

9 November 2019

## Submission on Research Science and Innovation Strategy

### Introduction

The National Energy Research Institute (NERI) welcomes the opportunity to comment on the Draft Research Science and Innovation Strategy (“the Strategy”).

NERI is a Charitable Trust incorporated in New Zealand. Its primary purpose is to enhance New Zealand's sustainability and to benefit the New Zealand community by stimulating, promoting, co-ordinating and supporting high-quality energy research and education within New Zealand.

Its research members are Victoria University of Wellington, Auckland University of Technology, GNS Science, Scion, University of Canterbury and the University of Otago, and its industry association members are the Bioenergy Association, BusinessNZ Energy Council, the Energy Management Association of New Zealand, the New Zealand Wind Energy Association, the Road Transport Forum and Tourism Industry Aotearoa.

This submission has been prepared in consultation with the membership but may not necessarily represent their individual views in the detail. In it we focus on the implications of the Strategy for energy research in New Zealand.

### Contribution of Research, Science and Innovation

#### **Question 1: Where can the RSI system make the greatest contribution towards the transition to a clean, green, carbon-neutral New Zealand?**

New Zealand uses ~380 PJ<sup>1</sup> of fossil fuel for domestic energy representing ~40% of our gross domestic Greenhouse Gas (GHG) emissions<sup>2</sup>. This excludes perhaps a further 130 PJ servicing New Zealand with international transport<sup>3</sup>.

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<sup>1</sup> MBIE (2019) *Energy Balance Tables 2018*.

<sup>2</sup> MfE (2019) *New Zealand's Greenhouse Gas Inventory 1990–2017*

<sup>3</sup> MBIE (2019) Op. Cit.. Inward bound fueling estimated as equal to domestic fueling for international transport use.

NERI in conjunction with industry, government and research interests has published *Energy Research Strategy for NZ: The key issues*<sup>4</sup>. It identifies the priority issues to be addressed by the New Zealand energy research sector based on the following criteria:

- Aligned to themes common to the New Zealand Energy Strategy and other energy related strategies, and thus the need to reduce GHG emissions from the sector;
- Have a significant national impact;
- Are beyond the capacity of individual businesses or sector groups to address (“beyond business-as-usual”);
- Require medium-term research investments (5+ years) with impacts well beyond this; and
- Are peculiar to New Zealand and/or not likely to be solved by overseas research, or are in areas where New Zealand has world class capability.

The key strategy areas it identified needing to be addressed are:

- electricity generation and distribution (to service the growth in demand for renewable generation and the impact of new electricity technologies coming on-stream);
- transport (reflecting its role as the major user of fossil fuels and impact of ICT on the sector);
- industrial processing (the second biggest user, together with transport representing ~80% of current fossil fuel use<sup>5</sup>);
- residential (because of the social impacts of change); and
- system wide considerations including growing our internationally competitive niche energy RSI capabilities.

We recommend the Energy Research Strategy and subsequent work as providing the framework for where and how the RSI system can make the greatest contribution towards the transition to a clean, green, carbon-neutral *energy* sector in New Zealand.

## **Question 2: Where else do you see it making a major contribution?**

Sustainably increasing New Zealand’s wellbeing needs access to relatively low-cost renewable energy, with a supply that is secure, resilient and that meets environmental objectives and obligations, while ensuring everyone’s basic energy needs are met.

Thus, energy RSI will also contribute to each of these wider needs:

- improved material well-being e.g. major export earners tourism, international trade, and food are all energy intensive, as is domestic mobility;
- social well-being e.g. low-cost energy is essential to keep homes warm and dry and to allow mobility; and

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<sup>4</sup> NERI (2017), available from [www.neri.org.nz/strategy](http://www.neri.org.nz/strategy) (accessed 6 November 2019).

<sup>5</sup> MBIE (2019) Op. Cit.

- the environment e.g. the use of energy resources has a significant potential impact on the environment.

Again, we recommend the Energy Research Strategy and subsequent work as providing the framework for where and how energy sector RSI can contribute towards sustainably increasing New Zealand’s economic, social and environmental wellbeing.

**Question 3: What else could else the RSI system be doing to accelerate the progress towards the Government’s priorities?**

The answer to Questions 1 and 2 by and large addresses this, but in terms of the particular priorities identified in the Strategy, energy research will have a particular impact on: prosperity (1), transitions (4), connected communities (6), warm dry homes (7), and reputation (12).

**Researching and innovating towards the frontier**

**Question 4: Do you agree that the RSI Strategy should be focused on innovation at the “frontier” (creating new knowledge) rather than behind the frontier (using existing knowledge to improve the ways we do things)?**

The term “frontier” has particular connotations in the context of research and science. In the vernacular it is seen as being at the boundaries of science, and more particularly with a basic science flavour to it.

The risk is that using this terminology may bias the investment portfolio further towards novel technologies and away from (say) the applied engineering and social disciplines. This is reinforced by the definition of “behind the frontier” in terms of “*adoption of existing **technology***” [emphasis added], and the cited reference being about diffusion of technologies through high productivity firms.

The problem is that “*the boundaries of what we are capable of doing*” can equally be extended by the “*novel adoption and application of existing technologies and practices*”<sup>6</sup>. This is the bread and butter of the engineering and social disciplines and will be a significant contributor to achieving the outcomes we desire from the future energy system. For example, the social sciences are essential to help manage the demand-side in energy and address the changes that will be inevitable going forward.

In the Energy Research Strategy we didn’t use the “frontier” concept as a selection criteria for investment, but still captured the criteria on p. 18 by-and-large using the various uniqueness-to-New Zealand attributes (see answer to Q. 1). We also included a beyond business-as-usual criteria to support the public policy rationale for the Government’s involvement.

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<sup>6</sup> In particular as a research methodology it will deliver on the criteria on p.18.

In the end public RS&I investments do service a purpose, and what gets funded needs to derive from that. The Government does expect outcomes to be delivered<sup>7</sup> and it is most doubtful that these are limited to frontier knowledge. Just focusing on a single potentially ambiguous attribute (“frontier”) will be risky.

We therefore recommend that the Strategy de-emphasize both the use of the term “frontier” and the focus on “technologies” for MBIE’s RS&I investments (p. 15), and instead:

- Focus directly on enlarging the boundaries of what we can do in New Zealand, exploiting where relevant the unique characteristics of our capabilities, resources, society and other endowments.
- Explicitly acknowledge novel applications of existing technologies and practices as contributing to this.
- Include medium-term research beyond business-as-usual as a requirement for this class of publicly funded investigator-led research.

**Question 5: In which research and innovation areas does New Zealand have an ability to solve problems that nobody else in the world has solved? Why?**

**Question 6: In which areas does New Zealand have a unique opportunity to become a world leader? Why?**

**Question 7: What do you consider to be the unique opportunities or advantages available to the RSI System in New Zealand?**

**Question 8: What RSI challenges are unique to New Zealand, that New Zealand is the only country likely to address?**

We consider that aspects of energy research address each of these questions, but for convenience will address them in the context of comments on renewable energy as an area for focus.

**Question 9: What are the challenges of innovating in the public sector? How do they differ from those in the private sector?**

Renewable energy futures have strategic importance for the Government in achieving its own and international policy commitments. Hence understanding those futures and what can be achieved in New Zealand is central to policy development in energy and energy resources, and to those sectors particularly exposed to energy futures (e.g. food, transport, tourism).

These are medium-term issues with high uncertainty and are often relatively unique to New Zealand. Public policy requires a good understanding of the options and risks, and how to manage these. This kind of research has spill-over benefits into the private sector.

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<sup>7</sup> This is reflected in the increasing number of de facto “portfolios” being adopted, and the investment criteria relating to government priorities

The basic challenge in getting this work done in energy is a complete absence of departmental funding to purchase research in any of the relevant votes: Energy and Resources; Transport; and Tourism. This contrasts with the funding to the primary sector including The Sustainable Food and Fibres Futures Fund.

We recommend that there be significant allocations to Votes: Energy and Resources; Transport; Tourism to support policy directed RS&I.

## Our Key Challenge – Strengthening Connections

**Question 10: Do you agree that the key challenge for the RSI system is enabling stronger connections? Why or why not?**

We support a move in this direction both internally and externally as part of an effort to ensure good and timely access to expertise we need, and because of the likely impact on the quality and competitiveness of our efforts.

## Guiding Policy – Excellence

There are two separate questions: “What is excellent RS&I?” and “What are the conditions that predispose to it?” The Strategy focuses on the latter when it is the former that is the appropriate starting point.

RS&I is a heuristic process. So “excellence” needs to be defined in terms of the achievement of its goals rather than in terms of the process itself i.e. not “*ongoing pursuit of the best thing possible*”. Persistence may be a virtue and a necessary condition for success, but it isn’t necessarily excellent.

Having defined RS&I as *expanding the boundaries of what we can do in New Zealand* in selected target areas (Q. 4), then “research excellence” is what delivers that, particularly where the boundaries are difficult to expand. Excellent research teams will be those that deliver this consistently over time. The indicators of success for excellence in Annex Two do not address this.

We recommend the Strategy define research excellence as “*expanding the boundaries of what we can do in New Zealand where this is judged particularly difficult or high risk*”, and not “*the ongoing pursuit of the best thing possible*”.

In this context “diversity” may be helpful; a “global outlook” and access to the best the world can offer must be advantageous; as will constructive “partnerships”.

We note that the expansion of knowledge in the global context, global competitiveness, risk (i.e. difficulty of boundary expansion) and quality of the team are all existing measures used to assess excellence for Endeavour Fund investments.

## Guiding Policy – Impact

### Question 15: How can we improve the way we measure the impact of research?

Assessing portfolio level impact depends upon having a reasonably explicit view of what is being sought from a Fund. This is currently relatively high-level and weak but will be aided by some of the developments proposed in the Strategy designed to make this more explicit. But the lesson from other areas of public policy is the need to “design-in” the monitoring and evaluation framework from the beginning<sup>8</sup>.

We can see from our energy research strategy the value for portfolio assessment in having defined the issues that are being addressed and the rationale. For example, a suggested priority area from that strategy is “*Increasing the availability of even lower cost, cleaner, geothermal energy for both electrical and thermal loads*”. This then provides a basis for measuring and evaluating the impact of a portfolio of relevant investments, even where the proposals are investigator-led.

Again, the indicators of success for impact in Annex Two do not address this.

We recommend having clearer measurable statements of desired impacts at the portfolio level at the time of investment, and these be used to measure success/impact.

## Guiding Policy – Connections

The barriers to connection (e.g. transactions costs) will be lower where there are existing networks, and this suggests New Zealand should support these and assist participation in them where they are of strategic importance<sup>9</sup>.

In the case of the connections referenced in Q. 18 the appropriate relationships may initially be ill-defined or diffuse (as often occurs with investigator-led proposals, particularly where they are intended to be transformational within a sector). In this case industry organisations provide existing networks that could be leveraged to improve the connections. Industry organisations will, inter alia, be able to:

- Leverage existing low-cost trusted relationships with the range of organisations in the sector, both small and large, and good means of communication with them;
- Take a longer-term industry view in the early stages of the research, often not available from specific organisations within it. This could include investing in capability to facilitate longer-term research, provide a view on strategic issues in the sector and the potential contribution of research to it;
- Help identify key relationships within the sector as the research develops.

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<sup>8</sup> The foreshadowed work in this area, linking to Treasury’s work on Living Standards and hopefully their and international wider evaluation frameworks will assist.

<sup>9</sup> The current government support of some IEA memberships is an example from the energy sector.

In levy funded research associations these linkages are already strong, but the opportunity is there to extend these relationships. NERI has been developing this capability with its association membership by industry organisations (see Introduction) with a view to help improve these connections in the energy sector.

We recommend consideration of further assistance with membership and other forms of involvement in key international networks of researchers; and exploring the use of industry organisations to help develop connections with the groups identified in Q. 18.

### **Actions – Making New Zealand a Magnet for Talent**

We support the intentions of this section and the specific initiatives. Individual member organisations will no doubt comment in greater detail.

### **Actions – Connecting Research and Innovation**

We have noted the problems with the preoccupation with “technology”, and it applies particularly in this section. This sets up a very narrow view of the contribution of the RS&I system.

For example, in the energy sector in Taranaki the processes by which firms and communities adjust to shocks and uncertainties are more important than any technology developments, at least over the next decade or so.

It is ironic that the Strategy adopts two managerial and social processes, “best practice research commercialisation” and “improving international connectiveness”, as major themes, yet de facto excludes the RS&I system from *expanding the boundaries around what we can do in New Zealand* in these areas, let alone transferring this understanding into the relevant sectors.

In respect of the recommended actions the choice of Singapore and Australia as targets for deep integration runs somewhat counter to the desire to see international connections with the best in the world.

In energy one would be looking to jurisdictions with similar renewable energy resource endowments (e.g. hydro, wind, geothermal, biomass) and energy sector and demand characteristics.

We recommend the Strategy review its emphasis on “technologies” as per our response to Q. 4, and reconsider if deep integration with Singapore and Australia is suitable for all areas of its investment portfolio.

### **Actions – Start-up**

There are a wide range of potential start-ups in the energy sector. ICT is an important source of innovation in the sector and these firms have similar characteristics and needs to other ICT firms.



However, there are firms that are working on novel solutions where the ultimate success of the offering lies in the ability to scale up innovations, integrating them competitively into complex machines or processes. The RS&I system can help de-risk the early stages of what is a costly and risky process in three ways.

First, by RS&I investments in pilot scale testing for common processes. (This is available in the food and pharmaceuticals sectors).

Second, a new innovation alone will usually not be “drop-in” but will need further RS&I investment to develop novel balance of plant and processes to enable the scale up. This is an issue we will return to in the “Scale-up” section.

Third, the start-up needs to be well informed early in the process of the potential techno-economic performance of the system, the key figures of merit, and the potential market response. RS&I investment to develop the capability to make these assessments will better inform the scale-up process, improve the capacity to raise investment and terminate poor prospects early.

Each of these is fundamental to research investments having impact, occur at a time when innovations are still highly risky and unproven, and thus need to be considered partly as a cost to the original programme.

We recommend that RS&I investment be available to research teams and industrial start-ups to develop pilot infrastructure where indicated, to develop the balance of plant for novel plant and/or process, and to develop capability to provide better information on the start-up’s competitiveness.

## **Actions – Innovating for the public good**

As noted, in the energy sector the priority need is for Votes Energy and Resources, Transport, and Tourism to include funding commensurate with the amounts available in the primary sector. We will discuss the need for a focus on Renewable Energy in the next section.

## **Actions – Areas of focus**

Renewable Energy has the characteristics required to be a focus area under both categories set out in the Strategy. This is particularly reinforced by its importance in achieving the transition to a clean, green, carbon-neutral New Zealand<sup>10</sup>.

By way of example:

- Potential sustainable advantage:
  - We have a relatively unique portfolio of renewable energy resources – hydro, geothermal, wind, biomass – and consequently we have

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<sup>10</sup> There is extensive literature on the importance of RS&I in achieving. A recent contribution and partial summary can be found in Propp, David (2019) “*Promoting Innovation for Low-Carbon Technologies*” The Hamilton Project, The Brookings Institution.



significant ability to grow our production of low-cost renewable energy ahead of much of the rest of the world.

- Energy is an important input into other core products and services New Zealand relies upon, particularly Food and Tourism, so we can potentially add significant value by using our renewable energy to further differentiate these sectors as “clean and green”;
- The wood processing industry is already a heavy user of renewable energy, but as it moves up the value chain into biorefining bioenergy products will need to be developed as co-products<sup>11</sup>. We have research capability here;
- We have strengths in functional materials and in biological process like fermentation that are likely to be important enablers of lower cost, more efficient conversion and upgrading of our energy resources;
- We also have strengths in managing renewable electricity systems and are facing issues that will only start to emerge in other jurisdictions 10 - 20 years from now. This offers the potential for products developed here to scale internationally, particularly those based on the convergence between energy management and ICT. We have research capability in all these areas;
- We are part of a limited group of countries that have geothermal resources and strong research capability in it, and some of the best wind resources in the world.
- Unique challenges:
  - Our high penetration of renewable electricity globally, and our focus on achieving a renewable energy system ahead of much of the world;
  - Our relative isolation and dependence on long-haul aviation, one of the more difficult areas to address when it comes to emissions. This will require attention to both fuels and the demand side. However, our strengths in VR/AR could assist with demand and lead to significant international opportunities;
  - Our relatively high levels of low-cost renewable electricity should mean BEVs will be economic for low duty cycle transport earlier than in much of the rest of world. This will be both a challenge and an opportunity. The impact of ICT convergence on BEV will therefore also potentially be seen early in New Zealand;
  - Just Transitions in some areas will be another challenge we are facing ahead of much of the world, but we have capability and thus this could also in time represent a significant export opportunity.
  - We will need to grow RS&I capability in a number of these strategic areas.

## Actions – Scale up

We support the approach here but would argue that the investments to build scale need to be done in the context of the value chains we are trying build. This means that rather than just investing in the areas where we might have competitive advantage

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<sup>11</sup> See New Zealand Wood Fibre Futures Project.

or specific needs, we need to look up and down the value chain and secure the strategic areas to help make the value creation sticky in New Zealand.

Some simple examples drawn from our comment on Areas of Focus would be:

- Energy for clean food will likely be more expensive. This will entail consideration by the researchers of how that energy is sourced and used, through to the additional value it creates (e.g. what is the margin available for renewable energy food). Investment in innovation will be required along the whole value chain.
- Similarly, it appears biorefineries/biofuels will need to be considered as a combined value chain to make them economic.
- As well as being world leading in geothermal prospecting and extraction, we need to be looking at how we use it e.g. low-grade heat to realise the maximum value.
- Much of the materials research will end up in larger systems. We have discussed the need to be able to take full advantage of the novel materials by both capturing value by scaling up the production of the wider system, and by the production of the material (or components it enables).
- Etc.

### **Actions – Towards an Extended ‘Vision Mātauranga’**

In the energy sector (as with other areas) Māori interests often own or have rights to significant resources. The potential to develop those resources through research creates opportunities to strengthen connections.

### **Actions – Building Firm Foundations**

These issues are broader than the energy sector, and our members will no doubt be commenting individually.

### **Actions – General**

**Question 42: How should the government prioritise the areas of action, and the initiatives proposed under each area?**

There are some fundamental issues that need to be addressed first, particularly an agreed definition of what the RS&I is delivering (e.g. “excellence”), and the use of clearer measurable outcome statements for the portfolios.

Beyond that the priorities should be driven by the changes with the greatest contribution to the outcomes. This may not be the same for each portfolio.