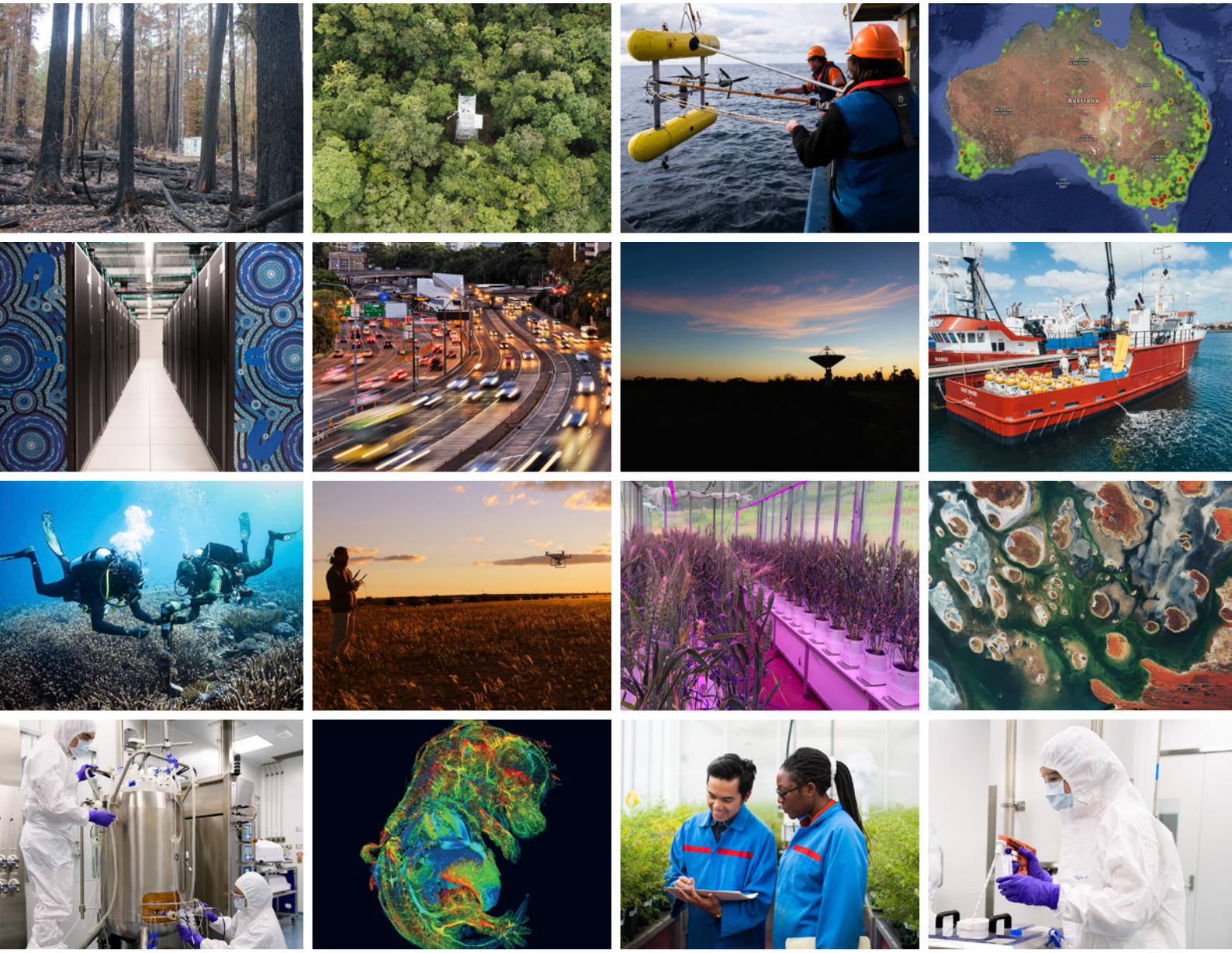
Australian Government

2020 RESEARCH INFRASTRUCTURE INVESTMENT PLAN

November 2020



ISBN 978-1-76051-952-0 [PDF]
ISBN 978-1-76051-953-7 [DOCX]

With the exception of the Commonwealth Coat of Arms, the Department's logo, any material protected by a trade mark and where otherwise noted all material presented in this document is provided under a Creative Commons Attribution 4.0 International (https://creativecommons.org/licenses/by/4.0/) licence.

The details of the relevant licence conditions are available on the Creative Commons website (accessible using the links provided) as is the full legal code for the CC BY 4.0 International (https://creativecommons.org/licenses/by/4.0/legalcode)

The document must be attributed as the Australian Government 2020 Research Infrastructure Investment Plan.

Ministers' Foreword

This 2020 Research Infrastructure Investment Plan will continue to provide Australian researchers with access to modern and world-class national research infrastructure (NRI). This will enable advances in science, technology and knowledge; boosting productivity, creating jobs, and delivering economic growth.

The Australian Government has made a 12-year, $4 billion investment to support Australian researchers with world leading research infrastructure from 2017–18 to 2028–29. Investments through the National Innovation and Science Agenda and biennial Research Infrastructure Investment Plans are consolidated through the National Collaborative Research Infrastructure Strategy (NCRIS) and have resulted in a mature and networked suite of NRI.

Our NCRIS facilities and services have shown a responsiveness and capacity to assist in times of need. They have swiftly deployed resources to support the national and international COVID-19 research effort. This agile and rapid response capability has kept Australia at the forefront of emerging global responses. Many of the NCRIS projects have provided critical support, including:

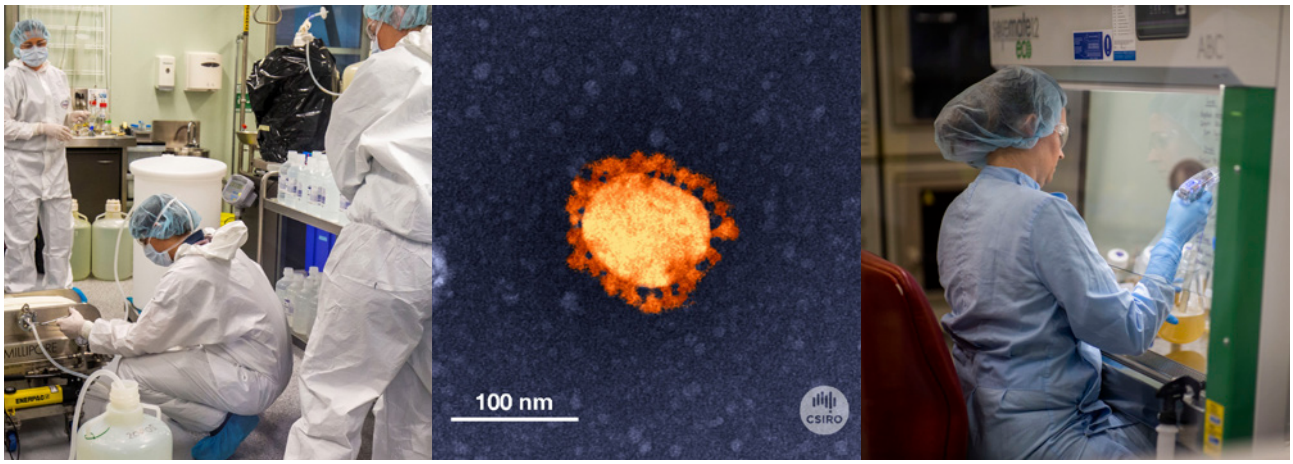
- Bioplatforms Australia, Microscopy Australia and Translating Health Discoveries into clinical applications (THD managed by Therapeutic Innovation Australia) are involved in the University of Queensland's vaccine program.
- Australian Centre for Disease Preparedness (ACDP) (formerly the Australian Animal Health Laboratory) are heavily involved in supporting academic, industry and government departments in response to COVID-19 through imaging, gene sequencing and bioinformatics, evaluation of antiviral candidates and virus survivability studies.
- Bioplatforms Australia has enabled DNA sequencing to support diagnosis of COVID-19.
- Phenomics Australia (formerly Australian Phenomics Network) is providing critical support for COVID-19 research through the production and supply of pre-clinical model systems for the discovery of novel treatments and vaccines.
- Astronomy Australia Limited (AAL) supported Swinburne University of Technology and the ARQ Group in the development of a COVID-19 Symptom Tracker. The Symptom Tracker is available online or via an app and primarily helps users track their symptoms over time. Anonymous data from these users will also help health authorities and medical researchers understand more about COVID-19 and pandemics more broadly.
- Microscopy Australia and the National Imaging Facility (NIF) are heavily involved in supporting COVID-19 research through assisting with imaging, diagnosis, and analysis of new Personal Protective Equipment (PPE) and test kit materials.
- National Imaging Facility (NIF) is supporting hospital loads through shared facilities and has developed a novel way of manufacturing low-cost ventilators, has prepared itself to supply clinical tracer and FDG (fluorodeoxyglucose) to Australian hospitals if international supplies become an issue, and is supporting COVID-19 vaccination studies.
- National Computational Infrastructure and Pawsey Supercomputing Centre reprioritised their services to offer computation and data analysis support to COVID-19 research projects.

- The Australian National Fabrication Facility (ANFF) redirected their equipment to quality control test face masks for frontline workers when they could not be sourced with appropriate safety assurance. In addition, ANFF was ready to supply for emergency patient situations by producing valves for respirators. ANFF has supported and managed product-based technology outcomes, for COVID-19 related devices, accelerating their development during the isolation period.
- Genomic analyses of COVID-19 have been published on the international Galaxy eResearch platform supported, in part, by Bioplatforms Australia and the Australian Research Data Commons (ARDC).
- ARDC's Health Studies Australian National Data Asset program is creating the fundamental infrastructure to enable data sharing from Australian clinical trials. This is critical to enable Australian researchers to respond to the COVID-19 pandemic.

We are proud to continue our support for these projects, as well as investing in emerging research priorities through the 2020 Research Infrastructure Investment Plan. Targeted investment in emerging priorities, such as synthetic biology and improved climate modelling, demonstrates the Government's ongoing commitment to respond to research challenges and develop capability in new fields of discovery for research and industry.

The Hon Dan Tehan MP
Minister for Education

The Hon Karen Andrews MP
Minister for Industry, Science and Technology



Contents

1 2020 Research Infrastructure Investment Plan Snapshot ____ 4

2 Impact of National Research Infrastructure Investment ____ 5

3 Funding existing capabilities to continue the vision of the 2016 Roadmap ____ 11

4 Funding new national research infrastructure capabilities ____ 13

Synthetic Biology ____ 13
Australian Community Climate and Earth Systems Simulator (ACCESS) ____ 14
Humanities, Arts and Social Sciences (HASS) and Indigenous Research ____ 15
National Sea Simulator (SeaSim) ____ 16
Coastal Vessels ____ 16

5 Next steps ____ 17

Scoping Studies ____ 17
2021 National Research Infrastructure Roadmap ____ 17

A Appendix A: Funding for projects through NCRIS under the 2020 Research Infrastructure Investment Plans (RIIP) ____ 18

1. 2020 Research Infrastructure Investment Plan Snapshot

The 2020 Research Infrastructure Investment Plan (Investment Plan) provides continued support for Australia's national research infrastructure (NRI) facilities, as well as investment in emerging research priorities that were first identified as potential areas of support in the 2016 National Research Infrastructure Roadmap (Roadmap). This investment will support Australian researchers to remain internationally competitive and help maximise the potential for economic benefits from scientific discoveries.

The $157 million 2020 Investment Plan provides:

- funding of $96 million in 2022–23 for 20 projects currently funded through the National Collaborative Research Infrastructure Strategy (NCRIS).
- funding of $61 million over 2020–21 to 2022–23 for new NRI capabilities:
  - $36.3 million for the expansion of the National Sea Simulator (SeaSim) operated by the Australian Institute of Marine Science to support research for protecting the Great Barrier Reef.
  - $7.6 million to transform the existing Australian Community Climate and Earth System Simulator to improve Australia's weather, climate and earth system modelling capability (ACCESS-NRI).
  - $8.3 million to establish a national synthetic biology research infrastructure capability (BioFoundry) that will increase automation and improve timeframes of products to market.
  - $8.9 million to develop targeted national Humanities, Arts and Social Sciences (HASS) and Indigenous eResearch data tools and platforms to improve the way researchers discover, access, curate and analyse Australia's social, cultural, heritage and Indigenous data.

Investments in ACCESS-NRI, Synthetic Biology and HASS will be as pilot projects with consideration of future investment made in the context of the 2021 NRI Roadmap and the 2022 Investment Plan. More information on specific projects is at **Appendix A**.

2. Impact of National Research Infrastructure Investment

The Government is providing over $4 billion from 2017–18 to national research infrastructure. This funding is administered through the NCRIS program.

Our current suite of NCRIS projects provide critical services and facilities enabling research across the whole spectrum of fields of research. Facilities include:

- Digital infrastructure, including supercomputers, platforms for urban research and environmental information. As well as a network of data stores and services for nationally significant research and a national research cloud offering digital tools and virtual laboratories.
- Observing systems to support research into food, water, resources, environment, biological security and the impacts of increasing human population.
- Fabrication and characterisation research infrastructure to support advances in medical research and innovation in material design.
- High quality omics and bioinformatics infrastructure to provide new knowledge in biomedicine, bio-industry, agriculture and the environment.
- Equipment to identify molecules with high potential as therapeutic drugs and accelerate their progress into clinical trials.
- Earth imaging and geospatial systems to support research into Earth's structures and materials, foster advances in the mining industry, and develop new products and industries associated with accurate, reliable global positioning.

Continued investment in research infrastructure is necessary to maintain an NRI system that will deliver the research excellence needed to drive innovation across the economy and create jobs. NCRIS facilities are also drivers of collaboration – they integrate researchers from across broad disciplines, catalysing relationships and supporting cross-disciplinary research. Our current NCRIS facilities employ approximately 1400 highly skilled technical staff and support 65,000 researchers in Australia, and a further 12,000 international researchers.

High-quality and accessible NRI is necessary for attracting international innovators and industry, driving Australia's reputation for scientific and research excellence. Our research infrastructure encourages strong long-term industry and research partnerships, both domestically and internationally, which provide a conduit for knowledge to support industry to deliver future jobs and economic growth.

The 2017–18 National Research Infrastructure Census highlighted the positive impact that NCRIS projects have on the research sector, economy and society. Further investment by the Government through this Investment Plan will help NCRIS facilities continue to deliver these results and more.

- NCRIS facilities are enabling world-class research – measured by the high citation rates of academic publications developed using NCRIS facilities (on average almost twice that of other similar publications).
- The top three industries served by the NCRIS facilities are the scientific and technical services, agriculture industry and mining industry.
- In 2017–18, NCRIS facilities produced 72 patents, an increase of 80 per cent over the past two years, showing substantial commercialisation outputs.
- The NCRIS program attracts significant co-investment from industry, universities and other stakeholders—estimated at $1.29 for every Australian Government dollar invested over the three financial years 2015–2018.
- Over 70 per cent of NCRIS projects provide critical or operational services to enable Australian Government policies and program delivery, as well as providing specialist advice and data.
- NCRIS projects enable cross-disciplinary research opportunities, for example in areas such as the biological sciences, medical and health sciences and environmental sciences.

Therapeutic Innovation Australia (TIA) and Australian Centre for Disease Preparedness (ACDP) enabling development of COVID-19 vaccines

TIA's involvement in the vaccine development is part of the University of Queensland's (UQ) group, commissioned by the Norway-based Coalition of Epidemic Preparedness Innovations (CEPI), to fast-track vaccine development against COVID-19. UQ has a novel molecular clamp technology that can rapidly accelerate development of new vaccines. To enable a fast-tracked development and manufacturing scale-up of UQ's COVID-19 vaccine into Phase I clinical trials, more than $20 million has been pledged by various organisations, including $5 million from the Federal Government, to support the project.

Three TIA-funded facilities are directly involved in COVID-19 vaccine development. The UQ vaccine team is utilising the National Biologics Facility (NBF; Queensland and Victoria nodes) and TetraQ. NBF's Queensland node is conducting cell line and process development of the vaccine candidate working closely with the Victoria node to produce material for the preclinical and Phase I clinical trial. TetraQ are performing the preclinical toxicology studies and will be involved in the clinical trial testing. The advanced manufacturing work completed to date by the NBF will now be transferred to CSL, who have partnered with CEPI and UQ for further development of the vaccine.

Another facility receiving NCRIS funding, that is engaged by CEPI to support pre-clinical COVID-19 vaccine testing is CSIRO's ACDP. The work undertaken at ACDP's high-containment facility (one of only two Physical Containment Level 4 (PC4) facilities in Australia) is a key step in developing a new vaccine as it allows researchers to test efficacy of potential vaccines in animal-based preclinical studies. The CSIRO team at ACDP has tested two international COVID-19 vaccine candidates to date.

Australian National Fabrication Facility (ANFF) and spinifex grass commercialisation

The ANFF supports micro and nanotechnology research in Australia by providing all researchers with micro, nano and advanced materials fabrication facilities – and the associated expertise – on an open-access basis. Collectively, ANFF-supported research spans 30 universities as well as CSIRO. Apart from fostering significant research, ANFF has supported the development of numerous new technologies.

One of ANFF's current projects involves investigating the commercial potential for spinifex grass, a species of grass native to Australia, which covers approximately 26 per cent of Australia's mainland, and adapted to regions with high temperatures, low rainfall and poor soil quality.

This initiative, being led by the Queensland Node of the ANFF at UQ, takes advantage of the myriad of opportunities that the structure of spinifex offers. The versatility of spinifex at the cellular level has driven exploration of its potential to be used in construction (i.e. cement, mortar, grout), bio-composites (such as reconstructed wood) and reinforcing plastics, paper and rubber (such as surgical gloves and cardboard boxes).

Aside from the commercial applications development, this project will utilise existing spinifex supplies, along with facilitating Indigenous partnerships with industry, Indigenous training and employment. Trial testing is currently underway for the use of spinifex fibre in cardboard and packaging products with one of the largest Australian paper manufacturers. A new company will also be formed and funded through private equity to develop Spinifex gels in the medical field. Applications of these biodegradable Spinifex gels would include management of osteoarthritis, tissue engineering and dermal fillers. Through NCRIS funded projects, Australian-owned businesses can access equipment and technical specialists that would otherwise be unaffordable or not available in Australia. As ANFF is intellectual property (IP) neutral, Australian industry can get a significant advantage with their products without having to risk compromising their IP, which is a fantastic opportunity for new businesses. ANFF's strategy is to be central to the activity of stimulating advanced manufacturing and sovereign capability in the post COVID-19 economic rebuild.

Terrestrial Ecosystem Research Network (TERN) assisting with Australian bushfire recovery

TERN collects critical ecosystem observations and makes the data available, along with modelling tools, to allow research into how ecosystems are responding to environmental pressures. This includes collection, storage and sharing of infrastructure, such as instrument towers, plot networks for flora and fauna surveys, and real-time environmental sensors and data streams.

Capability developed through TERN is driving a new wave of advances in our use of satellite and other remote-sensing technologies, to obtain accurate, up-to-date information about environmental variables that influence fire risk, and to track fire impact on the Australian landscape. TERN is providing researchers with unique quality time-series data on the exchanges of water and carbon before and after the fire event. Such data are very rare globally and may challenge some of our assumptions about carbon losses during fires. TERN data is improving bushfire behaviour models for forests and other ecosystems, which help Australian scientists to predict how our ecosystems respond to recurring extreme events.

Marine National Facility (CSIRO)

RV Investigator is an integral component of the Marine National Facility and provides Australia with a dedicated capability to survey, sample and monitor its oceans. This was recognised in the 2018 Research Infrastructure Investment Plan, with funding allowing for the maximum allocation of 300 research days per year to be delivered. The continuation of support under the 2020 Investment Plan ensures the Marine National Facility continues to meet the aspirations of the United Nations' Decade of Ocean Science for Sustainable Development (2021–2030) and support Australia's world leading ocean and atmospheric scientists.

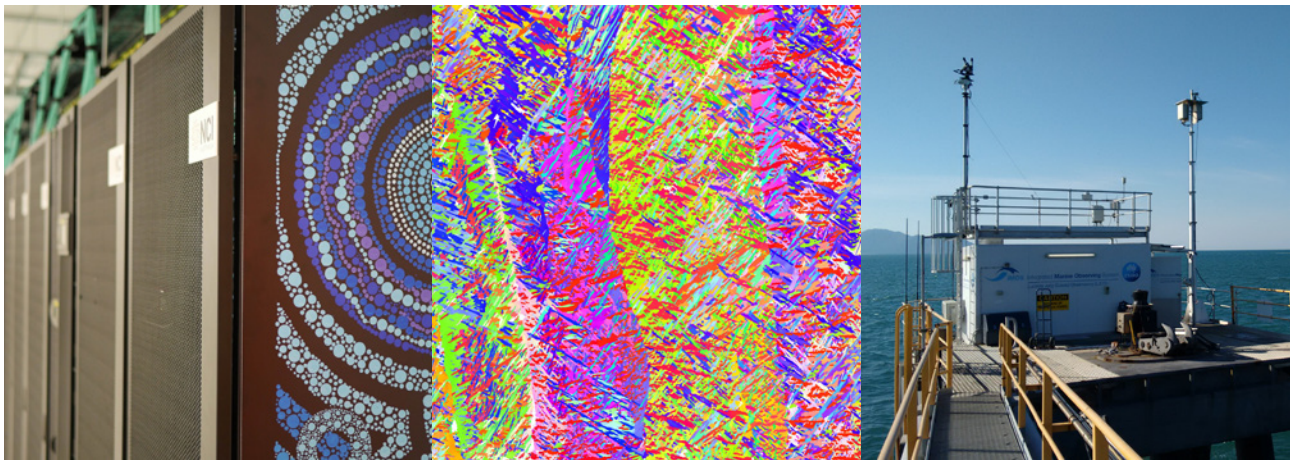
Annual applications for sea time are highly competitive and consistently exceed 300 days per year. Successful applications must demonstrate excellent science and a national benefit. Continued Government support for this research capability will ensure these projects will proceed. Examples of projected deployments generating benefits to Australia include:

- A study led by researchers from the Australian Antarctic Division to assess Antarctic krill distribution and abundance in waters around Antarctica. Antarctic krill are a key component of the Southern Ocean food web and also form an important global resource through krill fisheries. The scientific data collected during this voyage will increase our understanding of the Antarctic krill population, helping to ensure the sustainability of commercial harvesting practices and contributing towards protecting the Antarctic environment.
- A biodiversity survey to investigate the conservation values of Australia's marine territories around the remote Cocos-Keeling and Christmas Islands. The biological communities around these islands are almost completely unknown and potentially harbour unique species that are new to science. The scientific data collected will fill a major spatial gap in marine biodiversity datasets, support future conservation and management, and directly contribute to Australia's international obligations to understand the marine environment around claimed offshore territories.

3. Funding existing capabilities to continue the vision of the 2016 Roadmap

The 2020 Investment Plan provides $96 million in 2022–23 for 20 existing NCRIS projects. This investment will continue to support NCRIS facilities involved directly in bushfire prediction and recovery and the global response to the COVID-19 pandemic. It will continue to support benefits across a broad range of areas including:

- The Atlas of Living Australia (ALA) supports the research that informs policy decisions of government by improving the infrastructure and data products that interface between research and policy. For example, ecosystem scientists use the ALA infrastructure to support management decisions and practices through the provision of trusted biodiversity data services for environmental assessment by Commonwealth and state governments.
- Microscopy Australia is helping novel materials and compounds, which are being commercialised for environmental remediation, such as those for use in cleaning up contaminated soil and water in Australia and around the world. Further applications include new generating components for mobile X-ray units and more environmentally friendly cement that uses waste products such as fly ash and carbon dioxide.
- National Imaging Facility (NIF) enables imaging to study complex issues from epilepsy localisation and cardiovascular thromboses to protecting soldiers and looking inside oil pipelines. This research better informs medical health and engineering design.
- The Integrated Marine Observing System (IMOS) curate long-term data collections that are beneficial for maintaining historical data sets required for applications such as monitoring fish stocks, which has flow on effects to Australia's food security.



Beyond 2022, our NCRIS projects will empower Australian researchers to address key national and global challenges and support Australian industry and employment, including:

- Phenomics Australia providing experimental and technological capabilities that can underpin the potential genome-based medical diagnoses and treatment that will become the standard practice of medical care in the Australian health system.
- Bioplatforms Australia providing next generation sequencing and mass spectrometry that can allow Australia to increase the scale and capacity of research outputs.
- The Australian Plant Phenomics Facility (APPF) is developing a range of data assets and cloud based data management and data analysis solutions including Virtual Laboratory tools. These will provide researchers and industry with improved access to APPF-generated research data, as well as creating new data collections to further accelerate knowledge transfer, for example into breeding programs for the development of novel crop varieties.
- AuScope is building a Downward Looking Telescope (DLT) for geoscience, which includes integrated field based instrument deployments, including national seismic monitoring arrays, analytical laboratory infrastructure, FAIR[1] data repositories and the development of virtual environments and analytics, which underpin the delivery of key geoscience datasets to enable next generation research using high performance computing.
- Australian Research Data Commons (ARDC) Public Sector to Research Sector Data Bridges program will facilitate specialist research access to public sector health information to accelerate responses to health/social crises such as COVID-19 and bushfires, together with the associated economic disruption.
- The Australian Urban Research Infrastructure Network (AURIN) is enhancing and developing data access, management and analysis computer infrastructure for improved data-driven planning and policy making in urban, regional, rural and remote areas of Australia.
- Microscopy Australia is enabling the development of new materials providing solutions for industries (e.g. solar power, LED light sources, energy generation and storage, manufacturing, ICT and electronic devices, quantum computing, biomedical devices and drug discovery and delivery).

1. Findability, Accessibility, Interoperability and Reusability.

4. Funding new national research infrastructure capabilities

The 2020 Investment Plan provides funding for new capabilities that were identified in the 2018 Investment Plan and 2016 Roadmap. This targeted investment demonstrates the Government's ongoing commitment to respond to emerging research challenges and develop capability in new fields of discovery for research and industry.

The 2018 Investment Plan identified a number of scoping studies to explore potential new NRI activities, including the role of Government in supporting 'green-fields' projects. Scoping work has been undertaken in the following areas:

- Platforms for HASS and Indigenous Research
- Australian Community Climate and Earth Systems Simulator (ACCESS)
- Synthetic Biology

Extensive work has been undertaken with the research sector on these topics and Government considers a three-year pilot investment is critical to support the development of these new NRI capabilities and provide a 'proof of concept' to enable the incremental development of these research infrastructures. The 2021 Roadmap will provide further opportunity to consider where these projects sit in Australia's emerging NRI needs and priorities.

The 2018 Investment Plan also outlined future investments in the SeaSim and a Coastal Vessels capability. These capabilities have been considered in the context of the 2020 Investment Plan and are outlined below.

Synthetic Biology

Australia already has expertise in basic and translational research across medicine, agriculture and industrial biotechnology and boasts a world-leading regulatory framework for gene technology. There is an opportunity to build on this expertise, by investing in a synthetic biology capability, so Australian researchers will be at the forefront of global technologies and developments.

Investment of $8.3 million over the forward estimates (2020–21 to 2022–23) provides seed funding for a small scale, synthetic BioFoundry. A BioFoundry (or biological foundry) can be described as an integrated facility that can design, build, and test genetic material to address a certain need or reach a goal. This facility will help address critical gaps in technology platforms and informatics which remain a serious impediment for bridging the research to commercialisation pathway, potentially preventing Australia from realising economic and health benefits worth billions of dollars. This new capability will increase the number of concurrent biological development research activities that can be undertaken with synthetic biology through automation, robotics, machine learning and artificial intelligence – potentially accelerating research outcomes. This will help address national challenges, for example, the production of drought tolerant plants and crops that can respond to future drought and salinity impacts.

It is anticipated that a synthetic biology BioFoundry will contribute a wide range of broader impacts:

- Manufacturing new vaccines and developing living therapeutics (such as for COVID-19).
- DNA constructs generated in this facility could deliver life-saving corrections to diseased cells in patients through personalised gene therapies.
- Developing biosensors to detect disease in crops before the onset of visual symptoms, enabling early detection of food spoilage in the supply chain, thereby reducing waste and increasing food security.

- Enabling the complex engineering of bacteria to convert sugar to hydrogen gas to possibly power remote communities.
- Enable the technologies which underpin biomanufacturing of chemicals, new materials, pharmaceuticals and fuels.
- Assist with national capability in crop improvement at a Plant Transformation Facility. Here crops will be improved for drought tolerance and disease resilience under Australian conditions.

This new capability will help Australian researchers gain access to new global markets, like the US which in 2017 was worth US$137 billion in the pharmaceutical sector, US$104 billion in crops and US$147 billion from industrial biotechnology.[2]

Australian Community Climate and Earth Systems Simulator (ACCESS)

Australia's current climate modelling capability is primarily delivered through the ACCESS. An enhanced ACCESS capability, ACCESS-NRI, for the research community will assist Australia to better prepare for, and respond to, natural disasters and emergencies. This includes increased understanding of the effects from bushfires, floods and other weather related events which impact the economic and social wellbeing of Australian communities. The Government, through the Bureau of Meteorology, and CSIRO, holds a national leadership role to ensure the best information and forecasts are available to inform critical real-time decision making in operational agencies. ACCESS-NRI is a software infrastructure project that will bring together the required leadership, scientific and research expertise with software development, high performance computing and data management and analysis skills to improve Australia's weather, climate and Earth system modelling capability. ACCESS-NRI will ensure researchers are equipped with an enhanced ACCESS model to conduct research and contribute improvements into the forecasting model and to prepare for future climate and weather patterns.

Investment of $7.6 million over the forward estimates (2020–21 to 2022–23) in an enhanced ACCESS-NRI will assist Australia to:

- Accelerate research in support of policy makers at the forefront of economy-wide grand challenges including disaster risk reduction, emergency management, health risks, emergent disease, water security, agriculture, urban sustainability and natural resource management.
- Navigate and manage the risks and opportunities presented by environmental change and natural disasters through improved weather, climate and Earth system modelling capability.
- Enable new research into water and carbon management, ecology, air pollution, agriculture and public health, and to integrate research into a sustainable national modelling system.
- Create an environment for researchers to prepare for and take advantage of the national capability in areas that are emerging from transformations to exascale high performance computing technology.

2. The Economist (2019): *The engineering of living organisms could soon start changing everything*, https://www.economist.com/technology-quarterly/2019/04/04/the-engineering-of-living-organisms-could-soon-start-changing-everything.

Humanities, Arts and Social Sciences (HASS) and Indigenous Research

Government investment of $8.9 million over the forward estimates (2020–21 to 2022–23) will help build national HASS and Indigenous eResearch infrastructure, creating new tools and platforms to extend researcher capacity. It will provide easier access to data and analysis methods enabling effective data mining and re-use, maximising the return on previous research investments. The infrastructure will enhance research in a broad range of fields including education, Australian cultural studies, linguistics, history, economics, commerce, tourism, law and legal studies, and the creative arts. The investment will help institutions share HASS data more freely and cooperatively following FAIR data principles.

The investment over three years will include:

- Improving Indigenous research capabilities
  - Supporting the Indigenous Data Network to consolidate and expand its technological, training, and governance initiatives following CARE data principles (Collective benefit, Authority to control, Responsibility and Ethics).
- HASS eResearch platforms initially comprising three elements:
  - Developing the Linguistics Data Commons of Australia (LDaCA)
    - Capitalising on existing infrastructure, rescuing vulnerable and dispersed collections, and linking with improved analysis environments for new research outcomes.
  - Developing a Trove researcher platform for more advanced research
    - Complementing existing National Library of Australia resources, enabling a focus on the delivery of researcher portals accessible through Trove. This platform will create tools for visualisation, entity recognition, transcription and geocoding across Trove content and other corpora.
  - Integrated social sciences research infrastructure
    - Expanding existing social sciences initiatives and providing a coordinated governance model for access to data. This will improve the capacity of researchers to access, preserve and disseminate quantitative and qualitative social sciences data sources. It will also drive the development of systems and tools for capturing new and emerging real time, or near real time, data.

These initiatives will leverage existing NCRIS capabilities including the ARDC, The Population Health Research Network (PHRN) and AURIN.

National Sea Simulator (SeaSim)

SeaSim is a unique, world-class research aquarium facility for tropical marine organisms, located near Townsville in Queensland. SeaSim is operated by the Australian Institute of Marine Science. SeaSim directly supports research into coral reef adaption and resilience strategies for the Great Barrier Reef that cannot be performed anywhere else in the world. Access to the facility is in high demand.

An expansion of this facility was scheduled to commence in 2022–23, supported by the 2018 Investment Plan. However, this additional capacity is required earlier in 2020–21 to support the Great Barrier *Reef Restoration and Adaptation Program (RRAP)* research and development phase. $36.3 million over the forward estimates (2020–21 to 2022–23) will support the fast tracking of the design and construction of the SeaSim expansion program. This includes expanding the capacity of the SeaSim large tank systems and associated physical containment and culture laboratories.

It is estimated that research undertaken by SeaSim will directly support approximately 70 per cent of the total RRAP research and development phase, and will impact all interventions being progressed. RRAP aims to create an innovative toolkit of safe, acceptable interventions to help the Reef in resisting, adapting to, and recovering from, the impacts of climate change. Some examples of these interventions include: creating artificial reef structures to speed recovery following a disturbance, and enhancing temperature tolerance, and other desirable traits to facilitate natural populations' adaptation to environmental change.

Coastal Vessels

Investment of $720,000 in 2022–23 will support establishment of a southern coastal research vessel fleet. This new NRI capability, identified in the 2016 Roadmap and outlined in the 2018 Investment Plan for investment post 2021–22, will both increase access to sea time on existing coastal research vessels to enhance Australia's marine research capability across southern, western and eastern Australia, and assist planning for a new coastal research vessel for southern Australia. This investment will increase our capability to deliver national benefits that exist from scientific discovery in our vast and largely untapped oceans.

It will provide increased collection of critical data and information from across our marine estate, enabling greater understanding of environmental baselines and impacts, ocean conditions, petroleum and mineral resources, climate change, fish stocks and biosecurity threats.

Australia's marine environment supports fishing, aquaculture, marine reserves, ship building, renewable energy, ecotourism and mining, which contributes almost $70 billion each year to the economy and supports 197,000 direct jobs.[3] Research vessels contribute to the blue economy by providing platforms to take researchers to Australia's diverse marine habitats, supporting field observations, vehicle deployments and offshore infrastructure.

This investment will greatly enhance coordination, efficiencies and potential cost-effectiveness amongst vessel operators. Increased coordination of vessel operations and transparency of schedules will increase opportunities for access and collaborative vessel-based science and marine training, as well as fill gaps in the marine estate coverage.

3. Deloitte Access Economics (2018). *The AIMS Index of Marine Industry Australian Government*, https://www.aims.gov.au/sites/default/files/2018%20AIMS%20Marine%20Index.pdf.

5. Next steps

Scoping Studies

Eight scoping studies on potential new research infrastructure capabilities were identified in the 2018 Investment Plan. Three have been completed and the National Environmental Prediction System will be completed in 2020. The remaining four scoping studies in relation to Biobanks, Biosecurity, Precision Measurement, and High Performance Computing, are the subject of ongoing discussions with the sector to ascertain how best to incorporate these areas into the development of the 2021 National Research Infrastructure Roadmap.

2021 National Research Infrastructure Roadmap

The Government has a critical responsibility to ensure that research infrastructure funding is effectively targeted to maximise benefits to Australia's economic development, innovation, social wellbeing, environmental sustainability and overall prosperity. The Government is demonstrating leadership by continuing to work closely with the research sector and other key stakeholders on identifying strategic priorities and future planning for NRI projects.

The 2021 Roadmap will provide a new five year outlook for infrastructure investment. It will provide a strategic, whole-of-government view to investing in Australia's NRI system with an understanding of the need to meet the evolving landscape of research infrastructure and technological advancements.

More information on the 2021 Roadmap process and opportunities to contribute to its development will be made available shortly.

Appendix A: Funding for projects through NCRIS under the 2020 Research Infrastructure Investment Plans (RIIP)[4]

National Research Infrastructure Facility	2020 RIIP Allocation ($m)
Enhanced Australian Community Climate and Earth Systems Simulator (ACCESS)	7.6
Atlas of Living Australia (ALA)	2.39
AuScope	5.71
Australia Telescope National Facility (ATNF) - ASKAP (CSIRO)	0.26
Australian Urban Research Infrastructure Network (AURIN)	5.08
Australian National Fabrication Facility (ANFF)	3.20
Australian Plant Phenomics Facility (APPF)	6.07
Australian Research Data Commons (ARDC)	15.85
HASS and Indigenous eResearch Platform	8.9
Bioplatforms Australia (BPA)	14.26
Synthetic Biology	8.3
Centre for Accelerator Science (CAS) (ANSTO)	1.62
Coastal Vessels	0.72
Integrated Marine Observing System (IMOS)	5.89
Marine National Facility (MNF): RV Investigator	7.61
Microscopy Australia (MA)	4.57
National Deuteration Facility (NDF) (ANSTO)	0.26
National Imaging Facility (NIF)	2.67
National Sea Simulator (SeaSim)	36.3
Australian Centre for Neutron Scattering (ACNS) (ANSTO)	4.20
Phenomics Australia (formerly APN)	1.89
Population Health Research Network (PHRN)	1.23
Terrestrial Ecosystem Research Network (TERN)	5.89
Therapeutic Innovation Australia (TIA)	6.89

4. Note that NRI projects, Heavy Ion Accelerators, Astronomy Australia Limited, and the European Molecular Biology Laboratory, National Computational Infrastructure and Pawsey Supercomputing Centre are also funded through NCRIS via the National Innovation and Science Agenda.

Photo Credits for Public version of RIIP

Credits and captions for images on front cover (from left to right)

Terrestrial Ecosystem Research Network (TERN) – Warra SuperSite Post Fire

TERN – TERN

Integrated Marine Observing System (IMOS) – John and Daniel bringing in AUV– credit to Asher Flatt

Atlas of Living Australia (ALA) – Coverage of Australian government investments in natural resource management in the NCRIS enabled ALA research infrastructures MERIT project

National Computational Infrastructure (NCI) – Looking down the aisle between two pods of the Gadi supercomputer

Australian Urban Research Infrastructure Network (AURIN) – iStock–471846040

AuScope – Geospatial

AuScope – Geophysics Project Spence Gulf SA – Robert Lang

IMOS – Animal Tracking field servicing – credit to Fabrice Jaine

TERN – Fowlers Gap Drone – Yincai Zhou

APPF – Wheat in the DroughtSpotter platform, APPF, Adelaide

NCI – Lake Mackay 2017 ESA

National Biologics Facility

Microscopy Australia – Howard VIndin Black background MsEmbryo Developing Vasculature Decon MIP depth CodedYMCK1

Australian Plant Phenomics Facility (APPF) – Researchers in an APPF greenhouse, Adelaide

National Biologics Facility

Credits for images on page 2

National Biologics Facility

COVID-19 JEM1400-16 orange blue – CSIRO

National Biologics Facility

Credits for images on page 4

ALA – Aboriginal ranger using The Tracks App, a bi-lingual app to help record animal tracking data in the field. The Tracks App was developed by ALA for the Central Land Council

AuScope – Earth Imaging

TERN – FNQ Robson Creek Super Site Credit Kim Calders

Credits for images on page 6

APPF – Wheat at the APPF, Adelaide

AuScope – Earth Composition

IMOS – East Australian Current Deep Water Mooring – credit to Thomas Moore

Credits for case study image on page 7

National Biologics Facility

Credits for case study image on page 8

One of the lead scientists (Celine Chaleat) working on the refinement of the grass at UQ

Credits for case study image on page 9

TERN – Warra SuperSite Post Fire

Credits for case study image on page 10

CSIRO Research Vessel Investigator provides Australia with an unrivalled ocean research capability. Image Kendall Sherrin, CSIRO

Credits for images on page 11

NCI – Gadi

Microscopy Australia – Will Davids Ti-6Al-4V L3small

IMOS – Lucinda Jetty CalVal – credit to Thomas Schroeder

Credits for images on page 12

APPF – Researchers in a Smarthouse, APPF, Adelaide

AuScope, – AuScope

IMOS.– Lucinda Jetty Radiometer – credit to Thomas Schroeder

Credits for images on page 17

TERN – TERN

IMOS – Animal Tracking field servicing – credit to Fabrice Jaine

AuScope – Tectonic plate subduction simulation from Professor Louis-Moresi. COURTESY-OWEN-KALUZA-MIVP

ESE20-0119