ADP
An ayesa company

White paper

Think... AI: Ambition vs. appetite

Inspire a better world through influence and design

We acknowledge the Traditional Custodians as the first engineers and designers of the lands on which we live, gather and work.

We pay our respect to the Elders past and present.

Artwork: Created by Timothy Buckley, a proud Mununjali Man, this artwork titled 'Thrive' was commissioned by ADP Consulting, as a representation of our reconciliation journey.

Think... Mega, Giga, Tera

Data centres are "essential engines" of the digital world. But they are also resource-hungry. Clever design and parallel investment in power, water and human resources will determine whether Australia flourishes in the next digital age.

Early cancer detection, new drug discovery, next-generation materials, predicting disasters before they strike... artificial intelligence is already delivering breakthroughs once thought decades away.

From boardrooms to parliaments, expectations of AI are rising fast. Businesses are chasing efficiencies, governments are tightening regulation so more data is stored onshore, and the Australian Treasurer Jim Chalmers has said AI will be central to solving the country's productivity crisis. AI, alongside cloud, streaming and other digital demands, is fuelling inexorable growth in data centres. Managing that exponential rise will require smarter, faster and more responsible design.

By 2030, data centres could account for 8-15% of Australia's electricity.[1]

This growth is occurring just as coal-fired power stations shut and the grid shifts to renewables.

Consider the size and scale of what's ahead:

- **38.6 gigawatts** – the highest total power output ever recorded on Australia's national electricity grid
- **1 gigawatt** – the size of some proposed individual Australian data centres
- **5 gigawatts** – the size of Meta's proposed facility in the United States.[2]

Think... Essential ingredients

Data centres and other major infrastructure projects can propel Australia to a prosperous future. But to get there, the demand for electricity and other resources could exceed anything in human history – risking resource shortages and widespread consequences.

The resources required are broad: natural, material, financial and human.

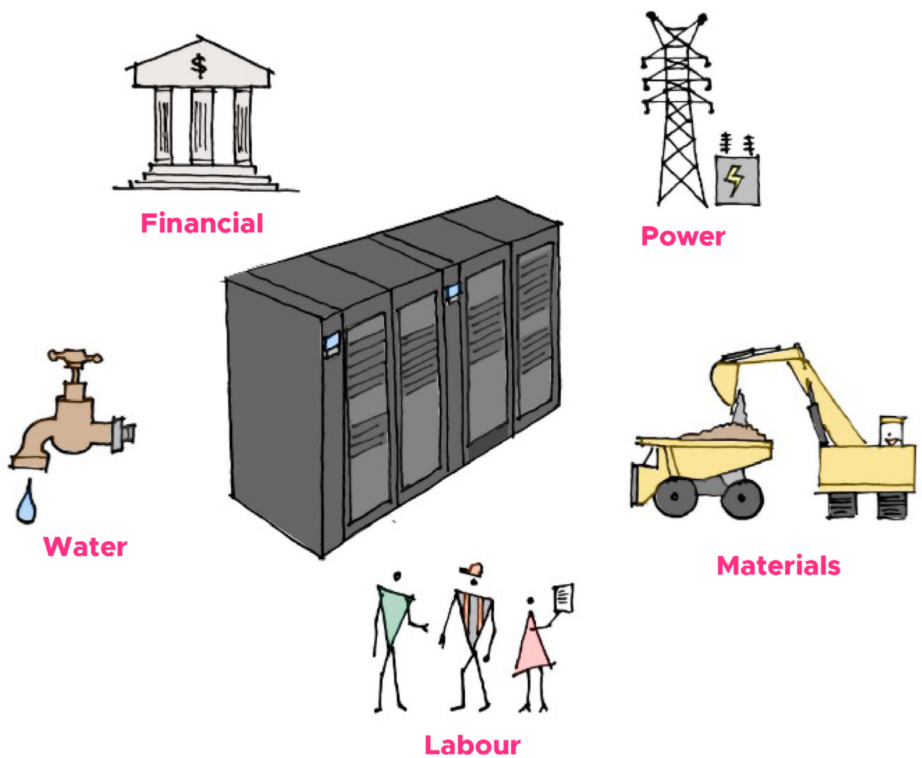
From water to workers, the pressure is mounting. Sydney Water has stated that data centres could use up to a quarter of Sydney's water supply by 2035.[3] Meanwhile, developers say the quest for talent could be the biggest challenge. Any number of critical resources can soon become a limiting factor.

The data centre boom is colliding with the energy transition and large infrastructure projects – and the strain is already spilling into other challenges, like the housing crisis.

A 2025 report by global energy consultancy Rystad found that Australia's renewables transition was already seven years behind schedule.[4] At this rate, we may need to extend the lives of coal-fired power stations.

As resources tighten, governments are likely to put housing, infrastructure and essential services first, with new data centres for AI further down the approvals queue.

Investment in these essential ingredients must keep pace.



Think... Fuelling the boom

Australia cannot afford to stumble into the AI era unprepared.

As a nation, Australia needs to address a host of challenges to avoid stagnation across multiple industries and sectors:

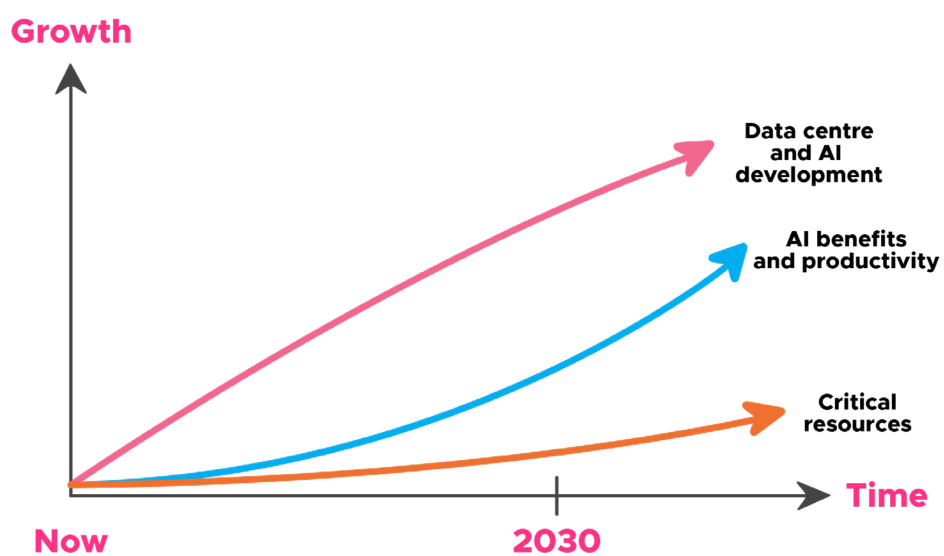
- **Energy**: Accelerate the rollout of renewables, batteries and other technologies, to match soaring loads and keep pace with environmental targets.
- **Water**: Investigate opportunities for cooling using desalination and treated wastewater.
- **Workforce**: Expand the pool of skilled engineers and trades through education, upskilling and migration.
- **Manufacturing & Supply chains**: Invest in onshore manufacturing to support prefabrication factories and DFMA (Design For Manufacture and Assembly). Help source cheaper materials and critical equipment.
- **Education**: Steer students at schools, universities and TAFEs towards relevant trades.
- **Ecosystem**: Invest in AI businesses, tech hubs and incubators to capitalise on this new technology and the potential prosperity ahead.
- **Engage, coordinate and plan**: Work closely with data centre stakeholders to plan and potentially unlock mutually beneficial infrastructure and local investment.

These are national challenges for governments, but they will directly shape the **timeline, cost, viability and pipeline** of every data centre project.

The AI revolution cannot occur in a vacuum. We need power, water, materials and labour to keep up, while carefully considering the social and societal impacts.

It's clear that vital decisions made now will determine Australia's success in the AI world.

In this paper, we share critical insights into the technology and design considerations of data centres. We focus on efficiency measures available to developers, designers and builders through planning, construction and operation.



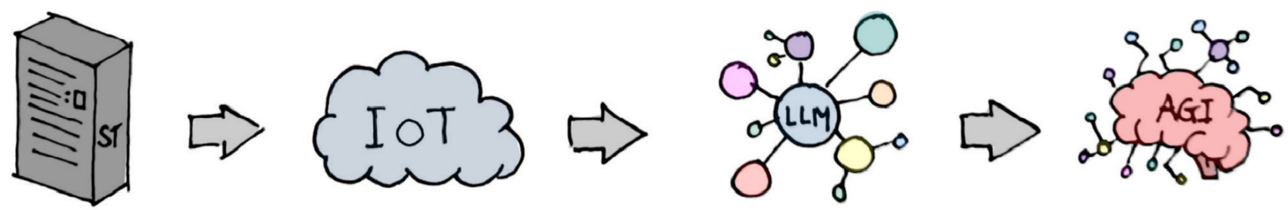
Data centre growth requires parallel investment in power, water, materials, labour and finance.

Think... Rapid evolution

Data centres are evolving at breakneck speed, as every technological breakthrough demands more data.

As we move into the second phase of AI, we'll move from large language models eg. ChatGPT to Artificial General Intelligence (AGI), where computers will surpass human ability to learn.

AGI will power domestic assistants, industrial robots, scientific breakthroughs, and "AI factories" that will support the next generation of manufacturing and logistics.



	2000s	2000-2025	Since 2023	2025-2030 and beyond
Advanced functions	Data storage, websites and email	IoT, e-commerce, cloud storage, streaming, online gaming	Large language models and early AI	Artificial general intelligence (AGI)
Typical individual rack power	**1kW**	**4-40kW**	**40-130kW**	**500kW+**
Typical data centre power requirement (MW)	**1MW**	**5-100MW**	**100-500MW**	**1-5GW**

Think... Key design influences

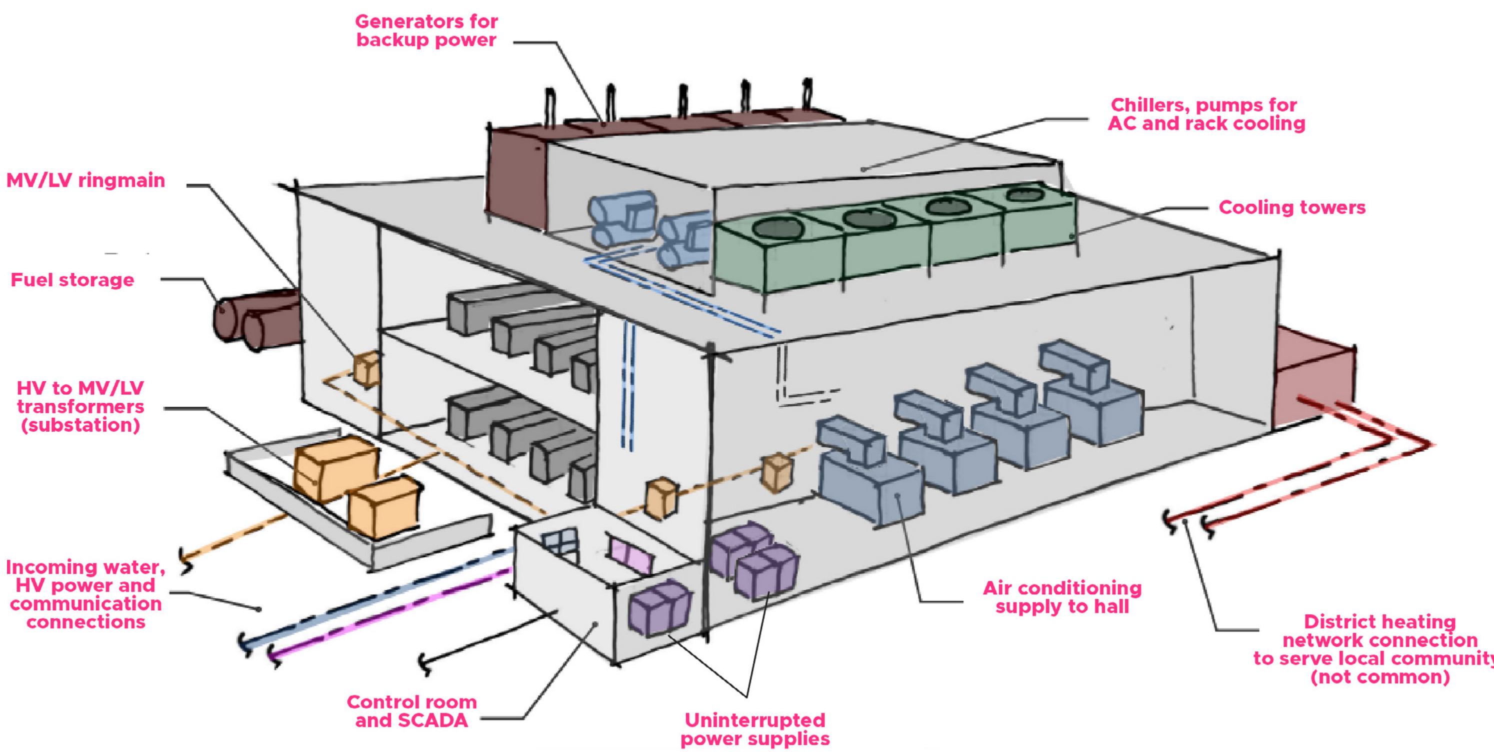
Data Centres are being built with flexibility and future expansion in mind, shaped by customer and operator briefs.

Design can vary dramatically depending on the business model, location and environmental targets, with each major decision carrying its own new rating system or layer of jargon to navigate.

Hyperscalers (typically tech giants) usually want scale, speed and efficiency. Co-location and edge providers (data centres local to end-users) need speed and flexibility, and operators balance cost with uptime. Tier rating sets resilience, while functions like AI, storage and networking drive power, location and cooling choices all impact the final design.

For data centre operators, time is as critical a resource as power or water, and the speed of construction shapes every project.

Prefabricated elements shave months off project timelines. Investment in onshore manufacturing can save on limited labour resources.

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RISK OF ELECTRIC SHOCK
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SWITCH AC

Think... Power resources

By 2030, data centres could consume between 8-15% of Australia's electricity.[1]

That's a huge addition to a grid that is turning off coal-fired plants, especially as renewables don't always match the 24/7 nature of our data needs.

Accelerating our energy transition

The Australian Energy Market Operator's (AEMO) latest Integrated System Plan (ISP), released in 2024, maps out our future power infrastructure.[5] But it doesn't even reference data centre load. That's how fast our world is moving.

Because of the large loads and infrastructure connections required, securing approval to bring power to site can take more than 36 months. Often sites are constrained by the need to extend transmission lines, with easements of 30-80 metres and transmission lines over 65 metres tall.

In mid-2025 AEMO stated that the cost estimates in the ISP had increased by 25-55% for transmission lines and 10-35% for substations.[6]

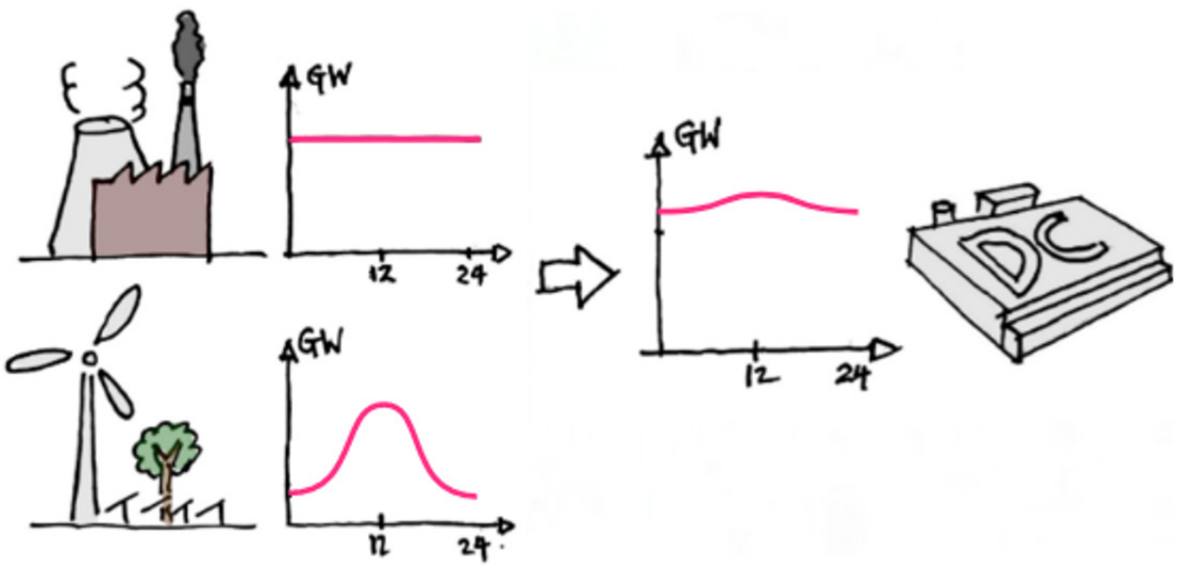
Prices for power connection and the flow-on power costs are rising at levels beyond any typical feasibility.

Constant electrical demand conflicts with the variable nature of renewables

There are now calls to co-locate batteries with data centres to smooth the load. Some centre operators in the US are now being asked to run their generators when the grid is under stress.

Other operators are flexing computational and AI loads from different centres when renewable sources are available.

The tech giants are fully aware of these limitations, with both Google and OpenAI investing heavily in nuclear energy in 2025 to solve supply issues.[7]



Where does the power go?

We’ve established that data centres require lots of power. So, where is that energy being used?

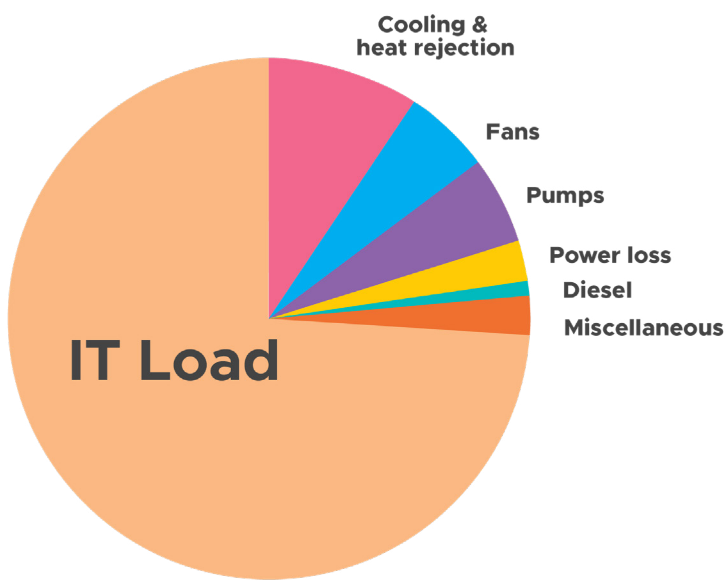
Data centres are often judged on Power Usage Effectiveness (PUE), which equates to total data centre energy usage divided by its IT energy usage. This PUE ratio is very closely linked to a centre's NABERS rating.

The energy split shown is for a PUE 1.34 that corresponds to just below a 5-star NABERS Energy rating, which is now required for data centres owned or leased by Commonwealth[8].

As illustrated, IT loads are clearly the largest proportion of energy usage, and are defined by the chips, racks, software and hardware. This load is hard for designers to reduce.

Larger purpose-built facilities have been shown to be better at achieving lower PUEs approaching 1.2 and below. In comparison, distributed facilities (e.g. A comms room in a commercial tenancy) can have a PUE of 2 or more.

However, designers can influence the remaining slices, especially the large cooling pump and fan loads required to cool the facility. Supplying a district heating network is the best way to reject heat whilst lowering data centre cooling energy requirements.



Typical energy split for a 5 Star NABERS data centre

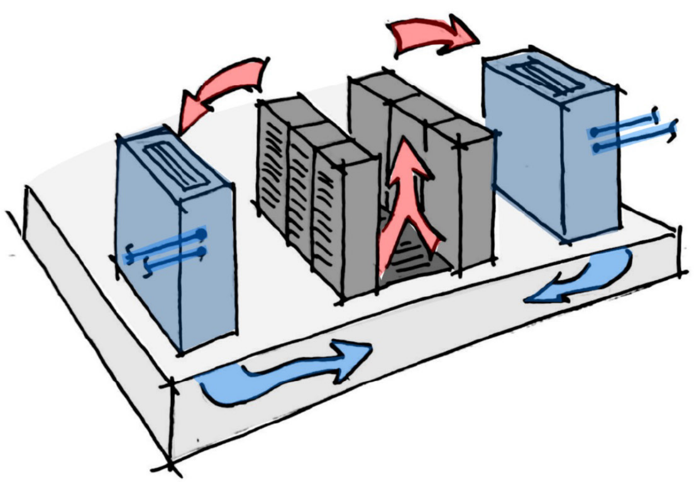
Cooling system design is key

IT load is hard to reduce, so designers focus on the next big energy usage – cooling systems.

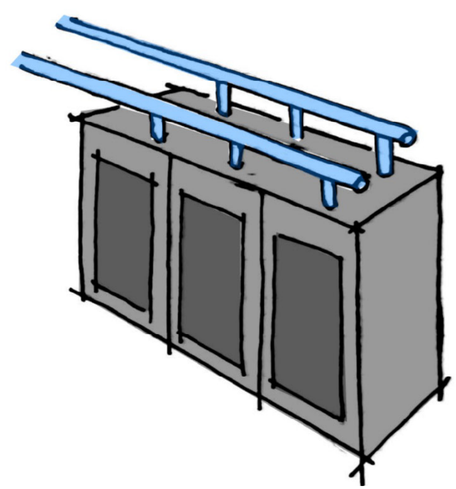
Data centre cooling systems have advanced to keep pace with increasingly energy-dense data racks. Over time, basic air-cooling has been replaced with more targeted cooling techniques like direct-to-chip and liquid immersion, where racks are cooled via submersion in a dielectric fluid.

Water-based systems are typically more efficient, quieter and able to extract more heat from smaller and more energy-intensive chips. As we move to racks upwards of 100kW we'll see more liquid immersion applications.

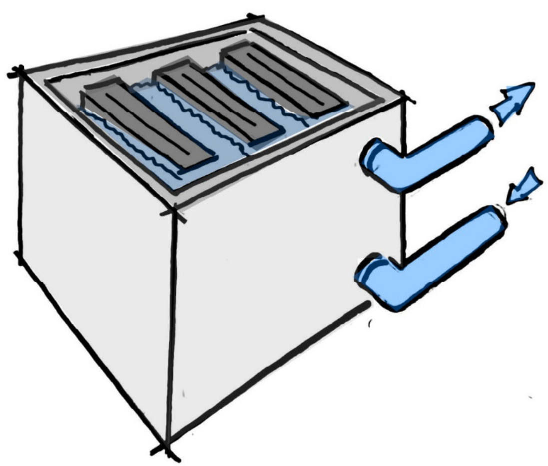
Many new data centres use a combination of cooling techniques and operate at higher internal temperatures than traditional data centres (some exceeding 40°C). Some are so hot that only robots can perform extended maintenance tasks. When data centres operate at higher internal temperatures chilled water supply doesn't need to be as cold, which reduces chiller power usage, and increases free cooling opportunities.



Air-based cooling



Direct-to-chip cooling (used in combination with air-based heat rejection)



Liquid immersion

Think... Water resources

The chilled water used in cooling systems is usually generated by air-cooled chillers, water-cooled chillers or directly by cooling towers. Systems that use cooling towers save around 30% of energy, but they come with a large water usage penalty.

A 2025 ABC investigation found Greater Western Water is assessing 19 new data centre applications that could use 19,714 megalitres – nearly 20 gigalitres – of drinking water each year.[9]

In Greater Western Water's catchment, data centres consumed.

- 33.1 megalitres in 2024
- 1,334 megalitres approved
- 18,380 megalitres pending.

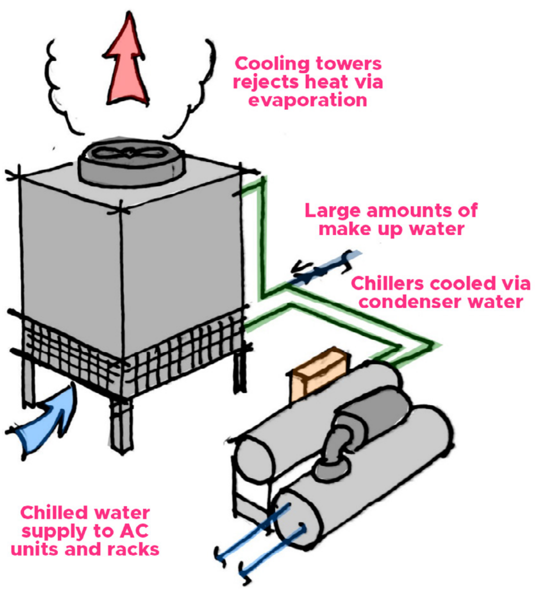
All up, proposed usage is equivalent to what 330,000 Melburnians (greater than the population of Geelong) consumed last year in a catchment area of 1.4 million people.

No wonder calls for mandatory water efficiency standards for data centres are getting louder.

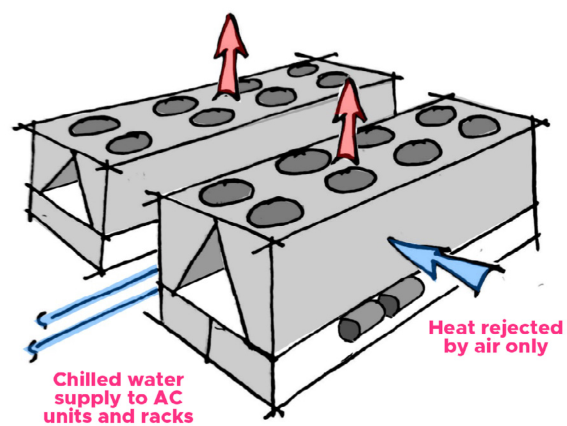
Solutions for water supply are already being discussed - Sydney Water[3] is considering treated wastewater as an option, while Victoria has the option of utilising the rarely used desalination plant (particularly during times of high solar generation and low wholesale energy prices).

Internationally, the tech titans are moving towards air-cooled solutions – but only after several host countries restricted their water access. Air-cooled systems cause more strain on the grid, but they only need to be filled up once (with some occasional top up).

Data centre operators are also exploring hybrid adiabatic and condenser water-based heat rejection cooling systems that use optimal cooling processes, depending on external conditions and data centre processing needs.



Water-based cooling



Air-based cooling

Think... Environmental resources

When usage is high, ratings can have a huge impact.

But ratings can only do so much.

A 1GW data centre that achieves 6-star NABERS Energy and 6 Star Green Star still uses 1GW!

Sustainability in data centres extends far beyond energy and water consumption.

True environmental impact includes embodied carbon in materials, particularly steel, concrete and façade systems. While low-carbon cement options exist, they often struggle to meet the high tolerance, loading capacities and curing demands of mission-critical infrastructure.

Data centre developers are seeking ratings for sustainable design, construction and operations to meet their own strategic objectives and the objectives of the local authorities.

Holistic sustainability is best assessed by third party rating tools like NABERS, Green Star and LEED. These tools enforce design review, best practice benchmarking, construction and operations beyond minimum standards.

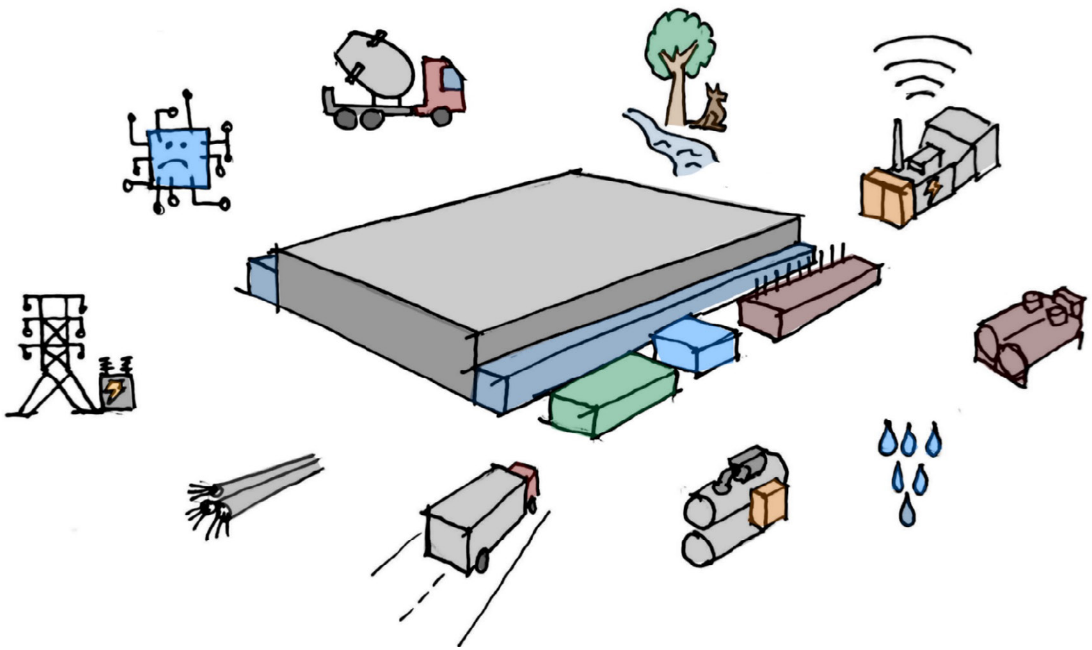
E-waste is a mounting challenge as server refresh cycles accelerate. One recent study estimated the additional e-waste stream from generative AI alone could reach 5 million tonnes over the decade to 2030.[10]

Infrastructure like roads, substations and drainage systems often involve significant land clearance, contributing to biodiversity loss, water runoff and habitat fragmentation.

Diesel generators emit particulates and greenhouse gases, while plant noise affects nearby communities and ecosystems.

Refrigerant leakage from cooling systems is another potent emissions source, and transport emissions from logistics all add to the lifecycle impact.

Finally, in a rapidly-evolving industry, we must also consider decommissioning and second lives of these enormous buildings.



Think... Financial resources

Financial investment in data centres comes from governments, private companies, real estate investment trusts (REITs), private equity, superannuation funds and, of course, the tech giants.

JLL has estimated that Australia needs investment of $26 billion for data centre growth[11], while the Trump Administration has announced the intention to invest up to US$500 billion into the US AI sector.

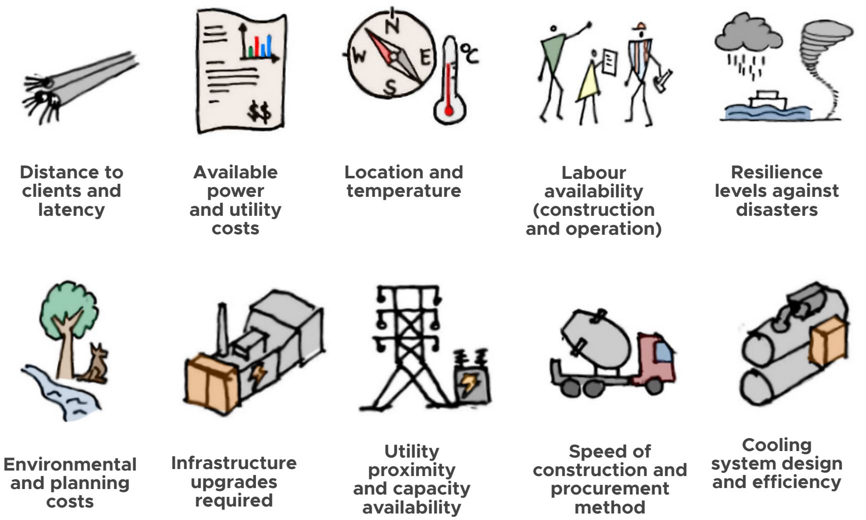
Data centres are unusual in carrying both high CAPEX (around $15m per MW) and high OPEX (around $2m per MW). For large-scale facilities above 100MW, the total bill runs into the billions. This makes early design decisions critical to overall viability.

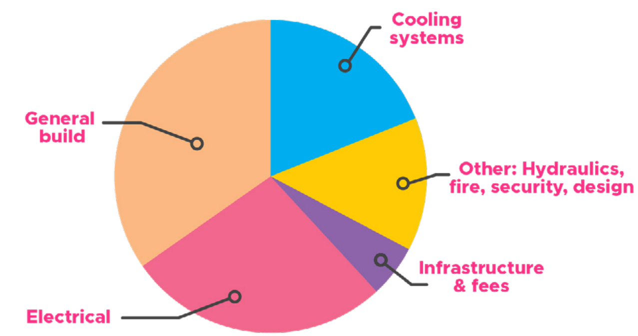
Revenue models vary, from pure rental to hyperscale, full operation with tenants to hybrids in between.

Risk forms a central part of business investment and operational stability and requires careful scrutiny across a range of potential issues:

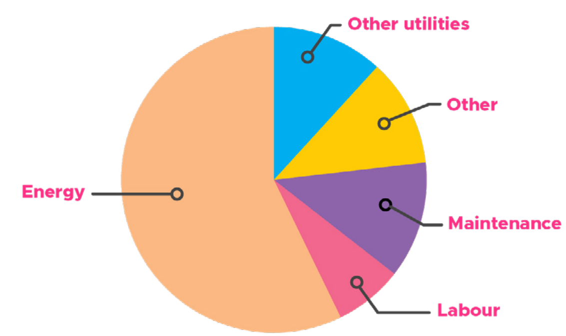
- land aquisition
- planning and utility approvals
- redundancy and back-up power
- latency and grid stability
- exposure to natural disasters
- human error

Cost impacting considerations





Typical Capex



Typical Opex

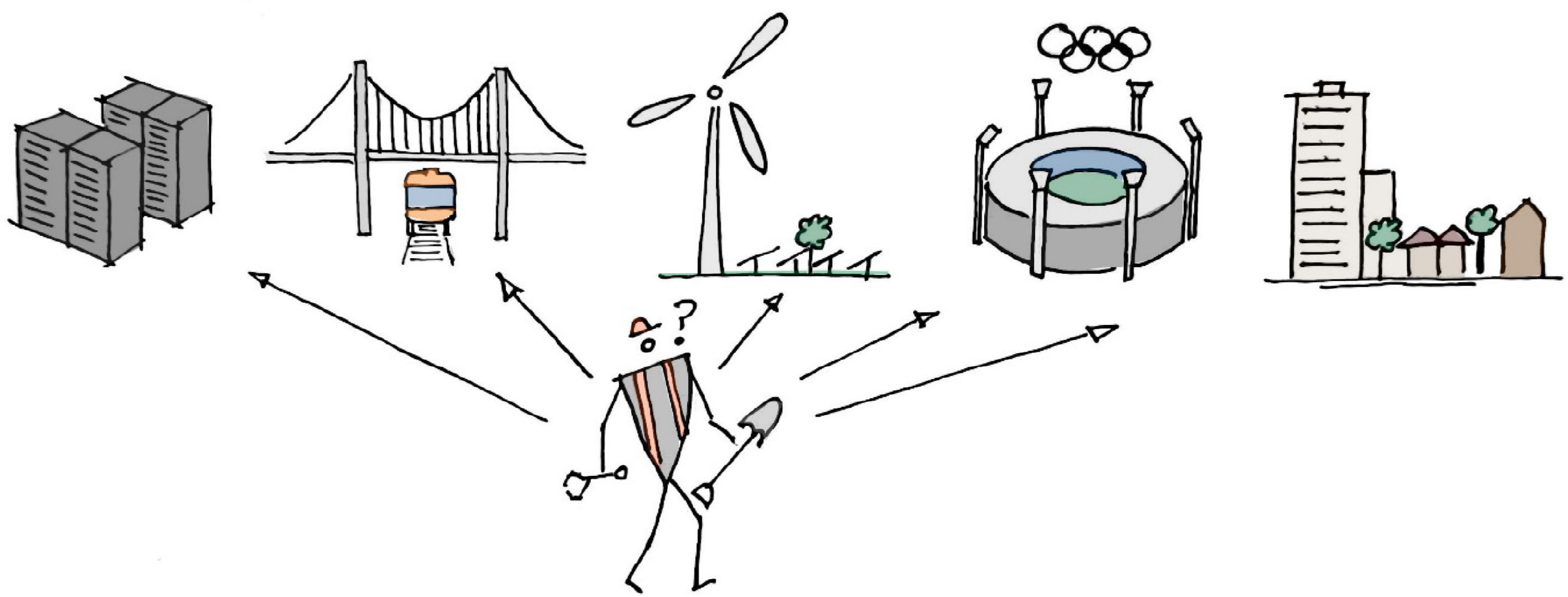
Think... Human resources

Skilled worker shortages will naturally lead to delayed projects and increased labour costs across a range of sectors. Training and overseas skilled workers are needed.

Many developers and operators now consider the shortage of skilled labour their most pressing issue as they compete for talent with other booming sectors.

Jobs and Skills Australia's clean energy study estimates that an additional 26,000-42,000 electricians will be needed between 2023 and 2030 just to fuel the net zero transition.[12]

These same skills are required for data centre builds, and costs will inevitably rise unless the talent pool expands.

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Think... Emerging tech and trends

Control, back-up and grid-interaction

Data centres rely on Supervisory Control and Data Acquisition (SCADA) systems for real-time control and monitoring of electrical, thermal, back-up and network systems. These systems integrate with utilities to enable predictive performance, higher uptime and increasingly autonomous infrastructure management.

Diesel generation and centre operations may one day be required to flex with the grid during times of low or high renewables.

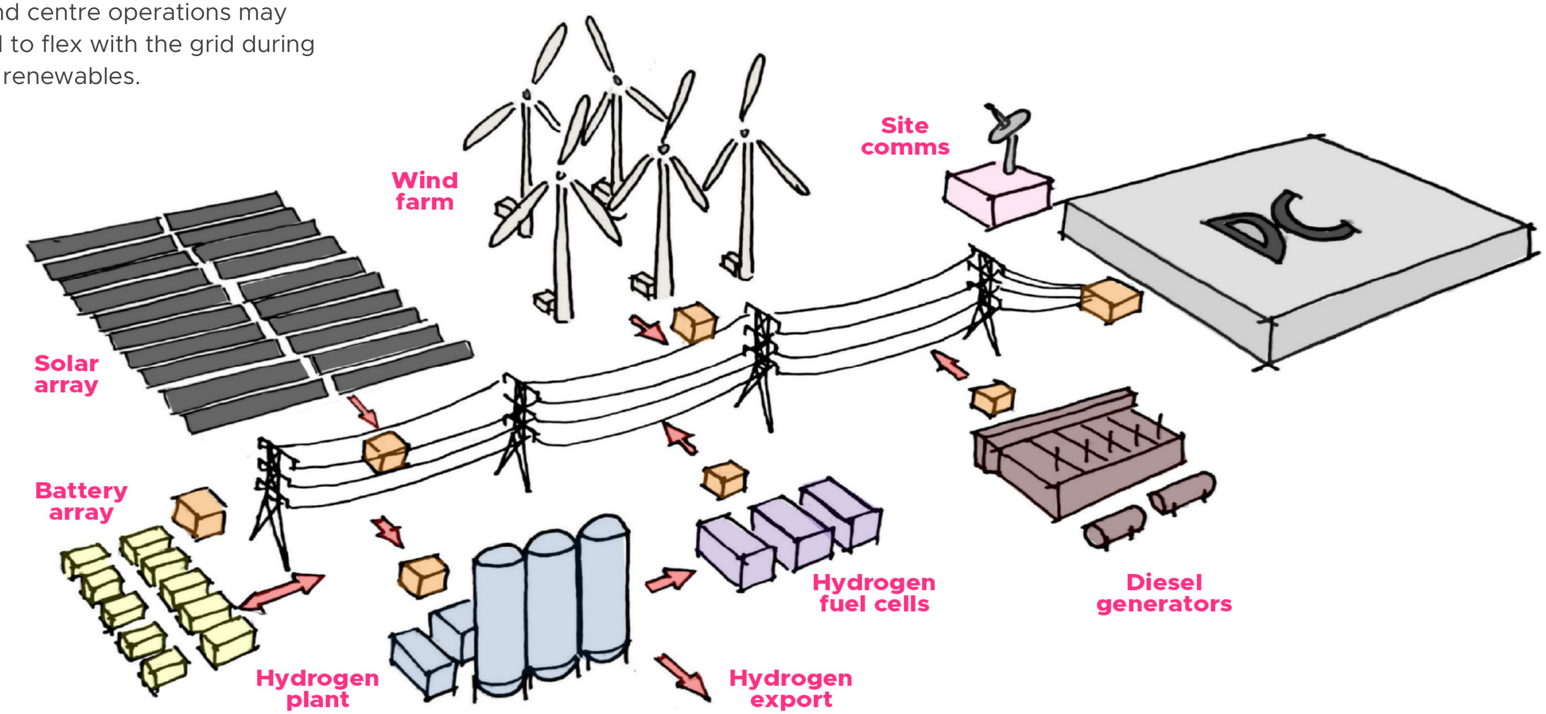
Quest for off-grid

Fully off-grid data centres remain rare but are emerging in the defence, mining and disaster recovery sectors, and are being explored by hyperscalers seeking unrestricted expansion.

These centres run on self-contained microgrids, typically powered by solar, battery storage and backed up by diesel generators.

Freedom from the grid comes with trade-offs: the need for high levels of built-in redundancy, the challenge of a remote location, increased latency and a higher levelised cost of energy for the same output.

For AI operators, these trade-offs can sometimes be acceptable, making off-grid data centres a growing area of interest.



Think... Emerging tech and trends

Heat rejection can also be a benefit

Operators are trialling creative heat rejection methods. Think 'edge' data centres venting into adjacent buildings, or subsea cooling that leverages oceanic heat sinks. These approaches aim to reduce urban heat loads and lower water and energy usage.

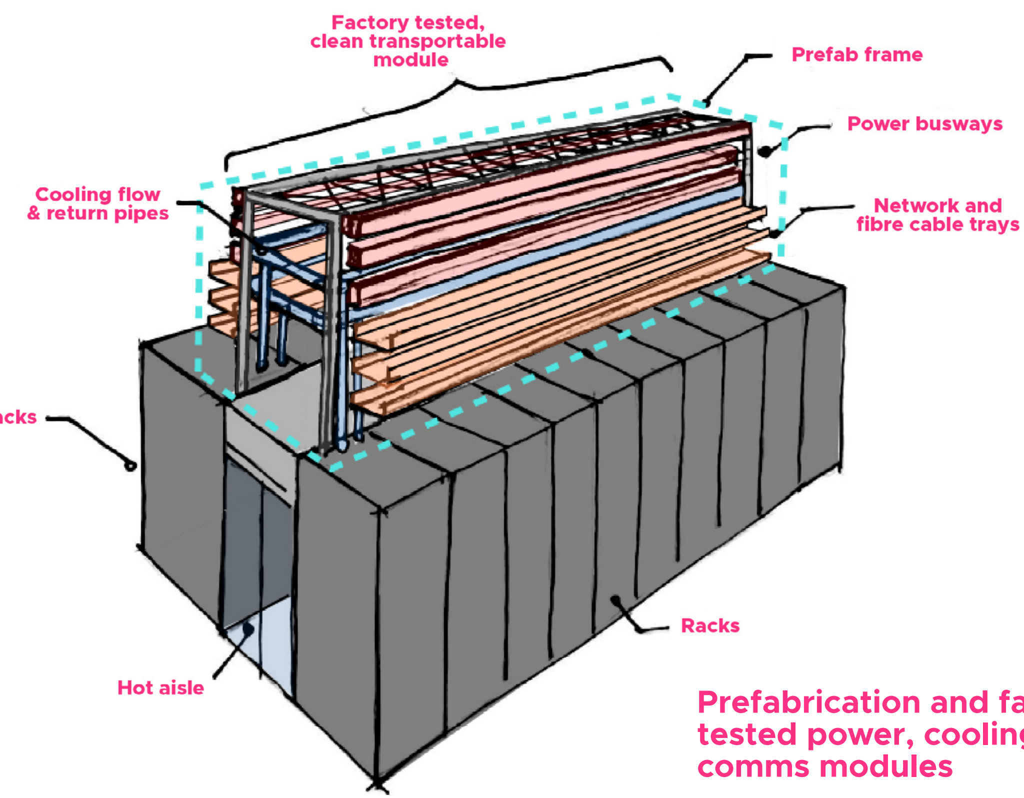
ADP Consulting has completed an immersion facility in Sydney which rejects its heat into a commercial tower. This reduces energy used for heating and improves the building's NABERS rating. Other common district heating systems connect to wastewater treatment, public swimming pools or wider non-commercial applications. See our Think... Liquid cities paper for further details.

Emerging chips

New-generation AI chips from companies like NVIDIA and AMD are redefining processing power and thermal demands in data centres. These developments drive continual density increases, centre layouts, reshaping electrical and cooling design.

Prefabrication and procurement

Prefabricated, factory-tested power, cooling and communication containment modules can be trucked to site – speeding up construction, reducing on-site labour and minimising waste and dust on site. These solutions can shave months off project timelines, but often require new supply chains to be created.



Prefabrication and factory tested power, cooling and comms modules

Think...Quantum leap

Commercial quantum computing is still five-to-10 years away, but several companies have constructed prototype computers.

Quantum computing, through quantum processes like superposition, entanglement and interference, will allow computations and analysis beyond that of a conventional 0 or 1 bit computer. This will enable us to solve complex problems previously beyond human capability.

For qubits (quantum bits) to function effectively, quantum computers must operate in extreme conditions – with temperatures approaching absolute zero (0°K), protected from electromagnetic interference, and within ultraclean environments.

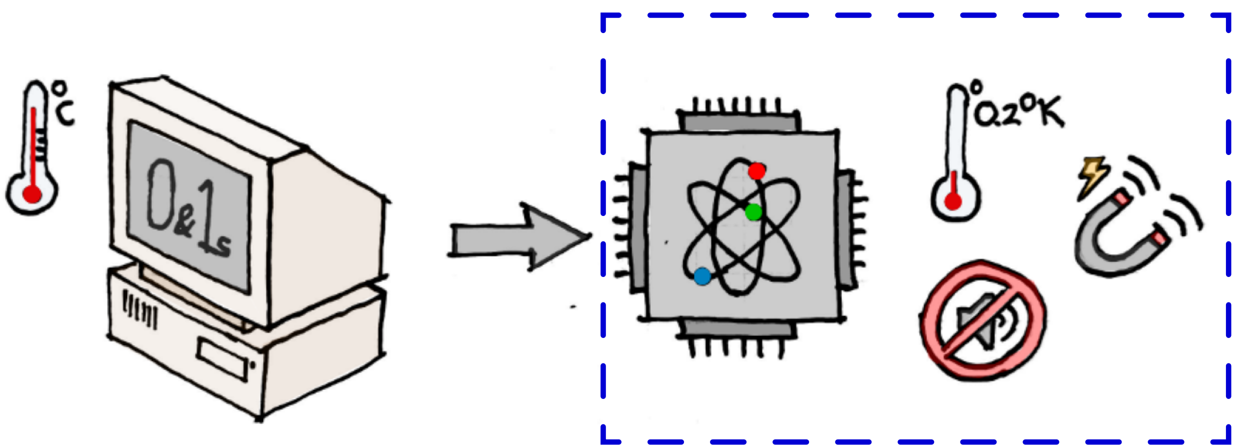
Cooling is achieved using unconventional methods such as "dilution refrigerators" which work by exploiting the endothermic process with Helium isotopes.

Quantum computing can explore simulation of molecules for drug design, optimisation of massive logistics networks and open up areas of science previously beyond our reach.

We may be on the cusp of solving some of nature's and the universe's greatest and most complex questions.

Quantum computers won't replace classical processors; they'll work alongside them for specialised tasks. That means data centres will need new, extreme infrastructure. Think hybrid facilities with specialised quantum halls demanding more power, more cooling, new siting decisions that all reshape how next-generation data centres are designed and operated.

ADP Consulting is currently supporting the development of sustainability solutions on the PsiQuantum facility in Queensland – a joint $940 million investment by the Australian and Queensland governments.



While conventional computers operate at room temperature, Qubits require custom facilities at near absolute zero, with no vibration or noise and shielded from electromagnetism.

Think... Social capital

Social capital is the final resource needed for planning and utility approvals – and that means community support.

Social capital is the final resource that data centres depend on.

Planning approvals, utility connections and ultimately community support will decide which projects move forward. Once that support is lost, it is hard to regain, as we've already seen with rural backlash against renewable and transmission projects that has caused costly delays.

The challenge is bigger than data centres alone. Australia faces a tangle of priorities: major infrastructure builds, coal-fired power stations shutting down, net zero targets, water and biodiversity pressures, gas-to-grid transitions, labour shortages and a housing crisis. Data centres are entering this crowded field, competing for the same finite resources of power, water, people, land and goodwill.

Against this backdrop, community scepticism about AI cannot be ignored. Many people see AI as a job killer, an educational disruptor, or a frivolous tool for memes and email fixes.

Around the world, people are asking difficult questions about AI:

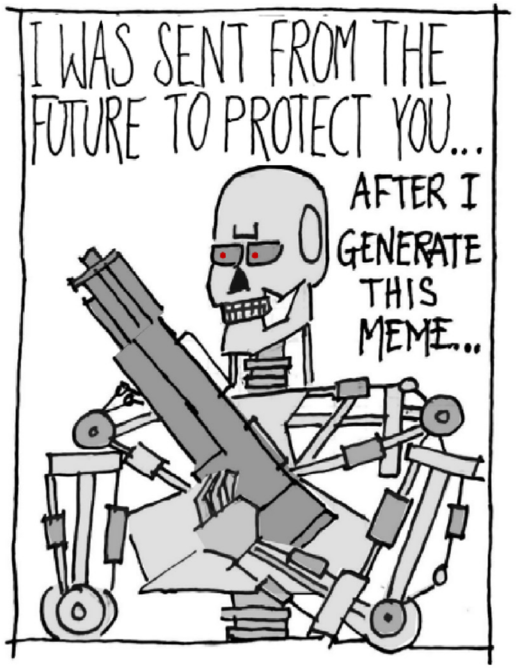
- Should AI be used to create art or music?
- How do we teach children in an AI world? Whose jobs will be kept?
- Will AI lead us to extinction or prosperity?

At the moment, we have more questions than answers.

Securing a social licence will mean showing that the resources consumed by AI are balanced by tangible benefits for society, like breakthroughs in health and science, and improvements to daily life that matter to ordinary people.

For data centre developers, approvals will depend on how well projects demonstrate responsible design, efficient use of scarce resources, and genuine value to the communities they touch.

AI's footprint is taking shape. Australia's success depends on balancing ambition and appetite with the finite resources that underpin growth.



Saviour, danger, or fad? The role of AI remains a source of ongoing debate.

'Think' is a thought leadership series developed by ADP Consulting to ask and answer some of the big questions confronting the property and construction industry.

ADP Consulting's vision is to inspire a better world through influence and design.

Founded in 2011 in Australia, ADP Consulting is is a trusted sustainability-led multi-services engineering consultancy with more than 350 Thinkers, and a growing international footprint.

ADP Consulting has now joined forces with Ayesa, one of the world's largest technology and engineering companies, in a move that facilitates new pathways and accelerates our growth.

We provide building services engineering, structures, sustainability, ICT, acoustics, audio visual, security, vertical transportation, specialist lighting and energy design to the property and construction industry.

We brings together a team alive to the immense opportunities, as well as the obstacles ahead. Through thoughtful design, education and collaboration we are optimistic the AI revolution can be carefully managed through its inception, allowing us all to benefit from it in the long term.

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