20-Year NSW R&D Roadmap - Consultation Paper

In January 2021, NSW launched the Turning ideas into jobs: Accelerating R&D in NSW Action Plan. The Action Plan was guided by an Advisory Council, chaired by David Gonski AC, which included eminent leaders in innovation, business, government and the tertiary sector. The Action Plan recommends five Priority Actions and 16 Supporting Actions that will accelerate the rate at which ideas are translated into new industries, jobs, products and services, and will help make NSW the R&D leader in Australia and a world-class contributor.

The Action Plan recommends that: "*The NSW Government develop a 20-year NSW R&D Roadmap (the Roadmap) that identifies NSW's current and future research and industry competitive advantages and ensure these inform NSW's R&D investment and activity over a 20-year timeframe".* The development of the Roadmap is being led by the Hon. Gabrielle Upton MP, Parliamentary Secretary to the Premier, and R&D NSW, part of Investment NSW. The 20-Year NSW R&D Roadmap will:

- Identify and assess NSW's existing competitive advantages.
- Identify and assess critical and strategic sectors, technologies and applications for NSW.
- Prioritise sectors, technologies and applications that NSW should focus R&D investment on to enable the development of future industries.
- Make recommendations to guide government, business and research organisation R&D priorities, expenditure and activities in NSW.
- Develop five-year action plans for R&D capability, investment and outcomes in each priority area.

The Roadmap focuses on NSW's competitive advantages and strategic needs because although demand for R&D is almost unlimited, public and private resources are finite. Therefore, it makes sense for NSW to focus its R&D investment on sectors, technologies and applications where it can leverage competitive advantages or where there is a strategic need to develop capabilities. The Roadmap will assist the NSW Government to prioritise its own R&D investments, and provide a signal to industry and researchers on where R&D investment opportunities exist in NSW.

The R&D Roadmap will be iterative, reviewed periodically and adaptive and responsive to what is happening in the local and global economy.

Competitive advantages are attributes that allow a business or state to outperform its competitors. Competitive advantages can be general (for example in a sector or technology) or specific to a particular application. The R&D Roadmap will assess a broad range of competitive advantages including:

- **R&D capability** – capabilities in institutions and businesses
- **People and skills** – a skilled workforce
- **Education and training** – program, facilities, and pipelines
- **Facilities** – access to equipment for testing and production
- **Infrastructure** – for production, logistics, trade, and export
- **Natural/geographic** – access to resources and climate
- **Regulatory** – supportive regulatory environment
- **Markets** – strong local demand for existing and new products
- **Industry** – existing industry clusters and business networks
- **Supply chains** – existing business and export relationships

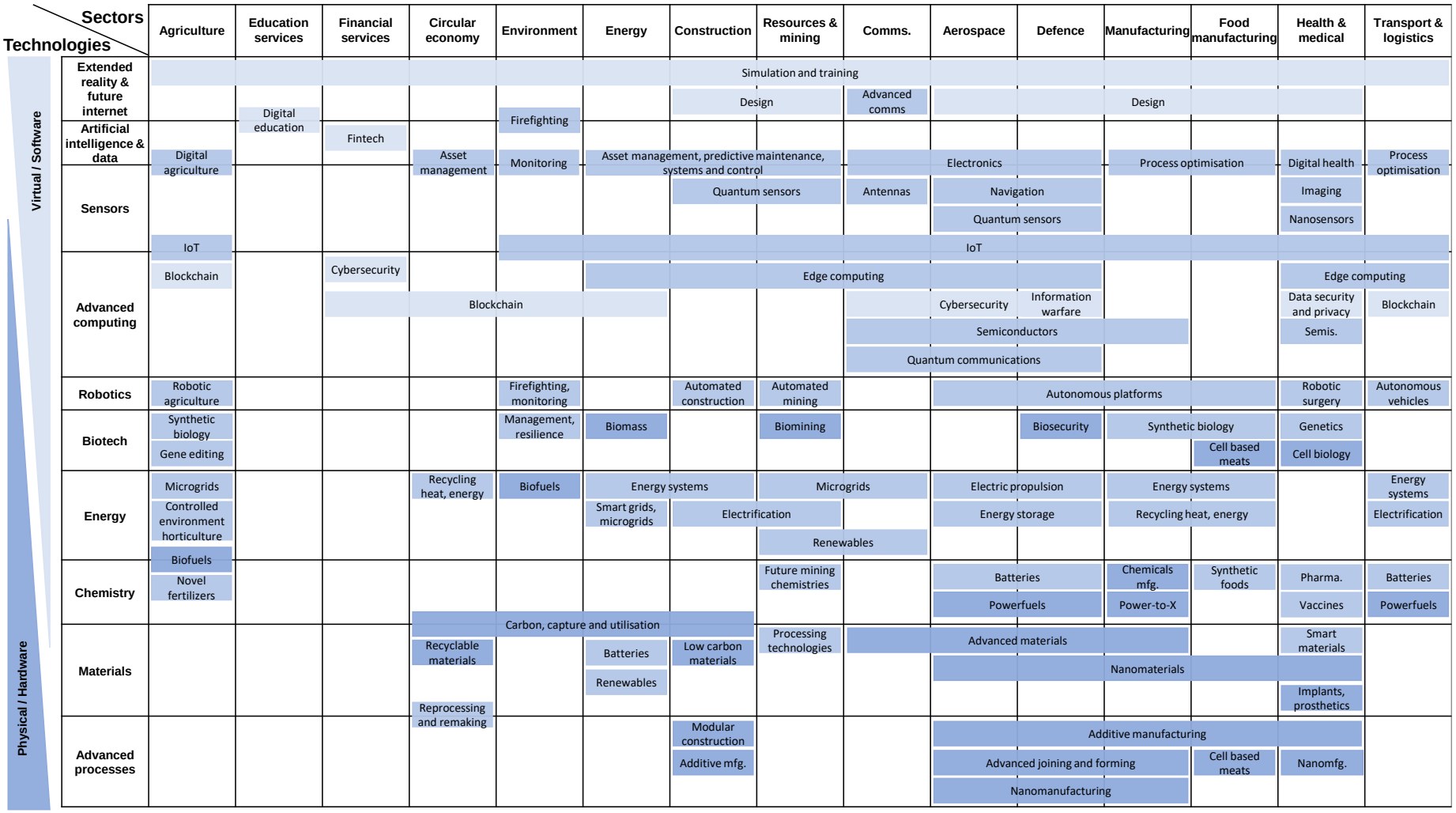
The R&D Roadmap will focus on assessing NSW's competitive advantages in sectors, technologies and applications:

- **'Sectors'** – broad industry areas focused on supply chains for common products and/or customers and sharing similar attributes. For example, the 'agriculture' sector which comprises entities involved in (or directly supporting) the production and harvesting of food, forest, and fibre products from cultivated or natural habitats.
- **'Technologies'** – methods, systems and devices with common attributes and functions that can be applied in a variety of applications across different sectors. For example, 'artificial intelligence (AI)' which comprises methods, systems, and devices for the simulation of intelligent behaviour (learning and problem solving) in machines; and can be used across different sectors for multiple applications including visual perception, speech recognition, decision-making, and language translation. See Technology Group Definition (page 4).
- **'Applications'** – the use of technology for a specified purpose, generally in a specific sector. For example, 'robotic agriculture' which comprises the use of robotics to perform tasks in the agricultural sector such as planting and harvesting.

An aggregation of sufficient competitive advantages in a sector, technology or application can make that sector, technology or application 'an area of competitive advantage for NSW'.

While NSW needs to prioritise areas where it has competitive advantages, NSW also needs capabilities in certain sectors, technologies and applications that are critical for economic and national security. For example, the Covid-19 pandemic has demonstrated how having a local vaccine research and manufacturing industry has been critical for countries to rapidly access to sufficient supplies of highly effective vaccines. Therefore, the R&D Roadmap will also identify and prioritise sectors, technologies, and applications that NSW needs for strategic reasons**.** These are areas that could become competitive advantages, with deliberate effort and investment, enabling new industries to emerge.

The NSW Industry Landscape Diagram (below) illustrates the relationships and overlaps between sectors (vertical), technologies (horizontal) and applications (matrix). The R&D Roadmap will expand on the below diagram, to develop a comprehensive view of the sectors, technologies and applications that comprise the current NSW and potential future industry landscape (with a focus on the latter).



NSW Industry Landscape Diagram: Illustrates the relationships between sectors (vertical), technologies (horizontal) and applications (matrix).

Technology definitions

Technology	Definition	Examples
Extended reality and future internet	Technologies that enhance or replace our view of the world.	**Augmented Reality (AR)** – overlaying vison with computer-generated information. **Virtual Reality (VR)** – immerses a user within a computer-generated virtual environment. **Virtual worlds** – digital environments including digital twins and simulations. **The 'metaverse'** – a persistent, synchronous, functioning virtual experience spanning digital and physical worlds and the Internet.
Artificial intelligence (AI) and data	Technologies that leverage computers and data to solve problems and make decisions.	**Speech recognition** – processing of human speech into written text. **Virtual agents** – providing customised information and assisting decision making, including in response to conversational requests. **Computer vision** – processing and identification of features, objects and text from images and videos. **Autonomous vehicles** – integrating multisensory inputs with large data sets to enable self-driving.
Sensors	Technologies that detect or measure physical properties.	**Acoustic sensors** – sensors that detect and/or measure acoustic waves **Biosensors** – sensors that detect and/or measure biological structures, molecules, and organisms. **Quantum sensors** – systems that use quantum properties or phenomena to measure physical quantities.
Advanced computing	Technologies that support advanced applications of computers.	**Internet of Things** – system of internet-connected physical objects including everyday devices, machines, and sensors. **Cybersecurity** – hardware, software, processes, and practices for protecting networks, devices, and data from digital threats. **Blockchain** – distributed, unanimous and immutable digital ledgers for recording information. **Edge computing** – distributed computing that bring computation and data storage closer to the sources of data and users. **Quantum computing** – systems that use quantum properties or phenomena to perform computation. **Semiconductors** – semiconductor devices are electronic components, either discrete devices or integrated circuits, critical to the functioning of almost all technology applications.

Technology	Definition	Examples
Robotics	Technologies that enable machines to perform physical tasks.	**Drones** – unmanned aerial vehicles that are remotely piloted or can fly autonomously through embedded sensors and systems. **Automated construction** – the application of automated robotic systems for construction of buildings and infrastructure. **Automated mining** – the application of automated robotic systems for mining. **Robotic surgery** – the application of human-controlled or automated robotic systems for medical procedures.
Biotech	Technologies that use biological organisms, systems, or processes.	**Synthetic biology** – redesigning organisms for useful purposes by engineering them to have new abilities. **Gene technologies** – understanding, making, or adapting genetic material. **Biomining** – using microorganisms for mineral processing. **Biomass** – biological material used for energy or other applications.
Energy	Technologies that store, transport, manage, convert and use energy.	**Energy systems** – systems to optimise energy generation, transmission, storage, and consumption. **Electrification** – power from electricity replacing other power sources, especially fossil fuels. **Biofuels** – fuels produced from biomass. **Smart- and micro-grids** – future electricity grids, especially decentralised grids with advanced controls, automation, and other digital technologies.
Chemistry	Technologies that use chemical properties and interactions.	**Synthetic foods –** the chemical synthesis of substances into edible products. **Pharmaceuticals** – compounds manufactured for medicinal purposes. **Vaccines –** substances used to stimulate antibody production and provide active acquired immunity against disease. **Carbon capture and utilisation** – capturing carbon dioxide to be recycled for further use.
Materials	Technologies to develop, process and use materials.	**Smart materials** – designed materials that can controllably and reversibly modify their properties in response to stimuli. **Nanotechnology** – materials with unit sizes at nanoscale dimensions or produced with nanotechnology. **Low carbon materials** – materials with low carbon emissions and energy use in their production, assembly and transport. **Circular materials** – renewable, recyclable materials that enable regenerative supply chains.
Advanced processes	Advanced technologies for processing and production.	**Additive manufacturing** – also known as 3D printing, producing objects by precision layering of materials.

Technology	Definition	Examples
		Advanced joining and forming – advanced processes for joining and forming or materials into objects. **Nanomanufacturing** – the production of nanoscale materials, structures, devices and systems. **Biomanufacturing** – use of biological systems to produce biomaterials and biomolecules.