Rethinking Public Support of Science and Innovation in the National Interest

An Innovation Architecture Approach

Submission to the Productivity Commission on the issue of public support for science and innovation in Australia

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Submission Structure

This submission is divided into the following sections:

Section 1 presents a series of current and emerging trends in the global economy and Australia's competitive position. We consider that these trends lead to an urgent need to rethink policy in light of the massive innovation-driven changes in the global economy.

Section 2 presents recent thinking around the processes of innovation which give rise to the need for new approaches by Government.

Section 3 presents a selective snapshot drawn from around the world surveying innovative policy responses of other countries.

Section 4 presents some tentative suggestions for a way forward for Australia in terms of public support for innovation.

Section 05 presents our conclusions.

1 The Pre-eminence of Innovation – Global and National Drivers

The world is undergoing rapid change across the fields of economy, society and technology.

Countries are in intense competition to attract investment, skills, knowledge, technology and other resources. Australia is part of this transformation process but can and needs to do better.

While history is characterised by continuous change, we consider that the current recent period of change is unique in size, nature and scope and that some changes – and their associated drivers of change – are very significant, if not 'seismic'.

While innovation has been important for economic development historically, we argue that the current period is unprecedented in terms of the intensity, speed and scale of the development and diffusion of knowledge and technologies. This is especially the case in the convergence between, and within, technologies.

Further, a number of challenges are confronting nations around the world, including in the environmental and security arenas, the ageing of populations, disease management and eradication. The solution to these problems lies in new thinking, innovation and collaboration, especially on a global basis.

In particular, we consider that some of the major shifts stem from the increasing importance of innovation and include:

- The rapid growth and emergence of Asia and the developing world in general
- Explosive growth and potential of frontier / converging / platform technologies
- Internationalisation of R&D, science, technology and innovation more broadly
- Many problems are increasingly been seen as global in nature requiring a coordinated approach and
- The rise of new forms of corporations, driven by knowledge acquisition and management.

1.1 Increasing importance of innovation

Innovation is widely recognised, empirically and theoretically, as the key factor underpinning growth, wealth creation and the improvement in global living standards.

The importance of innovation in the economy can be seen in a myriad of ways, not the least the growing knowledge and R&D intensity of economic activity, the growth in 'knowledge workers' and collaborative science and technology.

Radically new technologies that redefine entire industries - in relatively short periods of time - have been one of the defining features of this new global wave of innovation and economic development.

As an Australian author recently noted:

"At the end of the twentieth century Alan Greenspan Chairman of the US Federal Reserve, estimated that more than seventy percent of US growth in gross domestic product in the second half of the preceding century had been due to the exploitation of new technologies.

Attendant to the march of science, whole industries exist now that were scarcely even dreamed about a generation ago.

The internet, biotechnology and mobile telecommunications have created entirely new sectors of economic activity. International trade in industries that have high intensities of research and development is rapidly increasing. Such trade roughly doubled over the 1990's alone."[1]

The pre-eminence of innovation has also seen a reshaping of the way companies and nations compete.

While economic growth and competition was once largely driven by low-cost, natural resources, and the search for investment to fund the mass-production of relatively low-value added production and manufacturing, it is now increasingly based on knowledge and innovation, value adding, differentiation and the exploitation of 'niche' target markets. Advanced services, embodying high levels of complexity and knowledge, are also becoming key industries.

We consider that innovation, rather than any other factor and more than any other time in history, is now the key driver of competitiveness and the only sustainable form of long term competitive advantage for firms, industries and nations.

However, while Australia has done well in recent years on some counts – especially in terms of overall economic growth relative to the rest of the OECD – there are grounds to believe that we are falling behind in the race to become an innovation driven economy.

This is for various reasons, not least the fact that much of Australia's current growth is driven by industries we have a comparative advantage in due to our abundance of natural resources.

Strongest growth is currently being experienced by States with a comparative advantage in natural resources and / or a 'lifestyle' driven economy (for example Western Australia in the case of mining and Queensland which is being driven to a great extent by net interstate migration and tourism).

In contrast, states with a traditional reliance on manufacturing are experiencing challenging economic conditions.

In the future, Australian policy makers will need to devise policies which leverage the complementary advantages of Australian firms, the nation as a whole and which will ultimately driven by innovation.

This is means that innovation must become the key focus of attention across both business and government.

As a start, we consider that policy decisions need to be undertaken - and reviewed - in light of Australia's ability to be a world class innovation nation.

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[1] Barlow, T (2006), *The Australian Miracle: An Innovative Nation Revisited*. Pan Macmillan Australia Pty Ltd.

On a longer-term basis, our policy institutions and decision making architecture need to reflect the fact that innovation – more than any other factor - will play *the* critical role in Australia's future economic development.

1.2 Frontier / Converging / Platform Technologies

Various authors have noted that Australia faces a range of challenges when it comes to innovation.[2]

One challenge is utilising innovation and technology to bolster our industrial advantage and competitiveness in the sectors we now have.

A second challenge is developing new industries based on new and often quite radically different technologies and innovations.

Arguably, while both are important, Australia deals better with upgrading advantage in *existing* industries rather than developing *new* industries and technologies that represent significant growth and wealth creation opportunities.

In an environment of speed-to-market, short production cycles and intense technological change, we consider that first mover advantage and early adoption of cutting edge technologies is critical.

This strategy applies equally to firms, industries and nations.

In the current global economy, a range of technologies are seen as 'leading edge', 'frontier' or 'platform' technologies.

By 'leading edge', 'frontier' and 'platform' technologies, we mean those that are at the edge of current scientific and technological thinking.

These include biotechnology, nanotechnology and information and communication technologies. These technologies are characterised by their immense spillover benefits and convergence with both current and emerging technologies.

Australia is in danger of falling behind in being a key player in these platform / frontier / leading edge technologies.

We consider that Australia needs to focus on those areas that we are, or potentially can be, leading edge or have access to the world's best in areas where we cannot be at the frontier.

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[2] See for example Smith, K and West, J (2005) *Australia's Innovation Challenges: The Key Policy Issues* (2005). University of Tasmania. Submission to House of Representatives Standing Committee on Science and Innovation, Inquiry into Pathways to Technological Innovation. *(http://www.aph.gov.au/house/committee/scin/pathways/subs/sub18.pdf).* See also Balaguer, A., Bryant, K., Dalitz, R., Holmen, M., Jones, A.J., Matthews, J., and Scott-Kemmis, D (2003). Innovation Management and Policy Program Australian Innovation Systems Study (AUSIS) *Working Paper 5: Innovation Systems in Australia* National Graduate School of Management Australian National University Canberra, Australia. Innovation Systems in Australia Working Paper 5 of the Australian Innovation Systems Study. (http://ngsm.anu.edu.au/Research/_documents/WP5.pdf

As the Committee for Economic Development of Australia (CEDA) rightly pointed out in a 2004 study on innovation, these significant issues have not been adequately debated in the current public policy debate (see Figure 1).

This is ironic given the pre-eminence of innovation in the modern global economy and is in stark contrast to earlier discussions in Australia's history where these issues were considered of paramount importance. In previous policy debates, innovation and mastery of new technologies was clearly seen in the national interest.

Figure 1. Innovation, New Technologies and the National Interest

> "….one issue that figured prominently in past debates about industry development has been missing from more recent bipartisan deliberations. This is the benefits and costs of national participation in 'platform' or transfiguring industrial sectors.
>
> Earlier political deliberation, from Alfred Deakin to Chiefley, Curtin and Menzies, focused on the national interest as a key consideration. Themes included the creation of jobs that would encourage Australia's best and brightest to remain at home or, when they had left, to return; national independence; defence capabilities; and our attractiveness to talented migrants and to international companies. In the former electro-mechanical age, this involved sectors that offered access to the most modern production techniques or technologies (for examples cars, steel, oil and shipping)."

Source: CEDA (2004)

As a small player in the global economy, it is true that Australia cannot achieve mastery in all new technologies. We must decide, however, which technologies we wish to be a player in and focus our energies on those.

This can be done (if the example of our history or that of other similar or smaller size countries is anything to go by) but will require a new approach to economic development and innovation.

The alternative is that, at the very least, Australian industry may be forced to 'wait in line' for the latest advances in technology.

In a worst case scenario, Australia may be denied access altogether to these new innovations tomorrow if we allow other countries to take the lead today.

1.3 The emergence of Asia and the developing world

The emergence of Asia and various emerging economies around the world is a defining feature of the current age.

Innovation, facilitated by an increasingly borderless world, has propelled these economies through the value chain allowing them to produce goods and services that are increasingly complex and which they can trade with Australia in exchange for our (largely) raw materials and agricultural produce exports.

Although the world once marvelled at the rise of Japan and the Asian tigers (including countries such as Hong Kong, Taiwan, Singapore, and South Korea), China and India are now widely regarded as the new Asian powers.

The large pools of skilled workers and the rapid adoption *and* development of cutting edge technologies has seen India and China undergo a dramatic transformation in a relatively short period of time.

Importantly, other fast-growth emerging economies are also expected to become leading edge in the future.

For example, Brazil and Russia are becoming increasingly integrated into the global economy and, together with China and India, are expected to play a major role in global economic and political affairs.

Indeed, according to Goldman Sachs, a leading global investment bank, the four economies of Brazil, Russia, India and China (the so-called 'BRIC' economies), will account for an increasing share of global economic output and may overtake the G6 economies by 2040.[3]

Importantly, Asia's rapid development shows that fast growth - which is spurred by innovation - is not just the domain of the advanced industrialised economies.

In addition, the long-range and systematic planning of these countries shows that they are leaving little to chance, the market (in the sense of expecting market forces alone) or 'miracles' to drive their development.

Many Asian countries (and many other nations including Ireland, the Scandinavian countries, Israel etc) are aggressively and systematically pursuing innovation driven growth strategies.

They are also developing their own distinctive approaches which reflect their unique resources, capabilities, skills and aspirations.

The rapid development of some of these countries has led some commentators to describe their growth as 'leapfrogging', a process whereby these nations move through the various stages of economic development (for example from low-technology to high-technology manufacturing or from a largely agricultural based economy to one based on manufacturing and services) quicker than other countries (or that recorded in the past).[4]

We consider that leapfrogging – or rapid growth - can only occur through an innovation driven economic development strategy, a fact recognised by many developing countries.

An example of this perspective can be found in the Planning Commission of India's *India Vision 2020* document which states that:

"by 2020, the people of India will be more numerous, better educated, healthier and more prosperous than at any time in our long history."

The Indian Government aims to achieve this through a range of strategic actions, primarily those in the arenas of employment, education and embracing the development and use of new technologies and knowledge.

On the employment front, India aims to create more and better employment opportunities, including generating around 200 million additional jobs in the next two decades alone.

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[3] Wilson, D. and Purushothaman, R. (2003) *Dreaming With BRICs: The Path to 2050* Global Economics Paper No: 99.

[4] Many developing countries are aiming to 'leapfrog' in various industries. For example, China aims to leapfrog in strategic high-technology fields (see http://www.most.gov.cn/eng/programmes/programmes1.htm) while some consider that China and India could leapfrog many advanced economies within a decade and become global leaders in sustainable energy and agriculture (http://www.worldwatch.org/node/3893).

India also aims to boost its education quality and coverage from basic literacy to advanced science and technology.

Section 3 provides more detail on Indian initiatives.

China is also working to improve education, employment and its knowledge base in its push to become a leading innovator.

One of the interesting and innovative ways this is being achieved is through improving communication flows between Chinese graduates around the world while also seeking to attract overseas Chinese graduates back to China.

As the OECD has noted, many of these graduates are being invited specifically to specialist industrial parks dedicated to Chinese graduates (see Figure 2).

Figure 2. China's Industrial / Technology Parks

> "Chinese authorities have expanded communication channels between inland and overseas Chinese graduates, in an effort to strengthen the cooperation among different regions, government agencies and overseas Chinese graduates groups. Meanwhile, the construction of online information platform and database of overseas Chinese graduates has been accelerated. Overseas Chinese graduates enjoy, through widened communication channels, services in different forms and at different levels in rendering their contributions to homeland development.
>
> As shown by statistics, since the adoption of reform and opening policy, China has registered an overseas Chinese student population of more than 460,000, with 150,000 of them having returned home. At present, there are in the country more than 60 industrial parks dedicated to overseas Chinese graduates. These parks have housed nearly 4,000 businesses created by more than 10,000 returned overseas Chinese graduates."[5]

Source: OECD (2004)

1.4 Internationalisation of R&D and innovation

R&D, innovation, science and technology is increasingly global and footloose.

In line with the other shifts identified in this section of the report, knowledge is transferable around the world and firms seek knowledge and expertise globally.

According to the OECD, one in 6 inventions patented at the European Patent Office is owned (or co-owned) by parties outside of the country of invention and, in developed countries, foreign ownership is growing strongly.[6]

Many fear that Australia is good at inventions but bad at commercialisation and that many of our good ideas are commercialised overseas.

[5] OECD Science, Technology AND Industry Outlook, Country Response to Policy Questionnaire, p. 10 http://www.oecd.org/dataoecd/31/27/34241720.pdf

[6] Barlow, op. cit, p. 21.

Although this could be an issue, in his book *The Australian Miracle: An Innovative Nation Revisited,* Thomas Barlow notes that the problem Australia faces lies not so much in the extent of ownership of Australian inventions by foreigners but the lack of Australian ownership of foreign inventions. This limits Australia's to ability to leverage the ideas of the world.

We consider that there are three challenges in seeking to leverage the benefits of increasingly global R&D and innovation:

- Attracting the increasingly mobile factors of production (like R&D, labour and capital)
- Access to new ideas from around the world and
- Building and developing creative / innovative capacity at home that can add value to the flow of ideas from elsewhere.

We consider that all three challenges are critical and need to be addressed as a matter of priority. This is because international collaboration in the knowledge space - and links to those with ideas and concepts around the world - will be critical in the future.

This is especially the case as Australia, as a relatively small country in terms of population, is home to only a small share of the world's ideas and knowledge.

Another important aspect of the internationalisation of R&D and innovation is the offshoring of innovation itself.

One author recently finds that finds Asia's greatest attraction for innovation – its core competitive advantage – is its talent pool. [7] In higher education, for example, China graduates almost 4 times as many engineers as the US. US firms, amongst many others, are expanding overseas their investment in R&D and seeking to integrate Asia's new innovation systems into global networks of production, engineering, development and research-mobility.

Arguably, offshoring of innovation and R&D will be the next wave of globalisation and Australia must be prepared for it.

1.5 The rise of 'metanationals'

Closely allied to the global flow of ideas and knowledge is the role of the 'metanational' corporation. These firms are a new breed, operating beyond the nation state and seeking to bring together and exploit knowledge globally ('meta' is the Greek word for word beyond).[8]

These firms see innovation and technology as being scattered throughout the world and not residing in one country or even a set of countries. Other firms, research institutes, governments and other players in the market place are all potential source of innovation and advantage.

These firms specialise in identifying, accessing and integrating unique pockets of knowledge and excellence around the world.

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[7] Ernst, D (May 2006). *The offshoring of innovation.* Far Eastern Economic Review.

[8] Yves Doz, Jose Santos, and Peter Williamson (2001) *From Global to Metanational: How Companies Win in the Knowledge Economy*. Boston, MA: Harvard Business School Press

In order to attract these firms, Australia needs to have a compelling case that goes beyond a cost or natural resource advantage. This case can – and should be built on – our knowledge strengths including as an innovative country and an advanced industrialised economy with a skilled, diverse and educated workforce.

1.6 Increasing focus on global solutions and problems

Although modern technologies and innovation have helped to solve many problems, there are a range of challenges that are, arguably, unprecedented in their possible impact. These include climate change, ageing, the cost of health care and the threat of global disease.

The solution to these problems requires a coordinated global approach and smart and innovative thinking. There is a premium therefore on both innovation and collaboration.

We suggest that Australia needs to look at new technologies, solutions and new approaches to solving the challenges and maximising the opportunities that are emerging around the world.

2 Reconceptualising Innovation and Public Support for Innovation

There is an urgent need to develop and promote Australia's innovative capabilities.

The first part of this submission outlined the crucial need for this in the context of massive change in the economic landscape globally.

The second part focuses on the new approaches to the process of innovation in both a theoretical and practical sense.

2.1 Understanding Innovation

Traditionally, innovation has been thought of as linear process where a discovery phase (where an idea is found) is followed by a commercialisation phase where the idea is exploited by a business and then more broadly diffused.

However, research in the field of innovation studies suggests that the innovation process is anything but uniform and linear and can vary across industries, countries and other variables.

Collaboration and interdependencies play a key role as does the management of significant risk in the innovation process.

Smith and West (2005) describe the innovation capabilities of firms and the ideal characteristics of an environment conducive to innovation as follows:

'capability-based, cumulative, collaborative in character, and highly uncertain. So any successful innovating economy needs mechanisms and institutions to sustain investment over time in capabilities, to manage collaboration, and to cope with risk and uncertainty and their implications for business development.'

This view is consistent with new theories on economic development and innovation which suggest that:

- Technology is endogenous and exogenous
- Collaboration and capacity building is vital (in addition to competition)
- Location and proximity matter (for example in the capture of tacit knowledge and the development of clusters)
- There are increasing returns from innovation and knowledge ('knowledge creates knowledge') and
- Network externalities and spillover benefits are significant.

Figure 3 lists some key findings from recent thinking around innovation drivers, processes and capabilities.

Figure 3. Innovation Drivers, Processes and Capabilities

Key findings from innovation studies research includes:[9]

- Innovation is a *discontinuous* process involving *continuous* feedback between a range of economic actors
- Innovation is determined to a large degree by the 'strategic capabilities of firms' and their ability to identify and exploit opportunities. Long-range planning, risk sharing / management and foresight is critical in this process. However, firms differ markedly in these strategic capabilities
- R&D is not the only catalyst for innovation but part of the process, albeit a very significant one. A range of studies point to the extensive private and social returns from R&D
- Cooperation / collaboration is a key feature of innovation as firms draw on a wide range of knowledge 'pools' and skills sets
- Innovation processes operate in highly uncertain environments but where the payoffs can be significant. Risks are significant and must be managed, often in concert with other players
- Innovation is usually a process of gradual and cumulative effort but can result in disruptive technologies or other innovations
- Ideas can come from anywhere, including from customers and suppliers
- Technology is endogenous and exogenous
- Capacity building is vital in promoting a strong innovative environment
- Location / proximity matter and there is often a spatial dimension of innovation (for example in the case of tacit knowledge transfer, clusters and region-states)
- There are increasing returns from innovation and knowledge (knowledge creates knowledge) and
- Network externalities are significant.

Source: Adapted from Smith and West (2005)

It is important to also note that innovation processes – and the innovation system itself - are not static and can change in response to new factors, such as technology and market demand.

The implication for government policy is that it too must change. Recent work by the OECD in thinking about this issues is further discussed in Figure 4.

[9] Smith and West (2005)

Figure 4. New National Innovation Systems – The OECD Approach[10]

A recent report (*OECD Governance of Innovation Systems, Synthesis Report 2005*) notes that there are now greater linkages between economic development, innovation, technological change and various economic and social factors. Because of this, innovation policy is no longer just about science and technology institutions but more generic agendas requiring broader, cross ministerial attention. Accordingly, the OECD flags a 'beyond national systems of innovation' approach as previously understood to now reflect a broader perspective in which structural change and adaptability is fundamental.

The OECD notes that a "a more dynamic innovation policy appears to imply a need to broaden the focus from the original S&T platform to a more generic area in which a number of ministries participate. In this third generation of innovation policy, strategic actions are needed to induce a coherent policy framework for dynamic innovators and structural change." Hence, innovation is now recognised as not being about only technology but also including non-technology areas which bear on economic and social development. In addition, innovation is more than just narrowly based science and technology policies and programs but also includes innovation governance in a holistic sense. In particular, the OECD points to key role for governance which:

- Refers to a set of institutions and actors drawn from but also outside Government
- Identifies the blurring of boundaries and responsibilities for tackling social and economic issues
- Identifies power dependency involved in relationships between institutions involved in collective action
- Is about autonomous self-governing networks of actors and
- Recognises a capacity to get things done but not for Government to command or use authority but to use new tools and techniques to steer and guide.

Essentially, the OECD sees innovation governance as an interactive process involving collaboration, competition and negotiation and notes that "governments are increasingly concerned about fragmentation, complexity and governablity. They increasingly respond by creating structures ….(for example) policy councils or strategic frameworks to help achieve co-ordination and coherence." Finally, the OECD speaks of important capabilities for government which include:

- 'Balancing imperatives (for example the economy, society, environment) and creating a vision
- Developing knowledge bases and a strategic horizontal approach
- Refocusing on the design of agencies stressing flexibility and links between various agencies and Ministries and developing public/private interfaces and
- Integrated learning in Government practices, developing and implementing action plans with monitoring and reporting functions, improving evaluation and learning, conducting 'meta analyses' which includes evaluations of the institutional framework and environmental scans.'

Source: OECD Governance of Innovation Systems, Synthesis Report 2005

[10] OECD (2005) *Governance of Innovation Systems, Synthesis Report 2005.*

2.2 Public Support for Innovation

Public support for innovation has a critical role to play in Australia becoming an innovation driven economy.

It is now generally acknowledged that the public sector has a role to play in facilitating innovation although views differ on the exact nature and extent of this support.

From a minimalist perspective, the neoclassical school of economics posits that knowledge has public good characteristics and thus a solution left to the market is likely to be sub-optimal.

Limited public support of innovation is required to address perceived 'market failures.'

However, more recent thinking has shown that the realm of public policy extends beyond this traditional and narrow approach.

For example, Professors Jonathan West and Keith Smith argue that public policy has a key role to play in developing dynamic and successful innovation system.

This is for two reasons. [11]

Firstly, innovation requires access to a body of knowledge that is held by many.

Secondly, innovation operates in circumstances of significant risk and uncertainty.

Public policy, therefore, has a role to play in developing knowledge sharing, risk management and appropriate incentive mechanisms.

It is for this reason that innovation processes typically have a 'systems' approach which emphasises collaboration as a key vehicle in helping to both diversify / diffuse risk and to share knowledge.

Alternative approaches to economics, such as the Institutional and Evolutionary schools of thought, also stress this systems / holistic view of innovation.

Public support of innovation is therefore treated as paramount in these schools of thought throughout the whole lifecycle of the innovation process (from knowledge creation and diffusion to investment facilitation, commercialisation and risk management).

These schools also consider 'system failures' (in addition to market failures) which refer to a range of issues beyond the scope of traditional economics.

[11] See *Australia's Innovation Challenges: The Key Policy Issues* (2005). Professor Keith Smith and Professor Jonathan West. University of Tasmania. Submission to House of Representatives Standing Committee on Science and Innovation, Inquiry into Pathways to Technological Innovation.

3 International Policy Responses

A scan of the international policy environment suggests that various national and sub-national jurisdictions around the world are rethinking their approaches to innovation.

At the heart of this reconsideration is the recognition of innovation's importance and the increasing significance of public support for this most important driver of growth.

Our brief review of international best practice suggests that many nations have also reconsidered and revised their own institutional architecture to place a primary focus on innovation. Our review further suggests that a 'systems' approach and a focus on the 'long-term' is now being widely adopted.

The list below is a selective snapshot of international best practice in the field.

The review shows that there is no one 'answer' to maximising a nation's economic and innovation potential but that diverse circumstances require diverse responses.

Recent work by the Australian Business Foundation (ABF) compares the National Innovation Systems (NIS) of Finland, Sweden and Australia. The work articulates the factors that constitute a successful NIS.[12] These include:

- Government invests in each element of the NIS and their interdependencies
- The NIS has a global focus and serves leading edge customers from around the world
- There is significant networking / clustering / collaboration and there are linkages between science and industry
- There is a diversified R&D base with both high business and government expenditure on R&D
- There is a supportive financial system and
- Above average rates of investment in education, research and innovation which form a key part of the knowledge infrastructure.

The report notes that the Australian NIS has the following weakness:

- Insufficient attention to human capital formation (including entrepreneurship)
- Low average company size. This impedes the ability to compete in new industries
- BERD is poor by international standards and
- Poor linkages of research institutions with users.

[12] Roos, G. S , Fernstromando, L and Gupta, O. (2005). *National Innovation Systems: Finland, Sweden & Australia Compared. Learnings For Australia.* http://www.abfoundation.com.au/pdf/NISRoosShortPaper22Nov05.pdf

The ABF also notes that, in terms of Australia prioritizing long term goals and issues (such as the environment, infrastructure and health), there is an increasing desire towards strategic planning and research. However, "without a co-ordinating body, priority criteria have varied and cross checking reveals many differences and overlaps."[13]

3.1 Europe

3.1.1 Finland

Institutions and policy organisations have played a significant role in Finland's economic development as a knowledge economy.[14]

Many of these institutions and policy organisations have been working in the context of a systems approach well before Finland became one of the most competitive economies in the world. Indeed, the "first definition of the systems view of industrial policy is found in the 1990 Review of the Science and Technology Policy Council. The Council made the concept of a national innovation system an important cornerstone for science and technology policy."[15]

Today, although various players in the Finnish innovation system have their own discrete roles, there are a range of public initiatives and efforts to maximise long-term strategic thinking and collaboration.

This collaboration occurs throughout the innovation lifecycle with all stages (from basic research to commercialisation) funded simultaneously.

The key players in the Finnish system are discussed below.

The Science and Technology Policy Council includes the most important Ministers, with the Prime Minister as Chair, in addition to major science and technology stakeholders.

The Council is the most significant coordinator of science and technology policies and has two tasks:

- The strategic development / coordination of Finnish science and technology policy and
- The strategic development / coordination of the NIS.

The Academy of Finland finances basic research focusing on high-level scientific research.

The National Technology Agency (Tekes) develops Finnish innovation and technology policy and allocates funds for research and development for a range of firms, research organisations and universities.

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[13] Ibid, p. 24.

[14] This section draw on the following piece: *Finland as a Knowledge Economy. Elements of Success and Lessons Learned. Overview.* (2005). Edited by Carl J. Dahlman, Jorma Routti and Pekka Ylä-Anttila. The International Bank for Reconstruction and Development / The World Bank. http://info.worldbank.org/etools/docs/library/201645/Finland_ES.pdf

[15] Edited by Carl J. Dahlman, Jorma Routti and Pekka Ylä-Anttila (2005).

The Technical Research Centre of Finland, or VTT, develops new technological solutions and performs a range of roles including:

- Helping firms improve their competitiveness and
- Promoting technology transfer by participating in national and global research programs and collaborative networks.

The Finnish National Fund for Research and Development (Sitra) is tasked with experimenting and initiating activities.

The Fund is an interesting early example of institutional innovation (the Fund was established in 1967) and operates as a public foundation under Parliament.

The Fund has a financial endowment and the flexibility to makes decisions without being obstructed by budgets and delays.

The Committee for the Future, another example of Finnish institutional innovation, is a standing committee of the Parliament of Finland (see Figure 5).

The Committee is another example of Finland's response to the need to create a knowledge-based economy based on innovation, a long-term orientation and consensus building policy processes.

Figure 5. Finland - Committee for the Future

'The Committee for the Future is one of the Parliament of Finland's 15 standing committees. The committee has 17 members who all are Members of Parliament and represent different political parties. The committee is the only of its kind in the world. Its task is to conduct active and initiative-generating dialogue with the government on major future problems, including knowledge economy developments. The committee has been given the special task of following and using the results of research on future trends.

The idea of conducting policy work on the future in Parliament came from the floor. In 1992 a large majority of Parliament Members accepted an initiative that called for the government to submit a report to Parliament on Finland's long-term prospects and options. In 1993 Parliament established a temporary Committee for the Future to prepare responses to the policies outlined in the government's report. In 2000, in connection with Finland's constitutional reform, Parliament decided to make the Committee for the Future a permanent committee. The tasks of the committee include[16]:

- Assessing the social impact of technological development and serving as the Parliamentary body responsible for assessing technological development and its consequences for society Issuing statements to other committees on matters related to the future when asked
- Initiating public discussions of issues pertaining to future development factors and development models
- Analysing research regarding the future.'

Source: Carl J. Dahlman, Jorma Routti and Pekka Ylä-Anttila (2005)

3.1.2 Sweden

The Swedish Government's main innovation policy document is *Innovative Sweden*, released in 2004.

Some of the key priority areas in *Innovative Sweden* include:[17]

- Development of knowledge platform for innovation (the knowledge infrastructure)
- Creation of innovative businesses and promoting entrepreneurship (including social entrepreneurship) and
- Increasing the state's contribution to the innovation sphere.

Technology and innovation policy development and funding is performed through a selection of key government agencies.

Key agencies include:

[16] See www.parliament.fi/FutureCommittee

[17] National Innovation System in Sweden, Vasiljeva, N. Toivonen. http://cua.karelia.ru/report29.doc

- VINNOVA - Swedish Governmental Agency for Innovation Systems
- The Swedish Agency for Business Development (NUTEK)
- The Space Agency (Rymdstyrelsen) and
- The Energy Agency (STEM).

VINNOVA, in particular, is a key agency and was created to better align and *coordinate* economic growth policy and research policy.[18]

The agency focuses on a long-term strategic work program for sustainable growth and innovation linked research.

It follows an industrial policy based on the development of ground-breaking products, services or processes with scientific basis.[19]

VINOVA also:

- Strengthens the knowledge infrastructure through funding needs-driven research and
- Develops networks between firms, universities, governments and other key players.

The agency is driven by a systems view of innovation while adopting a 'systematic and strategic model' of development.[20]

VINNOVA therefore focuses on opportunities and weaknesses in the innovation system and in areas with strong growth prospects working closely with other players to develop strategy programmes for key industries.

VINNOVA's funds:

- Represent around five percent of total Government R&D investments and
- Are matched almost always by other financiers and players (annually, the agency invests over SEK 1.1 billion in problem-oriented research and innovation systems development leveraging almost the same amount).

The 2005 program areas included:

- Working life
- Biotechnology
- Services and IT implementation

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[18] Ibid.

[19] VINNOVA (2005) *A Driving Force for Growth* *http://www.vinnova.se/upload/EPiStorePDF/vi-06-08.pdf and http://www.vinnova.se/default___612.aspx and VINNOVA - for an innovative Sweden! http://www.vinnova.se/upload/EPiStorePDF/vi-05-06.pdf*

[20] VINNOVA (2005) *A Driving Force for Growth*

- Information and communications technology
- Advanced manufacturing and materials
- Transportation

3.2 Asia

3.2.1 India

India has recently created a 'National Knowledge Commission' (NKC).

The NKC is tasked with developing India as a knowledge economy and promoting excellence in the country's education system to make India 'a globally recognised player in the creation, application and dissemination of knowledge.'[21]

The NKC reflects the innovation and reform focus of the Indian Government and the recognition that long-range planning and consensus building are important elements in the formulation of innovation and economic development policy making.

Arguably, the NKC also reflects the recognition by the Indian Government that a new economy needs a new set of institutions, especially in the field of education, research and economic policy making.

In his address at the launch of the NKC on 2 August 2005, Prime Minister Manmohan Singh of India noted that "the time has come for us to create a second wave of institution building and of excellence in the field of education, research and capability building in India so that we are better prepared for the 21st Century."[22]

The Commission is tasked with examining a range of areas including education, science and technology, agriculture, industry and e-governance.

The NKC's terms of reference include to:

- 'Build excellence in the educational system to meet the knowledge challenges of the 21st century and increase India's competitive advantage in fields of knowledge
- Promote creation of knowledge in S&T laboratories
- Improve the management of institutions engaged in intellectual property rights
- Promote knowledge applications in agriculture and industry
- Promote the use of knowledge capabilities in making government an effective transparent and accountable service provider to the citizen and promote widespread sharing of knowledge to maximize public benefit.'

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[21] Knowledge Commission website http://www.knowledgecommission.org/ Knowledge Commission set up (2005). The Hindu http://www.thehindu.com/2005/06/04/stories/2005060404541200.htm and http://planningcommission.nic.in/aboutus/committee/sb_letters.pdf

[22] Prime Minister of India, Manmohan Singh (2 August 2005) Address at the launch of the NKC.

Working Groups have been established for focus areas and have been tasked with formulating specific proposals which are sent directly to the Prime Minister.

The Commission also work closely with business, community, research and other players in Indian society.

A National Steering Group under the Chairmanship of Prime Minister also includes the following high-level members:

- Minister of Human Resource Development
- Minister of Agriculture
- Minister of Commerce and Industry
- Minister of Communication and Information Technology
- Deputy Chairman, Planning Commission and
- Minister of State for Science and Technology.

3.2.2 China

Economic development driven by innovation and technology is a key focus in modern China.

In China's Tenth Five-Year Plan (from 2001 and 2005), the second most recent Plan, innovation is a key focus and technological progress is identified as the 'driving force' of economic growth and reform.[23]

Key actions in this Plan relating to innovation include to:

- 'Modernize and diversify agriculture through new technologies and other policy measures
- Further develop traditional industries with new and advanced technologies, develop new and high technology industries, use information technology to stimulate industrialization, accelerate the development of the service industry and
- In science and education, work on technological innovation and related basic research, pursue wide-ranging education policies adapted to country modernization, and …..attract talented people, including high quality public servants, enterprise managers, and scientists.'[24]

In the more recent 11th Five-Year Plan, policy makers have continued to focus on innovation and technology.[25]

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[23] Kazuyuki Motohashi and Xiao Yun (2005) *China's Innovation System Reform and Growing Industry and Science Linkages.* RIETI Discussion Paper Series 05-E-011. https://www.rieti.go.jp/jp/publications/dp/05e011.pdf and Dahlman, C. J and Aubert, J, E (2001). *China and the Knowledge Economy: Seizing the 21st Century,* p. 14.

[24] Dahlman, C. J and Aubert, J, E (2001), op. cit.

[25] New Five-Year Plan to see revolutionary changes (2005). http://english.sina.com/china/1/2005/1011/48978.html

In this latest Plan, science, education and the development of human capital are key pillars in improving China's nation's competitiveness.

Key actions include:

- Independent innovation promotion
- 'Leapfrog' advances in key strategic areas
- Innovation capacity building for firms
- Acceleration / development of a NIS
- Education development with the goal that China will become a 'learning society' and
- Training of people (especially in the field of high-technology).

4 A Way Forward for Australia

This section presents some tentative suggestions for a way forward for Australia in the field of public support for innovation including in our national 'innovation architecture.'

By innovation architecture we mean the institutions, frameworks and interrelationships between agents in Australia's policy making establishment that support and help drive Australia's development as an innovative nation.

While there are a range of issues to be addressed in the broader field of public support for innovation we consider that Australia's innovation architecture needs to be addressed as a matter of priority.

This issue is a priority as we consider Australia, first, needs to establish the most appropriate decision making mechanisms and interrelationships to best position the nation for growth in an era characterised by persistent innovation.

The alternative is that we continue to address specific policies or gaps in Australia's innovation system, in a piecemeal fashion, or worse ignore them.

Two key issues for consideration stand out:

- Australia needs a new nation building agenda to rival that of the post-war period but now based on innovation and technological progress and
- Australia needs a 'systems' view of innovation that promotes collaboration and competition, institutional support for innovation and engagement with international science, technology and innovation.

4.1 Innovation and nation building

Australia is in danger of being left behind in the global race for innovation by not maximising current opportunities and not responding adequately to the challenges arising from other countries.

In order to respond effectively, Australia must place innovation at the centre of a new nation building agenda that will rival that of our post war development strategy and will refocus on upgrading our competitive advantage across the economy and in key strategic sectors (for example those that produce or are intense users of frontier / platform / leading edge technologies).

Australia's economic development framework is currently focused on efficiency / competition, rather than innovation, as a key driver of growth.

It is also focused on short-term rather than long-term strategic thinking.

Accordingly, discussions on economic reform issues in Australia are today often couched in terms of 'constraints' and 'impediments' (for example the current debate on skills and infrastructure) rather than opportunities.

Policy also needs to consider the delicate balance between competition and collaboration, as exemplified in more recent innovation thinking, with innovation being the major focus of national economic policy making.

In a sense, this will be a departure from the traditional approach Australia has used since the deregulatory push of the last two decades and will require new institutions to drive the innovation agenda at the Federal, State and local government levels.

An innovation driven approach must also be based on a systems view of innovation that links economic, social, environmental and other issues.

We are currently coming to adopt such an approach but, arguably, remain behind global leaders.

An example where we fall behind in taking a holistic approach to innovation is the Australian public library system.

As core building blocks of the national innovation and knowledge infrastructure system, libraries play a critical role in Australia's economic and social development.

Many of Australia's libraries are outstanding.

Ironically, however, libraries rarely if ever receive the attention of the main government economic departments except in the case of the standard annual budget review process.

It is no accident that Finland, one of the world's most competitive economies in the world, also has one of the most advanced library systems in the world with very high library usage amongst the population.

4.2 Innovation Architecture for the 21st Century

As discussed, other countries have either begun or are well on their way to reorganising their policy and institutional architecture around innovation and knowledge.

Some of the key possibilities for consideration in Australia are:

- Foresighting capability which at least provides some guide posts to the future
- Active forms of dialogue, debate and discussions at all levels of the economy and society given that ideas can originate from any source
- Institutions to promote the rapid identification and dissemination of ideas, including from overseas
- The encouragement of think tanks on a variety of issues including, especially, in new economic thinking and
- Vehicles to promote collaboration across the entire innovation system.

Some further tentative options for Australia are presented below.

Firstly, we require a more proactive approach to working with the Australian Diaspora for the benefit of Australia. The Diaspora is a useful source of ideas, information and networks from around the world.

Secondly, a national body to rival current government organisations (for example the Australian Competition and Consumer Commission) and with a focus on innovation policy and collaboration is required. The body would:

- Research innovation issues and help build innovation capabilities and

- Would draw on the expertise of the best in the various fields of economics, science and technology and actively use this expertise on an ongoing base.

4.3 Long range planning

Our survey of international best practice suggests long range planning (LRP) and foresighting is an area receiving significant attention by government, business and other organisations.

LRP and foresighting are areas that require further attention in Australia.

LRP involves identifying the opportunities and challenges we face as a nation in the long-term. The process would be systematic and significant in size and scope and involve a coordinated approach across a range of stakeholders including Government, business and the academic community.

If Australia were to reshape its economic development strategy with the primary focus being on innovation, LRP could be used to support a range of innovation related problem-solving exercises.

4.4 Australia as the 'experimental' economy / a global solutions hub

Ideas creation and development is a critical part of the innovation process.

In this process many ideas succeed and fail but environments in which a multitude of ideas are created and developed are the ones that are most successful. This is why current business practice places a significant emphasis on ideas generation across corporations and decentralising (if not democratising) innovation.

Australia could apply this thinking and seek to become an 'experimental' economy where ideas are tested and developed. Although a set of industries or issues could be a focus on which to build an Australia 'experimental' economy, there is nothing to stop us from creating an environment where creativity in general can flourish.

Importantly, as an open and advanced industrialised economy that has undertaken significant reform over the last few decades, Australia has fostered a culture of leading edge demand.

This has made our domestic market lucrative to many firms, especially in developing and refining products and services for sophisticated consumers that can then be also sold in other markets.

In an Australian 'experimental' economy, entrepreneurship development should also be paramount.

Entrepreneurship is currently narrowly defined in the Australian policy debate focusing on identifying the 'barriers' rather than maximising the opportunities and on building capabilities.

Social entrepreneurship is also hardly discussed or seen as a core policy objective.

Importantly, many problems are now global with the result that solutions to these international issues are also being investigated around the world.

Countries that are able to play a constructive role in solving global problems can be expected to reap a large share of the gains.

We consider that Australia could become a global solutions hub for many of the world's most pressing problems.

As part of becoming an 'experimental' economy, Australia also needs to develop an innovation identity and this could include one or more of the below:

- A trial and testing centre
- A place of leading edge customer IP and
- A solutions hub for some of the world's pressing problems.

5 Conclusion

This submission has argued that we are in an era of unprecedented change.

Much of this change is a result of innovation being the real focus of economic activity and leads to innovation being a key focus of policy making now and in the future.

We contend that new ways of thinking about innovation and economic (and social and environmental) policy are required to address challenges that nations face.

Recent thinking argues for a systems, and perhaps even a "post systems" view of development, something that has been noticeably absent in Australian policy making.

We look briefly at the experiences of a number of overseas countries, in both developed and emerging economies, which have in place impressive long term goals and supporting policy and institutional frameworks.

Finally we contend that, among other reforms, new institutions to meet the challenges in Australia are required including ones that can help drive foresighting, long term planning and collaboration, while also helping to develop long term aspirations about Australia's role in a global innovation economy.