Submission | Draft National Statement of Science Investment 2014–2024

22 August 2014

Dear Sir/Madam,

Draft National Statement of Science Investment (NSSI) 2014–2024 – Draft for Consultation.

Thank you for your invitation to comment on the *Draft National Statement of Science Investment (NSSI) 2014–2024 – Draft for Consultation*. Please find attached our feedback. The first section provides a brief overview of the Institute. The submission is separated into two parts. Part one contains our high-level observations while part two responds to the consultation questions.

If you have any queries, please do not hesitate to contact the Institute.

Kind regards,

Wendy McGuinness
Chief Executive

Attachments:
Appendix 1: Report 9, *Science Embraced: Government-funded science under the microscope* (Published February 2012)
Appendix 2: Report 16, *An Overview of Genetic Modification in New Zealand 1973-2013: The first forty years.* (Published September 2014)
Appendix 3: Think Piece 19, *I would rather New Zealand be smart then lucky* (August 2014)
Appendix 4*: Government department strategies relating to science from July 1994 to June 2014*

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About the McGuinness Institute

The McGuinness Institute, formerly the Sustainable Future Institute, was founded in 2004. The Institute is a non-partisan, not-for-profit research organisation, working towards a sustainable future. It contributes to public dialogue on strategic issues through evidence-based research and policy analysis. *Project 2058* is the Institute's flagship project which includes a research programme that aims to explore New Zealand's long-term future. In preparing this submission the Institute draws on a number of reports and submissions, in particular:

- April 2014: *Submission on the Environmental Reporting Bill*
- March 2014: *Draft for Consultation: Exclusive Economic Zone and Continental Shelf (Environmental Effects - Discharge and Dumping) Regulations 2014*
- February 2014: *Draft for Consultation: Exclusive Economic Zone and Continental Shelf (Environmental Effects—Non-Notified Activities) Regulations 2013*
- September 2013: Report 16, *An Overview of Genetic Modification in New Zealand 1973–2013: The first forty years.*
- September 2013: *Activity classification under the EEZ Act: A discussion document on the regulation of exploratory drilling, discharges of harmful substances and dumping of waste in the Exclusive Economic Zone and Continental Shelf*
- April 2013: *Ministry for the Environment discussion document: Improving our resource management system*
- June 2012: *Regulations proposed under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill*
- May 2012: *New Zealand King Salmon Proposal: Proposed Plan Changes and Resource Consent Applications (Part 1 of 5)*
- February 2012: Report 9, *Science Embraced: Government-funded science under the microscope*
- February 2012: *Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill – Written responses to questions from the committee*
- February 2012: *Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill (oral submission)*
- January 2012: *Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill (written submission)*
- October 2011: *Environmental Reporting Bill*
- April 2011: *Application A1042 – Food derived from herbicide-tolerant corn line DAS-40278-9*
- September 2010: *Draft New Zealand Energy Strategy and the Draft New Zealand Energy Efficiency and Conservation Strategy*
- April 2010: *Proposed National Environmental Standards*

About the Chief Executive

Wendy McGuinness wrote the report *Implementation of Accrual Accounting in Government Departments* for the Treasury in 1988. She founded McGuinness & Associates, a consultancy firm providing services to the public sector during the transition from cash to accrual accounting. From 2003–2004 she was Chair of the NZICA Sustainable Development Reporting Committee and became a fellow chartered accountant (FCA) in 2009. In 2004 she established the Institute in order to contribute to a more integrated discussion on New Zealand's long-term future.

Part One: High-level Observations

Writing a strategy on how the government should invest in science over the next 10 years is not easy. Not only is government-funded science one of the more complex areas of public policy, it is a significant investment that deals with 1.4 billion dollars of taxpayers' funds. It is both *complex,* as there exists a wide range of stakeholders with differing objectives, and *important*, because it is one of the few levers New Zealand has to improve economic outcomes for future generations.

Our own experience in preparing our 2012 report (see Appendix 1) is a case in point; it took over a year to research and resulted in another year of rewrites – five in total. As a result of this work we proposed a strategy, outlining four objectives for the publicly funded science system – what we have referred to as the strategic intent. These are outcome-driven objectives to help guide decisionmakers in terms of what this investment will deliver. If the investment does not meet one or a mix of these needs it should not be progressed. The four objectives are:

(i) to inform public policy;
(ii) to improve the physical and mental health of New Zealanders;
(iii) to increase the financial security of New Zealanders; and
(iv) to contribute to solving global problems.

The objectives proposed in the *Draft NSSI* are not outcome driven or comprehensive in nature. In contrast they are an assortment of goals, many of which are input and process driven. They are explained below:

(i) Producing excellent science of the highest quality (output driven)
(ii) Ensuring value by focusing on relevant science with highest potential for impact for the benefit of New Zealand (a mix of process and output driven)
(iii) Committing to continue increasing investment over time (input driven)
(iv) Increasing focus on sectors of future need or growth (process driven)
(v) Increasing the scale of industry-led research (process driven)
(vi) Continuing to implement Vision Mātauranga (process driven)
(vii) Strengthening and building international relationships to strengthen the capacity of our science system to benefit New Zealand (process driven)

The contrast between the two sets of objectives is significant. One aims to guide the system to deliver better outcomes for New Zealanders, while the other is about the inputs, processes and outputs within the system. For example, the inputs (e.g. [iii]), the process of picking winners (e.g. [iv] and [iv]), and output characteristics (e.g. [i] and [ii]) change the system but do not drive the system. Importantly the terms 'benefit of New Zealand' and 'benefit New Zealand' are stated but the kinds of benefits are not specified. In contrast our 2012 objectives specify the types of benefits such as 'physical and mental health' and 'financial security' (which includes risk management) 'for New Zealanders'.

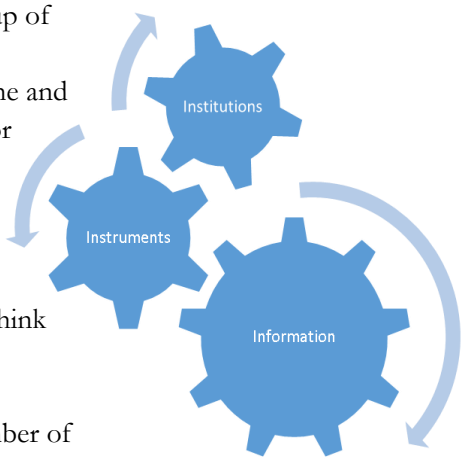
In 2013 we undertook a review of the history of genetic modification in New Zealand (see Appendix 2). This research proved insightful as it showcases the challenges that face the public service when something brand new enters the public policy arena. How do we respond to new technologies and how do we create systems to assess and then manage the possible benefits, costs and risks? How should we apply the precautionary principle? These and other questions drive the relationship between science and society.

Most importantly, genetic modification was an example where the public policy response was slower than those wishing to commercialise the technology. This meant regulators were always in a position of playing catch-up, trying to grapple with the science at a time when some scientists were rushing to create novel GMOs. This put CRIs, such as AgResearch, Scion and Plant & Food, at loggerheads with scientists concerned about the risks to agriculture and our flora and fauna. The lessons from both these reports are that we must get this area of public policy right.

In 2013 and 2014 the Institute undertook a project called *TalentNZ*. It looks at Sir Paul Callaghan's idea of how we might create 'a place where talent wants to live'. The more that we have looked into his vision for New Zealand, the more we have appreciated how his vision has the ability to engage and progress our economic growth, protect our environment and strengthen society. Interestingly, his response to the question 'What is the thing that science cannot answer or solve?' was 'Science cannot tell us how to live as humans. It cannot solve human ethical issues'.[1] A discussion on talent, in particular how the strategy will support emerging scientists and how we can ensure they operate ethically, is not included in this strategy, yet at the heart of any investment in science must be people – both the scientists and the wider community.

The invitation to comment on the *Draft NSSI* arrived at a time when the Institute was in the process of reviewing how the public service develops and implements government department strategies (GDSs). The research question driving this work is as follows: Is the public service good at developing and implementing strategy? Our Think Piece 19: *I would rather New Zealand be smart than lucky* (Appendix 3) explains the characteristics of what we believe makes a strategy different from a plan or mindset. It is with this framework in mind that we provide our feedback.

The Institute views the system driving public policy as being made up of three interplaying components: 'institutions', 'instruments' and 'information'. Institutions are entities with the resources, money, time and authority to make things happen. Instruments are the mechanisms or tools that strengthen and empower the links between institutions. Information can take many forms but its role is to collect and collate data so that it can used to create useful information and ideally strategic knowledge. Information is the key component that should drive changes to the other two (see Appendix 3 to read the think piece).



The *Draft NSSI,* when finalised, will drive the actions of a large number of institutions over the next 10 years. Below we discuss our high-level observations in terms of the three components driving the taxpayer's investment in science.

1.1 Institutions

Following the amalgamation of the Ministry of Business Innovation and Employment (MBIE), this *Draft NSSI* is an excellent opportunity to explore the opportunities to develop integrated policy on science funding, but it should not be rushed. We believe a more cautious and useful approach would be to collect relevant data and survey the community to understand what works and what does not and why. We also advocate a closer look at the history of science policy in New Zealand and what is

[1] See http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=10787305

happening now across government (Appendix 4 would be a good starting point) and internationally (although the Irish and EU models are mentioned, neither is explained).[2] These topics would make excellent working papers for MBIE to explore and ideally publish. This may take 12–18 months. Once this work was completed, we believe a much more focused document could be produced for public discussion. What follows below is a brief list of observations with regard to the aforementioned institutional components:

Integrated long term thinking is necessary

- Many issues are exceedingly expensive, technical or complex for individuals, businesses or even councils to tackle, therefore New Zealanders must depend on government to facilitate long-term strategy development and fund institutions to solve problems or develop opportunities. Mapping the current and emerging issues facing New Zealand over the next 20 years would be something MBIE could undertake as it would help inform science investment in the future.
- Science, by its very nature, does take time. Any strategy must therefore take into consideration the need to provide a stable environment for research as well as incentive for increased non-government investment. The *Draft NSSI* does not have this as an objective nor is it discussed in any detail. Fluctuations in funding cause uncertainty which is disruptive or at worst destructive to long-term research projects. Uncertainty and confusion are the enemies of publicly funded science. For example, objective 3 ('committing to continue increasing investment over time' [page 8]) is at odds to the Ten Year Funding Profile Table where investment decreases from 1.410 billion to 1.342 billion over the next 10 years (page 18). This needs to be clarified.

A whole systems approach is necessary

- The *Draft NSSI* does not explain how science investment impacts with other areas of government activity. For example: regulators, such as the EPA, play a key role in delivering 'science without risks', yet their important role is not made clear in the *Draft NSSI*. Further, government funding of GMO experiments in the early 2000s was used as an indication benefits existed when ERMA (the previous EPA) made their assessments to then approve or decline such experiments. This shows how interlinked the system is.
- The *Draft NSSI* does not discuss the need for independent scientists. The science system in New Zealand is very connected, creating a number of areas where conflicts can arise. These conflicts should at worst be transparent, and at best be directed by high-level objectives that guide discussions and assessments. For example, NIWA, which is a CRI, provides both commercial services as well as acting as an independent advisor to government agencies. We understand that organisations equivalent to CRIs in the US cannot undertake commercial work and keep that information private. These dual roles in New Zealand must to be very carefully managed, especially in areas of national significance such as the King Salmon Board of Inquiry in 2012/2013. New Zealand must provide for independent scientists' career paths so that they are able to assist and inform the public and the judiciary on complex issues. This needs to operate away from the commercial arm of science. One solution could be a list of 'government

[2] We note that the *Draft NSSI* takes significant inspiration form European examples, such as the European Union (EU) Horizons 2020 Framework (page 12) and the Irish model (page 76). We assume the mention of the 'Irish model' refers to the impact assessment approach being developed by Science Foundation Ireland. Again, a level of background information about this approach and how MBIE envisages its potential application in New Zealand should have been included in the *Draft NSSI*. It is unlikely that many in either New Zealand's scientific community or general public will be aware of changes to Ireland's science funding system and therefore without proper documentation or referencing it is inappropriate for inclusion in a draft document intended for public consultation.

scientists' who operate solely in the public interest. This mechanism could be managed by MBIE as a way of dealing with one of the key risks of our small science system: the conflicted scientist.

- Effective and well-resourced primary and secondary education is a prerequisite to the tertiary education initiatives mentioned throughout the *Draft NSSI*. Joint strategies between MBIE and the Ministry of Education such as the *A Nation of Curious Minds* strategic plan could help facilitate this. We believe the strategy should look more deeply at the pathway to create the scientists – the talent we need going forward.
- Mapping talent over the next 20 years in order to understand the talent gaps and surpluses that might exist if we continue on our current course.

1.2 Instruments

Government department strategies are one of the key instruments designed to bring about a change in direction. In terms of a timeframe, we consider that the *Draft NSSI* is about a third of the way through the process necessary to develop a strategy that enables New Zealand to do something extraordinary with our scarce science funding. It is important to use this development stage appropriately, as implementing a poor strategy well is still a wasted opportunity. Alternatively, implementing a good strategy in an average manner is likely to deliver better outcomes for New Zealand over the long term. Our observations are:

The objectives and high-level strategy proposed in the *Draft NSSI* could be improved

- Table 1 in our latest think piece (see Appendix 4) outlines the differences between a plan, a strategy and a mindset. It argues a strategy should place more focus on the end/s rather than the means (in keeping with the discussion of objectives at the start of this section). A strategy should not only explain 'how', but also 'why' this strategy will deliver the desired outcomes in comparison with other strategies. The *Draft NSSI* is more a report on funding mechanisms (which it does well), rather than a discussion on strategic options to deliver a well-articulated outcome.
- In the Institute's upcoming *Working Paper 2014/01 List of government department strategies between 1 July 1994 and 30 June 2014* we have identified over 300 New Zealand government department strategies (GDSs) within a 20-year period from 1994–2014.[3] In the collation and review of these strategies we found that science was a recurring theme. In particular, 10 strategies listed in the table in Appendix 4 (numbers 18 to 29) represent strategies that have been put in place by MBIE or departments that have undertaken similar responsibilities to MBIE in the past. In our opinion the objectives and 'new direction' referred to in the *Draft NSSI* do not differ significantly from the general objectives and vision of strategies developed over the last 20 years. The *Draft NSSI* would be a stronger document if it acknowledged how this strategy differs from previous strategies and how it interrelates with current strategies being implemented by MBIE and with the other 28 departments.
- We recommend MBIE reviews the government strategies listed in Appendix 4 as part of its research phase in drafting and reviewing the current *Draft NSSI*. This would ensure the work undertaken by each department when producing science-based strategies for their own future programmes is fully represented in the final NSSI for appropriate translation into government policy.

[3] This draft working paper is currently undergoing a final review by departments before being published later this month. Copies of the strategies can be found on our website under 'timelines' 'government department strategies'.

More focus on how to grow talent within the science system would be useful

- Science takes time, and often teams of scientists over many years are required to solve complex problems.
- Funding to institutions and facilitator groups such as the CoREs is important for the integration of science into wider society, yet ensuring funding reaches scientists themselves is vital to support our scientific base for the future.
- The erosion of funding and support for postdoctoral researchers is of significant concern, as this represents a considerable portion of national scientific research. When funding is not forthcoming for these scientists in the eight to 10 years after earning their PhDs it is likely they will emigrate to work on funded research projects overseas. The fact is that postdoctoral research remains underfunded despite clear examples of how spin-off inventions from universities deliver real benefits to economic growth.
- Building strong relationships with universities and other tertiary organisations should be embedded in the strategy (see, for instance, Cambridge Universities Centre for Entrepreneurial Learning [CfEL]).[4]

Terminology in the *Draft NSSI* could be improved

- A glossary and a list of abbreviations would have been helpful.
- Our opinion is that the terms 'investigator-led, mission-led and industry-led' are perhaps better defined in terms of the person driving the investment, i.e. 'scientist-led, government-led and industry-led'. 'Scientist-led' identifies directly with the scientists who lead investigative science. 'Government-led' is preferable to 'mission-led' as it gives a clearer understanding that the goals or objectives are defined by government in contrast to 'industry-led' which drives science investment in commercially viable science.
- The terms 'priorities' (page 8) and 'objectives' (page 75) are used to discuss the same list of seven points. The final NSSI should ideally use one term rather than two.
- The terms 'impact', 'benefit', 'value' and 'relevance' are embedded within the *Draft NSSI* . As these terms are all based on value judgements, substantive explanation of how they will be quantitatively and qualitatively defined is needed. This is of significant concern as much of the data used to inform decisions when considering which science is 'high impact' or 'relevant' can only be produced by investigator-led research.
- A clear understanding of what is understood by 'collaboration' and how it is used in the science sector is also desirable.

Indicators must link to the objectives

- The indicators should have a direct relationship with the objectives. How the indicators relate to the proposed indicators on page 29 is unclear.
- The recommended indicators to measure success should be stress tested in the same way as the NSSI overall objectives. In particular the indicators proposed on page 29 of the *Draft NSSI* will need to be thoroughly reviewed. The Institute considers that many of these indicators are weak or restrictive, and would produce ambiguous and incomplete results. One example relates to the target concept 'Enabling infrastructure for innovation and science,' for which the recommended indicator would measure 'Fixed and mobile broadband subscribers per 100 people'. Consultation with the individuals who use the infrastructure would produce far more

[4] See http://www.cfel.jbs.cam.ac.uk

conclusive data. Correspondingly, international measurement of scientific progress by the number of patents is an inappropriately narrow indicator, one which is made less relevant with the expansion of creative commons and other information sharing trends. We suggest more work is done on linking objectives to indicators.

- It is difficult to assess New Zealand's international placement for research and development (R & D) spending against the OECD as we do not create an incentive for businesses to account for R & D in the same way as other countries. New Zealand does not have an equivalent R & D tax credits system, so there is no incentive for businesses to collate R & D costs (which means R & D expenditure could be sitting in wages). There are new tax changes being proposed that may result in better reporting.[5] In the meantime, we need to be careful that we are comparing apples with apples.

Strategy maps are very effective tools for stress testing and gaining consensus

- It is critical that strategy is both stress tested and properly communicated. Likewise, the value of mapping a strategy on a single page cannot be overemphasised; as an example we have included a full copy of the strategy map from our 2012 report below (page 10). The *Draft NSSI* does not contain a strategy map, but we strongly suggest that one be included. The process of preparing a strategy map itself initiates a stress test of thinking behind the strategy – it allows you to see gaps or opportunities to adjust your strategy in order to achieve powerful synergies. It provides a visual opportunity to analyse a strategy and ask whether it will achieve the desired outcomes, and if not, to ask why not.
- Figure 1 below (page 10) is an example of a strategy map for government-funded science. It indicates the multiple levels and interplay between the elements contributing to a strategy map. A strategy map enables anyone to review the logic underlying the strategy and therefore see if gaps or obstacles exist. A similar map would be a useful tool in the *Draft NSSI*.
- The seven objectives outlined in the *Draft NSSI* (page 8) should be stress tested against previous New Zealand science investment objectives over the last few decades (see Appendix 4) as well as against international examples.

Concerns over diagrams in the *Draft NSSI*

- Chart 1 on page 14 of the *Draft NSSI* models the funding system within the current framework, but it is unclear whether this is the 'ideal year' (as stated in the paragraph before the table) or whether it is the actual situation as implied by 'provides an overview' in the opening paragraph. It may have been more useful to include two charts – the first outlining the current system and the second suggesting how a strategic outcome would be different from the status quo. The table on page 15 implies Chart 1 represents the 2016/17 year but this is not made clear.

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5 See two new R & D measures at http://www.beehive.govt.nz/release/two-new-tax-measures-support-business-rd.
(i) R&D-intensive start-up companies will have early access to all or part of their tax losses in the form of a cash receipt, rather than carrying these losses forward.
(ii) All capitalised costs on depreciable, intangible assets (for example, patents) will be deductible over time. Currently, only the legal and administrative costs of registering the asset are treated as depreciable. Additionally, a one-off tax deduction will be allowed for capitalised development expenditure on intangible assets that are written-off for accounting purposes. This will relieve 'black hole' expenditure on R & D projects that ultimately turn out to be unsuccessful.

- The table on page 29[6] should be divided along the same lines that the *Draft NSSI* has used to classify research funding. As mentioned above, the three types of science should have their own dedicated objectives and appropriate indicators should into determined on the basis of these objectives. A package of indicators should be developed with a very clear understanding of what we are still unable to measure. The Institute's conceptual approach to indicators is to imagine being in a dark room with a torch; indicators are where you shine the light. MBIE needs to be aware of the areas in the current framework where we cannot get a good visual, and must work on innovative ways to shine light on these. In its current form the table looks like an initial brainstorm of indicators, but if indicators are not linked to specific objectives it cannot be known whether the system is working as intended.

1.3 Information

The quality and quantity of information is critical if we hope to manage complex systems, such as government-funded science. Transparency is also key; a prominent US Supreme Court judge once said sunlight is the best disinfectant.[7]

Improving collaboration

- There is general consensus in the scientific community that this engagement has been lacking in New Zealand. The development of the National Science Challenges (NSC), for instance, remains highly contentious: a recent survey of 289 practising researchers by the New Zealand Association of Scientists indicated moderate to high levels of dissatisfaction with the management of the Challenges.[8] Further communication with these scientists is likely to bring insightful suggestions for a science system they would consider beneficial to the scientific community.

Informing the public that the *Draft NSSI* is open for comment

- Modern communication: In addition to the general communication of the Draft NSSI to the public we identified issues related to communication of content within the Draft itself. A prominent example of this is Chart 9: 'Government engagement to help the science and innovation system deliver outcomes' on page 28. We consider this chart to be particularly unclear and suggest that it obscures as much as it reveals. An ongoing issue is that the communication of government policy to the public is not up to date with modern technology and communication standards; these are far more design oriented than has been the case in the past. This trend is reflected in the recent adoption of citing STEAM subjects, where the A stands for Art and Design. The Tertiary Education Strategy 2002-2007 published over 10 years ago in 2002 identified this trend, commenting '…the traditional barriers between different disciplinary areas, including those between the arts and the sciences, are being broken down.' Yet very little has changed.

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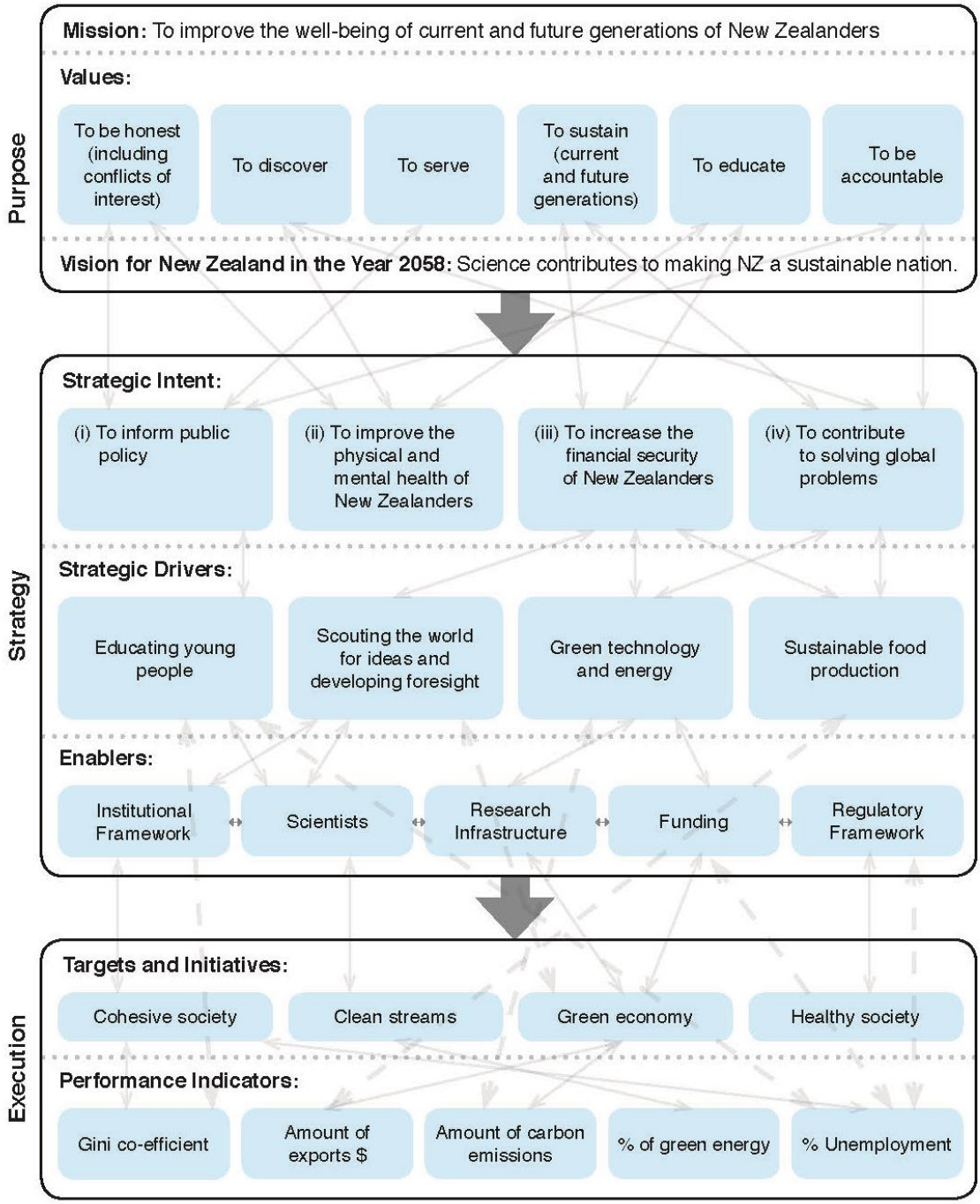
6 It would have been helpful if tables were given a reference number – there are no table numbers in the *Draft NSSI*.

7 'Publicity is justly commended as a remedy for social and industrial diseases. Sunlight is said to be the best of disinfectants; electric light the most efficient policeman.' See http://www.brandeis.edu/legacyfund/bio.html

8 See http://www.scientists.org.nz/news/2014/08/national-science-challenges-survey-results

Figure 1: The Institute's 2012 Strategy Map for Government-funded Science
Source: McGuinness Institute, *Science Embraced* (2012: 126)



Note: This strategy map aims to show the internal cohesion within the strategy. The horizontal dotted lines show the horizontal integration between ideas, while the vertical lines indicate the linkages between the purpose and the execution. The dashed lines represent the high-level linkages between strategy and performance indicators. This map is provided for discussion and to show what a useful tool a strategy map can be. However it must also be assessed in terms of external cohesion and how it fits within the probable, possible and preferred futures. See discussion in Section 8.3.

- We believe that a central portal for consultation (invitation to comment) across the whole of government would be a great way of collecting information and ideas about how to resolve complex issues. Departments could download their invitations to comment at the beginning of the process, and at the end of the process, the department could then download the summary of submissions. Once the document under consolation became final it could also be downloaded. This would keep an ongoing record for all parties – building institutional knowledge and adding to ongoing debate. The public could register their interest in certain topics/applications and get advised of updates. This would be a very cost-effective and democratic way of streamlining consultation – ensuring no one feels left out of the process and gathering everyone's observations and ideas.

Ensuring the funding and results from public investment in science is easily accessible

- Providing comprehensive registers of our national scientific resources and available workforce would provide an excellent foundation for assessing the state of the science sector in New Zealand. These resources may be equipment-based, knowledge-based, personnel-based or organisation-based, and their cataloguing would expose apparent gaps in our science infrastructure and where our international connections can best support our national research matrix. It could also provide useful details on which research is working for public and/or private good.
- Public availability of the above registers and data as well as details and results of all publicly funded science would provide for a much stronger and more interconnected science system. Making scientific data freely available to both researchers and the public would foster collaboration, reduce time and money spent on obtaining or duplicating data and increase public engagement with the national science system. In a similar manner, providing information in the form of a register of physical scientific assets, science equipment and the personnel who can use or loan equipment, would enable faster and more collaborative research between scientists.
- International organisations are natural partners for collaboration, especially bodies such as UNESCO and those foreign consulates with scientific interests. Tapping into these resources, and keeping up to date with which organisations are operating in particular areas of science would provide the information necessary to make the most of international potential.

Ensuring that independent government scientists exist in the future

- In addition to a register of independent government scientists (mentioned above), there are other ways of ensuring those who are given public funds operate to the highest ethical standards. As part of accepting the funds, scientists and their institutions could be required to sign a code of ethics. Currently it is only voluntary to join the Royal Society so there are many scientists in the public arena that do not have a code to operate under. A similar set up to *The Royal Society Code of Ethics*[10] signed by scientists each year is a suggested way to coordinate this.
- Publicly available documentation of the MBIE board of scientific experts' decisionmaking processes is undeniably important. As the board is expected to be independent and politically neutral, public information supporting this is absolutely necessary to show that appropriate checks and balances are in place. Proof of independence of Crown Research Institutes (CRIs) is of a similar nature.

[10] See http://www.royalsociety.org.nz/organisation/about/code

Part Two: Responses to questions contained in the *Draft NSSI*

Due to a lack of information contained in this document, we have not addressed every question posed by MBIE. The Institute would like to see MBIE undertake additional research and consultation before the strategy document is made final. Please see the concluding remarks section (pages 26–27 of this submission) for a list of research questions we believe would help MBIE design an effective strategy.

A: FEEDACK ON OVERALL SCIENCE INVESTMENT OUTLOOK

Question 1:
What is your reaction to the overall balance of Government investment in science? In particular:

a. Do we have the right balance of direct funding for institutions versus more contestable funds? If not, what should it be and why?
b. Do we have the right balance of funding between CRIs, universities, independent research organisations, and industry? If not, what should that balance be and why?
c. Do we have the right balance of funding between investigator-, mission- and industry-led funding? If not, what should that balance be and why?

Response to (a)
This depends on the meaning of the terms *direct funding* and *contestable funding*. We note there is no glossary provided other than the following description:

- collaborative mechanisms, such as the National Science Challenges (around **$127** million per year including relevant Crown research institute (CRI) core funding), where collaboration between different researchers and institutions is essential to assembling New Zealand's best teams to address challenges of national significance
- contestable mechanisms, such as Ministry of Business, Innovation and Employment (MBIE)-administered sector-specific research funds (**$189** million), where competition and openness drive the emergence of new ideas, knowledge, technologies and applications
- institutional funds, such as the Performance-Based Research Fund (**$300** million from 2016/17) and CRI core funding (around **$202** million), to provide flexibility and stability to our research institutions
- business-led mechanisms to support research into new products and services, such as various business R&D funds (about **$141** million) and the Primary Growth Partnership (about **$65** million).

In order to answer this question, it would be helpful to know how the 1.41 billion dollars outlined on page 18 of the *Draft NSSI* has been categorised by direct funding and contestable funding. Further, it would be useful to know what MBIE think is the right balance. What is productive and what is not? In asking this question you are wanting to know which system of funding delivers better value. We suspect this is best determined in light of the objectives of the system and more specifically, the outcomes MBIE want to deliver New Zealanders.

Response to (b)
To answer this question – where we have the right balance of funding between CRIs, universities, independent research organisations and industry – we need to have the data broken up this way and reported over time. As this is not available in the *Draft NSSI* we cannot answer this question. What we do argue in our 2012 report is that we have too many CRIs for such a small country and we should look seriously at incorporating CRIs into universities as government-owned, mission-led research entities. We do not think the mix is right but we believe much more research and discussion is required before it would be possible to design and implement the right model for New Zealand.

Response to (c)
Page 15 goes some way to breaking up research into the different types, but it does not provide a view of changes over time, which means there is no way to benchmark or contextualize this information. Therefore we are unable to answer this question other than very broadly.

As noted above in the terminology section, the Institute suggests 'scientist-led, government-led and industry-led' as more appropriate terms for the three streams of science in New Zealand. Each of these has different strengths and weaknesses. For example, scientist-led may focus on long-term results while industry-led may focus on short-term results. This is acknowledged in the *Draft NSSI*, which notes that 'Government-funded research is seen around the world as an important complement to private sector investment'. As the OECD observed in 2000, 'The shortening of private-sector product and R&D cycles carries the risk of under-investment in scientific research and long-term technologies with broad applications' (page 10). A robust and stable economy in the long term cannot be based solely on short-term product development. Scientist-led research, more widely known as 'basic' or 'fundamental' science, is critical for building the scientific knowledge for later technological, social, environmental and economic innovation.

Question 2:
Are there parts of the Government's wider objectives and system for investing in science that are over- or under-emphasised in terms of scale or scope? If there are parts that are under-emphasised and need to grow, can you identify other parts of the system that are less important, that could be scaled back over time?

The Institute believes that a national science strategy should centre on a comprehensive outcome-focused set of objectives that is able to drive science investment. Such objectives should lay out the desired outcomes of the strategy – guiding investment. As discussed at the beginning of Part 1 (pages 3–4 of this submission), we do not consider the proposed objectives are capable of setting a 'new direction' for publicly funded science in New Zealand.

Question 3:
How well do the different parts of Government's overall investment system perform, both individually and in combination? Could settings be changed to improve their performance? If so, how?

New Zealand's science sector is highly fragmented and lacks an overarching strategic focus. The recent development of the National Science Challenges (the Challenges) was an excellent opportunity to create coherent research strategies around some of the most pressing issues facing the country. However, there is widespread dissatisfaction in the scientific community around processes

surrounding the Challenges. A recent survey of researchers by the New Zealand Association of Scientists found that the majority of respondents did not agree that the Challenges in their current form were the best way to organise research for the benefit of New Zealand.[11] Respondents also widely disputed the government's claim that the Challenges are well aligned with key scientific questions of national significance. In our view, this says more about the way the policy instrument has been implemented than the value of the instrument. We believe it would be a shame for this policy instrument to be removed. There is an opportunity to learn from the current process and improve it.

We find it highly concerning that so many of our scientists consider themselves disenfranchised from one of the most significant changes in the way research is organised in this country. The performance of research funding could be most comprehensively addressed through a process of engagement and dialogue with the workforce in the science sector. Attention must be paid to the needs and aspirations of the scientists who constitute the core of New Zealand's research community, an issue which we further address in question 16.

Question 4:
Do we have the right mix of public research institutions in New Zealand?

As you will see on the Institute's strategy map on page 10 of this submission, the institutional framework is a key enabler for the system. Understanding what institutions exist and how they might work better together is critical. Our first observation is that you cannot make decisions about public research institutions without having an understanding of the private research institutions and how they interrelate. The MacDiarmid Institute and the Cawthron Institute are cases in point. Secondly, we need to grow capability in the science system which means we need to look very closely at how we educate our science and engineering graduates and how we create a space for them to become part of a research team and if they want to, commercialise (spin-out) their work. This means we need to focus on creating sound and diverse career paths, telling stories about a range of role models, and most importantly creating great places to work and live. If we have too many institutions, we will lose the opportunity to build scale and momentum, whereas if we have to few, we are likely to create large bureaucracies and lose the opportunity to create creative teams. In our mind, this raises three fundamental questions.

(i) Do we have too many tertiary institutions?

The Institute is interested in doing research into the tertiary landscape in New Zealand. Recent trends to note are:

- Universities are increasingly building campuses in a range of cities throughout New Zealand
- Tertiary institutions are on the rise
- Benchmarking universities is on the rise. This means universities must develop excellent research reputations in order to rank well both to attract students from overseas and to ensure students are well-positioned when applying for jobs or postgraduate studies internationally. Hence, scale matters.

[11] See http://www.scientists.org.nz/news/2014/08/national-science-challenges-survey-results

Together these trends are unlikely to deliver optimal outcomes for students or provide value for money for the taxpayer.[12] This means we need our universities to be amazing research hubs – creating research that is notable on the world stage. They have become increasingly important to society.

(ii) Do we have too many CRIs?

In our 2012 report *Science Embraced* the Institute noted that the then eight CRIs did not align with the investment areas prioritised by the government at the time. We advocated consolidating the CRIs into three entities: a biological development arm, a high-value manufacturing and services sector arm and an environment research arm. Our thinking and suggestions on this issue can be found on pages 103–106 of the report (see Appendix 1).

The intent was to create a more collaborative approach by CRIs within each CRI, between CRIs and most importantly with each CRI and industry.

In 2014 New Zealand has seven CRIs[13] competing for funds, which arguably means we still have a competitive rather than a collaborative model. We would advocate it is timely for CRIs to undergo a robust review, not just in terms of the extent they individually provide value, but whether institutions are the best way to achieve the overarching goal. Are there ways they could be brought into the systems more – connecting them to universities and industry? Research questions could include:

- Do CRIs meet the purpose initially intended?
- Do they collaborate or compete?
- How well do they interact with universities?
- Is competition among CRIs getting in the way of great outcomes for New Zealanders?

A review of the 2010 Taskforce recommendations would be an excellent starting point.[14]

(iii) Do we need to find a new model?

We would argue that there have got to be more effective ways to commercialise science through the CRI model. One such model that is proving successful overseas is the university model for commercialising science. This would look something like this:

- Support universities to build in-house science capability (people and assets)
- Consider mergers for some universities (or parts of universities) such as Massey's College of Creative Arts and Victoria, or Massey and Lincoln animal sciences
- Reduce tertiary institutions
- Revert to a one 'University of New Zealand' model (creating synergies at a postgraduate level but keeping undergraduates to be managed independently at college level)
- Incorporate CRIs into universities in postgraduate hubs. Natural groupings by topic and geography could result in the following hubs:

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12 Very roughly, some initial research indicated public funding of tertiary organisations was in the range of 25–45 percent, but as noted above this requires a deeper understanding of the nuances. With a population of 4 million – and the average population per university in OECD counties being in the vicinity of 500,000 – New Zealand has about the right number of universities (eight in all). But what about other tertiary organisations?

13 'Each of the seven CRIs is aligned with a productive sector of the economy or a grouping of natural resources. They are: AgResearch, Institute of Environmental Science Research (ESR), Institute of Geological and Nuclear Science (GNS), Landcare Research, National Institute of Water and Atmospheric Research (NIWA), Plant and Food Research and Scion'. Excerpt from http://www.msi.govt.nz/get-connected/crown-research-institutes

14 See http://www.msi.govt.nz/assets/MSI/CRI/Report-of-the-Crown-Research-Institute-Taskforce.pdf

1. Plant and Food Sciences Hub (e.g. Canterbury, Lincoln, Plant & Food)
2. Animal Sciences Hub (e.g. Waikato, AgResearch)
3. Forest Sciences Hub (e.g. Waikato and Scion)
4. Engineering Hub (e.g. Canterbury)
5. Medical and Health Hub (e.g. Auckland and Otago)
6. Natural Sciences Hub (e.g. Canterbury, Victoria, Landcare, NIWA, GDS, ESR)
7. Art and Design Hub (e.g. Massey's College of Creative Arts)
8. English and Languages (e.g. Otago and Victoria)
9. Business, Economics and Public Policy Hub (e.g. Victoria and Auckland)

Question 5:
How could we improve the way we monitor and evaluate the performance of:
a. research institutions in the science and innovation system?
b. our policy instruments for making investments in science and innovation?
c. the science and innovation system overall?

Page 19 lists a range of indicators, but in reality they are a list of ideas worth exploring. What is concerning is that the title of the *Draft NSSI* emphasises investment while the content focuses on funding. We appreciate how this happens, but the real indicators get lost in this move from an investment approach to a funding approach. Investment puts the focus on return – the value we generate from the investment. Therefore MBIE needs to think more in terms of investing in institutions rather than funding institutions. An investment approach is about the quality of the people you are investing in, how long are you going to invest in them before you get a return, when will the return be realised, what checks and balances need to put into the investment contract and what happens in terms of costs and risks if the return is not realised. Most importantly, you want to build knowledge about what works and what does not. Until the government starts answering tough questions about the quality of its previous investments in detail, the status quo will prevail.

Question 6:
Are there any features of our institutions, policy instruments or overall system that are particularly relevant or useful for benchmarking or monitoring performance?

Effective monitoring and evaluation of New Zealand's research investment is critical but is not addressed comprehensively in the *Draft NSSI*. It is clear that many within the science sector share this concern. In comments provided to the Science Media Centre, Professor Shaun Hendy of the MacDiarmid Institute states that it is 'clear that we don't understand how our science spending produces value'. The *Draft NSSI* makes a number of conflicting and opaque references to the need to 'focus on performance' without adequately defining the kind of value or benefit desired from this spending (see page 25). We are concerned that such lack of clear definition may facilitate damaging assumptions equating 'value' with short-term profit from the commercialisation of research outputs, without consideration of the wider impacts of different types of scientific activity for New Zealand's future. To quote Professor Hendy again, 'we need a much deeper examination of our investment decisions and their impacts, something that requires an assessment of the opportunity costs of these investments'.

Within the existing funding system, monitoring of government-led or mission-led mechanisms such as the National Science Challenges is particularly problematic. The *Draft NSSI* states that 'a performance framework for the National Science Challenges is currently in development' (page 46). We are surprised that this was not done prior to the request for proposals. It is difficult to see how applicants can construct successful proposals for a major long-term research programme without knowing how their performance will be assessed; nor is it clear how MBIE can effectively assess the potential performance of lead institutions if an assessment framework is created after the contracts are signed.

Question 7:
To what extent does the current set of Government-wide investment policies and processes, and balance of investment in different mechanisms, address critical problems either in the science system or to New Zealand as a whole? What changes could be made to ensure those problems are being addressed?

Although the Institute has significant concerns regarding the 'objectives' for New Zealand's science investment identified in the *Draft NSSI* (see pages 3–4 of this submission), we do agree there is a need to analyse the current system with a view to designing an effective and efficient system guided by high-level objectives. In its executive summary the *Draft NSSI* states that MBIE has 'committed to raising Government's expenditure on science to 0.8 per cent of GDP' (page 7). We support this commitment but want to ensure that the funds are invested well. Interestingly, Sir Paul Callaghan had recommended 0.7 percent.[15] However the projected funding profile for government research investment on page 18 projects a stagnation and decline of funding in real terms over the next decade. The Institute is concerned that MBIE's own investment profile contradicts its public commitment to increasing overall science funding. This implies more thinking and analysis needs to be done in order to balance the different mechanism, as outlined on pages 28–29 of this submission.

Question 8:
To what extent do Government's different science mechanisms work together? Could they be made to work together more coherently? If so, how? Do we have enough investment mechanisms, or too many? If too few, where are the gaps? If too many, which could be combined, changed or removed to simplify the system?

This is where a glossary would be helpful. Is this question referring to the mechanisms noted in the excerpt above, in answer to question 1 above? Without clarity over what is being referred to it is difficult to answer this question. If it is to do with institutions, we have discussed this in question 4 above.

Question 9:
How can New Zealand achieve more international collaboration and cooperation? How well do existing mechanisms support this objective? What policy changes or new mechanisms could advance this goal?

Most scientists in New Zealand are well aware of international scientific activity in their fields and are already well connected with their international colleagues. The scope and scale of international collaboration which actually occurs, however, may be either assisted or impeded by our national

[15] See second to last slide at https://www.youtube.com/watch?v=OhCAyIllnXY

policy instruments and funding mechanisms. With this in mind we emphasise that the kind of research New Zealand chooses to invest in now will shape our capacity to engage with the international scientific community over the coming decades. A 2004 opinion piece by the International Council for Science makes the highly relevant point that 'the practice of science is increasingly international and the research agenda is set by those who participate. A country with no basic scientific research capacity effectively excludes itself from having any real influence on the future directions of science'.[16] Developing an internationally connected body of professional researchers in New Zealand thus depends on maintaining a robust and creative culture of scientist-led research.

Question 10:
Is there anything else we should consider about Government's overall mix of investment in science?

The Institute has ongoing conversations with some of the top scientific minds in New Zealand. A common piece of feedback is that there is no shortage of good research ideas with the potential for nationally significant outcomes as well as increasing our scientific standing on the world stage. This is also reflected in applications to the Marsden Fund, considered by many practising scientists to be the premier source of research funding in the country. However, a chronic lack of funding means that 9.4 percent of Marsden applications from researchers in universities and Crown Research Institutes currently receive funding.[17] Clearly not all funding applicants should be successful, but we also suspect that the bulk of Marsden applications are logical, creative and well-thought-out research projects, and their rejection may result in a significant number of lost opportunities. The Institute stresses the implications of frustrating the professional ambitions of New Zealand's best scientists in this way, and suggests that progressive increases to the Marsden Fund may play a significant role in enhancing the creativity and research output of our public research institutions. We are disappointed that MBIE projects only a very small increase in the Marsden Fund projected over the next two years, followed by a decline and stagnation over the period 2016–2024 (see funding profile, page 18 of *Draft NSSI)*. Such a funding trend for our most foundational scientist-led research cannot be anything but detrimental for the health of New Zealand's science sector, and we urge that it be reviewed.

Another critical problem facing the science system in New Zealand is the continual loss of talent and expertise due a chronic lack of opportunities for postdoctoral researchers. Scientists who have completed their doctoral studies in New Zealand often have no option but to pursue their careers overseas, in part because of the erosion of funding for postdoctoral fellowships and research. The *Draft NSSI* acknowledges the immense importance of postdoctoral research, stating that 'the value of postdoctoral fellowships to the science sector is that they perform the translational and interdisciplinary work in the university system that underlies and generates innovation' (page 68). Despite this, recent years have seen the loss of major funding schemes such as the NZS&T Postdoctoral Fellowships. These have been replaced with a few large awards for small numbers of high-profile, high-performing researchers through the Rutherford Discovery Fellowships. While it is important to recognise excellence, high-value prizes for a few top performers are not a substitute for comprehensive support of the scientists who will form the core of New Zealand's research and innovation sector over the coming decades. Callaghan Innovation's R & D internships, recently

16 See http://www.icsu.org/publications/icsu-position-statements/value-scientific-research/the-value-of-basic-scientific-research-dec-2004

17 See http://www.royalsociety.org.nz/2013/10/29/59-0-million-awarded/

rebranded as R & D student grants, are a positive step in encouraging tertiary students to engage with industry, particularly in the high-technology and engineering sectors. Comparative support needs to be given to the highly qualified graduates and postdoctoral researchers within universities and CRIs who pursue important research that does not have an immediate commercial application. This is an example of an area that could be a useful indicator over time, not only reporting internships but mapping their progress over the next 10 years.

B: GENERAL FEEDBACK ON THE DIRECTION

Section 1 of this Statement sets out some proposed objectives for Government's science investment. These are:

- Producing excellent science of the highest quality
- Ensuring value by focusing on relevant science with highest potential for impact for the benefit of New Zealand
- Committing to continue increasing investment over time
- Increasing focus on sectors of future need or growth
- Increasing the scale of industry-led research
- Continuing to implement Vision Mātauranga
- Strengthening and building international relationships to strengthen the capacity of our science system to benefit New Zealand.

These objectives **signal a new direction** for Government's science investment. Your feedback might consider the following questions. [bold added]

Question 11:
Should our funding mechanisms have a greater focus on the quality and on the relevance and impact of research? If so, why, and how could it be achieved? For example, should investigator-, mission- or industry-led, funded investments, across most mechanisms, have a sound pathway to impact and application, even if long-term?

The need for quality, relevant, high-impact research output makes up the second objective identified in this *Draft NSSI*: 'Ensuring value by focusing on relevant science with the highest potential for impact for the benefit of New Zealand.' Within this objective there are a number of key terms, each of which is open to various interpretations but not one of which is defined within the document. The Institute is highly concerned that if left unaddressed this objective could facilitate unfounded and unjustified assumptions about the kind of science to be prioritised in New Zealand.

Our specific concerns include:

- The focus on 'ensuring value … for the benefit of New Zealand' is highly problematic and raises a number of crucial questions. What kind of value or benefit is being referred to? How will this value and potential benefit be measured? What happens when the benefits of research accrue to one section of the population or sector of the economy at the expense of another? Any strategic approach to science investment must address these questions.
- The objective also raises questions as to what constitutes 'relevant science'. Even when working on a well-defined scientific question it is highly debatable as to which research projects are of most 'relevance' to solving a particular problem. For a funding body to decide on the relevance

of research proposals is necessarily a value-laden judgment; when such judgments are made without reference to well-defined ends or outcomes they are at risk of being either biased or arbitrary.
- Similarly, no definition is given as to what kind of 'potential for impact' will be focused on. Research impact assessment is highly contentious, and a strategic approach to science investment should lay out in detail how 'high-impact' science will be identified.

Implicit within this second objective of 'Ensuring value by focusing on relevant science with the highest potential for impact for the benefit of New Zealand' is the concept that it is possible to predetermine the types of science which will have the highest 'impact' before the research itself is done. Whilst particular themes and projects should certainly be prioritised, the outcome of scientific research is never certain. As noted in our response to question 1, the Institute stresses the value of 'fundamental' or 'blue-sky' research for the long-term health of New Zealand's society, economy and environment.

Pathways to commercial application are appropriate for certain types of research, most notably those that are industry-led. Other modes of science, including much research that is scientist-led, are more suited to building a fundamental knowledge base, as discussed in our response to question 1 above. We would suggest that the vast majority of scientists, including those engaged in 'blue-sky' research, will have potential impacts of their work in mind when proposing a particular course of research. Imposing a predefined impact pathway on such research, however, is likely to have the effect of constraining scientific output rather than channeling it towards a particular application. The great strength of scientist-led research is its ability to pose creative, open-ended questions and answer them in a rigorous and systematic way. A compulsory pathway to application will necessarily restrict the nature of scientific inquiry, with concurrent deterioration of the ability of the scientific community to contribute to the broader body of knowledge on which our society and economy are based.

Question 12:
Do you support a greater orientation of public science investments towards a stronger contribution to business innovation and economic growth?
a. If not, towards what high-level outcomes or orientation would you direct shifts in our science investments?
b. If yes, what, if any, key enabling technologies or industry sectors would you place as priorities for our science investments?

(i) Concerns over the lack of performance measurement in the current system

Our key concern is the clear lack of evidence to support our current investment strategy, let alone determine the best direction for New Zealand over the long term. To haphazardly change the strategic direction of public science not only risks any potential gains from the provision of a durable and consistent system for stakeholders, but also inhibits our ability to benchmark the system over time. This calls for ministers and policy analysts to think very hard about what they are trying to achieve. We have two concerns related to the lack of such objectives (see earlier discussion on pages 3–4 of this submission).

(ii) Concerns over the three 'types of science' investment approach

The division between the three types of science investment is said to 'use a similar framework to the EU's Horizons 2020 Framework Programme'. On looking closely at the reference provided (footnote 4, page 12), we were unable to find any reference to the discussion of the three types of

science other than a few broad statements incorporating the term 'mission'. We have included the excerpt below to show our understanding of the EU programme, and have underlined our interpretation of their mechanism (a financial instrument), their overarching approach (coupling research and innovation) and their method (one large fund for all, simple structure, less red tape, quicker time frames):

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly – and achieve results faster.

The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation. [18] [Underlines added]

The EU approach appears to centre on assessing ideas in terms of economic growth and employment, with a focus on product commercialisation (i.e. a commercial-outcome approach). It is difficult to see 'blue-sky' or 'fundamental' research being given much weight within such a framework, suggesting there might be alternative frameworks for blue-sky research. It would be interesting to learn more about this framework and MBIE might like to look at it more closely.

As the three types of science (investigator, mission and industry-led) appear to be novel we would have expected substantial explanation regarding the choice of these new terms. We question the need to discard terms used in the past, such as 'blue-sky' or 'fundamental' research, and have concerns over the ramifications of doing so. What benefits will be brought about by adopting these new terms in contrast to terms used previously or are these changes simply about creating a new word for an old idea? Introducing new terms can be an effective way to promote a fresh approach, but an explanation would be useful.

Our interpretation is that MBIE's intention is to classify science investment on an 'input basis' defined by the party which brought a particular funding option to the table. We would question whether an input basis is useful. From the perspective of an 'investment approach' (in contrast to a narrower 'funding approach'), classification on an output or even an outcome basis is more useful. Although called a *Statement of Science Investment*, at a high level this document is still based on a funding approach and promotes a very different system than if an investment approach had been applied. The latter approach indicates the definition of very detailed objectives as to what is wanted from the investment. We believe that MBIE has attempted to articulate such objectives in this document, but suggest that a more conscious investment approach is needed in order for this to be successful.

[18] See http://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020

Question 13:
How should collaboration between scientists and institutions feature in our science investments? What can we learn from the collaborative approaches taken to date? What is the appropriate balance in the system between collaboration and competition?

Collaboration and competition are different ends of the same continuum. We question whether competition is an effective mechanism in a small country with only a few specialists in each field. See our answer to question 4 on the benefits of reducing the number of CRIs and tertiary institutions and how this might create more effective collaboration.

Question 14:
How might the current set up of New Zealand's research institutions either encourage or discourage across-research institution collaborations, international researcher collaborations, or user collaborations?

See response to question 13 above.

Question 15:
How should knowledge users engage in improving the impact of our science investments? What can we learn from how they have been engaging to date?

There is already substantial involvement by certain sectors of industry with the allocation of research funding. Beyond this, in addressing engagement with the scientific process, we need to reconsider which groups, institutions and individuals we class as 'knowledge users'. As we have stressed elsewhere in this submission, the value and impact of science are far broader than its commercial applications and short-term economic impacts. Users of the knowledge produced by scientists in New Zealand include Māori, primary and secondary schools, community groups, think tanks and a wide variety of the general public. With this in mind the Institute proposes that results from publicly funded science in New Zealand should be published in a form accessible to the wider public. We see no reason why publicly funded research, particularly that undertaken within the universities and CRIs, should not be freely available on an easily accessible public database.

We also would like to stress the importance of a genuine integration of mātauranga Māori into the science system. This must go beyond the token use of Māori terms or phrases to a deeper engagement with Māori concepts and modes of knowledge by active scientists and the industrial and government partners who support research. We recognise that this is the responsibility of all involved in the science system, and acknowledge the work already done by MBIE in promoting Vision Mātauranga within the *Draft NSSI*. The Institute considers that Vision Mātauranga must be further integrated into our investment mechanisms. This will both broaden the impact of science within Māori communities and extend the meaning and cultural significance of knowledge produced by researchers within all disciplines in New Zealand.

Question 16:
Is there anything else we should consider about the proposed general direction of change?

The Institute does not consider that the new objectives set out in the *Draft NSSI* can deliver a new direction – see discussion at the front of part 1 (pages 3– 4 of this submission).

Question 17:
How can we continue to improve the quality and impact of the science we fund?

The Institute would like to suggest that the quality and impact of science done in New Zealand could be vastly improved by a focus on scientists themselves rather than merely on the mechanisms and institutions by which science is funded. Scientists in New Zealand face fewer career opportunities or prospects for professional development than their overseas counterparts, and in general earn significantly less than researchers of equivalent expertise in Australia, Canada, the US or the UK.[19] There are also fewer scientific job opportunities than doctoral students who graduate from New Zealand universities each year, as discussed in our response to question 9 above.

The Institute has concerns about how the concepts of 'quality' and 'impact' are approached in the *Draft NSSI,* which are addressed elsewhere in this submission. We emphasise that however these terms are defined, quality and impact will suffer if we continue to underinvest in the scientists who are expected to work within the research frameworks proposed in this document. There is an ongoing risk that our most talented researchers will continue to go elsewhere, with inevitable long-term effects on the quality and impact of science done in New Zealand. Once lost from a country, basic scientific expertise cannot be easily recovered.

Question 18:
Should quality be assessed differently in investigator-led, mission-led, and industry-led research? If so, how?

Yes, but objectives for each of the three types (investigator-led, mission-led, and industry-led) would need to be developed first. Only once the objectives are clear can the indicators be developed to assess performance against those objectives. We also consider corporates manage funds and report on investments far more effectively than the public service. In other words, the *Draft NSSI* would not meet the commercial standard of an investment strategy as it does not provide adequate information on the investments to date or outline what the proposed investment strategy will deliver stakeholders going forward. There are many investment tools that are used in business that could be applied to the public service. The fact that the investor is the New Zealand public arguably calls for more transparency than in the private sector. See also our response to question 10 above.

Question 19:
How can we improve the international connectedness and engagement of our research community and research-active companies?

We are unsure why New Zealand does not make more use of our consulates, both those in New Zealand and New Zealand consulates overseas. The British High Commission and the work of Steve Thompson (past chair of FRST and past president of the Royal Society) is a great example of how consulates can contribute.[20]

We would suggest looking into international speaking tours across all New Zealand universities. When interesting scientists visit New Zealand, it always surprises us how little uptake there is in sharing these visits both within and between universities. For instance, the Ministry of Education could look at creating a coordinated speaking tour where universities could see who is speaking where on what topic.

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19 See http://www.universitiesnz.ac.nz/node/685

20 See https://www.gov.uk/government/priority/uk-science-and-innovation-network-working-with-new-zealand

This brings us to a final observation for this section that New Zealand's science system could be made more effective if scientists applied their research skills and technology skills to the system. Solving complex problems is what they are naturally good at.

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

Feedback on the structure of MBIE sector-specific research funds has been summarised together in the following discussion:

MBIE's sector-specific funds are worth approximately 189 million dollars per year, excluding any contributions from the National Science Challenges. As such they are one of the largest single mechanisms with which government can direct the course of scientific research (see page 44).

As the *Draft NSSI* acknowledges, there is a high degree of uncertainty surrounding the amount of funding allocated to research sectors from year to year (see chart 12, page 46). We agree that this is problematic, since the efficacy of high-impact research tends to depend on the consistency of financial input beyond short-term funding cycles. Some research opportunities may also be time-critical, meaning that a single year's absence of funding within a particular sector may lead to permanently missed opportunities. Rather than answer specific questions, we summarise our observations below:

Observations

- The *Draft NSSI* states on page 44 that 'research contracts are awarded to the highest-scoring proposals, with no commitment to renew funding after the initial contract period'. Recognising the importance of consistency of funding as discussed above, we agree with the proposed move from a one-year to a five-year funding envelope for sector-specific research funds.

- Despite the point above we retain concerns over the continuity of research supported by the sector-specific funds, in part because of the acknowledgement that 'Government sets priorities for them (effectively defining the mission) and these priorities can change from time to time' (see page 44). That the objectives and strategic direction of one of New Zealand's most important funding mechanisms can fluctuate based on the short-term priorities of the election cycle is unlikely to be conducive to the success of meaningful long-term research projects.

- Similarly, we are concerned that major decisions as to the allocation of MBIE's sector-specific funds are delegated to the Science Board, whose members are appointed directly by the minister. While we strongly support the concept of a cross-disciplinary board of scientific experts to assess funding applications, we consider this board should be independently appointed and politically neutral. We are concerned that the current framework may allow for politically motivated appointments to influence the nature and scope of scientific research to receive public funding. We realise that the appointment of the Board is governed by the Research, Science and Technology Act 2010 rather than the *Draft NSSI* under discussion, but consider it to be important in the context of ongoing reform of the sector-specific funds.

- Lobbyists should not be members of the Science Board.[21]

- The *Draft NSSI* proposes 'having fewer, larger funding pools and using fewer funding mechanisms' (page 45). Currently each sector-specific fund and funding mechanism has specific policy objectives and is targeted towards specific outcomes. Although in principle we support the reduction of complexity in science funding, we are concerned that releasing the sector-specific funds for open contestation may lead to some sectors dominating this contestable research funding. The current funding mechanisms are already polarised towards research that can be swiftly commercialised. However, we stress that funding for research in areas such as environment, health and society must be protected. Open contestation of funds is unlikely to achieve this.

- In the discussion of the performance management and reporting requirements by which contracts under the funds are monitored and assessed, the *Draft NSSI* mentions that 'the contracts are increasingly emphasising outcomes and system impact' (page 45). No explanation is given as to what kind of outcomes are emphasised or how appropriate outcomes are decided. The definition of 'system impact' is highly contestable, and a coherent public discussion around the allocation of these funds requires explicit consideration of the kind of impacts MBIE is referring to here and how these impacts will be measured and assessed. Although there is reference to a 'performance framework' currently 'under development' (page 46), the details of this framework are highly relevant to the future of the sector-specific funds and should have been included for discussion in the *Draft NSSI*.

- We are also highly concerned about the lack of detail as to MBIE's proposed reforms 'to align contestable funding with the objectives set out in this Statement' (page 47). Our particular concerns include:
  - No information is given as to which of the sector-specific funds the proposed 56.8 million dollars of new funding starting in 2015/16 will be directed towards (page 47).
  - In the same section it is stated that MBIE proposes to 'consider the role of "contest" in refreshing and supporting emerging opportunities' (page 47). It would be helpful to have some clarity regarding what is meant by this statement, and the ways in which MBIE is proposing to alter or adjust the contestability of these funds.
  - The *Draft NSSI* proposes to 'increase the focus of the funds on research with direct relevance to the most pressing industry, environmental and social needs' (page 47). We have questions as to how 'direct relevance' is to be defined, how these needs are to be determined, and what kinds of measures will be used to assess the potential 'relevance' of a research proposal to a perceived need. These are all value-laden judgements, and it is concerning that the *Draft NSSI* does not make reference to criteria by which such judgements will be made. In the same way, no information is provided as to how the reforms will 'place greater emphasis on impact' (page 47).

[21] Dr William Rolleston was Chairman of the Life Sciences Network (LSN), which was a lobby group involved in promoting genetic modification during the time of the Royal Commission on Genetic Modification. See https://www.mfe.govt.nz/publications/organisms/royal-commission-gm/appendix1/section-4-2.pdf. The Life Sciences Network website was removed about 2004. Rolleston's bio on the MBIE website does not mention his role as Chairman of LSN. See http://www.msi.govt.nz/about-us/science-board.

D: CONCLUDING REMARKS

Our 2012 report (see Appendix 1) contains 10 recommendations, all of which continue to be relevant today. To summarise, New Zealand needs the government-funded science system to:

(i) inform public policy;
(ii) improve the physical and mental health of New Zealanders;
(iii) increase the financial security of New Zealanders; and
(iv) contribute to solving global problems.

To do this we need to focus on enabling five key components to work in unison:

(i) institutions;
(ii) scientists;
(iii) research infrastructure (i.e. science assets);
(iv) funding (i.e. the investment); and
(v) the regulatory framework.

The *Draft NSSI* focuses on one component within the system: the investment of funds. The task for MBIE is to act as a guardian for the whole system. This requires MBIE to also focus on how to make institutions, scientists, science assets and the regulatory framework work together to deliver great outcomes for New Zealanders over the long term. This is not an easy task.

Our final suggestion is to consider:

(i) Mapping the current and emerging issues facing New Zealand over the next 20 years in order to help inform science investment in the future (page 5)
(ii) Exploring international models – what are the strengths and weaknesses of international models (e.g. the Irish model and the EU model)? (page 5)
(iii) Exploring joint strategies between MBIE and the Ministry of Education (e.g. *A Nation of Curious Minds*) (page 6)
(iv) Mapping talent over the next 20 years in order to understand the talent gaps and surpluses that might exist if we continue on our current course (page 6)
(v) Exploring universities that are creating effective spin-offs – what are the challenges and how have they been resolved? (page 7)
(vi) Considering creating objectives for each type of science being funded (i.e. investigator-led, mission-led and industry-led') and providing data on how these have changed over time (going back say 10 years and going forward 20) (page 7)
(vii) Preparing a glossary of terms (such as 'impact', 'benefit', 'value' and 'relevance'), types of science ('investigator-led', 'mission-led' and 'industry-led'), institutions, funding terms ('direct funding' and 'contestable funding'*)* and funds in operation (pages 7 and 12)
(viii) Exploring the R & D tax credit systems operating overseas – what works and what does not? (page 8)
(ix) Developing a strategy map for publicly funded science (page 8)
(x) Exploring ways of creating a central portal for consultation (invitation to comment) across the whole of government (page 11)
(xi) Exploring the idea of a register of 'independent government scientists' (page 11)
(xii) Exploring the idea of requiring those that accept public funds to join the Royal Society and therefore be required to operate under their code of ethics (page 11)

(xiii) Considering creating objectives for each form of funding (i.e. 'direct funding' and 'contestable funding') and providing data on how these have changed over time (going back say 10 years and going forward 20) (page 12)
(xiv) Mapping the public and private institutions currently in existence (pages 14 and 15)
(xv) Looking at how the CRI model (or similar) is working overseas – what are the lessons to be learnt? (page 15)
(xvi) Exploring the idea of building closer links between universities and CRIs (page 15)
(xvii) Looking at ways corporates manage funds and report on investments (page 23)
(xviii) Exploring ways consulates could contribute (page 23)

We hope that our feedback has been useful and look forward to reading the summary of submissions on this important topic. Thank you again for your invitation to comment.