Infrastructure Sustainability Council

Sydney WATER

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Honeywell

DIGITAL INFRASTRUCTURE FUTURES

PHASE 1 – Emerging Insights Report

June 2026

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The views and findings expressed in this paper are those of the Infrastructure Sustainability Council and do not necessarily reflect the views of any sponsor, partner, or contributor.

Foreword

The way we plan, build, and operate the assets that underpin our communities, economy, and environment is being reshaped by digital technologies at a pace few could have anticipated just a few years ago. Connectivity, data, sensing, and artificial intelligence are no longer emerging concepts, but common enablers transforming how infrastructure delivers value today.

For the Infrastructure Sustainability Council (ISC), this moment calls for clarity and leadership. Our 2030 strategy reaffirms our purpose: *enabling connected infrastructure that supports people to thrive on a healthy planet.* That word 'connected' matters. It speaks to the role digital infrastructure plays in making our built environment more intelligent, more responsive, and more sustainable. It is a challenge we must meet head-on.

This interim report represents the first step in that effort. This is a working document shaped by the insights of ISC members, industry leaders, and practitioners who have engaged generously with this process. Their perspectives are at the heart of what follows, and their continued input will inform our recommendations to the sector, and ISC's own actions in the exciting world of digital infrastructure.

We are grateful to the sponsors that have made this initial work possible: Honeywell, Jacobs, and Sydney Water. Their support reflects a shared commitment to getting digital infrastructure right for our industry, and the communities and ecosystems we all serve.

There is more work ahead. We welcome your feedback, your questions, and your future involvement.

Toby Kent

Toby Kent
Chief Executive Officer
Infrastructure Sustainability Council

Participating Organisations

The ISC wishes to thank the sponsors who have contributed resources to help bring this document to life and are strong advocates for the digital enablement of our infrastructure assets to enhance sustainability outcomes.

Honeywell, Jacobs, Sydney Water

The following organisations have further contributed to the development of this report through interviews, roundtable participation, committee membership, or formal review. ISC thanks them for their contributions.

Arup, Bentley Systems, CPB Contractors, Circulus, City of Melbourne, Hexagon, John Holland, Mott MacDonald, Murdoch University, NBN Co, Urbis

The ISC would also like to thank our partner and lead author Adam Beck of NEON.URBAN.

Chapter 1

Introduction

Infrastructure shapes how people live, work, move, and connect. It underpins economic productivity, environmental health, and social wellbeing, and it is changing fast.

The systems we rely on, from power grids and water networks to transport corridors and communications infrastructure, are being transformed by a wave of digital technologies that offer new ways to plan, build, operate, and sustain these assets. Looking ahead, the trajectory of digital infrastructure demand is inherently uncertain, with the pace of technological change raising real risks of stranded assets and underutilised capacity. Meeting this challenge will require infrastructure systems that are adaptive, flexible, and modular by design, capable of scaling and reconfiguring as needs evolve.

This report is part of the ISC's contribution to that conversation. It asks a simple yet critical question: what does the digital enablement of infrastructure mean for sustainability outcomes in Australia and Aotearoa New Zealand?

This report starts to answer this question with rigour, honesty, and is driven by input from ISC members and stakeholders who are at the heart of the sector and this digital transformation. And more importantly, as this phase 1 report evolves into the final recommendations and action plans, it will offer a set of practical recommendations for ISC and its members.

1.1 Purpose and Scope

Connected infrastructure' is not only about digital networks and data systems but also about the relationships among assets, ecosystems, communities, and institutions. But digital connectivity plays a significant and growing role in improving those relationships and making infrastructure outcomes more sustainable across every dimension of the asset lifecycle.

This paper considers that role and examines how the digitalisation of traditional infrastructure assets creates opportunities to create efficiencies and reduce waste, improve productivity, extend asset life, and generate environmental and social value.

1.2 How The Paper is Being Developed

This phase 1 report has been developed through a structured process designed to ground its findings in the experience and expertise of ISC's members and other key stakeholders most closely connected to the challenges it examines. Virtual and in-person roundtables, regular reviews with ISC's AI and Digital Member Committee, and broader industry survey processes are being used to inform the content of the final paper and its potential uses.

The paper is being developed for several important audiences, including ISC members across infrastructure owners, operators, contractors, consultants, and technology providers, as well as the policymakers, investors, and regulators shaping the conditions under which infrastructure is delivered.

1.3 Digital Infrastructure and ESG Disclosure

For many organisations reading this report, the most immediate lens may not be opportunity, but rather obligation. Mandatory climate disclosure is reshaping how asset owners, operators, and contractors account for their full emissions profile, and digital infrastructure sits within that frame.

In Australia, the Treasury Laws Amendment (Financial Market Infrastructure and Other Measures) Act 2024 requires large entities to report against the Australian Sustainability Reporting Standards, aligned with IFRS S1 and S2. Aotearoa New Zealand's mandatory disclosure regime is already in force. Across both jurisdictions, Scope 3 reporting requirements mean the emissions and resource footprint of procured digital services (such as cloud platforms, co-location facilities, network infrastructure) now flow through to an organisation's own disclosure obligations.

The sections that follow in this report, and in the final paper, will examine various categories of digital infrastructure through the lenses of digital infrastructure as an enabler of sustainability outcomes, and as a subject of sustainability accountability.

Chapter 2

The Digital Infrastructure Landscape

2.1 Defining Digital Infrastructure

There is no single, universally adopted definition of "digital infrastructure". ISC acknowledges the Australian Security of Critical Infrastructure Act 2018 that includes the following relevant sectors: Communications, Data Storage/Processing and Space. The Australian Bureau of Statistics' Digital Activity framework, used for measurement purposes, defines "digital enabling infrastructure" as "computer hardware, software, telecommunications equipment, and support services that form and facilitate the use of computer networks" (https://www.abs.gov.au/articles/digital-activity-australian-economy). In Aotearoa New Zealand, in early 2026, the Department of the Prime Minister and Cabinet consulted on mandatory cybersecurity early 2026, the Department of the Prime Minister and Cabinet consulted on mandatory cyber security obligations for critical infrastructure entities, which included communications and data, along with energy, transport, and other sectors.

The OECD's Going Digital framework is potentially the most substantive international policy reference available, stipulating that access to communications infrastructure and services is essential for digital transformation and that these elements form the technical foundation for an open, interconnected digital economy (https://www.oecd.org/en/publications/the-oecd-going-digital-integrated-policy-framework-2026_0254ae07-en.html).

These existing definitions were developed before the current scale of AI and sensing infrastructure, however, they explicitly position ISC's five-category matrix (see below) as an extension of that lineage.

For the purposes of this report, ISC defines digital infrastructure as "the physical and virtual systems that enable data to be generated, transmitted, stored, processed, and applied for the enhancement of infrastructure performance".

Furthermore, this paper refers to digital infrastructure through the lens of the full asset lifecycle – from project planning through design, construction, to operations and maintenance.

To help bring this definition to life, ISC has organised digital infrastructure into five categories, as outlined below. This framework is further contextualised in Section 4, with the full Digital Infrastructure Sustainability Matrix set out in **Appendix A.**

These categories are interdependent, often relying on one another to meet their respective performance requirements. For example, sensing infrastructure generates data that must be transmitted via connectivity networks, stored and processed in data infrastructure, and analysed using computing and AI tools.

Based on this definition and matrix, we can identify which global, regional, and local trends are relevant to assessing opportunities in Australia and Aotearoa Aotearoa New Zealand.

Digital Infrastructure Categories	Example technologies
Connectivity infrastructure	Fixed broadband, mobile networks (4G/5G), LPWAN, subsea and terrestrial fibre cables.
Data infrastructure	Data centres, cloud platforms (IaaS/PaaS/SaaS), edge compute nodes, data integration and interoperability layers.
Sensing and device infrastructure	Connected technology (IoT) sensor networks, smart and multifunction poles and other urban infrastructure elements, environmental sensing stations, and transport monitoring systems.
Computing and AI infrastructure	Digital twin platforms, AI (generative, agentic and physical) and machine learning systems, high-performance computing clusters, and AI-specific hardware.
Autonomous and Robotic Infrastructure	Robotics, autonomous plant and vehicles, drones, and human-machine systems that translate digital intelligence into physical action across the construction, operation, and maintenance of infrastructure.

2.2 Global and Regional Trends

Several converging forces and technologies are reshaping the global digital infrastructure landscape. Each carries significant sustainability implications.

A major trend relates to the rapid demand for data centre infrastructure, driven predominantly by cloud migration and, more recently, AI workloads. Energy consumption by data centres is projected to double globally by 2030, putting significant pressure on electricity grids and water systems in regions where large-scale facilities are concentrated.

AI is accelerating compute intensity, thereby increasing the workload on data centres and similar compute hubs and facilities. The hardware required to train and run large AI models is highly energy and resource-intensive. The sustainability cost of AI infrastructure is not yet well understood or consistently reported, but it is in focus by many regulators and investors. At the same time, edge computing is distributing processing closer to the source, reducing latency and backhaul energy but introducing new challenges around hardware management, security, and distributed sustainability governance.

Running parallel to edge compute, and consistently being powered by edge AI (also known as Physical AI), is automation and robotics which are emerging as a complementary force reshaping how infrastructure is delivered and operated. The expanding use of robotics across construction, maintenance, logistics, and inspection is altering workforce requirements, construction methodologies, and energy use profiles.

Digital twin adoption continues to scale across the horizontal and vertical infrastructure sectors, with governments and large infrastructure owners investing in virtual asset replicas to improve planning, operations, and maintenance.

Sovereign digital infrastructure is also emerging as a policy priority across multiple nations and regions, reflecting concerns about data security, supply chain concentration, and the strategic value of communications and compute infrastructure to those economies.

Leading jurisdictions, including Singapore, the Netherlands, and the United Kingdom, are developing integrated frameworks that treat digital infrastructure sustainability as a regulated and reported dimension of infrastructure performance. Australia and Aotearoa New Zealand are at an earlier stage of that journey.

Data centres

Energy consumption by data centres doubling by 2030

Accelerating AI compute intensity

The sustainability cost of AI infrastructure is not yet well understood or consistently reported

Edge computing

Lower latency & transmission energy but with new challenges around governance, security and hardware lifecycle management

Automation and robotics

The growing use of robotics across infrastructure is transforming workforce needs, construction methods, and energy consumption patterns

Sovereign digital infrastructure

Emerging as a policy priority due to concerns about data security, supply chain and strategic value.

2.3 The Australian and Aotearoa New Zealand Context

Australia and Aotearoa New Zealand are witnessing many of the global trends above, while also exhibiting some important regional characteristics. Geographic scale, dispersed populations, and a significant remote and regional infrastructure challenge mean that connectivity gaps carry greater social and economic consequences in Australia and Aotearoa New Zealand than in more densely populated countries and regions.

The policy environment regarding digital infrastructure continues to evolve as well. Key frameworks, actions and plans are shaping the digital infrastructure landscape in this region, including the likes of:

- Australia's National Digital Economy Strategy and AI Action Plan, which set out ambitions for digital connectivity and AI adoption without yet embedding explicit sustainability obligations.
- The Security of Critical Infrastructure Act 2018, which designates data storage and processing as critical infrastructure, with implications for how digital assets are governed and secured.
- The multiple digital infrastructure efforts responding to Australia's data centre growth, which has driven Federal and state governments to publish guidance and commence strategic reviews.
- Australia's National Robotics Strategy (2024) makes explicit reference to labour market pressures as a driver, while in Aotearoa New Zealand published its first national robotics roadmap, jointly funded by KiwiNet, NZRAS and Callaghan Innovation.
- The SEQ Digital Plan, a product of a tri-government commitment (Federal, state and regional councils), which articulates clear investments such as Common Data Environments, Data Centre Strategy development, acceleration of telecommunications infrastructure and digital planning and design processes for the development sector.
- Aotearoa New Zealand's Digital Strategy 2030, which emphasises inclusive digital access and trust but has limited integration with sustainability planning frameworks.
- Infrastructure Australia and Infrastructure Aotearoa New Zealand pipelines, which include significant digital infrastructure investment but lack consistent sustainability assessment criteria across digital asset types.

ISC acknowledges that First Nations data sovereignty is a distinct and important dimension of the Australian and Aotearoa New Zealand context. Digital infrastructure affects how data about Country, communities, and culture is collected, stored, and used. The AIATSIS Code of Ethics and emerging Indigenous Data Sovereignty frameworks set out principles that should inform the design and governance of digital infrastructure in this region.

Chapter 3

The Digital Infrastructure and Sustainability Opportunity

This section frames the relationship between digital infrastructure and sustainability as a two-way lens, with digital infrastructure both an enabler of sustainability outcomes across the broader infrastructure system and a category of infrastructure with its own material sustainability footprint.

The discussion also extends beyond environmental considerations to encompass social, cultural, and economic dimensions of value, consistent with ISC's mission.

3.1 How Digital Accelerates Sustainability Outcomes

Digital infrastructure can accelerate sustainability outcomes across every stage of the infrastructure lifecycle, from planning and design through construction, operations, and end-of-life. Based on member input and case study review, the digital capabilities that are considered enablers for enhanced sustainability outcomes include:

- Data-driven planning reducing material waste and improves asset utilisation through accurate demand forecasting and integrated decision-making
- Digital twins supporting efficient design and construction sequencing, reducing rework, project timelines, and embodied carbon
- Internet of Things and connected technology enabled operations, cutting energy use and extending asset life through condition monitoring and predictive maintenance
- Artificial intelligence optimised grid, transport, and water network performance in real time, improving efficiency and renewable integration
- Connected infrastructure underpinning coordinated emergency response and climate adaptation actions across agencies and jurisdictions.

3.2 The Sustainability Footprint of Digital Infrastructure Itself

Digital infrastructure also carries a material sustainability footprint of its own. Data centres, cable networks, mobile telecommunications infrastructure, sensing devices, and computing hardware consume energy and water, embed carbon, and generate end-of-life waste. And now, as artificial intelligence workloads intensify these pressures, the physical and material footprint expands. ISC considers the following as critical issues to be addressed:

Direct Impacts

- Data centre energy demand is rising sharply, alongside the material and land use impacts of supporting transmission infrastructure such as pipes, towers, and substations
- Scope 3 emissions from hardware manufacturing, logistics, and global supply chains
- Water consumption for cooling, particularly in water-stressed regions
- E-waste volumes and the limits of current circular economy pathways
- Land use, siting pressures, and biodiversity impacts of large-scale rollout.

Second-order and systemic impacts

- Rebound effects, where efficiency gains delivered by digital tools drive higher overall consumption, offsetting the savings they were intended to produce
- Accelerated growth in total resource use, energy load, and water demand driven by the rapid scaling of AI workloads and the compute infrastructure that supports them
- Lifecycle pressures created by rapidly obsolescing hardware and assets, including shortened refresh cycles, stranded equipment, and the compounding embodied carbon of frequent replacement
- Locked-in dependencies on global supply chains for chips, rare earths, and critical minerals, raising both sustainability and sovereign risk exposure
- Demand-side pressure on host grids and utilities, where digital infrastructure growth can crowd out decarbonisation pathways for other sectors.

3.3 Social, Cultural, and Economic Value

A credible discussion of digital infrastructure must also consider social equity, economic productivity, cultural values, and workforce transition, all of which carry distinct weight in the Australian and Aotearoa New Zealand context. ISC has noted the following opportunities with respect to digital infrastructure delivery:

- Digital connectivity enables social equity and access, supporting education, health, employment, and civic participation in regional and remote communities
- Economic productivity gains from digitisation extend beyond cost savings to new service models and improved decision quality across portfolios
- Cultural considerations shape digital infrastructure siting, the handling of data drawn from Country, and the recognition of First Nations data sovereignty
- Workforce transition and digital skills development are central to realising the benefits of digitalisation while supporting an inclusive labour market
- Alongside these opportunities sits a more disruptive dimension that the sector cannot afford to treat as a future concern. The combined pace of AI and robotics development is changing what work in infrastructure looks like, who does it, and under what conditions. ISC notes the following considerations:
- The distinction between job displacement and job augmentation is becoming a defining workforce question. Some roles, particularly in routine inspection, monitoring, scheduling, and data processing, face genuine displacement risk as autonomous systems and AI tools mature. Others are being augmented, with practitioners working alongside digital twins, generative design tools, and AI-enabled decision support. The sector's response should distinguish clearly between the two and plan for both, rather than treating digital adoption as uniformly additive to existing jobs.
- The role of humans in infrastructure delivery and operations is shifting from direct execution toward oversight, judgement, and exception handling. Field crews are increasingly supervising autonomous plant rather than operating it directly. Engineering teams are reviewing AI-generated options rather than producing each one from first principles. Control room operators are interpreting recommendations from optimisation systems rather than running networks manually. This shift carries implications for training pathways, professional accreditation, and the design of safe systems of work, none of which have fully caught up with the change.
- Ethical considerations are becoming material as autonomous systems take on more consequential decisions. Questions of accountability when an AI-recommended action causes harm, transparency in how optimisation systems weigh competing community impacts, fairness in how algorithmic decisions affect different population groups, and the appropriate level of human oversight for safety-critical operations all need deliberate attention. These are not abstract concerns. They show up in procurement decisions, in operating licences, and in community trust in the infrastructure sector.

For ISC and its members, these issues sit at the intersection of sustainability and social licence. Infrastructure that delivers strong environmental performance but erodes employment quality, transparency, or community trust does not meet a credible definition of sustainable. Bringing automation-driven disruption into the sustainability conversation, rather than treating it as a separate workforce or technology issue, is part of what makes this report's framing distinctive.

Chapter 4

The Digital Infrastructure Sustainability Matrix

4.1 Matrix Context

Understanding digital infrastructure as a matrix rather than a single category matters to ISC and its members because the sustainability implications vary significantly across each category.

For example, a subsea cable has a fundamentally different footprint profile from an AI training cluster. An IoT sensor network across port operations creates different governance challenges than a hyperscale data centre hosting sensitive information for the police.

Without a structured way to distinguish between technologies, those delivering, owning and operating infrastructure risk applying generic sustainability thinking to challenges that demand specificity.

The matrix developed in this report is a proposed way to bring that structure. It makes visible the differences in energy intensity, embodied carbon, hardware lifecycles, water consumption, and data governance obligations that sit behind the umbrella term 'digital infrastructure', and in doing so, creates a more honest foundation for decision-making.

4.2 An Action Framework for the Infrastructure Sector

For ISC and its members, the matrix has direct practical value. It provides a shared reference point for conversations between infrastructure owners, technology providers, contractors, and consultants who often approach digital infrastructure from different angles and with different vocabularies.

It also surfaces a challenge that sits at the heart of digital infrastructure decision-making: deep uncertainty about future demand, technology evolution, and the regulatory environment. Data centre capacity requirements driven by AI workloads have outpaced forecasts repeatedly over the past three years. Sensing networks are scaling faster than originally projected. Standards, sustainability disclosure requirements, and grid connection conditions continue to shift. Traditional infrastructure planning approaches, which assume reasonably stable demand curves and long, predictable technology lifecycles, struggle in this environment.

This calls for a different planning posture, one that is explicit about uncertainty rather than working around it. Three approaches are particularly relevant for the infrastructure sector.

The first is **adaptive planning.** Rather than locking in a single forecast and designing to it, adaptive planning frames decisions as a sequence of staged choices with built-in review points. Initial commitments are sized to what is reasonably known. Trigger conditions, such as a demand threshold, a regulatory change, or a cost shift in a key input, prompt the next decision. This approach is well established in water and transport planning and translates directly to digital infrastructure, where the pace of change makes long-horizon point forecasts unreliable.

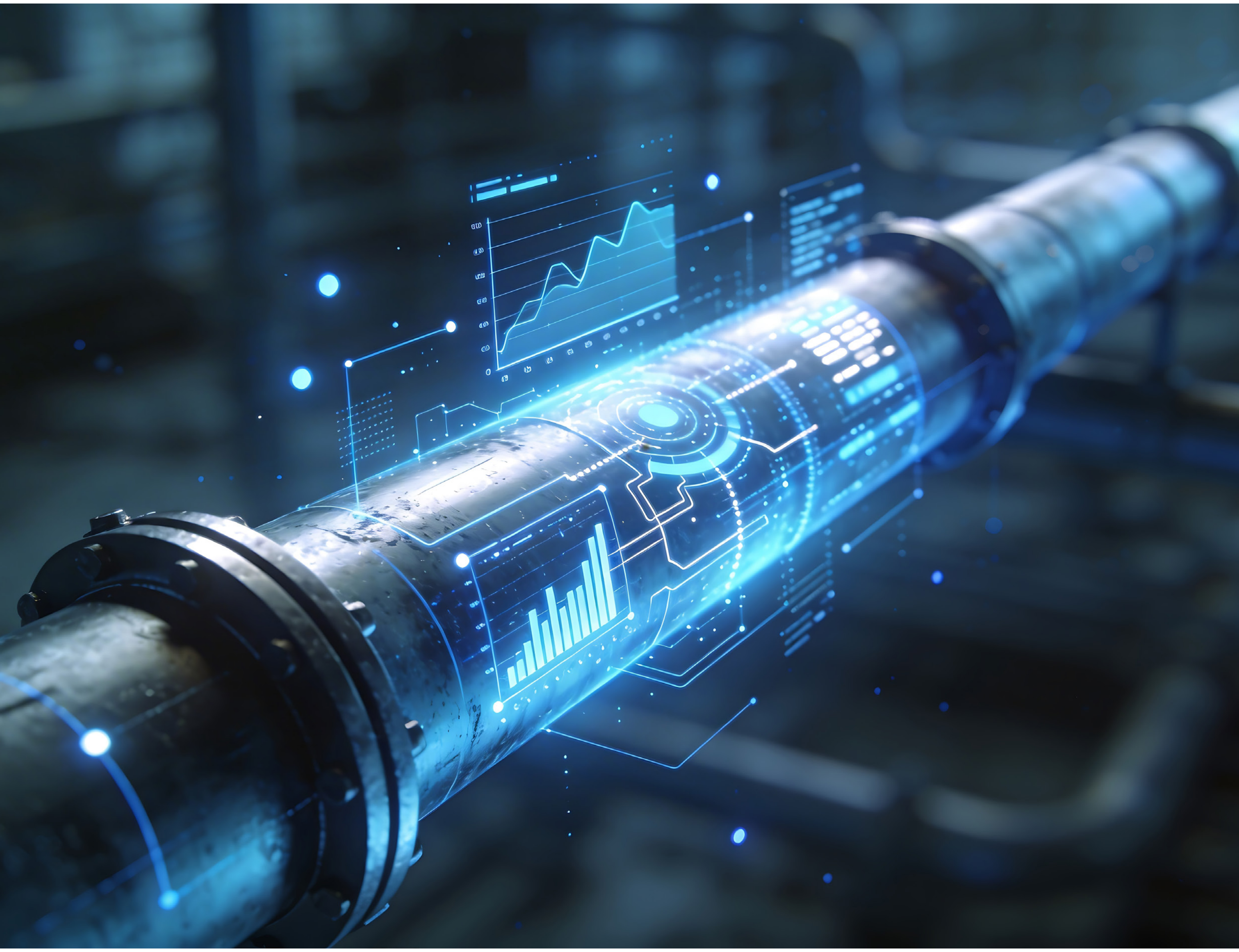
The second is **scenario-based infrastructure design**. Project teams develop multiple plausible futures for digital demand, energy availability, water access, workforce capacity, and regulatory settings, and test design and procurement decisions against each. The aim is not to predict which scenario will occur, but to identify decisions that perform reasonably well across all of them, and to flag decisions that depend heavily on a single assumption. This is particularly valuable when committing to long-lived passive infrastructure such as cable corridors, building shells, and grid connections, which must accommodate workloads that may look very different in a decade.

The third is designing for **flexibility and upgradeability.** Digital infrastructure assets benefit from modular design, oversized passive elements such as conduits and power feeds, and clear separation between long-lived physical components and shorter-lived digital ones. A data centre designed for cooling system replacement and rack-level density upgrades retains value through multiple AI hardware generations. A sensor network with open data standards and replaceable nodes survives platform changes. A digital twin built on interoperable data schemas can absorb new analytics layers without rework. Designing in this way trades a modest uplift in upfront cost for substantially reduced stranded asset risk and waste over the asset lifecycle.

These approaches also point to capability gaps that ISC is well-positioned to address. Current professional development and guidance in the infrastructure sector tend to treat digital as a delivery tool rather than a sustainability subject, and tend to assume the same planning certainty that has historically applied to conventional assets. The energy and resource implications of data infrastructure, the governance of sensing data, the sustainability credentials of AI systems, and the planning practices needed to navigate genuine uncertainty are not yet standard considerations in infrastructure project teams. By mapping these issues explicitly, the matrix and the planning approaches built on it identify where practitioner guidance, training, and the development of tools and other products could have the greatest impact.

For ISC's advocacy work, the matrix and an uncertainty-aware planning framework provide an evidence base for targeted engagement with government and regulators. The national data centre expectations, the NSW strategy review, and the emerging regional connectivity agenda all represent moments where ISC's voice, grounded in a structured understanding of digital infrastructure's sustainability dimensions, can shape policy outcomes that matter to members.

Advocacy on this foundation can move the conversation beyond broad calls for sustainable digital growth toward specific asks: mandatory sustainability reporting for data centres above a defined threshold, sustainability criteria embedded in digital infrastructure procurement standards, requirements for adaptive and scenario-based planning in major digital infrastructure approvals, and extensions to rating tools that cover sensing and AI infrastructure on par with conventional built assets.



Chapter 5

Conclusion

As evidenced in this report, digital infrastructure is not a separate conversation to sustainability. It is a fundamental element of the same conversation. The way we connect, compute, sense, and store data shapes how efficiently our assets perform, how equitably communities are served, and how responsibly we use our planet's resources. Getting this right is not just a technical exercise, it's also a sustainability imperative.

ISC is well placed to lead. Through its rating tools, networks, and advocacy, ISC can set expectations and raise the bar for how digital is deployed across infrastructure in Australia and Aotearoa New Zealand. But leadership requires a community, and this paper will only reach its potential if owners, operators, designers, builders, and technology providers stay engaged.
The path to the final recommendations and action plan is clear. Feedback gathered from members and stakeholders at ISC Connect will directly inform the next draft. The ISC AI and Digital Member Committee will continue to provide technical guidance and strategic direction. And the leadership of our sponsors — Jacobs, Honeywell, and Sydney Water — and additional ones along the way will help ensure the final output reflect both ambition and practicality.

The finished paper will go further than this interim report, offering deeper guidance for the infrastructure sector on how to act on the opportunities identified here. Additional resources to support implementation are also on the horizon.
If your organisation wants to help shape what comes next, a partnership pathway is available.

The digital transformation of infrastructure is well underway. ISC is committed to ensuring sustainability travels with it.

Appendix A

Digital Infrastructure Sustainability Matrix

This matrix maps the four categories of digital infrastructure against key attributes, capability, sustainability enablement, footprint, and current ANZ maturity. It is intended to inform Section 2.1 of the discussion paper and support the development of ISC's rating tool gap analysis.

Category key: 1 · Connectivity 2 · Data 3 · Sensing and devices 4 · Computing and AI 5 Autonomous and Robotics Enablement (+) Footprint (–)

	Infrastructure capability	Sustainability enablement	Technology	Key attributes	Sustainability footprint	Current maturity
Connectivity	Supports real-time asset monitoring, remote operations, and data-intensive workflows across infrastructure sites.	+ Enables remote workforce, reducing commuter emissions + Supports smart metering and demand management	**Fixed Broadband (NBN/fibre)**	High bandwidth Low latency Always-on Wired	– Energy use in exchanges and headends – Copper legacy infrastructure e-waste	Established — NBN coverage >96%
	Connects mobile assets, remote sensors, and field workers; enables real-time data exchange at infrastructure sites.	+ 5G enables low-latency control of autonomous machinery + Supports connected vehicles and smart transport	**Mobile Networks (4G/5G)**	Wireless Low-latency (5G) Device density Edge-ready	– Tower energy consumption – Hardware refresh cycles and e-waste	4G mature; 5G metro rollout underway
	Connects distributed sensors across large geographic areas — suited to water, agriculture, and remote infrastructure.	+ Enables environmental monitoring at scale + Low-cost connectivity for remote and regional assets	**LPWAN / LoRa networks**	Ultra-low power Long range Low data rate Low cost	– Minimal — battery life 5–10 years – End-of-life battery disposal	Growing — water and agriculture sectors
	Backbone of international and interstate data exchange; critical for cloud and AI workloads.	+ Enables distributed data infrastructure, reducing centralised energy loads	**Subsea and Terrestrial Fibre Cables**	Very high capacity Sovereign risk dimension Long-lived asset (25+ years)	– High embodied carbon in installation – Marine environment impacts during laying	Established; new cable investment ongoing
Data	Hosts enterprise workloads, cloud services, and AI training infrastructure at scale.	+ Consolidates workloads — more efficient than on-premise per unit compute + Renewable PPAs driving clean energy procurement	**Hyperscale Data Centres**	Massive compute & storage PUE-optimised Renewable energy targets Centralised	– Very high energy and water consumption – Embodied carbon in construction – Land use and heat island effects	Rapidly growing — AirTrunk, NextDC, Equinix
	Processes data close to source — reduces backhaul, enables real-time response for critical infrastructure.	+ Reduces data centre energy by processing locally + Enables real-time optimisation of transport, energy, water	**Edge Compute Nodes**	Distributed Low-latency processing Small footprint Near source	– Harder to manage and optimise than centralised – Distributed hardware harder to power with renewables	Emerging — pilot deployments in transport
	Provides scalable compute, storage, and integration for asset management, BIM, and digital twin applications.	+ Enables rapid scaling without new hardware + Shared infrastructure more efficient than siloed on-premise	**Cloud Platforms (IaaS/ PaaS/SaaS)**	Elastic Multi-tenant API-driven Globally distributed	– Scope 3 emissions from cloud usage can be opaque – Vendor lock-in limits sustainability governance	Mature — widely adopted across sector
	Connects disparate data sources across the asset lifecycle — enabling coordinated planning and operations.	+ Reduces rework through data continuity across lifecycle stages + Unlocks cross-sector optimisation (transport + energy + water)	**Data Integration and Interoperability Platforms**	Standards-based (IFC, CityGML, GTFS) API-first Real-time and batch	– Primarily software — footprint in underlying compute	Developing — standards fragmentation remains a barrier
Sensing and devices	Monitors asset condition, environmental parameters, and operational performance continuously.	+ Predictive maintenance reduces material waste and unplanned outages + Real-time environmental monitoring informs climate adaptation	**IoT Sensor Networks**	Low-power Distributed Real-time High-volume data	– Battery waste from large-scale deployments – Hardware refresh and e-waste at scale	Growing rapidly — water, transport, built environment
	Street furniture that hosts lighting, sensors, cameras, comms, and EV charging.	+ Reduces duplicate street infrastructure + Supports active transport monitoring and air quality sensing + EV charging integration	**Smart / Multifunction Urban Infrastructure**	Multi-use Urban Networked Power-integrated	– Embodied carbon in manufacture and installation – Lighting energy use (offset by LED efficiency gains)	Pilot stage to Mature — City of Melbourne, City of Sydney
	Measures air quality, water quality, noise, biodiversity indicators, and climate parameters.	+ Provides evidence base for sustainability outcomes reporting + Supports early warning for climate and environmental hazards	**Environmental Sensing Stations**	Continuous monitoring Multi-parameter Fixed and mobile	– Minimal — low-power, long-lived assets	Established in water and environment agencies
	Enables active traffic management, incident detection, and demand-responsive infrastructure operations.	+ Dynamic traffic management reduces vehicle emissions + Enables modal shift measurement and active transport planning	**Transport Monitoring Systems**	High bandwidth Real-time Safety-critical Data-intensive	– High bandwidth generates large data volumes requiring storage – Camera hardware refresh cycles	Mature — Transurban, TfNSW, VicRoads

Computing and AI	Creates virtual representations of physical assets enabling simulation, planning, and operational optimisation.	+ Reduces physical prototyping and rework — embodied carbon savings + Optimises operations for energy and resource efficiency + Enables climate scenario testing	**Digital Twin Capability**	BIM-integrated Real-time data feeds Simulation Full lifecycle	– Compute-intensive — ongoing energy cost – Requires high-quality data to avoid misleading outputs	Rapidly growing — Sydney Metro, Jacobs, Arup, WSP
	Optimises infrastructure operations in real time — grid balancing, predictive maintenance, demand forecasting, route optimisation.	+ AI-driven grid management reduces curtailment and emissions + Predictive maintenance extends asset life and reduces waste + Route and flow optimisation reduces energy use	**AI / Machine Learning Systems**	Pattern recognition Prediction & optimisation Requires training data	– Training compute is highly energy intensive – Model inference at scale has ongoing energy cost – Risk of greenwashing without measured outcomes	Rapidly growing — varies by application
	Supports large-scale simulation, climate modelling, structural analysis, and AI model training.	+ Enables climate and resilience modelling at infrastructure planning scale + Underpins digital twin simulation environments	**High-Performance Computing (HPC) Clusters**	Parallel processing High energy Specialised hardware On-premise or cloud	– Extremely high energy and cooling requirements – High embodied carbon and short hardware refresh cycles	Established in research, growing in infrastructure sector
	Provides the compute substrate for AI applications across infrastructure planning, construction, and operations.	+ Next-gen chips dramatically reduce inference energy per operation + Enables on-device AI at the edge without cloud dependency	**AI-Specific Hardware (GPUs, TPUs, neuromorphic chips)**	Accelerated inference Energy-per-operation improving Rapid evolution	– Manufacturing resource-intensive (rare earth minerals) – Short product cycles drive significant e-waste – Supply chain concentration — geopolitical risk	Embedded in cloud; emerging on-device (Physical AI)
Autonomous and Robotics	Automates earthmoving, haulage, and repetitive site operations; removes workers from high-risk operating environments.	+ Optimises fuel use through precision operation and reduced idling + Reduces rework via centimetre-level accuracy + Improves safety and reduces site incidents	**Autonomous Plant and Haulage Vehicles**	GNSS / LiDAR guided Geofenced operation Fleet-managed Heavy-duty	– Diesel-powered fleets still dominate – Sensor and compute hardware refresh cycles – Workforce transition risk in operator roles	Established in mining (Pilbara autonomous haulage); emerging in civil construction
	Self-driving vehicles that interact with road infrastructure and other vehicles to deliver passenger and freight services.	+ Smoother traffic flow reduces fuel use and emissions + Enables on-demand transit and shared mobility models + Removes human error as a road trauma factor	**Connected and Autonomous Vehicles (CAVs)**	Sensor-rich (LiDAR, radar, camera) V2X-capable Software-defined Safety-critical	– Battery raw materials and supply chain concerns – Sensor and compute energy load per vehicle – Induced demand may offset efficiency gains	Pilot stage — CAV trials in NSW, VIC, QLD; broad deployment 5–10+ years
	Surveys, monitors, and inspects assets across difficult-to-access environments, such as power lines, pipelines, bridges, marine infrastructure.	+ Replaces helicopter survey, cutting emissions by orders of magnitude + Faster inspection cycles reduce asset downtime + Removes workers from at-height and confined-water risks	**Aerial and Submerged Drones (UAVs / UUVs / ROVs)**	Battery-powered Remote or autonomous Payload-flexible Rapid deployment	– Battery e-waste from short product cycles – Airspace and privacy management overhead – Limited endurance restricts mission scale	Mature in surveying and utilities inspection; growing for asset monitoring and delivery
	Performs repetitive, precise, or hazardous construction tasks, such as bricklaying, welding, rebar tying, additive manufacturing of structural elements.	+ Reduces material waste through precision placement + Lowers embodied carbon through optimised material use + Enables off-site modular fabrication, cutting transport impacts	**Construction and Fabrication Robotics**	Task-specific Programmable On-site or factory-based AI vision integrated	– Embodied carbon in robotic hardware – Specialist skills and workforce transition – Maintenance and downtime can erode productivity gains	Emerging — early ANZ deployments in modular construction, tunnelling, and 3D-printed elements
	Operates inside pipes, tunnels, tanks, and other confined or hazardous spaces to inspect conditions and perform targeted maintenance.	+ Extends asset life through earlier defect detection + Reduces shutdown periods for inspection + Removes workers from confined-space and high-risk environments	**Inspection and Maintenance Robotics**	Confined-space capable Tethered or autonomous Sensor-integrated Specialist form factor	– Niche hardware with limited reuse across asset classes – Specialist operator training required – Connectivity-dependent in deep or submerged environments	Growing — water utilities (Sydney Water, Melbourne Water), rail tunnels, energy networks
	Augments human capability through wearable robotics, teleoperation, and AR-assisted operations on infrastructure sites.	+ Reduces musculoskeletal injury through load assistance + Enables remote operation of plant from safer locations + Improves first-time-right rates through guided workflows	**Exoskeletons, Teleoperation, and Augmented Reality Systems**	Wearable or wearable-integrated Human-in-the-loop Real-time feedback High collaboration / low autonomy	– Battery and electronics in wearables generate e-waste – Teleoperation dependent on robust connectivity — fragile in remote areas – Limited interoperability between vendor systems	Emerging — pilot deployments in construction, rail maintenance, and logistics

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