Closer Australia – US Engagement via a Free Trade Agreement: Opportunities for Research and Innovation

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Terms of Reference are provided in Appendix 1.

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EXECUTIVE SUMMARY

AUSFTA Impact on the Economic System

The *Australia-United States Free Trade Agreement* (AUSFTA) provides an umbrella to bring about an increase in the level of trade and commercial interaction between the two signatories to the agreement, a potential gain to Australia's gross domestic product of the order of $4 billion annually within 10 years[1].

Both nations already operate open economies, and AUSFTA will be the start of a progressive build-up over time of closer economic ties. These ties will create an increasing climate of confidence to help overcome other obstacles to trade and commerce.

AUSFTA Impact on the Science and Innovation System

It appears unlikely that the AUSFTA will contain any significant clauses that will directly impact the science and innovation system. It will bring the two countries closer together and create the platform for ongoing discussions, negotiations and follow on agreements to address specific areas of cooperation.

However, for Australia's science and innovation system[2], AUSFTA carries strong longer term implications. The closer economic relationship may boost Australia's science and innovation activities because of their connections to Australia's economic system.

Broad impacts on Australia's science and innovation system include stronger links with the US in funding big research projects and developing frontier technologies. Over time, moves towards mutual recognition of patent search and examination could deliver savings to both economies.

Particular Impacts

Market access will boost competitiveness and innovation. It is widely recognised that competition drives innovation (compare the Porter principle[3]). As the US and Australian economies are already very open, innovation gains are likely to be most marked in sectors where market access restrictions still apply, eg access to the US government procurement market. Access is one thing, competitiveness is another. Competitiveness is underpinned by innovation. Therefore, building

[1] Centre for International Economics (CIE) report "Economic Impact of an Australia-US Free Trade Area", prepared for DFAT, June 2001. Estimate dependent on $US / $AU exchange rate. US$2 b. at the time.
[2] The national innovation system comprises institutions and businesses engaged in research, intellectual property, seed and venture capital, new products and services, learning, research commercialisation, support for these activities, and importantly the linkages between all the players engaged in these activities
[3] "The Competitive Advantage of Nations", Michael Porter, 1990. See pp 578 – 584 on competitive advantage in international competition.

increased export levels to the US in these newly opened areas may strongly depend on gains in Australian innovation over time. Significant results on the ground will take time and effort.

Australian productivity will grow, according to the Centre for International Economics. As science and innovation are one of many key contributing factors for advances in a nation's productivity, the connection may strengthen.

*In research commercialisation, w*hile Australia's public research is world class, and while US – Australia linkages and interaction in many areas of scientific research is excellent, Australia needs more start-ups and spin-offs from this effort. AUSFTA may help here, because up to now there are presently few US investors interested in commercialising Australian research. AUSFTA may encourage US venture capital and know-how investment into Australia that will boost scientific research uptake, especially commercialisation of research. Distance between the US and Australia is the major impediment, but fine tuning of the tax regime will lift investment. The free trade agreement will strongly complement recent initiatives by the Australian and State Governments aimed at attracting US sourced investment into the Australian venture capital industry. These involve revisions to the taxation treatment of gains from US investments and modifications to investment vehicles.

In research training, Australia could leverage AUSFTA to secure some improved access to USA funded research fellowships and increased collaboration between both parties. Australia might reciprocate with moves to provide some access to Australian research training funds. The outcome would be far greater opportunities for diverse training and education as people move to acquire skills in a more conducive environment.

In the important area of technical standards for products and services, over the longer term there may be a trend towards mutual recognition or harmonisation of standards. This will reduce the difficulty and costs of selling Australian products in the USA, and may foster downstream development and application of frontier technologies. A similar advantage will exist for the US.

In Government procurement, AUSFTA may address a number of barriers faced by Australian suppliers to the US market, such as restrictions imposed by the *Buy America Act*, the *Small Business Act*, the *Balance of Payments Act,* and tendering process barriers.

Case Studies in Science and Innovation

The broad impacts on the science and innovation system described above are best illustrated by specific opportunities where Australia can leverage its strengths.

The case studies are on *energy, neurosciences, plants, light metals, biomedical equipment*. Particular emphasis is given to a clean and secure energy future. In addition, US investment is such an important area that *venture capital* is looked at in some detail, and perhaps some domestic initiatives are needed there. To illustrate this, a "hypothetical" scenario is developed on the impact of US funding and expertise in the specialist field of research commercialisation.

Clean and Secure Energy is an area of crucial importance to both countries; the science and innovation that needs to be done will require a massive effort. In most areas the USA will have a lead position, but there are areas where Australia can make very significant contributions indeed. In other words there is scope for technical and financial collaboration in the area of clean energy and the emerging hydrogen economy that will benefit from having the FTA in place providing, as it will, a basis for an equitable approach for the distribution of costs, effort and benefits. It will also enable Australia to maximize opportunities arising from its leading researchers.

Fossil fuels coupled with carbon dioxide capture and storage provides the transitional pathway to the long term objective of a hydrogen economy based on renewable energy. Australia has natural advantages in the lead-up to the hydrogen economy, notably its abundant fossil fuels and its massive CO_2 storage capacity.

While AUSFTA may not produce a massive change in the conduct of science and innovation related to clean energy in Australia, nor immediately mean even closer links with the United States, it will effect changes. It will be a catalyst for change in areas such as clean energy related "big science" and areas with major energy security or economic implications.

The Way Forward

The closer economic relationship creates an opportunity for the Australian science and innovation system to tap into the contemporary world's largest, most successful and best funded science and innovation system. To capture this opportunity Australia should adopt a strategy of:

- proactively leveraging AUSFTA to engage in follow on negotiations about access to the funding and the human and physical capital of the science and innovation system in the USA, bearing in mind the need for reciprocal arrangements (although other cooperative funding mechanisms might also be explored);

- Work to "get our own house in order" so that the closer interaction with the USA is not hampered by constraints in Australia, but rather that Australia is seen by the US science and innovation system as a welcoming and attractive place with which to engage; and

- Identify areas of mutual benefit to improve efficiencies and reduce costs.

The two recommendations on the way forward follow the above strategy.

RECOMMENDATIONS

Recommendation 1

The Australian and US Governments negotiate effective and efficient access to each country's science and innovation systems, taking steps such as:

(Immediately)-

- facilitate entry to research and demonstration infrastructure
- encourage exchange of research expertise, eg biological security
- facilitate rapid movement of research and innovation personnel, and scientific information, or samples
- finalise a satisfactory *Science and Technology Agreement*

(In the long term)-

- ease restrictions on access to government research funds and/or establish specific co-funding agreements
- fine tune Australian investment and tax regulations to optimise US investment here
- review immigration and tax regimes to ensure substantial movement of skilled scientists and technology managers, as well as increased investment flows
- open government procurement markets, particularly defence and other high technology areas
- increase cooperation in patent assessments by mutual recognition of patent search and examination work, as well as product and education standards

Recommendation 2

Establish an expert group for three years to monitor the science and innovation effects of AUSFTA implementation, and drive a cross agency agenda that captures the benefits of the closer relationship:

- Map key US research strengths relevant to Australia's national research priorities; map key Australian research strengths for US collaboration.

- Promote efforts by Australian science and industry research bodies in establishing stronger links and cooperative arrangements with their US counterparts.

- Monitor science and innovation outcomes under AUSFTA with particular reference to the recommendations above.

- Report to an appropriate Minister, who will provide relevant strategic input and champion the impact of AUSFTA on the science and innovation system.

1. INTRODUCTION

The scene is unfolding for the Australian and US Governments to agree on the text for a Free Trade Agreement (FTA) by December 2003. It will then be submitted to the US Congress for a 90 day review.

While the working group has not seen a draft FTA, it has received several briefings from the *Department of Foreign Affairs and Trade* about the progress of the negotiations.[4] Both countries are using the examples drawn from recent free trade agreements with Singapore or Chile as the basis for the negotiation process which will provide the format, content and style of the expected AUSFTA.

There are a number of FTA issues that may affect science and innovation. The terms of reference[5] for the working group tended to focus more towards identifying research and innovation opportunities in the manufacturing and services industries, rather than FTA areas such as agriculture or communications. Using the US – Chile FTA as a guide, the major issues that might impact on Australian science and innovation are investment flows, the US regulatory environment including intellectual property regimes, US Government procurement processes, and movement of skilled personnel.

Specifically, the working group wanted to learn if the FTA will have a significant bearing and influence on Australia's science and innovation system. Could the FTA create enhanced opportunities for Australian researchers to participate in large US Government research programmes? Will closer economic alignment lead to better success with research commercialisation in Australia? Will Australian industrial innovation activity pick-up? These are some of the questions that the working group raised in a consultative process[6] and the views expressed in this paper are the group's collective view on the answers.

The US is a powerhouse in science and innovation and a natural alliance has existed for many years in scientific collaboration. Australia has strengths in science such as medical research, and world class innovative industrial areas such as minerals. The object of this paper is not to cover all areas, but to draw out if there are any overall impacts of the FTA on the science and innovation system, and illustrate this with a few selected case studies. These are issues that will require further attention and review as the proposed FTA is implemented.

Should the FTA lead to closer ties that boost our productivity, new products and services, then this will be underpinned by many factors, and at least in part, by Australian science, technology and engineering.[7] To maximise the

[4] Briefings from Stephen Deady, Special Negotiator, Office of Trade Negotiations, DFAT
[5] Appendix 1
[6] Consultations included the ANU, CSIRO, DEST, ITR, US Embassy, IP Australia, ANSTO, NHMRC, ARC, ACCI, and University Qld. (See Appendix 2)
[7] "A review of the Evidence on Science, R&D and Productivity", Steve Dowrick, paper prepared for DEST, 11 August 2003. This paper is an example of the studies linking S&T to productivity growth, and discusses international linkages.

opportunities flowing from the closer bilateral relationship flowing from the free trade agreement, Australia needs to pursue further agreements with the US not only at the trade and inter-governmental levels, but also the science and innovation level. These agreements should focus on a range of issues, including funding flows, access to research infrastructure and intellectual property.

2 THE FREE TRADE AGREEMENT

2.1 Objective

The development of negotiations between Australia and the US to establish an FTA represents a significant development in Australian trade policy. Its importance is illustrated by the Prime Minister's statement to Parliament in November 2002 "This is, by any measure, an historical development in the bilateral relationship".[8] The Government's specific objectives for negotiations with the US , announced 14 November 2002, cover the following issues:[9]

- Trade in industrial goods and agriculture
- Rules of origin
- Quarantine / Sanitary and Phytosanitary Measures
- Trade Remedies
- Customs Cooperation
- Trade in Services
- Investment
- Intellectual Property Rights
- Telecommunications and Electronic Commerce
- Government Procurement
- Competition Policy
- State-to-State Dispute Settlement
- Environmental Issues

The above issues, and the guidance provided by the US FTAs with Chile or Singapore, provide the template for the development of the AUSFTA.

2.2 Expected outcomes

There have been a number of studies on the Australian side of the expected outcomes from the FTA. The two main ones are from *Monash University's APEC Study Centre* and the *Centre for International Economics*.[10] Both modelling studies conclude that there will be modest initial economic gains for Australia from AUSFTA. The Monash study highlights the prospect of "important flow-on effects, particularly in attracting US investment to Australia and expanding linkages with the dynamic US new economy and leading edge

[8] Hansard, The House, Thursday 14 November 2002, pages 9079 – 9080.
[9] Much greater detail on these issues is provided by DFAT on its website www.dfat.gov.au
[10] "An Australia – United States Free Trade Agreement – Issues and Implications", Australian APEC Study Centre, Monash University available at www.dfat.gov.au/publications; and "Economic Impacts of an Australia – United States Free Trade Area", Centre for International Economics, Canberra, available on the same website. For more detail, and direct links, see Appendix 2.

US business practice". The Centre's report proposes a significant productivity increase throughout the Australian economy from greater exposure to US industry.[11] This would be on top of "Australia's Economic Miracle" underpinned by a productivity surge, although our manufacturing productivity remains well below US levels.[12]

Both reports hardly touch on science and technology. In personal communication one of the authors of the Centre for International Economics report (Andrew Stoeckel) pointed out the attraction for US researchers and businesses of the lower operating costs and environmental attractiveness of Australia. Other studies confirm this.[13] They point out there is scope for greater international marketing and promotion of these attributes. This is something an FTA could foster.

2.3 Status and assumptions

In October 2003 the negotiations entered a final phase that dealt with some difficult issues, such as foreign investment and intellectual property. This is expected to lead to the two governments agreeing on a text, which then must be submitted to the US Congress for a 90 day period of review.

The Australian and US science and innovation systems are very different. Closer interaction on both sides will bring both benefits and difficulties. There may be pain along the way. Australia's research support bodies are generally not open to international researchers, except through cooperative arrangements *via* Australian researchers. Industry R&D cooperative arrangements could be complex because Australian programs such as the IR&D tax concession vary greatly from those in the US.

Given the fact that the precise contents of the FTA will only be settled once Congressional approval is given sometime in 2004, the group's working approach was to develop a list of specific assumptions about its content, and from this derive a corresponding list of possible science and innovation outcomes. Any assumption that is disproven in the future obviously carries no science and innovation outcomes. This working table is in Appendix 6.

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[11] A third study, prepared by ACIL Consulting, tends to dispute the economic findings of the first two reports.
[12] "Australia's Economic Miracle", Gary Banks, Chairman, Productivity Commission. This is an address for the Forum on Postgraduate Economics, National Institute of Economics and Business, ANU, 1 August 2003.
[13] "Benchmarking Study of R&D Costs in Selected Segments of Australian Biotechnology", Ernst & Young report to ITR, January 2001.

3 KEY ISSUES

Possible impacts of closer bilateral ties between the US and Australia on the Australian science and innovation system include changes in funding flows, the regulatory environment, standards and conformance, access to infrastructure, government procurement, and people movement. These issues are discussed in this section under three headings: indirect impacts (of AUSFTA); longer term impacts; and domestic initiatives.

Immediate benefits from the proposed AUSFTA are likely to be from trade in goods and services, with indirect impacts on science and innovation.

Over the longer term, the closer bilateral relationship between the US and Australia, generated as a result of AUSFTA, may offer a number of opportunities to stimulate innovation in this country. To capitalise on these opportunities, impediments created by domestic policies will need to be identified and addressed, illustrated by venture capital.

3.1 Indirect Impacts

In liberalising trade between the two countries, AUSFTA may have an indirect impact on Australian innovation which is close to market. In particular, it may represent an opportunity to enhance the commercialisation of products and services by increasing access to the US market for innovative Australian firms. However, it must be noted that the two economies are already among the most open in the world. As a result, while there may be benefits in some sectors, the direct impact of liberalising measures on the innovation system as a whole may not be substantial.

Government procurement

One impediment to market access which may be dealt with under the AUSFTA involves restrictions created by US government procurement policies. The US federal government currently spends A$130 billion per annum on purchases of goods and services. (This figure rises to A$300 billion if defence expenditure is included). However, Australian firms are prevented from accessing this market due to a number of restrictions including:

- the *Buy America Act.* This Act imposes a number of restrictions on foreign suppliers, including prohibiting public sector bodies from purchasing goods from overseas and extending preferential price terms for domestic goods;

- the *Trade Agreements Act*, which imposes a general prohibition on government agencies from sourcing any goods or services from countries that are not a signatory to the *WTO Government Procurement Agreement* (GPA). (Australia is not a signatory to the GPA – see also Section 4.5).

- the *Balance of Payments Act* which applies to procurement outside the US and sets conditions for the use of non-US suppliers; and

- the *Small Business Act* which requires government agencies to place a fair proportion of their procurement with domestic small businesses. It is estimated that set asides under this Act represent almost 30 per cent of US federal government procurement.[14]

The FTA may provide an opportunity to overcome additional restrictions that apply to US defence procurement. Australia has received a general waiver from the *Buy America Act* relating to defence purchases. However, there is a complex web of policies and practices, extending from legislation through to the management of US government contracts, which restrict foreign participation in the US defence market. Given the size of US defence expenditure, the removal of these restrictions could serve to stimulate research commercialisation in the Australian defence sector.

Standards and conformance

Moves under the AUSFTA to address non-tariff barriers created by country specific product standards and conformance testing regimes may also have an indirect impact on innovation by increasing access to the US market for Australian firms.

There are many differences in product standards between Australia and the US, as this country tends to adopt international standards, while the US has its own standards system. The standards setting process in the US is also opaque with over 1000 different bodies involved in this area. Many of these bodies are private and anecdotal evidence suggests that US industry can exert significant influence over the process.

This can potentially create a number of difficulties for Australian firms in advanced sectors such as electronics, telecommunications and information technology. To enter the US market these firms first need to access information about US standards, an expensive and time consuming process. They then need to undertake modifications to their existing products (if cost effective) to meet these requirements.

Having completed this process, Australian firms face requirements to test and certify that their products meet the appropriate standard. The product certification process can create significant impediments for suppliers trying to enter the US market. For example, in many cases US certification authorities refuse to accept Australian test results and mandate that testing be done in accredited US laboratories. This testing is often carried out at a much higher cost than in this country. In other cases, accreditation has been required for Australian manufacturing sites, which has involved covering costs for regular visits by US certifiers.

It must be noted that while progress in this area may be made through the AUSFTA, there may be limits on the outcomes this process can achieve. The fractured nature of the US standards system with its large number of private players may make it difficult for some of these issues to be addressed in a high

[14] The actual set-aside is 10%, with an overall "goaling objective" of 23%.

level agreement such as an FTA. It is clear that the achievement of harmonisation or mutual recognition of standards and conformance testing regimes between the US and Australia will be a long-term process.

3.2 Long Term Impacts

In the longer term, closer bilateral ties may provide opportunities to integrate the Australian and US science and innovation systems in ways which serve to stimulate Australian research and commercialisation. To illustrate this, several components of the innovation system are examined, namely research, intellectual property, infrastructure and skills

Research[15]

Australian public research is marked by its international linkages which have always been strong with the US. The highest incidence of international collaboration through ARC grants to universities is with the US,[16] and CSIRO's activities with the US are also more numerous than with other countries (see Section 4.6). Many of the companies partnering CRCs are US subsidiaries.

With this strong collaborative base in place, AUSFTA might provide the broad umbrella to catalyse increased public research collaboration, particularly in areas considered important to Australia's future needs. These are well defined particularly by Australia's National Research Priorities, Australia's National Health Priorities, and CSIRO's National Research Flagships.[17] Along with this a special alertness needs to be kept by ARC, CSIRO and other research bodies on collaborating in newly emerging areas of high research potential.

AUSFTA may boost US investment in Australian research since it has the potential to allow Australian universities greater access to US research funds, venture capital and markets; it would, however, also lead to increased exposure to US litigation, and associated costs.[18] Reciprocity may require US access to Australian research funds. This would have a significant impact on the success rate of Australian applications for ARC and NHMRC funding. Highly competitive applications that cannot currently be funded, and those that are funded, would be under increased pressure. Australia's public research support is generally protected from direct international access under GATS and US access may prove difficult[19]. However, alternative funding models may be possible, such as the joint funding arrangements for international research programs established by the NHMRC, the Health Research Council of NZ, and the Wellcome Trust in the UK.

[15] Business research collaboration is not discussed at length here. It is a difficult area because of the very different incentives both governments employ to encourage business R&D. It should be noted also that US business is comparatively more research intensive than Australia, spending the equivalent of around 2% of US gross domestic product on business R&D.

[16] The ARC reports in "Commonwealth Research Investment through the 2003 ARC funding round", December 2002, that of 921 "Discovery-Projects" grants, 476 reported 1036 collaborations with 62 countries. The highest incidence was with the US (276 projects).

[17] See list of national research priorities on DEST website. A revised version incorporating enhancements will be announced shortly. Flagships are described on the CSIRO website. National Health Priorities can be located on the Department of Health and Ageing website.

[18] AVCC Statement "Free Trade Agreement with US – Higher Education Issues".

[19] Further information on educational services and GATS is in Appendix 4.

To capitalise on the opportunities offered by possible increased access to US government research funding, it will be necessary to address issues relating to the ownership of any intellectual property arising from the research performed with the funding.

The US *National Institutes of Health* (NIH) argue that intellectual property generated by projects receiving NIH funds must be retained by the US Government, irrespective of the Australian share in terms of contributing funds, research expertise and infrastructure.

Anecdotal evidence suggests that these intellectual property practices are less of a hindrance when scientists are collaborating at the basic and very early stage research levels. However, as research proceeds downstream to the applied level, lack of clear intellectual property ownership arrangements have proven to be an inhibitor of productive collaboration.

There may be some impact on Australian business R&D if business enters into more collaborative arrangements with the US, or if market access opens up in areas where strong barriers presently exist. The US is the home of many large global businesses for Australian small and medium enterprises to market innovative goods and services under an AUSFTA, other things being equal.

SYNROC

Synroc is an encapsulation method for storing radioactive wastes, invented in Australia in 1979.

Testing work during the 1990s on encapsulating plutonium and other nuclear wastes in *Synroc* had been carried out in the US as a joint collaboration between ANSTO, Pacific Northwest National Laboratory, the Lawrence Livermore National Laboratory, and others. The collaboration involved funding primarily from the US to support the flow of expertise and advice, rather than research performance, from Australian scientists. However, IP rights accrued to the Lawrence Livermore Laboratories under the arrangements in place at that time.

Subsequently, a US subsidiary, "ANSTO Inc", was established in the late 1990s to commercialise Synroc and to tender in US procurement processes at that time aimed at acquiring technologies to dispose of high level plutonium and other nuclear waste. Although initially successful in this bidding, the development of contracts was cancelled around the time of the change of administration in the US (early 2001).

This illustrates the difficulties of doing business in the US in the past. IP difficulties have been consistently encountered in dealings that ANSTO and CSIRO have conducted with the US Department of Energy, and it is to be hoped that in the future closer bilateral ties may offer the opportunity to reduce these impediments.

Another example is *Silex Systems Pty Ltd*. This company has explored the possible commercial development of processes for production of low enriched uranium for electricity production. This involved contracts with the United States Enrichment Corporation, but the collaboration ceased.

Research Infrastructure

Major research infrastructure is becoming more and more critical to not only scientific research but also to research driven innovation by industry[20]. Major research facilities are abundant in the US and some are not stretched to over-capacity. This infrastructure is very attractive to a relatively small country

[20] AAS Submission "Australia's Major National Research Facilities" to the National Strategy on Research Infrastructure review, July 2003, section 2.8.

such as Australia. There are also increasing difficulties for many foreign nationals to access US infrastructure resources because of security concerns.

An infrastructure area of great attraction for Australia is "e-science". Better interaction with the US may facilitate access to high-bandwidth communications facilities that enable analysis of very complex and large datasets by remote means. Any increased access to very sophisticated simulation and data analysis tools will enhance Australian science and innovation. Access to relevant *US National Science Foundation* and *National Institutes of Health* facilities would be a critical step. The current review of research infrastructure is exploring access to international facilities.

Intellectual Property

One area where closer bilateral ties between the US and Australia may stimulate innovation is intellectual property, in particular the granting of patents. At present applicants wanting certainty of coverage in both Australia and the US must apply for a grant of patent in each country. This process involves duplication and additional costs.

There is scope to pursue arrangements with the US to allow mutual recognition of work by each country's patent office. The ultimate aim of this process would be to enable an Australian patent applicant to file an application here, have it examined and granted, and then have any corresponding application in the US processed to grant with minimal additional work.

IP Australia is currently engaged in a benchmarking exercise with the *US Patent Office* to assess the workability of arrangements that would allow for mutual recognition of search work, the first stage in the process.

Phase 1 of the pilot program commenced at the beginning of August 2003 and is scheduled for completion by January 2004. Under the program both offices will provide each other with the search results for a selected number of applications for which they were the office of first filing. Each office will then individually evaluate all the search results of the other office to assess the extent to which they can rely on each others work. There is a possibility that this could be extended over the longer term to mutual recognition of patent examination.

Mutual recognition of work between the two patent offices would provide benefits to applicants in terms of increased certainty in gaining patent protection across multiple jurisdictions and reduced costs in obtaining that protection.

Skills

Over the longer term closer bilateral ties catalysed by the AUSFTA may stimulate innovation by providing Australian research institutions and innovative firms with greater access to required skills. The skills base is a vital component of the innovation system as it serves as a basic building block of research and development. Given the availability and depth of expertise in the

US, both in pure research as well as the business skills necessary for commercialisation, increased access to these human resources could provide significant benefits to Australia.

Opportunities for Australian research, industry and education consultants could arise under AUSFTA. A two-way flow of people will build further relationships and alliances, resulting in growth of joint ventures, enhanced research training through exchange of researchers, and overall mutual benefit.

AUSFTA should reduce the barriers to movement of professionals and skilled workers. For example, visa access processes require significant streamlining to facilitate two-way access and hopefully AUSFTA will help.

At the professional level, there are many restrictions on people movement based on their qualifications. These include medicine, dentistry, related health science professions, law, accounting and auditing, architecture, engineering, social work, psychology, or teacher education.

There may be significant benefit in increased exchange of research and innovation managers. This will strengthen the entrepreneurial approach and facilitate greater access to US innovation networks. Core skills are needed in areas like biotechnology, ICT, photonics, solar power, energy, economic regulatory systems, and new media.

US students and skilled personnel may also become more aware under AUSFTA of Australia's specific strengths and wish to visit. Australia offers access to unique research assets, such as Australian biota. Many Australian undergraduate education programmes are also distinctive and very sound in their intellectual foundations as well as customised to Australian flora, fauna or geology.

A risk to Australian education products is the enormous volume and high quality of educational services available from the US, which could swamp Australia. The "MacDonaldisation" of education could be a threat. Another risk is the likely wave of US students coming to Australia, raising issues of government subsidies (eg fee-waivers), equity and diversity. Other issues include customisation of courses, use of regional examples in teaching, and the harmonisation of degree awards.[21]

3.3 Domestic Initiatives (Venture Capital)

To capitalise on the opportunities to increase innovation offered by a closer relationship with US, domestic policy changes may need to be made in a number of areas.

A number of domestic initiatives could be discussed here, but they are best illustrated by the important area of investment flow. Arguably, one of the keys to harnessing the benefits of Australia's science and innovation system is more widespread venture capital availability. Another is the business acumen and associated assessment skills for commercialising new technology.

[21] The working party is grateful to Professor John Hearn, ANU Deputy Vice-Chancellor (Research), for discussing some of these issues with them.

Over the longer term the signing of the AUSFTA may increase the profile of Australia as a destination for US investment. To capitalise on this opportunity, Australia should take steps to increase its attractiveness to US venture capital investors. While many significant changes have already been made, the ongoing lack of US venture investment in this country suggests that further adjustments may need to be considered.

AUSFTA is unlikely to have a direct effect on US venture capital investment in Australia, as there are no significant restrictions on capital flows between the two countries. Instead, the prospects for such investment are influenced more by the tax regimes which affect the investment returns that can be generated, the factors that impact on the commercial success of invested companies in Australia, and the effects of time differences and distance.

These are complex issues and in most cases will not be addressed by the FTA. However, it is expected that a closer relationship will develop between the two countries as a result of the FTA, which will open up opportunities in subsequent bilateral discussions to work to remove some of these investment inhibitors.

In addition, and probably more importantly, Australia should prepare for this opportunity by improving its "investment attractiveness." Many significant steps have been taken in this direction, but the ongoing lack of US venture investment in this country would suggest that further "tweaking" needs to be considered.

The two main types of venture capital investment are direct investment in Australian companies by US venture capital funds, and US investment in venture capital funds based in Australia.

Direct investment is quite rare, mostly because of the time differences and distance. Venture capital investment is very "hands on." Venture capital investors have a portfolio of investments, and want to be able to regularly visit invested companies to review progress and take corrective action if necessary. Most venture capitalists prefer to invest within a 1 hour drive from their office, or at least a day trip distance away. This is virtually impossible when a transpacific flight is necessary, and so investment in Australian companies is "just too hard" compared to the many opportunities they have to invest closer to home.

Despite this, there have been a few direct investments in Australian companies by US venture capital funds, but this is rare. Investments are usually through a local venture capitalist who the US venture capital firm is confident can manage the investment on its behalf. Over time this type of investment will grow, but it is not the normal "modus operandi" and will not provide the venture capital investment which is needed.

The second type of investment is investment by US Pension Funds (Super Funds) into Australian Venture Capital funds, which are then managed locally. Until recently, the Australian tax regime prevented this type of investment because the tax paid on profits was higher than if the Pension Funds had invested in the US. However, the Government's *Venture Capital Limited*

Partnership (VCLP) legislation has removed that disincentive, albeit with some restrictions that seem to continue to discourage such investment. The legislation has only recently been enacted, and it may yet be possible that this type of investment will increase. However, feedback from the industry suggests there are still some issues with the operation of the VCLP rules.

VENTURE CAPITAL INVESTMENT – A Hypothetical Case Study

A researcher at an Australian University has devised a concept for a new approach to clean energy. The project requires significant funding, beyond the normal capability of Australian granting agencies.

The researcher applies to the US Department of Energy for a grant. Because of the FTA, the Department of Energy assesses the application on the same basis as a US application, and it is awarded. Negotiations take place over the ownership of the results of the funded research, and an agreement is reached which fairly takes account of the prior research funded by the Australian Government, and any ongoing contribution.

The research program progresses well, and develops a working prototype. As this is a significant breakthrough, a US venture capital firm becomes interested. They are comforted by the fact that the work has been funded by the US Department of Energy, even though it is far away in Australia.

One of the venture capital firm's partners drops in on the lab while on holidays. He/she is impressed with the work and the researcher, and begins to think how it might be possible to make an investment. The first issue to be addressed is how the investment could be managed. The US venture capitalist is not familiar with any of the Australian venture capital firms, but does know of a top class US CEO who they have confidence in and who is exceptionally well connected in the clean energy field.

However, how would the CEO be attracted to Australia to run the company? Fortunately, there are attractive tax provisions for US venture capital backed company Chief Executive Officers to come to Australia for 2-3 years to start new ventures before returning to manage them in the USA.

The venture capital partner asks the CEO to go to Australia to undertake due diligence on the technology and to find an Australian venture capitalist to co-invest. The due diligence report is favourable, the Australian VCs like the concept of the US CEO running the company in Australia for a few years, then managing it in the USA with a US venture capitalist to look after it over there. The package is finalised, the US venture capitalist makes a direct investment as does the Australian venture capitalist, the US CEO is hired, and the company proceeds to develop the technology for the market.

So, at present, investment by US investors is quite low, either directly in companies or in Australian Venture Capital Funds. The closer economic relationship that will be created by the free trade agreement will reduce the "non financial" hurdles to US Venture Capital investment in Australia, and we should work to ensure that any structural barriers are removed to encourage such investment.

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4 OPPORTUNITIES OPENED BY THE FREE TRADE AGREEMENT FOR FRONTIER TECHNOLOGIES DEVELOPMENT IN AUSTRALIA

This section cites several case studies to highlight the specific opportunities that AUSFTA may open for Australian research and innovation.

4.1 Clean and Secure Energy

This case study focuses on how the signing of an FTA might open opportunities for Australian science and industry to participate fully in the early and exciting stages of the US hydrogen economy programmes.

The Challenge

Energy is the world's largest business. Energy demand is increasing, with the greatest growth in Asia, particularly China and India.[22] But producing and consuming energy presently carries negative environmental consequences.

The energy business is addressing the changes it faces. These are societal demand for cheap energy production in a "greenhouse gas constrained" future, as well as the desire of governments for energy security and independence. One example is BP's response, reported at the Broome Conference[23], as one investing $500 million over three years in renewable energies, to build up competencies and skills needed for the business in the future.[24]

New total energy solutions are needed by scientists, engineers, and social scientists working together to meet these demands. The preferred solution for many countries, none more than the United States, is for hydrogen as the prime energy source. When ignited with oxygen, it produces water and no greenhouse gases – a completely clean energy source.

The problem lies in producing hydrogen. Hydrogen produced from fossil fuels also produces greenhouse gases, while its production from renewable sources does not. However, the latter process is prohibitively expensive and this will be the case for some time[25].

Australian and International Initiatives

A high level of international collaboration will be essential for achieving the necessary technological breakthroughs for clean hydrogen production. These include not only the production of hydrogen from a variety of sources over time, but its safe storage and distribution. Significant investment will be required in design and development of new pipelines, storage facilities, or fuelling stations, presenting opportunities for Australia.

[22] "Energy – the challenges before us", Karl Foger, Australian Academy of Science symposium 3-4 May 2000.

[23] "Australian and International Hydrogen Energy Conference", Broome, WA, 18 – 21 May 2003.

[24] The Business Report, Radio National 24 May 2003 "Hydrogen Use Conference held in Broome", comment attributed to Mike Jones, BP

[25] Generation of hydrogen from water or algae using solar energy are approaches being investigated in Australia at the University of NSW, and University of Queensland, respectively (See "New Power Generation", in the Bulletin, August 19, 2003, pp 58-60).

In addition, it is certain that fossil fuels overwhelmingly will be the resource for hydrogen production for many years. This is because it will be some time before renewable resources can be exploited through economically usable new technologies.

Considerable global effort is being directed at developing technologies required to build a hydrogen infrastructure. Global investment has accelerated dramatically over the past few years and is now in the range of several billion dollars.

NATIONAL HYDROGEN STUDY AND INTERNATIONAL HYDROGEN PARTNERSHIP

The Minister for Industry, Tourism and Resources released a report, the *National Hydrogen Study*[26], on 17 October 2003, which recommends Australia position itself as a leader in the hydrogen economy.

The report's main recommendations include a national vision for hydrogen and greater involvement in international research and industrial collaboration programs.

The Australian Government will participate in the *International Partnership on the Hydrogen Economy (IPHE)* to be hosted by the US Government.

IPHE is a US proposal for 15 national members, including Australia, to form a partnership.

An inaugural Ministerial meeting in Washington, 18-21 November 2003, involves three levels of discussions:

(1) At a general level, information sharing on overcoming obstacles to the introduction of hydrogen technologies.

(2) At the government level, discussions about the terms of reference and membership.

(3) Foster collaborative partnerships for research and commercialisation of relevant technologies.

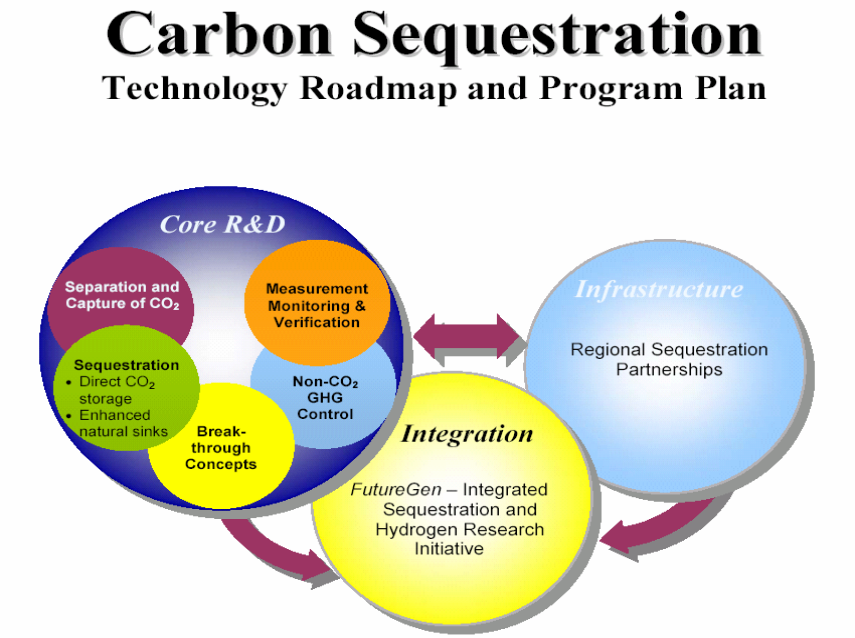
The US is the world leader in hydrogen technologies and recently announced a number of major clean energy initiatives using hydrogen, notably the *Freedom Car* and *FutureGen* programs.

The former is a $US1.7 billion program directed at advancing fuel cell vehicles. BP, Shell, General Motors, Toyota, Honda and BMW are putting hydrogen on the agenda.

The latter, the integrated sequestration and hydrogen research initiative (*FutureGen*) is a US$1 billion government/industry partnership to design, build and operate a nearly emission free, coal-fired electric and hydrogen production plant.

The use of fossil fuels (specifically coal) as the source of H_2 is significant both to the United States and Australia as the two countries have massive coal reserves. Australia also has very large "stranded" natural gas reserves such as Barrow Island that could be used as a feedstock (see Box on Clean Energy).

[26] Report is available at www.industry.gov.au under "What's New"



Japan is also serious about the hydrogen economy, for example, it has announced plans to introduce around 4,000 hydrogen filling stations by 2020.

Iceland is perhaps the best-known example of a planned hydrogen economy, setting the goal of a complete transition to hydrogen by 2030. In this scenario, hydrogen is produced from renewable geothermal and hydro resources. It is then fed into fuel cells to produce energy for homes, businesses, cars, buses, or fishing boats. Hawaii is currently conducting a similar feasibility assessment on its potential for large-scale use of hydrogen, fuel cells, and renewable energy.

ICELAND

Iceland is using cheap geothermal energy to make hydrogen.

A hydrogen economy is now official Icelandic Government policy. The first step is emission-free fuel cell buses on Reykjavik's streets, eventually to replace the capital's entire 80-strong fleet.

Buses will be fuelled at a new hydrogen filling station built on the outskirts of the city by Shell, one of three major corporations funding the project. Hydrogen will be produced at the hydrogen filling site, by splitting water using clean (geo-thermally produced) electricity from the grid.

The next stage will be the conversion of private cars on the island. Iceland's experts are also looking at the practicality of switching the huge trawlers that tie up at Reykjavik's fishing harbour to hydrogen power, making the country energy independent.

Iceland's abundant geo-thermal energy

It is very important for Australia to be part of the US research initiatives on hydrogen. Australia can develop initiatives that both contribute collaboratively to the US programs and take account of Australia's future needs. The US-

Australia FTA provides a framework within which collaboration, cooperation and support (including financial support) will be fostered.

CLEAN ENERGY INITIATIVES BY THE US AND AUSTRALIA

Australia and the US can both work together, speeding up the development of technologies essential for clean energy from coal. This is the first step to a hydrogen economy, and indeed to the development of economically renewable energy technologies such as solar cells. Australia cannot beat the US and must join it - clean energy will happen, with the enormous US resources being directed there. In cooperation, Australia will have the capacity to be a fast follower if it shows leadership in strategic research niches. Initiatives include:

FutureGen *is a US Government initiative involving around US$1 billion over 10 years to construct a* prototype plant for testing cutting-edge technologies in clean power, carbon capture, and coal-to-hydrogen technologies. It will be the cleanest fossil fuel-fired power plant in the world. The new technologies will expand options for producing hydrogen from coal, providing diversified and more secure sources of feedstock.

The plant will convert coal to a mixture of hydrogen and carbon monoxide, which will be reacted with steam to provide more hydrogen and simultaneously convert the carbon monoxide to CO_2. The hydrogen and CO_2 mixture will be separated, perhaps by novel nano-material based membranes currently under development (see following story). The concentrated stream of CO_2 would then be geologically sequestered. Hydrogen will be used for electric power generation either in turbines, fuel cells or hybrid combinations.

Coal21[27] is an Australian business initiative. It aims to realise the potential of advanced technologies to reduce or eliminate greenhouse gas emissions associated with coal, while at the same time maintaining Australia's competitive advantage of low cost electricity from coal.

The Carbon Sequestration Leadership Forum[28] focuses on development of carbon capture and storage technologies as a means to long term stabilisation of greenhouse gas levels in the atmosphere. It involves cooperation in data gathering, information exchange, and joint projects. Notable cooperative projects involve scientists from 18 nations monitoring if carbon dioxide remains entrapped after sequestration in an active oil field in North Dakota, and in a similar way in the North Sea off the coast of Norway. Australia will be hosting the second ministerial meeting of the Forum in Melbourne in September 2004. Australia is also vice-chair of the of the policy working group of the Forum and is taking a major role in developing positions for working group meetings in Pisa, Italy in January 2004.

Barrow Island - Geo-sequestration of carbon dioxide generated from natural gas is planned in a reservoir under Barrow Island in WA. The operators of the Gorgon natural gas field off the coast expect to be sequestering more than 5 million tonnes of the gas each year, equivalent to about 1% of Australia's total greenhouse emissions. This may be the world's biggest scale geo-sequestration project and attract US interests, facilitated by AUSFTA. It is expected to generate billions of dollars in exports.

Effective CO_2 capture and storage

There are a number of steps along the path to the hydrogen economy which are outlined in detail in Appendix 5. Here we focus on the present challenge, and the most critical first step and illustrate scientific research on nanomaterials that may prove very attractive to the US *FutureGen* programme mentioned above. The present most economical process of generating hydrogen for energy is from petroleum or coal sources. This process also

[27] See www.coal21.com.au
[28] See www.fe.doe.gov/programs

produces CO_2. Therefore, development and application of geo-sequestration technologies – those to remove and dispose of CO_2 in disused oil and gas reservoirs, deep aquifers and deep coal seams, instead of the atmosphere (geo-sequestration) – is essential. The condensed CO_2 remains trapped. This is the very first, crucial step to an ultimately clean energy environment.

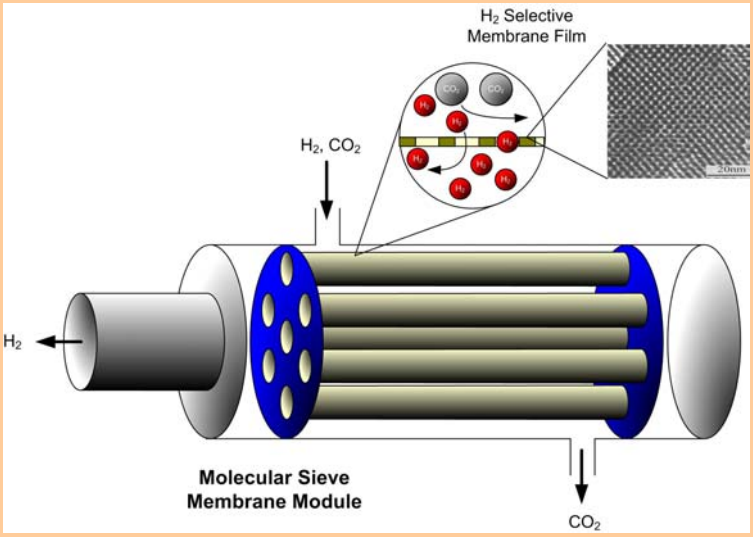
AUSTRALIAN FRONTIER TECHNOLOGY:
NANOTECHNOLOGY SEPARATION OF H_2 AND CO_2

Australia's national research priorities embrace both reducing and capturing emissions in energy generation, and frontier technologies to power world-class industries of the future.

Frontier technologies include nanotechnology. Australia has cutting edge science critical to development of porous, highly selective nano-material membranes. The scale and sophistication of these materials can be seen in the fact that they are engineered structured assemblies of molecules at around levels of a few billionths of a millimetre (nanometres), as the illustration below shows at the 20 nanometre level.

It is these nano-material membranes that can separate CO_2 from H_2, providing a major breakthrough in clean hydrogen generation from coal because the separated CO_2 is then available for geo-sequestration, and the hydrogen for energy production in fuel cells. This is an example of Australia's window of opportunity in key frontier technologies that can be integrated into a *FutureGen* model power plant. It has the potential to make a very significant contribution to the efficiency and economics of coal sourced hydrogen production.

These nano-porous membranes were invented by Professor Max Lu and colleagues at the *Nanomaterials Centre of the University of Queensland* (WO 01/93993). Membrane advantages include easy regeneration after many cycles of service *in situ*, reducing the need for replacement, and the economics appear to be very favourable compared to other technologies such as precious metal membranes.



A nano-porous membrane used as a molecular sieve to separate gases.

The diagram shows a hydrogen and carbon dioxide mixture entering a tube containing a sieving membrane. The cross section shows the membrane at the molecular level. Only the small (red) hydrogen molecules can pass through the gaps, with near 100% efficiency.

The membrane can withstand high temperatures. The membranes are designed to have pore sizes tailored for specific gases. They can be tailored for oxygen enrichment, another key requirement in gasification of coal.

The development of improved (and cheaper) technologies for CO_2 capture and separation represents a considerable challenge at this time. Some technologies for capture and storage are already available, but there is a need to understand how best to adapt, apply and optimize them for the very large scales required for power plants. It is unrealistic to expect that Australian research, undertaken in isolation, will produce the necessary breakthroughs. Australia must act in concert with the USA and other countries in order to achieve a step change in capture-separation technologies and move to more advanced energy systems. The free trade agreement will catalyse that collaboration, described in the two boxes above.

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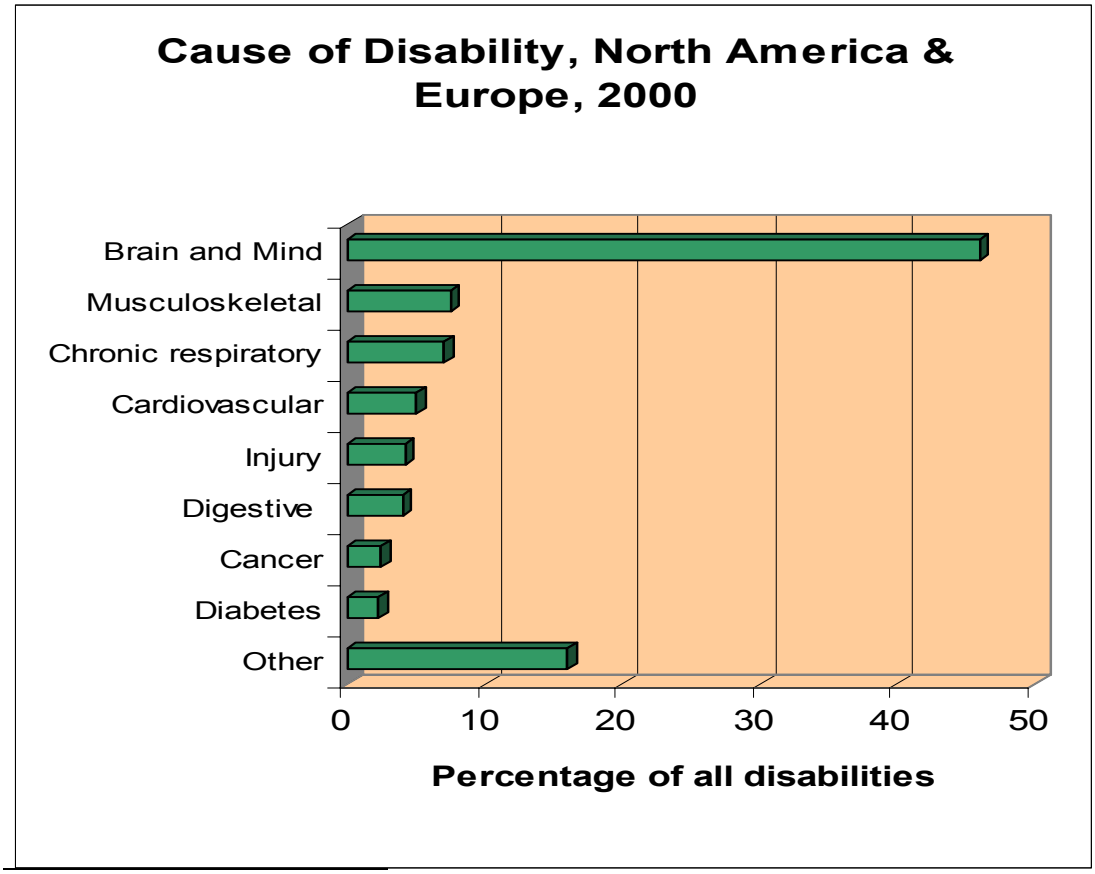
4.2 Neuroscience for Brain and Mind Disorders

The last meeting of the Prime Minister's Science, Engineering and Innovation Council featured a presentation on *Brain and Mind Disorders: Impact of the Neurosciences*.[29] The presentation showed the power of neuroscience research in understanding mental disorders, and the potential for the area to provide drugs and other highly focussed therapies to ameliorate the personal suffering and costly burdens associated with these disorders over the next decade or two. One of the areas featured was the use of stem cells to regenerate nerve cells for repair of the human nervous system. This frontier area is the case study of this section, as Australian research involves considerable collaboration and support from the US.

Brain and mind disorders

The following chart[30] shows the contribution of brain (nervous system) and mind (mental illness) to the total burden of disease and injury in North America and Europe. Brain and mind disorders are responsible for more total life years lost than either cardiovascular diseases or cancer.
The same detailed pattern is mirrored in Australia.[31]



[29] PMSEIC 27 June 2003; report available on the DEST website.
[30] Mental illness ranked first in causing disability in the US (and other developed nations) in 2000, according to a study by the World Health Organisation (WHO, 2001). Study is discussed in "Interim Report to the President", prepared by the President's New Freedom Commission on Mental Health, October 29, 2002.
[31] For Australia, see the PMSEIC presentation on neuroscience, June 2003, on the dest.gov.au website, p 12

Diseases of the brain and central nervous system account for a staggering 45% of the burden of disease in the Australian community, and similar levels in North America, but at present there are virtually no extant therapies available.

Underpinning most of the major neurological diseases, such as Alzheimer's disease and stroke, are the loss of function caused by nerve cell death. In addition, mental illnesses, such as schizophrenia, also appear to involve a significant loss of neurons, and the effectiveness of anti-depressants has recently been linked to the promotion of nerve cell production.

But these and other central nervous system drugs are not very specific and often carry side effects. Lithium is still one of the best drugs and it was discovered in 1949.

Neural Stem Cells

The goal of modern Australian research led by Professor Perry Bartlett at the University of Queensland is to develop a new generation of therapeutics that stimulate the production in humans of new nerve cells (neurons).

Professor Bartlett's group showed in 1992 that the adult brain contains stem (or precursor) cells capable of producing new neurons. This opened for the first time the possibility of repairing the diseased or injured brain. Over the years since then, an increasing number of studies in the US and Australia confirmed the importance of nerve cell production in the adult brain, revealing that new neurons are produced every day in a number of areas of the human brain, such as the area concerned with memory formation.

NEURAL STEM CELLS: The Importance of Lifestyle[32]

Although the skin, liver and many organs of the body can all generate new cells to replace damaged ones, until recently this was thought not to extend to the brain itself. Now we know that the brain can generate new cells throughout life. The birth of new neurons from neural stem cells is called *neurogenesis*. This groundbreaking discovery and its elaboration originate in Australian and US research.

The new brain cells and connections that humans make may provide the extra capacity for the variety of challenges that humans face. They may also be the basis for natural brain repair after injury (such as mild stroke). But what broad characteristics stimulate their formation and growth?

The intriguing answer may lie in 'brain workouts'. Scientific links are being established between neurogenesis and increased mental activity and exercise. Regular physical activity such as running can lift depression in humans, perhaps by activating neurogenesis. People may be able to reduce their risk of neural disease and enhance the natural repair processes in their brains by choosing a mentally challenging and physically active lifestyle.

Furthermore, this production of new cells can be influenced by both environmental and behavioural factors. New cellular production is reduced by anxiety and depression, but enhanced in response to environmental

[32] For detail see "Repair Yourself", Scientific American, September 2003, pages 29 - 35

enrichment and learning. Thus, the concept of the adult brain has dramatically changed from that of a static, hard-wired organ to one that is capable of continual change in response to behavioural regulation and higher brain functions, such as memory or learning. This characteristic has been termed *plasticity*.

POTENTIAL BENEFITS OVER TIME FOR NEUROSCIENCE

Access to funds

The closer bilateral relationship catalysed by the free trade agreement may give Australian neuroscientists an opportunity to gain access to US Government research funding on an equal footing with their American counterparts. Note that Australian scientists already have access to NIH's competitive extramural funding programs. Australian medical researchers are very competitive, attracting significant funding from the NIH – we rank second after Canada and similar to the funding attracted to the UK.

The free trade agreement may increase funding access to other US sources, such as the "disease alliances" related to Alzheimer 's disease, or Multiple Sclerosis.

Access to US funds would be facilitated by resolution of issues surrounding US Government policy towards ownership of intellectual property generated by US funded research accompanied by Australian contributions.

Increased awareness of Australia as a profitable destination for investment may encourage US venture capital funds to become more involved in the commercialisation of promising Australian medical research.

Regulatory advantages

The closer bilateral relationship may provide an impetus to mutual recognition of search and examination between the two countries, giving Australian researchers faster access to commercialisation in the largest pharmaceutical market in the world. At present, delays can be significant. AQIS/US Customs will face increased pressure for standardizing procedures and processing time for research compounds.

Infrastructure

Access to research infrastructure, such as high definition *Magnetic Resonance Imaging* facilities, which may be facilitated by the closer bilateral relationship, would allow Australia to directly test the action of drugs on nerve production in the brain. Access to reagents and compounds developed under license to NIH could be enhanced. Inclusion in networks such as Neuro-informatics and Brain Mapping projects in the USA would provide a competitive research advantage.

People movement

Access to USA funded fellowships and increased USA collaboration would give postdoctoral scientists and students a far greater opportunity for diverse training.

Thus, the prospect arises of harnessing this innate potential of the normal brain in order to generate new nerve cells to correct disease or injury effects. Recently, several studies have demonstrated the efficacy of this approach to repair damage following stroke and trauma in experimental animal models.

The key is to discover the molecules in the brain that promote new nerve cell production. The vital first step in doing this is to obtain pure brain stem cells in order to conduct systematic experiments to see what stimulates their

differentiation into nerve cells. This has been achieved by Australia and gives it a competitive edge in studying the behaviour of these stem cells. In a discovery published on the front cover of *Nature*, Professor Bartlett reported in 2001 the isolation of these neural stem cells.[33]

From this base, Professor Bartlett's group developed a picture of the molecular characteristics of the neural stem cells. This is now the technology platform that enables screening and identification of substances and optimal conditions for nerve production. The group currently has identified twelve receptors exclusively expressed by the adult brain stem cell and has begun to screen for molecules that activate signalling (growth factors). Patent applications are pending for stem cell isolation and screening techniques, and for the identity of the growth stimulants.

Professor Bartlett's group anticipates, with the appropriate level of support, the next stage of the process will be testing in animal models, possibly within 12 – 18 months. They are looking for new partnerships and an injection of capital to take these lead drug candidates into clinical trials and to seek partnership for discovery of other drug candidates using their platform technology. Clearly, US infrastructure and expertise, both public and business, is a prime attraction for the development of their work. Relevance and expertise is clearly evident in the activities of the US *National Institute of Neurological Disorders and Stroke.*

Past Australian Discoveries illustrate the Potential

The most commercially significant drug discovered by an Australian scientist was *Colony Stimulating Factor* (CSF) discovered at the Walter & Eliza Hall Institute by Professor Don Metcalf. This molecule, now known as Neupogen, stimulates the production of a patient's own white blood cells and is used widely following surgery and in leukemia patients to stimulate new blood formation and promote recovery. The total sales are now about $4 billion per annum, mainly through **Amgen**, a US corporation. Unfortunately, due to patent discrepancies between the USA and Australia at the time, the vast majority of the royalties flow to the US companies.

The drug(s) Professor Bartlett proposes to develop would have similar broad application in patients and could be given following neuro-trauma and stroke, and in disease conditions such as dementia associated with ageing. Applications may also extend to psychiatric illnesses such as depression and schizophrenia. Potential economic return in this day and age is enormous, far in excess of that of CSF.

Australia has clear scientific leadership in this area. However, screening and animal model testing are very expensive and time consuming, and access to increased funding from the USA through NIH or other support agencies would clearly accelerate the rate of discovery. Venture capital and joint ventures with US biotechnology companies would also assist drug development.

Strategic linkages with the biotechnology and pharmaceutical industries and a significant injection of capital, may both be facilitated under AUSFTA It is very attractive if the AUSFTA partnership serves to foster US interests conducting

[33] "Stem Cells: Purification from the Adult Brain", Nature 412, 16 August 2002, 736-739

phase III clinical trials[34] in Australia. Also of benefit would be the removal of restrictions requiring Australian pharmaceutical and biotechnology companies to conduct trials in the US in order to gain US registration, due to the high costs involved.

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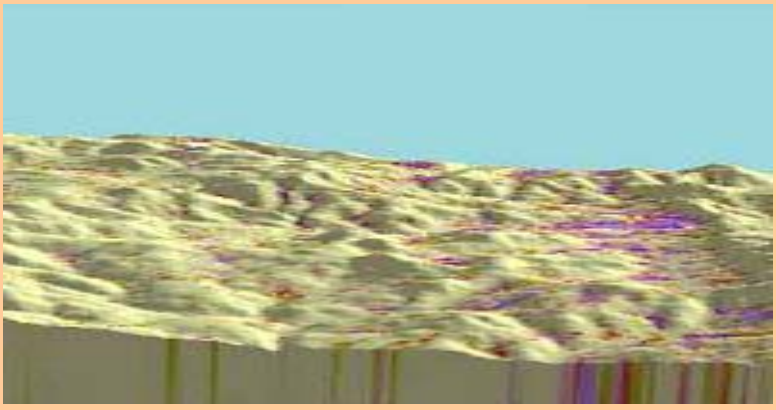
[34] Most clinical trials are designated as phase I, II, or III, based on the type of questions a study is seeking to answer: In Phase I clinical trials, researchers test a new drug or treatment in a small group of people (20-80) for the first time to evaluate its safety, determine a safe dosage range, and identify side effects. In Phase II clinical trials, the study drug or treatment is given to a larger group of people (100-300) to see if it is effective and to further evaluate its safety. In **Phase III** studies, the study drug or treatment is given to large groups of people (1,000-3,000) to confirm its effectiveness, monitor side effects, compare it to commonly used treatments, and collect information that will allow the drug or treatment to be used safely. These phases are defined by the US Food and Drug Administration in the Code of Federal Regulations. www.clinicaltrials.gov/ct/info/phase (NIH).

4.3 Plants for Arid Environments

Salinity

Work undertaken through the *National Dryland Salinity Program*[35] has estimated the current area of land threatened by salinity (principally as the result of rising water tables) to be in excess of 6.5 million hectares. This is estimated to grow to 17 million hectares by 2050. This salinity causes direct costs due to lost agricultural production, damage to buildings and infrastructure estimated to be in excess of $250m per annum. This does not include any attempted costing of broader environmental damage affecting wetlands, fauna and flora.

In the USA, salinity damage is most intense in California. Whilst there is less intensive research being done to quantify the economic cost than is the case in Australia, a search of websites concerning salinity in the USA indicates the extent and recognition of the problem.



SALINITY MAPS

Scientists are mapping Australian regions of greatest risk to salinity by combining information gained from NASA's aircraft and Space Shuttle with infrared imagery, computer-based geographical information systems, and computer models. Without the microwave data supplied in NASA's visits to Australia this would not have been possible. The picture above is an example of a salinity prediction map, where the darker areas represent high salinity potential.[36]

Legumes

Australia is an international research participant in frontier biotechnology developments related to sustainable agriculture and environmental management.

[35] See www.ndsp.gov.au
[36] www.abc.net.au/science/news/stories, Friday 5 May 2000

Pasture legumes are needed that have more extensive and deeper roots. These will mine the soil moisture and nutrients in areas where the water table is rising.

This example is a vital one, not only for maintaining the competitive advantage of Australian agriculture, particularly in view of the range of environmental conditions, from acid to arid to saline, encountered in Australia, but also to ameliorate environmental degradation through the use of specific legumes as environmental rescue crops.

Legumes are a unique plant category because of their root architecture. Their roots are characterised by knoblike outgrowths, or nodules, that contain soil bacteria (rhizobia). These bacteria convert atmospheric nitrogen into nitrogen compounds for use by the plant, a critical process called nitrogen fixation.

Legumes include pea, lupin and soybean, crops that provide sustainable pasture production and cereal rotation capabilities, and produce high quality farm based products such as vegetable oils, proteins, or high value nutriceuticals such as anti-oxidants, phytoestrogens or folate. Australia has a long record of outstanding legume research and its application to sustainable food production.

The Path to Drought Resistant Plants

Science and innovation in legumes in the US and Australia is paving the way to the creation of designer plants.

One example in Australia is Professor Peter Gresshoff's group, at the *ARC Centre of Excellence for Integrative Legume Research*. This group of researchers collaborates across several universities on developing plants that have dramatically improved drought resistance and capacity for environmental repair. They are looking specifically at what controls legume root growth, nodule development, and root architecture.

As an indication of the international significance of leading edge legume research, in the last year, ten research papers were published in the prestigious journals *Nature*, *Science*, and *Proceedings of the National Academy of Sciences,* including three by Professor Gresshoff's group. (The last two journals are the leading US publications of scientific research.) These are the culmination of work over some years exploring the mechanisms underlying legume nodulation.

The group recently reported a discovery of direct application to plant root architecture and nodule development, reported in *Science*[37]. It is the discovery of the gene which controls the signalling circuit for nodulation development in legumes. This circuit is likely to affect shoot development, cell division and plant disease responses. Understanding this "communication" signalling pathway opens the possibility of influencing plant development controls. This basic knowledge will contribute to producing plants that are very deep rooted,

[37] Science, January 2003

and therefore drought or salt tolerant. Within five years the group may be in a position to genetically alter the structure of roots to have these beneficial effects.

PLANT RESEARCH UNDER AUSFTA

A great deal of the genomic, phenomic and proteomic analysis undertaken by Professor Gresshoff's group relies on mutants and transgenic plant material sourced from laboratories in the USA. Current quarantine and customs procedures are very complex and administratively intensive.

The closer relationship generated by the free trade agreement may provide an opportunity to accredit prescribed laboratories in the USA and Australia to allow facilitated exchange of this material. This would greatly improve the efficiency of Australian research, and dramatically increase our competitiveness in gene discovery (e.g., compared with Japan, China and Europe.)

It is worth noting that current quarantine procedures do not differentiate between plants that are represented in Australian agricultural production and those that are not (e.g., *Arabidopsis and Lotus japonicus).*

Negotiations for a bilateral *Science & Technology Agreement* between Australia and the USA have been conducted over the last several years, without reaching a conclusion. Finalisation of this agreement within the context of a closer relationship generated by the free trade agreement would improve opportunities for research and innovation in Australia. A major objective of the agreement should be to actively facilitate the exchange of researchers between laboratories in both countries. Programs modelled on the Human Frontiers Program that is already in operation between the USA and Japan and Europe would be suitable.

Insights from Professor Gresshoff's research will have application to all plant systems and will generate valuable intellectual property. The expectation is that development and commercialisation of critical intellectual property will be greatly enhanced through closer bilateral ties, if frameworks can be set in place for equitable sharing of control and benefits.

New modelling and bioinformatics tools, many originating in the US, herald a bright era for deepening our understanding of nodule symbiosis. Exploration of new genes and their resultant gene regulatory networks to create better legumes and sustainable agricultural practices of benefit to the environment will reap benefits in the next five years.

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4.4 Light Metals for Transport and Defence

Australia and the US are closely tied into the future of the light metals (aluminium, magnesium and titanium) industry – evident from the relative strengths of the two countries in critical areas of their production and effective utilization, shown in the table.

Factor	**Australia**	**USA**
Natural Resource base	World class	Not well endowed
Electricity costs	Bottom quartile of world costs	Increasing steadily
People skills (metal production)	World class	Ageing
Metal component manufacturing	Emerging in export niches	World class
Design of components	Limited	World class
Integration of components into world leading applications (automotive, aerospace, computing)	Limited	World leader

Thus, Australian and US integration in light metals would enable a partnership that integrates and facilitates strengths in all parts of the value chain.

The partnership becomes even more critical when complemented by the greenhouse implications of significant light weight transportation applications brought about by light metals in air, sea and land vehicles.

The USA, through the Department of Energy[38], is seeking to promote light weight materials for use in transportation. Similarly, the US Department of Defence, through their *Defence Advanced Research Projects Agency,* is seeking to promote titanium use in defence and aerospace industries.

Light metals is one of six CSIRO flagships, which are major new initiatives (national and international) aimed at making Australia a stronger global competitor in the 21st Century.

[38] www.oit.doe.gov/aluminium/visions.shtml

Australia, through the Light Metals Flagship[39] is seeking to improve the energy efficiency and cost effectiveness of light metal production and promote applications in specific markets.

Much greater co-operation, if fostered by AUSFTA, would enable R&D expenditure to be allocated where it is most effectively utilised (lowest cost and best skills) rather than where the particular project proponent is located.

From an Australian perspective this would represent access to US Government funding for developments particularly at the resource end of the value chain.

For the US, there would be access to high calibre expertise critical to the technology developments desired by them.

A mutual interest example is titanium processing technology. Whilst the US's *Defence Advanced Research Projects Agency* is currently funding development of new processing technologies, these are all based in the USA. Several US companies with interests in titanium have substantive operations in Australia.

The integration of the R&D know-how of the two countries, an assessment of the most prospective areas for R&D from the ideas being independently pursued in the USA and Australia and a combined and focussed effort is much more likely to deliver the requisite outcomes.

Barriers that exist to such an approach are partially structural, (limitations on who and where funding can be applied) and partially behavioural.

The closer bilateral relationship catalysed by the free trade agreement may enhance the mutual capacity of both countries to develop more efficient and cleaner transport.

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[39] www.lightmetals.csiro.au

4.5 Biomedical equipment (ResMed)

Biomedical equipment is a showcase of Australia's capacity to link science and innovation. One of the most successful spin-off companies from Australian research, ResMed, manufactures devices for common sleep disorders, and has a story to tell about free trade.

THE RESMED STORY

Sound sleep is essential to health. The picture shows ResMed's new nasal mask.

ResMed is a leading respiratory medical device manufacturer, specializing in products for the diagnosis and treatment of sleep disordered breathing.

Formed in 1989, its primary purpose was to commercialize a device for treating obstructive sleep apnea. Developed in 1981 by Professor Colin Sullivan and colleagues at the University of Sydney, nasal continuous positive airway pressure provided the first successful non-invasive treatment of sleep apnea.

Operations have grown dramatically through the introduction of a number of highly innovative product lines. Its business strategy is to *Think global; act local.* Products are marketed and distributed in over 60 countries by direct employees as well as distributors with extensive knowledge and experience of local markets. This ensures that ResMed supplies the right products to the right markets—a key factor in the Company's business strategy. ResMed's principal manufacturing facilities are located in Sydney.

ResMed considers that it has been adversely affected by the lack of an FTA between Australia and the USA. While the problem may be solved by the imminent prospect for an FTA between Australia and the USA, the fundamental problem arises because Australia has not signed a World Trade Organization (WTO) *Government Procurement Agreement*. Only a few countries (and largely quite small ones from a competitive stance - eg Iceland) have not signed this WTO *Government Procurement Agreement*. It appears that one of the impediments to signing is that some State Governments may prefer to keep business within their own borders. The result of this in ResMed's view is that Australian companies are ineligible for US Federal Government purchasing.

The flow on effect on ResMed's business interests relate to sales to the US Veteran's Affairs (VA) Hospital System (run by the US Federal Government). ResMed sales to the VA Hospitals had been successful and grew to a point where the US decided a tender process was now required. An invitation to

tender was issued late in 2002 - with the concomitant focus on rules and regulations - which brought this problem to a head for ResMed.

There were two solutions from ResMed's perspective. On the one hand, it could wait for some type of trade agreement. On the other hand, ResMed could move some of its manufacturing out of Australia and to the USA. Not surprisingly moving some manufacturing to the USA was seen as a lower risk option - and indeed this was the basis for the tender submission.

Thus, earlier this year, ResMed bid on a contract from the US Veterans Affairs Department with a value in excess of US$5 million. That contract required Resmed to certify that its products were manufactured in compliance with the *Buy America Act* and *Trade Agreements Act*. In order to be able to fulfil the contract, ResMed made plans to manufacture its products in the United States. ResMed obtained a ruling from US Customs confirming that manufacture in the US would satisfy the relevant requirements.

The Veterans' Affairs Department ultimately withdrew that contract solicitation, but has indicated it intends to renew it some time in the near future. It has also indicated that it may expand the contract to include other products, which may make it of even greater value. Although it is not known when the contract will be resubmitted for bidding, the ability to bid -- and the amount of any bid -- will be impacted by the status of a trade agreement. That's why Resmed remain keenly interested in the timing of any agreement. But even if that contract were awarded before a trade agreement was reached, a trade agreement would be able to benefit ResMed in the future.

In addition to the possibility of that Veterans' Affairs contract, Resmed believes that it could increase other exports in excess of US $1.5 million per year if able to have its products considered on an equal footing with US manufactured products. That view is based on an estimate of sales to other government purchasers, and other products not included in the Veterans' Affairs bid.

ResMed sales in the United States during the last fiscal year ended June 30, 2003 were US$130 million. Virtually all those products were manufactured in Australia. ResMed is in the process of building a new manufacturing plant on a 30-acre site at Norwest Business Park, outside of Sydney, at a total cost of over US $63 million. It would like nothing better than to utilize that capacity for all US sales.

Current US Government procurement restrictions are forcing the company to make plans to manufacture approximately $6.5 million annually of its products in the US. Once that manufacturing capacity is established, it is possible that it will be utilized for non-governmental sales, as well.

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4.6 CSIRO

CSIRO was approached to learn about its collaborative experiences with the US, and for views on whether an FTA may lead to more extensive collaborative effort.

CSIRO[40] has 259 research activities listed on its website about collaboration with the US in 2002. Most do not involve intellectual property issues directly, as they tend to be fairly basic research projects. The more commercially oriented joint projects that CSIRO is involved in also have an Australian firm as a partner and these firms handle any intellectual property negotiations with US collaborators.

CSIRO's experience is that engagement with the US presently comprises a variety of impediments, and their view is that AUSFTA might lead to advantages for CSIRO.

CSIRO would like general intellectual property alignment with the US; less subsidisation by the US of industries such as the dairy industry; clarity on issues concerning biotechnology; higher NASA project funding levels flowing to CSIRO; and the removal of barriers to engaging with car manufacturers in developing hydrogen storage / super-capacitors or light metals imports into the US.

In the case of NASA, CSIRO has received relatively small funding even though NASA has a high interest in relevant CSIRO areas such as intelligent systems. It appears that this is because NASA faces limitations in funding transfers to foreign government entities. Any improvement in this process from AUSFTA would be very welcome to CSIRO.

In the case of energy research, CSIRO is laying the groundwork for much stronger engagement with the US automotive industry. Discussions are proceeding on hybrid and electric vehicles, fuel cells, light metals, hydrogen storage, and energy storage in the form of super capacitors and batteries. It would help if AUSFTA facilitates this engagement and removes both perceived and real barriers to expanded collaborative effort in these important areas.

CSIRO has extensive research collaboration with Boeing in Seattle, and would like this to expand.

CSIRO banknote technology expertise is also an area of potential for more intensive marketing in the US.

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[40] Full list of "CSIRO International Science and Technology Activities 2002" with the US appears on CSIRO's website www.csiro.au

5 CONCLUSION

Closer economic ties with the US are being brought about by the free trade agreement, and other initiatives within the Australian Government.

These close ties will effect changes to science and innovation in Australia. Changes will not be instant and perhaps painful in part. Gains to each nation will require reciprocal concessions.

Generally, with closer bilateral ties lifting Australian productivity, competitiveness, investment, and inter-governmental links, the science and innovation system will benefit in a number of ways:

There may be increased access to US research funding and infrastructure.

There will be enhanced opportunities to sell high technology goods and services into the US market.

There will be improved access to the skills necessary for successful research commercialisation.

In frontier technologies, research and innovation opportunities for stimulating cooperation will abound under the closer economic ties of AUSFTA.

Cooperation will speed up and intensify the securing of clean energy, which will reap billions of dollars and promote regional, skilled employment for Australia.

Cooperation in neuroscience may provide approaches to repairing brain injuries through stem cells, and may result in substantial economic gains to Australia through neuroscience commercialisation that may grow firms. This picture is reinforced in the neuroscience presentation to the last meeting of PMSEIC.

There is great scope for cooperation in developing designer plants that are very deep rooted and drought or salt tolerant to reverse the unforeseen environmental problems of the last 200 years.

Vigorous Australian export oriented companies like *ResMed* may increase manufacturing in Australia, boosting skilled employment.

Complementarities between our two nation's science and innovation strengths could be better exploited, illustrated in the light metals area.

Overall, the goals and national aspirations embedded in Australia's new national research priorities may be more easily met.

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APPENDICES

Appendix 1: Terms of Reference

The Working Group will prepare a paper and presentation for PMSEIC which will:

1 Briefly describe AUSFTA objectives, expected outcomes, and status of negotiations.

2 Identify opportunities and risks created by AUSFTA for the Australian innovation system, examining issues such as (H: High Priority; M: Medium Priority):

- funding flows (research and industry) (H)
- regulatory and innovation (including IP) (H)
- access to hard infrastructure (eg major national research facilities) and soft infrastructure (eg professional advice on entrepreneurial skills) and security clearances (H)
- government procurement (M)
- development of frontier technologies (M)
- people movement (M)

3 Identify and illustrate up to six specific examples of technologies under development in Australia, including hydrogen, and how the environment under AUSFTA would provide opportunities for them to be further developed or exploited.

Appendix 2: Consultations

Dr Miriam Baltuck, Science Attaché, US Embassy, Canberra

Professor Perry Bartlett, School of Biomedical Sciences, University of Queensland

Dr Brent Davis, Australian Chamber of Commerce and Industry (ACCI)

Stephen Deady, AUSFTA Special Negotiator, Office of Trade Negotiations, DFAT

Susan Farquhar, IP Australia

Dr Tony Filmer, Director, Light Metals Flagship, CSIRO

Professor Peter Gresshoff, Director, ARC Centre of Excellence for Integrative Legume Research, University of Queensland

Professor John Hearn, Deputy Vice-Chancellor (Research), ANU

David Herald, IP Australia

Ta-Yan Leong, Manager, International Affairs, CSIRO

Chris Roberts, ResMed

Tony Rothnie, Acting Manager, International S&T Relations, DEST

John Spasojevic, Deputy Secretary, Department of Industry, Tourism and Resources

William Thorne, Acting Group Manager, AEI, DEST

Kristie van Omme, AEI Group, DEST

Appendix 3: The Scope of Free Trade Agreements[41]

What is a Free Trade Agreement?

Free Trade Agreements (FTAs) and Customs Unions, such as the European Union, together comprise the main exception to the Most-Favoured-Nation (MFN) principle, the fundamental rule guiding trade in goods among members of the World Trade Organization. Under the MFN rule, members of the WTO must give fellow WTO members no less favourable treatment in terms of tariff rates and other trade measures than they afford to any other country.

FTAs and Customs Unions (together defined as Regional Trade Agreements or RTAs in WTO terminology) are exceptions to this rule. WTO rules allow individual countries to afford preferential treatment to partners in an RTA, provided that the RTA conforms to certain strict conditions.

The rationale for allowing this exception is set out in Article XXIV of the General Agreement on Tariffs and Trade (GATT) of 1947, which provided the foundation for the later WTO agreements. Article XXIV recognised the desirability of increasing freedom of trade by the development of closer integration between member countries through agreements establishing customs union or free-trade areas. At the same time, strict conditions apply to RTAs to ensure that they perform a truly liberalising function in international trade and do not encourage the establishment of new barriers, or provide an easy route to introduce new measures discriminating between trading partners.

The crucial test of an FTA or Customs Union is that it must **eliminate all tariffs** and other restrictions on **substantially all trade** in goods between its member countries. Although WTO members have differed over how precisely to define "substantially all trade", few would disagree that this means, at the very least, that a high proportion of trade between the parties - whether measured by trade volumes or tariff lines - should be covered by the elimination of tariffs and other restrictive trade regulations. Australia considers that this must be a very high percentage, and that no major sector should be excluded from tariff elimination.

While an FTA as defined under the WTO does not have to include trade in services, most contemporary agreements that are labelled "Free Trade Agreements" cover both goods and services, reflecting the growing importance of the services in the global economy. Such agreements are effectively a combination of FTAs and EIAs. In fact, FTAs together with EIAs provide a framework under which countries can negotiate a range of other bilateral undertakings governing their economic relations. In addition to trade in goods and services, Free Trade Agreements frequently cover such issues as investment protection and promotion, government procurement and competition policy, which are either not yet encompassed by WTO rules or only partially covered.

FTAs often also contain practical provisions in areas such as harmonisation or mutual recognition of technical standards, customs cooperation, application of subsidies or anti-dumping policies, electronic commerce, and protection of intellectual property rights. Such provisions do not have to be included in FTAs under WTO rules, but they can play an important role in facilitating trade between the parties and in a broader regional context.

Such bilateral or plurilateral economic agreements are often given titles such as "Closer Economic Agreements" or "Partnerships" to reflect their broad scope, even if FTA provisions eliminating restrictions on trade in goods form the core element.

Why an FTA with the US?

An FTA with the US offers substantial benefits for Australia. The US has the world's largest economy. It is Australia's second largest trading partner, the number one source of foreign investment and is now the largest destination for Australian direct investment overseas.

DFAT commissioned two studies on the economic and wider implications of an FTA. The first, entitled "Economic impacts of an Australian - United States Free Trade Area" by the Centre for

[41] This is an extract from the DFAT website description of international trade agreements.

International Economics, showed that liberalisation of bilateral trade and investment could boost Australia's GDP by as much as $4 billion annually within 10 years. This figure is based on modelling that assumes the removal of all tariffs and other barriers for which it was possible to estimate the quantifiable impact of their removal. If the final agreement were not to eliminate all barriers immediately upon entry into force then the impact would accordingly be proportionately less and spread over a longer time frame.

The second study, An Australia-USA Free Trade Agreement - Issues and Implication", was carried out by the APEC Study Centre. It showed that, in addition to the direct benefits of increased access for our goods and services to the US market, an FTA could play an important role in attracting US investment to Australia and would improve ties with US business practice in areas such as e-commerce. In addition, it would help to protect Australia's market access interests in the context of the US's other FTA initiatives, such as the Free Trade Area of the Americas.

There is widespread support from business groups and leading companies in both Australia and the United States. Business coalitions have been formed in both countries- the Australia United States Free Trade Agreement Business Group in Australia and the American Australian Free Trade Agreement Coalition in the United States.

What are the specific objectives Australia is pursuing in an AUSFTA?

The Government is giving high priority during the negotiations to reducing the most significant market access barriers facing Australian exports, particularly in the agricultural sector. Australia will continue to pursue a range of Australian interests in the US market covering all areas of the Australian economy, including manufacturing, services, investment, government procurement, telecommunications, electronic commerce, intellectual property rights and movement of people.

What consideration applies to existing Australian Government policies?

The Government is committed to ensuring that outcomes from the FTA do not impair Australia's ability to meet fundamental policy objectives in health care, education, consumer protection, cultural policy, quarantine and environmental policy. However, this does not mean that Australia should refuse to discuss any aspect of governmental regulation that impinges upon such issues. For negotiations to be constructive, each party must be allowed to explain its point of view on matters that it considers relevant. Australia has important interests of its own that it would not wish to be ruled out of bounds.

Such discussion also provides an opportunity for either party to clarify the rationale and operation of particular policies and measures and to address specific concerns or misconceptions. To be prepared to discuss such matters does not mean Australia is willing to contemplate significant changes to important policies or programs. The Government has made its position clear on a number of specific domestic issues that have attracted public attention, as outlined below.

- Cultural policy and local content quotas for TV and radio

The Government remains committed to preserving the right to regulate audiovisual media to achieve its cultural and social objectives, and to maintaining an appropriate set of support measures for the audiovisual sector to underpin Australia's cultural policy. Most support measures for our cultural industries, apart from local content rules for TV and radio, are delivered by grants and other subsidies. The US Chief Negotiator has stated publicly that the US was not seeking the removal of cultural subsidies or of existing local content quotas for broadcasting.

- Pharmaceutical Benefits Scheme (PBS)

The Government will ensure that the FTA negotiations will not impair Australia's ability to provide universal access to quality and affordable medicines through a sustainable PBS or to meet other fundamental policy objectives in health care. This objective has been made clear to the United States from the beginning of our negotiations, with the Government highlighting the importance of the PBS to the Australian community.

To date, the US has not made any specific requests or tabled any proposals seeking changes to the PBS. Senior US officials have stated publicly, in the context of these negotiations, that the

US has no intention of affecting the basic framework of the PBS or Australia's broader healthcare policy.

- Genetically Modified Organisms (GMOs)

We will defend Australia's GMO regulatory arrangements, both in respect of GMO food labelling and the arrangements under the Gene Technology Act as being consistent with Australia's World Trade Organisation (WTO) commitments.

- Government Procurement

Australia's position in seeking improved access to the US market will be pursued in accordance with the Government's overall objective of the AUSFTA – promoting job creation and economic development. The Commonwealth Government is working very closely with the States and Territories and industry and business organisations to achieve an outcome on procurement that delivers the widest possible benefit.

- Foreign investment screening

International investment has always played a significant and beneficial role in Australia's development. Foreign investment has brought, and continues to bring, new technologies and management skills to Australia and it has permitted Australians to enjoy a higher standard of living and higher rates of economic growth than otherwise would have been possible. The Government's approach to the FTA reflects the need to facilitate further investment while preserving the Government's capacity to protect the national interest.

Appendix 4: Australian Education in the Context of Trade Agreements

THE GATS (General Agreement on Trade in Services)

Australia is relatively open in terms of the trade in education services and is asking other countries to match its commitments. Australia's commitments on education services were made during the Uruguay Round negotiations (finalised 1994).

In GATS, primary education is excluded from Australia's schedule of commitments, as is public secondary and higher education. Because Australia remains unbound on National Treatment, it maintains the right to treat Australian providers differently from foreign providers (particularly in regard to government subsidies, research grants, student loans etc.) In addition, Australia has entered a horizontal commitment protecting all public research grants in all sectors. This is a domestic policy decision made by the Australian Government.

Interest and concerns about GATS have tended to focus on a domestic governments' ability to set policy, regulate services and maintain public services. GATS can not force the opening up of sectors or remove domestic regulation and policy affecting these sectors.

Australia's position, as endorsed by State and Territory governments and the Australian Vice-Chancellors' Committee (AVCC), continues to be that while it support a more liberal trade environment for education services it also support the right of governments to fund and regulate education as part of national policy objectives.

The Government announced (Minister Vaile's media release of 1 April 2003) that Australia will not be making any offers in the areas of public education, public health or the ownership of water. The Government also reiterated that it will ensure that the outcomes of the overall GATS negotiations will not impair Australia's ability to deliver fundamental policy objectives in relation to social and cultural goals.

It should be noted that GATS excludes services supplied in the exercise of government authority (i.e. not supplied on a commercial basis or in competition with others. This has been seen to include sectors such as public health, education, and defence.)

AUSFTA

In relation to the FTA, there should continue to be consistency between bilateral and multilateral trade agreements regarding education, science and training. (In this area, Free trade agreements should perhaps not go beyond Australia's current GATS commitments)

In relation to qualifications recognition, progressing mutual qualification agreements and quality assurance frameworks is perhaps more appropriately done through fora outside of Free trade agreements, although linkages might continue to be made between the GATS round and other processes.

Through APEC, Australia has been working with other APEC economies (including the US) to facilitate the movement of Engineers and Architects in the APEC region.

Appendix 5: The Pathway to a Hydrogen Economy

Zero Emission Energy

Zero emission energy able to meet Australia's rapidly growing energy needs is seen by many as being of critical importance to the future development of Australia's energy intensive economy whilst at the same time decreasing its emissions of CO_2 to the atmosphere. Zero emissions energy will also be important in securing future markets for Australia's LNG coal and energy intensive imports.

The long term objective must be to move to a hydrogen economy in which the hydrogen is derived from electrolysis of water using electricity derived from renewable energy (wind, solar, biomass) on a massive scale. Before this can be achieved, there are a number of hurdles to be overcome, but we are already able to define some of the key steps on the roadmap to the hydrogen economy. These include for Australia:

1. Application of CO_2 capture and storage technologies
2. Zero emissions electricity generation from fossil fuels
3. Production of commercial quantities of H_2 from fossil fuels
4. Development of H_2 infrastructure
5. Wide scale application of H_2 as an energy carrier for power and transport.
6. Production of commercial quantities of H_2 from renewable energy

Broad concepts of the hydrogen economy, and the crucial Step 1, are discussed in Section 4.1. Here a brief outline of the other steps is given.

1. CO_2 capture and storage (refer Section 4.1)

2. Zero Emission Electricity

Australia currently generates almost half its total CO_2 emissions from electricity production, with annual growth in electricity use set to continue to rise. If Australia's CO_2 emissions are to be curbed then it must be amongst various measures, including fuel switching and renewables. It may need to retrofit CO_2 capture and storage systems to existing plant (likely to be expensive) or move to advanced energy systems such as IGCC or oxyfuel systems, linked to geo-sequestration as illustrated below.

The prospect of developing a demonstration IGCC plant in Australia, with "sequestration ready" emissions, is being discussed at the present time. The United States proposes to undertake the much larger *FutureGen* programme (Section 4.1).

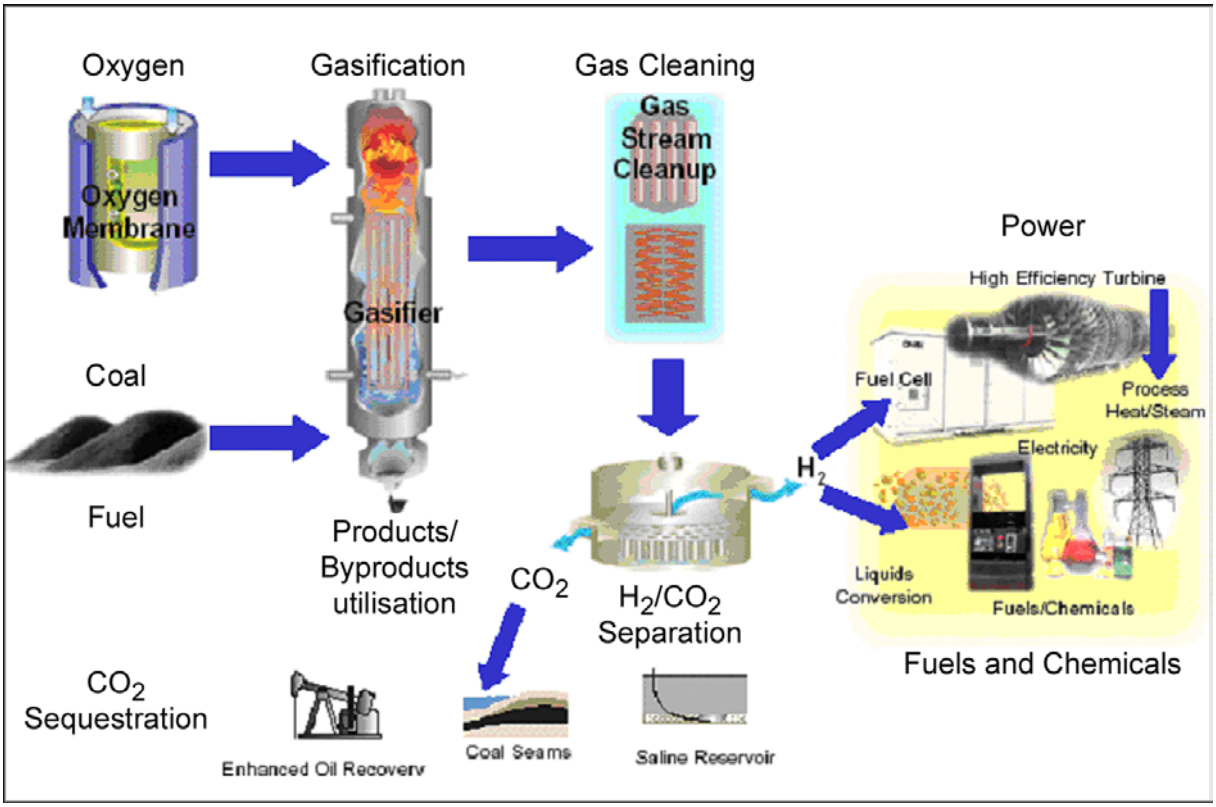

Figure 1: Concepts of FutureGen involving integrated technologies for clean energy (H_2) production from coal with carbon capture and disposal

3. Hydrogen Production from fossil fuels

Hydrogen is currently produced from natural gas at various sites mainly for the chemical and refining industries. The large scale production of hydrogen from fossil fuels and its use in energy production is an essential next step on the path to the hydrogen economy.

A BP-funded study found that hydrogen production from coal is the most economical approach taking into account carbon capture and storage. The study demonstrated that is was more costly (in $/tC) to decarbonise flue gas from electricity production than decarbonise a gas stream from H_2 production. This suggests that the more quickly H_2 fuel becomes competitive, the sooner a low-carbon energy future will emerge. This is the basis for the recent US Department of Energy *FutureGen* initiative. (Figure 1)

4. Development of a hydrogen infrastructure

Development of a hydrogen infrastructure requires effective technologies for using H_2 as an energy carrier, including for transportation and sufficient demand for hydrogen. The Australian economy is too small to be a leader in the widespread development of a hydrogen economy involving the generation, transportation, selling and use of hydrogen. However there is scope for Australia to develop niche opportunities and contribute to technology breakthroughs. The CSIRO Energy Flagship program has a particular focus on hydrogen and could be expected to have a significant impact. The advent of the FTA will catalyse a greater level of collaboration in this topic.

It also has to be borne in mind that Australia has two of the primary ingredients for an emission-free hydrogen economy namely abundant coal and gas as the potential feedstock and a high

potential for geo-sequestration of the CO_2 generated. This in turn could mean that Australia will in the long term be a preferred country for inward investment relating to the development of a hydrogen economy.

Having an FTA in place would enhance the prospects of inward investment focused on hydrogen. A model developed by CO2CRC that links all of the necessary ingredients to form an emission free node is illustrated below (Figure 2). Under this model industries would collaborate to share costs of CO_2 capture and storage, have access to cost efficient emission-free energy and provide a system for generating, storing and distributing H_2.

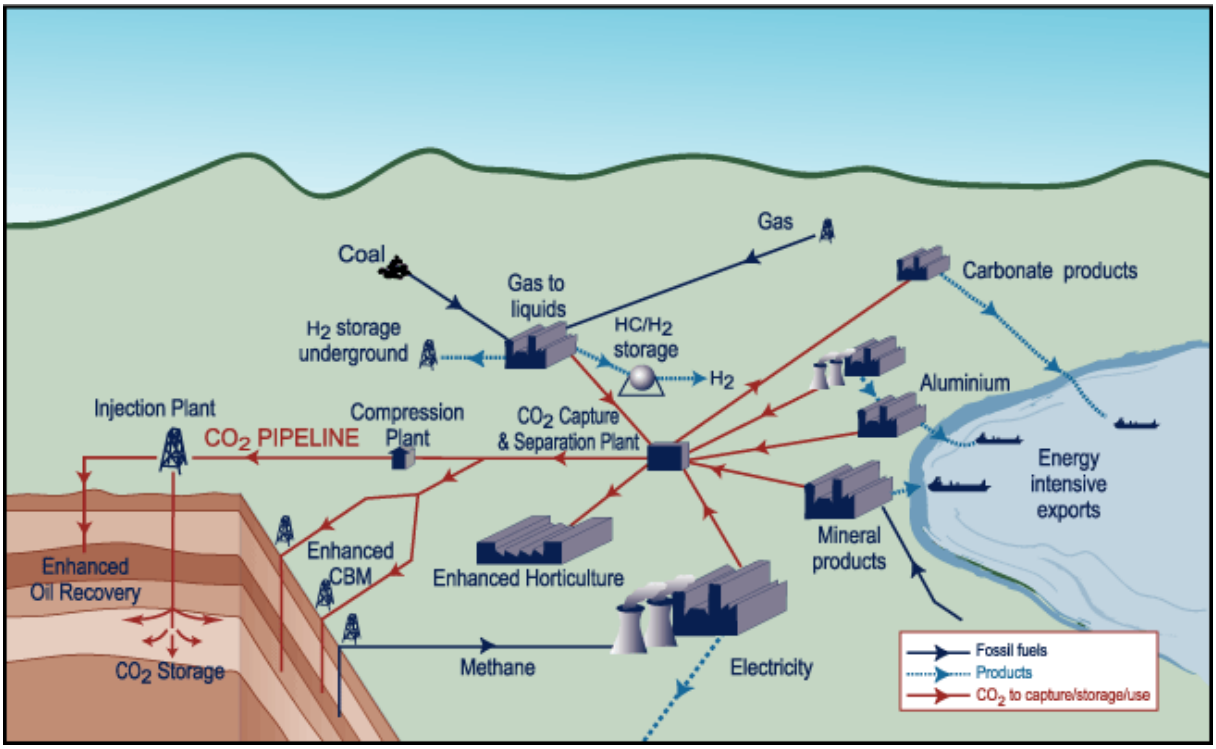

Figure 2. An emission free vision for the future

5. Widespread Use of Hydrogen

This phase of the H_2 pathway depends on the development and application of hydrogen fuel cells and the use of hydrogen for transport. The US$1 billion US presidential initiative, known as Freedom Car, is likely to provide a major boost to the development of the hydrogen car over the next decade but again a distribution and retailing system is critical to the widespread use of hydrogen-based transport systems.

As a small economy, Australia will not be a leader in this area but as pointed out earlier, Australia could become a high technology provider of "green hydrogen". Using its fossil fuel-sequestration capacity to exploit that potential will require a massive financial investment; the FTA will facilitate that massive investment.

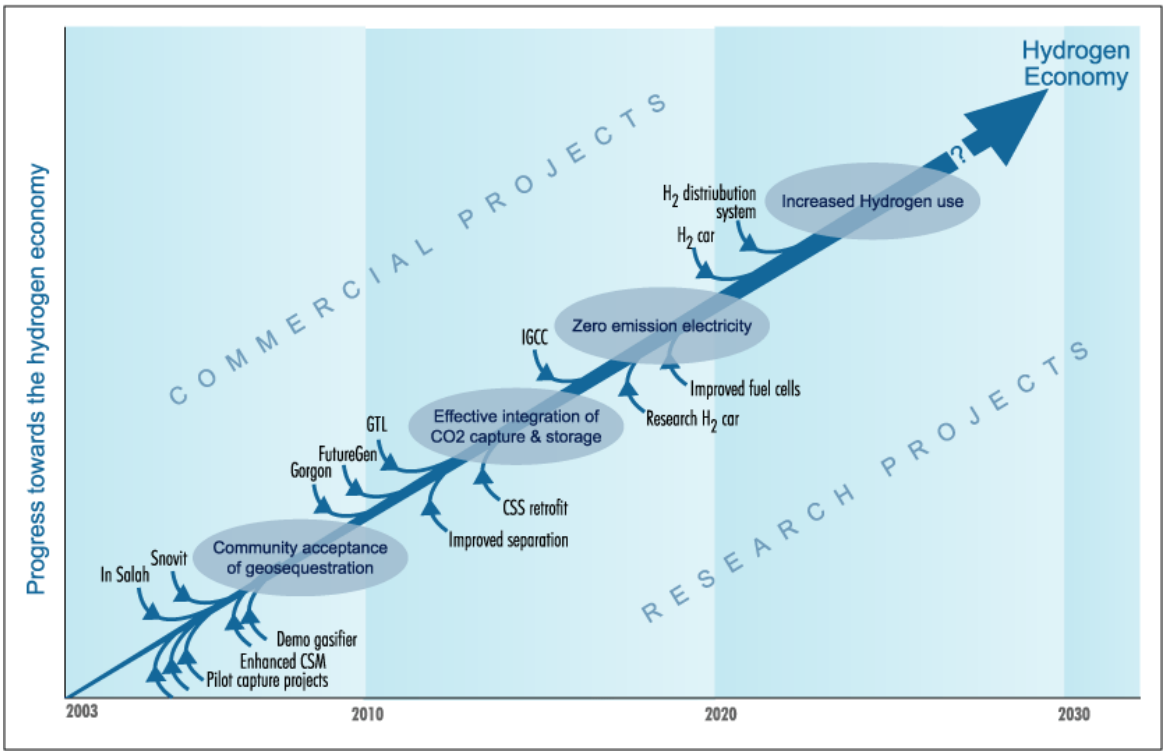

Figure 3. Progress towards the hydrogen economy

6. Hydrogen from renewables

The ultimate aim (Fig 3) must be to develop a hydrogen economy based on clean renewable energy derived from solar, wind or geothermal power or artificial photosynthesis or a combination of all these. However there are many technical challenges ahead and it will take time, perhaps, many decades before we can produce H_2 from renewable energy on the scale and at a cost that makes it commercially feasible. A fossil fuel-based H_2 economy will provide that time; it will also ensure that the new infrastructure required for hydrogen will already be in place and will not be a barrier to the take-up of renewable-based energy. Innovative hydrogen fuel cells, new types of membranes for separating H_2 and CO_2, more efficient solar cells will all be part of the necessary mix of technology innovations. The USA is the world's powerhouse in many of these areas and it is essential that Australia work with the USA to maximize benefits for both countries. Again the FTA will be a catalyst for that close technical (and financial) relationship. (Fig 4)

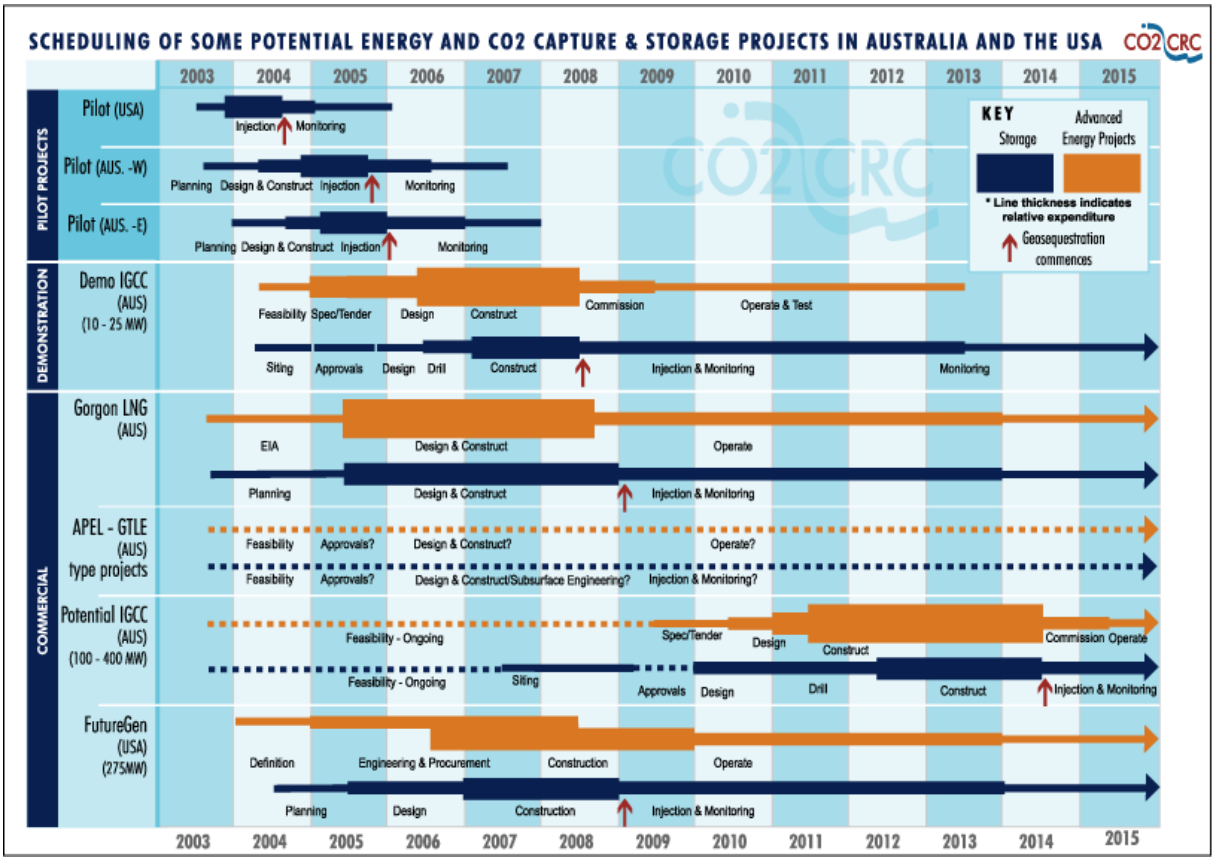

Figure 4. Scheduling of some potential energy and CO_2 capture & storage projects in Australia and the USA

APPENDIX 6: SUMMARY OF POSSIBLE SCIENCE AND INNOVATION OUTCOMES FROM AUSFTA

AUSFTA	
IMPACTS	**INNOVATION OUTCOMES**
Increased competition in some sectors*	Competitive environment stimulates increased innovation in these sectors[42]
US Government procurement market opened to Australian firms	Indirect impact on commercialisation by increasing access to the US market for innovative Australian firms such as Resmed
Increased mutual recognition or harmonisation of standards and conformance testing regimes	Indirect impact on commercialisation by increasing access to the US market for innovative Australian firms
CLOSER BILATERAL TIES CATALYSED BY AUSFTA	
IMPACTS	**INNOVATION OUTCOMES**
Increased access to both countries science funding schemes Liberalisation of restrictions relating to intellectual property generated by US funded and Australian funded research. Access to major research infrastructure	Stimulation of world class Australian research (It must be noted that direct access by US researchers to Australian funding would have a significant negative impact on Australian research; alternative cooperative funding models would need to be developed)
Mutual recognition of patent decisions	Reduced duplication and costs for Australian innovators
Barriers to people movement reduced	Increased access to skills necessary for research and commercialisation
DOMESTIC INITIATIVES REQUIRED TO CAPITALISE ON THESE OPPORTUNITIES	
INITIATIVE	**INNOVATION OUTCOME**
Venture Capital	
Customs	
Alter tax regime to provide favourable treatment to US nationals	Attract US nationals with research or commercialisation expertise to work in Australia.

[42] "The Competitive Advantage of Nations", Michael Porter, 1990. See pp 578 – 584 on competitive advantage in international competition.

Appendix 7: LIST OF ACRONYMS

ANSTO	Australian Nuclear Science and Technology Organisation
ARC	Australian Research Council
AUSFTA	Australia – US Free Trade Agreement
AVCC	Australian Vice Chancellors Committee
CRC	Cooperative research Centres
CSIRO	Commonwealth Scientific & Industrial Research Organisation
FDA	US Food and Drug Administration
FTA	Free Trade Agreement
GDP	Gross Domestic Product
IP	Intellectual Property
IR&D	Industry Research & Development
NHMRC	National Health & Medical Research Council
NIH	US National Institutes of Health
OECD	Organisation for Economic Cooperation & Development
S&T	Science & Technology
VC	Venture Capital
WIPO	World Intellectual Property Organisation