CallaghanInnovation
Te Pokapū Auaha o Aotearoa

Te Ara Paerangi.

Future Pathways Green Paper

Callaghan Innovation
Submission from Callaghan Innovation to the Ministry of Business, Innovation & Employment

March 2022

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Callaghan Innovation Te Ara Paerangi – Future Pathways Forum on Linkedin.

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Submission summary

We can achieve greater impact from the RSI system through innovation and commercialisation

The RSI system has distinct goals. These include knowledge discovery, solving societal problems and improving economic outcomes.

Aotearoa overachieves in knowledge discovery outputs, but underperforms in the other two areas where research needs to be applied, limiting impact. This is our system's weak spot - exceptional research sits on the shelf.

Innovation and commercialisation are key to addressing this underperformance, but suffer from underinvestment and a lack of attention at a system level.

These issues should be central to the radical rethink of the RSI system so it's fit for the future, yet they are largely missing from the Te Ara Paerangi green paper. There's a risk of perpetuating issues in the system and missing significant opportunities if the focus is largely on research alone.

We work with thousands of innovative companies on a daily basis. We see the challenges businesses face trying to tap into our research system. And we understand the huge untapped potential that exists because these parts of the system are largely siloed. This gives us insights into potential improvements.

The reform could achieve greater impact from the RSI system through innovation and commercialisation via the following changes:

- **Commission more demand-led science.** Applied research - at an individual project and national research priority level - needs to be connected to government and industry demand. Involving industry and innovators when designing, funding and implementing Aotearoa's research priorities will be critical to achieving this, along with other efforts to connect researchers and industry.
- **Boost support for commercialisation.** Significantly grow commercialisation funding and support mechanisms, make it easier to access IP, and increase government's use of commercialised science and innovation.
- **Grow commercialisation and innovation skills across the system.** This includes increasing the amount of highly skilled, well resourced, and coordinated innovation and commercialisation support in the system, upskilling researchers and founders, and exposing science students to innovation and commercialisation.
- **Provide targeted innovation support** for the businesses, sectors, technologies or challenges that are likely to have the greatest societal and economic impact for the whole country, rather than supporting innovation 'for innovation's sake'. This support should be aligned with relevant research priorities/missions.
- **Drive cultural change with the right incentives.** Use incentives and targeted funding and services to encourage diversity and inclusion, collaboration, growth mindset, and impact delivery. This will be the only way to change entrenched views and accelerate culture change. Getting this right is critical to strengthen the role of Māori in the system and have the system deliver better outcomes for Māori.
- **Design the RSI system for greater impact** by designing institutions and funding in ways that delineate the different roles and goals of the system, having baseline funding to provide

stability for organisations, and including innovation and commercialisation in infrastructure and co-location decisions.

"The reform could achieve greater impact from the RSI system through innovation and commercialisation."

The RSI system is currently lacking a coherent strategy and vision. We should embrace Te Ao Māori and be guided by a long-term, intergenerational view. In line with this, we strongly believe there needs to be a long-term (20 year +) strategy developed for the RSI system so that these and other policy changes in the coming decade can be anchored to a long-term strategy. Callaghan Innovation is open to any changes, including to our structure and infrastructure, where these are strategically informed and drive system-level benefits.

Aligning our suggestions to the Te Ara Paerangi focus areas

Our submission is focused on achieving greater impact from the RSI system through innovation and commercialisation. Not all of our suggestions fit neatly into the Te Ara Paerangi focus areas, but for ease of reference we have pulled out the key message for each focus area below.

Focus area	Callaghan Innovation's key message
Better impact delivery (section 4.6 within Institutions)	Enhance innovation and commercialisation funding and support mechanisms to achieve greater impact from research.
Research priorities	Involve industry in research priorities to drive more demand-led science.
Te Tiriti, Mātauranga Māori and Māori aspirations	Targeted innovation and commercialisation support mechanisms for Māori researchers and entrepreneurs could help the RSI system deliver more relevance and outcomes for Māori.
Funding	Funding to support commercialisation needs to be significantly increased, stable and better coordinated.
Institutions	Institutional design should significantly strengthen the system's innovation and commercialisation functions and improve the connection between these and research.
Research workforce	Developing the innovation and commercialisation workforce, which has unique expertise and skill sets, is equally important to developing the research workforce.
Research infrastructure	Equal focus should be given to the need for innovation and commercialisation facilities, as well as research facilities.

The structure of this submission

1. First we outline key terms, concepts and context fundamental to our thinking.
2. Next we share our insights on the challenges and opportunities facing the RSI system.
3. We suggest potential solutions to achieve greater impact from the RSI system.
4. We then describe the potential impacts and opportunities for Callaghan Innovation in a future RSI system.
5. Lastly, we align the potential solutions to the green paper for ease of reference.

Section 1: Key terms, concepts and context

For the purpose of this submission we believe it is essential to differentiate between the purpose and outcomes of research and science along three distinct categories. In this submission we refer to these three main categories:

1. **Knowledge discovery**, by which we mean the outcome of basic research (as defined in the green paper).
2. **Solving societal problems**, with research as the key enabler for applied problem solving to meaningfully address some of our key societal challenges such as climate change, housing, inequality, and environmental protection.
3. **Creating economic outcomes**, as the result of translating research into new innovative products, services and operations which leads to increased productivity, high-skill job creation, better decision making, and better delivery of government services.

There are different functions within the RSI system, each with a distinct purpose, which contribute to the above outcomes. In this submission, we consider the following functions as part of the RSI system:

1. **Core research functions:** Critical research functions, services, databases and collections (as discussed in the green paper as 'core functions' section 3.2 page 44).
2. **Basic research:** Knowledge creation, aligned with the definition in the green paper.
3. **Applied research:** Research to resolve issues, validate or create new products (aligned with the definition in the green paper). Some applied research can contribute to both solving societal problems and creating economic outcomes.
4. **Science support for innovation:** R&D, pilot and demonstration services for the private sector (not addressed in the green paper).
5. **Innovation:** See below.
6. **Commercialisation:** See below.
7. **Other business support:** Supporting the growth and export of new products and services (not addressed in the green paper).

We note that among leading innovative countries, such as the UK, Finland and Singapore, there is a clear distinction between the types of R&D activity by purpose and desired outcome.

Our submission is focused on achieving greater impact from the RSI system through innovation and commercialisation. Innovation and commercialisation are underdeveloped in Aotearoa. These parts of the system often get overshadowed by research, including in Te Ara Paerangi discussions to date, yet offer us the biggest opportunities. Below we elaborate on the definitions and context for these activities in Aotearoa to support the interpretation of our response.

Innovation

As defined in the green paper: "Innovation is the process of doing something new. An innovation may be a new or improved product, process or function. Innovation is a process that leads to new or better ways of creating value for society, businesses and individuals. The value of innovation arises from the use and implementation of an idea. The value created may be commercial, social or environmental. Innovation may be unplanned or even accidental, but it does not have to be."

We would add:

- Creating or doing something new is an invention - it's only innovation once it is put to use and creates value. Our RSI system has a lot of invention and not enough innovation.
- It is not helpful to think about innovation being 'accidental'. Innovation is a specialist role in its own right - it is a discipline and practice, which is backed up by an evidence base. Studies of over 2000 successful companies over 40 years identified patterns that lead to success and failure. This informed the '10 types of innovation' framework which shows that there is a common approach to innovation and more to innovation than product development, such as business or operating model innovations.[1] Similarly, McKinsey & Company studied more than 2,500 executives in over 300 companies and identified eight attributes shared in part or full across every big company that's a high performer in product, process, or business-model innovation.[2] Purposeful and planned innovation is linked with success and needs to be at the forefront of business operations.
- Organisations are more successful when they innovate on multiple fronts - e.g. a new product, new operating model and new business model.
- Innovation is more than technology and is not the same as R&D - R&D can be an input to innovation but innovation can occur without R&D.
- Innovation contributes to increased productivity, economic diversification, export growth, sustainability, growth in wages and high skilled jobs, and resilience to disruption, which benefits all New Zealanders and is crucial for our future.[3]

"Innovative economies are more productive, more resilient, more adaptable to change and better able to support higher living standards."[4]

[1] Keeley, L., Walters, H., Pikkel, R., & Quinn, B. (2013). *Ten types of innovation: The discipline of building breakthroughs*. John Wiley & Sons.

[2] De Jong, M., Marston, N., & Roth, E. (2015). *The eight essentials of innovation*. *McKinsey Quarterly*, 2, 1-12.

[3] OECD (2015), *The Innovation Imperative: Contributing to Productivity, Growth and Well-Being*, OECD Publishing, Paris; New Zealand Productivity Commission (2019). *Employment, labour markets and income. Technological change and the future of work, Draft report 2*; New Zealand Productivity Commission (2020). *New Zealand firms: Reaching for the frontier. Final report*; OECD (2021). *New Zealand Economic Summary Forecast December 2021*; Ministry of Business, Innovation and Employment (2021), *Strategic Intentions 2021-2025*

[4] OECD (2015), *The Innovation Imperative: Contributing to Productivity, Growth and Well-Being*, OECD Publishing, Paris

Commercialisation

The definition of commercialisation used in the green paper is limited to "the commercial use of publicly funded research outcomes by end users". We think the broader definition, used by Science for Technological Innovation (SfTI), more accurately depicts the application of commercialisation in Aotearoa's RSI system: "Commercialisation is the process of introducing new products or services to the market for the public to access. This process is employed by for-profit and social enterprises as well as many not-for-profits. This entails production, distribution, marketing, sales, customer support, and other key functions critical to achieving the commercial success of the new product or service."[5]

Science can be commercialised for social benefit, as well as economic. In some areas that require significant investment to take a product to market, such as medical technologies, commercialisation is often the only way to get breakthrough discoveries to the point where society can benefit. In addition to this, social entrepreneurs can commercialise science to create innovative, commercially viable, locally-responsive solutions to societal problems. Social enterprise is becoming more common - in fact, in a multi-country study from 2016, one third of start-ups were aiming for social good.[6] We expect to increasingly see science commercialised for social benefit in Aotearoa.

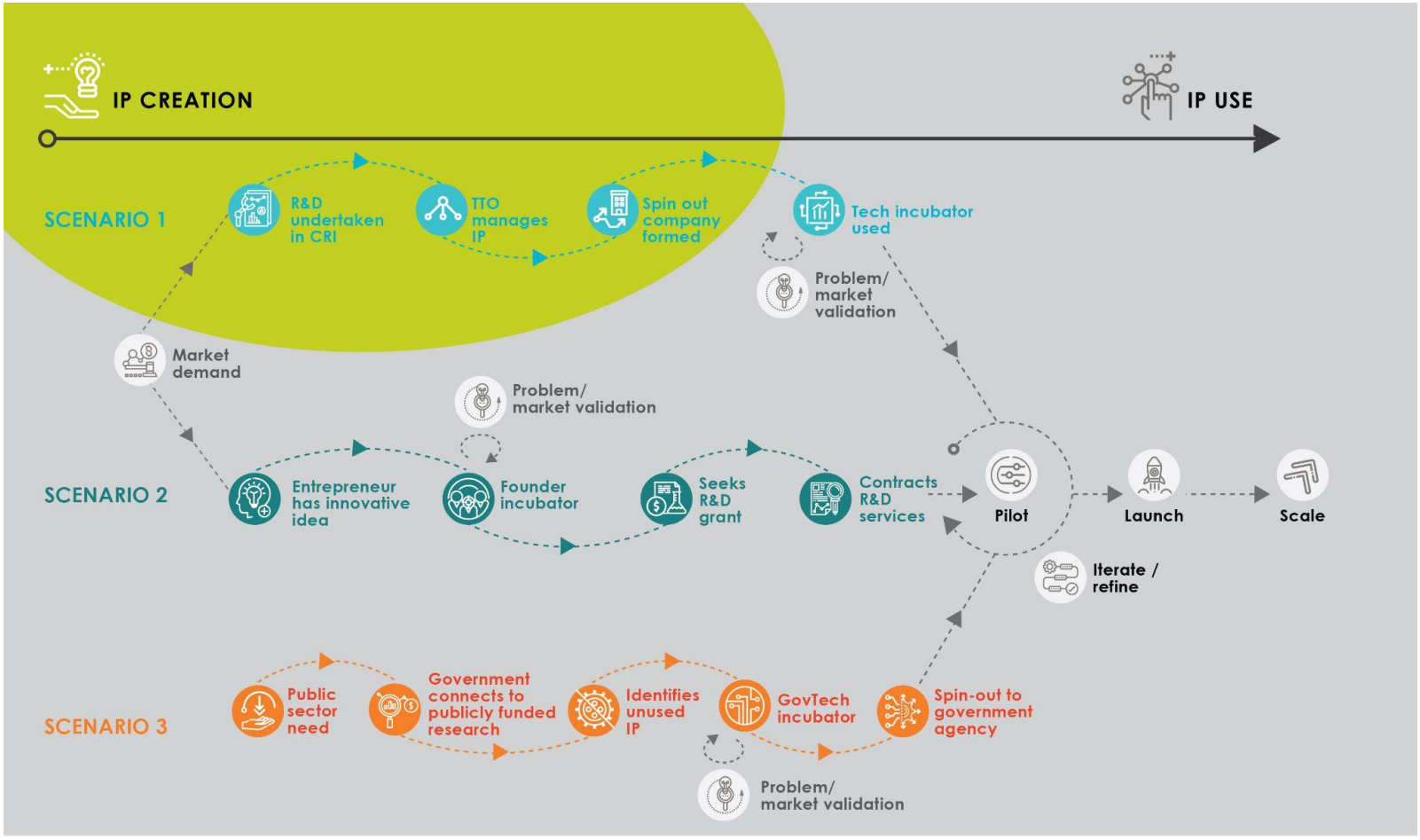
Public research organisations are involved in IP creation - but a significant amount of the process to get that IP into use occurs outside the organisation. Considerable expertise sits within the RSI system - but outside the public research organisations - to deliver the support to get it from 'idea' to 'impact' and capture value from the investment in research and innovation.

We therefore agree wholeheartedly with the green paper's argument to diversify how we think about commercialisation pathways and the kinds of support we have in place (section 4.6 page 62). The distinct commercialisation pathways require different levels and types of government support (figure 1 illustrates some distinct scenarios). For example, a CRI licensing IP requires little government support compared to establishing a new researcher-led venture via a spin-out company. The pathway and support required by an entrepreneur to commercialise IP is different from that of the public sector.

[5] *Commercialisation*. Science for Technological Innovation. (2020, September 28). Retrieved February 16, 2022, from https://www.sftichallenge.govt.nz/for-researchers/commercialisation/

[6] Bosma, N., Schøtt, T., Terjesen, S., & Kew, P. (2015). Global Entrepreneurship Monitor Special Topic Report–Social Entrepreneurship. *Londres: Global Entrepreneurship Research Association, London Business School*.

Figure 1: Example scenarios of different commercialisation pathways



Commercialisation support mechanisms need to account for the diverse commercialisation pathways that lead to the use of new science and technology based innovations.

KEY:

part of the commercialisation pathway that occurs within CRIs and universities

scenarios and parts of the commercialisation pathway that occur outside CRIs and universities

Commercialisation success factors

In our experience, successful commercialisation will only occur with the skills and capabilities to develop the idea from R&D to prototype, pilot, launch and scale. Each of these phases requires different technical and management capabilities. A promising R&D venture most likely will not have commercial success without:

- Alignment of incentives between the research institution, (future) investors, and the inventors/founders/researchers. In our experience, the current funding incentives (e.g. PBRF) and the way institutions work (promotions based on publications) actively dissuade researchers from engaging in commercialisation and instead promote sharing Aotearoa's IP for others to capitalise on.
- Market validation, product market fit and human-centred design to confirm there is a problem to be solved by a product, and that the designed product will do what the market desires.
- IP management, including appropriate management of Mātauranga Māori.
- An investment strategy.
- Local and global networks and connections between the RSI system and global market opportunities, multinational corporations and investors.
- Multiple types of innovation (e.g. innovative business model and operating model in addition to a new product).
- Industry-scale pilot plants to demonstrate the product's market, economic, and technical viability prior to launching and scaling (note that this may not apply to all R&D such as some digital innovations).
- The support and expertise of a commercialisation expert to guide this entire process.

Other key terms

- Demand-led: we use this to refer to doing research and innovation in response to a known problem or need, and connecting this research to end-users from early in the process.
- Commercialisation support mechanisms: this term encompasses a range of programmes or funding that exist to support the commercialisation of science and technology. Examples include incubators, accelerators, pre-seed funding, and industry-scale pilot plants.
- Frontier Ventures: high R&D and innovation intensity business ventures at the leading edge of the field of innovation (generally new to the world) with high aspiration for global growth. This is an innovation-specific definition, and therefore is slightly different to the Frontier Firm definition, as described by the Productivity Commission.[7] Frontier Ventures may or may not be high productivity firms at the productivity frontier. We use the term 'ventures' rather than 'firms' to encompass businesses, innovators that have not yet formed a business entity, and ventures within a larger organisation.
- Impact: we agree with the green paper definition that impact means a change to the economy, society or environment beyond a contribution to knowledge and skills in research organisations.
- Targeted innovation support: this is an approach where innovation support and investment is given to specific businesses, sectors, technologies or challenges, e.g. the Frontier Ventures defined above.

[7] New Zealand Productivity Commission (2020). *New Zealand firms: Reaching for the frontier. Final report*.

Section 2: Challenges and opportunities for our RSI system

Let's seize this opportunity to make Aotearoa's RSI system fit for the future

Ko ngā pae tawhiti whaia kia tata. Ko ngā pae tata, whakamaua kia tina.

Callaghan Innovation welcomes the RSI system reform and is open to change. We fundamentally agree with the case made to reform the RSI system to face the future. We acknowledge the taonga and mana of what the system has delivered to date, but we know the world we are heading into is different.

In 2040:[8]

- Climate change will have displaced 180 million people (1.7 million from the Pacific), leading to pressure on Aotearoa.
- 47% of jobs will be automated and remaining work will have been disrupted by technology.
- There will be 170 billion connected devices, the shift to AR/VR as a viewing platform will be ubiquitous, and half of all cars will be autonomous and electric.
- New Zealand's population over 65 will double, while the working-age population will only increase by 10%.
- Healthcare will look completely different, with AI supporting self-diagnosis of health issues and treatment options and 3D-printed functional organs and tissues available for transplant.
- Alternative proteins will be the first choice for the majority of consumers globally, driven by ethical and environmental values.
- Corporations will be the top economic entities, not countries, half of all middle class consumers will be in China and India, and NZ Inc will have to move from national competition to collaborating for global growth with shared risks and rewards.

This is the opportunity to radically rethink how the RSI system works so that we can turn the challenges above, and other future challenges, into opportunities. To do this, we believe the reform needs to expand into innovation as well as research, and focus on achieving greater impact from the RSI system through innovation and commercialisation. We risk perpetuating issues in the system and missing significant opportunities if the focus is largely on research alone.

> *"We believe the reform needs to expand into innovation as well as research, and focus on achieving greater impact from the RSI system through innovation and commercialisation."*

[8] Callaghan Innovation (2020). *Callaghan Innovation Briefing to the Incoming Minister*.

The RSI system has strong foundations to build on

Significant progress has been made in the 30 years since CRIs were formed. In that time, all CRIs and Universities have developed IP policy, Technology Transfer Offices (TTOs) and commercialisation networks. The skill sets needed to commercialise science have become more common and more specialised. There have been multiple initiatives to improve collaboration, such as the Centres of Research Excellence (CoREs) and National Science Challenges (NSC). Large changes in government policy have occurred – most recently and significantly with the introduction of the Research and Development Tax Incentive (RDTI). Business attitudes to innovation and to the role of start-ups are maturing. Incubators and Accelerators have started and matured. A venture capital industry has emerged and has begun to deepen. Our technology exports have grown quickly. And the media treatment of the role of innovation has transformed.

We can also see this progress through the growing public and private investment in R&D. Between 2010 and 2020, public funding for R&D increased by 75% (to approximately $1,800 million) and business expenditure on R&D (BERD) increased by 2.8 times ($971 to $2,709 million).[9] We expect BERD to increase even further as businesses' awareness and understanding of the RDTI improves.

This sizeable investment is leading to high quality research and science, with Aotearoa punching above its weight with research publications,[10] and a healthy private sector with many fast-growing, high-tech firms. There are 48% more businesses tapping into the government's innovation support for business (via Callaghan Innovation) compared to 2016, and the businesses that use these services have grown their productivity (as measured by revenue per worker) by 7.3% per year, which is 8.2 times faster than the average New Zealand rate.

"Businesses that use the government's innovation support services have grown their productivity (as measured by revenue per worker) by 7.3% per year, which is 8.2 times faster than the average New Zealand rate."

The status quo isn't working well enough

Despite this progress, we know the mechanisms employed over the past decade aren't enough. Aotearoa has dropped from 9th (2010) to 26th (2020) on the global innovation index. Comparatively, other small advanced economies (SAEs), Switzerland (1) Sweden (2), Finland (7), Singapore (8) and Denmark (9) dominated the top 10 most innovative economies globally.[11] We know from our work with researchers and innovative businesses that there are numerous barriers that are slowing progress to achieve greater impact from the RSI system through innovation and commercialisation.

The biggest commercialisation challenges currently facing Aotearoa are that research sits on the shelf, researchers aren't incentivised (or are actively dissuaded) to commercialise their research, institutions overvalue IP, people underestimate the effort to turn IP into consumable and desirable products, the effort to scale, and the difficulties attracting suitable investment at the right time. These must be addressed so that our RSI system delivers for New Zealanders.

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[9] Ministry of Business, Innovation & Employment (2021). *The Research, Science and Innovation Report - 2021 - Performance of the New Zealand RSI system.*

[10] WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis.* Geneva: World Intellectual Property Organization.

[11] WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis.* Geneva: World Intellectual Property Organization.

At 1.4% of GDP, our R&D spend is still below the OECD average of 2.5%.[12] Growing New Zealand's R&D spend is a critical component of getting more from the RSI system. Government R&D investment alone is not enough to compete with leading innovative countries. Instead, the focus should be on achieving a healthy ratio of public to private R&D spending through system settings that encourage growth in BERD. Israel - the country that invests the highest proportion of their GDP in R&D - has a ratio of public to private R&D spend of around 1:6, whereas Aotearoa's is currently around 1:1. Clearly, in order for New Zealand to achieve the OECD average R&D spend we need to intensify initiatives that leverage private sector funding. A useful example is the Tech Incubator program which delivers a ratio of 1:3.5 public/private investment. A scaled up version of this programme or other initiatives with a similar ratio would give the RSI system a realistic opportunity to capture the value being created through research. The Tech Incubator programme illustrates that with the right settings we can increase private:public R&D investment in New Zealand. The private sector needs access to commercialisation opportunities from publicly funded R&D to drive this investment.

As recognised in the green paper, there are still significant barriers to Māori participation in the RSI system. In particular, where Mātauranga Māori is not eligible for R&D funding and governance structures typical of Māori entities are not accepted in our current settings, we limit the ability for Māori to lead research that will benefit Māori.

We see Te Ara Paerangi as the opportunity to address the barriers to successful commercialisation, build strong relationships between industry and research, and accelerate the increasing investment in R&D to make the RSI system fit for purpose for the next 30 years.

We tautoko the green paper's aspirations to improve our RSI system

We tautoko (support and endorse) many of the suggestions and aspirations in the Te Ara Paerangi green paper. Specifically:

- Te Tiriti O Waitangi, Mātauranga Māori and Māori aspirations being central to the system. Given that Māori businesses have a higher rate of innovation than non-Māori businesses in Aotearoa, this is likely to strengthen our innovation ecosystem.[13]
- The proposal for national research priorities and using funding as a mechanism to drive outcomes in the priority areas. We strongly encourage making these 'missions', aligned to the rise of mission-led innovation approaches overseas.[14]
- The need to improve the impact of research, through commercialisation and public sector procurement - though we believe this needs to be much more of a focus given that New Zealand lags behind in delivering impact from research.[15]
- Taking a system-wide approach to national research infrastructure. In an internal survey, businesses identified access to equipment or facilities as a major challenge, so considering how industry can co-locate and/or access infrastructure will further benefit the system.[16]

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[12] OECD (2022). *Gross domestic spending on R&D (indicator).* doi: 10.1787/d8b068b4-en (Accessed on 17 February 20. Note the most recent data available at the time of writing was from 2019.22)
[13] New Zealand Productivity Commission (2020). *New Zealand firms: Reaching for the frontier. Final report*.
[14] Stakeholder Strategies (2020). *Leading Innovation Agencies: International Insights Report* (available on request); Larrue, P. (2021). *The design and implementation of mission-oriented innovation policies: A new systemic policy approach to address societal challenges*. OECD Science, Technology and Industry Policy Papers, No. 100, OECD Publishing, Paris; Mazzucato, M. (2017). *Mission-oriented innovation policy.* UCL Institute for innovation and public purpose working paper, 1.
[15] WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis.* Geneva: World Intellectual Property Organization.
[16] Callaghan Innovation (2019). *RTS Strategy Development: Summary of results from quantitative and qualitative stages*.

- The need for better research and industry connections. The evidence that research in universities that is funded at least in part by business has substantially higher economic impacts suggests that this should be a key area of focus to drive more impact from research.[17]
- The need to make the RSI system more equitable, diverse and inclusive. There's a significant body of evidence showing that diversity is beneficial for innovation and productivity.[18]

We also tautoko the intention to redesign institutions to make them more collaborative, adaptive, agile, and responsive. However, we think a robust and comprehensive system-wide, long-term strategy is a prerequisite to institutional design. With this in place, the appropriate structure will become clear.

The green paper doesn't capture all of the issues

We agree with the problem statement in the green paper for the research component of the RSI system (page 18 'case for change'). However, we see this as only part of the problem as it only relates to part of the system (see figure 2 below).

Other issues that the reform of the RSI system should address include:

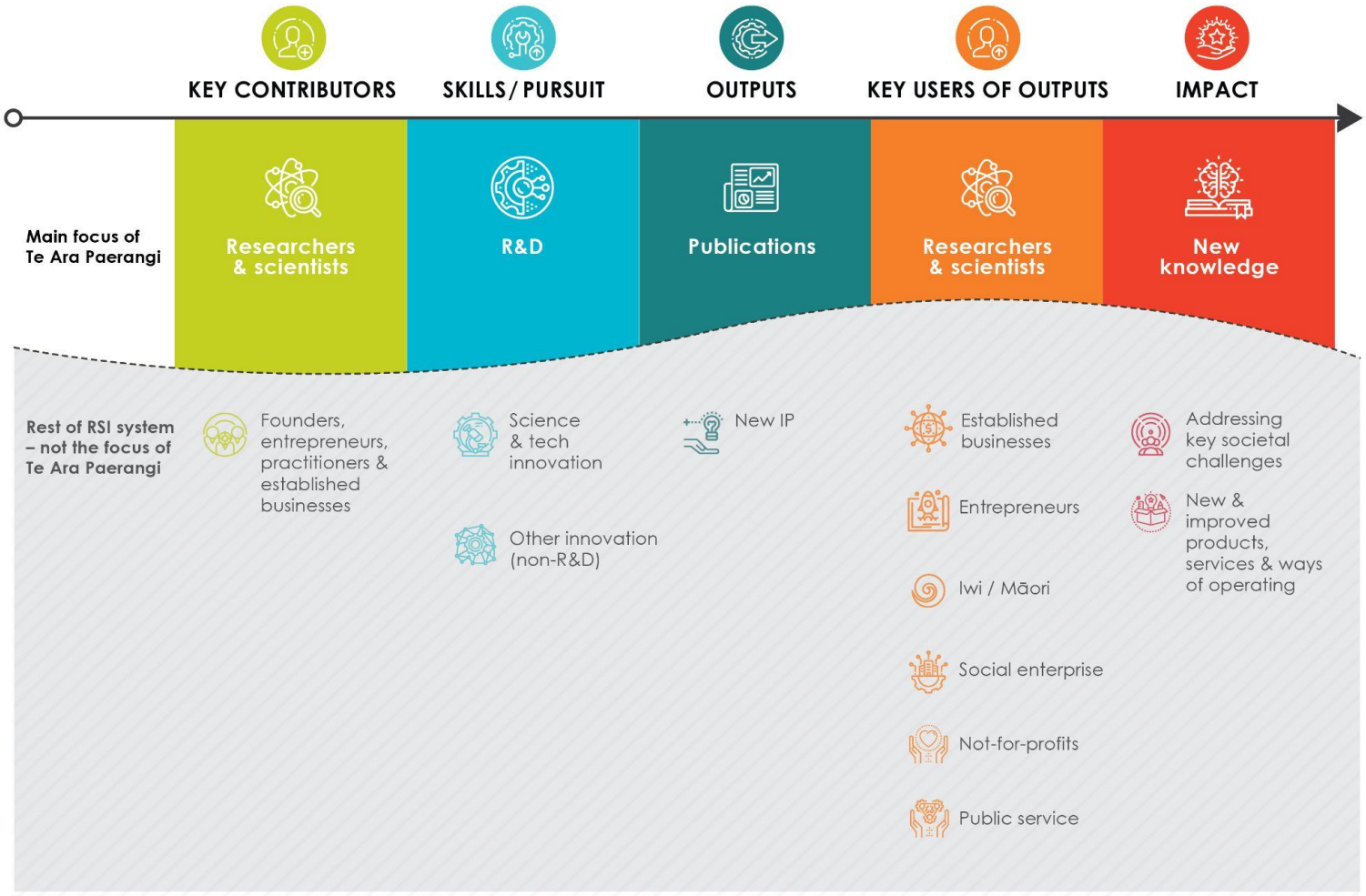
- Aotearoa's low commercialisation and innovation levels, which contribute to low productivity and wages, and a lack of economic diversification.[19]
- The high volume of research publications produced in Aotearoa that sit on the shelf and don't deliver impact due to low rates of technology transfer, weak investment in knowledge-based capital, and limited demand-led research.[20]
- The lack of commercialisation and innovation skills in government, and limited commercialisation of publicly funded science back into government.[21]

The reform should aim to achieve greater impact from the RSI system through innovation and commercialisation.

Critical to achieving this is the recognition that a lot of innovation and commercialisation happens independently of the research and science system. For example, in the health tech sector, the vast majority of businesses are founded by entrepreneurs (73%), with the remainder spread across DHB, University and CRI researchers.[22] The RSI system needs to serve all innovators, not just those within the publicly funded research system, and discussions to reform the system should include all innovators too.

[17] Ministry of Business, Innovation & Employment (2021). *The Research, Science and Innovation Report - 2021 - Performance of the New Zealand RSI system.*
[18] Hunt, V., Prince, S., Dixon-Fyle, S., & Dolan, K. (2020). *Diversity wins*. McKinsey & Company; West River Group (2021). *The Power of Diversity: Why Homogeneous Teams in Venture Capital Are Bad for Business*.
[19] Conway, P. (2016). *Achieving New Zealand's productivity potential.* New Zealand Productivity Commission; OECD (2021). *New Zealand Economic Summary Forecast December 2021*: In 2021, New Zealand's GDP growth per capita continues to lag behind OECD countries - at 25% lower than OECD best performers. Productivity is 35% lower than OECD best performers. The OECD explicitly identifies the need to "promote innovation in tandem with export and foreign direct investment" as a key structural reform priority for New Zealand in 2021.
[20] WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis.* Geneva: World Intellectual Property Organization; Cleantech Group (2021). *New Zealand Climate Tech for the World.*
[21] *Innovation Barometer.* Creative HQ (no date). Retrieved February 17, 2022, from https://www.innovationbarometer.co.nz/#results
[22] Data from the Health Tech Activator

Figure 2: Parts of the RSI system that should be considered in any system reform



The main focus of **Te Ara Paerangi** to date is reflected above the dotted line - but activities below the line contribute significantly to our RSI system as well. We believe that to build an RSI system fit for Aotearoa's future all aspects of our RSI system should be considered.

Section 3: Suggestions to make Aotearoa's RSI system future-ready

Mō tātou, ā, mō kā uri ā muri ake nei

The green paper (page 19) states the reform goal as "We want to create a modern, future-focused research system for New Zealand. It needs to be adaptable for a rapidly changing future, resilient to changes, and connected: to itself, to industry, to public sector users of research, and internationally."

Our suggestions for the RSI system reform that follow are largely focused on the applied research, science support for innovation, innovation, commercialisation, and other business support functions of the system (as described in key terms). We feel these need to have a greater focus in the ongoing Te Ara Paerangi work programme to achieve the above goal.

We note where our suggestions align to a specific key question in the green paper. The majority of our response relates to Key Question 13:

How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge into operational environments and technologies?

Commission more demand-led science

Commercialisation pathways work best when it's 'market pull' not 'science push'. Publicly funded applied R&D is more likely to succeed commercially, and create economic and social benefits for Aotearoa, when the research is driven by market demands and oriented toward concrete applications and results. This is evident in Germany where every euro of public funding spent on the Fraunhofer Institutes contributes 3-4 times the amount in tax revenue and over 18 times the amount to the GDP.[23]

"Every euro of public funding spent on the Fraunhofer Institutes contributes 3-4 times the amount in tax revenue and over 18 times the amount to the GDP."

The RSI system should be reconfigured so that it drives more demand-led science aligned to government and market needs. This is in addition to, not in place of, capacity and capability for disruptive science. People within the system can be supported to undertake more demand-led science by being given a global view of priority opportunities to go after.

To achieve greater impact from the RSI system through innovation and commercialisation we need to drive more demand-led science. Our suggestions of how system changes could achieve this are below.

[23] Fraunhofer Institute for Systems and Innovation Research ISI (2018). *Contribution to the German Innovation System – Fraunhofer-Gesellschaft.*

1. **Connect research and innovation to demand.** New Zealand's RSI system must view engagement with multinationals and other businesses as a necessary component to scaling and sustaining innovation. In Climate Tech, SAEs that have successfully established a market for innovative tech have made sure that the innovations are targeted towards consequential markets and address an industry need. This is coupled with coordinated efforts to drive innovators into export markets through innovation agencies (sometimes called "outposts") that act as both a business promotion mechanism and a source of information-flow back into the ecosystem.[24] This is a business support function currently missing from our RSI system, which could be led by NZTE. We can also look to Canada's Superclusters to learn how to establish business-led demand-side innovation clusters to commercialise more science.[25] [Key question 13]
2. **Align research priorities to government priorities and major global challenges**, and set up time bound missions for the toughest challenges. Priorities should go beyond being multidisciplinary (within science/research) and instead be transdisciplinary. Include researchers, iwi, industry, NGOs and relevant government departments/agencies in missions and design these to be more demand-led than the NSCs. Learn from the UK's Grand Challenges.[26] [Key question 1]
3. **Include industry** - particularly multinationals, investor funds, and Māori entities - in priority setting, strategy setting and governance for the missions to connect the research to real-world demand. Founders and entrepreneurs, as well as larger commercial entities, should be welcome to contribute to missions. Overseas we see involvement from independent/advisory bodies with diverse composition - in some countries highly aligned with the private sector (not academia) - in missions/research prioritisation. [Key question 3]
4. Fund **Māori-led missions/research priorities** that aim to address issues or opportunities that are a priority for Māori, bringing together Māori researchers and practitioners, innovators and iwi, with dedicated services to translate the research into practice e.g. via commercialisation. This should be in addition to all research priorities being co-developed and co-governed with Māori. [Key question 2b]
5. Balance this against a **tech opportunity focus** by having emerging disruptive technologies (e.g. robotics, blockchain, regulatory tech) in scope for missions/research priorities as well. [Key question 1]
6. Include **'potential for impact'** upfront in prioritisation of missions/research priorities. [Key question 2a]
7. Use **open days and open access databases** to promote the research coming out of missions to industry, iwi and government to assist end users in translating the research into products and services. There are existing databases such as KiwiNet's Te Tūapapa Auaha[27] and our Scale-Up NZ[28] platform that can likely fulfil this purpose with some further development and promotion. [Key question 13]

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[24] Cleantech Group (2021). *New Zealand Climate Tech for the World*: Examples of innovation outposts launched by SAEs include Swissnex (San Francisco, Boston, Shanghai, Tokyo, Seoul, New Delhi, more), Swedish Cleantech Hubs (San Francisco, London, Shanghai), and Netherlands Innovation Network (San Francisco, Boston, Shanghai, Tokyo, Seoul, New Delhi, Singapore, Berlin, and more).
[25] Knubley, J. (2021). *Building Superclusters for Canada. Brookfield Institute for Innovation + Entrepreneurship*.
[26] *The Grand Challenges*. GOV.UK. (no date). Retrieved February 16, 2022, from https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/industrial-strategy-the-grand-challenges
[27] *Te Tūāpapa Auaha Innovation Platform*. KiwiNet (no date). Retrieved February 16, 2022, from https://kiwinet.brightidea.com/
[28] *Scale Up NZ*. Callaghan Innovation (no date). Retrieved February 16, 2022, from https://www.scaleup.nz/

Boost support for commercialisation

The benefits of commercialisation go beyond economic impact - commercialised science is already solving environmental,[29] housing,[30] mental wellbeing,[31] and health issues,[32] and can be applied by the government, social enterprise and not-for-profits, as well as business.

Australia, which faces similar challenges to Aotearoa in translating research to impact, has recently announced an Action Plan to "supercharge research commercialisation" backed by $2.2 billion in new investment.[33] We could look to Australia's plan to inform our own approach to increase commercialisation.

"Australia, which faces similar challenges to Aotearoa in translating research to impact, has recently announced an Action Plan to "supercharge research commercialisation" backed by $2.2 billion in new investment."

In order to achieve greater impact from the RSI system, the reform needs to lead to an increase in the amount of science commercialisation occurring in Aotearoa. We suggest ways to do this below.

8. **Significantly grow commercialisation funding and support mechanisms** and make better connections to private sector financing. This could include scaling the Tech Incubator programme, developing accelerators for science entrepreneurs, and funding the 'development' component of R&D to ensure a technical idea has good product market fit (see deep dive below). [Key question 13]

9. **Make it easier to access IP.** Given our small size, and the time, money and effort required to secure agreement between academic and industry partners, a standardised process and framework to assist negotiations that involve IP would benefit Aotearoa. This would align with the approaches in Ireland (the National IP Protocol[34]), the UK (the Lambert Toolkit[35]) and Australia's recently announced standardised IP Framework.[36] The framework needs to ensure inventors and founders are properly incentivised and address the current problem of research institutions overvaluing their IP. It should also allow social enterprise or government access to unused IP for free. Importantly, the framework needs to have appropriate consideration of protecting Mātauranga Māori.[37] In New Zealand, publicly funded research does not have the obligation to 'systematically capture, protect, and progress resulting discoveries', which is in the US Bayh-Dole Act of 1980.[38] We suggest regulatory or policy tweaks are looked at as an option to drive capture, protection and progress of discoveries to commercialisation. Lastly, a way to

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[29] *Fast track to electric ferries*. Callaghan Innovation (2021, September 30). Retrieved February 16, 2022, from https://www.callaghaninnovation.govt.nz/customer-stories/fast-track-electric-ferries
[30] *Cementing eco-friendly building*. Callaghan Innovation (2021, September 30). Retrieved February 16, 2022, from https://www.callaghaninnovation.govt.nz/customer-stories/cementing-eco-friendly-building
[31] *Fresh thinking*. Callaghan Innovation (2020, November 3). Retrieved February 16, 2022, from https://www.callaghaninnovation.govt.nz/customer-stories/fresh-thinking
[32] *Taking it to heart*. Callaghan Innovation (2021, September 30). Retrieved February 16, 2022, from https://www.callaghaninnovation.govt.nz/customer-stories/taking-it-heart
[33] Australian Government, Department of Education, Skills and Employment (2022). *University Research Commercialisation Action Plan.*
[34] Government of Ireland (2019). *Ireland's National IP Protocol 2019: A Framework For Successful Research Commercialisation*.
[35] *University and business collaboration agreements: Lambert Toolkit*. GOV.UK. (2022, January 5). Retrieved February 16, 2022, from https://www.gov.uk/guidance/university-and-business-collaboration-agreements-lambert-toolkit
[36] Australian Government, Department of Education, Skills and Employment (2021). *Higher Education Research Commercialisation IP Framework Consultation paper.*
[37] Ayoubi, L. (2019). *Intellectual Property Commercialisation and Protection of Mātauranga Māori in New Zealand Universities.* New Zealand Universities Law Review, Forthcoming.
[38] Massachusetts Institute of Technology Technology Licensing Office (2010). *An Inventor's Guide to Technology Transfer at the Massachusetts Institute of Technology.*

share experiences in IP management, such as a Commercialisation Centre of Excellence, may support our institutions to get better at balancing incentives through shared experiences rather than each institution learning in isolation. [Key question 13]

10. **Enhance innovation and commercialisation in the public service** so the government applies research and innovation as new technologies and services (further detail in deep dive below). [Key question 13]
11. Have specific funding and stand up unique support mechanisms to **commercialise the research out of each mission/research priority**, including Māori-led missions. The Health Tech Activator can be the model for this. This commercialisation support mechanism was designed as part of the New Zealand Health Research Strategy and helps innovators from the public and private sectors navigate the challenges unique to commercialising health tech. [Key question 3]

Deep dive: Commercialisation funding and support mechanisms

A key way to achieve greater impact from the science and innovation supported by public funds is to commercialise it and get it to market. As demonstrated locally through data from KiwiNet, and validated by findings from the UK Higher Education Innovation Fund, investing in knowledge exchange leads to a return on investment of around eight times.[39]

Our high-level estimates suggest that the government invests approximately 20 times more in research compared to commercialisation (data and caveats outlined in Appendix 1). This disproportionate funding may offer insights into why our RSI system struggles to get research off the shelf, and how we might be able to get a greater return on Aotearoa's science investment.

Currently there are individual well-designed funding and support mechanisms for commercialisation on offer, but these have not been designed in a systematic way leading to gaps and redundancies. The commercialisation process is complex with expertise and resourcing required across all stages to achieve successful commercialisation.

The current funding and support mechanisms and our suggestions for how to improve this to achieve greater impact from the RSI system are listed in table 1.

Table 1: Current and suggested funding and support mechanisms across the commercialisation process

Activity	Purpose	Current funding & support mechanisms	What's needed
Development (market validation, product market fit, human centred design)	Determine if there's a need for the technical ideas/product in the target market, and that the product will meet market need	No specific support mechanism (though aspects supported as part of incubators, accelerators, Health Tech Activator, NZTE)	Specific 'development funding' for these activities to increase return on R&D technical investment
R&D	Develop new or improved products or services	RDTI for business Numerous R&D funds for researchers in public science system	Development component to match technical funding (see above)
Innovation	Putting new or improved product, process or function to use	No specific support mechanism for commercialising innovation, but some support for 10 types of innovation (e.g. Innovation Skills programme)	Funds to commercialise innovation, which is particularly important to support the Digital sector due to falling outside traditional definitions of R&D
Pre-seed and seed funding	Early investment around an idea	Pre-seed accelerator fund (PSAF) for publicly funded research	Scale the PSAF

[39] KiwiNet (2021). *2021 PreSeed Report*; *Higher Education Innovation Fund.* UKRI (no date). Retrieved February 16, 2022, from https://www.ukri.org/our-work/browse-our-areas-of-investment-and-support/higher-education-innovation-fund/

Structured start-up support	Invest in and support building a business around a concept, idea or technology (via incubators), or rapidly develop a product or technical idea to be investor-ready (via accelerators)	Tech incubators Founder incubators Accelerators for entrepreneurs NZ GovTech Accelerator (CreativeHQ) Kōkiri	Scale these mechanisms (in number, funds available, loans available) Establish a 'Science Entrepreneur Accelerator' to support entrepreneurial scientists to build a business Scale accelerators for government innovation Scale or establish accelerators for minority entrepreneurs (e.g. Māori, female, regional)
Investment strategy	Get the necessary investment to continue developing & launching the product	NZTE/NZGCP investor strategy	Better connect this into the RSI system (i.e. to deep-tech opportunities)
Industry scale pilot plants	Develop the new product in a controlled quantity to demonstrate its market, economic, and technical viability prior to launching & scaling	Food Innovation Network	A review of pilot plants in NZ, funding new ones aligned to future industry creation/growth (i.e. Catapults in the UK) Early proof of concept funding for research-industry collaboration
Networks, connections & introductions to investors	Connect the science system to local and global market opportunities (e.g. emerging tech), and commercialisation enablers	Scale-Up NZ Auaha Innovation Platform Industry 4.0 network International connections via existing incubators	Open days based on sector/tech (not institutions) Creation of strong researcher networks into commercialisation enablers (e.g. investors, multinationals)

Overall, we advocate for a reweighting of research and commercialisation funding, so that more is invested in translating research into products and services that can have positive social, environmental and economic impacts. To be effective, the increase in investment in commercialisation needs to be stable, and done alongside other changes suggested in this submission (e.g. driving more demand-led science, incentivising commercialisation, and growing commercialisation skills).

There's opportunity to partner with the private sector for investments (e.g. angels/venture capital [VC] or new purpose-driven decentralised autonomous organisations [DAOs]) and target areas where we know there is growing demand and therefore investor appetite. For example, the

CleanTech space is growing globally and there's a wealth of capital to tap into. $16B of VC was invested in Climate Tech in 2019 (6% of total VC funding), growing 3750% since 2013.[40]

Australia's recently announced University Research Commercialisation Action Plan includes $1.6 billion over 10 years for a new stage-gated competitive funding program to help university projects bridge the 'valley of death' on the road to commercialisation (Australia's Economic Accelerator) and $150 million capital injection to expand the CSIRO Main Sequence Ventures program, which backs start-up companies and helps create commercial opportunities from Australian research.[41]

Funding could be used as a lever (supported by co-location and/or other services) to drive collaboration between the breadth of skill sets needed for successful commercialisation. For example, part of the criteria to receive funding could be having a scientist(s), multinational and entrepreneur collaborating, or a scientist(s), government agency and entrepreneur.

The role of coordination is critical. We think a Commercialisation Centre of Excellence would address this. Similarly, having one entity coordinate and administer funds could help join things up.

"The role of coordination is critical. We think a Commercialisation Centre of Excellence would address this."

[40] Herweijer, C., Azeem, A., (2020). *The State of Climate Tech 2020.* PwC

[41] Australian Government, Department of Education, Skills and Employment (2022). *University Research Commercialisation Action Plan.*

Deep dive: Innovation and commercialisation within the public service

The potential role for the public service in commercialisation pathways is touched on in the green paper and we believe the role of government in the RSI system is an area of opportunity that could be looked into in much more depth in future Te Ara Paerangi work.

The following potential roles for government in the RSI system could be explored further.

- **Government being early adopters of commercialised science and innovation through procurement** - as outlined in the green paper as a possible commercialisation pathway (section 4.6 page 62). Though many technologies require global markets for success, government can act as a 'test bed' for some technologies (e.g. in health or other 'public good' areas) or be early adopters of locally developed technology. There are examples of this not occurring in our current system.[42] There may be some applications where the government is the key market. Government willingness to apply new innovations will help to foster an innovative culture in Aotearoa.
- **Government using innovation themselves to develop new or improved products and services.** The Innovation Barometer, a tool for measuring and improving innovation in the public sector, shows that there is room to improve innovation skills in government.[43] There are some new programmes that support public service innovation, such as CreativeHQ's NZ GovTech Accelerator,[44] but we need adoption on a larger scale.
- **Government driving demand for science and innovation.** Te Ara Paerangi could explore how government departments/agencies can best influence the research and innovation being undertaken in the system so that it meets their needs (i.e. as the 'market pull'). This might be through funding, alignment via research and innovation strategies, or collaboration via missions. This relates to the goal of commissioning more demand-led science, discussed above.
- **Government commercialising government-funded science themselves** to use in operations and services e.g. in health, education and the environment. This would involve government departments looking at IP that is already 'on the shelf' to apply and therefore capture value from the research investment. The extent to which this is occurring, and whether this does offer a significant commercialisation pathway, needs to be explored.

Callaghan Innovation has suggestions for how to achieve greater impact from the RSI system through innovation and commercialisation in the public service.

- **Make it an expectation**
    - Clearly set expectations, implement standards and embed skills across government to increase innovation and commercialisation.
    - Include commercialising research from the science system and local innovations in government procurement best practice and processes to support a culture of uptake.
    - Include the public service in the government priority-aligned missions, with the expectation to commercialise some of the research into government operations.

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[42] *The FDA-approved, Kiwi-owned, PCR test technology the Health Ministry wouldn't even look at.* Mandow, N. (2022, March 11). Newsroom. Retrieved March 11, 2022, from https://www.newsroom.co.nz/pro/the-fda-approved-kiwi-owned-pcr-test-technology-the-health-ministry-wouldnt-even-look-at

[43] *Innovation Barometer.* Creative HQ (no date). Retrieved February 17, 2022, from https://www.innovationbarometer.co.nz/#results

[44] *Better, faster, more inclusive government.* GovTech Accelerator (2022, February 16). Retrieved February 17, 2022, from https://llgovtech.co.nz/

- **Remove barriers**
    - Create an environment that allows a greater risk appetite for public sector innovators.
    - Ring fence funding for government to innovate and commercialise science.
    - Give government departments/agencies full visibility of research projects and entrepreneurs solving ideas that touch or could impact their mandate or service delivery (i.e. through an open access database, as in suggestion 7).
    - Make IP extraction easy (as stated in suggestion 9, we suggest it should be free for government where the research was 100% publicly funded and otherwise is not being commercialised).
- **Upskill and draw on expertise**
    - Provide education and training on the discipline and practices of innovation and commercialisation for the public sector (relates to section on skills below).
    - Attract talent from the innovation ecosystem into the public service e.g. through secondments.
    - Partner with entrepreneurs in service delivery.
    - Set up support mechanisms the public sector can call on (e.g. partners in the innovation ecosystem or a specific Commercialisation Centre of Excellence).
- **Develop and scale government-specific support mechanisms**
    - Consider an incubator for government minimum viable products (MVPs) to get early ideas off the ground. This could be modelled off Sitra in Finland where the incubator does the product development then spins it back out to the government agency to scale.[45]
    - Use government-specific accelerators to speed up the growth of new ventures that already have an MVP. Adapt and scale existing ventures (e.g. NZ GovTech Accelerator) where appropriate.

[45] *Public-sector leadership.* Sitra (2021, May 7). Retrieved February 17, 2022, from https://www.sitra.fi/en/topics/public-sector-leadership/

Grow commercialisation & innovation skills

Innovation and commercialisation are not a part-time science activity. There are many people in the RSI system who are not researchers, such as commercialisation experts, founders and practitioners. There are parts of the system that don't fit neatly into the linear model of innovation, such as non-R&D innovators. And there are ways of innovating in how we think and work that will enable us to deliver more impact from research, science and innovation, which might include using Te Ao Māori principles, missions, agile practices and transdisciplinary approaches.

Successful knowledge intensive economies such as Israel and Singapore have a wealth of innovation and commercialisation expertise distributed throughout their RSI system. New Zealand does not have enough.[46] In order to achieve greater impact from the RSI system through innovation and commercialisation, we need to grow the expertise and capabilities within the system. Our suggestions to achieve this are below.

12. Give scientists and researchers **highly skilled, well resourced, and coordinated innovation and commercialisation support**. This is likely to be best achieved through one dedicated organisation that covers all innovation and commercialisation support and acts as the connective tissue for the system. [Key question 13]
13. **Upskill founders and researchers** through support services, mentoring and skills development. We could look to Australia's recently announced $242.7 million Trailblazer Universities initiative which will support training, recruitment, infrastructure and partnerships to accelerate commercialisation outcomes.[47] We could also scale successful industry facing skills programmes, such as Innovation Skills, to universities and CRIs. [Key question 13]
14. **Invest in capability building.** Our research has shown that a successful RSI system requires investment in innovation capabilities if it is to maximise innovation impact and deliver economic and public good outcomes. These innovation capabilities are 'vertical' (specialist science expertise), 'horizontal' (broader enabling capabilities such as in commercialisation) and 'dynamic' (capabilities to undertake sustained, radical and often disruptive long-term innovation, rather than safe, incremental innovation) (see Appendix 2 for further explanation). Examples of the 'dynamic capabilities' include strategic foresight scanning, open innovation and dynamic governance. Building these 'dynamic capabilities' was recommended in the Productivity Commission's report on Frontier Firms.[48]
15. **Expose science students to innovation and commercialisation.** The system can build on the already strong Student Grants programme run out of Callaghan Innovation. We note that Australia is investing $296 million over 10 years for 1800 industry PhDs and over 800 in fellows in an effort to lift commercialisation.[49] We can also look to the University of Waterloo in Canada where students have a term of work experience each year of study, which has resulted in an innovation hub where large organisations, startups and funding all come to draw on the talent pipeline.[50]

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[46] KiwiNet (2021). *New Zealand research commercialisation practice in real life - lessons from Universities, CRIs and Research Organisations*

[47] *Trailblazer universities to build jobs of the future.* CSIRO (2021, November 24). Retrieved February 17, 2022, from https://www.csiro.au/en/news/News-releases/2021/Trailblazer-universities-to-build-jobs-of-the-future

[48] New Zealand Productivity Commission (2020). *New Zealand firms: Reaching for the frontier. Final report*.

[49] Australian Government, Department of Education, Skills and Employment (2022). *University Research Commercialisation Action Plan.*

[50] *Five charts that illustrate Waterloo's unique tech hub credentials.* Waterloo EDC (2019, November 28). Retrieved February 17, 2022, from https://blog.waterlooedc.ca/five-charts-waterloo-tech-hub; *Nine big ways Waterloo has changed in the last 10 years.* Waterloo EDC (2021, April 6). Retrieved February 17, 2022, from https://blog.waterlooedc.ca/nine-big-waterloo-changes-last-ten-years

Provide targeted innovation support

Evidence indicates that Aotearoa's innovation system is not delivering as well as it could.[51] We see Te Ara Paerangi as an opportunity to get the innovation settings right in Aotearoa. Expanding the reform into innovation would require significantly more discussion and consultation, with a particular focus on bringing innovative businesses into the discussions. This is critical to make the increased funding and support for innovation and commercialisation, which we suggest above, more effective.

Over the last decade, countries that Aotearoa benchmarks against have shifted the focus of their innovation support from driving innovation 'for innovation's sake' to driving innovation to improve societal outcomes.[52] The shift is shown by leading innovative countries moving from providing broad, generic support across all sectors and organisations in an open and competitive regulatory environment to instead targeting support in a more focused and strategic way. Our innovation policy settings still mostly seek to address impediments to business innovation and investment in R&D.

To achieve greater impact from the RSI system, Aotearoa's innovation support should be targeted to innovators or areas with the greatest potential to create lasting societal and economic benefits for the whole country. This aligns well with the suggested approach to shift to national research priorities. Specific ways to achieve this are suggested below.

16. Use **mission-led innovation approaches** to orchestrate innovation around our toughest challenges (aligned with suggestion 2). Canada, Denmark, Spain and Thailand are focused on addressing major societal and economic challenges through innovation. The innovation agencies in these countries convene and drive missions, often in policy areas of significant traditional R&D spending such as defence, energy, the environment, or health. [Key question 1]
17. Target the most **intensive wraparound support to those with the most potential for impact**. Some innovation agencies are targeting support by investing in the development of a set of new sectors or technologies to build those industries. These include agencies in Thailand, Taiwan and Austria. Shifting the focus of R&D and innovation services from revenue generating products and services to R&D for Frontier Ventures may be one way to achieve this. More general support for the innovation ecosystem outside these areas can still be delivered digitally. [Key question 13]
18. Agencies in countries that are considered world leading in innovation, such as the UK, Singapore, Israel and Sweden, are focused on optimising their country's innovation system through **continuous experimentation and improvement** using different policy and programme mixes. This approach is taken because much of what works when it comes to innovation development and economic growth is not clear, therefore new evidence needs to be built through experimentation. TAFTIE (The European Association for Innovation Agencies) has set up a programme to support innovation agencies across Europe to be more experimental themselves. [Key question 9]

[51] WIPO (2021). *Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis.* Geneva: World Intellectual Property Organization.
[52] Stakeholder Strategies (2020). *Leading Innovation Agencies: International Insights Report* (available on request)

Drive cultural change with the right incentives

To be fit for the future, the RSI system's culture and capabilities need to be transformed. Incentives that encourage diversity and inclusion, collaboration, growth mindset, and impact delivery - especially through commercialisation of research - will be needed to change entrenched views and accelerate culture change. There is ample evidence of the positive impact of diversity on innovation and business outcomes.[53] Getting this right is crucial so that the efforts to get more people trained in STEM are met with conditions that make people want to build a career in the RSI system.

Culture change and alignment of incentives will be needed to bring many researchers on board with a greater focus on impact delivery via commercialisation.[54] The worlds of science and business have entirely different languages, timeframes, pace, skills, knowledge sets, value systems and incentives. In some cases not only are economic activity or commercial outcomes not a 'key driver' for research, these can sometimes be actively discouraged out of fear of corrupting the science process through commercial interests. In Climate Tech, New Zealand scores low in the R&D-to-commercialisation pipeline layer of the innovation ecosystem compared against other SAEs, which implies that researchers do not have the incentives to bring new technologies out of the lab and into organisations.[55] In our experience, the current funding incentives (e.g. PBRF) and the way institutions work (promotions based on publications) actively dissuade researchers from engaging in commercialisation and instead promote sharing Aotearoa's IP for others to capitalise on.

The misalignment between drivers and desired outcomes is pronounced for early career researchers and those spanning disciplines. Early career researchers working in the applied and commercial space currently suffer from a lack of recognised 'outputs' (i.e. publications) to support their promotion in the sector - though they are doing the type of research we want to encourage. We also want people equipped to work in complex multidisciplinary areas, but in our current system changing fields can reduce traditional 'outputs' and stifle careers.

Achieving greater impact from the RSI system through innovation and commercialisation requires a huge culture and capability shift. Below we suggest specific ways to accelerate an evolution in culture and capabilities in Aotearoa's RSI system.

19. **Set incentives for researchers that encourage commercialisation.** Count patents/spin-outs as well as publications for grants and promotions. Develop equivalent ways to recognise and reward the work of early career scientists in the applied and commercial space, who may not be named on patents or involved in spin-outs - e.g. letters/recommendations from companies scientists have worked with. Follow the types of schemes seen in the US where post-grad students are given around three years to spin-out the IP from their research for free, after which it reverts to their research institute, coupled with mentoring and wraparound support. [Key question 13]
20. Adopt People and Culture policies and **employment structures that enable risk taking and movement** between the public and private sectors. Have built in periods of leave without pay or a culture of allowing secondments which creates security to return to a role should the venture fail. For example, CSIRO allows 3 x 12 months leave without pay, which covers the riskiest years of a new venture.[56]

[53] Hunt, V., Prince, S., Dixon-Fyle, S., & Dolan, K. (2020). *Diversity wins*. McKinsey & Company; West River Group (2021). *The Power of Diversity: Why Homogeneous Teams in Venture Capital Are Bad for Business*.

[54] KiwiNet (2021). *New Zealand research commercialisation practice in real life - lessons from Universities, CRIs and Research Organisations*

[55] Cleantech Group (2021). *New Zealand Climate Tech for the World.*

[56] Thorburn, L. (1997). *Technology Transfer through Spinoff Companies: CSIRO - 1985–1995.*

21. **Target an increase in funding and services to minority researchers and founders** (including Māori, Pasifika, female) across the whole pipeline - student grants, R&D funding, publicly funded commercialisation support, and investment funds. [Key question 16]
22. Ensure that **Mātauranga Māori is eligible for R&D and commercialisation funding** and that Māori entities that want to lead research projects are eligible for funding.
23. Implement mandatory **transparent and consistent annual reporting of system outputs** from research, with shared platforms, reporting mechanisms and metrics. The UK Research Knowledge Exchange Framework dashboard provides a great example of transparent reporting for institutional performance for knowledge exchange[57] and Knowledge Transfer Ireland publishes a gold-standard annual review of business engagement and commercialisation activity in the State funded research sector.[58] [Key question 9] For Aotearoa's publicly funded research organisations we specifically suggest:
    a. Measuring and reporting on IP use rather than IP creation
    b. Reporting commercialisation (new products and services) separate from commercial revenue from public or private sector clients (fee-for-service).
24. **Make funding conditional on performance measures and system outputs** to put more weight behind the changed incentives e.g. tie funding to the use of IP, inclusion of Mātauranga Māori research, and researcher diversity. [Key question 16]
25. Develop ways to **keep talent in the RSI system**. For example, capture minority scientists (e.g. Māori, female) who leave the science education system because it is not inclusive, into the innovation system. [Key question 5]
26. Have diverse leadership by **establishing quotas** to appoint more diverse CEOs, leadership teams and boards across the whole RSI system, guaranteeing equal pay, and setting recruitment quotas for government organisations. [Key question 16]

"The current funding incentives (e.g. PBRF) and the way institutions work (promotions based on publications) actively dissuade researchers from engaging in commercialisation and instead promote sharing Aotearoa's IP for others to capitalise on."

Design the RSI system for greater impact

The green paper indicates that the reforms will prioritise system-level benefits. We agree that for the reforms to lead to greater impact from the RSI system, the shift from a fragmented to a system view is critical. Taking a systems view aligns well to Te Ao Māori.

Institutional form, funding and infrastructure are key system settings that need to take this system-level view and decisions on the design of these should be anchored to a long-term strategy. Our suggestions related to these system settings are below.

27. **Delineate distinct roles in the system, via funding or institutional form**, so that each maintains focus and optimises outputs, with important connecting and supporting roles between these functions (see deep dive below). Specifically delineate between the roles of basic research, applied research and commercialisation. [Key question 9]
28. **Baseline funding should cover infrastructure, fully allocated overheads and supportive/enabling capabilities** such as commercialisation support. The funding model should be set up in such a way that it encourages collaborative behaviour (both researcher-researcher collaboration and

[57] *Research England Knowledge Exchange Framework.* UKRI (no date). Retrieved February 17, 2022, from https://kef.ac.uk/dashboard
[58] Knowledge Transfer Ireland (2020). *Annual Knowledge Transfer Survey 2020*.

researcher-industry/end users) and discourages revenue generating behaviour at the expense of more impactful research, to drive genuine 'market pull' and better commercialisation outcomes. [Key question 8]

29. Have a **centralised, strategic, long-term and stable approach to infrastructure investment**, which includes infrastructure to drive innovation and commercialisation (see deep dive below). [Key question 17]

30. Consider the **capital intensity** of a research domain or priority much more carefully in whether Aotearoa's researchers should compete in the area. There are some areas of research that are very capital intensive because of the specialist infrastructure, equipment and resources that are required to conduct research. Given New Zealand's relatively small R&D spend due to our small size, we should conduct applied research mostly in areas that are attractive from a commercial perspective but also inexpensive to research - and play in niche areas where Aotearoa can excel, as observed by Sir Paul Callaghan.[59] Some countries are ring fencing areas of research through their 5-year plan and it is likely that capital intensity is considered. This needs to be weighed alongside government priorities (e.g. ITP areas) and whether New Zealand researchers can collaborate internationally or work as part of an international network in an area. [Key question 1]

[59] *Sir Paul Callaghan: Our strength lies in the weird stuff* (2020, September 16). NZ Herald. Retrieved February 20, 2022, from https://www.nzherald.co.nz/nz/sir-paul-callaghan-our-strength-lies-in-the-weird-stuff/ZH7GNVIIILANY2OABLAH2WFLQY/

Deep dive: Delineating roles in the system

To support decisions on institutional form and funding to be made, we have highlighted below some options and how these would support the RSI system to deliver on its distinct objectives (knowledge creation, solving societal problems, and improving economic outcomes), improve connections between researchers and industry, and ultimately achieve greater impact. Clarity of responsibility is important so that key functions, such as connecting industry and research, do not fall through the cracks, and that each distinct objective gets appropriate weighting and resource.

Table 2: Options for delineating different roles in the RSI system

	Core research functions	Basic research	Applied research	Science support for innovation	Innovation & commercialisation	Other business support (e.g. NZTE, NZGCP)	Implications
Distinct purpose	Critical research functions, services, databases and collections	Knowledge creation	Research to resolve issues, validate or create new products	R&D, pilot and demonstration services for innovative businesses & frontier ventures	Develop new products or services and bring them to market	Supporting the growth and export of new products and services	
Challenges in current system	At the whim of resourcing decisions and competitive funding	Unstable funding; sometimes forced to link to an application when that's not the purpose	Limited connections to real market demands; some 'public good' applied research without commercial potential forced to have revenue targets	Career progression incentives mean researchers are disadvantaged by focusing on shorter commercial contracts over publishing research	Spread across several organisations; Callaghan Innovation not always viewed as 'honest broker' in system due to RDS function	Not well connected to the rest of the RSI system	
Option 1	Ringfenced non-contestable and long-term funding;	Distinct funding and the majority occur in	Establish public research organisation(s) that focus on	Establish a public applied research & innovation organisation with a	Co-locate rather than merge	Co-locate rather than merge	Delineation of system objectives ✓✓✓

	operations sit with relevant government agency	universities	serving public good and government demand for applied research and also undertake some basic research Distinct funding & no focus on revenue targets	commercialisation focus that serves the private sector - with revenue targets OR Support establishment of a private applied research organisation with a commercialisation focus that serves the private sector			Research-industry connections ✓
Option 2		Establish public research organisation(s) that focus on serving public good and government demand for applied research and also undertake some basic research - by technology or skills not sector		Establish public research & innovation organisation(s) that focus on commercial outputs of publicly funded applied research by having all private-sector focused R&D, innovation and commercialisation, and business support functions within one organisation			Supports delineation of system objectives ✓✓ Supports research-industry connections ✓✓✓
Option 3			Establish one applied research organisation that services public and private sectors with distinct funding. This would need to maintain a focus on serving the private sector so that our businesses have the support to do R&D and innovation	Create a single innovation and commercialisation agency to better coordinate the support for science and business and connect these groups			Delineation of system objectives ✓✓ Research-industry connections ✓✓

Deep dive: Innovation and research infrastructure

This deep dive relates to Key Question 17: How do we support sustainable, efficient and enabling investment in research infrastructure?

Callaghan Innovation is broadly supportive of the principles outlined in the paper and the proposals regarding infrastructure.

Investment aligned with strategic priorities

Infrastructure investments must be better aligned with national strategic research and innovation priorities. This is essential to improve system responsiveness. This would create a sustainable network of infrastructure to better support and accelerate research and science and the commercialisation of innovation so that it can directly improve economic outcomes and solve societal problems.

Alignment to strategic priorities would reduce competition, duplication and inefficiencies in the system, and provide the basis for a more collaborative and shared access model to infrastructure and assets, beyond individual institutions, to drive system-level rather than institution-level benefits. Given Aotearoa's relatively small size this is critical to resolve - both from a budget perspective, and to create an integrated infrastructure network that supports an agile and connected RSI system.

Consider the infrastructure needs of innovation and commercialisation

Infrastructure decisions need to pay greater attention to the needs of innovation and commercialisation. While we support the desire for modern and adaptable research and scientific facilities, **equal focus should be given to the need for innovation and commercialisation facilities** (such as collaborative and flexible commercialisation spaces, prototyping, piloting and early production workshops).

Co-located and integrated infrastructure leads to better outcomes

We support the desire to move to co-location and recognise the benefits that this can bring through collaboration as a result of increased density and proximity.

However, we would propose that this **co-location should ensure appropriate clustering of both research and science with industry, business, society and government, supported by innovation, knowledge transfer capabilities and support services**. This aligns with the recognised spheres of collaboration in the quadruple helix model that underpins the RSI system.

"Innovation locations are not exclusively dependent on the presence of knowledge or technology-intensive institutions - after all not all university cities are centres of innovation. Their success is also tied to an established culture of collaboration, a financial imperative to commercialise and a related system of entrepreneurs"[60]

This mix of co-located institutions is demonstrated as necessary for creating thriving research, science and innovation communities. **Evidence has shown that this facilitates faster rates of knowledge transfer and commercialisation and adoption of research and innovations** (see Appendix 3).

However, we also recognise that a **degree of integration is necessary between institutions and the development, management and operation of facilities and assets** (capital and digital) which goes

[60] Clark G, Moonen T (2017). *The Logic of Innovation Locations: Understanding the Drivers that Enable Cities to Host Innovation Economies,* p10

beyond co-location to enable shared access across institutions with the research and science sector and business and industry.

Deciding what is important

The green paper requests specific detail about how the government could make decisions about what infrastructure is important. Here we provide some suggestions as to how this might be approached.

Callaghan Innovation suggests there is a need for a long-term national RSI Infrastructure Blueprint to provide a clear strategic roadmap for investing in priority infrastructure to align with strategic priorities, akin to the Australian National Research Infrastructure Roadmap.[61]

We propose this should:

- Provide clear classifications of infrastructure and their importance. Distinguishing between national, insitutation and local infrastructure.
- Identify how different classifications of infrastructure should connect and interact with each other to support the whole RSI system, being clear about what is core and complementary.
- Include provision for innovation and commercialisation as well as research and science.
- Recognise the need to maintain core infrastructure used by basic and core researchers.
- Provide sufficient flexibility and resilience to be able to pilot and scale infrastructure and platforms to respond to emergent innovations and technology.

A participatory stakeholder engagement process should be adopted to support the identification of opportunities for investment and inclusion in a 'Blueprint'. On this basis we support the factors outlined in the green paper (section 6.2.2 page 77) as providing a useful starting point for the development of a 'Blueprint'.

The importance of amenity and 'enabling infrastructure'

In addition, we note that any investment in RSI infrastructure also requires parallel investment in complementary infrastructure that is necessary to create the 'connective tissue' that enables the benefits from co-location and connectivity to be realised. Physical proximity alone is not sufficient to achieve this.

Studies highlight three core dimensions including "enabling infrastructure such as travel links; high quality telecommunications, IT platforms and reliable electric power; attractive locations for work and leisure and public space that has a 'stickiness' to encourage people to stay and interact; and strong supply of affordable housing in mixed use locations nearby".[62]

Infrastructure investment plays a role in building the range of capabilities needed to maximise innovation impact and deliver economic and public good outcomes (described in suggestion 14 and Appendix 2). As such the 'Blueprint' should include prioritising investments in:

- **Amenity of place.** Thriving locations are rich in amenities in which people want to interact. Specialised facilities with flexible connective spaces (such as event, social and meeting spaces) are co-located with recreational and service facilities such as childcare, cafes, restaurants, and outdoor spaces.

[61] *National Research Infrastructure.* Department of Education, Skills and Employment (2022, January 27). Retrieved February 17, 2022, from https://www.dese.gov.au/national-research-infrastructure
[62] Clark G, Moonen T (2017). *The Logic of Innovation Locations: Understanding the Drivers that Enable Cities to Host Innovation Economies,* p2

- **Transport connectivity.** Regular and accessible multi-modal transport options. For advanced manufacturing and production capabilities, easy connectivity between producers and access to arterial routes and sea and air ports is critical.
- **Enabling infrastructure.** Reliable high-speed broadband and power connectivity and capacity. A digital connective layer promotes and enables 'anytime and anywhere engagement'.
- **Connective infrastructure** such as deliberative programmes, incubators, activators, events, support services and community building. This so-called **soft infrastructure** requires investment to facilitate the benefits of co-location and connectivity and is a fundamental part of an infrastructure operating model.[63]

Sustainable funding

Wholescale transformation is required in the funding of infrastructure investment to provide stability, longevity and resilience for our RSI system infrastructure and assets.

To address the challenges of funding stability, we agree **that a core operating grant should be provided** to institutions or entities responsible for managing and operating RSI facilities and whole of life costs. This would remove the risk of financial uncertainty and prevent prioritisation of research over asset management.

We recommend that a new approach for **commissioning infrastructure investment** be adopted rather than contestable funding rounds which are short term, siloed and output-focused.

Such an approach would prioritise investment against national research and innovation priorities as identified in the RSI Infrastructure Blueprint and enable coordination across Government investments in parallel infrastructure such as transport.

We agree with the proposal to establish a **National Infrastructure Fund (NIF),** however note that this should be bulk funded, multi-year and outcomes driven. This approach we believe would support a market response, allowing institutions to plan accordingly and give confidence to the private sector to catalyse co-investment in complementary infrastructure and developments.

That said, we support the need for a smaller contestable RSI fund to enable localities and institutions to bid for investments in supportive and complementary facilities that may support core infrastructure outside the national research and innovation priorities.

It is also important that the approach to infrastructure investment drives the RSI system and individual institutions to make smarter and more complementary decisions around the purchase of scientific equipment within their own budgets, seeking to co-fund investment and develop shared access arrangements between institutions and industry. An example of this has been the recent investment in a new Clean Room at GIQ which has been co-funded between Callaghan Innovation and Victoria University Wellington. We would encourage the introduction of spending frameworks and incentives which facilitate this.

An independent National Infrastructure Entity

In principle we are supportive of the proposal to **establish a National Infrastructure Entity to provide oversight and governance of the national RSI infrastructure.**

[63] Katz B, Wagner J (2014). *The Rise of Innovation Districts: A New Geography of Innovation in America.* The Brookings Institute. Metropolitan Policy Programme; NSW Government (2018). *NSW Innovation Precincts: Lessons from International Experience*. NSW Innovation and Productivity Council; Clark G, Moonen T (2017). *The Logic of Innovation Locations: Understanding the Drivers that Enable Cities to Host Innovation Economies*.

We foresee such an Entity would be responsible for development of the RSI Infrastructure Blueprint and commissioning of the NIF against agreed infrastructure priorities and where appropriate delivery of nationally significant infrastructure investments.

Further, this would remove the need for replicated capabilities within RSI institutions, avoid competition for resources and increase purchasing power through economies of scale. However, we propose that the development, management and operation of RSI assets should sit regionally / locally (see figure 3).

We recognise that place-based co-located facilities require freedom to operate and agility to provide flexibility, independence and develop an identity which is anchored in its locality and is able to develop local approaches to securing talent, building partnerships and providing effect to Te Tiriti with a local mana whenua.

As such we recommend that the Entity would provide governance of a network of RSI infrastructure bodies at a regional level, providing support with the design and delivery of facilities, budget provisions and devolution of funding, and providing standards for design and operation.

How these assets are managed locally will be specific to each region, however, we also recognise that **a degree of integration is necessary between institutions and the development, management and operation of facilities and assets** (capital and digital) which goes beyond co-location to enable shared access across institutions with the research and science sector and business and industry.

The Entity should have a significant degree of independence to ensure that investments remain balanced and in line with national priorities. This requires strong governance, accountability and delivery frameworks that are inclusive, representative and participatory.

Māori as an equal partner

Callaghan Innovation believes that **Māori as a Te Tiriti partner should have greater involvement and equity** in the ownership, governance and decision making within the RSI asset infrastructure portfolio to ensure any investments can support Māori outcomes and aspirations and protect and enable māturanga Māori.

This extends to:

- Any National Infrastructure Entity should ensure equity of representation of Māori at all levels, specifically governance and a minimum threshold of Māori representation should be incorporated into the Board charter.
- Māori should be involved in the decision making processes for the commissioning of infrastructure investment and development of a National RSI Infrastructure Blueprint.
- Participatory processes should be grounded in a Te Ao Māori approach which is all encompassing.
- Investment in Māori owned and operated RSI facilities should be prioritised.

Learnings from Development of Gracefield Innovation Quarter

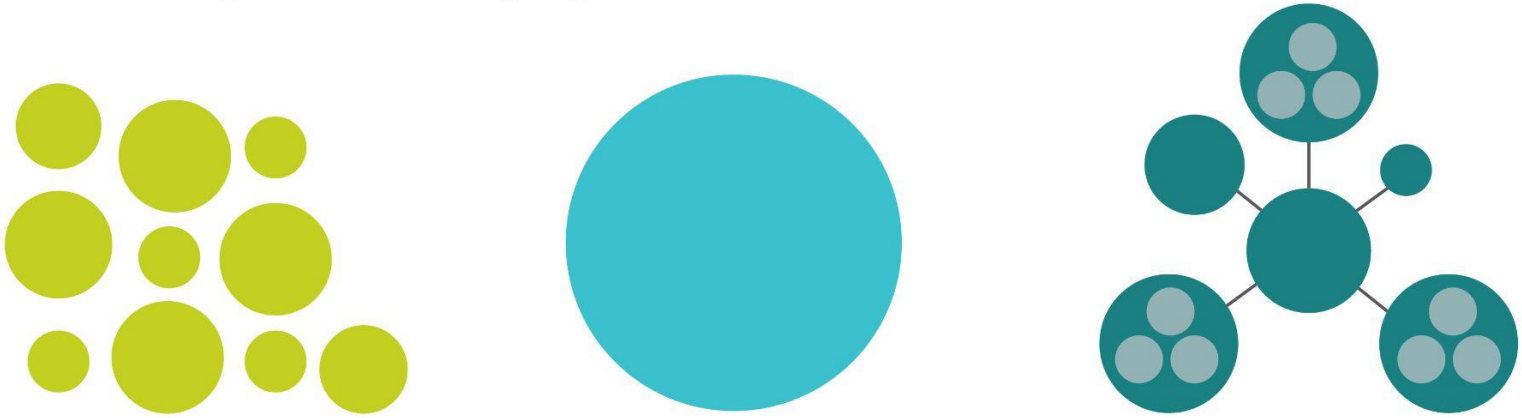
Callaghan Innovation has gained considerable experience of developing, delivering and operating co-located RSI infrastructure through its GIQ redevelopment programme.

Here we share some of the key insights from this experience that we believe are important to the conversations about infrastructure investment:

- Clarity of vision, outcomes and benefits is essential to identifying investment priorities and designing the form, function and configuration of infrastructure assets.
- Focus also needs to be given to the operating model and non-asset-based support to develop co-located capabilities and connective tissue, and how integration and shared access arrangements will work.
- A transdisciplinary team - construction and design expertise blended with strategic, economic development, scientific and innovation experts - ensures that the strategic development of the approach is aligned with vision / outcomes.
- Partnership is key but hard. Collaboration and partnership is a process. This requires extensive time commitment and investment to support.
- Precision design and implementation. Highly specialised scientific facilities require high precision construction and engineering.
- Creating inspiring places and ensuring parallel investment in amenity requires additional investment and funding should match the scale of ambition.

Figure 3: Models for governing and managing RSI infrastructure investment

Governing and Managing RSI Infrastructure



DISPERSED

Current model. Siloed approach. Individual institutions manage their own infrastructure requirements and investments. Funding is adhoc.

CENTRALISED

Alternative model. Centralisation of all infrastructure investment, management and delivery. Risk becomes too prescriptive with centre removed from local need. However, prevents flexibility to respond to local / regional RSI system needs regarding access, shared provision and interoperability, interface with local RSI ecosystem.

BRIDGED

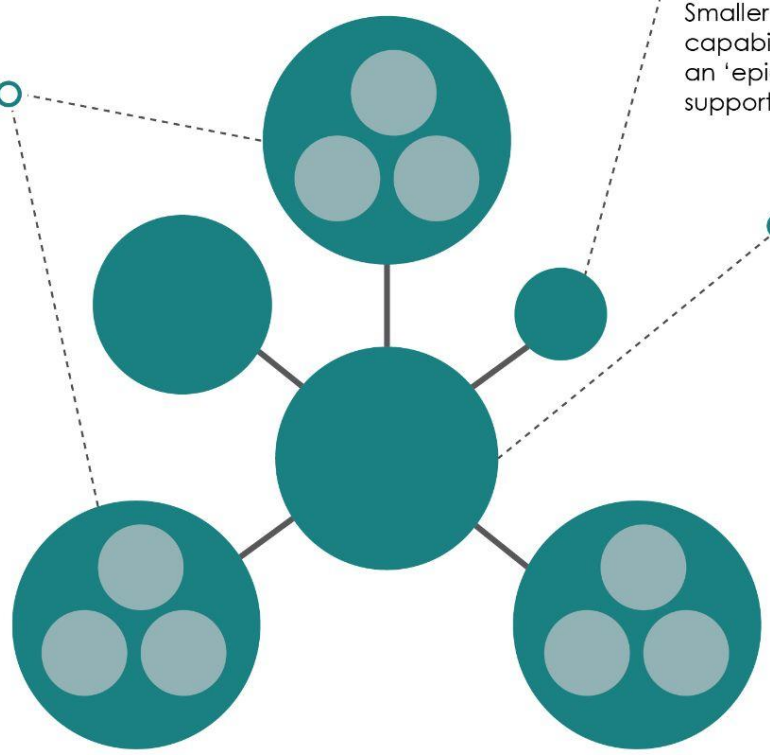
National infrastructure entity coordinates and governs investment aligned with national strategic innovation / research priorities. Infrastructure is developed and managed locally as part of a placed based co-located model.

Here we present three models for governing and managing RSI infrastructure investment. We believe that the bridged model is most appropriate for aligning investment with strategically important research and innovation system priorities with the need for local and/or institutional flexibility.

The Bridged Model

CO-LOCATED REGIONAL/ LOCAL RSI LOCATION

- Local cluster of co-located RSI facilities to support regional ecosystem requirements and provide national capabilities as required.
- Flexibility to coordinate across regions and interact with non-RSI public infrastructure facilities.
- Recognises the deep connection of Māori and mana whanau to place and regional mātuaranga.
- Identity, open access and shared resources / services are developed suitable to requirements of the region and in support of national priorities.



REGIONAL RSI HUB

Smaller RSI facilities focused on a single capability or where the local RSI system lacks an 'epicentre'. Provides a home to connect to support provincial RSI development

NATIONAL INFRASTRUCTURE ENTITY

- National infrastructure entity Develops national RSI Infrastructure Blueprint
- Governs, commissions and coordinates investment to align with national strategic innovation / research priorities and Blueprint.
- Provides standards, frameworks and quality assurance for infrastructure design, delivery and operation.
- Procurement platforms and economies of scale
- Professional and technical expertise and delivery support

This describes the **Bridged Model** in more detail. It aims to balance the need to provide national governance and coordination to better align infrastructure with strategic priorities, whilst at the same time recognising the specialist relationship of Māori to place and regional mātuaranga and creating regional/local flexibility to leverage the capabilities within place to support a connected RSI ecosystem.

Section 4: Callaghan Innovation-specific impacts and suggestions

We are focused on what's best for Aotearoa

New Zealand needs an RSI system that delivers new knowledge, social and economic benefits, and positions us well to respond to two decades of impending change. The RSI system is currently lacking a coherent strategy and vision to achieve this. We strongly believe there needs to be a long-term (20 year +) strategy developed for the RSI system so that these and other policy changes in the coming decade can be anchored to a long-term strategy. Callaghan Innovation will be open to any changes, including to our structure and infrastructure, where these are strategically informed and drive system-level benefits.

"We strongly believe there needs to be a long-term (20 year +) strategy developed for the RSI system so that these and other policy changes in the coming decade can be anchored to a long-term strategy."

Callaghan Innovation's role is to stimulate demand and accelerate commercialisation for New Zealand innovation. We work with over 3000 innovating businesses and connect those businesses into Aotearoa's RSI system. We support businesses through their innovation journey with R&D funding, 1:1 commercialisation coaching, deep tech expertise, innovation upskilling, and connection to experts. Our services allow more New Zealand businesses to commercialise their science, technology and Mātauranga-based innovations. Our position in the RSI system is unique, with resources, footprint, expertise and access deep into Aotearoa's innovative high-impact businesses.

In our unique role we see how rapidly technological change is happening, and the urgency with which our RSI system - and country more widely - needs to change to keep up. We are going through changes ourselves to become an innovation agency fit for Aotearoa's future.

- System-wide changes that give effect to Te Tiriti will add momentum to the journey Callaghan Innovation is on to genuinely honour Te Tiriti and better serve Māori innovators. We are enthusiastic to support changes that enable this, led by Māori.
- We have changed how we work, via our business model and operating model, to be more adaptable, responsive and transdisciplinary. This positions us well to work collaboratively with the rest of the RSI system to respond to existing and emerging national priorities. For example, we could easily stand up a multidisciplinary team to be involved in a government-led mission.
- We are moving to targeted innovation support, focusing on providing more intensive wraparound support to customers with the greatest potential to address societal challenges or improve economic outcomes. This specifically includes targeted support for Frontier Ventures so that New Zealand has more businesses at the productivity frontier which will lift national productivity and wellbeing.

There are a number of ways Callaghan Innovation in its current form could contribute to a future system. We would be best placed to design and lead commercialisation support mechanisms tied to missions or developed to support minority groups of innovators and scientists. As an institution that can connect and convene, we could be the central agency who coordinates a Commercialisation

Centre of Excellence. We are a natural fit to act as the facilitator to better connect research and industry and support a healthy and connected RSI system. We could support other government agencies to innovate and commercialise products and services, for example by acting as an incubator for government MVPs and then spinning the product back out to the government agency. And if technology-driven platforms or missions are established, we could play a lead role (e.g. for emerging applied tech such as big data, IoT, robotics).

That said, we are open to any change to our form or role that will enable Aotearoa to achieve greater impact from the RSI system, and have highlighted several options for system structure in the deep dive on institutional form.

We are also open to a different approach to infrastructure management if it will achieve better outcomes for Aotearoa's RSI system. Callaghan Innovation's current investment in infrastructure has been driven by a desire for system-level benefits, collaboration and co-location. The GIQ site is designed 'organisation agnostic' and is therefore well positioned to support a future, more collaborative RSI system.

Section 5: Direct response to green paper

Below we have simplified and aligned our response to the green paper key questions for ease of reference. Note this content is largely a repeat of the more detailed submission content.

Table 3: Callaghan Innovation's direct and summarised responses to key questions

Question	Response
Research priorities Key message: Involve industry in research priorities to drive more demand-led science.	
Proposed design feedback 1.2.1: He aha te tikanga o te whakaarotau? What do we mean by a Priority? Page 26	We agree with suggested design features 1. To use priorities (and suggest making these 'missions') 2. Te Tiriti approach for priorities 3. Direct link between funding and priorities 4. Long-term funding approach 5. Locus of coordination and information sharing approach 6. Priorities not covering all research in system 7. Priorities supporting full range of research activity - specifically, we agree wholeheartedly that funding should encompass knowledge transfer activities including commercialisation We disagree with the suggested design feature 8. Priorities should go beyond being multidisciplinary (within science/research) and instead be transdisciplinary and therefore include others outside science/research organisations. Industry, including entrepreneurs, founders and practitioners, should be involved in research priorities/missions.
Key question 1: What principles could be used to determine the scope and focus of national research Priorities? Page 27	Focus: A mix that must include 'technology' focused research priorities to cater to emerging disruptive technologies and 'problem' focused research priorities to address government priorities. Principles for scope and focus: a) potential for impact, b) low capital intensity research.
Key question 2: What principles should guide a national research Priority-setting process? How can the process best give effect to Te Tiriti? Page 29	We agree that the principles must include: predictable, transparent, flexible. We strongly recommend the process supports wide consultation and accommodates independent advisors (independent of the research system as well as government, e.g. industry) in the decision-making body. The approach could potentially include co-design with those currently outside the RSI system. We see Māori-led missions as one potential way to give effect to Te Tiriti, but defer to Māori views on the best approach. A pilot then scale approach would be a good way to deal with emerging out-of-cycle priorities.

Key question 3: How should the strategy for each national research Priority be set and how do we operationalise them? Page 32	We agree with the suggestion that the operation of research priorities needs to consider the needs and aspirations of end users and key stakeholders. For priorities with a focus on commercialising the research, we believe industry needs to be involved in the priority setting, strategy setting and governance. This is to connect the research to real-world demand.
Te Tiriti, mātauranga Māori and Māori aspirations Key message: Targeted innovation and commercialisation support mechanisms for Māori researchers and entrepreneurs could help the RSI system deliver more relevance and outcomes for Māori.	
Key question 4: How would you like to be engaged? Page 38	Our main insights are that targeted innovation and commercialisation support mechanisms could be established or scaled to support Māori researchers and entrepreneurs to translate their research into application, and that any standardised IP framework needs to have appropriate consideration of protecting Mātauranga Māori. We believe that using incentives and targeting funding and services to encourage diversity and inclusion will be the only way to change entrenched views and accelerate culture change. However, we defer to the feedback you receive from Māori researchers and innovators on how to best improve the RSI system for Māori.
Key question 5: What are your thoughts on how to enable and protect mātauranga Māori in the research system? Page 38	
Key question 6: What are your thoughts on regionally based Māori knowledge hubs? Page 39	
Funding Key message: Funding to support commercialisation needs to be significantly increased, stable and better coordinated.	
Section 3.2: Funding core functions Page 44	We agree with the proposal to separate out and ring-fence funding for the 'core functions' provided by the RSI system. We think it is important for funding (and/or institutional design) to delineate the different roles and goals of the system.
Key question 7: How should we decide what constitutes a core function and how do we fund them? Page 46	We agree that the mechanism for funding MSL provides a good model for core functions.
Key question 8: Do you think a base grant	Yes we agree with this approach. We think baseline funding should cover infrastructure, overheads and supportive/enabling capabilities such as

funding model will improve stability and resilience for research organisations, and how should we go about designing and implementing such a funding model? Page 48	commercialisation support, to provide stability for organisations. We also think it is important for funding (and/or institutional design) to delineate the different roles and goals of the system. If the sum awarded is based on performance or activity, we suggest that knowledge exchange (commercialisation being one example) is included in this measure. Metrics should not be based purely on publishing. The funding model should be set up in such a way that it encourages collaborative behaviour (both researcher-researcher collaboration and researcher-industry/end users) and discourages revenue generating behaviour, to drive genuine 'market pull' and better commercialisation outcomes. Regarding funding, we are mostly concerned with there being sufficient, stable and coordinated funding to deliver impact - e.g. commercialisation funding.
Institutions (including better impact delivery) Key message 1: Institutional design should significantly strengthen the system's innovation and commercialisation functions and improve the connection between these and research. Key message 2: Enhance innovation and commercialisation funding and support mechanisms to achieve greater impact from research.	
Section 4.3: Role of Callaghan Innovation in the RSI system Page 55	We agree with the need to think about the interaction with the innovation system and to consider the role of an innovation agency and innovation infrastructure when considering changes to the research system. However, we encourage Te Ara Paerangi to take this further and explicitly include the innovation system as part of the review, so that changes can be made viewing research, science and innovation as an integrated system with a clear long-term strategy. We also agree with the need to prioritise creating strong connections between New Zealand firms and public research institutions in these system changes. We are open to any change to our form or role that will enable Aotearoa to achieve greater impact from the RSI system. A priority for structural design should be strengthening the system's innovation and commercialisation functions and improving the connections between these and research.
Key question 9: How do we design collaborative, adaptive and agile research institutions that will serve current and future needs? Page 57	We agree that the structural reforms should follow the global trend towards a focus on industry-targeted research, and should focus on being able to respond to government priorities, industry demands and emerging opportunities. We think it is important for institutional design (and/or funding) to delineate the different roles and goals of the system. Innovative operating models can be used to allow larger organisations to be more agile (including the Agile framework). We emphasise that institutional design decisions should be based on a robust long-term strategy for the RSI system in order to deliver the best outcomes. The RSI system currently lacks a clear long-term strategy.
Key question 10: How can institutions be designed to better support capability,	We suggest standard contract settings that promote risk-taking and formation of spinout companies (e.g. 3 x 12 months leave allowed, which gets founders past the riskiest part of a venture).

skills and workforce development? Page 58	There are a number of programmes Callaghan Innovation runs to upskill the private sector that could be scaled into the research sector (e.g. Innovation Skills). Exposing science students to innovation and commercialisation will ensure a pipeline of talent needed to get impact from the RSI system, to future-proof the system. The system can build on the already strong Student Grants programme run out of Callaghan Innovation.
Key question 11: How should we make decisions on large property and capital investments under a more coordinated approach? Page 58	We agree with the benefits of co-location and encourage Te Ara Paerangi to expand co-location horizons past researchers to also include industry, government and iwi.
Key question 12: How do we design Tiriti-enabled institutions? Page 59	Our insights are that funding Māori-led research (e.g. via Māori-led missions), and removing barriers to Māori participation in the system (e.g. Mātauranga Māori not qualifying as R&D, and Māori governance structures not meeting eligibility criteria for some R&D or commercialisation funding) would be some - but not nearly all - of the changes that need to happen. However, we defer to the feedback you receive from Māori researchers and innovators.
Key question 13: How do we better support knowledge exchange and impact generation? What should be the role of research institutions in transferring knowledge into operational environments and technologies? Page 60	We wholeheartedly agree with the statement: "We want the research system to achieve greater impact. By impact, we mean a change to the economy, society or environment beyond a contribution to knowledge and skills in research organisations" and **focus the majority of our submission on suggestions relating to this question.** We support the development of a standardised IP framework for New Zealand.
Section: Ngā ara whakaarumoni Commercialisation pathways Page 62	We agree with the suggestion to diversify how we think about commercialisation pathways and think this would be hugely beneficial - our main suggestion is to include government. We believe commercialisation funding and support mechanisms need to be scaled and coordinated system-wide via a Commercialisation Centre of Excellence. We suggest Government innovation and commercialisation of science, and free access to unused publicly-funded IP for government and social enterprise, as alternative commercialisation pathways. Further barriers to getting ideas out of the research system and into the hands of end users include: institutions overvalue IP, people underestimate the effort to turn IP into consumable and desirable products, the effort to scale, and the difficulties attracting suitable investment at the right time.

	Emerging technologies or other applications where there might not be any current end users could be developed via research priorities/missions and then scaled to become platform technologies once the demand is there.
Research workforce Key message: Developing the innovation and commercialisation workforce, which has unique expertise and skill sets, is equally important to developing the research workforce.	
Section 5.1: What problem or opportunity are we trying to address? Page 66	We support the aspiration for a research system that is more connected, diverse and dynamic, that attracts and retains excellent talent - and encourage this to be broadened to the innovation system as well. This is an opportunity to encourage diversity and inclusion, collaboration, growth mindset, and impact delivery in our RSI workforce and we believe that this will require incentives and targeted funding and services to achieve this.
Key question 14: How should we include workforce considerations in the design of national research Priorities? Page 66	The reform should consider how we get the right innovation and commercialisation expertise to support impact delivery from the research priorities. Beyond the research priorities/missions, there needs to be an increase in the amount of highly skilled, well resourced, and coordinated innovation and commercialisation support in the system.
Key question 15: What impact would a base grant have on the research workforce? Page 70	We agree with the suggestion that a base grant could be used to drive desired system outcomes by tying the grant to conditions or performance expectations. These should include meeting quotas for equity, diversity and inclusion (EDI), and also for knowledge exchange / commercialisation, to transform the RSI system's culture and capabilities.
Key question 16: How do we design new funding mechanisms that strongly focus on workforce outcomes? Page 71	We support Aotearoa taking a serious approach to talent development, resourcing, attraction and retention, with a strongly international mindset, and encourage this approach to be extended to innovation and commercialisation talent as well as research. Funding mechanisms for upskilling researchers and founders will support workforce outcomes.
Research infrastructure Key message: Equal focus should be given to the need for innovation and commercialisation facilities, as well as research facilities.	
Key question 17: How do we support sustainable, efficient and enabling investment in research infrastructure?	Through strategically-led, priority-aligned, long-term and stable funding for infrastructure, including amenity considerations and enabling infrastructure. Include innovation and commercialisation in infrastructure and co-location decisions, and co-locate non-researchers as well (e.g. industry, Māori, government). **A large part of our submission is based on this, given our experiences with GIQ.**

We look forward to further involvement in Te Ara Paerangi

Callaghan Innovation understands that the green paper is the first in a series of discussions to reshape our RSI system to be fit for the future. We recognise that Te Ara Paerangi is a multiyear programme and that change won't happen overnight.

We are enthusiastic to be involved in ongoing discussions and are very happy to elaborate on any suggestions provided or workshop ideas further, as well as support efforts to bring the broader innovation ecosystem into ongoing Te Ara Paerangi conversations.

References that were foundational to our thinking for this submission

- Cleantech Group (2021). *New Zealand Climate Tech for the World.*
- KiwiNet (2021). *New Zealand research commercialisation practice in real life - lessons from Universities, CRIs and Research Organisations*
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- WIPO (2021). Global Innovation Index 2021: *Tracking Innovation through the COVID-19 Crisis. Geneva: World Intellectual Property Organization.*

Appendices

Appendix 1: Key funding for research and commercialisation

The purpose of this comparison is to stimulate discussion about how we strike the right balance between funding research and commercialisation - or even 'impact delivery' more broadly. We think the balance of funding is an important consideration for the future RSI system to ensure we achieve greater impact from the RSI system.

The table below includes a summary of the key research and commercialisation funds provided by the government. Such a comparison comes with significant caveats which we outline below.

Firstly, not all research is for commercialisation purposes and so there isn't a need for commercialisation investment for all research. That said, there might still be a need for funding to deliver impact or mobilise knowledge from non-commercialisable research. This raises the question: how much research are we funding with a line of sight to impact, and is there adequate funding to deliver that impact?

A further caveat is that for some funds it is hard to disentangle what is spent towards 'research' vs 'commercialisation' and therefore there may be some hidden investment (e.g. some PBRF funding may support the efforts in TTOs, or some MBIE research funds may include some impact delivery aspects). There is a continuum from basic research to applied research to the specific commercialisation support to get products to market. Digging further into how funding is spread across the continuum may also be useful to support discussions around the balance of funding to achieve greater impact from RSI investment.

We have included all relevant funds to the best of our knowledge, but the table is unlikely to be exhaustive. We have not included funding to launch in international markets in this comparison (e.g. NZTE funds).

Our estimates suggest that approximately 20 times the amount of funding is dedicated to research compared to commercialisation.

Table 4: Summary of government funding for research and commercialisation

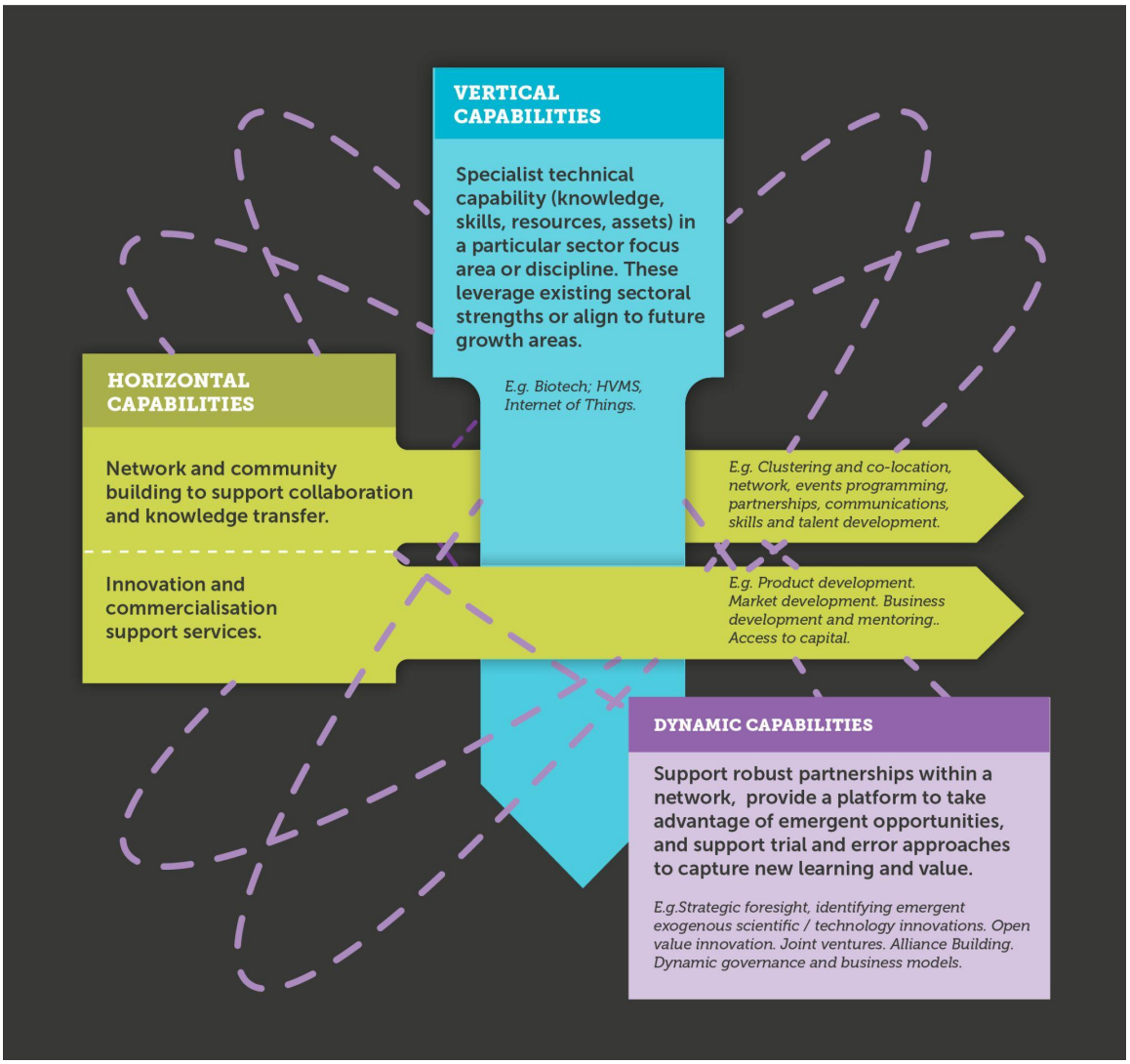
What	Type	Approximate funding per year (millions)	Source
Marsden Fund	Research	$79m	Appropriation (2020/21 Estimates) Bill
Strategic Science Investment Fund	Research	$324m	Appropriation (2020/21 Estimates) Bill
Endeavour Fund	Research	$243m	Appropriation (2020/21 Estimates) Bill
Catalyst	Research	$35m	Appropriation (2020/21 Estimates) Bill
National Science	Research	$68m	MBIE website

Challenges			
Health Research Fund	Research	$117m	Appropriation (2020/21 Estimates) Bill
Centre of Research Excellence	Research	$75m	Appropriation (2020/21 Estimates) Bill
Performance Based Research Fund	Research	$321m	Appropriation (2020/21 Estimates) Bill
The New Zealand Food Safety Science and Research Centre	Research	$2.1m	MBIE website
Partnered Research Fund	Research	$33m	Appropriation (2020/21 Estimates) Bill
Infectious Diseases Research Platform	Research	$12m	MBIE website
Greenhouse Gas Inventory Research Fund	Research	$1.1m	The fund's 2021 priorities paper
New Zealand Agricultural Greenhouse Gas Research Centre	Research	$4.85m	MPI website
Sustainable Land Management and Climate Change (SLMACC)	Research	$7m	MPI website
RDTI	Research	$281m	Appropriation (2020/21 Estimates) Bill
Targeted Business Research and Development Funding (Project Grants and Student Grants)	Research	$41m	Callaghan Innovation Annual Report 2020/21
Approximate total for research funding: $1600m			
Callaghan Innovation Building Business Innovation appropriation	Commercialisation	$38m	Callaghan Innovation Annual Report 2020/21
Repayable Grants for Start-Ups (Tech Incubators)	Commercialisation	$21m	Appropriation (2020/21 Estimates) Bill
Commercialisation Partner Network	Commercialisation	$4m	MBIE website
PreSeed Accelerator	Commercialisation	$9m	MBIE website

Fund			
Te Tītoki Mataora, the MedTech Research Translator	Commercialisation	$2.7m	Government press release
Research Acceleration Programme (RAP)	Commercialisation	$2.7m	CMDT website
Food Innovation Network	Commercialisation	$4.5m	Vote Business, Science and Innovation estimates 2021/22
Approximate total for commercialisation funding: $80m			

Appendix 2: Innovation capabilities

The diagram below illustrates the three core innovation capabilities.



Appendix 3: Evidence to support co-location

Evidence to support co-location includes:

- The benefits of knowledge spillover and resource sharing decrease with distance. Those concentrated within a square mile offer 10-1000 times greater opportunity for collaboration than between 2-5 miles away.[64]
- Collaboration and co-location in Australia was associated with a 70% increase in likelihood of new-to-world innovation and 32% increase in likelihood of new to Australia innovation.[65]
- Co-location reduces costs of collaboration resulting in greater collaboration on research projects, coordination, monitoring and transfer of knowledge leading to better quality research projects and undertaking of marginal research where risk is shared.[66]
- Co-located researchers are 3.7-5.7 times more likely to collaborate than researchers in non-collocated laboratories and 1.4 times more likely to produce a paper that will increase wider citation and distribution.[67]

Co-located researchers in close proximity leads to increased co-publication than those not co-located. This is 40 times higher than researchers located in the same town and 100 times higher than those not located in the same town.[68]

[64] Lawrence, S., Hogan, M., & Brown, E., (2019). *Planning for Innovation Districts: Questions for Practitioners to Consider*, p4. RTI Press.
[65] NSW Government (2018). *NSW Innovation Precincts: Lessons from International Experience*. NSW Innovation and Productivity Council p24
[66] Catalini, C. (2018). *Microgeography and the direction of inventive activity. Management Science*, 64(9), 4348-4364.
[67] *IBID*
[68] Mairesse, J., & Turner, L. (2005). *Measurement and Explanation of the Intensity of Co-publication in Scientific Research: An Analysis at the Laboratory Level*. NBER Working Papers, 11172.