Comments on the Draft National Statement of Science Investment 2014-2024

Introduction

This paper provides feedback for Ministry of Business, Innovation and Employment (MBIE) on behalf of the Royal Society of New Zealand (RSNZ) on the recently released draft *National Statement of Science Investment 2014-2024* (referred to here as NSSI)[1]. The feedback is provided by a panel (see Appendix 1) formed by the RSNZ to review the New Zealand Research System. Appendix 2 includes comments that address apparent misconceptions or important points that the RSNZ feels have been overlooked. The main body of this submission, however, is our response to the questions posed in the document under the 'Consultation' section[2].

Summary of key points

1. The NSSI document emphasises the importance of science excellence. We strongly endorse this view and encourage the use of high quality independent review processes. When it comes to science 'good enough' is not good enough. Problems are only solved by excellent science.
2. At less than 8% of the total science budget, funds for untargeted curiosity-driven (investigator-led) science are currently inadequate for sustaining an innovation-led economy. Curiosity-driven research was a key factor in creating the agriculturally-based economy that New Zealand currently depends on. Mission-led or industry-directed science is important for nationally significant science challenges but does not support the young scientists whose independent research may produce the serendipitous outcomes that our economic future depends on. Curiosity-driven research also builds the human and physical capability necessary to undertake mission-led research as well as to translate overseas developments for the benefit of New Zealand[3].
3. Better mechanisms are needed to ensure that the findings of curiosity-driven science are translated to economic, social, health and environmental outcomes. A key issue is a better appreciation of the variable (and often long) timescales of the return on the science investment.
4. Better mechanisms are needed for career development in the science system. The level of support for attracting talented Kiwi scientists back to New Zealand and retaining them is at least an order of magnitude below that of Australia on a population adjusted basis.
5. More evidence-based decision making around science investment is needed to ensure more stability in the science system. Major changes are made to our science system with inadequate scientific justification. Frequent restructuring of the Ministry overseeing science investment is also destabilising and costly for the science system.

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[1] www.msi.govt.nz/update-me/major-projects/national-statement-of-science-investment
[2] The RSNZ discussed an early draft of this submission with senior MBIE officials on August 14th.
[3] For example, we did not invent fertilizer but we had the capability to adapt its use to New Zealand conditions.

Overall comments

The draft *National Statement of Science Investment* (referred to here as NSSI) provides a convenient summary of the Government's current investment in the science system and an indication of future investment. It provides some context and a limited rationale for current and future investment but does not attempt to lay out a cohesive strategy or vision for future development of the New Zealand science system. For example, there is no indication of how the Government will deal with well recognised gaps in the current system, such as the lack of adequate postdoctoral support and career paths for young scientists, or how the relationship between researchers in the universities and Crown Research Institutes (CRIs) and the needs of companies operating in New Zealand can be improved.

There are, however, many statements that the RSNZ supports[4], and we commend the Government for providing a valuable resource for developing future science policy and for stimulating and informing a public discussion around the direction of future science investment in New Zealand. The document does provide an excellent starting point for a rational debate on the appropriate level of Government research funding and how this should be distributed among, for example, investigator-led, mission-led and industry-led research projects. It will however take time to gather the data and to achieve a consensus on recommendations from the science and business community. The RSNZ hopes that the publication of this document and the call for feedback indicate a genuine desire to work with the science sector to develop a vision and long term strategy for improving the science system. The Royal Society of New Zealand, as an independent body broadly representing New Zealand scientists (as well as other scholars), is certainly keen to work with the government and other interested groups to develop such a vision and strategy.

Responses to questions under the consultation section

A. FEEDBACK ON OVERALL SCIENCE INVESTMENT OUTLOOK

B. GENERAL FEEDBACK ON THE DIRECTION

C. FEEDBACK ON STRUCTURE OF MBIE SECTOR-SPECIFIC RESEARCH FUNDS

Some of the points below address more than one of these topics, so they are grouped together here.

1. **Investigator-led or curiosity-driven research**. The challenge facing those responsible for science policy is how to maintain an intellectual climate in which curiosity can flourish[5] . The famous comment made by the Nobel Laureate Sir George Porter that "There are two types of chemistry – applied and yet to be applied" is relevant for all areas of scientific research[6], and there is much evidence[7] to support the argument that most economically valuable outcomes from research are the serendipitous results of scientists passionately following their own research interests. Examples of

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[4] RSNZ particularly endorses the key priorities to "*produce excellent science of the highest quality*" (p7), to "*commit to increasing investment over time from 0.52 to 0.8% of GDP*" (p8) and agree, under the heading *Why invest in science?* (p10), that "*Government-funded research is seen around the world as an important complement to private sector investment*", that "*science is central in brokering the balance between the use of our rich natural resources for the benefit of all New Zealanders, and preserving our unique environmental heritage*" and that "*Research-led teaching in our tertiary education institutions is crucial to training the highest-skilled part of our future workforce*".

[5] From Sir John Enderby in the paper "Curiosity-driven 'Blue Sky' Research: a threatened vital activity?" by Sir John Cadogan – see http://learnedsocietywales.ac.uk/node/539

[6] Einstein's theory of relativity might seem irrelevant but satellite navigation would not work without it.

[7] For example: www.rcuk.ac.uk/Publications/archive/ExcellencewithImpact/; and A.J. Salter & B.R. Martin *The economic benefits of publicly funded basic research: a critical review*. Research Policy 30. 509–532, 2001.

this are: Lasers, the Haber process for the fixation of nitrogen, Optical fibres, All forms of spectroscopy from microwave to magnetic resonance imaging, X-Ray crystallography, X-rays and positron emission tomography, Nuclear fission, Penicillin and hence antibiotics, Dyestuffs, Photography, Liquid crystals, Small molecule therapeutics, Organic chemical synthesis in general, DNA and hence genomics, Monoclonal antibodies, Stem cells, Finite element analysis, Free radicals, Organic polymers and composites, The transistor, Photovoltaics, Radio, 3K and 'warm' superconductors.

To give an example close to home, the curiosity-driven research of Professor John Boys[8] on inductive power transfer (IPT) over a 20 year period gave the University of Auckland a patent portfolio that has produced a very substantial economic return to New Zealand. It is unlikely that this would have started in an application-driven research environment[9]. A second example is the University of Otago spinout cancer diagnostics company Pacific Edge[10] which is based on the cancer genetics research of Professor Parry Guilford. A third example is the work of Professor Colin Green at the University of Auckland on the gap-junction proteins (integrins) that regulate cell-cell connections. The patent family from this curiosity-driven research is now being exploited by the spinout company CoDa Therapeutics[11] to produce a new generation of wound care therapeutics known as 'gap junction modulators'. Sir Paul Callaghan's work at Victoria University in the field of NMR physics is another example of the importance of curiosity-driven research leading to economic returns (Magritek[12]), and most importantly, in Paul's words, 'a place where talent wants to live'[13]. Many other examples exist and of course the benefits are to social, health and environmental outcomes as well as to economic outcomes.

This year (2014) is the 20th anniversary of the Marsden Fund and a number of case studies have been assembled[14] to illustrate the social, environmental, health and economic impact of curiosity-driven research, including examples from Jeff Tallon on high temperature superconductors, Colin Green on healing wounds, Ngahuia Te Awekotuku on sustaining the art of the moko, Catherine Day on the life and death of the cell, Antonia Lyons on young adults and drinking cultures, Martin Reyners on tectonic plates, Jennifer Hay on linguistics, Harlene Hayne on how childhood experiences affect human development, Dillon Mayhew on geometry in the computer age and Ken McNatty on what makes a good maternal egg.

There are also many examples of important fundamental research that was motivated by solving a practical problem. The career of Louis Pasteur[15] is testament to this, but examples crucial to New Zealand's current agricultural economy are the work of Sir Geoffrey Peren[16] (Perendale sheep), William Riddet[17] (dairy science) and Hugh Whitehead[18] (the role of bacteriophages in making cheese).

As shown in Figure 1 below, New Zealand commits relatively little public funding to untargeted R&D funding (6.8% of public expenditure on R&D versus 18.7% across the OECD). Tripling the size of the Marsden fund would bring us closer to the OECD average in terms of the proportion of public funds

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8 http://www.uniservices.co.nz/commercialisation
9 This work of course relied on the curiosity-driven discovery of electromagnetic induction by Faraday and the theory of electromagnetic radiation by Maxwell.
10 http://www.pacificedgedx.com/
11 http://www.codatherapeutics.com/index.html
12 http://www.magritek.com/
13 http://www.royalsociety.org.nz/events/2012-transit-of-venus-forum-lifting-our-horizon/vision-statement/
14 http://www.royalsociety.org.nz/programmes/funds/marsden/marsden20/
15 http://en.wikipedia.org/wiki/Louis_Pasteur
16 http://en.wikipedia.org/wiki/Geoffrey_Sylvester_Peren
17 http://www.teara.govt.nz/en/biographies/4r17/riddet-william
18 http://www.teara.govt.nz/en/photograph/30990/hugh-whitehead

that we devote to untargeted R&D.

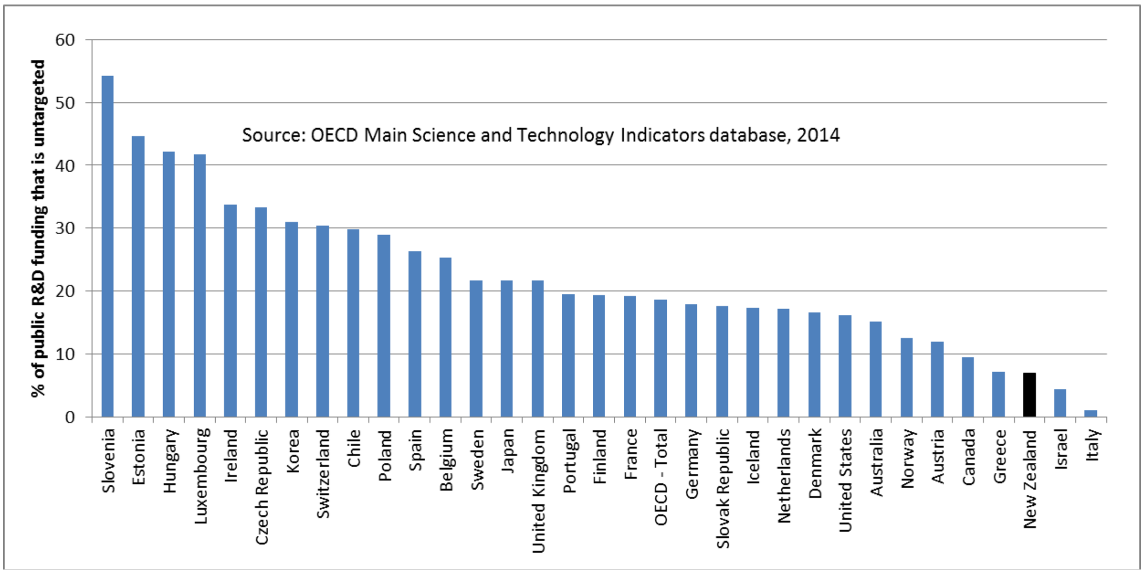

Figure 1. Percentage of public R&D funding that is untargeted, for countries in the OECD[19].

We must not undervalue or underfund curiosity-driven research, as serendipitous scientific discoveries in the long run are the single most important contributor to the country's well-being. Equally we must create innovation environments in our universities and CRIs that facilitate the development of these serendipitous discoveries, via companies, into economic returns to New Zealand. Moreover, the value of investigator-led research goes beyond the serendipitous results of curiosity. As New Zealand's science capacity has matured, individual investigators are well placed to conduct cutting edge research that can be used to solve New Zealand's problems right now. We need to have more faith in the science community to see the big issues and tackle them.

The chart on NSSI p14 is instructive in showing how the funding is broadly distributed, but what stands out is that most of the resources are directed at mission-led science. Contestable funding for investigator-led funding, which comes just from Marsden, Health Research Council (HRC) and Centres of Research Excellence (CoREs), amounts to only less than 8% of the total[20]. This is very low by international standards, and well below what most analysts argue as being appropriate to sustain a broad research capability. The majority of this research is carried out in universities, and access to such funds is vital for attracting and retaining top quality staff, training graduate research students, and maintaining the international stature of our universities. Current funding is inadequate for this. Mission-led science encourages collaboration, which is clearly a good thing, especially for nationally significant science challenges such as understanding the impact of the southern oceans on climate change or how to ensure that our water ways remain unpolluted in a high dairy production environment. But it favours large well-established groups and is much less likely to produce the scientific breakthroughs that are the key to wealth creation in the long run. Very little National Science Challenge (NSC) research funding will be available for investigator-led competitive bids.

The current 8% success rate (for applications to the Marsden Fund) is too discouraging and wasteful. Figure 2 below compares the level of R&D funding per researcher full time equivalent (FTE) in New Zealand universities with universities in other OECD countries.

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[19] http://www.oecd.org/sti/msti.htm

[20] Note that one important aspect of the Marsden Fund is the way in which it embraces a range of disciplinary areas, ensuring comparability of standards and processes under the oversight of the Marsden Council and RSNZ administration.

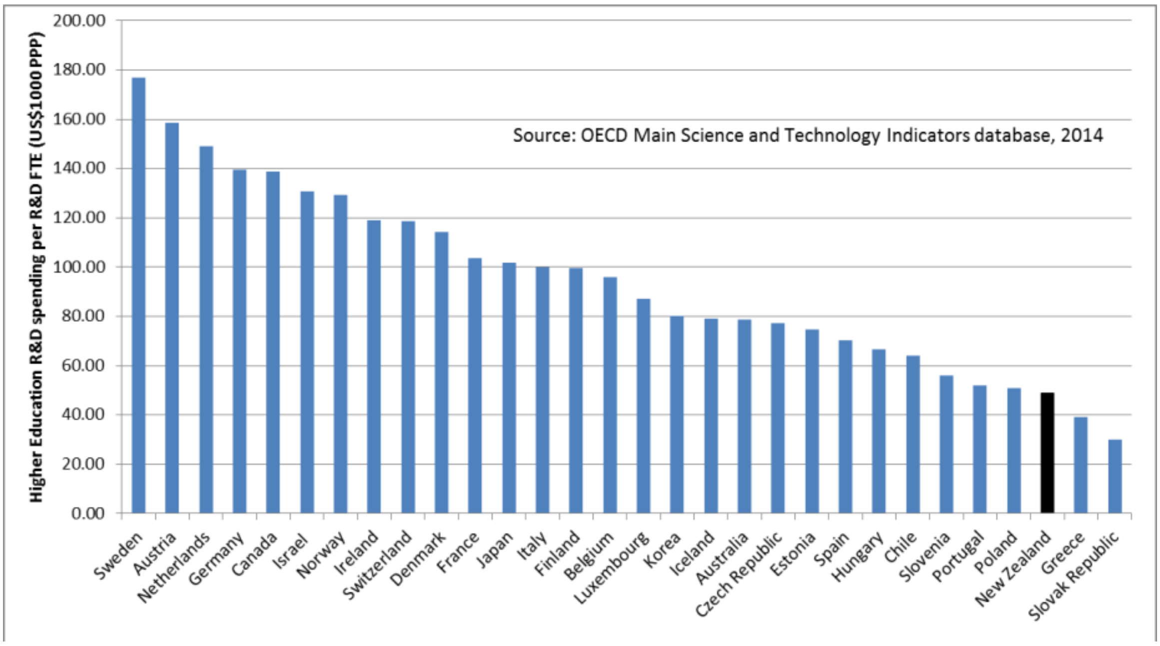

Figure 2. Higher Education R&D spending per R&D FTE, for countries in the OECD[21]. New Zealand's unfavourable position at the right hand end of this plot reflects the fact that university R&D in New Zealand is characterised by a large number of PhD students and a very low level of post-doc and other fellowship funding. This low level of R&D funding per researcher largely explains the declining world rankings for our universities.

2. **Lack of adequate career paths for New Zealand scientists**. The single biggest problem facing the New Zealand science sector is, in our view, the lack of adequate career development paths. This is partly linked to the need for more investment by New Zealand companies in research. One way to address this issue might be to offer a substantial number (say 100) of postdoctoral fellowships that are supported one third by Government, one third by a university or CRI and one third by industry (or other organisation that would be an end-user of the research). Requiring the industry contribution would ensure the relevance of the postdoctoral research to industry and having the university component would ensure the link to graduate supervision, a possible teaching role and the link to international research collaborations. The Government contribution would provide the enticement and serve a Government objective in encouraging an innovation-led economy. Similar schemes are needed for other (non-business targeted) areas. The first step, however, should be to consult with industry and other end-user groups to find the best strategy. Better structural integration of the CRIs with the universities may be another means of achieving more stable and attractive career paths – a question that needs to be explored in the RSNZ research system review.

   A related issue is that of bringing skilled expatriate New Zealand scientists back into the New Zealand research environment and other mechanisms are needed for this to ensure appropriate career development pathways. These career pathways should be to a rich and diverse science system that includes industry, government and the tertiary sector. Note that the Australian National Health and Medical Research Council (NHMRC) alone supports 800 career fellowships in the fields of biomedical and health research[22]. The RSNZ offers five Postdoc Fellowships (for people who are no more than two years post-PhD) and 10 Rutherford Discovery Fellowships (3-8 years post-PhD) for our entire science system. We therefore currently produce many talented research scientists from our graduate programmes who go overseas for postdoc training and then on to attractive fellowship schemes in Australia.

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21 http://www.oecd.org/sti/msti.htm

22 https://www.nhmrc.gov.au/grants/apply-funding/career-development-fellowships

Introduction of Rutherford Fellowships has been a welcome innovation, and along with Hercus Fellowships from the HRC and the James Cook Fellowships, these help fill the real gap for funding talented emerging researchers working on basic research questions or health research (in the case of the HRC). But there are too few available (as noted on NSSI p69). These fellowships are a vital component of the career development pathway for our top-achieving young researchers who wish to go on to research careers in the universities, CRIs and other research-based institutions.

3. **Over-fragmentation of the New Zealand science system and the high administrative overheads of mission-led research**. The new funding for the 10 NSCs are of course very welcome but the prospect of 10 new separately governed and managed entities, with the associated administrative costs, is alarming. New Zealand already has a fairly fragmented science system - 8 universities, 7 CRIs and Callaghan Innovation in a country of 4.5m people. The six (10 in 2016) CoREs, although hosted by the universities, also have separate governing boards. Are we spending proportionately too much on governance and administration and not enough on the actual science in the New Zealand research system? The RSNZ does appreciate that the laudable desire by Government to encourage more collaboration across the science system (in the form of both CoREs and NSCs) comes at the price of dealing with complex governance and management arrangements, but we are possibly not adequately considering these costs and how to reduce them. It may be time to think again about better integration of some CRIs with the universities[23] or mergers of CRIs and/or universities. The ownership of CRIs by Government and the greater degree of accountability to their business-focused Boards should not be an impediment if they were established as Research Institutes within universities with accountability for their business operation to Government and their research and educational activities to their host universities. The case for this would of course have to be carefully established.

4. **More stability is needed in the science system**. The New Zealand science community has paid a high price for the continual changes in the science system over the last five or so years. Five years ago the Ministry of Research, Science and Technology (MoRST) and its executive arm the Foundation for RS&T (FRST), were replaced with the Ministry of Science and Innovation (MSI), which was then disestablished and merged with other Government Departments to form MBIE. Each time there is a major upheaval like this there is a turnover of people, institutional knowledge is lost and new relationships with the science sector have to be established. The introduction of the NSCs in 2013 were yet another example of a new funding instrument being introduced rather than new money being used to enhance existing research funds[24]. Some of the mission-directed goals of the NSCs could have been achieved via more investment in the HRC or the Tertiary Education Council (TEC)-funded Centres of Research Excellence, which have very similar goals of long term research, training and nationally important outcomes. Compare this with the Marsden Fund which has now been running extremely successfully for 20 years. At the very minimum such changes in the system should be justified with a cost/benefit analysis.

5. **Evidence-based decisions**. Only lip-service is paid to the issue of evaluating the *effectiveness* of policies and mechanisms, and yet it is particularly important for a small nation like New Zealand to spend its limited resources wisely. Robust evaluation is needed, and not just of policies and mechanisms, but also of the effectiveness of the system structure. New funding instruments should not be introduced, or old ones discarded, without a clear cost-benefit analysis. We need to get much

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[23] The current 7 CRIs (AgResearch, NIWA, Plant & Food, Scion, GNS, Landcare, ESR) are descendants of the 8 original CRIs created as partially commercial entities out of the six divisions (Grasslands, Plant Diseases, Entomology, Soil Bureau, Crop Research, Geophysics Division) of the Department of Scientific and Industrial Research (DSIR) in 1992.

[24] Note the recent announcement by the Australian Government of an additional $20 billion (by 2020) for medical research (http://www.budget.gov.au/2014-15/content/overview/html/overview_12.htm) is being directed via the existing funding agency NHMRC.

better at gathering data on the effectiveness of research investment in order to provide a rational basis for how funds should be distributed across the various funding pots.

Another example of where a more rational evidence-based process is needed is in the rather sporadic and ad hoc nature of funding increases to the Marsden Fund and HRC. It would be far preferable to have a roadmap for improving the New Zealand science system – based on widespread discussion and broad consensus across the science sector. This is the primary goal of the RSNZ panel established to review the New Zealand research system.

6. **Focus should not be too inward on Research for New Zealand**. Key priority 2 (NSSI p8) and Objective 2 (p16) make 'benefit to New Zealand' a main focus for our science. Although this is reasonable as one objective, we must avoid being too inward-looking. New Zealand can (and does) compete internationally in many areas of science, making fundamental discoveries and innovations that advance knowledge and its application in a global sense. Exposure of this work at an international level is a driving force for our best scientists. Participating in international scientific collaborations is an essential part of world class research, and international investment in New Zealand hi-tech companies also often depends on the international reputation of scientists in our universities and CRIs. If one objective is to foster an innovation-led economy and economic growth from our scientific research (p10), and another is to retain and develop talent (p11), then international reputation should have a higher profile as a priority.

7. **Investment by the private sector**. In the third paragraph of the Introduction and elsewhere, there is a stated aim of "getting results directly to the areas where the knowledge can benefit New Zealand the most". This is admirable, but the document gives little sense about what role the private sector should play in helping to make this happen, and in fact it gives the impression that the Government is taking on the role of commercialising research for the private sector. This is not a sensible strategy in the medium to long term, and it can work against the aim of increasing R&D expenditure and beneficial outcomes. The Government should be doing all it can to incentivise far greater investment **by** the private sector in research, and use public resources to address market failure and support the things that the private sector will not - such as developing the pool of research expertise, providing and supporting infrastructure, and so on.

8. **Balance of R&D expenditure**. The graph on NSSI p22 illustrates the historical nature of R&D expenditure. Although a reasonable amount of Government money is now spent on research in/for the manufacturing sector, very small amounts are spent on research in/for the service sectors, and yet these make up a considerable proportion of the economy and could certainly benefit from research into improving efficiency and productivity. Research by Professor David Ryan and Dr Andrew Mason in the Engineering Science Dept at the University of Auckland, for example, reduced scheduling costs for organisations such as Air New Zealand and the St John's Ambulance and led to the spinout company Optima[25].

   Another example is in the level of funding for biomedical research (mostly administered via the HRC) where current funding rates, adjusted for population, are 3.4-fold higher in Australia, 4.5-fold higher in the UK and 9.7-fold higher in the US[26] than in New Zealand. There has also been a swing towards more translational/mission-led research in the HRC. Basic biomedical research is no longer one of HRC's high priorities, even though experts all agree that it is a necessity for underpinning other research. The inadequate support for biomedical science in New Zealand is a major obstacle to the recruitment and retention of clinical and academic staff in our hospitals and universities, and compromises our ability to carry out research on diseases that are particularly relevant to the New Zealand environment.

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[25] http://www.theoptimacorporation.com/

[26] Reid I, Joyce P, Fraser J, Crampton P, Government funding of health research in NZ. The NZ Medical Journal, Vol 127, #1389, 2014. http://journal.nzma.org.nz/journal/127-1389/5992/

9. **Infrastructure as an enabler, accelerating research and advancing research capabilities.** There is currently no clear vision for the potential of research infrastructures in the NSSI. The Business Growth Agenda highlights the importance of infrastructure, especially the evolution to hi-tech infrastructures typified by those based on digital technologies such as fibre optics and computing, and the relevance of related skills to the economy and society. Research infrastructures are a catalyst for the move to a 'first world' data informed society and economy, support us to achieve collaboration and interoperability across the sector, and enable our researchers to remain internationally competitive.

10. **Short term project contracting arrangements for infrastructure investments create unnecessary instability.** The intent of the NSSI to take a 10-year outlook for the investments noted is welcome. Investments in infrastructure contain significant cost and risk, and require medium to long time frames to mature. Sustainability during the course of their developments is essential, yet current project based contracting mechanisms are insufficient in providing this certainty and stability. The NSSI should indicate a willingness to consider longer term funding mechanisms to support growth and performance of critical national research infrastructures. Reference is made to such long-term funding commitments from the Government, yet these commitments are indicative in the form of forecasted long-term Vote appropriations, while funding is only committed within short-term 3 or 4 year contracts. Developments in the EU are shifting to long-term sustainable funding for key research infrastructures such as the Partnership for Advanced Computing in Europe (PRACE) high performance computing investment, as these infrastructures are shared and underpin all other research sector investments.

11. **The research data infrastructure gap was identified long ago - why is there still no government strategy?** Early open data initiatives focused on environmental data, and brought together public sector agencies and councils to focus on increasing the reach and impact gained from data collected nationally. With the subsequent changes from MoRST through MSI to MBIE, this work has all but ceased, and early carefully guided progress has stalled and momentum has been lost. Good 'All of Government' policy initiatives are in place for information management and data reuse, though without effect on and application to research. The open data and data management requirements in current research grants are not able to be consistently responded to by researchers nor are they well supported by institutions or infrastructure providers. A lack of coordination in approach is apparent – there are no overarching statements on vision, strategy, nor infrastructure from Government, despite these policies being increasingly embedded in research grants and contracts. The most recent example is within the NSCs, where each Challenge was required to propose their own Open Data policy – with such a broad sweep of national research communities supported within the NSCs, this is a once-in-a-generation opportunity to establish a coherent approach to research data policy and support, coordinated nationally. Recently the NZ Data Futures Forum supported by the Ministers of Finance and Statistics took a very brief and high level look at data related matters in the research sector, and even with a short analysis came away with clear recommendations for two research data infrastructures. The NSSI is entirely silent on this key gap in current strategy, policy, and supporting infrastructure.

12. **International relationships and sharing of research infrastructures.** The International Relationships Fund is indicated as a key mechanism for international collaboration and sharing of research infrastructures. In a national context, large scale research infrastructures are often invested in due to market failure. The capabilities and skills they contain are therefore often unique nationally. To ensure that acquisitions, operations, and the evolution of such infrastructures remain effective and at the leading edge of international practice, stronger international linkages with the research infrastructures of other nations is essential. Strong nationally coordinated and internationally linked research infrastructure programmes are common to advanced nations, with Australia having invested over the long term into their National Collaborative Research Infrastructure Strategy, and Canada taking an innovative approach with their national Digital Leadership Council. Strategic opportunities are open to New Zealand for increased participation alongside our peers in

international research infrastructure fora (International Conference on Research Infrastructures (ICRI), Research Data Alliance (RDA)), within bilateral relations (EU-NZ, NZ-Aus), and through direct collaboration on infrastructures. The proposed international science and innovation strategy appears as a potentially suitable vehicle for further discussion on this topic.

Appendix 1. RSNZ panel members

Professor Marston Conder, Dept Mathematics, University of Auckland

Professor Harlene Hayne, Vice-Chancellor, University of Otago

Professor Shaun Hendy, Dept Physics, University of Auckland

Professor Peter Hunter (Chair), Director, Auckland Bioengineering Institute, University of Auckland

Professor Warren McNabb, Research Director, AgResearch Ltd

Dr William Rolleston, Businessman and President, Federated Farmers

Professor Warren Tate, Dept Biochemistry, University of Otago

Professor Margaret Tennant, *Professor* Emeritus, School of Humanities, Massey University

Professor Christine Winterbourn, Centre for Free Radical Research, University of Otago, Christchurch

Appendix 2. Suggested corrections and additions

1. **Over-emphasis on economic outcomes**. The NSSI document is primarily concerned with economic outcomes, which are of course a key focus of MBIE and a very important outcome for scientific research, but it is not the only important outcome. Surely a statement of national science investment should comprehensively address many other Government policy areas such as how best to achieve a sustainable environment, a healthy population and a cohesive society.

2. **Misconception of Performance-Based Research Fund (PBRF).** The RSNZ is concerned that PBRF funding is misrepresented as being available to support investigator-initiated research. Money from the PBRF is won by tertiary education organisations (TEOs) on the basis of their research performance, but it is certainly NOT research funding per se. It is a component of bulk funding to TEOs, and was introduced as a complement to teaching subsidies, which on their own do not differentiate between the type of TEO or the courses they offer or the staff they employ to teach them. This part of bulk funding can be (and is) spent on a wide range of activities other than research, such as the salaries of its well-qualified staff and other support and infrastructure needed to maintain an environment for teaching at degree-level, especially postgraduate level. PBRF also covers all university disciplines, not only science. It is inappropriate to describe PBRF money as science research funding, and it should not be included in the figures for New Zealand's R&D spend[27]. A similar argument can be made for at least some of the CRI Core funding.

3. **Research categorisation**. The description of different kinds of research on p13 is useful but this categorisation is a coarse one and many activities stretch across more than one of the categories.

4. **Vote Education expenditure on research**. In the chart on p28, the figure of $3b for universities from Vote Tertiary Education is inaccurate. It is about twice the reality. Approx. $1b is spent on teaching subsidies, and about another $280m through the PBRF, and the rest in much smaller amounts. It looks as though the document is wrongly claiming that the money provided to students in allowances and loans is "for universities". It may go to students but they spend most of it on living expenses, not on their education. The same error is made in the list on p29.

5. **University business contracts**. In the second paragraph of p25 is a statement about only 4% of university R&D being funded by business (in 2011). In fact this is variable. The University of Auckland brings in over $100m pa through its UniServices arm[28] (some from international contracts), and this is over 10% of the University's entire budget, not just the part spent on research.

[27] A small fraction (about 5% in the case of the UoA) is used to support research activities directly.
[28] Some of this is sub-contract revenue which can be traced back to government grants.

6. **Business investment in science**. p20 contains a statement that New Zealand's business expenditure on R&D is low, which it certainly is. But the NSSI document should be addressing the low level of business expenditure on R&D (BERD) to a far greater extent. Even the small amount that is written about addressing the issue is not convincing. We should be developing measures to double or triple BERD over a period of time. The evidence presented to suggest that there is a relatively low utilisation of university research by business is misleading. As a percentage of business expenditure on R&D, New Zealand businesses spent 2.9% on university R&D compared to the OECD average of 2.2% (using data from 2010-2012)[29]. Similarly businesses devoted about 8.5% of BERD[30] on the CRIs and government labs compared to 1.9% across the OECD. Thus one can make an argument that business R&D is better connected to public sector R&D (both University and CRI) in New Zealand than it is across the OECD. The low level of financing of HERD[31] by industry noted in the NSSI simply reflects the low level of expenditure in general.

[29] http://www.oecd.org/sti/msti.htm
[30] Business expenditure on R&D
[31] Higher education spending on R&D