### Advanced Explosives and Energetic Materials

Materials with large amounts of stored or potential energy that can produce an explosion. Applications for advanced explosives and energetic materials include mining, civil engineering, manufacturing and defence.

#### Key Australian Government Actions

<table>
<thead>
<tr>
<th>Initiatives</th>
<th>Example Outcomes</th>
<th>Underpinning Science</th>
<th>Example Applications</th>
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</thead>
<tbody>
<tr>
<td>Critical Minerals Facility – providing $2 billion of loans for critical mineral projects supporting the Critical Minerals Strategy</td>
<td>Development of innovative and improved raw material extraction methods</td>
<td>ANZ Standard Research Classification Category</td>
<td>Military weapons</td>
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<td>Critical Minerals Facilitation Office including 2019 Critical Minerals Strategy</td>
<td>More efficient propellant for satellites (in terms of weight and energy)</td>
<td>Physical chemistry</td>
<td>Shaped charges for controlled explosions, e.g. perforation of oil and gas wells</td>
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<td>US-Australia Critical Minerals Plan</td>
<td>Reduced risk of uncontrollable, unintended or accidental explosions</td>
<td>Geochemistry</td>
<td>Solid rocket motors for space system launch</td>
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<td>Modern Manufacturing Strategy</td>
<td>Decreased environmental impact during the use of advanced explosives and energetic materials</td>
<td>Chemical engineering</td>
<td>Propellant for satellite attitude control</td>
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<td>Sovereign Guided Weapons and Explosive Ordnance Enterprise</td>
<td>Decreased sustainment costs for military weapons</td>
<td>Resources engineering and extractive metallurgy</td>
<td>Solid propellant fire extinguishers and airbag inflation systems</td>
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<td></td>
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<td>Classical physics</td>
<td>Solid propellant gas generators for emergency surfacing of ships</td>
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#### Regulations

- Defence and Strategic Goods List 2021
- Environment Protection and Biodiversity Conservation Act 1999

#### Australia’s place in the world

China has the highest research impact in this area and also has 6 institutions in the top 10 internationally, including the top 3. The United States is 2nd and Australia is ranked 13th. The United States has the highest venture capital (VC) investment ahead of the Republic of Korea, with Australia having the 5th highest amount of VC investment. Globally, the number of patents has been increasing at around 9% p.a. since 2015, with China having the greatest number of patents, more than double 2nd ranked United States; Australia is ranked 14th. Given the sensitive nature of this technology, much cutting-edge research is unlikely to be in the public domain, meaning this assessment may not be a true reflection of overall research capability.

China has considerable strength in research and patent filings in this area, well ahead of the United States and Australia. Australia’s Defence Science and Technology Group leads national efforts in advanced explosives and energetic materials. Together with renewed focus on space exploration and with Government’s $1 billion investment into guided weapons and explosive ordnance, domestic capability in this area is anticipated to expand.

### Key Sectors

- Construction
- Defence & Defence Industry
- Manufacturing
- Mining & Resources
- Space
- Transport & Logistics

#### Estimated impact on national interest

<table>
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<tr>
<th>Economic Prosperity</th>
<th>National Security</th>
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<tbody>
<tr>
<td>Low</td>
<td>Low</td>
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</table>

#### Key Technologies

- Advanced Explosives and energetic materials are essential for construction, mining and space technology. Without continued access to these technologies, Australia would be limited in its ability to continue infrastructure projects, resource mining, housing development and more. The recent establishment of the Australian Space Agency creates opportunities to build domestic capability in space launch technologies, for example propellants, which may have applications in other areas, such as transport and logistics. Advancements in explosives and energetic materials, have the potential to create more directed and controlled explosions, improving safety and efficiency in the mining and resources sector.

### Opportunities and Risks

**Opportunities**

- Advanced explosives and energetic materials
- Airframed and space technologies

**Risks**

- Australia’s Defence Force
- Explosive ordnances are considered critical enablers for Australia’s Defence Force
- Economic downturns

#### Readiness Level – Now

- Military weapons
- Shaped charges for controlled explosions, e.g. perforation of oil and gas wells
- Solid rocket motors for space system launch
- Propellant for satellite attitude control
- Solid propellant fire extinguishers and airbag inflation systems
- Solid propellant gas generators for emergency surfacing of ships
- Explosives for drilling and blasting to break rock for excavation in mining, construction and demolition
- Explosive rivets for aircraft manufacturing
- Explosive bonding of metals such as titanium and steel
- Fireworks
- Marine distress flares
- Decoy flares for defence assets
- Pyrotechnics for bird control at airports

#### Readiness Level – 2-5 years

- Low-impact emission rocket propellant for satellite launch
- 3D printed explosives
- High temperature explosives for hypersonic weapons

#### Readiness Level – Beyond 5 years

- Asteroid mining
China has the highest research impact in this area, ahead of the United States, with Australia ranked 13th. Total volume of published research has been increasing at 5% p.a. over the 5 year period 2016–2020, with 11% of research involving international collaboration.

The United States has the highest amount of venture capital (VC) investment, ahead of the Republic of Korea and China. Australia is ranked 5th for VC investment for advanced explosives and energetic materials. Globally, investment in this area has been increasing at 15% p.a. since 2016.

The number of patents filed in this field has increased by 9% annually from 2015 to 2019. Most patents in this field were filed by applicants or inventors from China, ahead of the United States and the Russian Federation; Australia ranks 14th.

The research impact provides an indication of the productivity of a country or institution. Here, productivity was assumed to be represented by the volume of publications (i.e. scholarly output) as an indicator of the resources & facilities, and the level of interest in the publications as an indicator of quality.

China has 6 institutes in the top 10 international institutions, including the top 3 institutions. The United States, Germany and the Russian Federation make up the remaining institutes in the top 10 international institutions.

Within Australia, the University of Melbourne has the highest research impact. No Australian institution is in the top 50 international institutions.

Top 5 Australian Patent Applicants
- Dyno Nobel Asia Pacific
- Bhattacharya, Utpal
- CMTE Development
- Commonwealth of Australia
- Defendtex