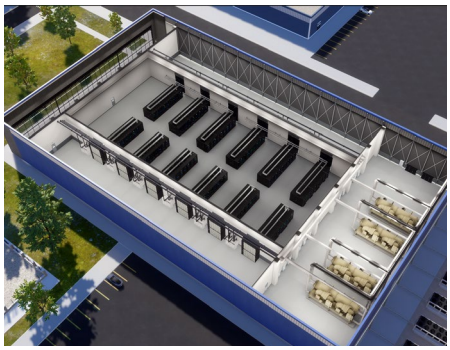
13%

Of surveyed operators cited cooling as the primary cause of their data center's most recent impactful outage.[3]

Bring thermal expertise into the design conversation early.

Your thermal management system needs to support today's workloads and adapt as requirements change. That flexibility starts with early design decisions, including how you'll add capacity and accommodate higher rack densities.

Trane works with your team to evaluate those requirements before equipment is specified. By considering liquid cooling and modular configurations as part of the overall system, we help you plan thermal infrastructure that can evolve with your data center.



FROM ACTION TO IMPACT

A chiller plant designed for data center growth[4]

To support a doubling of data usage, a customer was building a Tier III data center with demanding performance requirements and sustainability goals. Trane collaborated early with the general manager, mechanical contractor and engineers to develop a chiller plant around the facility's special tolerances and guaranteed capacity requirements. With a single point of responsibility, Trane helped the customer achieve:

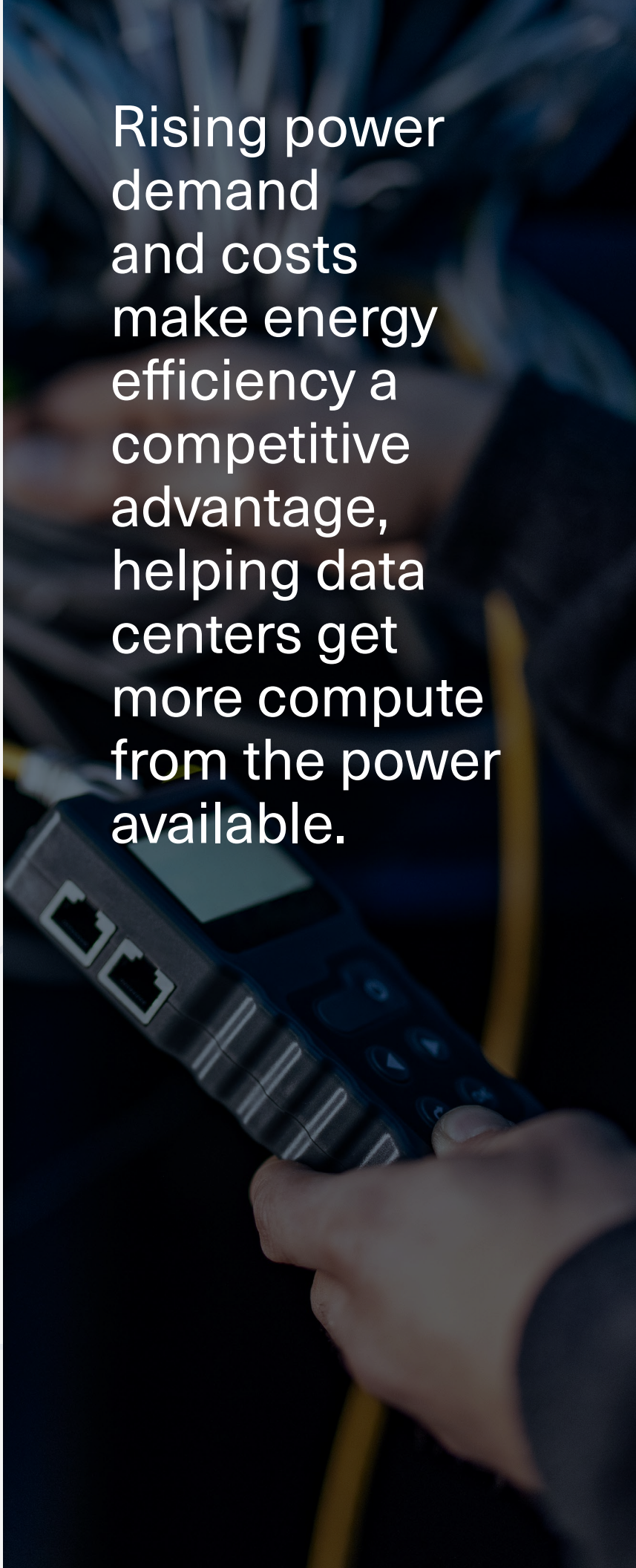
- **540,288 kWh** in annual energy savings
- **More than 330 metric tons** in CO_2 emissions reductions

The project also received industry recognition for sustainability.

1. NVIDIA, "NVIDIA Contributes NVIDIA GB200 NVL72 Designs to Open Compute Project," 2024.
2. International Energy Agency, "Energy demand from AI," 2025.
3. Uptime Institute, "Annual Outage Analysis 2025," 2025.
4. Trane, "Ford Motor Company Data Center Cooling Solution," 2022.

TREND 2

Rising power demand and costs make energy efficiency a competitive advantage, helping data centers get more compute from the power available.



2 Growth Depends on Power

Your data center's growth depends on access to power. This single factor shapes not only site selection, but also considerations around design and timelines. By reducing the power needed for cooling, you can help make more energy available for compute. Today, energy efficiency isn't just about savings — it's about capacity. That's why your data center's thermal strategy is central to infrastructure planning.

2-4x Power required by AI-optimized chips compared with traditional chips.[1]

Nearly 3x Projected U.S. data center load in 2034 compared with 2025.[2]

8% nationally
more than 25% in parts of Virginia
Potential increase in wholesale electricity costs by 2030 from data center and cryptocurrency mining growth, under the policies modeled.[3]

More than 9x
PJM's 2025/26 capacity auction price compared with 2024/25, rising from $28.92 to $269.92 per megawatt-day.[4]

Plan data center cooling and power together.

Energy costs matter, but access to power determines whether you can build more capacity at all. As AI workloads continue to grow, every kilowatt saved on cooling can help support additional compute. That means thermal management is now a central part of a data center's energy strategy. Each design decision affects available capacity and operating costs, along with your ability to scale.

Trane helps you make the most of available power through an integrated approach to thermal management. By helping improve efficiency and maximizing plant performance, we help you add capacity without compromising reliability.



FROM ACTION TO IMPACT

A more efficient way to power cooling[5]

The Eaton-Trane reference design optimizes cooling equipment with power architecture to help minimize losses and reduce complexity. Supplying Trane chiller motors over 1,000 hp with medium-voltage power eliminates low-voltage transformation. Smaller conductor size simplifies material requirements and allows more streamlined configurations.

When compared with conventional low-voltage architectures, medium-voltage designs can potentially offer:

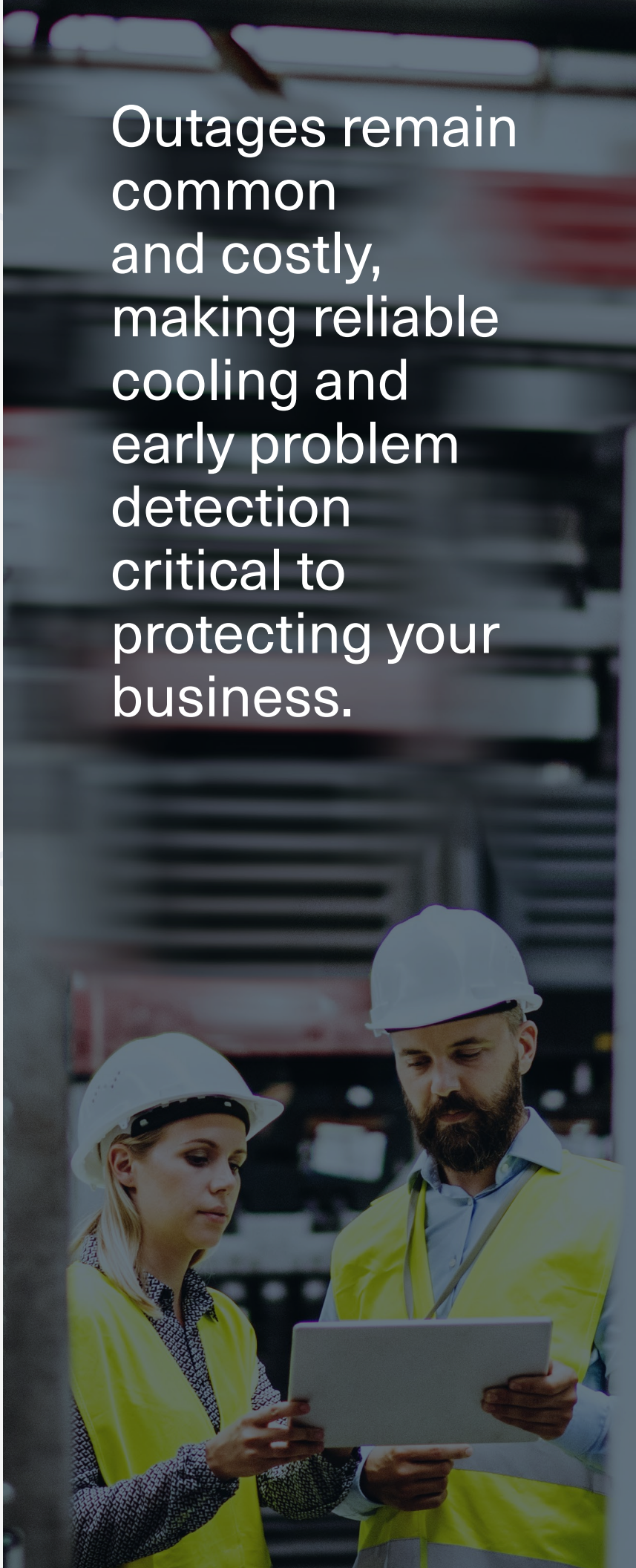
- **15%-30% savings** on electrical equipment and installation costs
- **Over 80% reduction** in copper
- **1%-5% improvement in total energy efficiency,** depending on site design and operating conditions

Fewer transformation steps and reduced distribution losses can mean more of your supplied power is used for cooling.

1. Pew Research Center, "What we know about energy use at U.S. data centers amid the AI boom," 2025.
2. Guidehouse Research, "U.S. Data Center Load Poised to Nearly Triple by 2034," 2025.
3. Open Energy Outlook Initiative, "Electricity Grid Impacts of Rising Demand from Data Centers and Cryptocurrency Mining Operations," 2025.
4. PJM Interconnection, "2025/26 Base Residual Auction Report," 2024.
5. Trane, "Reference Design #505: Eaton 1GW Power Architecture Meets Trane Thermal Management," 2026.

TREND 3

Outages remain common and costly, making reliable cooling and early problem detection critical to protecting your business.



3 Uptime, the Ultimate KPI

Downtime is not just an inconvenience — it can potentially be catastrophic. System failures can cause major financial and operational disruptions, with many outages traced to cooling-related issues. Today, reliability has become the defining metric of success in the data center industry.

50%

Of surveyed data center operators reported an outage at their organization in the previous three years.[1]

1 in 5

Respondents reported that their most recent significant, serious or severe outage cost more than $1 million. Another 33% reported costs between $100,000 and $1 million.[2]

About 20%

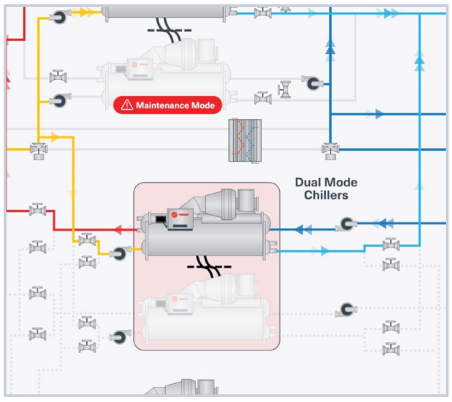
Of data center outages could have been prevented with equipment controls.[3]

Pair resilient design with proactive service.

Reliability has moved from a priority to a mandatory outcome. As increased capacity, hybrid configurations and human errors in controlling push systems beyond design limits, smarter detection and response become essential to helping prevent downtime.

Uptime requires resilient design and expert insights to keep systems functioning as intended. Trane helps you interpret equipment controller data and identify problems before failures occur.

Our services provide proactive maintenance and active monitoring based on your data center's requirements. We work with you on faster response and access to critical spare parts to speed maintenance and repair, with 24/7/365 support for emergencies.



FROM ACTION TO IMPACT

Swing chillers put backup capacity where it's needed[4]

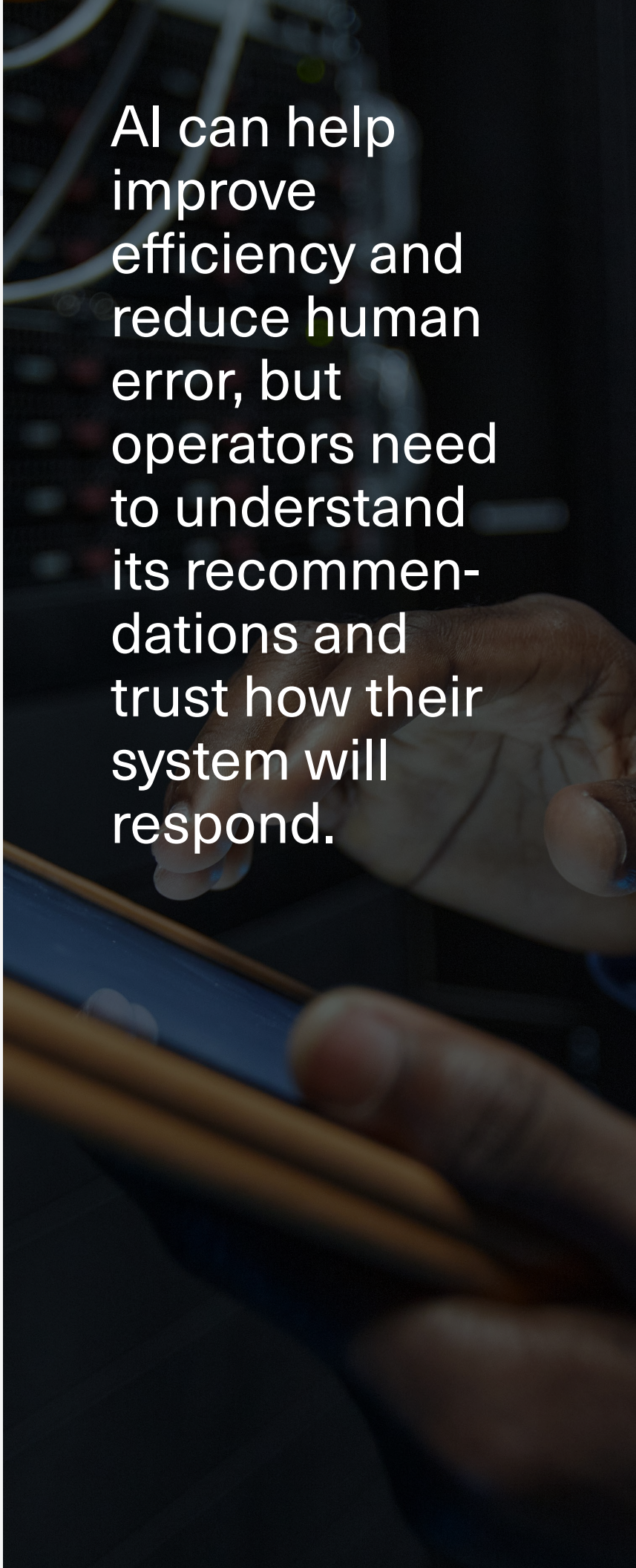
Traditional redundancy often means installing dedicated backup equipment for each cooling loop. Trane's swing chiller architecture allows multi-mode chillers to support either high- or low-temperature loops, shifting capacity where it's needed.

Where full, independent redundancy for both loops isn't required, this approach can help reduce the number of installed chillers while maintaining the planned level of protection. As the balance of air and liquid cooling changes, you can reallocate capacity to help meet new demands without overbuilding the plant.

1. Uptime Institute, "Global Annual Data Center Survey 2025: Facility Outages and AI Integration," 2025.
2. Uptime Institute, "Uptime Institute Global Data Center Survey 2024," 2024.
3. U.S. Energy Information Administration, "Commercial Buildings Energy Consumption Survey (CBECS)," 2018
4. Trane, "1 GW AI Factory Reference Design," 2026.

TREND 4

AI can help improve efficiency and reduce human error, but operators need to understand its recommendations and trust how their system will respond.



4 Rise of Operational Intelligence

Higher rack densities and changing AI workloads are making cooling harder to manage with fixed settings and manual adjustments. Operators are turning to predictive controls that use equipment and environmental data to help spot problems early and adjust cooling as conditions change. The shift is gradual, however. Many facilities still rely on basic controls, and operators want to understand how AI makes decisions before giving it more control.

Up to 40% Reduction in carbon emissions

Up to 25% Lower heating and cooling energy costs

Through AI-enabled systems[1]

Top motivations operators cite for adopting AI in data center operations[2]

58% Increase in facility efficiency

55% Less risk of human error

45% Improvement in staff productivity

Static control strategies aren't enough anymore.

AI workloads shift cooling demands faster than traditional systems were designed to respond. At the same time, operators are expected to maintain uptime while using less energy and meeting tighter sustainability requirements.

To manage these challenges, operators are turning to intelligent controls that continually analyze operating data to help spot problems early and assist in improving cooling response. They want to understand what the system is doing and why, while still applying their own judgment. Before giving it more control, they need confidence that critical infrastructure will keep performing as designed, even as conditions change.



SPOTLIGHT

Intelligence at Scale

"The challenge isn't one chiller anymore — it's understanding hundreds of interconnected systems operating together in real time. At that scale, reliability depends on visibility. Operators need more than alarms after something goes wrong. They need predictive insights that help them understand what's changing, identify risks early and make confident decisions before uptime is ever threatened."

Matt Bye
Intelligent Services Senior Product Manager, Trane

1. Trane Technologies, "Trane Technologies Ignites a New Era for Smart Buildings with Game-Changing AI Controls and AI Agent," 2025.
2. Uptime Institute, "Global Data Center Survey 2024," 2024.

TREND 5

A crowded pipeline and labor shortages demand faster, repeatable builds.



5 Deployment Speed Matters

As demand for capacity grows, operators are feeling the pressure to expand, but it's not always possible to build quickly. Permitting, access to power, supply chain delays and labor shortages can all hamper rapid expansion. To get online sooner, operators are turning to modular systems, rented equipment and repeatable designs that are easier to build. Because the sooner they can deploy additional capacity, the sooner they can potentially generate revenue and remain competitive.

Nearly
5,000
U.S. data centers were announced or under construction as of September 2026.[1]

About
80%
Of those facilities were still in the announced stage, meaning construction had not yet begun.[2]

439,000
Net new workers the U.S. construction industry needed to attract in 2025 to meet anticipated demand.[3]

Build faster by not starting from scratch.

Every site has its own requirements, but some design decisions can carry over from one build to the next. Repeatable designs and modular systems let you standardize what doesn't need to change, while adapting the system where it does. Cooling and controls can be integrated in the factory, while prefabricated infrastructure shifts more work away from the site. This helps reduce the burden on field labor and can shorten the path to commissioning.

Getting the equipment installed is only part of deployment. The system still has to perform before handoff. Trane trains technicians and maintains service locations close to customer sites, with the scale to support startup and commissioning across large or multisite deployments. Rental load banks support on-site validation before handoff. This helps you bring capacity online sooner without leaving your operations team to discover performance issues later.



SPOTLIGHT

Speed and Scale

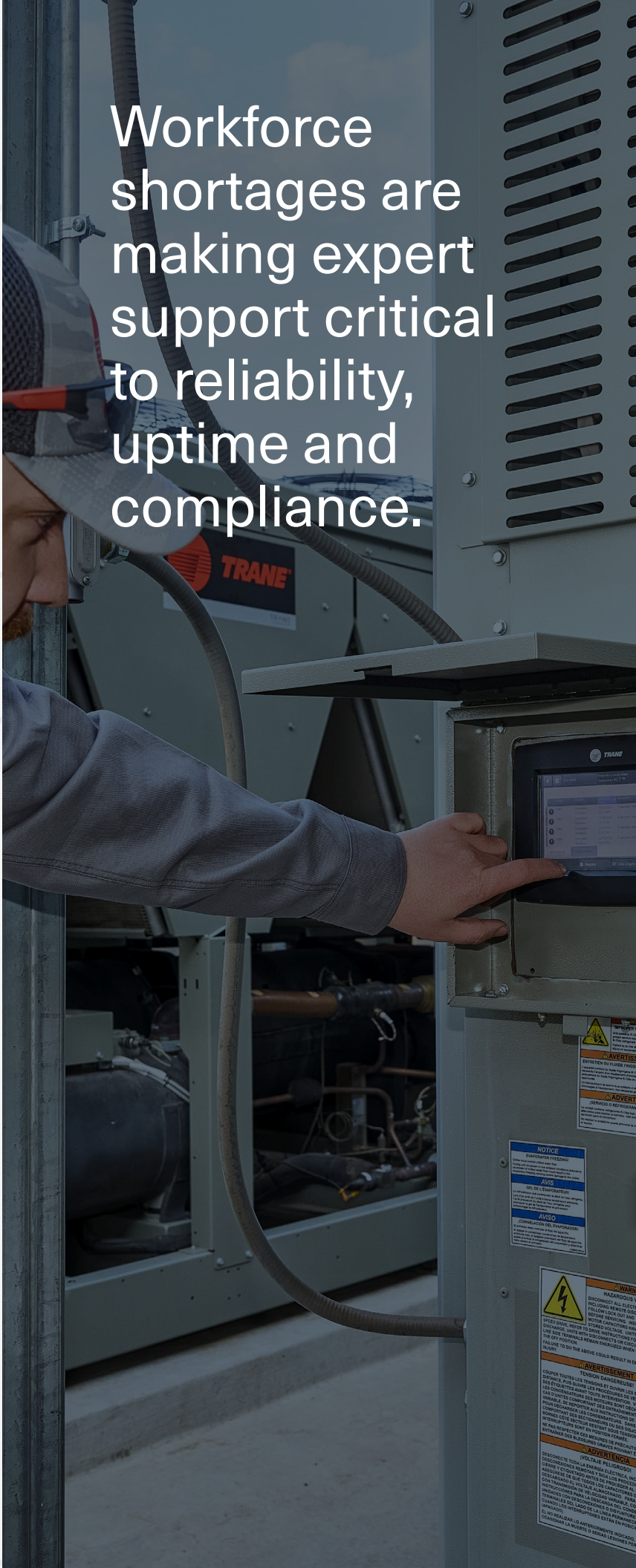
"What has fundamentally changed isn't the technology — it's the pace of the market. Customers no longer have the luxury of redesigning every project from the ground up. They need solutions that can be deployed quickly, scaled confidently and repeated consistently. The organizations that standardize how they design and deliver infrastructure will likely be the ones best positioned to keep pace with AI demand."

Matt Orcutt
Vice President, Strategy and Systems Product Management, Data Centers, Trane Technologies

1. Aterio, "Data Centers in the United States," 2026.
2. Aterio, "Data Centers in the United States," 2026.
3. Associated Builders and Contractors, "ABC: Construction Industry Must Attract 439,000 Workers in 2025," 2025.

TREND 6

Workforce shortages are making expert support critical to reliability, uptime and compliance.



6 Performance Defines Value

Having more capacity once gave the biggest data centers a clear competitive advantage. Today, capacity alone is no longer enough. As thermal systems become more complex, a data center's infrastructure becomes more difficult to operate. The industry is shifting focus from what's installed to how well it performs over time. Increasingly, operators are investing in services such as commissioning, monitoring, analytics and predictive maintenance, because getting the equipment installed and running is only the beginning.

51%



Of data center operators reported difficulty finding qualified candidates to fill open positions in 2024.[1]

Top three metrics that matter most to facility managers[2]

64.3%
Reliability and uptime

37.4%
Regulatory compliance

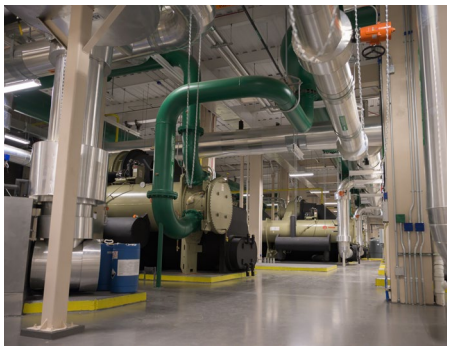
37.4%
Risk mitigation

Service is part of the performance strategy.

Your thermal management system is designed around the conditions you expect on day one. But those conditions won't stand still. Loads shift as equipment ages, and small changes in performance can become larger problems if no one sees them developing.

That's why Trane recommends that you plan commissioning and ongoing support while the system is still being designed. Commissioning helps confirm that it performs as intended at startup. From there, proactive maintenance and active monitoring can help identify changes early, when they're easier and less costly to address.

Trane services are tailored to the requirements of each data center. They can help establish faster response times and provide access to critical spare parts, helping shorten maintenance and repair time. And if an emergency repair is needed, Trane service support is available 24/7/365.



SPOTLIGHT

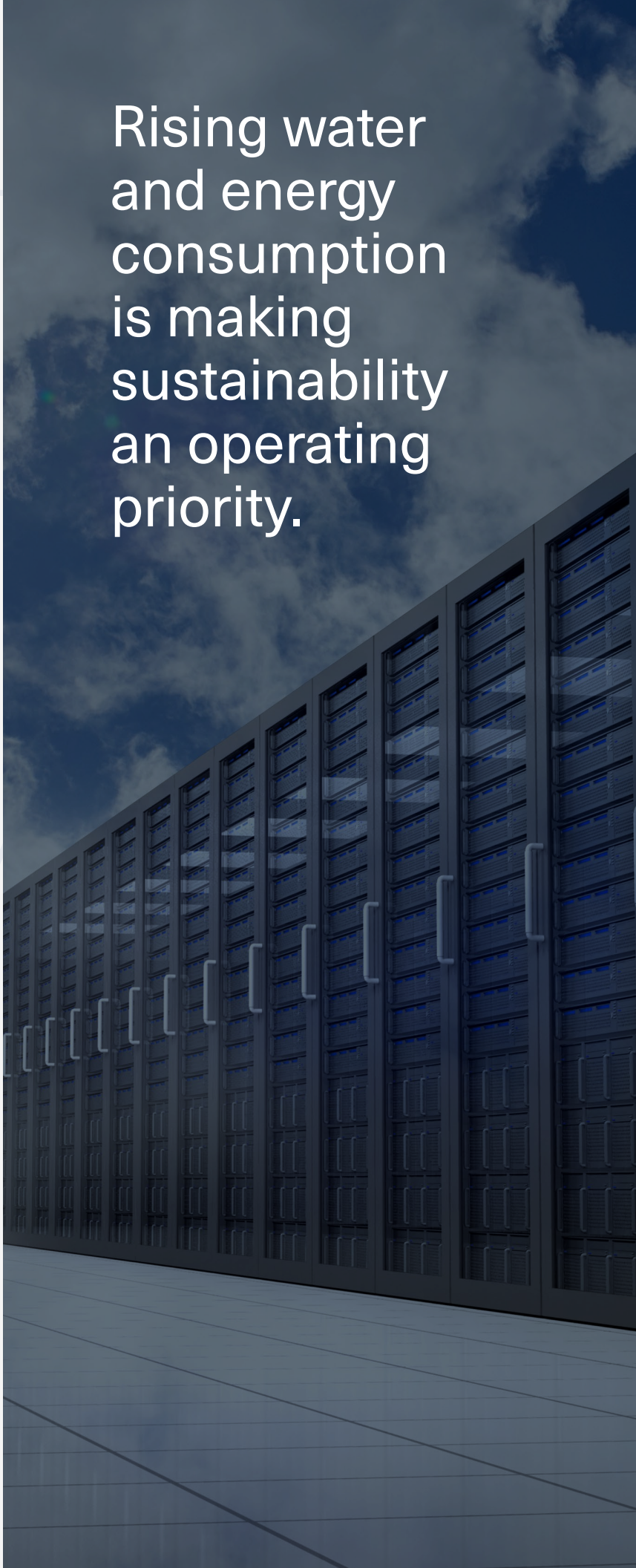
Outcomes Over Assets

"For years, we've measured success by looking backward — energy consumed, equipment failures or maintenance completed. Today's data center operators are asking a different question: what's going to happen next? As AI infrastructure grows in complexity, the real advantage comes from predicting risk before it impacts operations and designing systems that continuously deliver performance, not just report on it."

Steve Obstein
Vice President and General Manager — Data Centers, Trane

1. Uptime Institute, "Global Data Center Survey 2024," 2024.
2. JLL Technologies, "The State of Facilities Management Technology 2024," 2024.

Rising water and energy consumption is making sustainability an operating priority.



7 Sustainability Shapes Operations

As data centers scale up to meet demand, they typically use more power and water. At the same time, operators face growing pressure from investors, customers, utilities and regulators to show progress toward energy efficiency and environmental goals. That pressure is making sustainability part of day-to-day decisions about energy use, water, carbon emissions and system performance. Operators must find practical ways to use resources more efficiently without compromising the reliability and performance today's workloads require.

~4%
up to 9%

Share of U.S. electricity consumed by data centers in 2024 and projected for 2030, respectively.[1]

60-124
billion liters

Annual water consumption projected for hyperscale data centers by 2028.[2]

What data center operators track[3]

89%
Power consumption

36%
Scope 1 carbon emissions

27%
Scope 2 carbon emissions

18%
Scope 3 carbon emissions

Using less without giving up performance.

Sustainability and performance are no longer mutually exclusive. With energy, water and carbon constraints only continuing to tighten, operators need infrastructure that can help increase efficiency without negatively impacting reliability. The greenest data centers of the future won't just be measured by their sustainability pledges, but by their ability to continually enhance resource maximization while meeting the needs of modern workloads.

SUSTAINABLE INNOVATION

A Historic Canal Helps Power and Cool a Modern Data Center

The facility operator faced a familiar problem. The data center needed more capacity — fast. And they wanted to build closer to customers in a secondary market and redevelop a site with real history.

So the customer brought in Trane to help answer the practical questions behind that vision: Could a nearby canal support the cooling strategy over the long term? Could it provide hydropower for the data center's energy use?

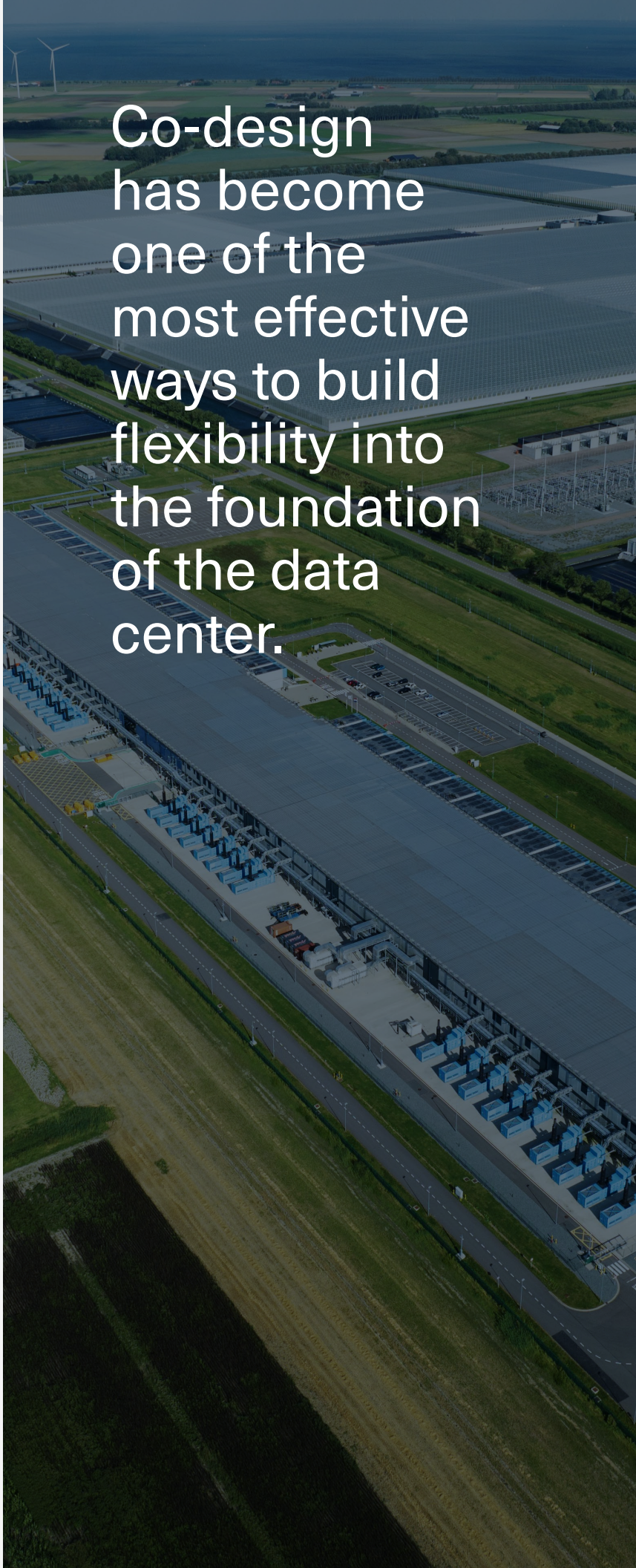
The developer and its engineers came to La Crosse, Wisconsin, for a Design Day with the Trane account team, systems experts and product managers. Together, they worked through the hard questions. What challenges did the site present? What would long-term use of the canal require? What had to perform reliably under every operating condition?

From there, the team developed an integrated system built to help deliver both reliability and efficiency. The design was developed to take advantage of free cooling and hydropower from the canal. CenTraVac® chillers and Performance Climate Changer® air handlers would provide cooling, while Tracer® Ensemble® would manage the system as a whole.

The result was a practical cooling strategy that reduced energy use and environmental impact without compromising performance.

1. Electric Power Research Institute, "Powering Intelligence: Analyzing Artificial Intelligence and Data Center Energy Consumption," 2024.
2. Lawrence Berkeley National Laboratory, "2024 United States Data Center Energy Usage Report," 2024.
3. Uptime Institute, "Global Data Center Survey 2024," 2024.

Co-design has become one of the most effective ways to build flexibility into the foundation of the data center.



8 Flexibility Drives Design

Today, data centers must be designed for equipment and workloads that may not exist yet. AI is changing rack densities, power requirements and cooling strategies faster than many facilities can be built. Yet operators still have to make infrastructure decisions that will shape performance for years. That's making flexibility a design requirement. Systems need to support today's loads while leaving room to add capacity, change cooling approaches and adopt new technology without rebuilding the facility around them. Future-ready data centers will be the ones engineered to evolve.

More than
2,000
U.S. data center projects announced or under development.[1]



Estimated share of new data centers built over the next decade that will be colocation facilities.[2]

Plan for more than one future.

One of the greatest risks in data center design is assuming tomorrow will look like today. Compute densities, cooling technologies and power requirements will continue to evolve. Trane recommends designing infrastructure to adapt as those conditions change. That flexibility helps protect long-term performance without requiring a wholesale redesign.



FROM ACTION TO IMPACT

Design Days bring future requirements into today's decisions

During a Trane Design Day, customers work with Trane engineers and technology partners to explore future compute densities, cooling strategies and operating scenarios before equipment is specified.

This systems-first process helps operators make informed design decisions and determine where flexibility belongs in the architecture. The result is thermal infrastructure designed to help accommodate change, reducing the risk that future workloads will require costly retrofits.

1. Guidehouse Research, "U.S. Data Center Load Poised to Nearly Triple by 2034," 2025.
2. Guidehouse Research, "U.S. Data Center Load Poised to Nearly Triple by 2034," 2025.

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