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Realising Australia's uranium potential

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POLICY PAPER



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Executive summary

Australia is not fully realising the potential of its vast endowment of uranium resources.

Despite hosting the world's largest deposits of uranium – three times more than Canada – Australia supplies just over 10 per cent of the global market, down from over 20 per cent a decade ago.

In terms of global production, Australia has fallen from second to third place, while export earnings have declined from over \$1 billion in 2008-09 to \$622 million in 2013-14. Other producers have gained market share at Australia's expense. Over the past decade, Kazakhstan's production share has increased from 9 per cent to 38 per cent. At a time when global production had increased by 67 per cent, Australian output has fallen by 16 per cent.

Expansion potential in Australia's uranium sector is substantial

There are several factors that highlight both the growth potential of Australia's uranium sector, and the economic contribution that growth in the sector can provide.

First, Australia is home to one-third of the world's proven uranium resources but accounts for only 10 per cent of global output. It has the potential to further enhance and deepen its role as a diverse and substantial provider of global energy through a sustained expansion of its uranium export capacity.

Second, the economic dividend from an expansion of Australia's uranium sector would be significant. The modelling undertaken in this study, based on Australian Bureau of Statistics (ABS) data, shows that the uranium sector directly employs 2000

Australians with a further 1000 employed in related industries. To assess the potential economic contribution of a growing uranium sector, four scenarios were modelled.

Those four scenarios compare the impact on employment if Australia's market share remains at 10 per cent, and if it grows to 30 per cent by 2040. The analysis includes scenarios where uranium demand (as share of global energy demand) remains stable, and if uranium demand grows in a carbon constrained world.

The bottom line is that the potential for employment growth is substantial. Under conservative scenarios, employment in the sector could grow 5 to 7 fold over the next 25 years (see table 1).

Importantly, these estimates represent the potential economic benefit to the Australian economy resulting from increases in export value. They do not take into account the potential benefit that may result from developing a complementary power generation industry. Internationally, countries such as Canada have demonstrated the economic payoff including increased activity valued at C\$5 billion, 60,000 jobs as well as being a leading employer of the local indigenous populations. Such examples are complemented by US studies that calculate the contribution of power generating stations to be as large as US\$1.3 billion providing employment for over 10,000 individuals. A recent study in the UK also demonstrated the potential economic benefit estimating additional employment could amount to 32,000 jobs and a significant increase in GDP.

Table 1 Current and potential employment and economic contribution of the uranium economy

Current contribution	Direct jobs	Indirect jobs	Total employment contribution	Economic contribution
Current industry contribution	2,000	1,000	3,000	\$0.6 billion
Projections to 2040	Direct jobs	Indirect jobs	Total employment contribution	Economic value (potential)
Scenario 1: Australia maintains existing (10 per cent) market share of uranium market and nuclear power comprises 10-12 per cent of global energy production in 2040.	2,100-3,500	1,100-1,900	Up to 5,400 by 2040	\$1.3 billion - \$2.3 billion per annum
Scenario 2: Australia grows market share to equal its global share of resources (30 per cent) and nuclear power comprises 10-12 per cent of energy production in 2040.	6,300-10,600	3,400-5,700	Up to 16,300 by 2040	\$4.1 billion - \$6.9 billion per annum
Scenario 3: Australia maintains (10 per cent) market share and nuclear power's market share grows to between 14.8 and 16.6 per cent.	3,100-4,900	1,700-2,600	Up to 7,500 by 2040	\$2.0 billion - \$3.2 billion per annum
Scenario 4: Australia increases market share to 30 per cent and nuclear power's market share grows to between 14.8 and 16.6 per cent.	9,400-14,700	5,000-7,900	Up to 22,600 by 2040	\$6.1 billion - \$9.5 billion per annum

The risks associated with uranium are well managed

While public perceptions of uranium might appear to be unfavourable, there is evidence that those attitudes are changing. The fact is that uranium mining is little different from other types of mining activity. The issues of public concern relate to radiation safety and the risk of nuclear proliferation. Both of these risks are well-understood, and well managed within Australia. According to the Australian Radiation Protection

and Nuclear Safety Agency average radiation doses to Australian uranium workers are well below 1 millisievert (mSv).

With respect to non-proliferation, the Australian Safeguards and Non-Proliferation Office together with the Department of Foreign Affairs and Trade closely monitors compliance with bilateral agreements between Australia and countries purchasing Australian sourced

uranium. Australia sells uranium only to those countries where there is a bilateral agreement committing the use of Australian sourced uranium to peaceful applications.

While the 2011 Fukushima incident drew great attention, the United Nations Scientific Committee on the Effects of Atomic Radiation reported that, by 2015, no radiation related acute illness or deaths had been observed as a consequence of radiation exposure, and no discernible increased incidence of radiation-related health effects are expected.

In essence, public attitudes are changing as more people are becoming aware of the economic and environmental benefits of uranium mining and nuclear energy in providing low emissions base load power to a world that is still energy deficient. This awareness is being fuelled by continuous improvement of risk management within industry, and ever more high profile environmentalists advocating the use of nuclear power.

Policy reforms are needed to fully maximise uranium's potential

Australia will not reach its potential as a uranium producer without changes to the regulatory and policy environment. Australia needs to improve the regulatory environment to gain the full economic benefit of its uranium resources.

There are three priority areas for reform.

First, exploration and the mining of uranium are still prohibited in Victoria. Queensland and New South Wales permit uranium exploration but not mining.

Second, uranium mining faces additional regulatory obstacles that are not applied to other mineral commodities. The federal *Environment Protection and Biodiversity Conservation (EPBC) Act*, for example, includes 'nuclear actions (including uranium mining)' as a Matter of National Environmental Significance (MNES). Accordingly, uranium projects require approval from the Commonwealth minister for the environment, who must decide whether assessment and approval is required under the *EPBC Act*. There is no scientific case, however, to justify default treatment of uranium mining as a Matter of National Environmental Significance. The *EPBC Act* imposes an additional, extensive Commonwealth assessment and approval process in addition

to existing state processes, irrespective of the location or conditions of the proposed uranium project. In addition to increasing compliance costs, the mandatory imposition of a second Commonwealth assessment and approval process generates uncertainty for investors and raises the cost of capital.

Third, there are regulatory obstacles to the transportation of uranium. Current arrangements see best practice packing, transportation and exportation of uranium through South Australia (Port Adelaide) and the Northern Territory (Darwin). Other states do not allow the exportation of uranium through their ports. This is despite the fact that all accept daily carriage of radiopharmaceuticals to and through over 200 hospitals and medical centres around Australia. The Australian Nuclear Science and Technology Organisation (ANSTO) sends around 2000 packages per month of radioisotopes for medical and industrial uses from Lucas Heights to destinations around Australia and overseas. This compares with Australia's current exports of fewer than 40 containers of uranium oxide concentrate per month.

Transportation restrictions mean Australian exporters cannot ship on vessels certified to carry Class 7 radioactive materials through ports other than Darwin and Port Adelaide. Such vessels can call at other ports with suitable or even preferable routes to end-customers. This can mean extra holding costs and delivery delays. If the few shipping lines that service Port Adelaide or Darwin are suddenly terminated, as has occurred in the past, market access may be completely restricted, requiring vessel chartering and the loading of a substantial proportion of the country's annual production onto a single vessel.

Australia's advantages as a uranium supplier

In addition to its considerable endowment, Australia has an additional comparative advantage as a politically stable liberal democracy with high levels of economic, and political and civil freedom. With the exception of Canada and the United States the top 10 uranium producers in the world do not necessarily share those characteristics. Australia is in a position to credibly commit to ensuring that uranium is only used for peaceful purposes in nuclear power plants.

The Australian Safeguards and Non-Proliferation Office enforces Australia's strict uranium export policies that ensure Australian uranium is only employed for 'peaceful non-explosive purposes' complying with International Atomic Energy Agency safeguards.

Ensuring that the Australian uranium regulatory environment is world's best practice and growing Australia's share of the global market to at least 30 per cent will maximise the value of the country's uranium resource endowment to the Australian people. Having Australia play a larger role in the global nuclear economy will see greater economic benefit to both Australia and its trading partners.

In a world where nuclear power grows to 16.6 per cent share of global electricity capacity, and Australian uranium grows to 30 per cent of global production, Australian uranium would be fuelling approximately 5 per cent of global electricity capacity with near zero carbon emissions.

Uranium cannot in itself generate the levels of wealth and economic activity as coal or iron ore, but as part of a well-diversified portfolio of economic activity it can and will provide employment opportunities to thousands of Australians, often in rural and remote areas; it can generate returns to shareholders, and revenue to government while providing low emissions electricity to millions of people around the world.

“

In a world where nuclear power grows to 16.6 per cent share of global electricity capacity and Australian uranium grows to 30 per cent of global production, Australian uranium would be fuelling approximately 5 per cent of global electricity capacity with near zero carbon emissions.

”

1 Introduction

In 2007, then South Australian Premier Mike Rann told the Australian Broadcasting Corporation that ‘if uranium is the fuel for the future, we’re not the Texas, we’re the Saudi Arabia of it in our state’.¹

But neither South Australia nor Australia is realising the full potential of its substantial uranium resources.

Uranium as a substance is plentiful, however, only a handful of countries have large enough deposits to make mining uranium economically viable. It is something of a paradox that Australia has the largest (economic) endowment of uranium yet supplies only a small fraction of total world supply. This paradox is particularly poignant when the major supplier is Kazakhstan, a land locked nation bordering several countries such as Russia and China. Many of the 32 economies that employ uranium to generate electricity are Australia’s major trading partners including China, Japan, Korea and the United States.

Opponents of uranium mining point to the mineral’s current poor economics to justify prohibitions on exploration and mining. Indeed, uranium mining remains banned in several Australian states, depriving Australia of potential wealth.

There is a real need for reform. Without reform, the Australian uranium industry can never aspire to reach its full potential. If Australia is to continue being a reliable provider of energy commodities, the industry should be permitted to responsibly service the world’s growing energy demand to the best of its capability.

The structure of this paper is as follows.

Section 2 addresses the uranium challenge. The sector has a strong record in managing those aspects of community concern unique to it, yet remains shackled with prohibitions and regulatory duplication. This is a theme explored further in section 6.

Section 3 assesses Australia in the global uranium market. Standard economic analytics suggest that given its resources, the Australian economy is disadvantaged in the production of uranium.

Section 4 examines the inter-relationship between uranium and the broader Australian economy. The uranium industry is estimated to directly account for 2000 jobs (and a further 1000 indirectly) in 2013. The overarching message of section 4 is there is potential for thousands more jobs in the uranium industry in the years ahead with appropriate policy reform. Those employment opportunities do not include the additional jobs that would be created were Australia to participate more actively in the ‘nuclear economy’, i.e. conversion, fuel enrichment, power generation and waste management.

Section 5 examines International Energy Agency scenarios for nuclear energy in 2040 and the consequent demand for uranium. It estimates the employment consequences of each scenario. In order to fully benefit from its uranium endowment, Australia should seek to grow its global market share in accordance with its resource endowment.

Section 6 discusses Australia's role as a responsible supplier of uranium in global markets. The scope for trade is high – most countries with substantial nuclear power programs do not have large uranium resources. At the same time, Australia is one of the more politically stable countries with large uranium resources. Political stability and a strong democratic tradition should ensure good policy. In Australia however, political stability has not extended to uranium policy consistency due to the country's historically volatile attitude towards uranium. This section compares the mining environment within Australia to that in other uranium producing countries, in particular, to Canada. While Australia does perform well generally, the mining policy environment retains significant scope for improvement with substantial national benefit.

To realise its potential market share, Australia needs to become known as a high quality reliable producer with a stable, efficient, science-based regulatory environment. While reform will not guarantee the commercial viability of the uranium sector, it will ensure that commercial viability is determined by commercial considerations, as opposed to political or regulatory distortions.

“

To realise its potential market share, Australia needs to become known as a high quality reliable producer with a stable, efficient, science-based regulatory environment.

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2 The uranium challenge

Uranium is a mildly radioactive metal predominantly used for the generation of nuclear energy and the production of radioactive isotopes for medical and industrial applications.

Historically it was also in high demand for military applications, specifically the development of nuclear weapons during the Cold War.

Uranium mining is generally little different from other kinds of mining.² It differs from most other mining activities in the management of two issues: radiation safety during mining and processing operations; and the risk of nuclear proliferation.

Radiation

The Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) detailed the environmental and health impacts of uranium mining in a 2014 report.³ It outlined how industry trends in radiation safety management have changed dramatically.

In the mid-20th century, there was little knowledge and understanding of radiation health risks and little appropriate protection or regulation. Following a range of epidemiological studies there is now increased understanding of the risks associated with uranium mining and radiation protection systems have been introduced and strengthened. With improved understanding, tightened regulatory controls and improved operational practices, worker exposures to radiation have been significantly reduced.

In Australia, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) maintains the Australian National Radiation Dose Register (ANRDR). This electronic database was developed in 2010 to ensure that workers' radiation dose records are maintained in a centralised register regardless of where an individual employee is working.

Analysis of the ANRDR data 'reveals that approximately 95 per cent of workers received a dose less than 3.5 mSv and 73 per cent of workers received a dose below 0.5 mSv.'⁴ The annual dose limit is 20 mSv. According to ARPANSA, 'average doses to workers remain consistently low'.⁵

Nuclear non-proliferation

The risk of nuclear weapons proliferation has been the other unique issue that the uranium and nuclear industry has needed to manage to secure public acceptance and trust.

Australia's track record with respect to nuclear non-proliferation has been an important factor in consolidating the uranium industry within the mining and industrial landscape. The Australian Safeguards and Non-Proliferation Office (ASNO), within the Department of Foreign Affairs and Trade, ensures that Australia meets its international obligations under the Nuclear Non-Proliferation Treaty (NPT), Australia's NPT safeguards agreement with the International Atomic Energy Agency (IAEA), the Convention on the Physical Protection of Nuclear Material, and various bilateral safeguards agreements.⁶

Australia sells uranium only to those countries where it has a bilateral agreement committing that country to the exclusively peaceful use of that uranium.

ASNO's last annual report concluded that 'all AONM (Australian Obligated Nuclear Material) is satisfactorily accounted for' and that 'no AONM was used for non-peaceful purposes in 2013'.⁷

Uranium is a low emissions energy source. The advantage of nuclear energy

Box 1

Environmental support for nuclear

While some environmentalists remain ideologically opposed to uranium mining, and nuclear power in particular, many prominent environmental and conservation scientists have spoken in favour of nuclear power in recent years.

James Lovelock, originator of Gaia Theory, has been quoted extensively supporting nuclear energy (and by extension uranium).

He is an enthusiast for nuclear power, which makes him unpopular with many greens. 'I'm a scientist and an inventor, and it is absurd to reject nuclear energy,' he says. 'It all comes from the religious side. They feel guilty about dropping atom bombs on people. Here was this extraordinary gift given to humans – a safe, cheap source of power – and it gets horribly abused right at the start. We're still playing out the guilt feelings about it. But it's sad because we in Britain could now be having cheap energy if we'd gone on building [nuclear power stations].'

Nuclear waste? 'It isn't a problem,' he insists. 'Sandy and I were invited to France, and we stood on 25 years of nuclear waste at La Hague. I had my own handheld monitor to check whether they were bullshitting me about it, and it was showing about the same reading as I was getting in this room. It was completely safe. The Swiss did a study of the number of deaths per year in all the various power systems, and nuclear beats everything.' What about the meltdown at Fukushima in 2011? 'That's the most amazing collection of lies ever known,' he says. 'There is virtually no wildlife damage anywhere near Fukushima. Levels [of radiation] are much too low. Nobody was killed, nobody was even hurt, so what was all the fuss about? It's all propaganda. People badmouth nuclear so nobody dares use it.'

Stephen Moss, 2014, James Lovelock: 'Instead of robots taking over the world, what if we join with them?', *The Guardian*, 31 March 2014.

Similarly, Stewart Brand, editor of the *Whole Earth Catalog* – has argued:

The dangers of nuclear power have been systematically exaggerated while its benefits have been ignored ... Nuclear power is the only other form of power generation that is as harmless to the atmosphere as hydro – and hydro is largely maxed out. Fission reactors – especially the new, smaller and safer designs – should be deployed rapidly, particularly in the U.S., China, and India, where the greatest power demand is.

University of Washington, *Conservation Magazine*, *Environmental Heresies*, 29 July 2008.

Stephen Tindale, former Executive Director of Greenpeace UK said:

I spent 20 years campaigning against nuclear, then decided I'd been wrong, and said so.... Nuclear power is not the whole answer to the climate threat. Energy efficiency, renewables and carbon capture and storage are needed too. But nuclear is part of the answer.

Stephen Tindale, 'Why We Should Support Nuclear Power', *Ecologist*, 8 April 2014.

was emphasised in the 2006 Stern Report which suggested that nuclear capacity be doubled by 2055 as a CO₂ abatement measure.⁸ Similar sentiments are expressed by the Intergovernmental Panel on Climate Change (IPCC) which says ‘the life cycle GHG emissions per kWh from nuclear power plants are ... comparable to most renewables.’⁹

Uranium can fuel the reliable provision of affordable, baseload energy. Its high energy density requires proportionally less input per unit of output than alternate energy sources.

Negative community attitudes towards uranium appear to be shifting. This is especially the case where uranium is a better known part of the socio-economic landscape such as in South Australia.

In a South Australian poll released in 2014, 55 per cent of respondents said they supported uranium mining. A further 19.5 per cent were neutral and only 25.5 per cent of respondents were opposed to the uranium industry.¹⁰ Despite these views only 14.8 per cent of respondents thought the community in general had a positive attitude to uranium mining. The actual level of support for uranium mining far exceeds public expectations.

67.5 per cent of South Australians either supported (48 per cent) nuclear power or were neutral (19.5 per cent) toward nuclear power. Almost two-thirds (62.9 per cent) believed nuclear power was an important contributor or an alternative to be considered in the current debate about climate change.

Survey results from the NEA demonstrate that individuals in countries that have nuclear power are more likely to think that the advantages of nuclear energy outweigh the risks than individuals living in countries that do not have nuclear power.¹¹ Similarly, individuals who think that nuclear power can be safely operated are more likely to live in countries that have nuclear power.

In essence, the uranium challenge is to build on the sector’s record of performance to ensure that the regulatory reform needed for the industry to capture its full growth potential occurs. In addition to the typical challenges of a cyclical commodity market, the uranium industry faces a regulatory burden based upon (now outdated) Cold War considerations. Within

Australia the production and export of uranium is highly restricted. At the Commonwealth level, at least, five Acts of Parliament govern uranium:

- *Atomic Energy Act*
- *Australian Radiation Protection and Nuclear Safety Act*
- *Nuclear Non-proliferation (Safeguards) Act*
- *Environment Protection and Biodiversity Act*
- *Environment Protection (Alligator Rivers Region) Act*

These laws are in addition to laws that govern business more generally. Some of these laws, to be sure, relate to the unique characteristics of uranium – yet it is clear that uranium remains over-regulated.

In addition, state laws and regulations regulate and even prohibit uranium exploration and mining. Victoria prohibits both uranium mining and prospecting. New South Wales and Queensland prohibit uranium mining. South Australia, the Northern Territory and Western Australia retain supportive policy frameworks, although the Western Australian Labor opposition remains opposed to uranium.

This sort of policy inconsistency is not conducive to attracting foreign investment. At the very least, policy inconsistency must place upward pressure on the cost of capital for Australian uranium investment.

Regulatory issues that need addressing include:

- **Policy inconsistency across different Australian jurisdictions** – in order to attract competitive capital for the development of new mines, Australia needs policy consistency across the various state jurisdictions, conveying long term policy stability to potential investors and uranium customers
- **Duplication of regulation** – in order to streamline project approvals without compromising environmental standards, Australia needs to first, remove the discriminatory treatment of uranium projects under the *EPBC Act* and second, allow projects to be assessed and approved under a One-Stop Shop process
- **Transport restrictions within some jurisdictions** – in order to ensure Australian

Box 2

The impacts of Fukushima

In March 2011 a Japanese nuclear power plant at Fukushima experienced massive damage after an earthquake (registering 9 on the Richter scale) and subsequent tsunami.

Despite this being the largest nuclear accident since the 1986 Chernobyl disaster, by 2015 there had been no recorded loss of life due to radiation. According to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) (*emphasis added*):

38. *No radiation-related deaths or acute diseases have been observed* among the workers and general public exposed to radiation from the accident.

39. The doses to the general public, both those incurred during the first year and estimated for their lifetimes, are generally low or very low. *No discernible increased incidence of radiation-related health effects*

are expected among exposed members of the public or their descendants. The most important health effect is on mental and social well-being, related to the enormous impact of the earthquake, tsunami and nuclear accident, and the fear and stigma related to the perceived risk of exposure to ionizing radiation. Effects such as depression and post-traumatic stress symptoms have already been reported. Estimation of the occurrence and severity of such health effects are outside the Committee's remit.

United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources, effects and risks of ionizing radiation UNSCEAR 2013 report*, 2014.

supply is as globally competitive as possible, state regulations need to allow uranium transportation to and through ports where it is safe to do so and where appropriate licensing for Class 7 Radioactive materials carriage can be economically obtained

- **The nuclear power ban** – the legislative prohibition of nuclear power and potential fuel cycle industries operates to 'delegitimise' uranium and its possible further use within Australia, undermining investor confidence in Australia's long term commitment to uranium mining.

The current regulatory framework is out-dated. It constrains the industry's potential to generate more economic activity and hence more jobs and export revenue, and its potential to facilitate low emissions electricity generation for Australia's trading partners.

3 Australia in the global uranium market

Australia is an under-performer in the global uranium market. Australia could perform at a much higher level generating more employment opportunities and more revenue for both the private and public sectors.

Australia is the world's third largest producer of uranium after Kazakhstan and Canada. In 2013, according to the World Nuclear Association, Australia produced 6350 tonnes of uranium. By contrast Kazakhstan produced 22,567 tonnes and Canada produced 9332 tonnes. Global production that year was 59,673 tonnes.

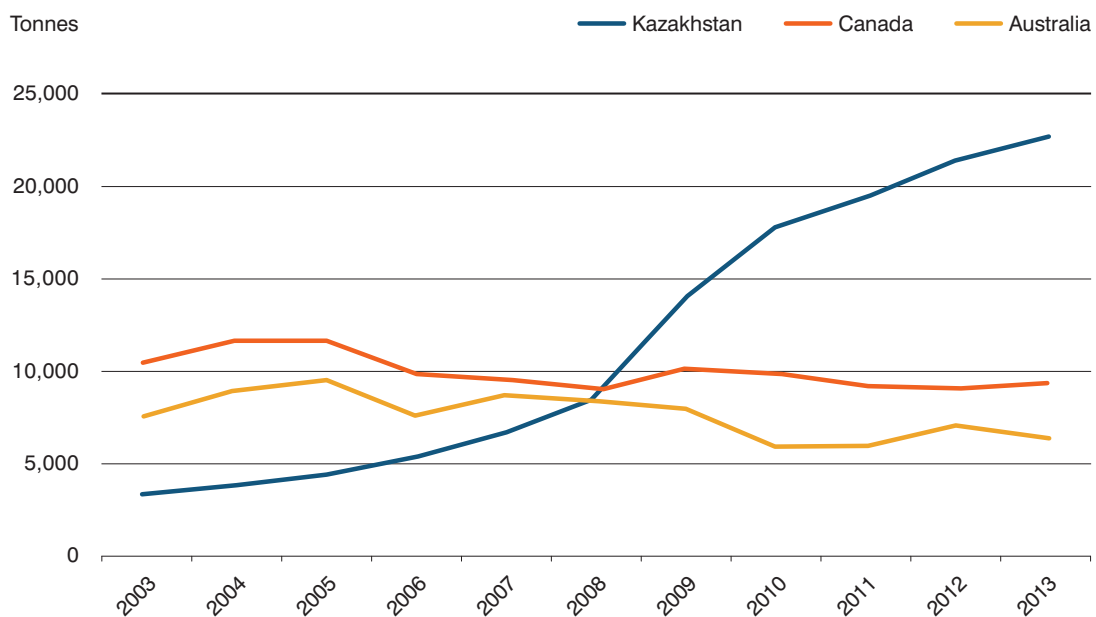
Kazakhstan has dominated a growing uranium market since 2008. Canadian production has been static, while Australian production has declined. Over the time global production increased 67 per cent, Australian output fell 16 per cent. Australia's share of global production has halved from 21.3 per cent in 2003 to 10.6 per cent in

2013. Over the same period, Kazakhstan's production share increased from 9.3 per cent to 37.8 per cent.

These figures contrast with Australia's massive uranium reserves. According to the OECD Nuclear Energy Agency and the International Atomic Energy Agency, Australia held a 31.74 per cent share of global Recoverable Resources (at less than US\$130/kgU) in 2013, up from 23.2 per cent in 2003. By contrast Kazakhstan's share of reserves fell from 16.7 per cent in 2003 to 7.7 per cent in 2013.

Table 2 shows the Reasonably Assured Resources (RAR) at less than US\$130/kgU for the top 10 countries in 2003 and 2013.

Chart 1 Uranium production (2003-2013)



Source: World Nuclear Association

Table 2 Reasonably assured resources (RAR) (tonnes) at less than US\$130/kgU

Top 10		2003	Top 10	2013
1	Australia	735,000	Australia	1,174,000
2	Kazakhstan	530,460	Canada	357,000
3	United States	345,000	Niger	325,000
4	Ukraine	345,000	Kazakhstan	285,600
5	Canada	333,834	Namibia	248,200
6	South Africa	315,330	Russian Federation	216,500
7	Namibia	170,532	United States	207,400
8	Mongolia	170,532	South Africa	175,300
9	Russian Federation	143,020	Brazil	155,100
10	Niger	102,227	China	120,000
Total		3,190,935	Total	3,264,600

Source: OECD Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA)¹²

Australia maintained its top position across that period while Kazakhstan slipped from second into fourth position. China and Brazil now rank in the top 10 at the expense of Ukraine and Mongolia.

Table 3 shows the ratio of the production share to the resources share for the top 10 uranium producers. It is immediately apparent that by top 10 producer standards, Australia is a significant under-performer. The Australian ratio of global production share to resources share is a mere 0.3353. That compares to 1.1779 average for the top 10 producers. By contrast, Kazakhstan has a production share to resources share ratio of 4.8979. Kazakhstan is in effect over-exploiting its uranium resources.

Australia also under-performs in its competitive position as shown by calculations of the location quotient. The location quotient is a very simple tool employed in regional economic analysis.¹⁴ It is an index measure comparing a regional share of economic activity to an aggregate measure of that economic activity. Location quotient is calculated:¹⁵

$$LQ = \frac{(\text{Country production/Country resources})}{(\text{Global production/Global resources})}$$

This measure provides an indication of whether Australian uranium production relative to Australian uranium resources has kept pace with world production relative to world uranium resources. Table 4 shows the results of this exercise for the top 10 uranium resources countries in 2003 and 2013. A number equal to 1 means Australian uranium production relative to Australian uranium resources is keeping pace with world production and world uranium resources, and a number less than 1 means it is not.

Australia's share of production relative to resources fell dramatically over the period 2003 to 2013. This is partly due to the increase in Australian resources over that period and partly due to the lack of Australian production expansion in that time. Australian uranium policy should be directed at changing this trend and capturing the benefits associated with greater uranium production in a world of growing uranium demand.

Table 3 Production share, resources share and production-resources ratio (2013)

	Production share	Resources share	Ratio
Australia	0.1064	0.3174	0.3353
Kazakhstan	0.3782	0.0772	4.8979
Russia	0.0525	0.0585	0.8976
Canada	0.1564	0.0967	1.6181
Niger	0.0759	0.0879	0.8636
Namibia	0.0723	0.0671	1.0776
United States	0.0308	0.0561	0.5484
China	0.0243	0.0324	0.7490
Uzbekistan	0.0402	0.0161	2.5045
Malawi	0.0190	0.0022	8.5571
Top 10	0.9559	0.8115	1.1779

Source: OECD NEA and the IAEA¹³, author's calculations

Table 4 Uranium location quotients 2003 and 2013 (top 10 resources)

	LQ 2003		LQ 2013
Australia	1.0274	Australia	0.3255
Kazakhstan	0.6204	Canada	1.5708
United States	0.2252	Niger	0.8384
Ukraine	0.2313	Kazakhstan	4.7549
Canada	3.1240	Namibia	1.0462
South Africa	0.2397	Russian Federation	0.8714
Namibia	1.1907	United States	0.5324
Mongolia	0.0000	South Africa	0.1854
Russian Federation	2.1966	Brazil	0.0768
Niger	3.0663	China	0.7271

Source: Author's calculations

4 The contribution of uranium mining to the Australian economy

Input-output tables released by the ABS can be used to estimate the flow on effects of uranium industry expansion on the broader economy.

Input-output tables are a rich source of economic information. The ABS releases input-output tables on a regular basis. The most recent version available corresponds to the financial year 2009-10 and was released in September 2013. One of the key uses of input-output tables is multiplier analysis. Multipliers are an estimate of how an economy changes with respect to a change (typically 1 unit) in a given sector.

Multipliers work on the principle that each industry has to purchase inputs from other industries and in turn supplies inputs to yet other industries. Each industry directly affects the output, employment, and income of (almost) all other industries. Under some simplifying assumptions it is possible to calculate the inter-relatedness of the industries that make up the Australian economy. Unfortunately these assumptions are quite strict and multiplier analysis can only provide a rough guide to policy analysis. Nonetheless multipliers are easily understood and have the important characteristic that they emphasise the relatedness of the economy. A policy that impacts one part of the economy very often has flow-on effects that can be, and often are, overlooked.

Historically the ABS estimated multipliers for only 28 industries. The information available is far more disaggregated. Uranium is a non-ferrous metal and the ABS provides input-output tables for non-ferrous metals. Multipliers calculated for non-ferrous metals generally are applied to uranium in this analysis.

Size

In the first instance the simple output multiplier and total output multiplier for the non-ferrous metal economy the financial years 2006-07 to 2009-10 was calculated. The result of this exercise is shown in table 5.

Over the time span considered, the output multipliers were reasonably constant. The average of the total output multiplier was approximately 2.1 indicating that for an additional \$1 of uranium output, other industries contributed \$2.10 additional input (stimulus) to satisfy an increase in 1 unit. In other words, for every \$1 the uranium industry was permitted to grow, an extra \$2.10 was estimated to be generated from other industries.

The uranium economy is small when compared to other energy based commodities such as coal. It represents, however, a significant growth opportunity. In practical terms, according to the Resources and Energy Quarterly¹⁶ uranium exports were valued at \$622 million.

As recently as 2008-09 that figure was \$990 million. In the most recent period South Australia produced nearly 70 per cent of those exports. Therefore an increase in 10 per cent of this share (\$44 million) would represent a growth potential of over \$90 million to the South Australian economy.

Table 5 Non-ferrous metals – output multipliers

	2006-07	2007-08	2008-09	2009-10	Average
Simple output multiplier	1.61836	1.510046	1.691408	1.664126	1.620985
Total output multiplier	2.10158	2.003283	2.131955	2.121468	2.089572

Source: Author's calculations

“

By restraining and restricting uranium production, the Australian economy as a whole is not performing as well as it otherwise could.

”

Employment

The employment multipliers are a function of production. The simple employment multiplier calculates the number of people employed for every million dollars of output from a particular industry. The so-called Type 2A employment multiplier, which estimates the total number of extra people employed in the economy as a result of people being employed in a particular industry, were also calculated.

The employment multipliers for non-ferrous metal mining are shown in table 6. Note that the multipliers are quite volatile over the four-year period they are calculated.

For every million dollars of output in non-ferrous metal mining the economy would see 3.24 jobs being created on average. In turn, for each one of those 3.24 people directly employed in the uranium industry, 4.97 people would be employed elsewhere across the economy.

The average simple employment multiplier is applied to the dollar value of Australian

uranium production to calculate direct employment. That figure is then multiplied by the Type 2A multiplier to estimate the indirect employment figure.

The method estimates that in 2006-07 there were 2130 jobs in the uranium industry and a further 1140 indirect jobs. This is higher than the 2006 Switkowski Report that indicated there were 1200 jobs in the uranium sector with an additional 500 jobs in uranium exploration.¹⁷ The Switkowski Report includes 60 regulatory jobs associated with uranium.

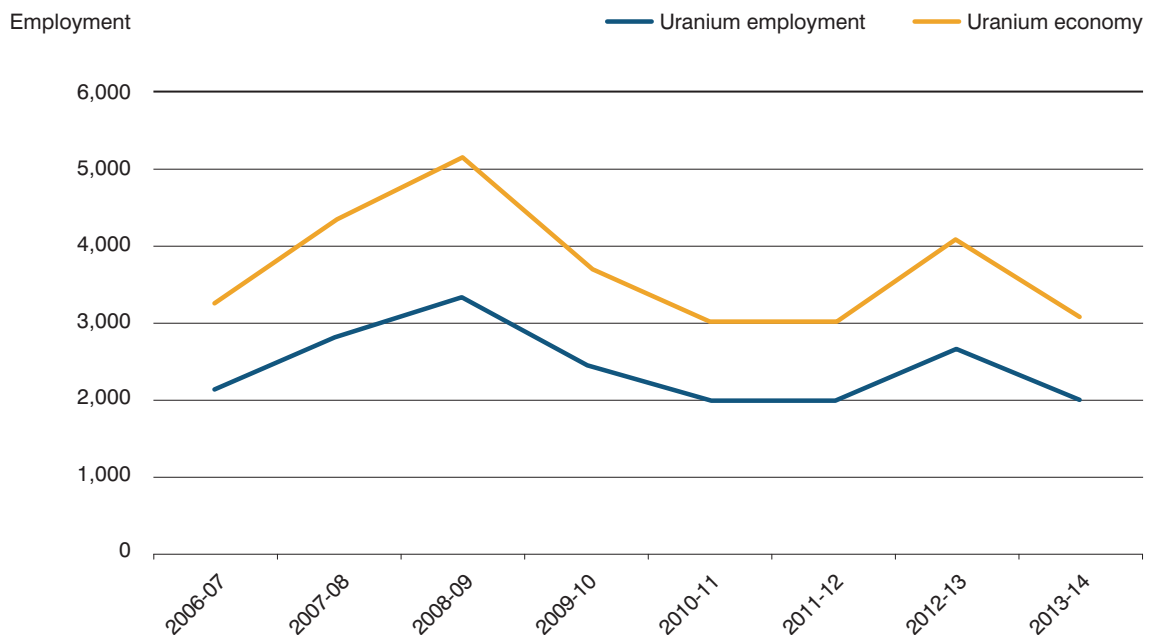
These employment estimates do not include the 1200 employees of the Australian Nuclear Science and Technology Organisation (ANSTO). They also do not include the entire Olympic Dam workforce which despite recent cuts remains around 3500.¹⁸ Given that the ore body at Olympic Dam is poly-metallic it may be the case that joint production of copper, gold and uranium is necessary for economic viability.

Table 6 Non-ferrous metal mining – employment multipliers

	2006-07	2007-08	2008-09	2009-10	Average
Simple employment multiplier	2.970	2.649	4.150	3.179	3.237
Type 2A employment multiplier	4.901	4.250	5.475	5.185	4.970

Source: Author's calculations

Chart 2 Direct and indirect uranium employment



Source: Author's calculations

Scope

The ABS input-output tables provide inter-industry flows allowing examination of the inter-relationships between non-ferrous metals (uranium) and the rest of the Australian economy.¹⁹ It also enables benchmarking against coal, the main energy commodity. This analysis begins by considering the question: If an industry were to increase its production by the value of \$100 what would be required from the non-ferrous metal sector? The top 10 industries are shown in table 7. In the left panel, the top 10 industries for non-ferrous metals are shown. The same information for the coal industry is presented in the right hand side panel. The amounts indicate the dollar amount required for a \$100 increase in the particular sector.

Commonalities include that both industries exhibit a high degree of internal supply activity as indicated by the 5th and 3rd rank of (self) interaction for non-ferrous metals (NFM) and coal respectively. Other similarities include

industry dependences on iron and steel manufacturing as well as iron ore mining.

More interesting are the contrasts. That is, if uranium was to be truly recognised as an energy-good, how might it reshape the economy? Not surprisingly, it has the potential to become a major source of electricity. This is an important point, as uranium represents a low emissions fuel, with a relatively small environmental footprint.

Attention turns now to the question: If the uranium industry were to increase its production by the value of \$100 what would be required from the rest of the economy? The top 10 industries are shown in table 8. Again there are interactions with itself for both industries considered.

Table 8 shows that if the uranium sector were to expand it would provide substantial stimulus to other sectors in the economy.

Table 7 Top 10 industries dependent on NFM (uranium) and coal

Industry	NFM	Industry	Coal
Basic non-ferrous metal manufacturing	32.869	Electricity generation	15.650
Other non-metallic mineral product manufact.	5.540	Iron and steel manufacturing	3.512
Iron and steel manufacturing	3.684	Coal mining	2.829
Ceramic product manufacturing	3.537	Non-ferrous metal ore mining	2.611
Non-ferrous metal ore mining	1.479	Iron ore mining	2.246
Non-metallic mineral mining	1.476	Non-metallic mineral mining	1.345
Cement, lime and ready mix concrete manufact.	1.131	Cement, lime and ready mix concrete manufact.	0.973
Iron ore mining	0.882	Oil and gas extraction	0.484
Electrical equipment manufacturing	0.592	Pulp, paper and paperboard manufacturing	0.468
Plaster and concrete product manufacturing	0.502	Basic non-ferrous metal manufacturing	0.366

*Note: NFM non-ferrous metals
Source: ABS Cat. 5209 Table 6*

Table 8 Top 10 industries stimulated as a result of a \$100 increase in output

Industry	NFM requires	Industry	Coal requires
Exploration and mining support services	9.593	Exploration and mining support services	10.351
Construction services	3.712	Construction services	3.458
Coal mining	2.611	Coal mining	2.829
Finance	1.902	Transport support services and storage	1.901
Professional, scientific and technical services	1.721	Wholesale trade	1.886
Non-ferrous metal ore mining	1.479	Finance	1.764
Oil and gas extraction	1.383	Professional, scientific and technical services	1.752
Wholesale trade	1.155	Rental and hiring services (except real estate)	1.528
Auxiliary finance and insurance services	1.056	Petroleum and coal product manufacturing	1.330
Specialised and other machinery and equipment manufacturing	0.930	Other repair and maintenance	1.287

*Note: NFM non-ferrous metals
Source: ABS Cat. 5209 Table 6*

Obviously increased uranium production would stimulate increased exploration, but more importantly it would stimulate the construction industry. Given the current distribution of uranium mining and development, that construction will most likely occur in South Australia, Western Australia and the Northern Territory. Increased economic activity will stimulate the finance sector – one of Australia's largest and most important service industries. The other important service industry that would

massively gain from an increase in uranium production is professional, scientific and technical services. It is worth noting that the uranium multipliers for the construction industry and finance industry are larger than those of the coal industry. To use a colloquialism, uranium provides more bang for buck in those industries than does coal. By restraining and restricting uranium production the Australian economy as a whole is not performing as well as it otherwise could.

Box 3

Should Australia diversify from mining into the nuclear fuel cycle?

It is always very tempting to argue that raw material producers can and should capture more of the value chain.

The Switkowski Report found that expansion was possible if not easy, and that there should be no prohibitions on such development:

The possibility of Australia becoming involved in one or more of the stages of conversion, enrichment and fuel fabrication presents both significant challenges and some opportunities. The integrated nature of the industry worldwide makes entry difficult. While Australia may have the capability to build an enrichment plant, any such decision would need to be a commercial one. The presumed high returns from enrichment services would need to be balanced against the high barriers to entry and the large technological, economic and political investments required.

...

There is no case for the Australian Government to subsidise entry into this value-adding industry. On the other hand, neither is there a strong case to discourage the development of the industry in Australia, and hence, legal and regulatory prohibitions would need to be removed to enable normal commercial decision-making.

Commonwealth of Australia, *Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia?*, Report to the Prime Minister by the Uranium Mining, Processing and Nuclear Energy Review Taskforce, December 2006.

5 Scenarios – what can the future hold?

The International Energy Agency has described five separate scenarios relating to energy demand out to 2040.

The Current Policies Scenario assumes a continuation of the current suite of policy that saw nuclear energy grow to 392GW of electricity capacity in 2013. In this scenario nuclear energy capacity increases by 32 per cent but still declines as a share of the global electricity market from 11 per cent in 2013 to 9.9 per cent in 2040. The International Energy Agency also describes a New Policies scenario as its Reference Case. This scenario sees the global share of nuclear energy rising to 12 per cent in 2040 and a 60 per cent increase in capacity. These two scenarios can be described as being ‘status quo’ scenarios. Depending upon whether existing nuclear power plants have their working lives extended and new plants are commissioned it is easy to imagine a global electricity share of between 10 per cent and 12 per cent by 2040.

The International Energy Agency also defines a Low Nuclear Case. In this scenario demand for nuclear energy declines over time and global capacity decreases from 392GW in 2013 to 366GW in 2040 and to 7 per cent

of the global electricity market. This can be described as being a ‘pessimistic scenario’.

Finally there are two ‘optimistic scenarios’. The High Nuclear Case sees capacity grow to 767GW and 14.75 per cent of the electricity market, while the 450 Scenario sees capacity grow to 862GW and 16.58 per cent of the global electricity market. These two scenarios rely on decisive global action occurring in response to climate change concerns and the cost-advantages and reliability of nuclear energy. It is worth noting that both these scenarios envisage a greater capacity than that suggested by the Stern Report. It is also worth noting that the 450 Scenario sees the deployment of an even greater amount of nuclear energy capacity than the High Nuclear Case.

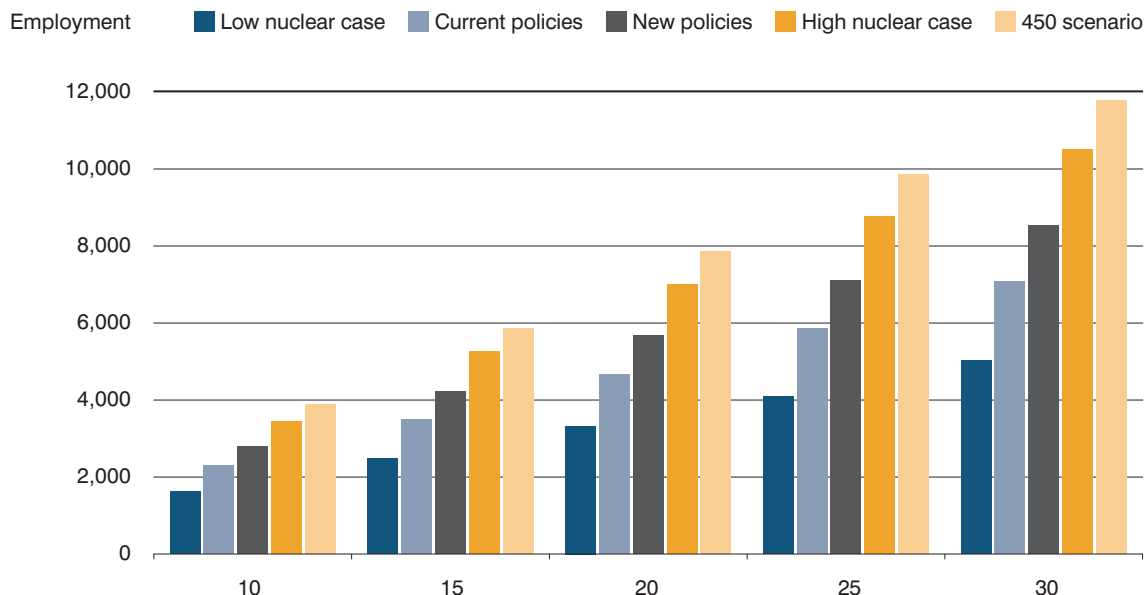
Table 9 sets out the detail of these scenarios including the estimate of the uranium demand for each scenario. That estimate is based on the assumption that between 140 and 195 tons of uranium are required to generate one gigawatt of electricity.

Table 9 Uranium scenarios

	2040 capacity GW	Uranium requirement (T) between		Global share of electricity (%)
Low nuclear case	366	51,240	71,370	7.04
Current policies	517	72,380	100,815	9.94
New policies	624	87,360	121,680	12.00
High nuclear case	767	107,380	149,565	14.75
450 scenario	862	120,680	168,090	16.58

Source: International Energy Agency, author's calculations

Chart 3 Employment estimates in 2040 at 140T/GW



Source: Author's calculations

Australia

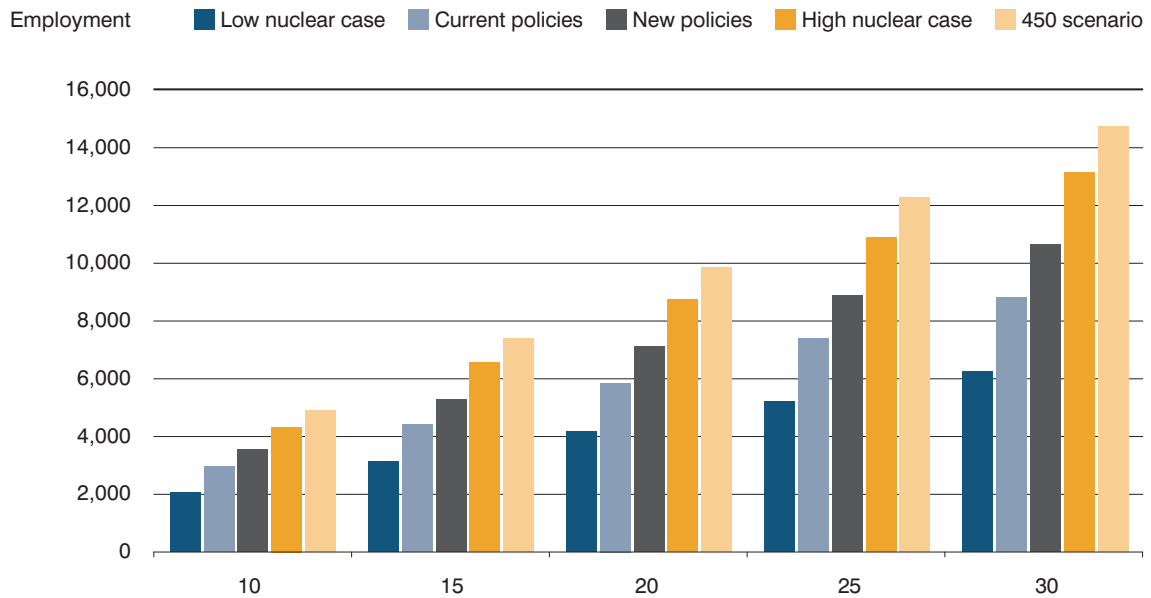
The Australian uranium sector is estimated to provide direct employment to 2000 individuals in 2013-14. In that year Australia provided some 10 per cent of the global market for uranium. Using the simple employment multiplier estimated earlier and IEA scenarios, the employment consequences for Australia under a number of growth assumptions can be estimated. For example, it can be assumed that Australia simply maintains its 10 per cent share of global production. Conversely Australia could grow its share of the world market (through either price or non-price competition) to 30 per cent – a number closer to Australia’s share of global reserves.

If the Low Nuclear Case was to pertain, but Australia grew its share of the market to 30 per cent, employment could grow from 2000 jobs in 2013 to nearly 4500 jobs in 2040. More likely, however, in the Current Policies

case employment could grow to between 6000 and 8000 jobs. In the 450 Scenario as many as 13,500 jobs could be sustained in uranium mining by 2040. Chart 3 shows the Australian employment outcomes in 2040 for various market shares if 140 tons of uranium per annum were necessary to fuel 1GW of electricity assuming a (real) price of \$90 per kilogram, while Chart 4 shows the equivalent information for 195 tons producing 1GW of electricity assuming a (real) price of \$90 per kilogram (i.e. more or less unchanged from current).

At 140T/GW the direct employment in the Australian uranium industry would range between 1493 jobs in the Low Nuclear Case (with current market share) and 10,547 jobs (450 Scenario and 30 per cent market share) in 2040. Given the current location of Australia’s uranium reserves many of these jobs will be created in rural and remote areas. Many of these jobs could

Chart 4 Employment estimates in 2040 at 195T/GW



Source: Author's calculations

be created in South Australia, Western Australia, and the Northern Territory where uranium mining is currently permitted. In addition to those direct employment opportunities an additional 800 to 5600 indirect jobs could be created.

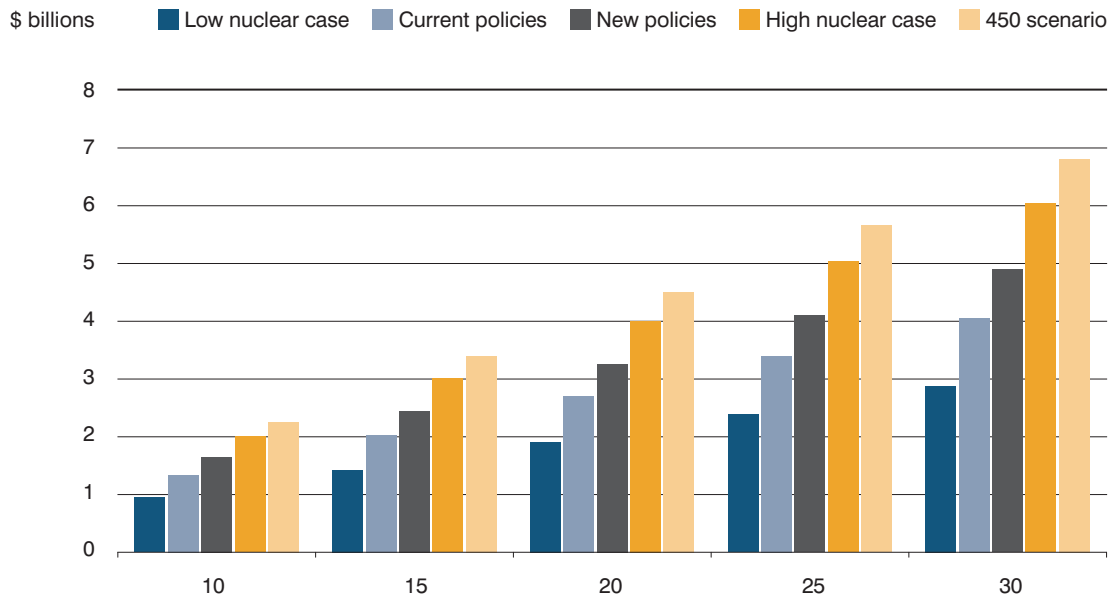
At 195T/GW the uranium jobs range from 2079 to 14,691 in 2040. It is important to note that these are direct jobs in the industry, not indirect jobs. The number of indirect jobs could range from 1100 to 7900 additional employment opportunities. Furthermore it is very likely that in the case of the 450 Scenario occurring, many of the flow-on jobs associated with a nuclear industry would become economically viable in Australia.

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Given the current location of Australia’s uranium reserves, many of these jobs will be created in rural and remote areas.

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Chart 5 Estimated economic benefit in 2040 at 140T/GW



Source: Author's calculations

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The benefits calculated are not limited to the uranium industry but include benefits to other sectors also.

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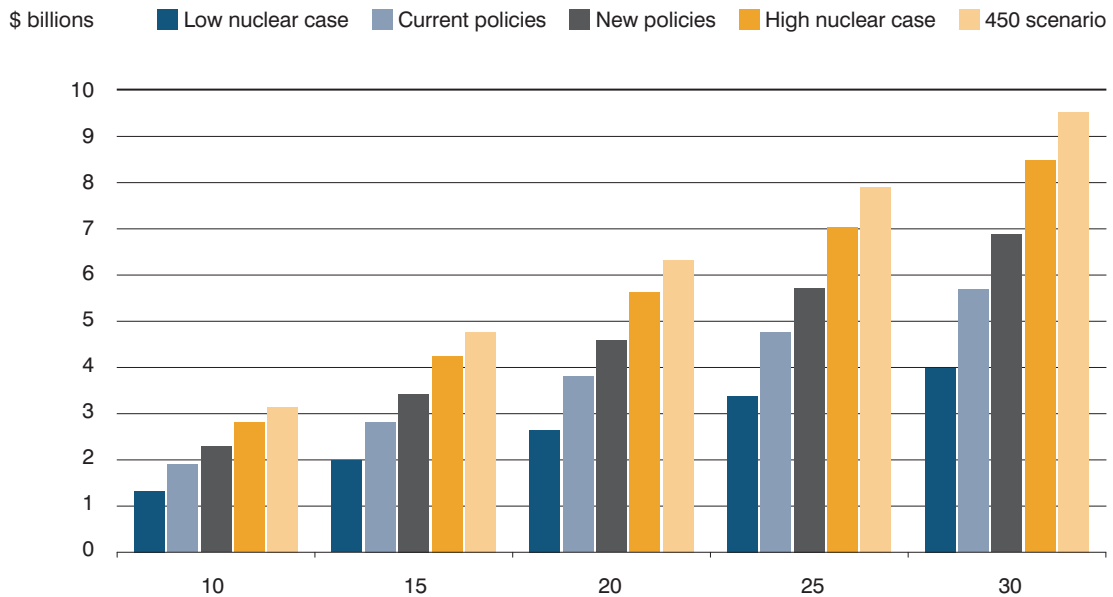
The potential economic value to the Australian economy can be measured following a similar process. The total benefit to the Australian economy could be as high as \$7 billion at 140T/GW.

At a minimum the industry has the potential to deliver approximately \$1 billion in economic prosperity. It is important to recognise that such a benefit would represent, in part, a sizeable economic boost to regional areas.

At the 195T/GW the size of the potential economic value of a larger uranium industry is higher. The economic benefit may be as high as \$9.5 billion. Once again it can be expected that regional areas would be major beneficiaries of this increase in economic activity.

It is important to note that the benefits calculated above are not limited to the uranium industry but include benefits to other sectors also. Further it is important to realise that the biggest contribution comes from Australia growing its market share in uranium production. There is no reason why the Australian market share should be limited to resource share – but nonetheless that goal would be a reasonable policy target.

Chart 6 Estimated economic benefit in 2040 at 195T/GW



Source: Author's calculations

Challenges

Australia's regulatory environment is unlikely to facilitate a substantial increase in market share, as evidenced by the decline in market share over the past decade. State and federal regulation need to be harmonised and simplified to ensure that uranium production and supply decisions are commercial decisions and not quasi-political decisions. The Australian uranium mining regulatory framework needs to be aligned with world's best practice as discussed further in section 6.

Australia needs to compete on both price and non-price factors. Given the economic structure of the global market, it is very likely that a massive increase in Australian supply would substantially drive down global uranium prices. That may or may not be in the best interests of individual Australian producers. On the other hand Australia could compete as a preferred supplier on non-price characteristics – such as being a stable liberal democracy with a well-diversified exports portfolio that will ensure that uranium is not diverted into military applications.

Of course, this implies that there needs to

be broad political consensus within Australia that further developing the uranium trade is in Australia's best interests, and that Australia playing a greater role in the global market is in the global best interest too.

Finally, future prices have not been modelled in this analysis. The analysis simply assumed a conservative real price (in 2015 dollars) of \$90 per kilogram or around \$41 per pound for illustrative purposes. This is in between spot and term prices at time of writing and below the Australian Government's forecast real price (in 2015 dollars) of \$58 per pound.²⁰ The same price was assumed for each scenario – that, of course, is entirely unrealistic, as uranium prices would very likely vary by scenario. In some scenarios it may well be the case that future market prices will be too low to justify Australian expansion in the global uranium market. That is a risk facing every business and every industry. Commercial decisions are best left to the private sector – the role of government is to ensure that those best placed to make commercial decisions make those decisions.

6 Australia as a responsible supplier

Given the distribution of uranium resources around the world and the location of nuclear power plants (both operational and proposed) it is very clear that international trade in uranium is important.

According to the World Nuclear Association there are 437 operational nuclear reactors, with an additional 65 reactors under construction and 165 in the planning stage. Table 10 shows the location of nuclear power plants in relation to the world's top 10 producers of uranium in 2013.

Of the top 10 uranium producers, Canada, China, the Russian Federation, and the United States already have a large proportion of the 437 operational nuclear power plants. The remainder – some 60 per cent of nuclear reactors – are in nations outside the top 10 producer list. This implies an active

international trade market for uranium. Of those plants currently under construction or being planned just under half of them are in nations not in the top 10 producer list. This too suggests an ongoing role for international trade in uranium.

Given that there are international concerns relating to the sale and usage of uranium there is a strong argument for Australia increasing its participation in the global market. Australia is a politically stable liberal democracy that is well-regarded and well-established as an energy exporter. Increased participation in the global uranium market

Table 10 The scope for uranium trade

	Production 2013	Reserves <US\$130	Nuclear power plants			
			Operational	Under construct.	Planned	Proposed
Kazakhstan	22,567	285,600	0	0	2	2
Canada	9,332	357,500	19	0	2	3
Australia	6,350	1,174,000	0	0	0	0
Niger	4,528	325,000	0	0	0	0
Namibia	4,315	248,200	0	0	0	0
Russian Fed	3,135	216,500	34	9	31	18
Uzbekistan	2,400	59,400	0	0	0	0
United States	1,835	207,400	99	5	5	17
China	1,450	120,000	26	23	45	127
Malawi	1,132	8,200	0	0	0	0
Top 10	57,044	3,001,800	178	37	85	167
Total	59,673	3,698,900	437	65	165	316

Source: World Nuclear Association

Table 11 Institutional features of top 10 uranium producers

	Economic freedom 2012	Political rights	Civil rights	Doing business	Investment attractiveness	Policy perception	Best practices mineral potential
Kazakhstan	7.00	6	5	64.59	49.4	42.39	0.54
Canada	8.00	1	1	79.09	83.6	89.65	0.80
Australia	7.72	1	1	80.66	68.5/75.1	69.21/76.09	0.68/0.75
Niger	5.70	3	4	47.63	36.5	41.79	0.33
Namibia	6.50	2	2	62.81	72.4	75.25	0.71
Russian Fed	6.65	6	6	66.66	53.0	30.49	0.68
Uzbekistan	na	7	7	54.26	na	na	na
United States	7.81	1	1	81.98	76.4	80.00	0.74
China	6.39	7	6	62.58	39.8	20.73	0.53
Malawi	6.01	3	4	49.20	na	na	na

Source: Economic Freedom Report, Freedom in the World Report, Doing Business Report, Fraser Institute. For Australia NT/SA

would not only be good for Australia, it would be good for Australia's major trading partners too. Deepening trade relationships would stimulate additional trade in other areas, and promote greater economic cooperation and cultural understanding between nations. Increased trade stimulates economic prosperity and reduces poverty. The provision of an affordable, reliable, low-emission energy source contributes to improved living standards in those economies that wish to industrialise rapidly.

The first column of table 11 shows the latest Economic Freedom of the World Index scores calculated by the Fraser Institute. This index purports to measure 'personal choice, protection of private property, and freedom of exchange' and ranges from zero (lowest) to 10 (highest). Australia scores very highly behind Canada and the United States. Kazakhstan also scores highly on this measure, while the other top 10 uranium producers score well behind Australia.

The second and third columns show Political Rights and Civil Rights scores calculated by Freedom House and reported in their Freedom in the World report. The scores are from 1 (most free) to 7 (least free). Here Australia, Canada and the United States perform very well compared to, say, Kazakhstan.

The fourth column shows the Doing Business summary score calculated by the World Bank. This index measures 'objective measures of business regulations and their enforcement ranging from zero (low) to 100 (high). Again Australia, Canada, and the United States score very highly on this measure compared to the other top 10 uranium producers.

Columns 5, 6, and 7 show measures taken from the Fraser Institute's Annual Survey of Mining Companies. Data for Australia are shown first for the Northern Territory and then South Australia. Canadian data are for Saskatchewan and US data are for Utah.

Table 12 Current mineral potential scores (2010-2014)

	2014	2013	2012	2011	2010
Kazakhstan	0.32	0.32	0.31	0.32	0.38
Canada	0.78	0.70	0.72	0.69	0.75
Australia (SA/NT)	0.68/0.63	0.65/0.60	0.65/0.58	0.58/0.62	0.54/0.56
Niger	0.14	0.13	0.40	0.38	0.42
Namibia	0.55	0.45	0.50	0.45	0.55
Russian Fed	0.22	0.17	0.40	0.30	0.30
United States	0.54	0.62	0.61	0.60	0.66
China	0.09	0.16	0.30	0.30	0.33

General Rule: Areas where scores are higher represent jurisdictions that are more conducive to mining

Source: Fraser Institute, Annual Survey of Mining Companies

The Investment Attractiveness score (column 5) is an average of the Policy Perception score and the Best Practices Mineral Potential score. The Policy Perception score (column 6) is an indicator of how attractive government policies are from the perspective of an exploration manager. The Best Practices Mineral Potential score (column 7) is a measure of mineral potential given 'best policy practice' (a world class regulatory environment, highly competitive taxation, no political risk or uncertainty, and a fully stable mining regime). Higher score for each measure are better than lower scores. On each of these measures Australia, Canada, and the United States score very highly.

While Australia scores well compared to most of the top 10 producers, it does not score well compared to Canada.

The Canadian approach is highlighted by the Fraser Institute's current mineral potential scores – shown in table 12. The current mineral potential score relates to actual policies as opposed to best practice policies.

Canadian mining policy (at least in Saskatchewan) scores better than South

Australia and the Northern Territory. It is also instructive to examine the gap between the Best Practices Mineral Potential scores and the current mineral potential scores – in essence this difference measures the scope for policy improvement. Table 13 shows the difference for Canada (Saskatchewan), Northern Territory, and South Australia.

While historically the Northern Territory and Saskatchewan compare somewhat favourably, South Australia shows scope for improvement. To the extent that the bulk of Australian uranium is mined in South Australia, there is a substantial opportunity for South Australia to benefit from closing this gap. Table 14 explores possible explanations for that gap.

Northern Territory and South Australia do not score as well as Canada (Saskatchewan) on 'encouraging investment', and often score worse on being a 'mild deterrent' and sometimes even on being a 'strong deterrent'. This suggests there is potential benefit in regulatory reform, be it in reducing uncertainty or environmental and other duplication, as well as land access reform, which closes the gap between Australia and Canada.

Table 13 The best practice – current potential gap

	2014	2013	2012	2011	2010
Northern Territory	0.10	0.05	0.03	0.08	0.18
South Australia	0.12	0.08	0.11	0.17	0.17
Canada	0.02	0.06	0.02	0.12	0.14

Source: Fraser Institute, author's calculations; Scores of larger magnitude represent greater opportunities for improvement

Importantly, the economic analysis presented in this report is based on Australian uranium remaining an export business. The estimates of the economic payoff that could result if a complementary power generation industry and other fuel cycle activities were also to develop have not been calculated.

Canada also has operational nuclear power plants, it may be that nuclear power capacity provides an incentive to ensure consistent mining policy. This would suggest the Australian uranium industry would benefit from the establishment of domestic nuclear power industries in the form of more consistent uranium mining policy.

A survey of international literature demonstrates that there are potentially significant benefits. For example US studies have calculated the contribution of nuclear power generating stations to be as large as US\$1.3 billion providing employment for more than 10,000 individuals.²¹ A recent study in the United Kingdom also demonstrated the potential economic benefit estimating additional employment could amount to of 32,000 jobs and a significant increase in GDP.²² Box 4 summarises the Canadian experience outlining three significant benefits Australia could realise if it developed its natural endowment.

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US studies have calculated the contribution of nuclear power generating stations to be as large as US\$1.3 billion.
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Table 14 Explaining the best practice – current potential gap

	Encourages investment	Not a deterrent to investment	Mild deterrent to investment	Strong deterrent to investment	Would not pursue investment due to this factor
Best practice					
Northern Territory	46.20	43.60	10.30	0.00	0.00
South Australia	53.20	42.60	4.30	0.00	0.00
Canada	63.00	32.60	4.30	0.00	0.00
Current practice					
Northern Territory	33.30	48.70	17.90	0.00	0.00
South Australia	36.20	53.20	8.50	2.10	0.00
Canada	58.70	37.00	4.30	0.00	0.00
Uncertainty re: administration, interpretation & enforcement of existing regulations					
Northern Territory	30.20	53.50	14.00	2.30	0.00
South Australia	48.10	36.50	11.50	3.80	0.00
Canada	56.90	35.30	5.90	2.00	0.00
Environmental regulation uncertainty					
Northern Territory	18.20	47.70	31.80	2.30	0.00
South Australia	21.60	47.10	23.50	7.80	0.00
Canada	25.00	51.90	21.20	1.90	0.00
Regulatory duplication and uncertainty					
Northern Territory	23.30	34.90	37.20	4.70	0.00
South Australia	21.60	45.10	25.50	7.80	0.00
Canada	28.80	50.00	19.20	1.90	0.00
Disputed land claims					
Northern Territory	7.10	42.90	23.80	23.80	2.40
South Australia	17.60	49.00	17.60	11.80	3.90
Canada	22.00	46.00	28.00	4.00	0.00
Quality of infrastructure					
Northern Territory	16.30	37.20	39.50	7.00	0.00
South Australia	19.20	50.00	21.20	9.60	0.00
Canada	48.00	38.00	14.00	0.00	0.00
Labour relations					
Northern Territory	17.90	59.00	20.50	2.60	0.00
South Australia	16.30	55.10	24.50	4.10	0.00
Canada	35.40	54.20	10.40	0.00	0.00

Source: Fraser Institute

The potential of the uranium economy: the Canadian example

In contrast to Australia, Canada has harnessed its uranium potential delivering benefits across society. In addition to harnessing its uranium potential, Canada also makes use of nuclear energy.

Key economic contributions include:

- Over C\$5 billion to the broader economy
- Over 60,000 jobs at various skill levels including over 4,000 in highly qualified positions integral to Canada's economy
- Inputs to various industries including the environment, electronics and medicine
- Business opportunities for approximately 150 companies
- C\$1.2 billion in exports
- A leading industrial employer of Aboriginal people (in Saskatchewan).

In addition Canada exports uranium to Europe, Asia and America.

In stark contrast, Australia has missed out on potential streams of economic prosperity, primarily due to restrictions placed on uranium mining. As the brief summary of the Canadian experience shows, recognising responsible

expansion of the uranium sector can deliver significant payoffs. These payoffs span many different sectors involving cutting edge industries including aerospace, medicine and a cross section of technology sectors.

Another benefit of uranium is the economic and environmental cost of energy. It has been well documented that nuclear energy represents a low-emission option that is reliable with relatively low running costs.

A third benefit derived from loosening restrictions would be the potential to further strengthen economic and political ties with China and India. Canada (and Kazakhstan) has shown how this can be done; in particular they have shown how responsible expansion can yield economic gain, further that this economic gain can deliver better global outcomes in the form of relatively cheap and low emission electricity generation.

Canadian Nuclear Association Fact Book 2015

7 Conclusion

The Australian uranium industry has great potential.

At present the Australian uranium industry performs well below its potential given its world leading uranium resources. The benefits to Australia have not been fully realised. This deprives Australians of employment opportunities and revenue. Workers, shareholders and taxpayers would all be better off if Australia's uranium resources were more fully developed.

This paper suggests that the economic benefits of uranium will be realised if Australia grows its market share from about 10 per cent at present to, at least 30 per cent. This expansion will only be viable if access to high-quality low cost resources

can be guaranteed, and if the transactions costs of supplying the market are minimised. This implies regulatory streamlining, infrastructure provision, access to ports, and stable government policy that is supportive of commercial decision making.

The federal and state governments should join with industry in promoting uranium as a responsible and viable energy source. They should also join with industry in promoting Australia as a responsible and reliable uranium investment destination and supplier.

Box 5

The South Australian Nuclear Fuel Cycle Royal Commission

The South Australian government has established a Royal Commission to consider ‘the feasibility of expanding the current level of exploration, extraction and milling of minerals containing radioactive material’.

To that end the Royal Commission released an issues paper calling for submissions in response to 13 questions.

Many of the questions related to issues of economic viability of the uranium trade. Economic viability requires willing customers to pay a price for a product that covers the costs of production, and provides a sufficient profit margin to compensate for the risks and opportunity costs of that production. Suppliers must be able and willing to meet demand for the product at the market price. Even in the most pessimistic International Energy Agency scenario there is significant demand for uranium.

It is not clear what market prices would prevail under that scenario but it is very likely that many uranium producers would exit the industry having lost some or all of their investment. Under other scenarios demand for uranium rises and quite likely market prices would rise too.

Other questions that the Royal Commission poses relate to government policy. What could or should government do to promote the industry? To be clear, there is no case for direct government assistance to the uranium industry. There is, however, a case to be made for regulatory reform and improvements to the business environment. South Australia is behind Canada (Saskatchewan) (for example) in mining regulation. Many of the indicators examined encourage mining investment in Canada (Saskatchewan) but are neutral or even mild discouragements in South Australia.

Ideally business would make commercial decisions in an environment that was broadly supportive of greater investment and expansion.

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Endnotes

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