Please note: the substantive content of the 2026 NRI Roadmap Survey begins at Question 20 (with prior questions dealing with administrative and other information).

As such all submissions that are published include the responses submitted from Question 20 onwards only.

Q20.

Part 2: Research themes

2.1 NRI comprises the assets, facilities and associated expertise to support leading-edge research and innovation in Australia and is accessible to publicly and privately funded users across Australia and internationally. We are seeking your input on possible directions for future national-level investment - i.e., where the requirements are of such scale and importance that national-level collaboration and coordination are essential.

The 2021 Roadmap used a challenge framework to support NRI planning and investment. With this in mind, consider likely future research trends in the next 5 - 10 years, and with respect to one or more of the 8 challenge areas identified in the 2021 Roadmap as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or not at sufficient scale and
- describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities.

Q21.

Resources Technology and Critical Minerals Processing

New research infrastructure is critical to fast-track emerging technologies for Australia's Future Made in Australia program, enabling industry to supply value-added raw materials for the net-zero economy, focusing on green iron via hydrogen reduction and mineral carbonation for CO2 sinks. The challenge lies in developing validated models, sensors and methods to enhance the economic viability and circularity of low-carbon technologies for metals, construction materials and ceramics, thereby meeting global demand for decarbonised products. Pilot-scale plants are needed for testing new mineral processing techniques such as hydrometallurgy, pyrometallurgy, beneficiation, calcination, reduction and smelting of Australian ores using low-carbon methods (e.g. green ferrous feed to steel, bauxite to alumina, limestone to cement, and ores to copper, nickel, zinc, lithium, and other metals. These plants must be flexible to test ore types, reactors (wet to dry, pellet to fluidised bed, flash processing), and energy sources (electrification like microwave/plasma/resistive heating, hydrogen, alternative fuels, CO2 capture/re-use). Refining hubs are required to produce high-purity metals for battery and renewable energy applications, with recycling facilities to recover critical minerals from end-of-life products. Mineral characterization and testing facilities are also required; geoscience labs with advanced spectroscopy, X-ray diffraction, and electron microscopy; high-pressure, high-temperature test facilities for simulating processing conditions; and rare earth and lithium-ion battery testing labs to support new materials research. Advanced instrumentation and measurement systems are also vital to generate data for next-gen engineering models, including AI-integrated numerical models for optimising processing. Equally important are facilities to develop and demonstrate improved ore sensing/sorting systems, using enhanced sensors to boost circularity. This includes mineral carbonation technologies to turn mine residues into CO2 sinks. Facilities to recover co-products from tailings/slag are essential for the economy, spanning beneficiation, co-product production for circularity, and thermal processing such as calcination. Investing infrastructure in these key areas will position Australia as a leader in cost-competitive, sustainable critical minerals for global markets like battery metals and green construction. In 5-10 years, basic ore labs may not fit NRI as commercial providers grow, shifting focus to large-scale, low-carbon hubs.

Q22.

Food and Beverage

Climate-resilient food production will advance through breeding heat-, drought-, and salinity-tolerant crop varieties and livestock using gene editing, alongside controlled environment agriculture such as vertical and indoor farming. Infrastructure needs to include climate simulation chambers and approved field facilities for stress-testing GM crops, fast genomics/phenotyping platforms for rapid breeding, and autonomous robotics for data collection/analysis. Infrastructure for livestock and other food-producing animals will be required to evaluate housing improvements to optimise animal welfare, the impact of climate change on meat production and breeding, and the assessment of animal emissions and other measures of sustainable farming. New beverages—low/no-alcohol and novel fermented options—will emerge, alongside non-traditional protein, fibre and nutrient sources e.g. insects, legumes, duckweed and algae. Required infrastructure includes pilot- and commercial-scale bioprocessing, precision fermentation facilities; formulation/texturizing labs; large, climate-controlled insect-rearing units, and sensory analytical platforms to assess nutrition, digestibility, and consumer appeal. Traceable food supply chains will leverage faster, automated food safety/quality analytics and real-time sensors for freshness/contamination monitoring. This demands real-time analytics, sensor fabrication labs for advanced, low-cost devices, and AI/ML-equipped data hubs. Sustainable, circular food systems will extract high-value products from spoiled/secondary-grade foods via valorisation. Necessary infrastructure includes pilot- and commercial-scale biorefineries for waste-to-by-product conversion, processing facilities for turning insects into protein powder, oil, and biofertilizers and lifecycle assessment (LCA) tools for sustainability evaluation. Functional foods with bioactive compounds for health benefits, microbiome-focused innovations for gut health, and plants as molecular farming factories will grow. This requires high-throughput screening for bio-actives and food formulation facilities. Food safety/quality will improve with rapid pathogen detection, real-time spectroscopy/imaging for quality control, & sustainable packaging with freshness indicators. Needed are biosensor development/validation labs, advanced spectrometry/imaging facilities, & field phenotyping for crop disease detection. Co-locating facilities with research, to scale effort. Understanding consumer shifts toward sustainable/functional foods and modelling novel product adoption will need consumer research facilities for preference testing, VR-enabled sensory labs, and data tools for real-time market insights. Existing NCRIS assets such as APPN, BPA (AGRF, Metabolomics Australia), Microscopy Australia, NIF, ARDC, and Pawsey will remain vital over the next 5-10 years but must adapt to evolve with new technologies to meet the continuum of demand from the food and beverage industries.

Q23.

Medical Products

Medical products research will shift toward personalised medicine, advanced therapeutics (e.g. mRNA vaccines, gene editing) and AI drug discovery. This will require national research infrastructure such as State-wide biomanufacturing hubs capable of producing clinical-grade materials at scale (e.g. biologics, monoclonal antibodies and mRNA technologies) - currently limited to small batches. Similarly, manufacture of splice switching and/or antisense oligonucleotides useful for the treatment of human genetic disorders will require specific infrastructure. Despite being FDA approved, Australia does not have Good Manufacturing Practices (GMP) manufacturing capabilities for these therapeutics (drugs and vaccines). High-resolution imaging and molecular analysis platforms also need updating as major opportunities are not being realised with integration of facilities (e.g. cryo-EM and/or lattice microscopy with spatial transcriptomics and proteomics paired with HPC support) and demand is outstripping availability, slowing breakthroughs in precision treatments. National facilities (with GLP accreditation) for 3D printing and biofabrication for medical implants, prosthetics and tissue engineering are required to advance the application of medical devices and engineered biological materials. Improvements in the curation of human samples will be critical. Over the next 5 years, biobanks will broaden sample collection to include vulnerable communities, longitudinal data, multi-omics data as well as capacity to investigate the impact of environmental and lifestyle factors, enabling comprehensive analyses and public health initiatives. There needs to be consideration of large scale National biobanks for rare diseases so that samples can be accessed more broadly for research. In 5-10 years, clinical trial facility capabilities will be bolstered with new technologies and capacity for data-extraction and data-analysis and close interaction with bioinformaticians and biostatisticians to ensure data accuracy and integrity. Such facilities will support newer trial designs (e.g. cluster trials, adaptive designs) that provide greater efficiency and better outcomes. Decentralised trials using wearable tech and real-world data will reduce reliance on centralised sites, shifting them to private or hospital networks. Similarly, basic diagnostic labs for standard testing (e.g., blood analysis) will become routine, with national investment better directed toward frontier facilities, such as quantum biosensors or large-scale genomic sequencing centres.

Q24.
Defence

The likely shift in US international cooperation and China's growing presence in the Southern Pacific highlight the need for Australia to bolster its sovereign defence capability. Defence research will focus on sovereignty, autonomy and resilience, especially in EW/cyber for both defence and attack. Key areas over the next decade include dual-use autonomous systems, cyber resilience, hypersonic tech and countermeasures. Emerging trends such as AI battlefield simulations and quantum cryptography demand new infrastructure—secure, national-scale test ranges for drones, hypersonics, and human-machine teaming. Current infrastructure falls short for integrated robotics and autonomous system testing at the scale needed to boost capability for Australia and its partners. Defence research will also require facilities to test directed energy (e.g. Ultra Short Pulsed Lasers—USPL), and metallurgy for super-strong alloys. The SUPER-FAB facility in Adelaide for Superconductor Quantum Receivers and Quantum Devices will enhance Australia's defence and supply chain, fostering deeper ties with partners. It will design, fabricate, and test advanced Superconducting Chips (up to 106+ elementary cells per chip). A facility in military airspace, backed by top university expertise, will fast-track sovereign capability development for Australia and its allies. Our view is that the broader quantum computing infrastructure for Defence should be a Defence-led, secure investment, not NCRIS-funded, leaving the NRI to focus on semiconductor/quantum materials facilities. In 5-10 years, conventional weapons testing needs will not be meet NRI and there will be a move towards commercial solutions, with a shift to AI-driven defence. As commercial providers handle small arms and basic electronics testing, national oversight will decrease. Legacy cybersecurity labs tackling outdated threats like basic malware could shift to collaborative platforms for AI-driven defence simulations, metallurgy hubs and space systems.

Q25.
Recycling and Clean Energy

New research infrastructure is vital to accelerate the development and scaling of technologies that reduce costs for net-zero energy and fuels, such as hydrogen from renewable and fossil sources with net-zero CO2 and CO2 recycling. This will support Australia's Future Made in Australia program, aiming to supply value-added raw materials for the net-zero economy. The research challenge is to provide validated models, sensors and methodologies to enhance the economic viability and circularity of these technologies. Critical infrastructure gaps exist for pilot-scale systems that produce net-zero hydrogen—via electrolysis powered by solar/wind or fossil fuels with carbon capture—and bio-derived fuels from waste biomass or algae. CO2 capture and conversion into products like sustainable aviation fuels, carbonated minerals and chemicals (e.g. methanol) also lack adequate facilities [e.g. carbon capture, utilization, and storage (CCUS) research sites for large-scale CO_2 removal; direct air capture (DAC) hubs for atmospheric carbon extraction; reforestation and soil carbon sequestration labs for nature-based climate solutions]. Emerging technologies like plasma-assisted hydrogen production, advanced photocatalysis for CO2 reduction, and solid oxide electrolysis could leverage Australia's abundant solar resources and mineral wealth. Infrastructure must include high-throughput testing platforms for catalysts, real-time emissions sensors, and AI-driven process optimisation tools. Pilot facilities should test hybrid systems, such as solar-powered hydrogen paired with CO2-to-fuel conversion, tailored to Australia's remote energy hubs like the Pilbara. Modular bioreactors for algae-based fuels and carbon sequestration via mineral carbonation (using nickel or magnesium-rich ores) are also key. To scale up energy storage and recycling, there needs to consideration of battery and energy storage innovation hubs. For example, NRI could include solid-state battery and lithium recycling research hubs for next-gen energy storage; grid-scale battery testing facilities to improve efficiency and reliability; and supercapacitor and flow battery labs for long-duration energy storage. These systems require flexible configurations to assess diverse feedstocks, energy inputs, and outputs, alongside workforce training for future industries. Advanced instrumentation—e.g. in-situ spectroscopy and drone-based monitoring—will validate next-gen models integrating AI with digital twins, optimising energy efficiency and scalability. Such investments will cement Australia's role in global net-zero supply chains In 5-10 years, small renewable labs may not fit NRI as industry scales, redirecting focus to large-scale hubs. Leveraging South Australia's Pilbara-like energy hubs, these investments will ensure cost-competitive, low-carbon energy and materials, cementing a global role in sustainable supply chains.

Q26.
Space

Space research will grow over the next 5-10 years, focusing on satellite constellations, deep space exploration, lunar/Martian In Situ Resource Utilisation (ISRU), geotech for off-earth construction and agriculture for space. Emerging trends such as low-cost launch systems, on-orbit assembly and space-based solar power will demand new infrastructure. Australia's national launch facilities are limited to small payloads, while advanced ground stations for deep space communication remain underdeveloped. High-fidelity space environment simulators for testing materials and systems are also lacking, hampering global competitiveness. Infrastructure needs include dedicated and upgraded rocket launch sites (e.g. in South Australia) for orbital and suborbital missions; mobile and fixed ground stations for tracking and communicating with satellites; and telemetry, tracking, and command networks for secure space operations. A national approach to satellite design, manufacturing and testing is required e.g. satellite assembly and integration hubs for small and large-scale satellites; environmental test chambers for thermal, vibration, and radiation testing; and anechoic chambers for radiofrequency testing of satellite communications. A critical direction of research is in Lunar and Martian regolith processing. Large scale simulated regolith testbed facilities are needed to study how to extract oxygen, water, and metals from Moon/Mars soil; electrolysis and chemical processing labs are needed for turning regolith into construction materials, fuel, and oxygen. Similarly, there needs to be at scale ISRU-based manufacturing and construction facilities e.g. additive manufacturing labs to create structures using lunar/Martian regolith, and sintering and ceramic processing hubs to produce bricks, landing pads and habitats from space materials. To support the new area of space agriculture, there needs to be bioregenerative life support labs for growing plants using extraterrestrial soils. A scale-up and national approach to space science and exploration is required, such as microgravity research labs to test biological and material science in space-like conditions; Lunar and Mars mission simulation environments for human and robotic exploration research; and biomanufacturing and regenerative medicine labs for space-based tissue engineering. In 5-10 years, basic radio telescopes and small satellite assembly labs may not meet NRI standards as commercial providers expand access, reducing the need for national investment. Future NRI should prioritise large-scale, collaborative assets like orbital testbeds, lunar mission support infrastructure, and re-entry facilities to sustain Australia's space ambitions. A sovereign mission system for space domain awareness—currently absent—offers another key opportunity.

Q27.
Environment and Climate

Environment and climate research will focus on adaptation, biosecurity and ecosystem resilience over the next 5-10 years. Emerging trends like large-scale climate modelling, nature-based solutions, and bio-sequestration demand advanced infrastructure. Australia's continental sensor networks for real-time environmental data are fragmented, while dedicated carbon sequestration test sites—vital for technologies like direct air capture and soil carbon enhancement—are underdeveloped. Advanced high-performance computing (HPC) for climate simulations is overstretched, lacking capacity for hyper-local predictions critical to Australia's diverse landscapes. New technologies like quantum sensors for precise emissions tracking, satellite-integrated climate models, and biochar production from agricultural waste could transform carbon management. Infrastructure needs include scalable testbeds for blue carbon (e.g., mangroves, seagrasses) and mineral carbonation using Australia's basalt deposits, paired with real-time data hubs. Coastal observatories with robotic submersibles will monitor ocean acidification and heatwaves, supporting fisheries and reef restoration. Climate change is expected to exacerbate the spread of vector-borne diseases by altering vector habitats, expanding their geographic ranges, and extending the transmission seasons, potentially leading to increased risks of diseases like malaria, dengue and Lyme disease. Infrastructure required for research into these challenges include experimental vector (insect) habitats, artificial breeding sites with controlled environments to study vector behaviour and intervention effectiveness; and insectaries to test genetic and biotechnological interventions e.g. releasing genetically modified insects to curb population growth. Climate change also directly influences crop physiology, productivity, and associated microbiota as well as the distribution, abundance and virulence of pathogens, all affecting crop health. An upgrade to the APPF will be required to ensure there are sufficient controlled experimentation and genetic research facilities - climate-controlled greenhouses that simulating future climate conditions (e.g. increased CO_2, higher temperatures) to study plant-pathogen interactions. In 5-10 years, traditional weather stations and basic ecological monitoring sites may not meet NRI criteria as automated, commercial solutions proliferate, shifting them to regional oversight. National investment should prioritise integrated, large-scale platforms like ocean observatories, AI-driven climate impact forecasting systems, and drone-supported biodiversity monitoring to tackle escalating challenges. These will leverage Australia's unique geography—from coastal reefs to arid interiors—for global impact.

Q28.
Frontier Technologies and Modern Manufacturing

Frontier technologies and modern manufacturing will emphasize AI, quantum technologies and smart materials over the next decade. Emerging trends like autonomous production systems, 3D-printed advanced components and self-healing materials require robust infrastructure. Australia's national quantum computing labs are limited, hindering breakthroughs in optimisation and cryptography, while large-scale additive manufacturing facilities lack capacity for industrial prototyping. AI training datasets and computing power fall short for sector-specific innovation, stunting progress in precision manufacturing. Fundamentally, Australia needs a State wide network of advanced materials research hubs including high-performance materials labs for lightweight composites, superconductors, and self-healing materials; nanomanufacturing facilities for next-gen electronics, drug delivery systems and coatings; and biofabrication centres for lab-grown tissues, bio-inks, and regenerative medicine and synthetic biology research hubs for engineering microbes for pharmaceuticals, biofuels, and biomaterials. Modern manufacturing will also need smart factories and robotics labs with AI-driven automation and digital twins for real-time process optimization. For example, there will need to be additive manufacturing (3D printing) hubs for prototyping and mass customization, and precision engineering and microfabrication centres for semiconductor, nanotechnology, and high-performance materials. New technologies such as neuromorphic computing for energy-efficient AI, photonic quantum systems for ultra-fast processing, and bio-inspired smart materials (e.g. shape-memory alloys) could revolutionise production. Infrastructure needs include scalable 3D-printing hubs for aerospace-grade titanium—leveraging Australia's mineral resources—and pilot plants for graphene-based electronics. AI-powered digital twins will optimise factory workflows, while quantum sensors enhance quality control for exports like lithium batteries. Collaborative testbeds integrating robotics, IoT, and augmented reality will accelerate workforce upskilling and prototyping in sectors like defence and renewables. These advancements will position Australia as a leader in high-value, sustainable manufacturing. In 5-10 years, basic robotics labs and small-scale 3D printers may no longer qualify as NRI, as industry adoption makes them commonplace, reducing the need for national oversight. Investment should shift to cutting-edge, collaborative assets like exascale computing for AI-driven design, national materials synthesis hubs, and quantum fabrication facilities to maintain Australia's global manufacturing edge.

Q29.
2.2 The 2024 statement of National Science and Research Priorities (NSRPs) includes outcomes linked to each priority to assist in identifying critical research needed in the next 5 to 10 years.
Consider the priority statements and, with respect to one or more of the 5 priority areas as listed below:

- describe emerging research directions and the associated critical research infrastructure requirements that are either not currently available at all, or
- not at sufficient scale and describe current national infrastructure requirements that you anticipate will no longer fit the definition of NRI in 5-10 years.

Do not limit your commentary to NCRIS funded capabilities, and where relevant, refer to the underpinning outcomes and research identified in the NSRPs document.

Q30.
Transitioning to a net zero future

The NSRP's push for a net-zero future prioritises leading low-emission industries and scaling emerging technologies. Research will focus on advanced energy storage (e.g., solid-state and flow batteries), next-gen renewables (e.g., perovskite solar cells, offshore wind optimisation), and carbon capture utilisation and storage (CCUS) tailored to Australia's geology and industries. Integrating AI and quantum computing to optimise energy grids and predict demand will build a resilient, decarbonised ecosystem. Critical infrastructure gaps include large-scale testing facilities for advanced batteries and CCUS, unavailable at sufficient scale. Australia lacks national setups to simulate gigawatt-scale renewable integration—like offshore wind farms or hydrogen plants—under real-world conditions. Current university labs and small pilot plants can't scale innovations industrially. A national energy transition centre with high-capacity simulators, AI-driven modelling, and material synthesis labs is essential to close this gap. In 5-10 years, some NCRIS-funded renewable labs may not fit the NRI definition, focusing on incremental gains (e.g., solar efficiency) rather than transformative systems like grid-scale quantum optimisation or bio-catalysts for green manufacturing. As research shifts to interdisciplinary, mission-led approaches—merging AI, quantum tech, and circular economy principles—static, siloed facilities will fade. Future NRI must enable dynamic, large-scale collaboration to decarbonise hard-to-abate sectors like mining and aviation. New technologies like graphene-enhanced batteries, tidal energy converters, and microbial CCUS could leverage Australia's coastal and mineral strengths. Infrastructure needs include pilot hubs for hydrogen electrolysis powered by desert solar, and quantum-AI platforms for real-time grid balancing. Circular systems, such as recycling rare earths from mine tailings, will support sustainable tech deployment, positioning Australia as a net-zero leader.

Q31.

Supporting healthy and thriving communities

The NSRP priority of healthy, thriving communities targets equitable healthcare, mental health resilience, and adaptive social systems. Research will advance personalised medicine via genomics and AI to tackle chronic diseases like diabetes and cardiovascular issues prevalent in Australia, neurotechnology (e.g., brain-computer interfaces) for mental health, and socio-ecological studies on climate change's community impacts. Digital health platforms integrating wearables and environmental sensors will drive preventative care. Critical infrastructure gaps include biobanks and genome-phenome databases reflecting Australia's diverse population, linked to electronic medical records—akin to the UK Biobank's success—for precision medicine. An AI-driven health analytics hub is needed to process genomic, lifestyle, and environmental data for population-scale studies. Australia lacks large-scale neurotech trial facilities, like non-invasive brain stimulation or community-level neural mapping. Current hospital-based units are fragmented, unable to handle interdisciplinary, data-intensive research. A national health innovation centre with advanced computing, biobanking, and neurotech labs is vital. In 5-10 years, some NCRIS-funded medical facilities may not fit the NRI definition, focusing on traditional trials rather than real-time monitoring or socio-ecological resilience. As research shifts to preventative, tech-integrated, and community-focused approaches—reducing inequities per NSRP goals—static infrastructure will lag. Future NRI must support scalable, interconnected systems blending biomedical, social, and environmental sciences. New technologies like CRISPR-based therapies, wearable biosensors for stress detection, and VR-augmented mental health interventions could transform care. Infrastructure needs include mobile health labs for remote Indigenous communities, quantum computing for genomic analysis, and drone networks for real-time environmental health data in rural areas. These will position Australia as a leader in equitable, resilient health systems.

Q32.

Elevating Aboriginal and Torres Strait Islanders knowledge systems

This NSRP priority emphasises outcomes like integrating Indigenous knowledge into national systems and strengthening cultural resilience. Emerging research directions include co-designed, co-led and co-created studies blending Indigenous ecological knowledge with Western science for land management, Indigenous-led health research (e.g., bush medicine genomics), and digital archiving of oral histories using AI to preserve and analyse cultural data. Research into Indigenous governance models for climate adaptation is also critical. Critical infrastructure not currently available includes a national Indigenous knowledge research network with culturally secure data platforms and labs for bio-cultural analysis (e.g., testing traditional plant compounds). Australia lacks sufficient facilities for large-scale, community-led research that respects Indigenous protocols, such as on-country labs or digital tools co-developed with Elders. A dedicated infrastructure hub—combining cultural archives, biotech labs, and AI systems—is needed to elevate these knowledge systems. Infrastructure should also support capacity building, not only knowledge discovery and transfer. A pathway for knowledge revival should be considered. Use of AI and the infrastructure to support virtual reality experiential knowledge/ learning for young Indigenous is needed. Current NRI, like some NCRIS-funded cultural or environmental facilities, may not fit the definition in 5-10 years. These may lack bespoke Indigenous governance or capacity for two-way knowledge integration, focusing instead on Western frameworks. As research aligns with NSRP outcomes—e.g., embedding Indigenous perspectives in national decision-making—existing infrastructure will be inadequate without co-design and scalability. Future NRI must prioritise Indigenous-led, place-based, and interdisciplinary platforms. There is also a need to support knowledge building capacity for Indigenous peoples living in cities so they can get to know about country. The need for infrastructure support to enable Indigenous-led and community governed bio-banking and associated services is needed. Another focus could be on 'purpose-built hubs/centres/facilities' with state-of-the-art technology to enable research which is holistic (responds to all cultural needs), interdisciplinary and from bench to bedside and beyond.

Q33.

Protecting and restoring Australia's environment

The NSRP priority of protecting and restoring Australia's environment aims for biodiversity recovery and climate resilience. Research will advance synthetic biology for ecosystem restoration (e.g., gene editing for coral resilience), high-resolution climate modelling for regional adaptation, and circular economy innovations like bio-based materials. Remote sensing and AI-driven ecological monitoring will track environmental shifts in real time. Critical infrastructure gaps include a national synthetic biology foundry to develop and test solutions such as drought-resistant crops or reef-protecting organisms, currently unavailable at scale. Australia lacks advanced climate simulation centres with exascale computing to model hyper-local impacts—vital for its varied ecosystems. Existing small-scale ecological labs can't support large-scale restoration or real-time monitoring. A national environmental resilience hub, integrating cutting-edge biotech, AI, and sensor networks (phenotype, atmosphere, soil), is urgently needed. In 5-10 years, some NCRIS-funded environmental observatories may not meet NRI criteria, focusing on passive monitoring rather than proactive restoration or emerging tech like synthetic biology. As research aligns with NSRP goals—reversing biodiversity loss and boosting resilience—static, observation-only setups will fall short. Future NRI must enable dynamic, solution-focused systems blending advanced computing, biotech, and field deployment. New technologies like CRISPR for species adaptation, drone-swarm ecological mapping, and bio-mimetic materials from waste could transform restoration efforts. Infrastructure needs include coastal labs for algae-based carbon sinks, satellite-linked AI platforms for bushfire prediction, and scalable bioremediation testbeds leveraging Australia's microbial diversity. These will position Australia as a global leader in environmental recovery and sustainability.

Q34.

Building a secure and resilient nation

The NSRP priority of building a secure, resilient nation targets resilience to geopolitical shocks, secure critical infrastructure, and countering misinformation. Research will advance quantum cryptography for uncrackable communications, AI-driven cybersecurity to tackle threats like deepfakes and supply chain attacks, and socio-technical modelling to predict cascading failures in infrastructure and democratic systems. Autonomous systems for disaster response (e.g., drones, robotics) and biosecurity tech—rapid pathogen detection, climate-resilient crops/livestock, and non-traditional protein sources (e.g., insects, algae)—are also vital. Critical infrastructure gaps include a national quantum security lab to develop quantum-resistant encryption, crucial as quantum computing nears. Australia lacks a comprehensive AI-cybersecurity simulation environment to model nation-state attacks on energy grids or water systems. Current university labs can't replicate real-world complexity. A national resilience hub blending AI, quantum tech, and social sciences is essential. For food security—worth over $70B in exports annually—agriculture needs plant phenomics, synthetic biology, and biorefineries to adapt to climate change, shifting consumer preferences, and stricter regulations. In 5-10 years, some NCRIS-funded digital infrastructure may not fit the NRI definition, focusing on basic connectivity rather than advanced needs like real-time threat simulation or misinformation research. As threats evolve—AI disinformation, climate-driven disruptions—static systems will falter. Future NRI must support adaptive, large-scale platforms integrating physical, digital, and human resilience. New technologies like blockchain for supply chain transparency, neuromorphic AI for threat detection, and biosensors for food safety could bolster security. Infrastructure needs include drone test ranges for disaster response, scalable biorefineries for sustainable food, and urban labs for socio-technical resilience, leveraging Australia's strategic position to lead globally.

Q35.

2.3 The case for a new NRI capability, or enhancements to existing capabilities, typically emerges through advocacy from research communities clustering around rigorously identified needs and goals. Such a concept could respond to a requirement for novel or expanded capacity within a domain, or across domains, and must be such that it could only be made available with national-level investment.
If you have identified such a requirement, briefly describe the need, the proposed infrastructure capability, the medium-term goals, impacted research communities, and the timeframe over which you advocate its establishment. Your response can include links to relevant existing reports.

National Hubs in South Australia for critical sectors South Australia’s unique assets offer the opportunity for new NRI capabilities in critical sectors: to evolve necessary infrastructure for net-zero energy, biosecurity, defence & space. A national-scale investment will unify fragmented efforts across the nation. Climate change & geopolitical shifts require scalable solutions in energy & metallurgy (e.g. green iron & metals), agriculture (net-zero, biosecurity), defence (quantum materials, directed energy), & space (ISRU, lunar/Martian geotech). Proposed Capability: hubs should include: (1) a net-zero energy/green metals catalyst in Whyalla; (2) an agriculture catalyst with co-localised climate chambers & plant phenotyping, imaging & biosecurity (including GMO entomology facilities); (3) semiconductor & quantum materials facilities for defence, USPL & sovereign alloys; (4) an ISRU & geotech lab for lunar/Martian construction & farming for Space. These are all underpinned by nation leading AI-driven platforms for optimisation. Medium-Term Goals: Over 5-10 years: (1) enhance net-zero energy, climate-resilient farming & biosecurity by 25%; (2) develop sovereign quantum materials & USPL for defence; (3) pioneer lunar/Martian ISRU technologies; (4) position Australia as a global exporter of resilience technology. Impacted Communities: Agricultural scientists, entomologists, defence engineers, space researchers & industry (e.g. BHP, CSIRO) will benefit. Facilities and universities (including regional campuses) & SMEs will drive interdisciplinary innovation at scale through these hubs. Timeframe: Launch in 2025-2027—funding in 2025, pilot by 2027, full-scale by 2030—aligning with climate & defence priorities. Context: South Australia’s net-zero energy/green metals catalyst/hub would build on Whyalla’s green iron investment and be inspired by Germany’s Fraunhofer model, requiring national-scale coordination to bridge research-to-market gaps, ensuring leadership in agriculture, defence & space resilience. Other hubs could be modelled on the example below, of what hubs such as this, could look like: A National Industry Catapult for Green Iron and Green Metals The global race to net-zero emissions requires radical innovation in carbon-intensive industries like steel & metals production - key contributors to Australia’s economy & global CO_2 output. A compelling case exists for a new NRI capability—a “Green Metals Catapult”—to drive the development of green iron & low-carbon metals. Modelled on Germany’s industrial prowess or the UK’s Catapult network, this would meet the urgent need for novel, scalable production capacity, requiring national-level investment beyond the reach of fragmented research efforts. The Need Steel & metals production accounts for ~7-9% of global CO_2 emissions, largely from coal-reliant blast furnaces. Green iron, produced via hydrogen-based direct reduction (H2-DRI) & green metals (e.g. low-carbon aluminium, copper) hinge on cost-competitive, scalable tech. Challenges include high energy costs, limited renewable integration & nascent supply chains. Australia’s research landscape—split across SMEs, academia & industry—lacks the heft to bridge lab breakthroughs to industrial reality. A national capability is critical to unify efforts, de-risk innovation & hit 2030 decarbonisation targets, aligning with global frameworks like the EU Green Deal. Proposed Infrastructure Capability The Green Metals Catapult would be a collaborative hub featuring: (1) an H2-DRI pilot plant to refine green iron processes; (2) renewable energy labs for low-carbon smelting (e.g., solar-powered plasma furnaces); (3) a circularity centre to boost scrap recycling; (4) a digital twin platform with AI for real-time optimisation; (5) an innovation arm to translate research into industry growth. Inspired by the UK’s High-Value Manufacturing Catapult & Germany’s Fraunhofer Institutes, it would link academia, industry & government, accelerating tech deployment. Facilities would test emerging methods like microwave-assisted reduction & bio-char substitution, leveraging Australia’s renewable & mineral strengths. Medium-Term Goals Over 5-10 years, the Catapult aims to: (1) slash green iron costs by 20-30% via efficiency & scale; (2) create a retrofit blueprint for existing plants; (3) set green metals certification standards; (4) establish Australia as a global exporter of green tech. These align with the EU’s Carbon Border Adjustment Mechanism (CBAM) & UK net-zero goals, boosting competitiveness in a carbon-priced world. Impacted Research Communities This would unite materials scientists (e.g. developing low-carbon alloys), engineers (e.g. advancing hydrogen electrolysis), energy experts (e.g. integrating tidal/solar power), & economists (e.g. assessing market fit). It would engage top universities (e.g. Adelaide, UNSW, Imperial College), national labs (e.g. CSIRO, UK’s NPL) & firms like BHP & Rio Tinto. SMEs would gain access to shared resources, amplifying innovation. Timeframe Launch within 2-3 years (2025-2027): funding/site selection in 2025, pilot operations by 2027, full scale by 2030. This syncs with climate deadlines & builds on initiatives like Australia’s Whyalla investment (over AUD$1B) & Germany’s Hydrogen Strategy. Justification and Context The scale—mirroring Germany’s €9B hydrogen push or the UK’s £1B Catapult network—demands national investment. Reports like the UK’s “Net Zero Strategy” (2021) & Germany’s “National Hydrogen Strategy” (2020) highlight centralised infrastructure’s role in crossing the research-to-market “valley of death.” Conclusion Only a national effort can deliver the cross-domain coordination & funding needed, enhance existing efforts and secure Australia’s industrial future in a dynamic geo-political global security situation across hubs for critical sectors.

Q36.

Part 3: Industry perspectives

This section is seeking input specifically from industry-based respondents. Other respondents can skip this section.

Recommendation 6 of the [2021 Roadmap] related to improvements in industry engagement with NRI. To complement work on this topic that has occurred since then, we are seeking additional advice on NRI requirements as perceived by current or potential industry-based users.

Q37.

3.1 Have you (or your organisation) interreacted with or used Australia's NRI?

- (●) Yes
- ( ) No

Q38.

3.2 If so, please briefly outline the NRI capabilities you (or your organisation) have interacted with or used. Do not limit your response to NCRIS capabilities.

Given we are a comprehensive, research-intensive university, we utilise offerings across the full suite of NRI capabilities to support our research efforts. As seen from earlier in the survey, we have recently interacted with the full range of NRI.

Q39.
3.3 Please indicate your (one or more) primary reasons for interacting with NRI:

- [x] For expertise or advice
- [x] Access to research resources or products
- [x] Access to equipment for research
- [ ] Access to equipment for operational reasons
- [x] Help in translating research
- [x] Access to data
- [ ] Support for clinical trials
- [ ] Other (please specify)

Q40.
3.4 If you answered no, please indicate your (one or more) primary reasons:

This question was not displayed to the respondent.

Q41.
Part 4: Other comments
4.1 Please elaborate on any of your above responses or add any other comments relevant to the development of the 2026 Roadmap. Your response can include reference or links to existing reports that you recommend be considered during the 2026 Roadmap development process.

N/A