# Research and Policy Questions for Making Strategic Use of Australia's Uranium Resource

**Based on an analysis of submissions to the recent House of Representatives Standing Committee Inquiry into the Strategic Importance of Australia's Uranium Resources**

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## Important Notice

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## Executive Summary

This report identifies research and policy questions relating to Australia's uranium resource that will help inform the current national debate. The questions have been extracted from a recent Standing Committee public inquiry into the Strategic Significance of Australia's Uranium Resources, covering the views of government, industry, non-government organisations, academia and individuals.

A data-mining software tool was used to draw out key perspectives from the submissions and public hearings to the Inquiry. These perspectives were then ordered under the most commonly cited themes as follows:

Theme 1: Uranium regulation and policy
Theme 2: Proliferation and safeguards policy
Theme 3: Uranium mine performance
Theme 4: Nuclear energy, demand and climate change
Theme 5: Nuclear waste
Theme 6: Technical trends and opportunities

Further analysis identified 46 research and policy questions that have been presented under the relevant theme. Given these research and policy questions are derived from the Inquiry they are not exhaustive or all-encompassing. Additionally they relate to economic, environmental and technology domains covered by a range of institutions within Australia, not solely CSIRO. The types of organisations that may be interested in or be able to progress research and policy outcomes include those that provided submissions to the Standing Committee Inquiry:

- Commonwealth Government
- Australian Nuclear Science and Technology Organisation
- Commonwealth Science and Industry Research Organisation
- Uranium industry
- Australian Bureau of Agricultural and Resource Economics
- Mineral Council of Australia and industry representative groups
- Environmental Groups
- Land Councils and Traditional Owners
- Academic and technical organisations

This report is intended to assist development of a research and policy portfolio that enables Australia to make strategic use of its uranium resources.

# 1. Introduction

## 1.1 Purpose of the report

The purpose of this report is to identify research and policy questions to support the current debate around Australia's uranium resources. It is a starting point for considering what information we need to make informed judgements about the future of Australian uranium. The report identifies 46 questions extracted from 83 submissions and 11 public hearings to the House of Representatives, Industry and Resources Standing Committee Inquiry into the Strategic Significance of Australia's Uranium Resources. These questions are drawn from matters raised in the Inquiry and are intended as a lead-in for further discussion and debate.

## 1.2 Background

This report was initially written as background material for exploring technical and policy directions for stewarding Australian uranium for the benefit of future generations. Uranium stewardship aligns with the current discourse on sustainable development and focuses attention on the systemic and long-term benefits and impacts of development decisions. The dataset taken from the Public Inquiry was valuable for this line of research because it engaged with diverse stakeholder views as well as helped identify key perspectives and themes that may be found in the general uranium debate.

There are many versions of what 'stewardship' or 'responsibility' mean in the context of Australian uranium (see extracts from submissions in the box below) and each version suggests a different technical and policy direction. The conclusion of this report reflects on how the questions can be prioritised to investigate uranium stewardship further. Others may find the questions of use to their particular area of interest.

**Perspectives on stewardship**

The [Australian Government] is closely involved in international efforts to address these [non-proliferation and safeguards] issues. Our position as a major uranium exporter gives us both the responsibility and the standing to pursue these issues effectively (sub33)

Australia hosts 30% of the estimated recoverable resources of uranium that exist in the world today. The nuclear world is looking to Australia to play a leading role in the supply of uranium for peaceful power generation purposes for many decades to come (sub39)

We are very worried about any further mining. We are worried because as Traditional owners we must both look after country and look after people. If the country is poisoned people's lives could be ruined, if the social problems are not fixed this could also ruin lives (sub44)

The Australian Conservation Foundation considers that there is no net benefit from the nuclear industry. Australia's global responsibility and national interest is best served by contributing to end the hazards of nuclear power overseas, and to end rather than expand uranium mining in Australia (sub48)

## 1.3 Structure of the report

The report is divided into three parts:

The first part outlines the analytical methodology and the use of a data-mining software tool to identify key perspectives and themes, and any limitations with the methodology.

The second part provides mapped overviews of the submissions as generated by the software tool. This includes a map of the submissions in their totality and then according to grouping: government, non-government organisations, industry and individuals. A brief commentary on the results follows.

The third part which comprises the bulk of the report is organised under themed chapters. Each chapter includes an overview of perspectives that make up a particular theme and the extracted research and policy questions that are numbered throughout the report. Research-related and policy-related questions are presented separately.

The conclusion provides a recommendation on how the questions can inform a discussion around the stewardship of Australian uranium for the benefit of future generations.

# 2. Methodology

## 2.1 Data source – The Inquiry

Full details of the House of Representatives Inquiry, including access to submissions and public hearings can be found on the parliamentary website[1]. A list of the submissions has also been provided in Appendix A of this report. The Inquiry was initiated by the Minister for Industry, Tourism and Resources, the Hon Ian McFarlane MP on the 17th March 2005. Submissions were requested that specifically addressed four Terms of Reference:

- global demand for Australia's uranium resources and associated supply issues
- strategic importance of Australia's uranium resources and any relevant industry developments
- current structure and regulatory environment of the uranium mining sector
- potential implications for global greenhouse gas emission reductions from the further development and export of Australia's uranium resources

The closing date for submissions was 6 May 2005 though late submissions have been accepted. At the time of gathering data for this report, the Standing Committee received 83 submissions and hosted 11 public hearings between August and December 2005, where representations were made by over 84 people in support of submitted information.

## 2.2 Analytical methodology

The methodology for the report is outlined in Figure 1 below:

[1] http://www.aph.gov.au/house/committee/isr/uranium/media.htm

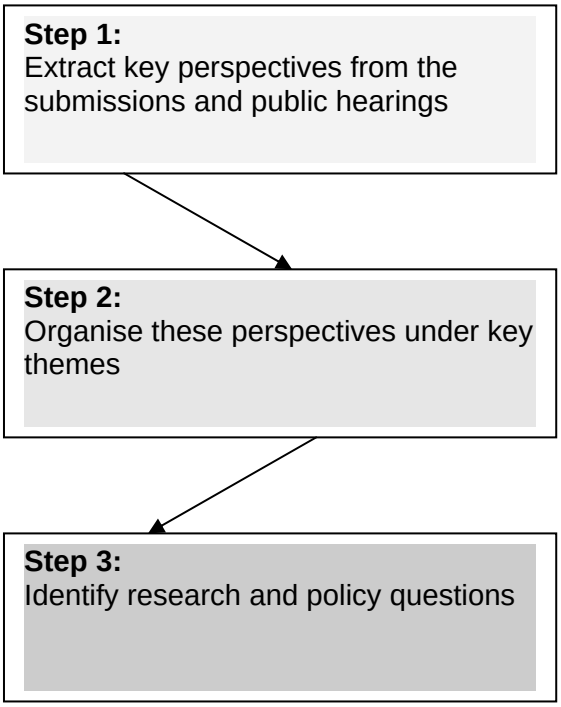
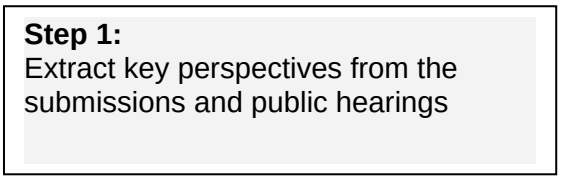



Figure 1: Analytical Methodology

The research methodology is detailed as follows:




The first step was to create a dataset of the key or most commonly stated perspectives across the submissions and public hearings. This was not achievable by simply reading through the documents because the collection was large and unwieldy. Similarly, although the Standing Committee Inquiry specified four Terms of Reference (TOR) it was difficult to organise perspectives under these themes because many submissions did not address all or any of the TOR and many raised matters not covered by the TOR. For this reason a data-mining software tool called Leximancer[2] was employed to create a more focussed dataset of perspectives in preparation for Step 2.

Leximancer is a software tool developed by the University of Queensland. It sorts through large volumes of text and ranks words by the number of times they arise with other words in the same few sentences. These statistically significant relational words (called ranked concepts) build a picture of the main topics of discussion across the document collection.

[2] See the Leximancer website for more details on the software http://www.leximancer.com/

The user can use these ranked concepts to link back to the original document, and by saving these quotes in a separate file create a database for further analysis.

The submissions were divided into four categories: individuals, government, non-government (including academia), and industry. Four ranked concepts (energy, development, should and environmental) were selected as the basis for building the dataset of key perspectives from each of these categories. Further details on the categories and selected ranked concepts are covered in Chapter 3. The public hearings were not included in the Leximancer process but were read separately.

**Step 2:**
Organise these perspectives under key themes

In order to develop themes from the dataset of perspectives a thematic analysis was undertaken. The most logical headings were derived from an overview of key perspectives in the submissions and public hearings:

Theme 1: Uranium regulation and policy
Theme 2: Proliferation and safeguards policy
Theme 3: Uranium mine performance
Theme 4: Nuclear energy, demand and climate change
Theme 5: Nuclear waste
Theme 6: Technical trends and opportunities

Each of these themes is a chapter in this report and includes an overview of the perspectives that made up a theme.

**Step 3:**
Identify research and policy questions

Step 2 resulted in a document that simply listed key perspectives under themes. These perspectives included a mix of general and specific statements, facts and figures and personal opinions. The research and policy questions were extracted by either reframing a

singular perspective or merging like-perspectives into an open-ended question for further study and analysis. The research and policy questions are numbered throughout the report.

## 2.3 Limitations of the Methodology

The perspectives and themes provided in the Inquiry provide a very useful dataset for identifying research and policy questions. However there are several general limitations that may impact on the application of this report:

- Data source: The questions are limited to matters raised in submissions to the Inquiry as well as what has been distilled through the Leximancer process
- Lack of boundaries: The questions have been presented without any analysis of their relevance to Australian policy or technical advantage
- Lack of peer comment/critique: The report and methodology has not been externally reviewed
- Application: Many questions address topics that have already been researched or around which policy has already been developed or is currently under consideration
- CSIRO role: Many of the questions identified in this report are outside the scope of CSIRO

# 3. Overview of Submissions to the Inquiry

The submissions were run through the Leximancer data-mining program and the statistically significant concepts are presented in the form of a visual concept map. These maps have been reproduced in this chapter. It is important to note that the brightness and clustering of a concept is the key to interpreting its rank and relation. An unclustered concept generally represents an anomaly. That is, a concept that has originated in a detailed single-issue submission.

For the purposes of this report, the submissions were divided into four groups. These are defined as follows:

**Individuals:** defined as any person making a submission on their own behalf and not as a representative of a government, non-government or industry organisation
**Government:** governmental departments and research organisations, as well as registered political parties
**Industry:** defined as any organisation that is registered as a company or is primarily funded by and/or exists to support company interests
**Non-government:** an organisation that is mission-driven and is not primarily funded or aligned with an individual, government or industry interest. This also includes academic institutions and entities.

## 3.1 Leximancer Map of All Submissions

The visual map for all submissions is set out below:

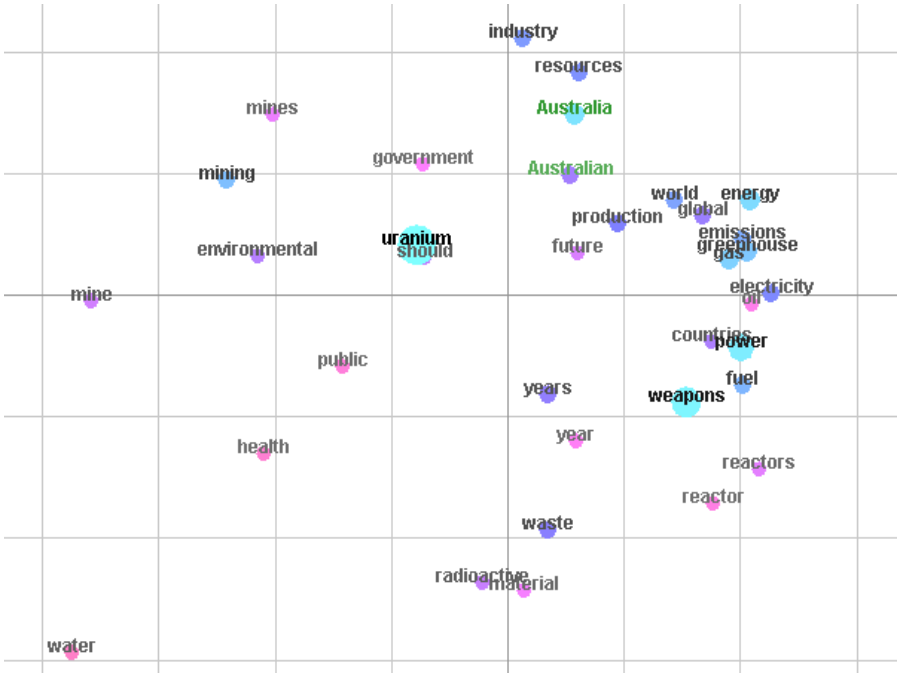



Figure 2: Visual Mapping of All Submissions

Key observations from this map include:

- In order of rank, the main concepts for all submissions are: uranium, weapons, [nuclear] power, energy, Australia, greenhouse gas emissions, mining
- The emergence of weapons as a highly ranked concept, clustered near [nuclear] power, fuel and countries suggests that matters relating to nuclear weapons proliferation and safeguards are important when considering the development of Australia's uranium resources
- The top half of concepts and clusters are strongly aligned with the Terms of Reference of the Inquiry and are as expected. Of note is the clustering of greenhouse gas emissions, energy and world, suggesting a strong focus on climate change and global energy demand issues
- By contrast the bottom half of concepts cover issues beyond the TOR and are more related to nuclear issues in general. For example, weapons, reactors and radioactive material. This suggests that discussions about Australia's uranium resources necessarily engage with wider social, environmental, and nuclear fuel cycle matters

## 3.2 Overview of Government Submissions

The ten government submissions are mainly from Commonwealth government agencies representing the Department of Environment and Heritage, Department of Foreign Affairs and Geoscience Australia. The Commonwealth Science and Industry Research Organisation (CSIRO) and Australian Nuclear Science and Technology Organisation (ANSTO) are also included here. Notable absences are the State and Territory Governments.

The visual map for government submissions is set out below:

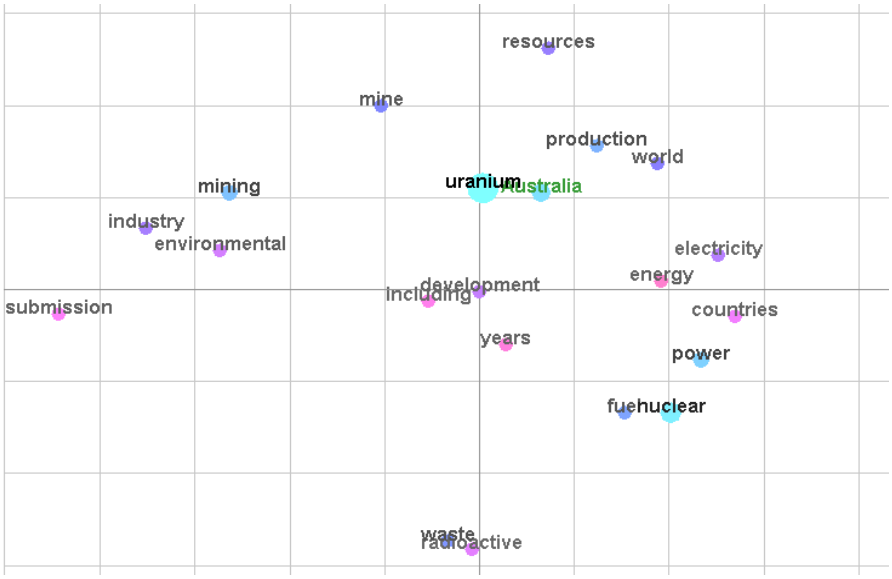



Figure 3: Visual Mapping of Government Submissions

The highest ranked concepts are uranium, nuclear, Australia, power, mining, waste and production. These results are self-explanatory given the Terms of Reference of the Inquiry. Uranium is clustered with Australia, production and world; and nuclear power is clustered with electricity, countries and fuel. This suggests a focus on global economic demand. The other cluster of interest is mining, industry and environmental which suggests a lesser though still important focus on mine operation and regulation. Radioactive and waste is presented as an anomaly or a primarily single issue submission.

## 3.3 Overview of Individual Submissions

Thirty-seven submissions were provided by individuals who are not formally aligned with a government, industry or non-government organisation for the purposes of the Inquiry. At least one-third of these individuals state that they have direct experience with or knowledge about nuclear matters. There does not seem to be any submissions from individuals living near uranium mines.

The visual map of individual submissions is provided below.

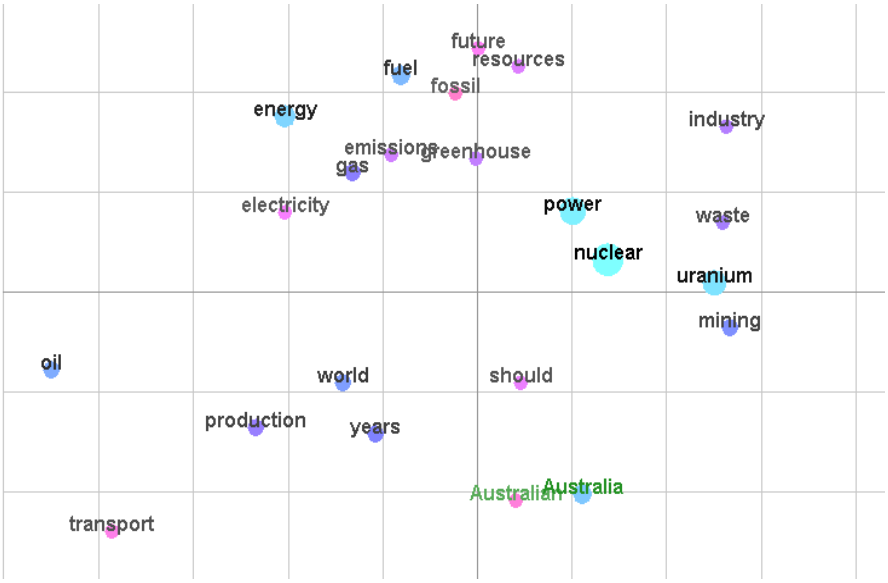



Figure 4: Visual Mapping of Individuals Submissions

The highest ranked concepts are nuclear, power, uranium, energy, Australia and fuel. The map is self explanatory given the Terms of Reference of the Inquiry. Uranium is clustered with nuclear power, mining and waste. Energy is clustered with greenhouse gas emissions, fossil fuels, future and resources. The uranium cluster is of interest and suggests that for individuals, waste is a significant matter for discussion when considering nuclear power and uranium mining. The energy cluster also suggests a focus on climate change issues.

## 3.4 Overview of Industry Submissions

Twenty-four industry submissions were provided to the Inquiry. The majority of submissions came from Australian companies with an interest in exploring for, or operating, uranium mines in the future. Two submissions were received from current mine operators and two submissions were provided by companies representing renewable energy interests.

The visual map of industry submissions is provided below.

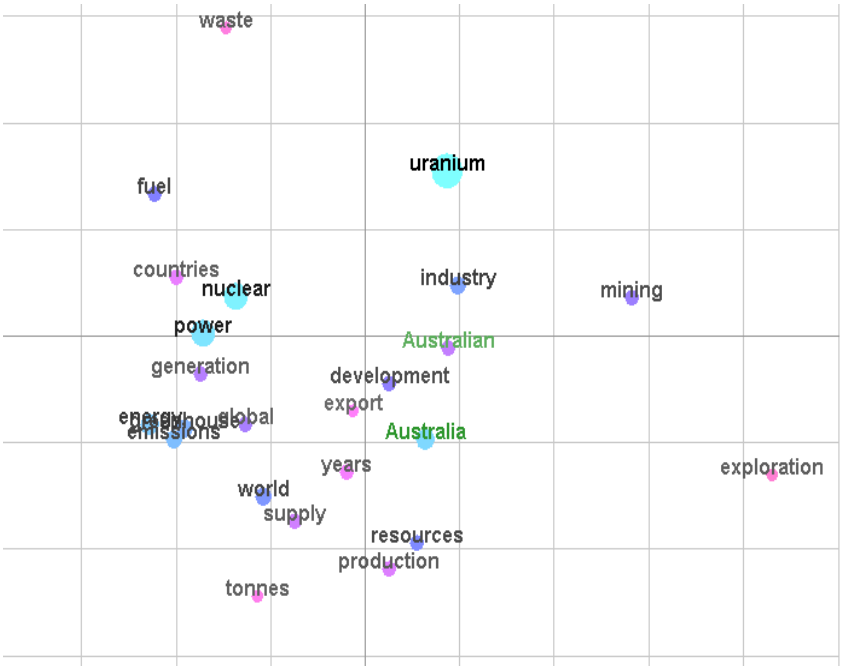



Figure 5: Visual Mapping of Industry Submissions

The highly ranked concepts for industry submissions are uranium, nuclear, power, Australia, greenhouse gas emissions, world and resources. These align with the Terms of Reference of the Inquiry. Clusters of note include energy and greenhouse gas emissions; and resources, production, tonnage, world, supply and years. This suggests a focus on energy demand in the context of climate change, and matters relating to supply and demand for uranium.

## 3.5 Overview of Non-government Organisation Submissions

There were eighteen submissions received by non-government organisations. The focus of this category is diverse, ranging from environment to public health to nuclear science. Two submissions from Aboriginal groups who are stakeholders in uranium mining in the Northern Territory are also included.

The visual map for non-government organisations is provided below:

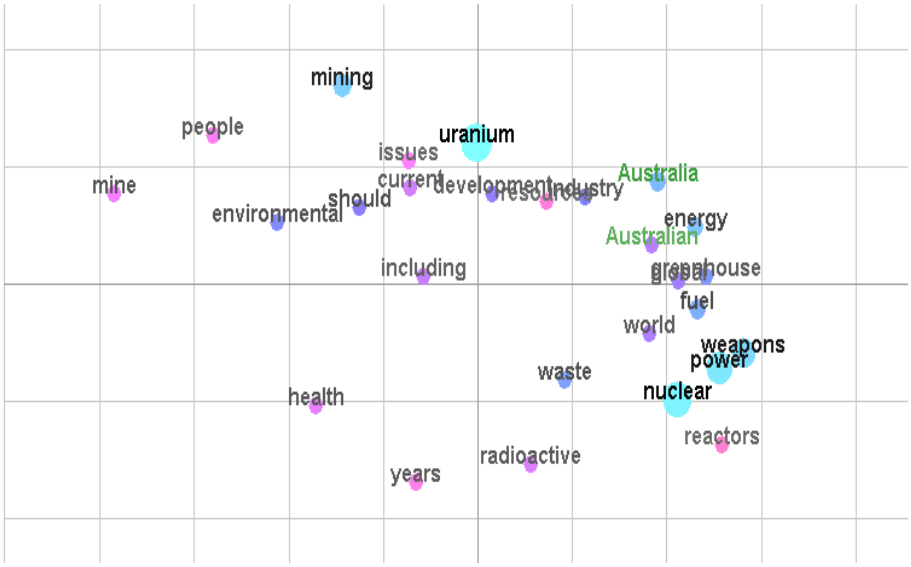



Figure 6: Visual Mapping of Non-Government Submissions

The highly ranked concepts for non-government submissions are uranium, nuclear, power, weapons, energy and mining. The emergence of weapons as a key concept suggests that proliferation and weapons concerns are very strong for this group. Overall the map aligns with the TOR of the Inquiry. The relatively higher number of anomalous concepts suggests primarily single-issue submissions. Concepts in proximity that are of note include nuclear power, weapons, reactors and world; and uranium, should, issues and development. This suggests that a key focus when considering nuclear energy is weapons, and that the development of uranium raises a number of questions for this group.

## 3.6 Developing the Themes

The visual maps indicate the rank and relationship of key concepts in the submissions. The task for Step 1 of the analytical methodology (refer to 2.2) was to create a more focussed dataset of key perspectives from these submissions. This was achieved by selecting four highly ranked concepts: energy, development, should and environmental. The four concepts were selected for the reasons described below:

**Energy** to capture information on nuclear energy, the nuclear and uranium market, greenhouse gas emissions, energy projects. This concept was a key focus in the submission-overview and across the four groupings of submissions.

**Development** to capture quotes relating to Australian resources, production and mine operations, as well as general views on developing the industry. 'Development' was a key focus in the industry and government submissions.

**Should** to capture perspectives across a range of issues that people or organisations feel strongly about, for example, weapons (which was a highly ranked concept overall) and radioactive waste. 'Should' was a key concept in both the individual and non-government submissions.
**Environmental** to capture information relating to Australian uranium mines. This was a key focus in government and non-government submissions.

These four concepts targeted specific areas that were statistically significant across groupings of the submissions. Note that the highest ranked concepts such as uranium, mining and power, provided a very general and large collection of quotes that was not useful. For example the concept of uranium generated about 300 pages of quotes on its own. By contrast, the four chosen concepts combined to create a 100 page document of quotes that was used to identify the following themes:

Theme 1: Uranium regulation and policy
Theme 2: Proliferation and safeguards policy
Theme 3: Uranium mine performance
Theme 4: Nuclear energy, demand and climate change
Theme 5: Nuclear waste
Theme 6: Technical trends and opportunities

These themes are used to structure the research and policy questions presented in this report.

# 4. Theme 1: Uranium Regulation and Policy

## 4.1 Overview of Perspectives

Perspectives about the role of government, the regulatory environment including the types of regulation, the severity and efficiency of regulation, uranium policies of State governments, and incentives and programs for developing uranium mines, can all be grouped under this theme. Perspectives about regulation matters relating to a particular mine site are covered by Theme 3 in Chapter Six.

In general, most of the perspectives under this theme are from industry submissions concerned with reducing impediments and creating a development-friendly Australian uranium sector. The views from individuals and non-government organisations relate more to other themes identified in this report. However a handful of non-government views commented on the need for greater power to environmental agencies in regulating uranium mines (e.g the Environment Protection Agency or Department of Environment and Heritage), and greater penalties for environmental incidents. Submissions by the Commonwealth Government agencies were not highlighted in detail through the Leximancer process, but provide a good overview of government roles and responsibilities in regulating the uranium mining sector. A selection of perspectives is provided below:

**Perspectives on uranium regulation and policy**

State and federal geological surveys and scientific organisations have directed virtually no resources to uranium over the last 20 years, constituting a negative subsidy when compared with other mineral commodities which provide large parts of the Australian resource economy (sub12)

The process must encourage investment in uranium exploration, associated technology and the development of new mines. It must also deliver certainty to the approval process where large investments are required over several years for new mines to be brought on stream (sub15)

Given the magnitude of environmental and human health damage that can be caused by radiation emanating from their wastes or leaks from their processes [the Australian uranium mining industry] needs to be highly regulated. Taking this into consideration, I would venture to say that penalties applied under legislation relevant to the uranium mining industry, and perhaps the mining industry in general, are woefully inadequate (sub38)

Commonwealth, State and Territory Government policy and legislation are not aligned and do not provide a positive framework to develop the uranium industry (sub50)

## 4.2 Research and Policy Questions

| | **Research Questions** |
|---|---|
| 1 | In what ways (if at all) does the current regulatory environment for uranium impact on (a) the position of existing uranium producers and (b) the position of coal mining and coal export industries? |
| 2 | How does Australia's performance in regulating uranium mining policy compare with other countries and is Australia in a position to establish 'International best practice' controls for the uranium cycle? |
| 3 | How can we rehabilitate legacy uranium mines? How do we ensure current or proposed uranium mines in turn do not create a legacy risk? |
| 4 | What are the benefits and costs of different State Government stances on uranium mining? |

| | **Policy Questions** |
|---|---|
| 5 | How can the current regulatory environment be improved to ensure uniformity and efficiency between Commonwealth and State agencies around exploration, mining, health and safety, environment and native title? |
| 6 | Are the Environment Protection Agency or Department of Environment and Heritage equipped to be the primary regulator of uranium mining operations? |
| 7 | How can the current regulatory environment be reviewed to determine the benefits and costs or different degrees or severity of regulation? |
| 8 | What penalties are applied to uranium companies that breach environmental regulations? Are they strict enough, especially in relation to leakage of radiation and seepage from tailings? |
| 9 | Are Australia's efforts in relation to standards and knowledge about occupational and public ionising radiation exposure satisfactory? Do we measure the long-term impacts of radiation on workers? |
| 10 | What is the feasibility of a tax or incentive scheme for the uranium sector focussing on encouraging Australian junior companies? |
| 11 | What tax schemes for Aboriginal businesses are possible so they can secure an equitable proportion of economic development opportunities generated by major projects such as uranium mines? |

| | |
|---|---|
| 12 | What would a uranium exploration program in Australia look like, taking note of incentives for junior exploration companies, and scientific support through organisations such as Geoscience Australia and the CSIRO? What is the feasibility of developing such a program? |
| 13 | Review the scope and power of the Office of the Supervising Scientist in the Alligator Rivers Region. Is it adequate? |

# 5. Theme 2: Proliferation and Safeguards Policy

## 5.1 Overview of Perspectives

This theme covered perspectives relating to proliferation in general and the effectiveness of safeguards policies in managing proliferation. There was a major focus on Australia's safeguards policy as carried out by the Australian Nuclear Safeguards Office in the Department of Foreign Affairs. The types of information covered by this theme include the effectiveness of current Australian policy, the actions of various countries within the proliferation and safeguards context, and general concerns about whether nuclear energy is intrinsically connected to weapons technology and proliferation.

The perspectives were fairly well divided between those who believed that safeguards policy (whether Australian or international) adequately manages the risk of proliferation, and those who believe that safeguards policy is inadequate for managing this risk. A selection of these perspectives is provided below:

**Perspectives on proliferation and safeguards policy**

Over 30,000 nuclear weapons exist. The plutonium in these weapons could provide fuel for nuclear power for years. Australia should not be providing any uranium to countries that have nuclear weapons (sub10)

The stringency of Australia's approach, ensuring Australian involvement in regulating for the full life of its nuclear material through ANSO, is internationally recognised for the contribution it has made to ensure such material is not diverted for military purposes. Australia retains the right to be selective regarding the countries with which it is prepared to conclude bilateral safeguard agreements (sub12)

Australia has in place an accounting system that follows uranium from the time it is produced and packed for export, to the time it is reprocessed or stored as nuclear waste, anywhere in the world. Australia's position as a major uranium exporter assist our influence in the ongoing development of international safeguards and other non-proliferation measures, which have arguable been the United Nation's most conspicuous success (sub16)

Movement of Australia-sourced uranium between countries occurs, such as in Europe, both before and after it has been used in reactors. Accounting procedures for nuclear materials involve uncertainties and margins of error which, on the industrial scale involved, means that it cannot be excluded that material sufficient to produce one or more nuclear weapons could be diverted. At any stage of enrichment, processing or fabrication, it is impossible to distinguish by any means uranium from one source from uranium from another source. Accounting is 'virtual' and so-called 'flag-

swapping' has been shown to be routine. Even if atoms of Australian uranium were not used for weapons, Australian uranium contributes to the total pool of uranium used for the intersecting purposes of electricity generation and weapons and the inseparable associated risks, including of accidents, proliferation, targeting of nuclear facilities by terrorists, and waste disposal (sub30)

## 5.2 Research and Policy Questions

| | **Research Questions** |
|---|---|
| 14 | How well is Australia's accounting procedures for tracking Australian uranium through the fuel cycle performing? How do we benchmark against other country's safeguard processes? |
| 15 | What is the risk of the nuclear fuel cycle to terrorist attack or misuse? Do the following adequately address this problem:<br>▪ ANSTO's project on the security and use of radioactive sources in the region?<br>▪ New technologies such as Generation III+ and IV reactors, fusion and thorium reactors, fast breeder reactors etc?<br>▪ New institutional arrangements e.g multi-nation facilities? |

| | **Policy Questions** |
|---|---|
| 16 | Is it feasible to reconsider the current safeguards policy and not sell uranium to countries that have nuclear weapons (e.g US, China, UK), have failed to sign the Comprehensive Test Ban Treaty (e.g US), and stock plutonium for reprocessing purposes (e.g Japan)? |
| 17 | In what ways can Australia use its position as a major supplier of uranium to influence international safeguard outcomes, including limiting the spread of enrichment and reprocessing technologies and responding to new proliferation challenges? Does Australia have a particular regional role it can play in safeguards? |

# 6. Theme 3: Uranium mine performance

## 6.1 Overview of Perspectives

Perspectives relating to the currently operating uranium mines were organised under this theme. These were focussed around Ranger Mine in the Northern Territory and Olympic Dam and Beverley Mine in South Australia, and covered the views of stakeholders involved in mine operations: industry, traditional owners, government regulators, researchers and public interest groups.

The Mirrar traditional owners and the Australian Conservation Foundation provided detailed submissions on environmental performance and areas for improvement at the Ranger Uranium mine. This created a focus on Ranger mine in the Leximancer sorting process. Several submissions by industry identified a new strategic direction for uranium mining under the banner of "sustainable development'" and "eco-efficiency". The government perspective was primarily captured by the Department of Environment and Heritage around environmental monitoring and the Office of the Supervising Scientist in the Northern Territory, and the Australian Nuclear and Science Technology Organisation around technical and research expertise in uranium mining.

A selection of perspectives is provided below:

**Perspectives by stakeholders**

The industry is worth some $1billion to the Australian economy, and is forecast to increase. There are considerable flow-on benefits to the economy from this industry. Uranium mining contributes to the economy in the form of corporate and PAYE income taxes, and indirect taxes and royalties and the provision of employment (sub20)

Members of the Mineral Council of Australia are required to be signatories to Enduring Value: the Australian Minerals Industry Framework for Sustainable Development. This Framework assists companies translate the principles of sustainable development into relevant, risk-based activities at the minerals site level. The MCA strongly supports the role of a 'social license to operate' as a complement to a regulatory license issued by government (sub36).

The Mirrar are concerned about the impacts of uranium mining and milling on their country, and wish to see improvements in environmental performance, monitoring and reporting of the Ranger and Jabiluka projects to ensure that the short and long terms impacts are minimised to the greatest extent possible (sub44).

Characteristic of uranium mining is the imposition of toxic radioactive, heavy metal and acidic tailings with serious long term environmental impacts and no credible means of containment . . . Mining demand on water supply threaten the Great Artesian Basin and the unique Mound Spring ecosystems dependent on natural groundwater flows for survival (sub48).

ANSTO Minerals is in a position to provide practical advice on dump design, closure strategies and monitoring programs, through the application of computational tools, measurement technologies and specialist expertise. ANSTO is confident that new uranium mines could be developed and operated sustainably with respect to sulfidic waste management (sub29)

The Environmental Requirements [for Ranger uranium mine] state that "… the company must rehabilitate the Ranger Project Area to establish an environment similar to the adjacent areas of Kakadu National Park, such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated areas could be incorporated into the Kakadu National park" (sub55)

## 6.2 Research and Policy Questions

| | Research Questions |
|---|---|
| 18 | What technical or process improvements are expected from the application of the minerals industry's "material stewardship" and "Enduring Value framework for Sustainable Development" to the three operating uranium mines and two potential mines (Jabiluka and Honeymoon)? |
| 19 | Can we focus a research effort around Ranger Uranium mine that:<br>▪ Responds to Mirrar concerns around monitoring, tailings management, rehabilitation and closure, empowerment for Traditional owners in decision-making processes?<br>▪ Technically meet the requirement set by the rehabilitation standards that "…the company must rehabilitate the Ranger Project Area to establish an environment similar to the adjacent areas of Kakadu National Park, such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated area could be incorporated into Kakadu National park" and use this as benchmark for all future rehabilitation projects?<br>▪ Allays environmental concerns about impact on the surrounding environment e.g World Heritage listed Kakadu National Park? |
| 20 | Can we focus a research effort around Olympic Dam mine that:<br>▪ Responds to concerns about the size and growth in uranium tailings and processes in place to manage the tailings for the long-term?<br>▪ Responds to concerns about the impact of the mine expansion on regional water supply? |
| 21 | What is in-situ leaching technology for extracting uranium, and what are the benefits in not having high capital investment and tailings waste and costs in terms of potential impacts on aquifers? |
| 22 | What is Australia's current expertise around uranium mining, milling, in-situ leaching, tailings, sulfidic waste management, rehabilitation, and closure? Are these adequately recognised, applied and/or resourced? |

# 7. Theme 4: Nuclear Energy, Demand, and Climate Change

## 7.1 Overview of Perspectives

This theme covered a significant number of the overall perspectives including views on nuclear energy as a source of electricity, the current and expected demand for nuclear energy in the short, medium and long term, and the resulting demand for uranium. There were also many perspectives on whether nuclear energy is a full, partial or inadequate solution to the challenge of climate change.

The key point that emerged in this theme is that nearly all submissions to the Inquiry accepted the seriousness of the global warming debate and the need to find practical solutions. Many perspectives, primary from industry and government, covered the global outlook for nuclear energy markets, especially in China and India. These submissions were generally also in agreement that nuclear provides a base load power supply that is greenhouse neutral. Many non-government submissions, including those by several individuals argued that on a life-cycle basis, nuclear power emits significant carbon dioxide (for example in the mining and enrichment and decommissioning phases) and that other risks associated with the nuclear fuel cycle, namely proliferation and radioactive waste made it a less attractive energy option.

A selection of these perspectives is provided below:

**Perspectives on nuclear and greenhouse gas reduction and Climate Change**

While the [Uranium Information Centre] has a positive view of the role of wind and solar power in the overall electricity supply, we wish to emphasise that the main demand in any urbanised country is for continuous, reliable supply on a large scale, and these intermittent renewables simply cannot meet that, let alone on an economic basis. Nor is there any prospect of them doing so (sub12_1)

A 1000MWe nuclear reactor uses approximately 30 tonnes of uranium per year as compared with 3.1 million tonnes of black coal per year for a conventional 1000MWe coal fired power station. A nuclear power station produces no greenhouse gases while the coal fired power station produces some 7 million tonnes of carbon dioxide each year and up to 200,000 tonnes of sulphur dioxide per annum (sub54)

When quantifying the greenhouse gas intensity of an industry, it is necessary to consider the lifecycle, from mining to decommissioning. While the production of steam in a nuclear reactor is essentially greenhouse-free, the same is not the case for the mining, transport and enrichment of the uranium

concentrate and the decommissioning of the plant. Uranium enrichment facilities in the United States (where Australian uranium is processed) are powered by fossil fuel energy at a rate of thousands of megawatts (sub4)

Is uranium a solution to the greenhouse problem? No. Nuclear power is not a greenhouse friendly source of electricity, and electricity production is only one part of the problem of reducing greenhouse gas emissions. Leaving aside considerations about proliferation, waste management and reactor safety, a dispassionate observer would be forced to come to the conclusion that nuclear power cannot make much of an impact on the emissions of greenhouse gases in the production of electricity, and what contribution it could make comes at too high a cost (sub45)

Constructing nuclear power plants requires substantial investment and long construction periods. Consequently, any significant change in the world energy mix is not likely in the short to medium term. Despite a substantial amount of capacity expected in Japan, China, India, Russia and South Korea, total growth in nuclear capacity will be largely offset by reactor retirements, particularly in Europe (sub14)

## 7.2 Research and Policy Questions

| | **Research Questions** |
|---|---|
| 23 | Is nuclear energy a feasible solution (medium term and/or long-term) to climate change, paying attention the following:<br>▪ Can nuclear provide a greenhouse-neutral continuous base load power supply?<br>▪ Is nuclear fission an intensive and efficient electricity source?<br>▪ What is the $CO_2$ contribution during the long lead times in developing mines and nuclear systems?<br>▪ What is the $CO_2$ contribution during different stages of the uranium and nuclear fuel cycle?<br>▪ What impact can nuclear energy make on global warming, given the significance of transport emissions?<br>▪ Can nuclear energy support energy demand management and energy conservation technologies? |
| 24 | What are the comparative advantages and costs of a range of energy solutions on a life cycle basis, according to benefits, costs and technology uptake, and other criteria as relevant? |
| 25 | What is the energy-use of nuclear energy on a life-cycle basis with a particular focus on technical ways to reduce the energy use of potentially energy intensive phases such as transportation, enrichment, and construction? Are there opportunities for using renewable or nuclear energy sources for these stages? |
| 26 | What are the evolving medium-long term projections for uranium covering expected mine production capacity, secondary sources, stockpiles of spent fuel for reprocessing, impact of more efficient reactor technologies, active exploration programs, reserves etc? |
| 27 | What are the evolving medium-long term projections for nuclear energy covering supply for the medium-long term covering reactors that are approved for development, in construction phase, earmarked for decommissioning etc? |

| | **Policy Questions** |
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| 28 | What are the latest energy policies and climate change commitment made by countries that use nuclear energy and the expected impact this will have on their energy mix, use of nuclear and the demand for uranium? |

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| 29 | Is Australia in a position to become a regional uranium supplier to developing nations (e.g India and China) and what conditions may be attached to this uranium to encourage best practice non-proliferation and waste disposal practices? |

# 8. Theme 5: Nuclear Waste

## 8.1 Overview of Perspectives

References to nuclear waste in the submissions to the Inquiry primarily focused on high-level radioactive waste from spent reactor fuel. Intermediate and low level waste did not come up as a key or commonly cited perspective. The perspectives in this theme were largely divided into two groups. One grouping of perspectives focused on the technological advancements in managing highly radioactive waste including deep geological repositories, current or planned facilities, and the Australian Nuclear Science and Technology Organisation's research into immobilising waste in the material Synroc. The other grouping of perspectives, primary non-government organisations and a number of individuals, expressed grave concerns about the long decay time of nuclear waste, the environmental and safety hazard presented by this waste for this period, and a lack of faith with current or planned waste disposal technologies.

**Perspectives on nuclear waste**

Nuclear power is too risky to be used anywhere. For nuclear to be touted as "pollution free" energy is a gross lie, the reality is that nuclear energy produces waste which is radioactive and highly poisonous for millennia (sub62)

Nuclear power is the only energy industry which takes full responsibility for all its wastes and costs them into the product. High level wastes have been contained and managed safely for over fifty years, by which time radioactivity has decayed to 0.1 percent of the original level. High level waste takes around 1000 years for its activity to become similar to that of the original uranium ore body (sub64)

The strategic importance of Australia's uranium reserves is implicitly connected with the strategic crisis of mounting nuclear waste reserves around the world. As long as there is no acceptable method for disposing of uranium, no responsible government should permit its further development. A quick review of developing legal opinion favouring "extended producer responsibility" should be sufficient to give caution to anyone who thinks we can guiltlessly "shovel and sell" with no care for future liabilities (sub75)

Integrated waste management implies the minimisation and management of radioactive waste, including reduction of long-term stewardship burden, through for example the design and development of fuel that is directly disposable after use (sub29)

In terms of choosing a repository, Australia has some of the best geology in the world. Many countries have much bigger problems than ours. Even so we would say there are hundred of sites in Australia which would be suitable for that purpose The desired criteria are that it is an area which is such that it

is a distance from a water table – so that it provides another layer of protection – and that the container itself and how you put it into the repository with a clay cap will provide the necessary protection, but there is another layer of defence: it is useful to have geology such that even if the wast migrated out it would migrate out so slowly that it would take thousands of years before radioactivity would reach any water table. By that time there is almost no radioactivity left (hearing 8805)

## 8.2 Research and Policy Questions

| | **Research Questions** |
|---|---|
| 30 | What is the nature of high-level waste, the amount generated and stockpiled, and the facilities and repositories either planned or in place to manage waste disposal globally? |
| 31 | What new technologies purport to reduce the longevity or amount of high-level waste e.g transmutation, Advanced Fuel Cycle Initiative, Generation IV reactors etc? |
| 32 | What is Australia's expertise in the immobilisation of high-level radioactive waste (e.g Synroc)? |
| 33 | What is Australia's position as a geologically stable location for radioactive waste disposal of high-level waste? |
| 34 | Are the facilities planned or in place to manage high-level radioactive waste technically and socially adequate? |

| | **Policy Questions** |
|---|---|
| 35 | Can Australia's expertise in the immobilisation of radioactive waste (e.g Synroc) be extended or developed in any way so that Australia can play a significant role in the management of radioactive wastes globally? |
| 36 | Is Australia a politically stable location for radioactive waste disposal? |
| 37 | What is the feasibility of an Australian role in international radioactive waste management e.g leasing of uranium for disposal in Australia, multi-nation facilities etc? |

# 9. Theme 6: Technical trends and opportunities

## 9.1 Overview of Perspectives

Perspectives around technical trends and opportunities focussed on Australia's current and potential role in nuclear-related research and development. Several general perspectives were primarily drawn from the public hearings to the Inquiry. The first discussed value-adding to the uranium cycle in Australia by developing the uranium industry through exploration programs and extending processing operations to include enrichment. This view was supported by a number of industry speakers and CSIRO (for more information on CSIRO views refer to the Earth Matters Issue 9 publication available from www.em.csiro.au). Another perspective was how Australia could build its expertise in nuclear research, using organisations such as the Australian Institute for Nuclear Science and Engineering to create linkages between universities and ANSTO, for example.

A significant counter-balance to these perspectives was raised in a number of non-government organisation submissions, by the Green Party (NT), and by a handful of individuals. This was the concern that a focus on nuclear research and development would shift investment away from renewable energy solutions.

**Perspectives on technical trends and opportunities**

We in CSIRO believe that the anticipated development of additional efficiency in the industry can come from four specific areas of the uranium value chain, in particular exploration – supporting the discovery of new resources; extract – supporting the extraction of uranium from the ground; adding value – supporting the processing of uranium into a useable commodity; and contributing to the lifetime stewardship of the management of the uranium value chain, including waste, in terms of safe storage, reprocessing and/or recycling (hearing 8544)

[The Australian Mineral Exploration Council] have a view that we should be looking towards value adding. Australia has a history of producing the resources but we do not take it any further – we send our resources overseas. I am hopeful that companies such as Cogema will look at value adding and that there is greater recognition of the efforts of Australians to be innovative and create technologies (hearing8750)

Public documents [from BHPB Billiton] show that their metallurgical recovery is only about 70%. The remaining 30% which is locked up in brannerite, presently goes to tailings … A breakthrough or improvements in the recovery of brannerite would have a major impact, because it would mean much greater production of uranium from mining the same amount of ore … the story of brannerite and

improving metallurgy is a very important research aspect in which breakthroughs will make a very significant change to our uranium resource production (hearing8724)

Geoscience Australia are helping us a tremendous amount out there in providing new technologies for getting below the regolith… What we have shown is that the western side if the Gawler Range volcanics, which we now believe is equally prospective for IOCGU deposits, has a shallower cover. . It still has a cover of some 30 to 40 metres, but we are able to strip that with these technologies, such as magnetism gravity and mobile metal ion geochemistry. They are very important to us, and any new technology that can be developed in that area is exactly what the industry requires (hearing8544)

The use of uranium as a fuel therefore cannot be sustained, and can only temporarily delay the need to develop sustainable energy options for the long term. By spending on the significant capital costs of nuclear energy, we not only delay but also reduce our capacity to generate the necessary investment activity in the inevitable sustainable energy options of the future (sub9)

## 9.2 Research and Policy Questions

| | **Research Questions** |
|---|---|
| 38 | What is Australia's current and potential comparative research and technical advantage across the uranium and nuclear fuel cycle? |
| 39 | What is Australia's current and potential comparative research and technical advantage in renewable energy e.g wind, solar, geothermal hot rocks etc? Does a focus on nuclear research and development threaten any potential advantage and provision of long-term solutions to managing climate change? |
| 40 | What is the feasibility of developing a research program around the development of additional efficiencies in the uranium value-chain, focussing on exploration (supporting the discovery of new resources), extraction (supporting the extraction of uranium from the ground), value-add (supporting the processing of uranium into a useable commodity), and lifetime stewardship (management of the uranium value-chain, including waste in terms of safe storage, reprocessing and/or recycling)? |
| 41 | What technical opportunities around breakthrough improvements in the metallurgy of recovery of uranium from brannerite to release up to 30% more uranium resource from Olympic Dam and other potential sites are available? |
| 42 | What is the feasibility of extending technological innovation in exploring below the regolith by building upon existing technology such as magnetism gravity and mobile metal ion geochemistry? |
| 43 | Can Australia contribute through materials or technical information to international nuclear-related projects e.g the International Thermonuclear Experimental Reactor (based on nuclear fusion of hydrogen isotopes), thorium reactors (producing no plutonium by-product and shorter-lived waste) Generation IV reactors (proliferation resistant and more efficient waste streams), fast breeder reactors, Advanced Fuel Cycle Initiatives, accelerator driven transmutation treatment of waste etc? |

| | **Policy Questions** |
|---|---|
| 44 | What training and development programs would be required to build the next generation of researchers with nuclear engineering skills? What role can the Australian Institute for Nuclear Science and Engineering play in this process? |
| 45 | What potential role does Australia have in relation to the development of multi-nation facilities in either enrichment or waste disposal as part of the International Atomic Energy Agency's discussion around limiting fuel cycle technology and facilities world-wide? |

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| 46 | How can Australia encourage technology transfer to developing nations in the region that currently utilise nuclear power? Can Australia encourage cleaner and safer outcomes for example in waste disposal or stockpiling of reprocessed material? |

# 10. Conclusion

This report has reviewed the submissions and public hearings to the recent House of Representatives Industry and Resources Standing Committee Inquiry into the Strategic Importance of Australia's Uranium Resources. It has provided an overview of the key perspectives organised by theme and identified 46 research and policy questions that warrant further consideration and span technical, environmental and economic domains of research.

This report was originally intended as background material for answering a particular research question: What technical and policy directions are required to steward Australian uranium for the benefit of future generations? Based on the experience of writing this report and the types of questions identified, the following points can be concluded.

- Any discussion on uranium stewardship must necessarily engage with diverse stakeholder views on the subject as well as consider the full uranium and nuclear fuel cycle
- We need to be clear of where Australia's comparative research and technical advantage lies and whether the choices we make now will meet medium-long term energy demand in the context of climate change
- Each stage in the uranium and nuclear fuel cycle involves both systemic benefits and costs. Whilst there is an opportunity to address these costs, it requires a firm commitment to technology transfer and investment. Low footprint or eco-efficient uranium mines may achieve a social license to operate and sustainable development outcome, but present a technical challenge that will require significant investment
- Radioactive high-level waste and weapons proliferation remain the two major concerns with nuclear energy

It is hoped this report will assist other researchers, policy makers and interested observers in their line of inquiry. The types of organisations that may be interested in or be able to progress research and policy questions include those that provided submissions to the Standing Committee Inquiry:

- Commonwealth Government
- Australian Nuclear Science and Technology Organisation
- Commonwealth Science and Industry Research Organisation
- Uranium industry
- Australian Bureau of Agricultural and Resource Economics

- Mineral Council of Australia and industry representative groups
- Environmental Groups
- Land Councils and Traditional Owners
- Academic and technical organisations

# Appendix A – List of submissions to the Inquiry

| Submission | Individual |
|---|---|
| 1 | Robert Elliot |
| 2 | Janet Marsh |
| 3 | Australian Academy of Technological Sciences and Engineering |
| 4 | Wind Prospects |
| 5 | John Reynolds |
| 6 | Compass Resources |
| 7 | Keith Adler |
| 8 | WA Branch of the Medical Association for Prevention of War |
| 9 | The Greens (NT) |
| 10 | John Schindler |
| 11 | Australian Nuclear Forum |
| 12 and 12.1 | Uranium Information Centre |
| 13 | Darwin No War Committee |
| 14 | Australian Bureau of Agricultural and Resource Economics |
| 15 | Summit Resources |
| 16 | Deep Yellow |
| 17 | Australian ITER Forum |
| 18 | Eaglefield Holdings |
| 19 | Australian Nuclear Association |
| 20 | Association of Mining and Exploration Companies |
| 21 | Submarine Institute of Australia |
| 22 | Arafura Resources |
| 23 | N Pastalatzis |
| 24 | R Parsons |
| 25 | Name withheld |
| 26 | CFMEU |
| 27 | Gavin Mudd |
| 28 | The Environment Centre NT Inc |
| 29 and 29.1 | Australian Nuclear Science and Technology Organisation |
| 30 and 30.1 | Victorian Branch of the Medical Association for Prevention of War |
| 31 | Jindalee Resources |
| 32 | Australian Radiation Protection and Nuclear Safety Agency |
| 33 and 33.1 | Hon Alexander Downer MP |
| 34 | Professor P Parsons |
| 35 | A Parker |
| 36 | Minerals Council of Australia |
| 37 | Commonwealth Science and Industry Research Organisation |
| 38 | AP Chem Australia |
| 39 | AREVA Group |
| 40 | The Uniting Church of Australia |
| 41 | Justin Tutty |
| 42 | Geoscience Australia |
| 43 | Cameco Australia |
| 44 | Gundjeihimi Aboriginal Corporation |
| 45 | People for Nuclear Disarmament NSW Inc |
| 46 | Energy Resources of Australia |
| 47 | Paladin Resources |
| 48 | Australian Conservation Foundation |
| 49 | Heathgate Resources |
| 50 | Nova Energy |
| 51 | Northern Territory Minerals Council |
| 52 and 52.1 | Friends of the Earth |
| 53 | Public Health Association |
| 54 and 54.1 | Southern Gold |
| 55 and 55.1 | Department of Environment and Heritage |

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|---|---|
| 56 | P Maiden |
| 57 | B Hedger |
| 58 | Dr Needleman |
| 59 | D Addison |
| 60 | AMP Capital Investors Sustainable Funds Team |
| 61 | R Hinkson |
| 62 | K Winter |
| 63 | J Wylie |
| 64 | Professor L Kemeny |
| 65 | W Lewis |
| 66 | B Daly-King |
| 67 | C Mitchell |
| 68 | B Morgan |
| 69 | C Salmon |
| 70 | J Catalano |
| 71 | L Joseph |
| 72 | R Broinowski |
| 73 | J Valentine |
| 74 | J Forsyth |
| 75 | Arid Lands Environment Centre |
| 76 and 76.1 | I Renwick |
| 77 | Australian Institute of Nuclear Science and Engineering |
| 78 | Northern Land Council |
| 79 | Alice Action Executive |
| 80 | S Riddel |
| 81 | C Pembroke |
| 82 | A Macintosh |
| 83 | R Warleigh |
| 84 | A Crooks |