Category 5

Autonomous and Robotic Infrastructure

What Type of Infrastructure Does This Include

Autonomous Plant and Haulage Vehicles
GNSS- and LiDAR-guided, geofenced, fleet-managed heavy vehicles that automate earthmoving, haulage, and repetitive site operations.

Connected and Autonomous Vehicles (CAVs)
sensor-rich, V2X-capable, software-defined vehicles that interact with road infrastructure to deliver passenger and freight services.

Aerial and Submerged Drones (UAVs, UUVs, ROVs)
battery-powered, remote or autonomous platforms that survey, monitor, and inspect hard-to-access assets.

Construction and Fabrication Robotics
task-specific, programmable robots for relevant tasks based on capability, such as bricklaying, welding, rebar tying, and additive manufacturing of structural elements.

Inspection and Maintenance Robotics
confined-space-capable robots that inspect and maintain pipes, tunnels, tanks, and other hazardous spaces.

Exoskeletons, Teleoperation, and Augmented Reality
human-in-the-loop systems that augment worker capability and enable remote operation.

About This Infrastructure

The infrastructure translates digital intelligence into physical execution across construction, operation, and maintenance. This is what separates it from sensing, which observes, and computing, which decides. When AI is used in the sensing-and-action loop, the term is 'physical AI'.

Deployed on construction sites, across road and rail networks, inside pipes and tunnels, power lines and marine assets, and on the bodies of workers. It operates in the environments people find most dangerous or hardest to reach.

Ranges from established autonomous haulage in mining through to emerging construction robotics and wearable systems still in pilot.

Because it changes what work is done, by whom, and under what conditions, its context is as much social, covering workforce, safety, and accountability, as it is environmental.

The Landscape: Investment, Legislation, and Trends

Australia has a National Robotics Strategy (2024) and Aotearoa New Zealand has published its first national robotics roadmap.

Autonomous haulage is established in mining, notably the Pilbara. CAV trials are underway in NSW, VIC, and QLD.

Drones are mature in surveying and utilities inspection. Inspection robotics is growing in water utilities, including Sydney Water, along with rail and energy networks.

References: Australia's National Robotics Strategy (2024); Aotearoa New Zealand national robotics roadmap (KiwiNet, NZRAS, Callaghan Innovation).

DUAL LENS: OPPORTUNITY AND FOOTPRINT

Sustainability Benefits of Digital Infrastructure

Precision reduces waste: highly accurate positioning and less idling reduce fuel use, rework and material waste on site.

Drones replace higher-emission survey methods: using drones instead of helicopters and crewed surveys substantially reduces inspection emissions and allows safe access to assets at height or in confined environments. The Sydney Water drone sampling case study below is an example.

Off-site robotic fabrication: construction robotics enables modular, factory-based fabrication that reduces material waste and transport impacts.

Safety and workforce: removing workers from high-risk tasks, and using tools such as exoskeletons to reduce strain injuries, improves worker safety and wellbeing. Through thoughtful design and deployment, automation can also create new skilled roles and learning pathways, but this depends on deliberate workforce planning.

Digital Infrastructure Issues to Watch

01 **Fuel source and hardware**
diesel-powered fleets still dominate autonomous plant, and sensor and compute hardware refresh generates e-waste. Efficiency gains do not remove the fuel or hardware footprint.

02 **Autonomous vehicle materials and induced demand**
battery raw materials raise supply chain environmental and human rights concerns, and easier autonomous travel may induce more travel that offsets the efficiency gains.

03 **Workforce transition**
routine inspection, monitoring, scheduling, and operator roles face possible displacement pressures, which is a sustainability issue through the employment quality and social licence lens.

04 **Accountability and oversight**
when an autonomous or physical AI-recommended action causes harm, questions of accountability, transparency, and the right level of human oversight and cybersecurity are likely, with few frameworks for transparency currently available.

The Key Questions

Considerations that might help a member organisation build a business case for action and investment and to govern well are included in the table below.

P — PROCESS
Have we brought workforce transition, safety, and accountability into procurement and approval, alongside capital cost and productivity?

O — ORGANISATION AND CULTURE
Are we planning for the shift from direct execution to oversight, judgement, and exception handling, and for the training and accreditation pathways it needs?

T — TECHNOLOGY
Are we considering the embodied carbon of robotic hardware and the fuel source of autonomous fleets, not just the operational efficiency gain?

I — INFORMATION
Have we defined accountability and transparency where autonomous decisions and physical AI affect communities and safety-critical operations?

Applying This Across the Asset Lifecycle

Below are five common questions you may face across the asset lifecycle, each from the perspective most likely to raise it.

This is the newest category, and the one with the largest social licence dimension. The lifecycle lens weighs clear environmental and safety wins against workforce transition, accountability, and the hardware footprint.

Planning

State authority asset owner

"We are planning to bring automation into our delivery and maintenance pipeline. What belongs in the sustainability case beyond productivity?"

Broaden the criteria beyond capital cost and productivity to include workforce transition, safety, and accountability. Infrastructure that improves environmental performance but erodes employment quality does not meet a credible definition of sustainable. As the newest category, practice is still forming, so planning decisions now shape the agenda and its social licence.

Design

Sustainability consultant

"I am advising on an automated or robotic solution. How do I assess its true sustainability?"

Consider the embodied carbon of the robotic hardware and the fuel source of any autonomous fleet, not just the operational efficiency benefits. Diesel fleets still dominate, and battery raw materials and induced demand can offset autonomous-vehicle gains. Design for the whole footprint, and quantify the clearest wins, such as drones replacing helicopter surveys.

Construction

Construction company sustainability manager

"We are introducing construction and inspection robotics on site. Where is the upside and the risks?"

Precision operation reduces fuel use, idling, rework, and material waste; drones substantially reduce inspection emissions, and workers are removed from high-risk tasks. The downside is sensor and compute hardware refresh generating e-waste, battery minerals with supply chain labour and environmental risk, drone and robot disturbance near sensitive habitat, and workforce transition.

Operations and Maintenance

Asset owner and operator

"We are moving to autonomous inspection and maintenance. What changes for us as operator?"

The human role shifts from direct execution to oversight, judgement, and exception handling, with implications for training, accreditation, and safe systems of work that have not caught up. Define accountability and transparency where autonomous action affects communities and safety-critical operations. Quantify the gains as well: emissions avoided compared with manned surveys and safety incidents removed.

End of Life and Renewal

Asset owner and operator

"Our autonomous plant and drones are reaching end of life. What are the sustainability considerations?"

Sensor and compute hardware refresh and battery raw materials create e-waste and supply chain exposure at end of life. Plan reuse, recycling, and responsible battery disposal, and record volumes. Renew with the fuel source and embodied carbon in mind, not just the productivity gain, so each generation reduces rather than repeats the footprint.

The Cost of Inaction: Gaps in the Current Landscape

Disruption not tracked
treating automation as a separate workforce or technology issue leaves its sustainability and social licence implications out of the sustainability assessment processes.

No way to weigh the trade-off
there is no shared method to weigh environmental and safety gains against employment quality, accountability, and community trust.

Change gets harder
practice is still evolving, so decisions made now, without a sustainability lens, may become established norms that are harder to change later.