# Scale and Secure: Powering Europe's Digital Sovereignty

Enabling scalable, efficient data centre growth to support Europe's digital economy and long-term competitiveness

**Table of contents**



GRUNDFOS

Possibility in every drop

# Executive summary

Data centres have become foundational infrastructure for modern economies, underpinning cloud computing, artificial intelligence, public services and industrial systems. In Europe, they are increasingly strategic assets that intersect with energy security, water resilience, industrial competitiveness and technological sovereignty.

However, data centres are resource-intensive. Cooling systems alone account for a significant share of electricity consumption and drive water use. As demand for compute capacity accelerates, Europe faces a dual challenge: expanding digital infrastructure to remain globally competitive while managing growing pressures on electricity grids, water resources and local communities.

Global trends indicate that these pressures will intensify. Worldwide data centre electricity demand could more than double by 2030, with water consumption rising alongside it.[1] Regions with abundant energy, water and supportive policy environments are already attracting disproportionate investment, increasing competitive pressure on Europe.

Within the EU, this challenge is compounded by diverse regional conditions. Northern regions benefit from cooler climates and greater water availability, while southern regions face higher temperatures and increasing water stress. At the same time, major urban hubs are experiencing grid congestion and land constraints, slowing deployment. Without careful coordination, inefficient or poorly sited data centres risk exacerbating infrastructure bottlenecks, increasing costs – including investment costs, operational expenses, and consumer electricity prices – and triggering public opposition.

Yet these constraints also present a strategic opportunity. Europe's position as both a major market and global regulatory leader enables it to define standards for sustainable digital infrastructure. By prioritising efficiency, heat and water reuse, and system integration, Europe can turn resource constraints into a competitive advantage.

This paper identifies several proven technical pathways to reduce data centre resource intensity:

- **Advanced cooling technologies**, particularly liquid cooling, significantly reduce energy demand and enable higher computing densities
- **Hydronic optimisation and smart pumping systems** can deliver 20–60% energy savings in cooling infrastructure[2]
- Water circularity and non-potable water use reduce dependence on freshwater resources
- **Excess heat reuse** enables data centres to contribute to district heating and industrial energy systems

These solutions are most effective when implemented holistically, optimising both energy (PUE) and water (WUE) performance while enabling integration with wider energy systems.

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[1] International Energy Agency, Energy and AI: Energy demand from AI, 2025a.

[2] Grundfos, White paper: Data centre policies, 2025b.

To scale these improvements, this paper outlines a policy framework centred on:

- **Integrating water and energy efficiency** into governance frameworks
- **Maintain and strengthen transparent reporting and benchmarking** of performance metrics, in accordance with ISO standards ISO/IEC 30134-2 and EN 50600-4-2
- **Aligning planning and incentives** with efficient cooling technologies
- **Supporting investment in efficiency upgrades**, as well as energy and water reuse infrastructure
- **Integrating excess heat reuse** into district heating and industrial energy systems
- **Promoting standards and certification frameworks** (e.g. green labelling or those outlined by AHRI) to ensure verified performance, and support efficient and long-term sustainable investment and siting decisions

Ultimately, this paper outlines why data centre efficiency is no longer a technical detail but a strategic lever. With the right policies, Europe can expand digital infrastructure while strengthening energy security, reducing environmental impact and enhancing long-term competitiveness. Poorly coordinated growth risks resource strain and investment friction; well-designed policy can position Europe as a global leader in sustainable digital infrastructure.

# Introduction

Data centres sit at the heart of modern economies. They underpin cloud computing, artificial intelligence, healthcare systems, financial services, manufacturing supply chains and public administration. As societies digitise at pace, secure and reliable computing infrastructure has become essential to economic stability, resilience and competitiveness.

For Europe, data centres are no longer a specialised segment of the technology sector, they are becoming strategic infrastructure. Their development intersects directly with energy security, water resilience, industrial policy, urban planning and technological sovereignty. Where data centres are located, how they are powered, and how efficiently they operate influence Europe's exposure to geopolitical risk, supply chain disruption and dependence on foreign resources and digital infrastructure.[3] For the EU, how data centres are developed will play a decisive role in strengthening security, independence and strategic autonomy.

At the same time, data centres are among the most energy- and water-intensive assets in the built environment. Electricity demand from the sector is rising rapidly and often concentrates in regions already facing grid congestion and land-use constraints. Across Europe and the UK, projects are being delayed, resized or reconfigured due to grid capacity limits, water availability and local environmental concerns.[4,5] These pressures are likely to intensify as AI-driven workloads expand.

This creates a dual imperative for European policymakers. Europe must ensure sufficient digital infrastructure to remain competitive in a global technology race, while safeguarding public resources, environmental resilience and a social lincence to operate. Poorly integrated development risks not sufficiently considering demands of local communities, infrastructure strain and strategic vulnerability. Well-designed policy, by contrast, can turn efficiency into a competitive advantage.

> **"If Europe wants to stay globally competitive in AI and cloud computing, efficiency must be the default for data centre growth. Clear and predictable policy frameworks will guide decisions and speed up investment in proven systems that reduce water and energy consumption and enable high-performance cooling. That way, together, we can support responsible growth that safeguards local resources."**

Inge Delobelle, CEO Grundfos IND Division

Europe is uniquely positioned to shape how this balance is struck. As one of the world's largest data centre markets and a global standard-setter in regulatory policy, the European Union has the capacity to define norms for sustainable digital infrastructure. The policy decisions made in the coming years will influence not only where computing infrastructure is built, but how effectively it integrates with Europe's energy systems, water resources and climate objectives – and how strongly it contributes to economic development, job creation and academic innovation. Through harmonised reporting requirements, performance benchmarks and alignment with broader climate and energy policy, European policymakers have the opportunity to demonstrate that digital growth and resource stewardship can advance together.

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[3] European Commission, Strategic foresight report 2025: Resilience 2.0 – Empowering the EU to thrive amid turbulence and uncertainty, 2025b.

[4] McKinsey & Company, The role of power in unlocking the European AI revolution, 2024.

[5] UK Government, Water use in AI and data centres, 2025a.

For policymakers and industry leaders alike, the challenge is therefore not simply to accommodate data centre expansion, but to guide it strategically. This paper aims to support that effort by providing an overview of the global data centre landscape, examining the structural opportunities and constraints facing the European Union, and identifying practical technical and policy solutions that can improve system efficiency while supporting continued digital growth. In particular, it highlights how improvements in system performance – including advanced cooling architectures, hydronic optimisation, water and excess heat reuse – can deliver verifiable reductions in both electricity and water consumption while enabling deeper integration between digital infrastructure and Europe's broader energy systems. By focusing on these opportunities, the paper seeks to inform policies that allow Europe to expand compute capacity while strengthening competitiveness, environmental resilience and strategic autonomy.

Section 1:

# The resource intensity of data centres

Before considering policy design, it is important to understand the physical realities that shape how data centres operate. These facilities are increasingly energy- and water-intensive, largely due to the continuous cooling required to maintain stable operating conditions for computing equipment.

> **"Data centres are becoming a vital part of modern society, significantly increasing demand for energy and water. However, the challenge is not whether data centres should be built but how they are built and how to operate them efficiently through intelligent solutions."**

Bent Jensen, CEO Grundfos CBS Divison

As computing capability increases, processors are packed more densely into servers and racks, raising the amount of heat they generate. This heat must be removed continuously to ensure reliable operation. Cooling infrastructure consequently operates around the clock and represents a core component of data centre operations. These systems account for a substantial share of facility resource use: cooling represents around 38% of total electricity consumption in an average data centre, and in large hyperscale facilities water demand for cooling can reach 11,356 to 18,927 cubic metres per day.[6]

**11-19,000 cubic metres water/day**

**= daily water use for 75-155,000 EU households**

### WUE, PUE and the water–energy nexus

Two key performance metrics are commonly used to assess the efficiency of data centre operations: Power Usage Effectiveness (PUE) and Water Usage Effectiveness (WUE). Together, these metrics help policymakers and operators evaluate the overall resource intensity of a data centre.

Cooling technologies demonstrate the interdependent relationship between electricity and water consumption in data centre operations, often described as the water–energy nexus. Some cooling systems might reduce electricity demand but increase water consumption, while other systems might reduce water use but increase electricity demand. Because of this interdependence, improving data centre efficiency is not about minimising a single metric, but about striking the right balance between both.

[6] Grundfos, Building America's digital economy: How smart policies can balance economic growth, resource conservation and community well-being, 2025c.

**PUE:** *Power Usage Effectiveness measures the ratio of total facility energy consumption to the energy used by computing equipment, providing an indicator of how efficiently electricity is delivered to IT workloads.*[7]

**WUE:** *Water Usage Effectiveness measures the amount of water consumed relative to IT energy demand.*[8]

**Water-Energy Nexus:** *The systemic interdependent relationship between water and energy. Disruption or mismanagement in one system, inversely affects risks, constraints and trade-offs for the other.*

| Cooling type | Description | Best for | Energy efficiency | Water use |
|---|---|---|---|---|
| Air cooling | Chilled air absorbs heat and is expelled via fans or evaporative systems | Low-density racks, dry climates | Moderate (PUE) | High (if evaporative) |
| Rear-door heat exchanger | Liquid-cooled panels mounted on back of racks cool air passively or actively | Mid-to high-density racks | High | Low to moderate |
| Direct-to-chip | Liquid delivered directly to CPUs/GPUs via cold plates | High-density, AI and HPC* servers | Higher | Low |
| Immersion cooling | Servers submerged in dielectric fluid, often using phase-change cooling | Ultra-high-density, AI, supercomputing | Highest | Lowest |

This balance is becoming increasingly important as the water–energy nexus extends beyond the data centre itself to the wider energy system. Higher electricity demand can shift water use to power generation, where significant volumes of water are often required for cooling purposes during the energy production – similar to how cooling is required in data centres. For critical infrastructure, this highlights the importance of system-level optimisation – ensuring that efficiency improvements deliver real reductions in both energy and water use across the full value chain, rather than shifting impacts between them.

These physical constraints increasingly influence where and how data centres are developed. As global demand for compute capacity accelerates, understanding how different regions are responding provides important context for evaluating Europe's own strategic choices.

[7] International Organization for Standardization (ISO), Information technology – Data centres – Key performance indicators – Part 2: Power usage effectiveness (PUE), ISO/IEC 30134-2:2016, Geneva, 2016.

[8] International Organization for Standardization (ISO), Information technology – Data centres – Key performance indicators – Part 9: Water usage effectiveness (WUE), ISO/IEC 30134-9:2022, Geneva, 2022.

* High performance computing

Section 2:

# A look at data centres around the world

Compute capacity is rapidly becoming a pillar of industrial competitiveness and technological autonomy, shaping where advanced industries locate and how governments position themselves in an increasingly data-driven world.

Electricity consumption is expected to double in the next five years, with water use increasing alongside it, amplifying the risk of grid congestion, resource scarcity, costly infrastructure upgrades and disruptions to community well-being.[1] As a result, physical constraints are increasingly shaping where data centres can be built and at what cost.

These dynamics are already influencing global investment patterns. Regions with abundant power supply, favourable cooling conditions and reliable water resources are attracting disproportionate shares of new data centre development. Parts of the United States, the Nordic countries and the Middle East have emerged as major growth hubs due to combinations of energy availability, climate conditions, supportive regulation and streamlined permitting processes.[10]

As competition for data centre investment intensifies, governments are increasingly confronted with a common challenge: how to capture the economic benefits of digital infrastructure while managing the associated pressures on energy systems, water resources and local communities. Europe's challenge is not only to expand computing capacity, but to do so in a way that strengthens long-term resilience, protects public resources and maintains social acceptance of infrastructure development.

**Global data centre energy demand = 415 TWh today**

**945+ TWh by 2030[1]**

**Global data centre water demand = Could reach billions of $m^3$ annually[5, 9]**

[1] International Energy Agency, Energy and AI: Energy demand from AI, 2025a.

[10] Reuters, Poor grid planning could shift Europe's data centre geography, 18 June 2025.

[5] UK Government, Water use in AI and data centres, 2025a.

[9] Mytton, D. et al., Data centre water consumption, npj Clean Water, 2021.

**Figure 1** illustrates how different regions are approaching this challenge, highlighting the policy and resource conditions shaping global data centre development.

| Region | Approx. Facility Count | Growth Outlook (to 2030) | Regulatory Intensity | Key Constraints |
|---|---|---|---|---|
| United States | ~5,427 [11] | 20–25% annual demand growth;[12] major driver of 10-year load growth[13] | Decentralised; state/local zoning; federal grid reliability oversight | Grid interconnection queues; permitting delays; water stress in drought regions |
| EU / Western Europe | ~2,765 [14]; Germany (~529), UK (~523), France (~322), Netherlands (~298) | Significant capacity pipeline;[15] grid constraints shaping deployment | Structured and harmonised; EED reporting; sustainability framework; GDPR; NIS2 | Grid connection delays; power availability; planning constraints |
| Middle East | ~283–326;[16, 17] ~170 colocation[18] | Market expected to roughly double by 2030;[17] Saudi Arabia ~29% annual growth[19] | Increasingly structured; sovereignty rules; cybersecurity tightening | Cooling intensity; water availability; power infrastructure buildout |
| China | ~449 [20] | Continued AI-driven expansion; utilisation optimisation underway[10] | Highly centralised; green data centre action plan; PUE <1.25 target; strong data governance[21] | Regional power balancing; efficiency enforcement; utilisation management |

Figure 1

[10] Reuters, Poor grid planning could shift Europe's data centre geography, 18 June 2025.

[11] Cloudscene, Data centres in United States of America, n.d., available at: https://cloudscene.com/market/data-centres-in-united-states/all

[12] McKinsey & Company, The data center balance: How US states can navigate the opportunities and challenges, n.d., available at: https://www.mckinsey.com/industries/public-sector/our-insights/the-data-center-balance-how-us-states-can-navigate-the-opportunities-and-challenges

[13] NERC, Characteristics and risks of emerging large loads, n.d., available at: https://www.nerc.com/globalassets/who-we-are/standing-committees/rstc/whitepaper-characteristics-and-risks-of-emerging-large-loads.pdf

[14] Data Center Map, Data centers in Western Europe, n.d., available at: https://www.datacentermap.com/western-europe/

[15] European Data Centre Association (EUDCA), State of European data centres 2025, 2025, available at: https://www.eudca.org/state-of-european-data-centres-2025

[16] Data Center Map, Middle East data centers, n.d., available at: https://www.datacentermap.com/middle-east/

[17] Kearney, A greener digital age: The Middle East data center opportunity, n.d., available at: https://www.kearney.com/service/sustainability/article/a-greener-digital-age-the-middle-east-data-center-opportunity

[18] GlobeNewswire, Middle East data center colocation market outlook forecast report 2025–2030: UAE and Saudi Arabia are the forefront markets while countries like Israel and Turkey emerge as new growth areas, 15 January 2026, available at: https://www.globenewswire.com/news-release/2026/01/15/3219318/28124/en/Middle-East-Data-Center-Colocation-Market-Outlook-Forecast-Report-2025-2030-UAE-and-Saudi-Arabia-are-the-Forefront-Markets-While-Countries-Like-Israel-and-Turkey-Emerge-As-New-Grow.html

[19] S&P Global, Saudi Arabia data center market, n.d., available at: https://www.spglobal.com/en/research-insights/special-reports/look-forward/data-center-frontiers/saudi-arabia-data-center-market

[20] Cloudscene, Data centres in China, n.d., available at: https://cloudscene.com/market/data-centres-in-china/all

[21] Carbon Brief, Explainer: How China is managing the rising energy demand from data centres, n.d., available at: https://www.carbonbrief.org/explainer-how-china-is-managing-the-rising-energy-demand-from-data-centres/

Section 3:

# Data centres in the EU: A challenge and an opportunity

The European Union occupies a distinctive position globally as both a major data centre market and a regulatory standard-setter. As digital infrastructure expands worldwide, the EU has a unique opportunity to shape the conditions under which that growth occurs, supporting both economic competitiveness and responsible resource management.

Current data centre capacity growth projections for the EU mean strain on energy and water resources will increase drastically in the coming decade. As policymakers look to integrate digital infrastructure responsibly, it is imperative to consider the constraints and limitations unique to each member state.

**EU data centre IT load = 10 GW today**

**35 GW by 2030[4]**

**EU data centre electricity demand = 3% of total EU electricity consumption today**

**7-9% (150+ TWh) by 2030[22]**

## Diverse Regional Conditions

Europe's diversity of climate zones, grid mixes and water availability means that cooling strategies and infrastructure design must be driven by local conditions. Southern regions are facing higher ambient temperatures and growing water stress, driving the need for efficient cooling technologies and water management strategies. And while facilities in northern Europe may benefit from colder climates that enable free cooling and, in some cases, more abundant water resources, resource efficiency is essential there too.

Infrastructure constraints also vary geographically. Urban data centre hubs often face land availability challenges and limited grid capacity, while rural and suburban areas may offer greater expansion potential but require new transmission infrastructure and network investment.[4] This makes placement critical – locating data centres near renewable energy sources and in areas with significant potential for excess heat reuse can maximise system efficiency.

These regional differences reinforce the need for flexible policy frameworks that allow infrastructure strategies to adapt to local conditions; and the importance of strategic energy planning at both the municipal and regional levels.

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4 McKinsey & Company, The role of power in unlocking the European AI revolution, 2024.

22 European Parliament Research Service (EPRS), Electricity consumption of data centres in the EU, 2025.

## Electrification and Grid Constraints

Data centre expansion in Europe is unfolding alongside a broader transformation of the energy system, placing growing demands on electricity networks across the continent. In major hubs such as Frankfurt, Amsterdam and Paris, these pressures are already visible through grid congestion and lengthy connection queues,[4] and continued electrification is expected to intensify these constraints. Without careful planning, inefficient facilities risk increasing peak electricity demand and accelerating the need for costly network reinforcement.

## Water Scarcity and Climate Exposure

Water availability is also becoming a defining consideration for data centre development, with seasonal droughts and changing precipitation patterns increasing water stress in parts of southern, central and western Europe.[23] As competition for water resources intensifies among agriculture, households and industry, large industrial water users such as data centres are likely to face increasing scrutiny. Efficient cooling systems, water reuse strategies and careful site selection will be increasingly important for ensuring that data centre development aligns with local resource conditions.

## Turning Constraints into Opportunity

Policymakers in the EU must navigate a complex landscape of regional constraints, infrastructure pressures and environmental considerations. However, with those constraints come opportunities to create policy frameworks that align digital infrastructure expansion with the EU's broader goals of energy security, environmental resilience and decarbonisation.

The EU's development of green labelling frameworks is one example of how policy can shape the future of data centres. This system helps to improve transparency and better align siting decisions with local resource conditions and community needs.

The next section explores practical pathways and technical solutions that enable the responsible development of digital infrastructure, which should be a central consideration when developing future-facing policies.

**Figure 2:** Illustrative EU data centre sustainability label, showing standardised reporting of energy (PUE), water (WUE), renewable energy use and system integration indicators.

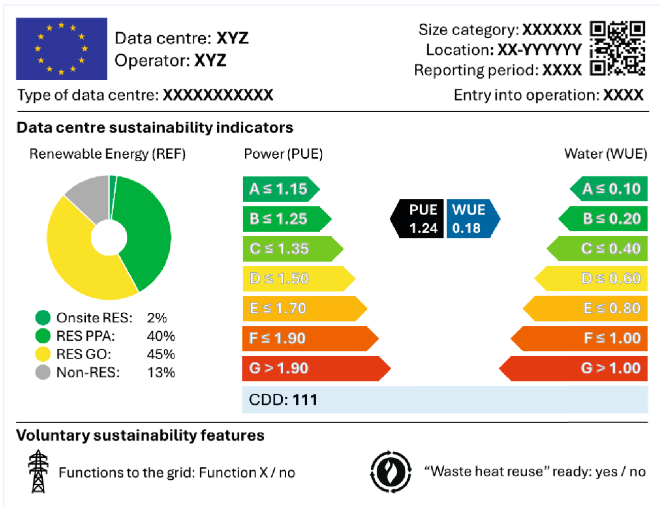


Figure 2

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[4] McKinsey & Company, The role of power in unlocking the European AI revolution, 2024.

[23] United Nations Environment Programme and World Economic Forum, Water risk and water stress analyses, 2025.

## Section 4:

# Practical pathways for responsible and resilient digital infrastructure development

If data centres are resource-intensive by design and current technology standards, then improving their efficiency, including water and energy reuse, represents one of the clearest paths to achieving Europe's long-term goals for responsible digitalisation. Reducing resource intensity per unit of economic output strengthens Europe's ability to withstand supply shocks, reduces dependency on external energy and water resources, and supports industrial competitiveness in global markets.[3] In addition, systems that deliver verifiable reductions in energy- and water-intensity are better positioned to comply with emerging efficiency standards, and to secure planning approval and grid connections.

Surprisingly simple and often overlooked, equipment upgrades – from retrofits to new builds – often represent one of the fastest and most cost-effective pathways to reducing data centre energy and water intensity. Pumps, control systems, and monitoring platforms form the backbone of modern cooling, water circularity, hydronic, thermal efficiency, and excess heat reuse infrastructure, and therefore directly influence a data centre's efficiency.

### Advanced Cooling

Traditional air-based cooling systems have long been the industry standard, but they are increasingly challenged by the heat loads of modern high-density computing environments. As supercomputing and AI continue to grow, liquid cooling has emerged as the scalable solution for high-performance infrastructure.

### Case study

Grundfos MTRE pumps enable high-efficiency recirculation of dielectric fluids in one of Greece's first immersion-cooled data centres, supporting reliable operation and reduced energy use in high-density environments.

Read the full case study here.

The physical properties of water make liquid cooling significantly more efficient than air cooling. Water has a much higher specific heat capacity and density than air, allowing it to absorb and transport over 3,000 times more heat per unit volume. This enables liquid cooling systems to remove heat from electronic components far more effectively, resulting in reduced cooling power requirements and lower PUE values, especially at high computational loads. It also reduces dependency on evaporative processes in water-stressed regions and improves the temperature and stability of recoverable heat, making heat network integration and other heat recovery technologies far more viable.

[3] European Commission, Strategic foresight report 2025: Resilience 2.0 – Empowering the EU to thrive amid turbulence and uncertainty, 2025b.

> **"There is an unprecedented shift in the data centre landscape as AI drives higher heat loads and the need for sustainable infrastructure grows. Investing in energy-efficient data centres, including heat reuse and renewable integration not only supports long-term growth but also secures grid resilience, and protects Europe's energy independence."**

Thomas Möller, EVP Alfa Laval, President Energy Division

## Water circularity & non-potable water use

Water circularity and the use of non-potable water are two key strategies for effectively reducing WUE, which is of particular importance in water-stressed regions.[5] Both of these strategies rely on on-site water treatment and closed-loop cooling systems, in which pumps play a central role by controlling the circulation, filtration and treatment processes.

### Definition

*Water Circularity: A systemic approach to water management that minimises freshwater use by treating, reusing, recycling and effectively managing water so it remains in productive use for as long as possible, while protecting water quality and ecosystems.*

The use of non-potable water to cool data centres is already proving to be an effective means of improving WUE in modern data centres. Cologix and Equinix have established facilities near Lake Ontario, a naturally cold body of water they draw on for cooling. Google has a similar facility located in Finland that uses nearby cold seawater for cooling, enabling it to drastically reduce its withdrawal of fresh water.[6]

## Hydronic optimisation

Hydronic infrastructure circulates coolant throughout a facility, and in many cases these systems operate below optimal efficiency due to oversizing, fixed-speed equipment or outdated control strategies. Replacing these systems with variable speed, electronically controlled pumps and optimising system hydronics can deliver mechanical energy savings of 20-60% while improving cooling performance and system reliability.[2]

### Case study

At a high-power data centre, NorthC deployed Grundfos MIXIT to enable precise, responsive chip-level cooling, improving efficiency and reliability as computing densities and temperatures increase.

Read the full case study here.

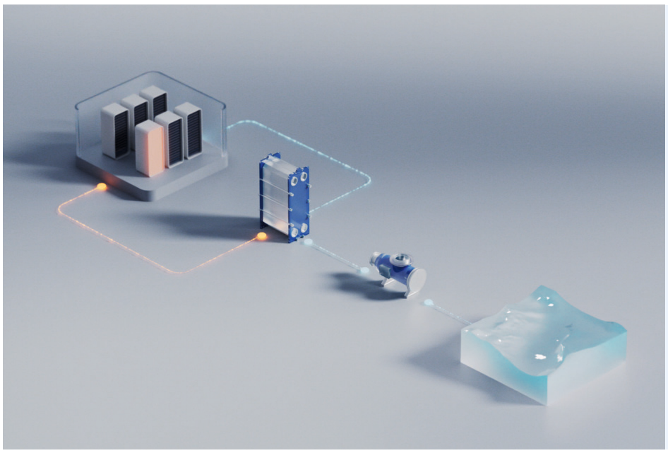
[5] UK Government, Water use in AI and data centres, 2025a.

[6] Grundfos, Building America's digital economy: How smart policies can balance economic growth, resource conservation and community well-being, 2025c.

[2] Grundfos, White paper: Data centre policies, 2025b.

## Thermal optimisation

Thermal optimisation improves data centre efficiency by managing how heat is moved and removed within cooling systems. High-efficiency plate heat exchangers (PHEs) help transfer heat more effectively between cooling loops, reducing the need for energy-intensive mechanical cooling and enabling greater use of free-cooling sources. When used in liquid-cooled systems, they support higher computing densities, stable performance and closed-loop operation that improves water efficiency. As a result, PHEs play an important role in delivering efficient, scalable and lower-carbon thermal management strategies.



### Case study

Alfa Laval partnered with Boyd to develop a further improved heat exchanger to deliver the performance needed.

Read the full case study here.

## Excess heat reuse

Data centres convert nearly all the electricity they consume into heat. Traditionally treated as waste, this excess heat can increasingly be captured and reused to supply meaningful shares of local heating demand. Excess heat is available at temperatures up to 50°C and can be upgraded through high-efficiency heat pumps for distribution through district heating systems or industrial processes.

# 100 GWh heat contribution/year

**Results from pilot projects in several European cities have exceeded this[24]**

[24] Arup, Data centre futures: Water and the sustainable data centre, 2025.

## Equipment Spotlight:
## Smart pumps & controls

Smart pumps use motors with integrated variable frequency drives (VFDs) and built-in sensors to respond dynamically to changing cooling loads. Unlike traditional systems that rely on throttling valves, which cause energy waste, smart pumps automatically adjust flow and pressure to match real-time demand. This precise control minimises energy use, improves temperature efficiency, and reduces strain on mechanical systems in cooling, water circularity, hydronic and excess heat recovery systems. Smart pumps can deliver:

- Up to 40% energy savings vs. fixed-speed pumps
- Optimised WUE and PUE through better flow control and lower footprint
- Compact footprint with built-in VFDs and PID controllers
- Seamless integration with building management systems using industry-standard open protocols
- High reliability, critical for the highest tier uptime requirements
- Reaction times < 1 second compared to valves (approximately 10 seconds), improving system efficiency

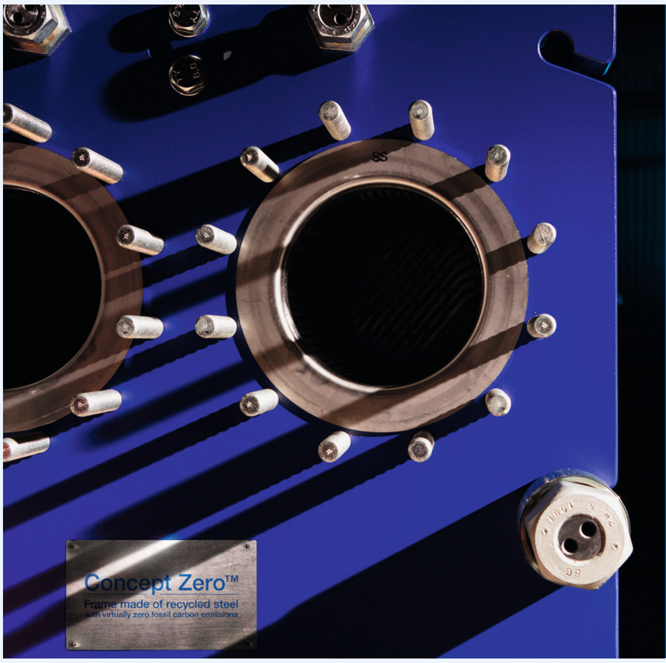

**Grundfos is a global leader in pumping solutions and is at the forefront of water and energy conservation in data centres.**

Read more about how sustainable pumping solutions are currently being used in the data centre industry.

## Equipment Spotlight: Efficient plate heat exchangers

Plate heat exchangers (PHEs) improve how heat is transferred within data centre cooling systems, helping to maintain stable temperatures while reducing reliance on energy-intensive mechanical cooling. Their design allows heat to be exchanged more effectively between cooling loops, supporting greater use of free cooling and liquid-cooled systems. By improving overall thermal performance, PHEs help lower energy use, support higher computing densities and enable more efficient closed-loop water systems. Efficient plate heat exchangers can deliver:

- Improved cooling efficiency through lower approach temperatures and reduced chiller load (therefore investment)
- Higher rack density capability by stabilising liquid cooling supply temperatures
- Optimised PUE and WUE through more effective free-cooling and closed-loop operation
- High reliability with low fouling risk and materials suited for varying water qualities




**Alfa Laval is driving data centre innovation with advanced heat transfer technology.**

Learn more:
Data centre cooling
and heat reuse


## The importance of a holistic approach

The latest research reinforces the need for these systems to be considered together when considering strategies and facility-wide upgrades to improve data centre efficiency. Evidence from SINES DC shows liquid cooled architectures, when paired with optimised fluid handling and high-efficiency plate heat exchangers, materially improve overall data centre efficiency.[25]

The IEE study demonstrates that leveraging free-cooling sources such as seawater, combined with expanded liquid cooling deployments, could reduce cooling energy use by up to 30% compared with traditional air-based systems, while maintaining WUE values as low as zero through fully closed-loop operation.[25]

Optimising liquid flow distribution, pump power and heat exchange performance allows operators to support much higher rack densities without proportional increases in cooling energy demand. These findings show that efficient hydronics are foundational not only for lowering PUE but for enabling scalable, low-carbon, high-density liquid-cooled compute environments.[25]

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[25] Alfa Laval, Advancing sustainability in data centres: Evaluation of hybrid air/liquid cooling schemes for IT payload using sea water, IEEE Transactions on Cloud Computing, Vol. 12, No 4, October–December 2024, 2024.

## Section 5:

# Policy recommendations: Enabling energy and water efficient data centre infrastructure

The technical solutions outlined above demonstrate that substantial improvements in data centre resource efficiency are achievable through advanced cooling systems, hydronic optimisation, efficient heat transfer and smart water circularity strategies. However, scaling these solutions across Europe's rapidly expanding data centre sector requires supportive regulatory frameworks and investment mechanisms.

Policy frameworks therefore play a critical role in aligning digital infrastructure growth with Europe's climate, energy and water resilience objectives. The following recommendations focus on enabling the deployment of efficient cooling technologies, water reuse systems and excess heat reuse infrastructure while improving transparency and system-level resource management.

### 1. Integrate water and energy efficiency in data centre governance

European data centre policy frameworks should explicitly address the water–energy nexus by embedding water performance considerations alongside energy efficiency requirements. Planning, reporting and performance standards should recognise that improvements in electrical efficiency must not come at the expense of water security and resilience.

Regulators should therefore integrate water considerations into existing energy efficiency frameworks, including the EU Energy Efficiency Directive and the EU Code of Conduct for Data Centres. Establishing aligned standards for both PUE and WUE will ensure that cooling strategies optimise overall system performance rather than shifting impacts between energy and water consumption.

Strategic energy planning should also require integrated assessments of grid capacity, water availability, cooling technology suitability, pump and motor efficiency and heat reuse potential as part of data centre permitting processes – considerations that should be made at municipal, regional and national levels. Such integrated planning can reduce infrastructure bottlenecks, mitigate community concerns and support more balanced geographic distribution of facilities across the EU.

## 2. Maintain and strengthen transparent reporting and benchmarking frameworks

Standardised reporting of environmental performance is essential for effective policy oversight and market accountability. Policymakers should mandate public disclosure of key operational metrics including power usage effectiveness, water usage effectiveness, potable water consumption, energy reuse factors and the share of non-potable water used in cooling systems.

A "report-and-reduce" framework could require quarterly disclosure of site-level performance data – including PUE, WUE, water reuse rates, water source type, basin-level water stress indicators and excess heat reuse rates – supported by independent verification and publicly accessible dashboards. Transparent reporting would enable regulators and communities to monitor local resource impacts while allowing operators to benchmark performance and demonstrate measurable improvements.

Beyond PUE and WUE alone, sustainability metrics should evolve toward integrated performance indicators that capture the broader system impacts of data centre operations, including water reuse, excess heat reuse and infrastructure resilience.

## 3. Align planning and incentives with efficient cooling deployment

Planning frameworks represent a powerful mechanism for accelerating the adoption of efficient cooling technologies. Regulators should integrate water efficiency and cooling design requirements directly into planning approvals for new facilities and large-scale expansions.

Planning approvals and financial incentives could be tied to verified performance thresholds such as progressive WUE improvement pathways, adoption of closed-loop cooling architectures and minimum shares of non-potable water use in water-stressed regions. For example, facilities in water-constrained basins could be required to achieve majority non-potable cooling supply initially, with a transition toward full non-potable sourcing over time.

## 4. Support investment in efficient cooling infrastructure

While many efficiency technologies offer strong lifecycle benefits, upfront capital costs can still present barriers to deployment. Targeted financial instruments can help overcome these constraints and accelerate the adoption of advanced cooling systems.

Governments should therefore provide clear investment incentives—including tax credits, green financing mechanisms and grant programmes—for technologies that demonstrably reduce energy and water consumption. Priority areas include high-efficiency pumping systems, hydronic optimisation, water reuse infrastructure and heat recovery integration.

Such incentives are particularly important for retrofitting existing facilities, where pump and hydraulic upgrades often deliver rapid efficiency gains but must compete for investment with core IT infrastructure.

## 5. Enable district heating integration and excess heat recovery

In order to support stronger integration between digital infrastructure planning and municipal heat development, policy frameworks will need to recognise and solve for complex challenges. Successful projects require proximity to district heating networks, sufficient heat demand density, investment in piping and exchange infrastructure and long-term offtake agreements that provide certainty for all parties.[24], [26]

Realising the potential of excess heat reuse depends less on technical feasibility than on institutional and contractual alignment. Often, the dominant barrier is negotiation between private data centre operators, district heating utilities and municipalities. Data centre operators are looking for short-term ROI (3-5 years) to remain competitive, whereas district heating companies are planning and investing for the long-term (30+ years), which often causes misalignment between the two parties.

Measures that can address these challenges include requirements for heat reuse feasibility assessments during planning approvals, obligations for large facilities to enable heat export where technically feasible, and financial incentives for connection to district heating systems and internal heat reuse. Another consideration is a state guarantee on investment for data centres, which could help overcome objections to invest in district heating capability. Streamlined permitting processes and standardised heat offtake contracts would also reduce commercial uncertainty and accelerate project deployment.

[24] Arup, Data centre futures: Water and the sustainable data centre, 2025.

[26] Lawrence Berkeley National Laboratory, United States data centre energy usage report, 2024.

## 6. Accelerate reclaimed water infrastructure deployment

Many of the water circularity solutions described earlier depend on effectively deployed water management and reliable access to reclaimed or non-potable water supplies. To enable large-scale deployment, policymakers should support the development of dedicated reclaimed-water distribution infrastructure in areas with significant data centre clustering.

One approach would be the creation of “reclaimed water accelerators” or “purple-pipe” programmes in partnership with water utilities. These programmes would finance and fast-track the construction of reclaimed-water networks in priority industrial zones, supported by template contracts and standardised tariff structures for long-term water supply agreements.

Such infrastructure investments can significantly reduce reliance on potable water while providing long-term water security for both communities and data centre operators.

## 7. Introduce water-positive performance incentives

In regions experiencing structural water stress, policymakers may also consider introducing performance incentives for facilities that deliver net positive water outcomes at the basin level.

A “water-positive” bonus framework could reward facilities that achieve high water efficiency thresholds while replenishing more water than they consume through a combination of on-site reuse, recycled water systems and watershed restoration initiatives. Aligning these incentives with the EU Water Resilience Strategy would help prioritise efficiency improvements in the regions where they are most needed.

Standardised reporting, integrated planning frameworks and targeted financial incentives together create the conditions necessary to scale the efficiency of data centre systems. By aligning data centre development with energy efficiency, water resilience and heat system integration, policymakers can support continued digital infrastructure growth while safeguarding Europe’s critical resource systems.

# Conclusion

**"We have a shared responsibility to develop Europe's future digital infrastructure in a way that is both efficient and sustainable. This requires a holistic, system-level perspective – where data centres, energy and water systems are designed to function together. When solutions are aligned across sectors, they can effectively support the EU's broader objectives for climate neutrality, resilience, and competitiveness."**

Isabelle Kemlin, Business and Innovation Executive, RISE

The coming decade will determine whether Europe accommodates data centre growth in a way that strengthens economic competitiveness and strategic autonomy, or whether resource constraints, infrastructure bottlenecks and social opposition generate friction that undermines investment and resilience.[1, 27] As artificial intelligence, cloud computing and data-intensive industries expand, data centres will remain indispensable infrastructure for modern economies. The question is therefore not whether these facilities grow, but how.

The sustainability and system integration of data centres will increasingly depend on improving the efficiency of cooling and water management systems that underpin their operation. Some of the most effective and immediately deployable levers include heat exchangers, pump and hydronic optimisation, advanced cooling architectures, water circularity strategies, redesigned sustainability metrics, digital monitoring and heat recovery integration.[24, 28] Implemented at scale, these measures can deliver measurable reductions in both energy and water intensity while improving operational reliability and enabling deeper integration with surrounding energy, heat systems and the communities.

Efficiency in data centre infrastructure is therefore no longer a marginal technical concern but a strategic imperative. Improving the performance of cooling systems, heat transfer, pumps and hydronic networks can simultaneously reduce electricity demand, limit pressure on freshwater resources and unlock opportunities for sector coupling through district heating and industrial heat reuse. In doing so, these solutions transform data centres from isolated energy consumers into active participants in more efficient and resilient infrastructure systems.

Realising this potential will depend on policy frameworks that align investment incentives, reporting standards and infrastructure planning with the technical pathways outlined in this paper. Embedding water stewardship alongside energy efficiency, expanding water reuse infrastructure, enabling heat recovery integration and supporting transparent performance benchmarking can accelerate the deployment of proven solutions while maintaining public trust in digital infrastructure development.

If these approaches are successfully implemented, Europe can support continued digital transformation while strengthening energy security, environmental resilience and industrial competitiveness. In doing so, they have the opportunity to position themselves not only as leading markets for digital infrastructure, but also as global benchmarks for how that infrastructure can coexist productively with both the built environment and the natural systems on which societies ultimately depend.

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[1] International Energy Agency, Energy and AI: Energy demand from AI, 2025a.

[27] UK Government, Warm homes plan, January 2026a.

[24] Arup, Data centre futures: Water and the sustainable data centre, 2025.

[28] Grundfos, Data centre solutions and pump case studies, 2025a.

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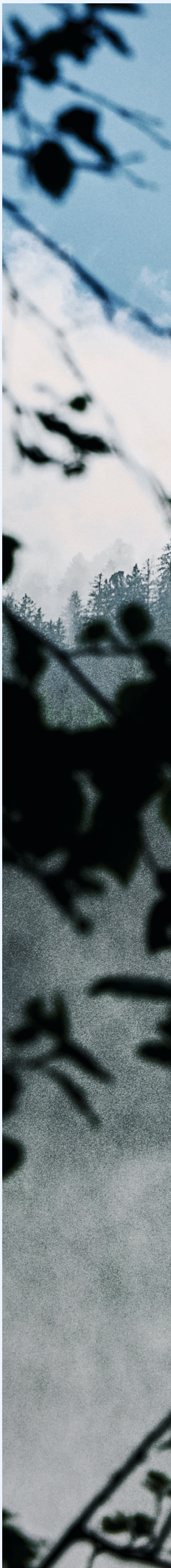
*This paper was developed by Grundfos, with contributions from Alfa Laval.*



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