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The nuclear option for data centre energy supply

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DAVID KENNEDY

david.kennedy@ventureinsights.com.au

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Abstract: As the demand for data centres grows, nuclear energy is seen as a promising solution to power these facilities sustainably. Nuclear-powered data centres could provide continuous, low-carbon energy, ensuring stability without the fluctuations of renewable sources like wind or solar. Small modular reactors (SMRs) offer flexibility and safety for local power generation. However, challenges such as high initial costs, regulatory hurdles, and public perception must be addressed. If managed effectively, nuclear energy could transform data centres into highly efficient, eco-friendly operations, essential for an increasingly digital world.

The nuclear option for data centre energy supply

Introduction

As the demand for data centres grows, nuclear energy offers a promising solution to power these facilities sustainably. Nuclear-powered data centres could provide continuous, low-carbon energy, ensuring stability without the fluctuations of renewable sources like wind or solar. Moreover, small modular reactors (SMRs) offer flexibility and safety for local power generation. The main challenges include high initial costs, regulatory hurdles, and public perception. If addressed, nuclear energy could transform data centres into highly efficient, eco-friendly operations, essential for an increasingly digital world.

The role of data centres in the modern economy

Data centres are pivotal to enabling digital interactions across society, processing, storing, and distributing vast amounts of data globally. They ensure seamless access to online services and digital activities, forming the backbone of the digital economy. In Australia, the reliance on data centres has surged, driven by the expansion of cloud computing services and applications. Australians now spend over six hours online daily, engaging in activities that depend on the advanced capabilities of data centres, such as messaging, video calls, online collaboration, internet searches, and e-commerce.

Beyond active online engagement, data centres support essential services integral to safety and daily operations, including emergency response systems, natural disaster warnings, transport, and banking. They provide the infrastructure necessary for internet and cloud-based applications, facilitating critical government services by storing and processing data for operations like Australia's passport, tax, and welfare systems. The technological advancements enabled by data centres drive innovation, productivity, and economic growth, unlocking opportunities for Australia.

The rise of digital technologies, particularly cloud computing, has modernised digital infrastructure, shifting computing power from individual devices and on-premise servers to centralised data centres. These high-tech facilities host numerous servers in data halls, scaling with the size of the centre. Data centres house cutting-edge servers supported by storage and networking infrastructure, capable of handling increasing workloads due to powerful computer chips.

Critical support systems complement the equipment in data halls, including efficient power distribution networks, advanced cooling systems like liquid cooling, and reliable backup generators. Data centres leverage the latest technologies to optimise performance and energy use, offering advanced physical, personnel, and cyber security protections to safeguard systems and data. Physical security measures include intruder-proof fences, double-skinned walls, CCTV, biometrics, and 24/7 security, protecting the digital economy's engine room.

Data centres form a crucial component of national digital infrastructure, integrating with utility services like power, water, and telecommunications to enable efficient and reliable digital service delivery. Organisations have transformed their approach to digital infrastructure, moving from maintaining on-premise servers to outsourcing computing and data storage needs to colocation data centres. These centres work alongside hyperscale

cloud providers to deliver scalable cloud services worldwide, underpinning organisations' ability to run digital services and applications efficiently.

The impact of data centres extends across the Australian economy, enabling cloud services leveraged by virtually all sectors to enhance operations, products, and services. This widespread adoption has driven a shift towards a digital lifestyle for Australians and organisations, all underpinned by data centres. Digital technologies and services are integral to modern life, facilitating communication, work, healthcare, trade, and entertainment. Emerging technologies like AI will further enhance productivity and convenience, with Australian households rapidly increasing their adoption of internet-connected devices.

Venture Insights estimates that Australia's data centres currently have a deployable, provisioned capacity of 1,280 megawatts (MW). As digital adoption continues, we expect deployable capacity to triple by 2028. Hyperscale data centres, characterised by scalability and efficient infrastructure, will drive much of this growth, supporting AI, automation, and big data computing.

Energy requirements of data centres

Data centres are the backbone of the digital economy, housing the servers and infrastructure necessary for data storage, processing, and distribution. As the demand for cloud computing, streaming services, and digital transactions grows, so does the energy consumption of data centres. These facilities require a continuous and reliable power supply to ensure seamless operations, as any disruption can lead to significant data loss and service interruptions.

The energy requirements of data centres are substantial due to several factors. First, the servers and networking equipment generate a significant amount of heat, necessitating robust cooling systems to maintain optimal operating temperatures. Cooling systems alone can account for a large portion of a data centre's energy consumption. Additionally, data centres operate 24/7, requiring a constant power supply to support their round-the-clock activities.

Why nuclear power is proposed: pros and cons

Given the high energy demands and the need for reliability, some experts have proposed nuclear power as a viable solution for powering data centres. The key reasons are:

- Reliability and Consistency: Nuclear power plants provide a stable and continuous energy supply, independent of weather conditions. This reliability is crucial for data centres, which cannot afford power fluctuations or outages. Unlike renewable energy sources, which can be intermittent, nuclear power offers a consistent output that aligns with the operational needs of data centres.
- High Energy Output: Nuclear power is capable of generating large amounts of electricity from a relatively small footprint. This high energy density makes it an attractive option for data centres, which require significant power to support their infrastructure. The ability to produce substantial energy from a compact source is particularly beneficial in areas with limited space for energy installations.

- Low Greenhouse Gas Emissions: During operation, nuclear power plants emit minimal greenhouse gases compared to fossil fuel-based power generation. This aligns with the growing emphasis on reducing carbon footprints and promoting sustainable energy solutions. For data centres seeking to minimise their environmental impact, nuclear power offers a cleaner alternative to traditional energy sources.
- Energy Security: Nuclear power can enhance energy security by reducing reliance on fossil fuels and diversifying the energy mix. This is particularly important for data centres that require a dependable power source to maintain operations. By incorporating nuclear power, data centres can mitigate the risks associated with energy supply disruptions and price volatility in fossil fuel markets.
- Technological Advancements: Recent developments in nuclear technology, such as small modular reactors (SMRs), offer more flexible and potentially safer solutions for energy generation. SMRs can be deployed in smaller increments, reducing the initial investment and allowing for scalable energy solutions tailored to the specific needs of data centres.

Against this, there are also costs and risks with nuclear power:

- High Initial Costs: The construction and maintenance of nuclear power plants require significant investment. The high initial costs, coupled with long development times, can be prohibitive for some data centre operators. Additionally, the regulatory approval process for nuclear projects can be lengthy and complex.
- Waste Management: The management of radioactive waste poses significant challenges. The long-term storage and disposal of nuclear waste require secure facilities and careful monitoring to prevent environmental contamination. This aspect of nuclear energy remains a major concern for its widespread adoption.
- Safety Concerns: Although rare, the potential for catastrophic failures in nuclear power plants poses safety and environmental risks. Incidents such as nuclear meltdowns can have severe consequences, leading to public apprehension and opposition to nuclear energy.
- Regulatory Hurdles: The stringent regulations governing nuclear energy can delay project implementation and increase costs. Navigating the complex regulatory landscape requires significant expertise and resources, which can be a barrier for some data centre operators.
- Public perception: Negative public perception and opposition to nuclear energy can impact the feasibility of projects. Public concerns about safety, waste management, and environmental impact can lead to resistance and challenges in gaining community support.

Conclusion

In conclusion, the energy requirements of data centres are significant, driven by the need for continuous power and effective cooling systems. Nuclear power has been proposed as a means of meeting these demands due to its reliability, high energy output, low emissions, and potential for enhancing energy security. While nuclear power also presents certain challenges, such as high initial costs and waste management, its advantages make it an option for powering data centres in the pursuit of sustainable and reliable energy solutions.

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David Kennedy, Managing Director
david.kennedy@ventureinsights.com.au

Venture Insights
Level 3, 461 Bourke Street, Melbourne, VIC 3000