



# **SUBMISSION TO THE NATIONAL INNOVATION SYSTEM REVIEW**

**(APRIL 2008)**

The AusIMM  
Level 3, 15-31 Pelham Street  
Carlton Victoria Australia 3053  
Postal Address:  
PO Box 660 Carlton South  
Victoria Australia 3053  
Telephone: +613 9662 3166  
Facsimile: + 613 9662 3662  
Email : [ceo@ausimm.com.au](mailto:ceo@ausimm.com.au)  
Web Page: <http://www.ausimm.com>

## TABLE OF CONTENTS

<b>The AusIMM</b>	<b>3</b>
<b>Mining Innovation: The Role of Innovation in a Period of Sustained Minerals Demand</b>	<b>3</b>
<b>Drivers for Change and Policy Responses</b>	<b>4</b>
<b>1. Shifting dynamics of global competitions, especially with the surge of activity from countries like Brazil, Russia, India and China.</b>	<b>4</b>
<b>2. A major lift in investment by many national and regional governments in education and research infrastructure</b>	<b>6</b>
<i>2.1 Investment in Minerals Related Higher Education</i>	<i>6</i>
<i>2.2 Investment in higher education at PhD level</i>	<i>7</i>
<i>2.3 Investment in Research Infrastructure for R&amp;D</i>	<i>9</i>
<i>2.4 Alternatives to the Current Research Infrastructure: the Canadian Model</i>	<i>11</i>
<b>3. Rise of globally networked operations and cyber infrastructure</b>	<b>12</b>
<b>4. The shift from in-house R&amp;D laboratories to networks of open innovation</b>	<b>13</b>
<i>4.1 Support for Innovation in the Mining Technology Services Sector</i>	<i>14</i>
<i>4.2 Support for Large Scale Commercialisation</i>	<i>16</i>
<b>5. An increased sense of urgency around finding solutions to global and national challenges like climate change, future energy sources, watersupply and a healthy population</b>	<b>17</b>

## **The AusIMM**

The Australasian Institute of Mining and Metallurgy (The AusIMM) is the leading organization representing minerals sector professionals in the Australasian region, primarily in the disciplines of mining engineering, metallurgy and geoscience. Our members are spread across academia, industry and government. Many of them have worked for, or in collaboration with, public research institutions. Those who work in industry have experienced both innovation successes and failures across the various facets of mining activity, including assessment, exploration, deposit appraisal, mine development, processing and restoration. Given their first hand, practical experience in one of Australia's key industries, our members are uniquely placed to comment on the systemic and policy factors that affect innovation opportunities and outcomes in Australia.

### **Mining Innovation: The Role of Innovation in a Period of Sustained Minerals Demand**

A strong capacity for innovation is particularly critical for a globally competitive, knowledge based industry such as mining. The recently released Productivity Commission Report on Public Support for Science and Innovation stated: "Over time the Australian mining industry has built up a competitive advantage [over other mining regions] by applying leading edge technologies, which have improved mining practices, reduced costs and increased productivity."<sup>1</sup> Australia's reputation as a leading edge minerals innovator is the envy of many nations which are now seeking to emulate our success. In order to continue to rank as a competitive destination for mining activities for the future, Australia needs to be proactive in continuing to identify, develop and harness our innovative capacity.

There are clear economic benefits that flow from maintaining Australia's position as a competitive destination for exploration and mining. In 2006-07 mineral resources exports increased by 16 per cent to \$90.8 billion, accounting for more than half of Australia's commodity earnings. During this time the industry contributed \$7.1 billion in State and Federal taxes.<sup>2</sup>

The benefits of mining innovation go far beyond the immediate economic rewards. Innovative activities in mining are often conjoined with technological developments elsewhere in industry and the economy, creating spillover effects and generating further innovation, productivity, and prosperity. For example, the accelerated mining activity in Australia has underpinned major expansions in supporting services, and spurred growth in the high value-add mining technology services sector, which is worth more than \$4 billion in export earnings alone.<sup>3</sup>

---

<sup>1</sup> See Chapter 6, 'Commercialisation and Utilisation', Productivity Commission, 'Public Support for Science and Innovation Draft Research Report (2 November 2006) at <http://www.pc.gov.au/study/science/draftreport/index.html> .

<sup>2</sup> Excludes crude oil, LPG, LNG, bunker fuel and other petroleum products. See ABARE, Australian commodities, September Quarter 2007.

<sup>3</sup> Invest Australian and Austrade, 'Innovation Australia: Backing Australia's Ability', Palamedia (2007) at <http://www.innovationaustralia.net/article/article.php?article=10,174> .

The reported success of the mining technology services sector underscores the potential of the mining boom as a platform for firms to position themselves in global supply chains across a range of industries. While these firms are categorised by their primary customer base of mining, this conceals the fact that companies within this sector also provide Information Communication Technologies (ICT), advanced manufacturing and environmental technologies and high level consulting services to transport, energy, telecommunications, infrastructure and government sectors.

At the present time the mining sector is strategically positioned to act as a fulcrum for innovation because of its strong domestic and global linkages and its history of technological innovation. The AusIMM submits that it is critical that the development of innovation policy at the present time occurs with close reference to the current industry structure in Australia and the reality of an era of sustained minerals demand.

### **Drivers for Change and Policy Responses**

The Drivers for Change that were listed in the Discussion Paper for the Innovation Review are recognised as particularly relevant to the minerals sector. The AusIMM submission will address the impact that of each of the Drivers listed below has had on minerals sector innovation, and the policy responses that are necessary to improve innovative capacity:

1. Shifting dynamics of global competitions, especially with the surge of activity from countries like Brazil, Russia, India and China.
2. A major lift in investment by many national and regional governments in education and research infrastructure
3. Rise of globally networked operations and cyber infrastructure.
4. The shift from in-house R&D laboratories to networks of open innovation
5. An increased sense of urgency around finding solutions to global and national challenges like climate change, future energy sources, water supply and a healthy population

#### **1. Shifting dynamics of global competitions, especially with the surge of activity from countries like Brazil, Russia, India and China**

Given Australia's position as a major resources supplier, the emerging strength of the BRIC economies presents new opportunities and challenges.

The prevailing economic wisdom is that the current resources boom and the prosperity that it has brought with it is no 'flash in the pan'; we are in fact entering a period of sustained global minerals demand. The current level of minerals consumption in emerging economies in China and India has been compared to the boom generated by development in Japan and Germany from 1950 to the late 1970s.<sup>4</sup> Consequently, there is significant opportunity for Australia to capitalize on our generous minerals endowments for decades to come.

---

<sup>4</sup> Garnaut R., 'The China Resources Boom,' (February 2006), Paper Presented at the Australian Agriculture and Resources Economics Conference, Sydney 8-10 February 2006, at <http://www.aomevents.com/AARES2006/keynote/garnaut.pdf> .

Conversely, there are also challenges posed by emerging economies. Australia is perceived to be 'mature' terrain for exploration, as the most obvious deposits have already been identified and, for the most part, are being mined. This leaves mining companies with two options for restocking and increasing reserves: move to higher risk areas – especially politically, as in the case of many African countries – or use technologies that are made available to them to identify potential “blind” deposits, located at depths or hidden by transported cover or rock cover, which are more difficult or expensive to discover and mine.

The current trend in exploration spending indicates that many companies are choosing the former option. The most recent data from the ABS has indicated that although levels of exploration expenditure in Australia are increasing, we are being steadily outpaced as a destination for exploration expenditure by the rest of the world with regards to a number of key commodities. Moreover, only 36% of exploration activity in 2006-07 was greenfields exploration (searching for new deposits), which is the lifeblood of the industry.<sup>5</sup>

If we are to continue to reap the benefits of our generous natural endowments, as opposed to becoming a declining quarry for the rest of the world, we must act now to reverse this trend. Australia already has a significant comparative advantage compared with underexplored nations. We have low sovereign risk, advanced infrastructure, a highly skilled local workforce and regionally clustered mining services and suppliers. However the area where we can most significantly increase our competitiveness is through innovation that will increase our prospectivity. We have increased our prospectivity numerous times in the past, as with the resurgence of the Australian gold industry following major innovations in exploration from 1980 onwards.

Prospectivity, or the likelihood of making an economic discovery, is a composite concept dependent on the state of science. In Australia we are able to increase our prospectivity through R&D and innovation that lead to better techniques and technologies for deep cover exploration, improved minerals processing techniques to render lower ore grades economic, more efficient mining methods to bring down costs, more sustainable practices to meet the conditions of the social license to operate and supporting services that increase efficiency and competitiveness.

Prospectivity is the key to a sustainable mining industry in Australia. For this reason The AusIMM recommends that Increasing Minerals Prospectivity for Australia's Terrain be identified as a National Innovation Priority.

**Recommendation:**

**1. Increasing Minerals Prospectivity for Australia's Terrain to be identified as a National Innovation Priority. This primarily encompasses the development of:**

- a. Better techniques and technologies for deep cover exploration**
- b. Improved minerals processing techniques to render lower ore grades economic**
- c. More efficient mining methods to bring down costs**

<sup>5</sup> Huleatt, M. and Jaques, L. 'Australian mineral exploration at record levels', *AusGeo News*, (December 2007) Issue No. 88, at [http://www.ga.gov.au/image\\_cache/GA10851.pdf](http://www.ga.gov.au/image_cache/GA10851.pdf) .

- d. More sustainable practices to meet the conditions of the social licence to operate**
- e. A diverse array of supporting technologies and services that increase efficiency and competitiveness**

## **2. A major lift in investment by many national governments in education and research infrastructure**

For a high technology industry such as mining, access to intellectual human capital and leading edge research facilities are critical inputs to innovation. In a recent submission to the Productivity Commission, Rio Tinto indicated that the decision to invest in R&D for a particular location is driven primarily by “the existence of a critical mass of world class research facilities and researchers supporting basic science, with which we can establish strong relationships”.<sup>6</sup>

### *2.1 Investment in Minerals Related Higher Education*

In a highly technical industry such as mining, professionals with higher education qualifications are instrumental in the innovation process. That is, innovation calls on a person’s ability to identify, acquire, assimilate and exploit knowledge from the environment including the outcomes of R&D undertaken by other firms, industries and countries. Without technical knowledge of the way a system works, an employee will merely perpetuate the processes into which they are inducted. The ability of higher education institutions to produce a sustainable number of graduates to staff our key industries is thus critical for the innovative capacity of the mining industry, and indeed all technical industries.

It is of deep concern that despite the increasing levels of activity in the Australian minerals sector, there is an escalating professional skills shortage, and the number of higher education programs capable of producing suitably qualified graduates is in decline. Since 2000, eight higher education minerals departments have closed, three are marked for closure and four have been merged into other degrees.<sup>7</sup>

The current challenge faced by minerals-related courses is largely due to the funding arrangements instituted under the *Higher Education Support Act 2003* (Cth). The Act provides funding for universities on the basis of the number of students enrolled in a particular subject. The per student allocation is based on general assumptions about costs of teaching a subject within a ‘cluster’; the formula took no account of the differences in course content requirements, infrastructure needs, location or any other course or institution-specific factor. Under this funding formula, small, capital-intensive courses such as mining engineering and field and laboratory intensive courses such as geoscience were particularly disadvantaged and for many universities it was simply not viable to run them.

---

<sup>6</sup> Productivity Commission, ‘Public Support for Science and Innovation Report’ (9 March 2007) at [http://www.pc.gov.au/data/assets/pdf\\_file/0016/37123/science.pdf](http://www.pc.gov.au/data/assets/pdf_file/0016/37123/science.pdf) p 390.

<sup>7</sup> Galvin J. and Carter R., ‘Strategic Review of Minerals Council of Australia Tertiary Education Initiatives,’ *Minerals Tertiary Education Council of Australia* (May 2003) at [http://www.minerals.org.au/data/assets/word\\_doc/4328/MTEC\\_Review\\_FINAL.doc](http://www.minerals.org.au/data/assets/word_doc/4328/MTEC_Review_FINAL.doc)

Several years of inadequate funding has had a serious impact on minerals-related courses. A survey of minerals-related course Heads of Department conducted by The AusIMM in 2007 indicated that these courses were facing major salary pressures, decline in staff numbers, outdated infrastructure and, in some cases, dilution of the technical content of the course.<sup>8</sup> The current funding formula, whereby the viability of courses is dependent on year by year enrolments, supplemented by full fees that reflect the popularity of the course, is inappropriate and short-sighted in a knowledge economy.

Similar challenges have been reported across a range of Science and Engineering departments. In the last decade, increasing the numbers and quality of graduates from these disciplines was not seen as a priority and we are now experiencing the results of this policy oversight. Only 7.9 per cent of all graduates from Australian universities are in engineering, ranking Australia 24th out of 28 OECD countries. Contrast this with countries such as Korea at 27 per cent, Germany at 19 per cent and even the United Kingdom at 10 per cent. This has clear implications for our international innovation competitiveness.<sup>9</sup>

The AusIMM submits that higher education policy must ensure that institutions can provide a quality graduate learning experience for students in technical disciplines for key industries.

## **Recommendations**

### **1. Implement higher education support policy that will:**

- a. Ensure that there are a sufficient number of graduates to meet Australia's projected professional skills needs in key industries, both established and emerging**
- b. Ensure that courses are well funded and delivered at a quality that will equip graduates with the knowledge they need to contribute to the competitiveness and sustainability of the industries in which they will work**
- c. Provide future researchers with the in-depth knowledge they need to provide innovative solutions to a range of economic, social and environmental issues**

### *2.2 Investment in higher education at PhD level*

A critical mass of capable researchers is a prerequisite for strong innovative capability. For example, AMIRA International, a consortium of companies which contracts out pre-competitive research to public institutions and is credited with spearheading Australia's research excellence, reported that between 1990 and 2004, more than 260 PhD students and 65 post-doctoral researchers were involved in its university-based research projects.<sup>10</sup>

<sup>8</sup> The AusIMM, 'The AusIMM Questionnaire Report – New Funding Arrangements for Universities' (July 2007)

<sup>9</sup> OECD, 'Education at a Glance 2007', (2007)

[http://www.oecd.org/document/30/0,3343,en\\_2649\\_37455\\_39251550\\_1\\_1\\_1\\_37455,00.html](http://www.oecd.org/document/30/0,3343,en_2649_37455_39251550_1_1_1_37455,00.html)

<sup>10</sup> Whitman, D., 'A Mine of Innovation', in *Innovation Australia*, (2007) Palamedia, at <http://www.innovationaustralia.net/article/article.php?article=10,169>

Meanwhile the contribution of an employee with advanced research qualifications within a company can be invaluable. In his input to our submission, an AusIMM member, who has been involved in both research and industry for more than 25 years, reflected on the innovative capacity his advanced technical knowledge enabled him to bring to industry:

*“After two years at Berkeley I returned to Western Mining to do my doctoral research at the Kambalda nickel mines part time, whilst working as a senior geologist. The isolation from academe was a challenge, but I was compensated by the opportunity to apply my research outcomes at the mines. For example, I applied my results to important practical issues, such as guiding exploration for more ore, improving ore reserve calculations, mine planning and grade control, and to metallurgical processing. This experience convinced me of the power of integrative applied research. It also showed me the potency of effective bridges between industry and research institutions, and the high practical and scientific value of applied research; insights that became part of my life.”*

Given the important role that PhD qualified professionals play in research institutions, in industry, and as a bridge between the two, maintaining a critical mass of such individuals should be viewed as a priority. Under current policies this has not been the case. According to the Minerals Tertiary Education Council, PhD enrolments for metallurgy, mining engineering and earth science between 2000 and 2004 declined 40%, 50% and 36% respectively.<sup>11</sup>

Attracting and funding PhD students is a complex challenge. On the funding side, Universities need the facilities and staff to support them. There is also some question of whether Australia needs to do more to attract students to conduct further study in their fields. It is unclear whether employers sufficiently recognize the value of a PhD. Finally there is little financial incentive for a talented student, even one who is committed and passionate about research, to undertake a PhD. A recent study by the Council for the Humanities, Arts and Social Sciences (CHASS) found that since 1999, standard PhD scholarship has fallen from about half of average earnings to about a third. The scholarship is now worth about \$20,000 which means it has now fallen below the official Henderson poverty line.<sup>12</sup> Broader issues around funding for universities, promotion of the value of research capability to firms, and the adequacy of current scholarship arrangements all need to be looked at closely.

It has been suggested that overseas students might be utilized to fill gaps in terms of both professionals and researchers. However as high-tech industries across both developed and emerging economies place increased demand on global supply of science and technology graduates, this will not be sustainable. Recent data shows an increasing competition between OECD countries for graduates from China and India, which produces a fifth of the world's supply of PhD graduates in science and engineering. They may even be staying at home. Consequently an over-reliance on overseas graduates could easily place us on the losing side of a talent war. Investment in a sustainable, highly skilled professional workforce should be a national priority.

---

<sup>11</sup> Minerals Council of Australia, 'University Enrolment Statistics', (2007) at [http://www.minerals.org.au/mtec/what\\_we\\_do/mtec\\_research/statistics](http://www.minerals.org.au/mtec/what_we_do/mtec_research/statistics)

<sup>12</sup> Council for the Humanities, Arts and Social Sciences, University of NSW, 'Five Point CHASS Plan for Government', (7 March 2008) at [http://www.chass.org.au/events/2008/phd/PhD\\_FivePointPlan.php#PhD\\_graph](http://www.chass.org.au/events/2008/phd/PhD_FivePointPlan.php#PhD_graph)

### **Recommendations**

- 1. Ensure that higher education institutions with records of research excellence in disciplines of national importance receive adequate funding to support PhD students**
- 2. Investigate options for promoting the value of PhD graduates to employers in industry**
- 3. Given current societal values and costs of living, review whether current scholarship arrangements are a sufficient incentive to attract talented and passionate students to PhD study**

#### *2.3 Investment in Research Infrastructure for R&D*

Australia's public R&D institutions are highly effective at investigating concepts, developing and applying them, and successfully diffusing them amongst major companies. This has been recognized in other mining jurisdictions, such as Latin America, which are now seeking to emulate us.

At this stage of the submission it must be noted that we recognize that innovation is broader than R&D. That is, whilst firms can innovate through R&D, they may also do so through an array of mechanisms such as their business strategy, work organization, financial systems, management practices, logistics management, capital investment, application of new technologies and process re-engineering, along with incremental changes to their products and services. Nevertheless, R&D infrastructure is a major contributor to innovative capacity, and we must ensure that we sustain and build on our current strengths.

Australia's current position as an R&D leader is largely due to our long history of government-university-industry collaboration that has resulted in outstanding value-added results for industry in the past. A particularly strong role has been played by AMIRA International which acts as a research broker between public research institutions and industry.

Due to consistent public and private investment in research infrastructure in Australia, we have a number of notable world class research facilities. These include Queensland University's Julius Kruttschnitt Mineral Research Centre, Victorian Institute of Earth and Planetary Sciences (VIEPS), the University of Tasmania's Centre for Ore Deposit Studies, the Perth-based Parker Centre, the University of South Australia's Ian Wark Research Institute, James Cook University School of Earth and Environmental Sciences and the national researcher CSIRO and CRCs.

The CRC program in Australia has been particularly successful in linking industry challenges to research solutions. Recent studies of the benefits of the CRC Program have indicated that for every \$1 spent by the Commonwealth Government on the CRC Program, GDP is cumulatively \$0.60 higher than it would have been had that \$1 instead

been allocated to general Government expenditure.<sup>13</sup> For the mining industry, some of the economic gains delivered by CRCs are:

- CRC Mining incurred costs of \$37 million to further develop CRC dig and dump technology between 2001 and 2003 and then from 2003 started reaping net average cost savings of \$8 million per annum through fitting technology to its existing draglines.<sup>14</sup>
- The adoption by industry partners of outcomes from the Parker CRC for Hydrometallurgy's thickener project led to a \$22.3 million increase in industry costs in 2002 to adopt technology followed by a \$99 million fall in capital expenditure costs in 2003 and annual net cost savings of \$20.6 million being achieved from 2003.<sup>15</sup>
- Technology developed by the CRC for Landscape Evolution and Mineral Exploration (CRC LEME 1) contributed to the discovery of gold deposits with an in ground value of more than \$3 billion<sup>16</sup>

Australia's two exploration focused CRCs, the CRC for Landscape Environments and Mineral Exploration and the CRC for Predictive Minerals Discovery, are both to cease in July 2008. AMIRA International is currently coordinating a proposal for a new CRC for Deep Exploration to commence in 2009. The proposal is still under development. The CRC will aim to address some of the industry's key challenges over the next decades:

- improving exploration efficiency;
- enhancing the greenfields and brownfields discovery rates;
- improving the safety and performance of all types of drilling; and
- development of a research base that will deliver new science, new innovation and (importantly) graduates.

The CRC proposal is being developed with industry partners, ensuring that there is early input by large companies into defining the business model and scientific goals of the CRC. Early collaborative planning will overcome some of the barriers to private-public collaboration that have been identified in the past. These include differential timelines between research institutions and their exploration clients, owing to institutional pressure on researchers for work standards that are not necessarily relevant to industry, and "mission creep" as poorly managed projects lose focus and sponsorship funds are tapped to support non-core avenues of enquiry.<sup>17</sup>

The AusIMM supports the current CRC proposal that is being developed, as well as the continual refining and reappraisal of CRC goals.

---

<sup>13</sup> Allen Consulting Group 'The Economic Impact of CRCs in Australia: Delivering Benefits for Australia,' (2005) at

<http://www.crca.asn.au/activities/2005/CRCAEconomicImpactFinalReport.pdf> , , p vii.

<sup>14</sup> Ibid., p 17.

<sup>15</sup> Ibid., p 17

<sup>16</sup> Ibid., p 25.

<sup>17</sup> 5th Biennial Exploration Conference, 'Maximising Exploration Efficiency and Success in a New World: Global Support for Research', (March 2003, WA).

Finally, The AusIMM is aware that a number of problems have been identified with the CRC program. These include significant bureaucratic hurdles to participation, concerns about dilution of IP rights, and in particular financial barriers to SMEs.

To some degree CRCs have sought to overcome the hurdles to SME participation. For example CRC Mining has utilised its 'SME Club' to successfully engage with some SMEs working in the mining technology sector. This has involved putting together a specific process to assess the relevance of SME interests to CRC Mining research and to then get them involved. The last CRC Mining Annual Report indicated that there were 20 SME Club members in mid 2006.<sup>18</sup> Measures such as the SME Club are to be applauded, but a strategic review of impediments to SME collaboration is needed, together with dissemination of best practice strategies to facilitate their inclusion.

**Policy Recommendations:**

- 1. Continue support for CSIRO Minerals Down Under Research Flagship, CRCs and key research centres**
- 2. Support a new exploration-focussed CRC for Deep Exploration Technologies**
- 3. Seek to simplify process for participation in CRCs, addressing in particular the application process, financial contribution requirements and contractual IP arrangements**
- 4. Disseminate best practice arrangements for involvement in SMEs amongst CRCs**

*2.4 Alternatives to the Current Collaborative Research Infrastructure: the Canadian Model*

For the most part, industry funding for collaborative research in Australia is sourced through research brokers such as AMIRA International, or via project by project agreements between research institutions such as CSIRO, Universities and CRCs and particular companies which initiate or are persuaded to buy-in to the project.

An exception to this in Australia is an organization such as the Australian Coal Association Research Program (ACARP). Under the ACARP model, funding for research is via an industry levy on members at 5 cents per tonne of coal production. Various technical committees comprised of representatives from member companies then assess which project proposals are worthy of being funded from the pool of funding each year, based on a number of mutually agreed criteria. The advantage of an ACARP style system is that funding for a particular project does not need to be negotiated through approaches to individual companies – rather it is from a decision making entity with both long and short term priorities.<sup>19</sup>

A similar approach has recently been implemented in Canada via the Centre for Excellence in Mining Innovation. CEMI is a new mineral sector research initiative in

<sup>18</sup> 24 CRC Mining, 'Annual Report 2004-05,' pp 13-31 at [http://www.crcmining.com.au/dynamic\\_page.php?page\\_id=71](http://www.crcmining.com.au/dynamic_page.php?page_id=71) .

<sup>19</sup> Go to ACARP at <http://www.acarp.com.au/funding.aspx>

Northern Ontario that was established in 2007 by industry and Laurentian University in collaboration with regional, national and international R&D partners. Similar to the ACARP model, the CEMI operates on the basis of a pre-existing pool of funds that is contributed by both government and industry. Proposals are then assessed on a case by case basis with reference to particular criteria.<sup>20</sup>

There are strengths and weaknesses in both systems. The benefit of a collaborative model such as ACARP or CEMI is that it allows researchers to focus on researching rather than spending too much valuable time seeking funding from an array of industry sponsors and expending resources on involved contractual arrangements. They can approach a single board. The potential shortcoming of such a mechanism is that large company members may exert a disproportionate influence on the direction of research. Moreover, as the fruits of research success are shared broadly, the scope of research that companies will be willing to collaborate on will be limited to that which is deemed 'pre-competitive'.

Meanwhile the current Australian model is excellent at providing focused R&D solutions, where certain companies can work with public research centres to gain a competitive advantage. The existence of AMIRA International as a research broker provides significant flexibility in the Australian system, allowing for varying permutations of partners. However the need for complex case by case negotiation regarding contributions from partners and IP rights for projects presents particular obstacles and generates a bureaucratic load in research institutions. Moreover the availability of AMIRA's brokerage services is still limited to its members, who for the most part are large companies. This means that many small players need to negotiate bureaucracies on an individual basis to access collaborative innovation systems. Finally, as AMIRA International now operates globally it now has no particular imperative to preferentially support research in Australian institutions.

Both systems of innovation are adept at achieving particular outcomes, therefore it is recommended that the Australian Government investigate the relative benefits of a collaborative research funding model such as CEMI for specific sectors, to complement our current mechanisms.

**Policy Recommendations:**

**1. Investigate the relative benefits of a collaborative research funding model along the lines of CEMI, that utilizes a joint corporate-government pool of funding administered by a sector specific panel of experts**

**3. Rise of globally networked operations and cyber infrastructure**

The rise of ICT technologies and automation has had a profound impact on the mining sector, and the supporting services sectors that have emerged to capitalize on this trend. The capacity to continually acquire and review information has opened up opportunities for innovation that were previously not considered.

<sup>20</sup> Go to CEMI at [http://www.miningexcellence.ca/about\\_overview.htm](http://www.miningexcellence.ca/about_overview.htm)

The use of IT in the mining industry evolved gradually, with the initial introduction of computers as time-saving conveniences for business applications such as word processing and spreadsheet analysis of inventory control. However with advances in computer hardware and software, a fundamental change in the nature of mining started to occur. Software packages became increasingly sophisticated and modelling and design techniques were adopted at all stages of production. In the last decade, innovations reached a critical mass and important new communications and sensing technologies took a leap forward. Mine-wide production systems were developed and Global Positioning Systems emerged.

Today, increasingly accurate technologies for the acquisition of real time data across the full spectrum of mining activities, coupled with increased automation and remote control has revolutionized mining. The applications are relevant to all stages of mining activity, with benefits across a range of areas such as safety and health, environmental performance, energy efficiency, extended equipment life and more responsive procurement. The ability to acquire the best information from moment to moment using ICT, and to then utilize that information to carry out actions with optimum efficiency using remote control and automation, has enormous benefits for economic, social and environmental sustainability.

As a major mining nation, with mining headquarters located on our shores and significant local skills and infrastructure, Australia has been well positioned to be at the forefront of the current technology revolution. The current climate has created opportunities for local firms; Australian mining software is now used in 60% of the world's mines. Meanwhile Australia has been identified to be the location of choice for first-of-a-kind technology R&D and application. For example, when announcing Rio Tinto's decision to commit \$21 million over five years to a new Research & Development (R&D) centre for mining automation at The University of Sydney, Rio Tinto's chief executive, Tom Albanese, said:<sup>21</sup>

*"Australia is a natural base from which to support our operations with the innovative technical solutions they will need in the future. A common feature of Rio Tinto's technical and innovation activities is their strong linkages with Australian academic and research institutions. This focus is a vote of confidence in Australia's innovation capability."*

Mining is a complex integrated system which generates technology pull in the areas of ICT and automation that cannot be matched by other industries. However in order to stay at the forefront of these developments, we need to maintain the skills and infrastructure for continued growth. A study conducted on 'Knowledge Management and Innovation in Service Companies' reported that mining technology service firms employed high proportions of tertiary qualified technical staff, and that at present these firms are having "a great deal of difficulty in finding suitable staff."<sup>22</sup>

---

<sup>21</sup> Rio Tinto, 'Australia Wins Rio Tinto Automation Effort', Media Release, (9<sup>th</sup> July 2007) at [http://www.riotinto.com/media/5157\\_6473.asp](http://www.riotinto.com/media/5157_6473.asp)

<sup>22</sup> Thorburn, L., 'Knowledge Management and Innovation in Service. Companies –. Case studies from Tourism, Software and Mining Technologies,' Study for the Department of Industry, Tourism and Resources (February 2005) at <http://www.oecd.org/dataoecd/58/39/34698722.pdf> , p 41.

The AusIMM submits that Australia needs to conduct an assessment of what skills and infrastructure are needed to support further growth in this area.

**Recommendations:**

**1. Review whether existing skills and infrastructure are sufficient to support further growth in the area of mining ICT and automation.**

**4. The shift from in-house R&D laboratories to networks of open innovation**

For the mining industry, it would not be strictly accurate to say that there has been a 'shift' in mining R&D from in-house laboratories to networks of open innovation. The bulk of mining R&D still occurs in-house. In 2005-06, the mining companies were the third largest contributor to business expenditure on R&D in Australia, and reported the largest absolute growth from 2004-05 by \$417.2 million (33.0%) and \$416.5 million (12.0%) respectively.<sup>23</sup>

Nevertheless mining technology and service firms have increasingly been a source of innovation for mining companies. In formulating innovation policy, it is important that the shift in the industrial structure is recognized. That is, the productive activity no longer takes place along a continuum whereby mining, manufacturing, retail and services operate as discrete units. In reality there are now clusters of interrelated firms, suppliers and support services operating across all stages of production. The revolution in ICT and automation described in the section above has been a great enabler of technology and services firms – good information being key to both the identification of opportunities, and the risks inherent in innovation.

*4.1 Support for Innovation in the Mining Technology Services Sector*

Clusters of technology and services firms are an increasingly critical part of the mining supply chain, although they do not fit traditional definitions of 'mining activity'. Some examples are :

- ICT – wireless communications technology and products; remote area communication; remote sensing and spatial data software applications; general systems and applications software
- Biotech – bioleaching, hydrometallurgical processing etc
- Environment – water and waste water management; solid waste management; land rehabilitation; geothermal energy.
- Renewable energy – Geothermal energy.
- Building and construction – project management, sophisticated engineering services and fabrication capability.

---

<sup>23</sup> ABS, '8104.0 - Research and Experimental Development, Businesses, Australia, 2005-06', (21<sup>st</sup> August 2007)

Moving beyond generalities, there are a number of spectacular success stories. For example, Gekko Systems, which specialises in the design, development and distribution of innovative mineral processing equipment and systems which maximise recovery and effect efficient removal of waste. Gekko units have been manufactured and installed in 33 countries.

Another example is Ausmelt, which was researched and developed by CSIRO to commercialise the Top Submerged Lance (TSL) smelting technology. This has been applied to a number of commodities and has resulted in projects in more than 10 countries.

The minerals boom has given the mining technology services sector a strong national customer base as well as access to wider global markets. The challenge is for firms, is to access start up funds for new ideas, and to position themselves firmly within a global supply chain.

The AusIMM has received a number of submissions from its members who work for technology and services firms indicating that the current arrangements for access to start-up capital are complex. The cost of putting together tender applications for Commercial Ready grants is viewed as prohibitive. Likewise the paperwork associated with applying for the 125% R&D tax concession is seen as overly onerous.<sup>24</sup>

Members have also complained that the Commercial Ready program only offers dollar for dollar grants, and does not include the repayable loan component that was a feature of the START program, which preceded it. We recommend that the Rudd Government review the potential for a policy of repayable loans, where the recipient of the grant repays in the event of commercial success. Such schemes have been used widely overseas and in some countries, such as Israel, they are a major form of R&D support.<sup>25</sup>

The relatively small size of many mining technology services firms has also served as a major barrier to their participation in major collaborative programs with public research institutions such as CRCs. This issue is addressed elsewhere in the submission.

Access to skills is another major issue. The need to invest in higher education has been addressed elsewhere in the submission.

**Recommendations:**

- 1. Streamline process for application for the R&D tax concession and Commercial Ready Programs**
- 2. Review the potential for repayable loans for commercialisation of products and services contingent on success**
- 3. Reconsider whether the dollar for dollar grants structure is appropriate**

<sup>24</sup> Graham, A., 'No Room for Small Players in Collaborative R&D', *The AusIMM Bulletin*, March/April (2006) pp 52-53 at [http://www.ausimm.com/policy/no\\_room\\_small\\_players.pdf](http://www.ausimm.com/policy/no_room_small_players.pdf)

<sup>25</sup> 'Public Support for Science and Innovation Report', above n 5, p 421 .

#### 4.2 Support for Large Scale Commercialisation

Financial incentives such as the R&D tax concession play a key role in encouraging business investment in R&D. AMIRA International has indicated that the deduction figures are an important consideration for its members, who conduct rigorous analysis of R&D proposals. The current R&D tax concession in Australia has been criticized by larger companies for focusing too much on the 'Research' side of 'R&D' and not enough on 'Development'. That is, at times R&D towards genuine innovation has been deemed too 'practical' or incremental to be eligible, despite that fact that they still incur risk.

The tax concession should recognize the high cost and risk of incremental innovation in the sector. That is, due to the large scale nature of mining, the majority of innovations in the mining industry are in fact incremental improvements in processes and product technologies on the basis of earlier operating experience.<sup>26</sup> Despite their incremental or 'practical nature', the risks associated with introducing a new technology or process into an integrated system are still extremely high. The efficiency gains that can be achieved through incremental innovation are often significant. The eligibility for the R&D tax concession must include incremental innovations for large scale industries.

The risk and reward equation is even more complex when it comes to R&D aimed at developing and commercializing true 'step change technologies'. Such innovations are infrequent in the mining industry due to the high risk, the long payback periods and the high failure rate. These risks are evident in the number of projects abandoned before commercial operation. Recent examples include the A\$2 billion, hot briquetted iron project in the Pilbara, Western Australia and the Australian Magnesium Corporation smelter in Gladstone, Queensland.<sup>27</sup>

For these high risk projects, R&D tax concessions play a pivotal role in encouraging companies to take that critical step to commercialisation. Rio Tinto has indicated that the 150% R&D tax concession was instrumental in deciding to proceed with construction of its Hismelt plant, which constituted a step change technology for iron and steelmaking. Taking the Hismelt process successfully from concept to commercialisation has cost between half a billion to a billion Australian dollars over two decades.<sup>28</sup>

It is of some concern that the concession has since been halved. We submit that in order for the necessary investments in step change technology to occur in Australia, a higher, more targeted R&D tax concession than the current 125% rebate in place is necessary. This should be aimed specifically at commercialisation, or construction of 'first of a kind' plant in Australia.

#### **Recommendations:**

##### **1. Review criteria for R&D tax concession eligibility to include practical**

<sup>26</sup> Upstill, G., and Hall., P, 'Innovation in the minerals industry: Australia in a global context' *Resources Policy*, Volume 3, Issue 3 (September 2006) pp 137-145 .

<sup>27</sup> School of Business, The University of New South Wales (ADFA Campus), Canberra, Australia

<sup>28</sup> Ibid.

<sup>28</sup> Rio Tinto, 'Submission to Productivity Commission Inquiry into Science and Innovation,' (28 July 2006), at [http://www.pc.gov.au/\\_data/assets/pdf\\_file/0009/37692/sub046.pdf](http://www.pc.gov.au/_data/assets/pdf_file/0009/37692/sub046.pdf) , p 3

**innovations in large scale industries such as mining**

**2. Implement an increased and targeted R&D tax concession for the commercialisation of step change technologies by large scale industries**

**5. An increased sense of urgency around finding solutions to global and national challenges like climate change, future energy sources, water supply and a healthy population.**

The imperative to reduce net emissions during a time of accelerated global demand for minerals and energy represents the largest, integrated applied research challenge the mining industry has ever faced. Effective solutions require carefully integrated contributions from all of the sciences, rigorous application of the scientific method, and clear, calm heads. They also require close collaboration between scientists and economists and policy specialists to ensure that our innovative capacities in key areas are maximized.

According to the International Energy Agency (IEA), global electricity production is projected to treble by 2050; emerging economies such as China and India are expected to account for over 80% of the growth in emissions in during this time.<sup>29</sup> Deep cuts in emissions will only be achieved if low and zero emissions energy technologies are developed and deployed in emerging economies, and more efficient ways of producing key commodities for them are brought online. As a major exporter of energy and energy intensive commodities and with significant R&D capability, Australia has the potential to play a leading role in developing a long term, technology based solution.

Australia has significant R&D capability in a number of areas which can deliver low and zero emissions energy technologies. We have extensive expertise in clean coal research such as carbon geosequestration technology, and are at the forefront of development of renewable energy options such as geothermal electricity from hot rocks. As a major exporter of uranium and nuclear technologies, Australia has also played a major part in enhancing safety in the nuclear supply chain by improving practices at home and abroad.

Another area where Australia can make a key contribution is in improved energy efficiency of minerals and energy processes, both through major R&D projects and more modest innovations. For example, the commercialisation of new processing techniques for aluminium currently being developed in Australia could deliver energy efficiency savings of up to 25%. More targeted mining technologies, such as in the area of underground bulk mining method to reduce the amount of energy used per unit of material mined can also make a significant difference. Meanwhile, innovation across a range of areas from logistics and equipment maintenance to mine planning, all have the ability to significantly reduce energy usage at a mine site.

Technology developments will not occur in a policy vacuum. There is currently a proliferation of policies at State and Federal level aimed at reducing emissions, employing a range of piecemeal measures with no real coordination. These policies

---

<sup>29</sup> ABARE, 'Technological Development and Economic Growth,' Research Report 06.1, (Canberra, January 2006), at [http://www.abareconomics.com/publications/2006/RR06\\_1\\_ClimateAsiaPacific.pdf](http://www.abareconomics.com/publications/2006/RR06_1_ClimateAsiaPacific.pdf) , p 24.

place a heavy compliance burden on industry and do not seem to have any overarching long term goal or strategy.

To be effective in developing the technology solutions Australia needs a coordinated technology policy that includes an increase in support for public research and commercialisation incentives, an emissions trading scheme that creates the technology pull needed to increase innovation and uptake of technologies commercially, and participation in a global emissions reduction scheme in which all countries embrace targets.

The Stern Review suggested that in order to accelerate technological innovation to deliver deep cuts, global energy R&D funding should double to around \$20 billion.<sup>30</sup> Australia currently has a number of programs and grants aimed at fostering low and zero emissions technology research. As well as the research taking place through universities, CRCs, the CSIRO, and ARC grants, there is also a \$500 million Low Emission Technology Development Fund for demonstration of low emission technologies, and \$100 million in competitive grants to promote the strategic development of renewable technologies. In addition, the Rudd Government has announced the \$500 million National Clean Coal Fund and the \$500 million Green Car Innovation Fund. The AusIMM submits that a review of publicly funded emissions research in Australia should be carried out to maximise the capability of research infrastructure to deliver solutions.

Policies that support the commercialisation of low and zero emissions technologies are the essential link between emissions trading and publicly supported innovation. The Stern Review indicated that this is an area that is significantly under-resourced, and that government support for commercialization of low and zero emissions technologies should increase two to five times globally from current levels of around \$34 billion in order to meet the global abatement task.<sup>31</sup>

As discussed previously, commercialisation of step change technologies for large scale industries such as mining is particularly challenging. Whilst process improvements can deliver significant energy improvements, the development of step change technologies is needed in order to bring order of magnitude reductions to emissions levels. Strong financial incentives in the form of an R&D tax concession aimed at commercialisation of step change low emissions technologies are needed for these to occur.

The AusIMM does not support the policy of substantially increasing the Mandatory Renewable Energy Target for energy suppliers and large energy users. This is clearly at odds with the principles embodied within emissions trading of encouraging business, through innovation, to choose the least-cost means of reducing their emissions.

The Rudd Government has committed to an emissions trading scheme that will be operational from 2010. It is critical that the model implemented adopt a simple and equitable, and is complemented by policies to promote rapid uptake of low emission technologies that will lead to the abatement of emissions at least cost to producers and

---

<sup>30</sup> Stern, N., 'Stern Review Report on the Economics of Climate Change,' *Paper prepared for HM Treasury* (October 30, 2006) at [http://www.hm-treasury.gov.uk/independent\\_reviews/stern\\_review\\_economics\\_climate\\_change/sternreview\\_index.cfm](http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm).

<sup>31</sup> Stern, above n 34, p 347.

consumers. Once this system is in place, Australia should look to link its scheme with other like-minded nations for optimal technology transfer to other countries, particularly developing countries, seeking to curb emissions growth.

Australia *can* substantially lower its emissions between now and 2050. This is a critical national task. But Australia can play an even more important role by building genuine support for a global framework for emissions reductions, and by helping to develop and deploy the critical low emissions technologies that will slow and reduce the much larger and fast-growing emissions of the rapidly industrialising nations in our region.

**Recommendations:**

- 1. Identify a technology-based pathway to emissions reduction as a National Innovation Priority**
- 2. Rationalise existing State and Federal Emissions Reduction policies to achieve a nationally coordinated strategy at the Federal Level**
- 3. Conduct review of publicly funded emissions research in Australia**
- 4. Introduce tax incentives for commercialisation of low emissions step change technologies**
- 5. Remove the Mandatory Renewable Energy Target**
- 6. Influence the Kyoto signatories to support a series of near term targets for all countries for the next commitment period**