KPMG

Meeting the demands of AI data centers

Power and heat management

Data center 2030 series

With AI uptake exploding at a pace unmatched by any previous technology, the world's hunger for data centres looks to be insatiable. However, the building of such centres faces a dearth of available low carbon energy connections, the necessary construction skills, bottlenecks in the component supply chain, and exponential cooling demands. The race to overcome these problems creates opportunities throughout the build and maintenance value chain.

Data centers: workhorses of the AI revolution

> **A new type of manufacturing has emerged - the production of intelligence. And the data centers that produce them are AI factories**
>
> **Nvidia CEO Jensen Huang[1]**

Data centers (DCs) are the essential foundation of today's much-hyperbolized AI revolution. The explosion in AI applications cannot proceed without scalable storage solutions to manage the vast quantities of data they require, and DCs are the primary solution to this problem. Unsurprisingly, growth forecasts are surging; tech market research outfits like Canalys and our own KPMG market diligence projects in the space predict latent demand growth at close to 20% on an annualized basis, and others have forecast a near tripling in the capacity of hyperscale data centres over the next six years.[2] But it is the ability of supply to keep up with that level of demand growth which we question.

1 https://www.theregister.com/2023/10/18/hyperscale_datacenter_capacity/
2 https://www.theregister.com/2023/10/18/hyperscale_datacenter_capacity/

Constraints, solutions

To meet such growth, DC builders must manage significant constraints. Many providers' current portfolios lack the specialized infrastructure needed to handle AI workloads, such as powerful GPUs, high-speed networking, and advanced cooling systems. DC energy usage is exploding, with some analysts predicting a doubling of their global electricity demand in just the next two years; all too frequently, ageing infrastructure and lack of available grid capacity compound this challenge, whilst on the labor side, most DC operators are struggling to find suitable talent at build phase.[3]

Naturally, DC providers are looking for solutions to these problems, which presents significant opportunities throughout the DC build and maintenance value chain. Here we enumerate some of the more prominent examples.

Infrastructure

Hyperscale providers are extending server lifespans to free up funds for the development of new AI clusters. Analysis firm Omdia estimates that the average life of servers located in enterprise data centres or colocation has now increased to 7.6 years, and that hyperscale providers raised the average lifespan of their kit to 6.6 years during 2023.[4]

Renewable energy

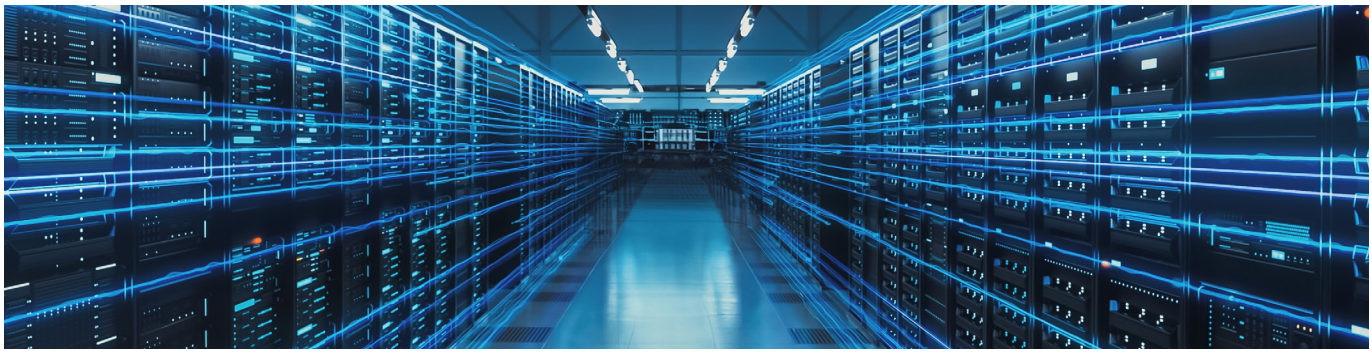
Aggressive pursuit of renewable energy is seen by some operators as a means to mitigate the impact of soaring energy usage and associated planning permission and social license to operate challenges. Google, for instance, is aiming to power its operations with 100% renewable energy around the clock by 2030, reflecting a broader industry trend towards sustainable practices.

Nuclear energy

Some operators are exploring nuclear energy, including traditional nuclear and small modular reactors (SMRs), as a potential solution for their supply issues. However, while SMRs offer a theoretically cost-effective and scalable option, long lead times mean their operational deployment remains 10-15 years away.

Batteries and fuel cells

Google has already piloted battery arrays as a cleaner backup alternative to diesel generators for its DC operations, whilst fuel cells are gaining traction as both backup and primary power supplies. Last year it was announced that Ireland's new Castlelost DC, a joint venture between SK Ecoplant and Lumcloon Energy, would be entirely powered by fuel cell technology, whilst Honda and Mitsubishi are testing the feasibility of powering a DC with fuel cells taken from electric vehicles.



3 The Uptime Institute's 2022 Global Data Center Survey revealed that over half (53%) of data centre operators reported difficulty finding qualified employees in 2022, an increase from 47% in 2021 and 38% in 2018.

4 (https://www.theregister.com/2024/03/05/nvidia_kingmaker_servers/)

DC providers are also in urgent need of next-gen cooling systems to complement the higher heat dissipation of new DCs, which legacy air-based systems struggle to cope with. The salience of this issue has been highlighted by major outages such as that experienced by DBS and Citibank in October 2023, when a cooling issue sent online banking apps offline for around two days, resulting in millions of incomplete transactions.[5] In response, operators are exploring a range of answers to improve uptime delivery.

Modular cooling units

Relatively simple to deploy into existing DC heating, ventilation, and air conditioning systems due to their prefabricated, plug-and-play design, modular units provide more targeted and efficient cooling than fan walls and AC systems. Their use is projected to double in the next five years due to increased focus on value engineering, which emphasises cost reduction and faster deployment.

> **Modular cooling units are really becoming more popular. They are increasingly containerized, making them easier to transport to the site. The end customer also has better visibility on when they will arrive, reducing the lengthy period of integrating their chillers into the data centre since they are already configured. Once onsite, they are often stacked, sometimes on the roof.**
>
> **– Head of Procurement, a large global co-locator.**

Liquid cooling

As DCs evolve to meet the growing demands of high-performance computing and AI workloads, the industry is witnessing a significant shift towards liquid cooling solutions, especially in systems exceeding 500W per rack unit (RU). Indeed, Charles Liang, CEO of server producer Supermicro, has predicted that over 20% of data centres worldwide will adopt liquid cooling in the coming years due to its efficiency and total cost of ownership benefits. Leading DC providers like Equinix, Digital Realty, and Colovore are already integrating liquid cooling technologies to support dense AI deployments, reflecting the industry's broader shift towards more sustainable and efficient cooling solutions, despite adoption challenges such as their complexity and high required capex.

Building Management Systems (BMS):

DC builders can complement and support advanced cooling systems with a focus on the software used to monitor and manage ventilation and cooling. Building Management Systems (BMS) integrate various functions to regulate heating, cooling, and ventilation, ensuring optimal air quality and energy efficiency, and can control a significant proportion of a building's energy consumption.

5 https://www.theregister.com/2023/11/07/overheating_datacenter_singapore/

Opportunities in the Value Chain

The DC sector will require relentless innovation to meet the many challenges presented by AI-driven hyper growth. This will inevitably create opportunities for startups and established operators who can provide solutions in: DC automation, component supply chain management and logistics, energy storage solutions, advanced cooling and maintenance, and more. We conclude with some key takeaways for others in the value chain:

DC operators

- Increased demand for DC capacity drives operators to expand their facilities and enhance their infrastructure. This includes investment in new sites, retrofitting existing ones, and adopting more efficient technologies.
- Meeting the challenges of the coming decade is likely to require significant investments in AI, advanced cooling, predictive maintenance and energy management, and other relevant technologies.
- Chronic labour shortages require that DC operators be proactive in developing skilled professionals for DC operations and maintenance, including partnerships with educational institutions, in-house training programmes, and non-conventional recruitment pathways.

Private equity and other investors

- The increasing demand for DC services driven by AI, cloud computing, and digital transformation presents significant growth opportunities; investors can benefit from this expanding market by targeting those players positioned to help DC operators sustainably scale operations.
- DC investors need to account for the substantial costs associated with upgrading existing infrastructure to support higher energy efficiency, advanced cooling systems, and renewable energy integration.
- DC operators require significant investment in cutting-edge technologies like liquid cooling, AI-driven management systems, and renewable energy solutions to maintain competitiveness.
- DC investors need a thorough understanding of the financial implications of rising energy consumption and cooling demands, particularly due to AI workloads, and their likely impact on future profitability.
- Growing policy focus on sustainability is also likely to drive up costs as energy usage rises and operators require more innovative mitigation strategies. Operators that demonstrate awareness and proactivity on this issue can attract funds from ESG-conscious investors.
- The sector's urgent needs to address pressures in cooling and energy usage create a strong premium on innovation. Investors should be wary of companies without a demonstrable track record of and strategy for innovative R&D.

Policymakers

- Prioritize grid modernization to support DCs' growing energy demands. This includes upgrading ageing infrastructure and enhancing grid reliability.
- Set and enforce emissions standards and best practices for DCs to minimize their carbon footprint, ensure compliance with environmental goals, and encourage the use of energy-efficient technologies and practices, including a ramp up in heat recycling for community purposes such as district heating or swimming pools.
- Provide R&D grants and funding for DC technologies, such as advanced cooling systems, energy storage, and AI-driven management solutions.
- Encourage collaboration between the government, academia, and industry to foster innovation and address technical challenges in the DC sector.
- Implement policies to retain skilled workers, including visa programs for international talent and incentives for continued professional development.
- Consider tax incentives to attract DC investments and expansions, especially in regions with underdeveloped digital infrastructure.
- Simplify the regulatory approval process for new DC projects to reduce delays and encourage investment.

Education sector

- Under-supply of skilled labor to the DC industry creates an urgent need for specialized programs at all levels (including continuing education and certification) in DC management, electrical engineering, HVAC (heating, ventilation and air conditioning) systems, and IT infrastructure, liquid cooling technologies, and data management systems.
- Consider industry research collaborations and internships in vital strategic areas, e.g. efficient cooling systems, sustainable energy solutions, and advanced data management.
- Develop educational curricula and vocational training programs focused on key skills, such as IT, electrical engineering, and HVAC systems.

Energy companies

- There is a growing demand for renewable energy solutions to power DCs sustainably. Companies like Google are leading the charge, aiming for 100% renewable energy by 2030, reflecting a broader industry trend, but some energy generators are also starting to see the solution beyond mere provision of electricity, to packaging a wider solution for co-located, low carbon energy parks, and even become landlords or co-locators in their own right.
- The promise of traditional nuclear and small modular reactors (SMRs) offering a scalable and long-term solution for energy supply remains, ever just beyond reach. Despite long lead times, the interest in SMRs is growing due to their potential for sustainable power.
- Opportunities abound in developing advanced battery arrays and fuel cell technologies. Google's pilot projects and the Castlelost DC in Ireland highlight the growing interest in these cleaner backup power solutions.

Cooling Unit Manufacturers

- The demand for modular cooling units is projected to double in the next five years. These units provide targeted and efficient cooling, are easier to deploy, and integrate seamlessly into existing HVAC systems.
- With the growing premium on cooling, advanced BMS that integrate various systems to regulate heating, cooling, and ventilation are increasingly mission critical.
- Innovations in cooling technology, such as immersion cooling and advanced liquid cooling systems, will be in high demand to manage the heat generated by AI and HPC workloads. The application of AI itself in improving energy efficiency at DCs will become increasingly common place, with hyperscalers often developing these competencies inhouse. 3rd party providers will therefore need to innovate more than ever before to remain relevant in providing smart systems to DC operators.

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