Case Study 26 Nov 2025:

Hyperscale Data Centres — Hyper-Important to Be Hyper-Efficient

Why the world's digital backbone must become radically more resource efficient.

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1. The Hidden Infrastructure Behind Everyday Life

Most people never see a data centre. Yet each digital action - from streaming a series, uploading a photo, or querying an AI model - triggers activity in vast, power-hungry server farms scattered across the world. They are the industrial backbone of the internet age, humming quietly behind glass, steel, and security fences.

Because they produce no visible smoke, it is easy to assume their footprint is light. But data centres are now one of the **fastest-growing sources of electricity demand globally**, and AI is pushing that trajectory sharply upwards. Even small improvements in efficiency can have outsized environmental impact.

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2. The Osmosis Model of Resource Efficiency

Osmosis evaluates companies using a **three-pillar model**:

- **Carbon Efficiency** — energy intensity, emissions trajectory, renewable sourcing
- **Water Efficiency** — cooling demands, water stress exposure
- **Waste Efficiency** — hardware turnover, lifecycle management, transparency

For hyperscale data centres, these three resources intersect uniquely: energy powers them, water cools them, and hardware drives their rapid generation of waste. Understanding these dynamics is crucial to identifying leaders, laggards, and transition risks.

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3. Understanding the Scale: Why This Matters Now

Data centres consumed 415 TWh of electricity in 2024 — 1.5% of global electricity use [1]. Within six years, that figure is expected to more than double to around 945 TWh [2]. That is almost the annual consumption of Japan [3].

The reason? AI.

GPUs (Graphics Processing Units) and specialised accelerators are extraordinarily energy-intensive, and hyperscalers are racing to build AI capacity at unprecedented speed. This makes **resource efficiency not just a sustainability issue but a capacity constraint and cost pressure**.

In this context, understanding which companies manage resources efficiently is becoming a core component of long-term valuation.

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4. Carbon Risk: Rising Demand, Shrinking Margins for Error

Big Tech's Growing Appetite

Google and Microsoft each consumed ~24 TWh of electricity in 2023 — surpassing the consumption of over 100 nations [4]— while Meta and Apple also require huge volumes of energy to power and cool their facilities.

But Efficiency Has Historically Softened the Blow

Despite workload growth of more than 550% between 2010 and 2018[5], energy demand rose just 6%, thanks to:

- consolidation into hyperscale sites

[1] Energy demand from AI – Energy and AI – Analysis - IEA
[2] AI is set to drive surging electricity demand from data centres while offering the potential to transform how the energy sector works - News - IEA
[3] Executive summary – Electricity 2024 – Analysis - IEA
[4] Google and Microsoft consume more power than some countries | Tom's Hardware

[5] The environmental footprint of data centres in the United States

- virtualisation and higher utilisation

- major gains in cooling efficiency

Many leaders now operate with **PUE (Power Usage Effectiveness) values of ~1.1**, close to the theoretical minimum.

The AI Challenge

The situation today is different. AI workloads are reversing some of these gains. GPUs consume more energy per unit of compute, meaning overall power intensity is rising even as operators chase ever tighter PUE scores.

Osmosis Insight

According to the Osmosis Model of Resource Efficiency, carbon-efficient operators are likely to enjoy **lower long-term energy costs, lower regulatory exposure, and better futureproofing** as demand rises. Many digital REITs, real estate companies operating data centres, have committed to match all their energy use with renewable energy. Iron Mountain, for example, has a commitment to do so by 2040, and is already disclosing zero ton of CO_2e for its Downstream Leased assets, showing commitment to their target.

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5. Water Risk: The Resource No One Notices - Until It is Scarce

Cooling Is Thirsty Work

The biggest surprise for many investors is that **water** can be a more immediate constraint for data centres than electricity.

- Currently, cooling systems remain the primary driver of on-site water withdrawals for data centres.

- But there is a growing trend toward water-efficient cooling designs. Microsoft's shift to zero-water-evaporation systems delivered a 39% improvement in Water Usage Effectiveness [6].

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[6] Sustainable by design: Next generation datacentres consume zero water for cooling | The Microsoft Cloud Blog

Innovation Is Emerging

Examples include:

- heat reuse for district heating (63% of homes heated in Denmark [7])

- free cooling with outside air (Amazon)

- canal-water cooling (Google, Belgium) [8]

- underwater data-centre pilots with dramatically lower failure rates (Microsoft Natick) [9]

A Growing Physical Risk

Data centres built in water-stressed regions face rising climate risk. Amazon explicitly acknowledges this in its disclosures.

Osmosis Insight

Water-efficient operators score highly under the Osmosis model, helping avoid future constraints and local opposition. Whilst the type of cooling depends on where the centres are located, efficiency gains can be achieved everywhere. Equinix uses air and chemical-based cooling in water-stressed Spain. In Toronto, the same company uses local solutions like cold water lake water for cooling. Others, such as Digital Realty, are moving away from water cooling, with 75% of its global portfolio not using water cooling at all. Instead, it has partnered with Ecolab to use AI to pinpoint further water conservation efforts.

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[7] regulation_and_planning_of_district_heating_in_denmark.pdf

[8] St. Ghislain, Belgium – Google Data Centre Location

[9] Project Natick Phase 2

6. Waste Risk: The Fastest-Growing - and Least Disclosed - Threat

Short Hardware Lifecycles Drive E-Waste

Worldwide, the annual generation of e-waste is surging by 2.6 million tonnes annually and is on track to reach eighty-two million tonnes by 2030, a 33% increase from the 2022 figure. [10]

Yet reporting is patchy:

- Meta does not disclose waste data.

- Amazon and Netflix do not disclose waste or water use.

Recycling Rates Remain Low

Globally, E-waste is being generated five times faster than it is being recycled [11]— meaning most retired servers risk becoming hazardous landfill. Efforts such as asset refurbishment, reuse programmes and automated component recovery are emerging, but adoption is uneven.

Osmosis Insight

Waste efficiency is often overlooked but increasingly material. Disclosure gaps create risk — and represent clear engagement opportunities. Osmosis regularly engages with companies to encourage and develop their environmental disclosures, for example our Non-Disclosure+ Campaign which launched last year and is backed by over US$750 billion in combined assets.

At the intersection between carbon, water and waste, is the issue of waste heat. Rather than using water for cooling purposes, air can be used. Equinix uses this heat in an energy efficiency partnership with a Finnish utility, re-using this waste heat and divert it to provide heat to business and thousands of homes in Helsinki.

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[10] E-waste is being generated five times faster than it is being recycled – The Mail & Guardian
[11] E-waste is being generated five times faster than it is being recycled – The Mail & Guardian

7. Storage Efficiency: The Quiet Resource Multiplier

Resource efficiency is not only a hardware issue. Software efficiency can reduce physical infrastructure needs dramatically.

- Facebook's Zstandard compression reduced storage demand by 6% and lowered CPU load for compression tasks by up to 40%, improving data-centre efficiency at scale. [12]

- Modern tiering and retention systems reduce energy, cooling, and e-waste by eliminating unnecessary storage expansion.

Next Generation: DNA Storage

DNA-based storage could cut energy, emissions, and water by >60%, offering densities of 1 exabyte per cubic inch. Major players like Microsoft have already piloted automated write/read systems. [13]

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8. Conclusion: Why Resource Efficiency Is Now a Strategic Imperative

Hyperscale data centres sit at the heart of the AI-driven digital economy — but their resource demands expose investors to escalating risks in **carbon, water, and waste**.

The **Osmosis Model of Resource Efficiency** provides a powerful framework for identifying which companies are managing these pressures effectively, and which are not. As data-centre expansion accelerates, resource efficiency will increasingly determine:

- cost competitiveness

- regulatory exposure

- long-term investment performance

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[12] How Facebook Made Its Data Warehouse Faster
[13] DNA Storage - Microsoft Research: News and Awards

Encouragingly, progress is already visible, but the scale of the AI era means the next decade will require deeper engineering innovation, better disclosure, and a far greater focus on resource-efficient growth.

Important Information