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FORUM

National innovation policy and public science in Australia

Lyn Carter[1]

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Abstract In this paper, I have positioned myself with Kean Birch and explored some of the political-economic actors/actants of policy suites implicated in the biotechnologies and bioeconomy. In particular, I have considered Australia's recent National Innovation and Science Agenda and allied documents and entities (that is, Innovation and Science Australia, the National Science Statement and the 2016 National Research Infrastructure Roadmap) as one of the National Innovation Strategies in place now in OECD countries and beyond. In overview, these policy suites utilise the same high knowledge creation/low translation and commercialisation arguments as elsewhere to press for particular ideologically based 'improvements' to public science. Mapping the terrain of these entities has revealed the innovation, biotechnology and bioeconomy policy space to be inordinately complex and challenging to navigate. Reviewing Australia's position enables the type of comparative work that contributes to a closer understanding of the largely neoliberal global economic imperatives shaping contemporaneity. Moreover, while these policy suites attempt to constitute and circulate particular visions of science education, their complex nature mitigates against science teachers/educators grappling with their implications.

Keywords Australia · Policy · Innovation · Bioeconomy

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This review essay addresses issues raised in Kean Birch's paper entitled: *The problem of bio-concepts: biopolitics, bio-economy and the political economy of nothing*. doi:10.1007/s11422-017-9842-0.

✉ Lyn Carter
lyn.carter@acu.edu.au

[1] Australian Catholic University, Melbourne, VIC, Australia

Positioning myself with Kean Birch

The conceptual medley of biopolitics described in the editorial to this volume is elaborated by Alexander Carnera (2012) when he suggests that perhaps there are two major identifiable streams of research. The first, he believes, promotes more abstract philosophical discussions around problems of politics, social values and aesthetic practices. Key questions become the attachment of life to politics and how biopolitics becomes a new critical perspective on economy and capitalism. Central theorists that readers might like to consult would be Roberto Esposito, Giorgio Agamben, Antonio Negri (along with Michael Hardt), Maurizio Lazzarato and others such as Paul Virno, all interestingly, from the Italian school. The second stream tackles studies of science and technology (STS), bioeconomy, medical research, health-care and the like. "Questions of 'health', 'eating habits', welfare, the policy for use of medical products, evaluation programmes in schools, and new scientific programmes for converting living organisms into artificial beings of technological innovation, are some of the issues being addressed in these approaches" (Carnera 2012, p. 69). In this strand, prominent scholars would include Melinda Cooper, Nikolas Rose, Stefan Helmreich, and Lars Thorup Larsen.

Kean Birch places himself firmly within the second category but with a definite tilt towards the former in his essay on *The problem of biopolitics: biopolitics, bio-economy and the political economy of nothing*. As noted in the editorial, Birch does a convincing job of critiquing ways some STS scholars 'fetishize' a great range of bio-concepts that he believes significantly diverge from Foucault's initial biopolitics conception of the relationships between capitalism, population and government. He argues for 'unpacking' bio-concepts circulating or constituting the bioeconomy like *biovalue*, *bioknowledge*, *bio-labour biocapital*, *biowealth* and *biocitizenship*. For him, the bio-economy—his preference is for a hypen which is not explained—describes the relationship between capitalism and the life sciences, especially medical biosciences and biotechnologies although he acknowledges that more recently it has broadened to incorporate areas like biofuels and bioplastics. The bioconcepts, for Birch, argues that "life has become a phenomena open to problematization, reinterpretation and reconfiguration as a result of modern bioscience and, in the specific context of the bio-economy, modern capitalism." Birch probes these notions by critically appraising the 2014 Melinda Cooper and Catherine Waldby book *Clinical Labor*. He believes that the focus on the 'biological' or 'material' to the detriment of the political-economic is only telling half the bioeconomy story. He argues that STS scholarship like that of Cooper and Waldby's (2014), conceptualises value as intrinsic to the commodified biological products, services, or intellectual property (IP). By contrast, Birch believes value is constituted primarily by the social practices of the political-economic actors who configure the financial value (also Birch and Tyfield 2013).

In responding to Birch's paper, then, I have taken on his position regarding the political-economic actors, knowledges, and practices involved in the creation and management of value, and look further into these factors implicated in the bioeconomy. Narrowing down the scope, I focus on the relentless drive for innovation as the processes of development, adoption and diffusion of new technoscientific knowledge purportedly critical for economic growth. This drive results from the decline in economic dynamism and profitability of the 1960s consequent to a range of factors, and the ensuring global turbulence, which animated the moves to deregulation, marketisation, privatisation and competition we have come to know as neoliberalism. Where once wealth creation in the Global North was related to resources and industrial processes within the welfare state, it is now built upon the ever-renewing knowledges necessary to efficiently innovate, produce and market products and services. This interplay between rapid technoscientific innovation and neoliberal economic practices creates the inevitability of stressing and entrenching scientific and technological innovation as the *only* mechanisms of contemporary knowledge and wealth creation. A distinguishing mark of these times of fast capitalism, argues James Paul Gee, Glynda Hull and Colin Lankshear (1996, p. 46), is "the capacity to create new knowledge and apply it rapidly" at ever increasing rates.

My particular focus is the recent assemblage of strategies, documents, entities, and actors flourishing in the Australian innovation policy space. For Sinclair Davidson and Jason Potts (2016), modern innovation policy, usually a reconstructed form of what was previously called 'industry' policy, seeks to harness science, technology and business to develop high-technology industries and other technology-centred drivers of growth. This of course, includes what has become known as the bioeconomy. Science education has been slow to engage with policy discourses like innovation even as they hold clear implications for how it is constructed and performed. Nevertheless, several of the innovation strategies and documents reviewed below directly proclaim and circulate their vision of science education. Moreover, Robert Sinnerbrink's (2005, p. 240) view of biopolitics as the "management of biological life as a resource, and the administration of human populations as the objects of social and political power relations" is evident in the ways these entities envision science students to be managed as resources for economic growth.

So I formulate my narrative of the recent Australian innovation policy space, mapping the terrain in the usual terms expected of a literature review, that is, by sampling from a range of relevant primary and secondary sources. This approach is consistent with Haggerson's (1991) view of critical philosophical inquiry which, in focusing on "written texts (as) texts of thoughts and actions" (p. 54), attempts to give meaning and enhance understanding of activities or institutions, bringing their "norms of governance to consciousness," and "finding criteria" by which to make judgements. Unfortunately, the requirements of constructing a coherent essay form necessarily elides the complexities, entanglements and webs of policy bureaucracy. Davidson and Potts (2016) remind us that innovation policy is really a suite of policies, ranging across different government departments and operating through networks of various actants. As such, it is messy, convoluted, repetitious, duplicative, and sometimes contradictory where intra-entity rivalries exist as does competition for resources, silo mentalities, empire building and self serving work practices. These characteristics, which are as much the part of a policy space as is its formalised content, remain opaque when the focus is on, as it is here, textual interpretation and analysis.

In the sections below, I provide a brief overview of National Innovation Systems (NIS) before considering the Australia's NIS, the *National Innovation and Science Agenda* released in late 2015. This requires a review of a number of allied entities, agencies and documents, whose navigation I facilitate by italising their first use and thereafter employing the usual font. I move on to examine the policy space that generates Australia's bioeconomy. Comments pertinent to science education are included where apposite. It is worth noting that Birch identifies as an interdisciplinary social scientist not a science educator. Within his essay, he only mentions science education a few times, typically making aspirational summative statements. I have some sympathy with this position, challenging as it is to curate a worthy discussion on complex concepts like the bioeconomy before teasing out the relevance to science education, all within the limits of one journal paper. I know I suffer the same constraints here.

I begin here, with a relevant snapshot of Australia that sets the context for the ensuring discussion.

A view of Australia

As the world's sixth largest country by area and a relatively small population of 24 million clinging to its eastern and south western seaboards, Australia is marked by vast distances and isolation. It is the world's oldest continent with a uniquely endemic biota that's makes it one of the most biodiverse regions on the planet. Its landscape is water scarce, resource rich and geologically fragile. Like other White settler societies, Australia's exploitation of its natural resources and agricultural potential has financed an affluent standard of living that sees it ranked second-highest on the global human development index for life expectancy, education, and income per capita. It has a well developed education system and research sector such that Australia contributes, for example on 2012 figures, 3.6 per cent of the world's biomedical research publications from just 0.3 per cent of the world's population placing it 9th in the *Organisation for Economic Co-operation and Development (OECD)* (Ferris 2016). Biomedical research, telecommunications, geosciences and mining engineering, and astronomy have been particular strengths prompted in part by Australia's isolation and need for self reliance, as well as its unique biodiversity and geoscape.

Australia is now very much the 'quarry economy' with its exports overwhelmingly dominated by iron ore and coal. It is also soon to be the world's largest natural gas exporter. Australia's isolation and rigid approach to biosecurity alongside clean air, soil and water, pioneering organic farming practices, and strong food regulation standards provide keenly sought high quality agricultural products. For Alan Fenna (2016), this reliance on commodities has a number of drawbacks which includes exposure to the short term fluctuations of the commodity cycle. As is the way with globalisation, transnational resource companies cream off economic rents that don't always advantage Australians as the resources' owners. Consequently, Australia perennially debates questions of reliance on commodities and the imperative to develop a more vigorous manufacturing and knowledge services sectors. Innovation and science unsurprisingly, have become the recent catchcry.

Public sector science in Australia, like innovation policy, is really a suite of policies and agencies, ranging across different government departments and also operating through networks of various actants. For example, Australia's premier science agency, the *Commonwealth Scientific and Industrial Research Organisation (CSIRO)*, as well as the *Australian Institute of Marine Science (AIMS)*, the *Australian Nuclear Science and Technology Organisation (ANSTO)*, and *Geoscience Australia* are housed within the *Department for Industry, Innovation and Science* while the *Bureau of Meteorology* and the *Australian Antarctic Division* are situated in the *Department of the Environment and Energy*. At the same time, the *Australian Centre for International Agricultural Research* is located in the *Department of Agriculture and Water Resources*, and defence science research agencies belong to the *Department of Defence*. And this only scratches the surface! Moreover, many of these agencies are keen to weigh in on science education with curricula advice, resource support, and lesson plans amongst other measures.

Undoubtedly, the very existence, as well as the location, of these agencies is both highly political and historic. Reflecting their ideological and economic priorities, successive governments carve up, realign, create, dissolve, and resurrect entities making for a complex and fluctuating array of content that those interested in Australian science and science education policy find difficult to navigate. Even science's place within government seems highly fluid. Where science was once its own minor department during the 1980s, technology was added in the 1990s. In the early 2000s, science became partnered with education and incorporated into the cabinet (major departments). A change of government saw science become part of an innovation, industry, science and research grouping, only to disappear completely along with innovation in the early 2010s. Most recently, with our current government keen to promote a future jobs agenda through a thriving technology sector, science has been reinstated as part of the Department for Industry, Innovation and Science.

Before exploring Australia's innovation agenda it is worth reviewing the general characteristics of NISs as they have developed over the past few decades.

National Innovation Systems and the case of Australia

Frédéric Claisse and Pierre Delvenne (2016) describe 1980s origins of a National Innovation Strategy (NIS) approach to economic development with the work of British science policy scholar Christopher Freeman in partnership with the OECD. Also known as the National System of Innovation (NSI), Freeman (1995) though, attests to a longer lineage back to the 1840s when industrialising Prussia was looking to marshal science and technological innovation for competitive advantage. Science and the economy have had a long history of entanglement. Claisse and Delvenne (2016) utilise Charles Edquist and Bengt-Åke Lundvall's (1993, p. 12) definition of NIS as that which "denotes the wide ambition of the approach: 'The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in society'." In other words, the concept of NIS aims to align and coalesce all the important economic, social, political organisational determinants for the production, diffusion and exploitation of knowledge within national borders. This would include the interactive system of existing institutions technical and scientific, private and public firms (either large or small), research universities and other aspects of national education systems, government agencies and their policy arms, industrial relations, cultural traditions, geographical resources bases, and other influential factors. For Davidson and Potts (2016), NISs are largely based on neoclassical welfare economics in which the diagnosis of market failure in the production of new information is translated into a case for innovation policy.

While national in focus, NISs also operate at supranational and subnational levels in complex and entangled ways. Global capitalism participation ensures that NISs have moved beyond OECD countries to the rest of the world where "the narrative is reified rather than questioned regarding its adequacy to other contexts … 'a sort of gospel that nobody questions anymore'" (Claisse and Delvenne 2016, p. 11). Transnational corporations, regional agreements like *European Union (EU)* and the *Association of Southeast Asian Nations (ASEAN)*, trade agreements like the *World Trade Organization (WTO)*, *Asia–Pacific Economic Cooperation (APEC)* and *Trans-Pacific Partnership (TPP)* all to which Australia belongs, and other supranational economic entities like the *International Monetary Fund (IMF)*, the OECD and so forth, contextualise and impact NISs.

Some global situations though, work outside NISs like the provision of global public goods (food security, health threats, climate change, and energy security) that can only be tackled cooperatively between nation states. Another example is 'Big Science' where large-scale infrastructure for advancing research requires strong international funding and resources partnerships. At best, argues Robert Kaiser and Heiko Prange (2004), NISs are a mosaic of sectoral systems and networks with an imposed national boundary that is "leaky" and can't contain innovation dynamics. They proffer a multi-level governance approach to take more seriously globalisation's impact. At the other end of the scale, the literature also documents many well known examples of regional innovation such as Silicon Valley in the United States and Shenzhen in China (Edquist 2005).

Nevertheless, for Freeman (1995) and Edquist (2005), competitive advantage still lies with nation states as it is at that scale power can often be effectively mobilised and local geographical material conditions become prominent. A good example of such national determinants would be Australia's outperformance of most other nations in the wake of the 2008 global financial crisis, due largely to a combination of its traditional and strong financial regulatory regime, monetary and fiscal policy, a resources boom and some government stimulus packages. Freeman (1995) goes onto argue that, though hard to quantify, differences in national economic structures, public policies, values, cultures, institutions and histories contribute profoundly to differences in NISs. NIS emphases thus vary from those like Poland's *National Cohesion Strategy* that seeks to enhance social cohesion while boosting economic growth, to countries like Denmark, Korea and Germany that aim to 'green' their NISs placing environmental issues, climate change and energy high on the agenda. Even so, nation states perform a complex dance between competiveness and cooperation, independence and compliance as they negotiate their places as players in intensified global economies.

Australia's National Innovation and Science Agenda

It is within this broader context that Australia's newly installed Prime Minister at the time, Malcolm Turnbull, saw a type of salvation alongside so many other nations in the development of its own NIS. In late 2015, he launched Australia's *National Innovation and Science Agenda (NISA)* that perhaps a little pejoratively quickly became known as the 'ideas boom.' In the related media coverage, Turnbull argued Australia's need to become 'nimble and agile' in the global economy given that its translation and commercialisation record is less impressive than its research output and knowledge creation. Australia's overall investment in research and development (R&D) as a percentage of its Gross Domestic Product ranks 15th out of 33 OECD countries. It ranks last within the same grouping for business-academia collaboration, and has slipped from 17th to 19th in the 2016 Global Innovation Index. Moreover, only 9% of Australian small and medium-sized enterprises brought a new idea to market in 2012–2013 compared to 19% in the top 5 OECD countries (Australian Government 2015). There are of course, notable exceptions and some of Australia's well known commercial innovations include in biomedical research, the pacemaker and bionic ear while in electronics, telecommunications and information technology arenas we see the flight black box recorder, wifi and even google maps.

As with most NISs, the aim of the NISA is to stimulate economic growth in the crucial sectors of science, technology, and business with a range of government initiatives worth $1.1 billion over 4 years (NISA 2015). In particular, it seeks to address the four key issues (known as 'pillars') firstly, of culture and capital, secondly, collaboration, followed by talent and skills, and finally, the 'Government as an exemplar.' The first pillar believes there to be insufficient access to early stage capital for start-ups/entrepreneurs and thus introduces tax incentives for innovation, some changes to bankruptcy laws and allocates money to public science. It establishes a new *CSIRO Innovation Fund* and the *Biomedical Translation Fund (BTF)* to support the commercialisation of nascent innovations from the CSIRO, Australian universities and other publicly funded research bodies, as well as to co-invest with the private sector in spin-offs from public-sector research The second pillar responds to Australia's apparent low level of industry research collaboration with the development of incubators and accelerators including five positioned overseas. The third pillar, talent and skills, argues the need for increasing STEM participation. This pillar is the one most readily relatable to education as it aims to encourage more Australian students to study science, mathematics, and computing beginning with the early years right through to university. It also seeks to attract entrepreneurial and research talent to Australia through selective and streamlined immigration, and further strengthen the talent pool by increasing opportunities for women. The final pillar responds to government following, not leading on innovation ("Government as exemplar") and is thus mostly a procurement policy that can be categorised as targeted public spending.

In terms of education, the NISA website claims to be providing $51 million over 4 years for initiatives at the primary and secondary school level. The clear focus is on digital literacy with grants and support programmes both within and out of school hours like the 'Cracking the Code' event for Years 4–12, national online computing challenges, and ICT professionals in the classroom. The second focus in on early years learning with the development of new play-based STEM apps for preschool children and support for parents to develop their children's maths skills by noticing, exploring and talking about numbers, counting, measurement and patterns in their daily lives.

Interestingly, although there is a government department for Industry, Innovation and Science (already noted above) whose website describes their mission as enabling "growth and productivity for globally competitive industries … (through) … supporting science and commercialisation," it is not the department responsible for developing the NISA. Rather the *Department of the Prime Minister and Cabinet* (*PM & C)* whose role is to provide "fresh thinking and creative advice" to the Prime Minister by coordinating government-wide policy, produced the NISA as a critical plank in its *A More Innovative and Agile Australia* policy agenda. The advantage of the NISA coming from the PM & C is not only greater visibility and patronage, but more access to other cross department and extramural government resources. Positioning in the PM & C exemplifies what the NIS literature argues as critical in aligning, coalescing and engaging all the important economic, social, political, organisational determinants for the production, diffusion and exploitation of knowledge. As expected, the NISA identifies the *Department of Education and Training* as well as the Department for Industry, Innovation and Science as strong contributors to its inception. Within the latter, much of the implementation heavy lifting is being carried by the CSIRO and the Office of the Chief Scientist.

All in all, there are 24 measures in the NISA aimed at propelling the nation's innovation performance forward. With the prioritising of all things digital and cyber, these include agencies like *Data61*, a data innovation group operational through the CSIRO to facilitate new technology-based industries and transform existing ones (Barrett 2016). Similarly, there is a new *Digital Transformation Office*, *a Digital Market Place*, a focus on quantum computing and targeted measures for increasing digital literacy in schools and the community.

Two initiatives of particular interest here is the establishment of *Innovation and Science Australia (ISA)*, an independent body responsible for researching, planning, and advising the government on all science, research and innovation matters, and the *National Collaborative Research Infrastructure Strategy (NCRIS)* tasked with driving "research excellence and collaboration between researchers, government and industry to deliver practical outcomes" (NCRIS website). To facilitate ISA's role, a *National Science Statement (NSS)* has been produced while the NCRIS will be informed in part by the *2016*

National Research Infrastructure Roadmap aimed at identifying Australia's national research infrastructure priority areas for the coming decade.

Innovation and Science Australia, the National Science Statement and the National Research Infrastructure Roadmap

Housed within the Department of Industry, Innovation and Science and with the Chief Scientist as its Deputy Chair, ISA's website describes its key job as conducting a to date performance audit of Australia's innovation and science system as a precursor to developing a long term strategic plan for innovation. The 2030 Strategic Plan due at the end of 2017, will envision the future innovation, science and research system and make recommendations to better target the government's current $11b annual investment. It will also suggest improvements to business, academia, and the broader community aimed at facilitating the achievement of the NISA pillars. One of the feeder documents for the 2030 Strategic Plan is the recently released NSS. According to its website, the NSS signals science as part of "the core mission of government", sets out "the government's enduring science objectives", and develops an "explicit framework," where previously there wasn't one, to "bring our collective strengths together and to guide investment and decision making in the longer term."

The NSS describes four objectives summarised here as firstly, engaging all Australians with science, secondly, building our scientific capability and skills, thirdly, producing new research, knowledge and technologies, and finally, improving and enriching Australians' lives through science and research. Perhaps a little self evidently, science education is explicitly mentioned within the first two as follows, and is arguable important for the latter ones:

> Science and mathematics education are interesting, relatable and valued by parents and teachers, supporting high levels of participation and appreciation at all levels of education.
> Science education is high-quality and work-relevant at all levels of education.

In a clear STEM pipeline economic agenda, it goes on to note that:

> The government will take a long-term strategic view of skills and talent, ensuring that the Australian education system provides the broad base of STEM skills required for the workforce of the future, while also maintaining the high quality of our cutting-edge skills. This means a strong focus on matching skills taught at all levels of education with those needed by employers. (NSS website)

The NSS sees yet another entity, the *National STEM School Education Strategy 2016–2026*, as a key actor implementing its education perspective. Produced by the *Education Council*, the National STEM School Education Strategy 2016–2026 was released at the same time as the NISA although neither strategy mentions the other. The Education Council as part of *the Council of Australian Governments (COAG)*, is an intergovernmental body involving all Australian federal and state governments. Without attached funding and with a large aspirational agenda, the STEM strategy goals are to "ensure all students finish school with strong foundational knowledge in STEM and related skills' and "that students are inspired to take on more challenging STEM subjects." This is to be achieved through "increasing student STEM ability, engagement, participation and aspiration, increasing teacher capacity and STEM teaching quality, supporting STEM education opportunities within school systems, facilitating effective partnerships with tertiary education providers, business and industry, building a strong evidence base." Sadly, there is nothing new here with these twin, and often antithetical goals, having been part of the science education landscape since its inception. Interestingly, the groups producing the STEM education strategy countered politicians, industry members and teachers amongst its number but no science education researchers or scholars.

The statement goes on to list the national science and research priority areas as health, food, soil and water, environmental change, cybersecurity, transport, energy, resources, and advanced manufacturing. It is an unsurprising list given Australia's unique and traditional history and interests. While it utilises the same high knowledge creation/low translation and commericalisation arguments for improvement outlined above, it simultaneously acknowledges Australia's already very strong performance against these objectives.

In somewhat of a departure from like documents, the NSS attempts to make some sense of the busy and messy science policy arena. Calling the space "hybrid" and recognising that the "science system is complex," it explains that the "responsibility for some (science) elements is distributed across government and located where it is most relevant" advocating for a "holistic view." Thus "maintaining strategic direction requires good coordination … through whole-of-government bodies for advice on specific issues, and strategic policy and governance arrangements for individual agencies." (NSS website). The statement makes mention of many of these bodies and entities. In no particular order, and already discussed above are the 2030 Strategic Plan, the NISA, the ISA, the BTF, the NCRIS, the Performance Review of the Australian Innovation, and 2016 National Research Infrastructure Roadmap. Others mentioned but not noted here so far include the *Australian Medical Research and Innovation Strategy 2016–2021*, the *National Science and Technology Centre*, the *National Computational Infrastructure*, the *Integrated Marine Observing System*, the *Medical Research Future Fund*, and the *Commonwealth Science Council*. When these agencies, entities and documents are allied with the others located in Department for Industry, Innovation and Science like the Office of the Chief Scientist, the CSIRO, the Australian Institute of Marine Science, the Australian Nuclear Science and Technology Organisation, and Geoscience Australia, it makes for complex array of content any actors interested in Australian science policy and its implications for science education find hard to digest. Faced with such a mélange, it is not surprising that science education scholarship in the policy space is scant.

Adding another layer of complexity is the recently released draft 2016 National Research Infrastructure Roadmap developed by the Chief Scientist and aimed at supporting future investment decisions in research infrastructure. Interestingly, this one can be found within the Department of Education and Training. The Roadmap identifies nine focus areas which will "address future needs, fulfil our national interests and build on our existing national capabilities"—they are digital data and e-research platforms, advanced fabrication and manufacturing, astronomy and advanced physics, environmental systems, biosecurity, complex biology, therapeutic development, platforms for the humanities, arts and social sciences, and characterisation. Not a well-known term, characterisation includes microscopy, spectroscopy and other materials science mechanisms the Roadmap suggests are essential for new materials and biological processes research for blue sky commercialisation, as well as new and potentially disruptive technologies. In an attempt at some coherence, the Roadmap tells us that these areas are aligned with the *National Science and Research Priorities* described in the NSS and *Industry Growth Centres* of advanced manufacturing; cyber security; food and agribusiness; medical technologies and pharmaceuticals; mining equipment, technology and services; and oil, gas and energy resources.

Clearly, “good coordination” will certainly be vital here. I will take up aspects of the Roadmap again when considering Australia’s bioeconomy.

Overview

It’s early days for any analytical scholarship of the NISA, ISA, NSS and Infrastructure Roadmap from political scientists, cultural theorists, economists, policy scholars and others given their neoteric nature. Clearly, the pillars and measures of the NISA presume Australia’s innovation performance (or perceived lack there of) is as a consequence of previously unresponsive and ineffective government entitles and policies, lack of support for startups, insufficient focus on STEM/education (particularly for women), and a lack of encouragement for collaboration, especially between industry and universities. Economists Davidson and Potts (2016) argue that in many ways the NSIA simply re-imagines extant government policy as innovation policy. Given that NISA was announced only a couple of months after Turnbull became Prime Minister, largely repackaging policy within a deficit and decline narrative while aiming towards a promissory future is perhaps not a surprise. This is also true of the National STEM School Education Strategy 2016–2026. The rhetorical devices liberally sprinkled throughout the policies enable us to apprehend a sense of the present, that is, doing something in the innovation space, even if the policy objectives may never actually eventuate as a consequence of the policy itself. Davidson and Potts (2016, p. 205) further argue that the NISA:

> does nothing to address any of the innovation challenges Australia faces, as identified by Dodgson et al. (2011, p. 145) as being:… a lack of clarity and tensions between education, science and industry policy; the unclear roles of the State governments in a Federal system; and structural impediments to innovation, such as a predominance of small firms in the industrial structure and a high reliance on overseas multinational companies in high-tech sectors…

Moreover, Harry Bloch and Mita Bhattacharya (2016) suggest that the NISA concentrates too much on increasing the level of activity and far too little on ensuring that the activity is successful. Also with an economists’ perspective, Bloch and Bhattacharya (2016), remind us that not all good ideas have a commercial spin-off and that overly privileging untested start-ups and previously failed entrepreneurs can lead to much wastage of precious resources.

In a satirical review, Liam Mcloughlin (2016) believes Turnbull’s strategy and allied documents has redefined the meaning of innovation as clinging to the past and recycling old programs, taking money from vital things to fund other vital things, and reinstating what had been previously been cut. Mcloughlin (2016) points out that in the ‘business as usual only more of it approach,’ there is an erasure of the environmental and social damage consequent to neoliberal hypercapitalism. Real innovation for him would see the development of a low carbon future, ecological sustainability and a fair redistribution of public and private goods.

Similarly, international relations scholar Karin von Strokirch’s description of the Australian government’s waning climate change position is a clear signal of ‘the science is important but only if it suits us’ thinking. von Strokirch (2016) describes Turnbull’s unwillingness to reverse Prime Minister Tony Abbott’s (2013–2015) damaging climate change agenda. From a previously strong stance under the Prime Ministers’ Rudd and Gillard (2007–2013), Abbott a well known climate change sceptic, closed the *Department of Climate Change*, and slashed funds to the CSIRO, Bureau of Meteorology and *Climate*

Change Authority which are world leaders in climate science. For von Strokirch (2016, p. 23), Abbott was motivated by "cynical wedge politics, a traditional 'quarry' view of prosperity, and narrow conceptions of national interest privileging a powerful section of corporate Australia, namely the fossil fuel industry." With the 2015 rise of the climate change believing Turnbull, little has changed. von Strokirch (2016) argues there is a yawning gap between Turnbull's rhetoric and the reality for Australian scientists as in 2016, the "CSIRO incurred another swathe of threatened cuts of up to 350 staff; many vital to monitoring climate in Australia's oceans, atmosphere and Antarctica" (p. 29). Thus despite Turnbull and the NISA's rhetoric about moving Australia into innovative industries, continued subsidies on coal, scant support for renewables and other questionable actions reveal that the vagaries of political survival migrate against progressive and visionary agendas.

Australia's bioeconomy

Despite Australia's crowded science and innovation policy space, it does not have a dedicated bioeconomy strategy policy or framework (Staffas, Gustavsson and McCormick 2013). Nevertheless, the Australian government has provided political direction and support in several areas related to bioeconomy and described a number of future research priorities. On the Department of Industry, Innovation and Science website, the bioeconomy definition as "the emerging concept of sustainable production and conversion of biomass (organic matter) for a range of food, health, fibre, and other industrial products as well as energy," is not dissimilar to the OECD's 2009 *The Bioeconomy to 2030: Designing a Policy Agenda*. In a 2013 review of the EU and 6 other countries including Australia's approaches to the bioeconomy, Louise Staffas, Mathias Gustavsson and Kes McCormick found quite disparate views in scope and direction. They saw some governments as believing the biosciences were the basis of the bioeconomy with a strong focus on biotechnology application in the health sector, while others privileged primary industries as the 'traditional' bioeconomy. In this instance, bioeconomy is thus defined as encompassing agriculture, forestry and the marine economy for new biomass value chains. A third grouping was seen to concentrate on emerging industries and high-tech development. Given the Department of Industry, Innovation and Science's definition, Australia's bioeconomy seems firmly placed within Staffas, Gustavsson and McCormick's (2013) traditional primary industry cluster. Additionly, in the 2015 report *Bioeconomy Policy (Part II): Synopsis of National Strategies around the World*, Christin Fund, Beate El-Chichakli, Christian Patermann and Patrick Dieckhoff found that Australia's approach as one of the 45 countries described in detail, could best be characterised as R&D aimed at fostering research capacities in the biosciences and biotechnology.

The government agro-biotechnology priorities integrating key topics of the bioeconomy, such as bioenergy/biofuels, ecosystem monitoring and management, food and health are clearly also a suite of policies, entities and strategies across a range of departments that include, in addition to Industry, Innovation and Science, the Department of Agriculture and Water Resources, Department of the Environment and Energy and the *Department of Health*. One area given prominence under the auspices of the afore unmentioned *Rural Industries Research and Development Corporation (RIRDC)* housed in the Department of Agriculture and Water Resources, is the bioenergy and bioproducts industries that seek to develop biomass value chains and biorefineries from tropical (sugar cane) and temperate (forest and crop residues) biomass. The RIRDC in one of a number of *Rural Research and Development Corporations (RDCs)*—the *Cotton Research and Development Corporation*, the *Grain Research and Development Corporation*, and the *Fisheries Research and Development Corporation*—all with similar agendas. For its part, the Department of Industry, Innovation and Science shepherds Australia's participation in the *International Knowledge Based Bio-Economy (KBBE)*, a collaborative policy/research initiative between the European Commission, Australia, Canada and New Zealand. In the key areas of biotechnologies for biorefineries and biobased materials; food and health; fisheries and aquaculture; and sustainable agriculture, the KBBE forum aims to "share knowledge on policy strategies and actions, and create new knowledge to address the societal challenges related to the bioeconomy. It also fosters collaboration and joint activities between participating countries to promote innovation in the bioeconomy sectors." Again we see the complex dance between global competiveness and cooperation that can turn nationally based systems into open arrangements with multi-level governance (Kaiser and Prange 2004).

Several of the nine areas of the 2016 National Research Infrastructure Roadmap are closely aligned with the bioeconomy although the term itself is not used. Instead we see biobased industries, synthetic biology, bioengineering, biologics, bioinformatics, biomolecular, and omics amongst others. This is reminiscent of Birch's bioconcepts surrounding and circulating the bioeconomy. Two areas are particularly relevant:

> Complex Biology – Global advances in medical, agricultural and environmental research are increasingly enabled by biomolecular research capabilities. While Australia has robust scientific infrastructure across the four technology platforms – genomics, proteomics, metabolomics and bioinformatics – efficiencies of scale and increased opportunities for interdisciplinary research by grouping or networking existing life sciences facilities will ensure Australia continues as a world leader in human, agricultural and environmental genetics
> Therapeutic Development – The translation of novel molecular candidates into ready-for-market therapies is a current and future national priority. (p. 8).

The Roadmap describes the types of infrastructure, institutional capacity, processes and practices required to progress the agendas which in the case of Therapeutic Development, includes clinical trials, expanded biobanks, new and better high-tech production facilities, and linking data. Biopolitics is clearly at work in the desire to "build soft infrastructure in the health care system so that every patient admission is viewed as a research event. De-identified data from all patient admissions should ideally be available for research and policy making" (p. 63).

Interestingly, and unlike so many of the entities already discussed, the Roadmap says nothing about education other than its need to be supported by high quality electronic infrastructure and on the job training, even though it was developed through the Department of Education and Training. Some national bioeconomy frameworks like Scotland and Germany specifically address science education at all levels as part of securing appropriate future skills. On a different but equally important point, is Staffas, Gustavsson and McCormick's (2013) critique the exhortatory tone of earlier Australian bioeconomy strategies/documents as having failed to account for limitations such as resources availability (for example, water) and potential conflicts between industries over inputs. This is also true of the Roadmap.

In summary then, given Australia's particular characteristics and challenges of isolation, unique biota, water scarcity, climate impacts on a fragile environment, clean agriculture and advanced research infrastructure described earlier, it is not surprising that biofuels, biosecurity for protecting biodiversity, agri-biotechnlogy and various omics sit at the forefront of Australia's bioeconomy. This is apparent even in the absence of a formalised policy. This is also reflective of differences in national economic structures, public policies, values, cultures, institutions and histories Freeman (1995) and Edquist and Lundvall (1993) argue contribute profoundly to differences in NISs.

Finishing here is really just a beginning

In this paper, I have positioned myself with Kean Birch and explored some of the political-economic actors/actants of policy suites implicated in the biotechnologies and bioeconomy. In particular, I have considered Australia's recent National Innovation and Science Agenda and allied documents and entities (that is, Innovation and Science Australia, the National Science Statement and the 2016 National Research Infrastructure Roadmap) as one of the National Innovation Strategies in place now in OECD countries and beyond. In overview, these policy suites utilise the same high knowledge creation/low translation and commericalisation arguments as elsewhere to press for particular ideologically based 'improvements' to public science. Reviewing Australia's position enables the type of comparative work that contributes to a closer understanding of the largely neoliberal global economic imperatives shaping contemporaneity.

Mapping the terrain of these entities has revealed the innovation, biotechnology and bioeconomy policy space to be inordinately complex and challenging to navigate. It is not surprising that many science teachers/educators don't bother to grapple with their implications. Regrettably, there is not the space here to explore the construction/production/circulation of science education through such policy in any more detail than has been attempted already. But this is a worthy undertaking for a future investigation. What is missing in the science education literature are empirical studies where STEM is mapped back to the policy settings that help produce common and marketable visions at the same time they foreclose other science education possibilities that might for example, promote social and eco-justice. There is definite work to be done.

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Lyn Carter work seeks new articulations of science education valuing cultural diversity, ecological sustainability and social justice in a globalised world. Her many published journal articles and book chapters emphasises consequences the for science education of globalisation and neoliberalism, and the ways in which postcolonialism and ecological sustainability can act as counter discourses.