



Australian Government
Department of Industry,
Science and Resources

Office of the
Chief Economist

Resources and Energy Major Projects

2022 Report

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About this report

The *Resources and Energy Major Projects* publication is an annual review of projects which seek to extend, increase, or improve the quality of mineral commodity output in Australia. These investment projects include greenfield projects, expansions, reactivations, processing facilities, and related infrastructure. Since 1997, the publication has estimated the value of current and potential investment in the sector and provided commentary on key development trends.

From 2017 to 2019, *Resources and Energy Major Projects* was published as a chapter in the *Resources and Energy Quarterly*. The 2020, 2021 and 2022 editions, as well as pre-2017 updates, are standalone publications.

This edition of the report presents an update on project developments over the twelve months from the start of November 2021 to the end of October 2022, and is accompanied by a [detailed project listing](#). This year, the list of major resources and energy projects in Australia features 423 projects.

Terminology

The methodology used in the report is detailed in the *Methodology* section.

This report and project list is the result of our research on major resources and energy projects under development in Australia. For the purposes of this report, ‘major’ projects are those costed at over \$50 million and which have the potential to reach a final investment decision (FID) within the next five years.

Projects are classified into four stages of an investment pipeline: publicly announced, feasibility, committed and completed. Earlier stages of developing mineral projects, such as identifying deposits and exploration activities, are not included in our lists.

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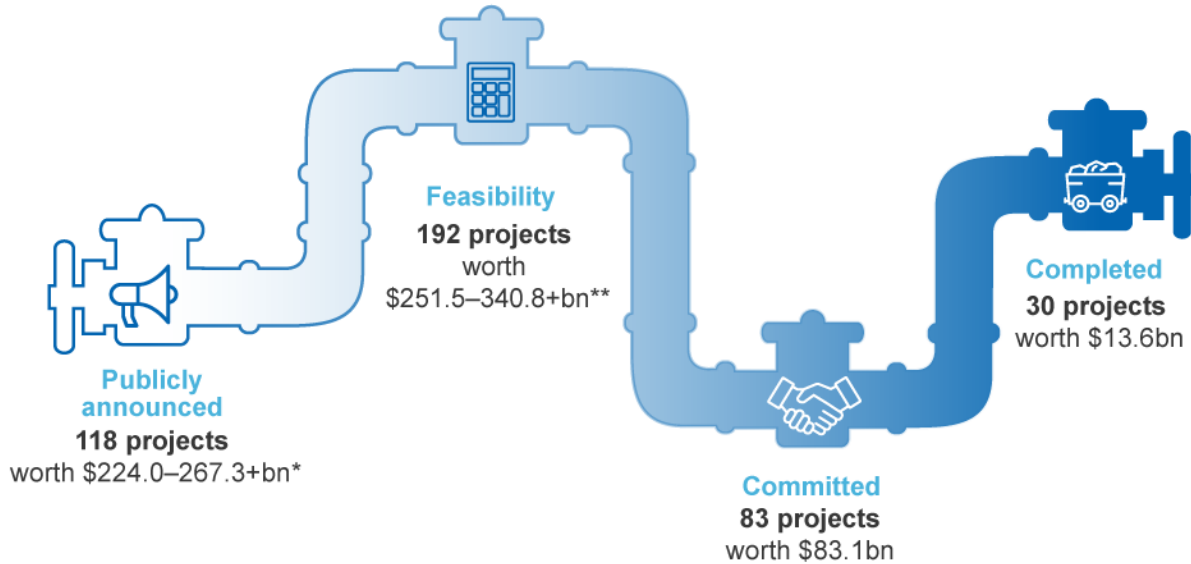
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Key statistics

Resources and Energy Major Projects 2022

Value of resource and energy projects

in the investment pipeline in the 12 months to 31 October 2022



*The hydrogen megaproject "Western Green Energy Hub" in WA accounts for \$100 billion of this total
**The hydrogen megaproject "Asian Renewable Energy Hub" in WA accounts for \$50 billion of this total

Jobs from committed projects (for projects with available job estimates)

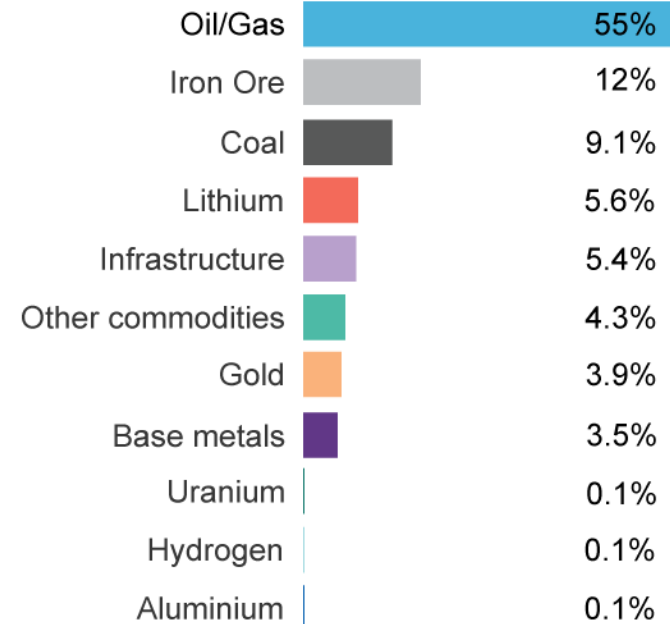
At least **21,000**
construction jobs



At least **9,700**
ongoing jobs



Share of committed projects by commodity (in value terms):



423

projects in the
investment pipeline

30+

different commodities
represented

+53%

increase in
value of committed projects
over the past year

Summary

- Australia’s resources and energy major projects pipeline increased over the past year, underpinned by a mix of traditional and new energy projects.
- Over the year from the start of November 2021 to end October 2022, the number of resources and energy major development projects rose to 423, compared to 367 in 2021.
- Hydrogen projects accounted for an estimated \$266 billion worth of potential investment, lifting the estimated total value of projects in the investment pipeline to a range of \$572–705 billion.
- The total value of committed projects rose to \$83 billion, strengthening the resources and energy investment pipeline.
- Demand for new energy metals and minerals saw Australia’s critical minerals major project pipeline increase to 81 projects, with an estimated value of \$30–42 billion.
- Proponents expect at least 21,000 construction and 9,700 ongoing jobs from committed projects (where estimates have been produced).

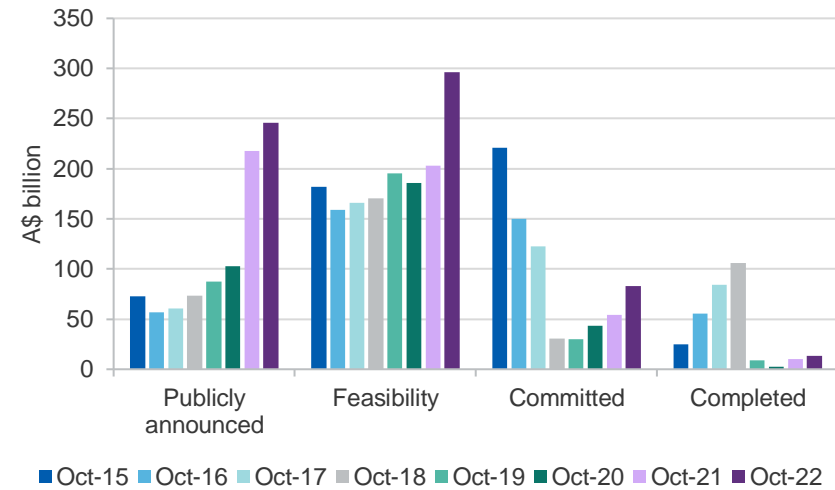
1. Overview

Growth in committed projects supports investment pipeline

This report highlights trends in major resource and energy project development and the scope of the potential pipeline of future investment. Our review of investment projects suggests that 2022 represented further growth in the resources investment cycle. The value of ‘committed’ resources and energy projects — those where a final investment decision (FID) has been taken — increased by 53% over the past year to \$83 billion (Figure 1.1). The continuing growth in value of projects at this stage was driven by oil & gas projects. New or progressed projects in the publicly announced and feasibility stages are dominated by hydrogen and iron ore projects.

Over the 12 months to the end of October 2022, 30 resources and energy major projects were completed (Figure 1.2). The value of completed

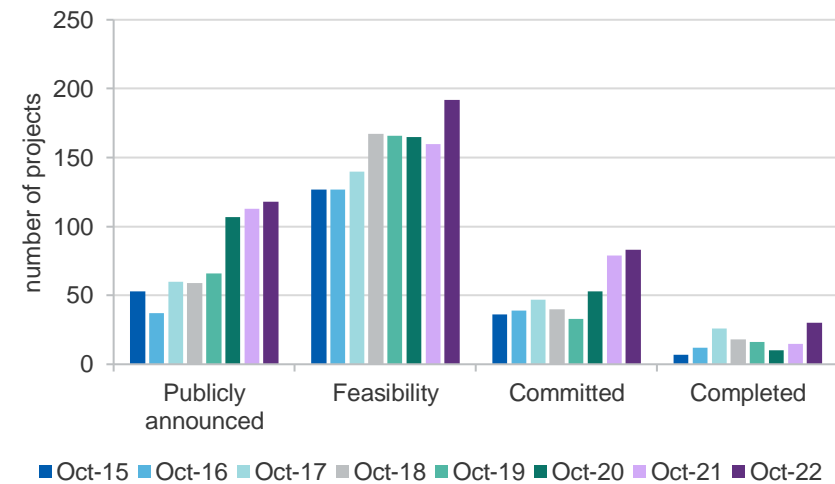
Figure 1.1: Value of projects in the investment pipeline, 2015-2022



Notes: Value of publicly announced and feasible projects represented as the mid-point in the range. Hydrogen was added as a new commodity in the 2021 edition.

Source: Department of Industry, Science and Resources (2022)

Figure 1.2: Number of projects in the investment pipeline, 2015-2022



Source: Department of Industry, Science and Resources (2022)

projects increased from \$10.1 to \$13.6 billion, as a number of iron ore projects were concluded.

Since the last *Resources and Energy Major Projects* report, over \$30 billion has been committed to oil and gas/LNG projects. Growth in oil and gas prices encouraged FID for several very large gas projects, notably Scarborough, the Pluto expansion and Crux LNG — all located in Western Australia (WA). Two gas pipeline projects — the Western Outer Ring Main around Melbourne (VIC) and the East Coast Grid expansion — progressed to the committed stage this year. The two have a combined estimated value of around \$400 million and will reinforce the eastern seaboard gas grid.

There are 33 coal projects at the feasibility stage, but many of these have been delayed. There has been a growing preference for expansions of brownfield sites over new greenfield investments, with an expanding list of lenders and investors withdrawing finance to new thermal coal projects. Some pension and equity funds are also divesting from, or reducing their exposure to, thermal coal, limiting the range of investment financing options available to thermal coal project developers.

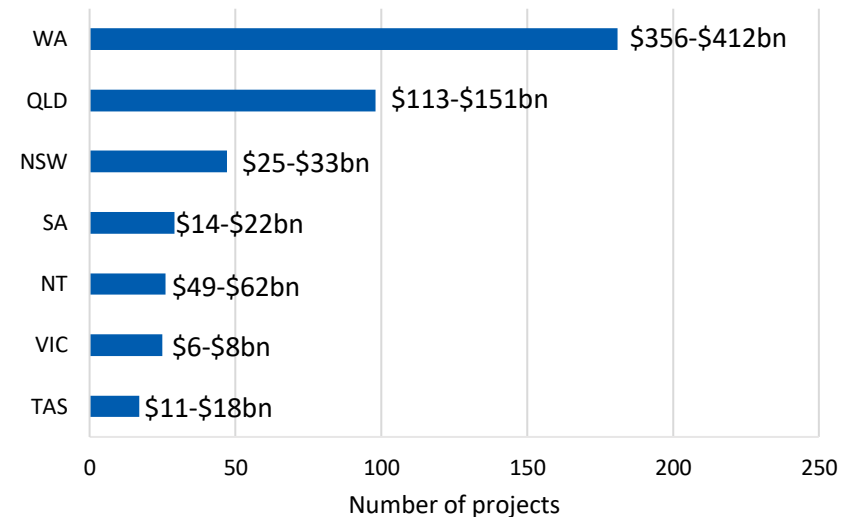
By State/Territory, WA remains the largest destination for projects, especially in the new energy space (Figures 1.3 and 1.4). WA also has sizeable reserves of lithium and gold, which have both enjoyed high Australian dollar returns in 2022.

The number of publicly announced projects is increasing

There has been an increase in activity at the early stages of the investment pipeline, with the value and number of projects at the ‘publicly announced’ stage increasing from 2021 (Figures 1.1 and 1.2).

The value of projects at the ‘feasibility’ stage increased despite the progression of several large oil and gas/LNG projects from ‘feasibility’ to the committed stage. Following the inclusion of hydrogen and ammonia projects in last year’s report for the first time, project numbers have risen substantially this year (see *Hydrogen* section).

Figure 1.3: Total projects by state and territory



Notes: Project value ranges reflect the use of cost bands due to the uncertainty around cost estimates for some projects (see *Methodology* section)

Source: Department of Industry, Science and Resources (2022)

Exploration expenditure increased in 2021-22

Australian exploration expenditure increased by 20% to \$5.0 billion in 2021–22, with mineral exploration increasing 22% to \$3.9 billion and petroleum exploration up 15% to \$1.1 billion. In 2021–22, gold expenditure increased to \$1.6 billion, accounting for over 40% of Australia’s mineral exploration expenditure. Exploration activity has been encouraged by high A\$ gold prices, as rising economic and geopolitical uncertainty drove strong demand from US/European gold-backed exchange-traded funds.

The new energy economy

The *Resources and Energy Major Projects* report last year increased coverage of low emissions technologies with the inclusion of hydrogen and ammonia projects in addition to the existing coverage of battery metals and their associated refineries (Figures 1.4 and 1.5). Australia’s pipeline for new energy projects increased to 134 this year (from 92 last year), with an estimated value of \$312 billion (Table 1.2).

The hydrogen project pipeline continues to expand, and they now comprise the largest single component (by value) in this year's report. Hydrogen projects almost doubled from an estimated range of \$133–185 billion in 2021 to \$230–303 billion in 2022, though these values are still dominated by two megaprojects worth \$150 billion (see *Hydrogen* section).

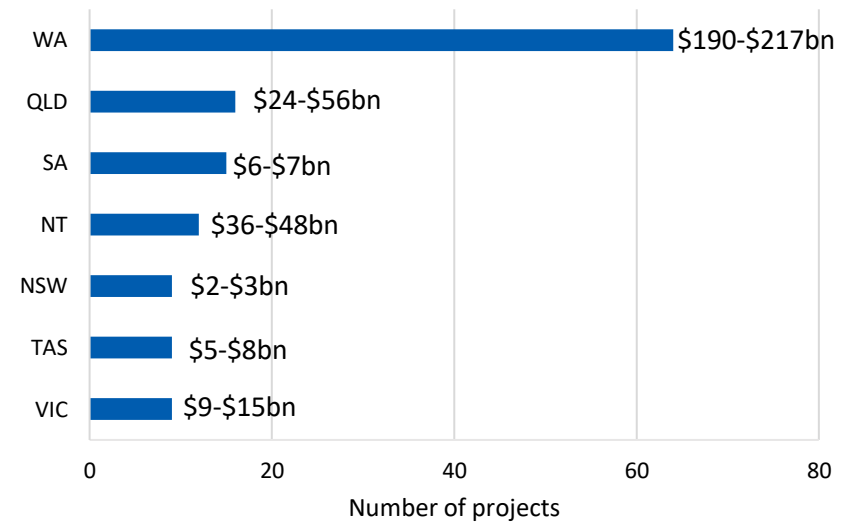
Australia's critical minerals major project pipeline increased to 81 projects (from 71 last year), with an estimated value of \$30–42 billion. Over two-thirds of the projects on this year's list will produce critical minerals that can support clean energy technologies — including graphite, rare earths, lithium (spodumene concentrate and lithium hydroxide), vanadium and manganese concentrates (see *Critical minerals* section).

Rising global demand for electric vehicle batteries saw lithium demand surge as supply shortfalls lifted prices to record levels. Australian producers accelerated plans to bring additional production online, with substantial progress made on a number of projects over the past year.

Expectations of higher demand for key battery metals are driving interest and investment in mine capacity and processing facilities, with interest growing in several major nickel, cobalt and graphite projects. Feasibility studies are also progressing for a number of rare earths projects. Several vanadium projects are also under development, with products from mineral concentrates to vanadium electrolyte for rechargeable vanadium redox flow batteries.

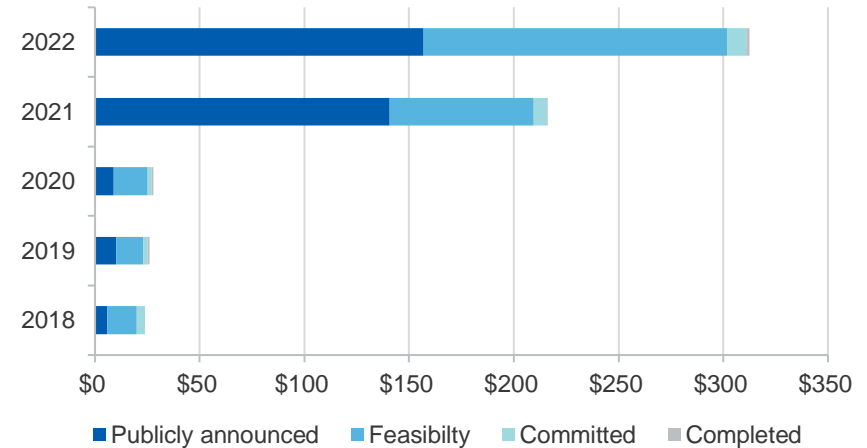
Finally, the addition of high purity alumina to Australia's critical minerals list in 2022 reflects its broad-ranging economic and strategic importance, including its role as key input for ensuring the stability of lithium-ion batteries, with several major projects under consideration.

Figure 1.4: New energy projects by state and territory



Source: Department of Industry, Science and Resources (2022)

Figure 1.5: Value of new energy economy projects



Notes: New energy economy refers to hydrogen, and battery and electric vehicle related minerals including commodities that have important inputs into rechargeable batteries and rare earth permanent magnets that are part of electric motors. Value of publicly announced and feasible projects presented as the mid-point of the range.

Source: Department of Industry, Science and Resources (2022)

Table 1.1: Summary of projects in the investment pipeline as at 31 October 2022

	Publicly Announced		Feasibility		Committed		Completed		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite			4	2.0	1	0.1			5	2.1
Coal	18	17.5 - 18.7	33	44.4 - 50.9	15	7.6	3	2.5	69	72.0 - 79.6
Copper	8	3.0 - 4.2	5	3.0 - 3.2	2	2.3			15	8.4 - 9.7
Gold	4	0.2 - 0.6	19	6.6 - 7.5	11	3.2	9	2.1	43	12.2 - 13.5
Hydrogen	22	139.2 - 155.5+	24	90.7 - 146.5+	1	0.1	1	0.5	48	230.4 - 302.5+
Infrastructure ^a	18	20.6 - 25.6+	9	8.5 - 11.7+	13	4.5	1	0.1	41	33.6 - 41.9+
Iron ore	11	18.0 - 29.5+	15	18.4 - 31.0	4	10.3	6	5.1	36	51.9 - 76.0+
Lead, Zinc, Silver	3	0.6 - 1.2	4	0.6	1	0.2			8	1.4 - 2.1
Lithium	1	0.7	7	1.6 - 2.5	8	4.6	2	0.7	18	7.7 - 8.6
Oil & gas	11	17.7 - 20.4	18	55.4 - 58.3+	15	46.0	5	2.4	49	121.5 - 127.2+
Nickel, Cobalt	4	1.2 - 1.4	6	5.5 - 7.5	2	0.4	2	0.2	14	7.2 - 9.4
Other Commodities ^b	17	4.7 - 8.9	43	12.5 - 16.6	9	3.6	1	0.1	70	20.8 - 29.2
Uranium	1	0.6	5	2.3	1	0.1			7	3.0
Total	118	224.0 - 267.3+	192	251.5 - 340.8+	83	83.1	30	13.6	423	572.2 - 704.8+

Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. Several gas pipelines span across more than one state but have been allocated to one state for reporting purposes. **b** Other Commodities is limited to resources and energy commodities not elsewhere identified. **c** Totals may not add due to rounding at commodity level.

Source: Department of Industry, Science and Resources (2022)

Table 1.2: Summary of new energy economy projects in the investment pipeline as at 31 October 2022

	Publicly Announced		Feasibility		Committed		Completed		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite			3	0.8	1	0.1			4	0.8
Copper	8	3.0 - 4.2	5	3.0 - 3.2	2	2.3			15	8.4 - 9.7
Hydrogen	22	139.2 - 155.5+	24	90.7 - 146.5+	1	0.1	1	0.5	48	230.4 - 302.5+
Infrastructure ^a	5	0.3 - 1.2	2	5.2 - 6.2+	1	0.2			8	5.7 - 7.7+
Lithium	1	0.7	7	1.6 - 2.5	8	4.6	2	0.7	18	7.7 - 8.6
Nickel, cobalt	4	1.2 - 1.4	6	5.5 - 7.5	2	0.4	2	0.2	14	7.2 - 9.4
Other commodities ^b	9	2.0 - 4.5	16	6.8 - 9.2	2	1.7			27	10.5 - 15.4
Total	49	146.3 - 167.5+	63	113.6 - 175.9+	17	9.4	5	1.4	134	270.7 - 354.2+

Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. **b** Other Commodities is limited to resources and energy commodities not elsewhere identified. **c** Totals may not add due to rounding at commodity level.

Source: Department of Industry, Science and Resources (2022)

2. Outlook for project investment

This section discusses the outlook for future investment in the resources and energy sector. Not all projects on the list will proceed through to an FID and construction, so projects at the ‘publicly announced’ and ‘feasibility’ stages are categorised by the likelihood (likely, possible or unlikely) they will proceed (see *Methodology* section). The projects included in the profile of future investment over the next six years are limited to those categorised as committed, likely or possible. Hydrogen projects are excluded from this analysis due to the novel and rapidly changing nature of the field. A separate *Hydrogen* section discusses this in more detail.

Commitments of mega projects drives project pipeline

‘Possible projects’ accounted for the largest share of overall projects in 2021–22, with 122 projects out of 342. There were also 67 likely projects and 71 unlikely projects across all stages of the investment cycle.

The ‘committed’ or ‘likely’ to proceed categories accounted for more than 40% of the project pipeline (Table 2.1). There was a marked increase in committed projects — up by over 60% — which saw the total increase to \$83 billion (Table 2.2). The number of completed projects rose from 15 to 29 (Table 2.1). ‘Megaprojects’ (projects involving over \$5 billion of investment) dominate the committed project pipeline, while there is greater uncertainty associated with smaller projects.

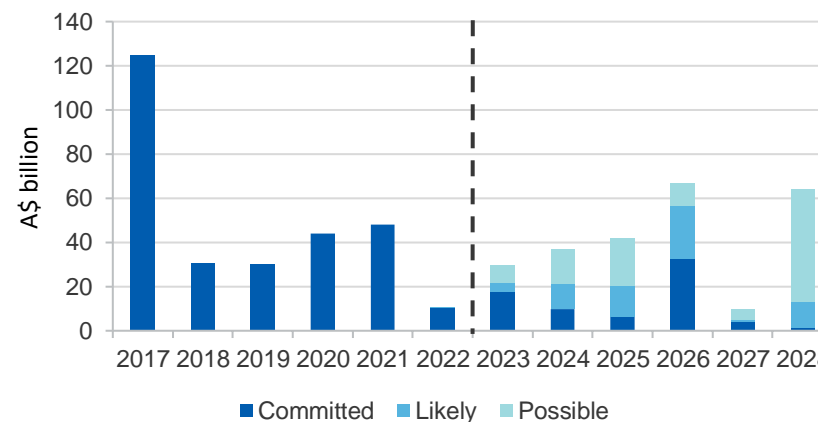
A significant uptick in resources and energy investment is expected in 2023, with potential for a further expansion in the next few years (Figure 2.1). New project commitments made since 2021 led to a fall in the value of projects at the ‘publicly announced’ and ‘feasibility’ stages that we consider ‘possible’ or ‘likely’ to receive an FID. The value estimated for these projects is \$156–198 billion, compared to an estimate of \$181–222 billion in the previous year.

Table 2.1: Number of projects by stage of investment and likelihood, as at 31 October 2022, excluding hydrogen projects

	Unlikely	Possible	Likely	Committed	Completed
Publicly announced	26	45	21		
Feasible	45	77	46		
Committed				82	
Completed					29
Total	71	122	67	82	29

Source: Department of Industry, Science and Resources (2022)

Figure 2.1: Outlook for project investment, excluding hydrogen projects



Notes: Due to the nature of project development and information release, the decrease in investment value towards the end of the outlook period reflects a lack of information rather than a reduction in investment. Value of publicly announced and feasible projects presented as the mid-point of the range.

Source: Department of Industry, Science and Resources (2022)

This potential investment depends heavily on the progression of bulk commodity projects. Iron ore, coal, gas, as well as related infrastructure, account for more than 70% of project value for projects we consider ‘possible’ or ‘likely’. Increasing oil and gas prices have encouraged FID for several very large gas projects, notably Scarborough, the Pluto expansion and Crux LNG, all in WA. Other notable investments progressing to the feasibility stage include an LNG import terminal in Geelong, Victoria, and the Glenaras gas project in Queensland. In addition, three new gas pipeline projects have also progressed, including an inland WA pipeline (Pluto-KGP Interconnector) which reached completion, and two pipelines on the eastern seaboard that reached committed status (Stage 2 of APA’s East Coast Grid Expansion and the Western Outer Ring Main in Melbourne).

Iron ore projects include large-scale, direct-shipping (hematite) ore projects, as well as a growing cohort of magnetite projects that will contribute to the global steel industry’s low emissions transition. At the same time, the industry is progressing a number of projects aimed at reducing emissions across the iron ore supply chain, with renewable energy projects being developed to supply power to both iron ore production and port activities.

Coal projects now at the committed stage include the Maxwell Underground Mine (which produces metallurgical coal) as well as mixed mines — notably Narrabri Stage 3 and Coronado’s Curragh Extension. Production has also begun at Bravus’ Carmichael mine in Queensland. However, the ongoing shift away from coal-fired power generation is expected to weigh on future investment decisions.

The project pipeline for new energy metals is growing

Developments in battery technology and growing electric vehicle manufacturing, continue to spur investment in Australia’s nickel, cobalt, rare earths and lithium resources. There are 8 lithium projects at the committed stage worth \$4.6 billion in investment. Several lithium projects are investing in processing facilities to produce battery cathode precursors

in the form of lithium hydroxide. In addition, 2 rare earths projects worth \$1.7 billion are at the committed stage, with another 6 projects currently undergoing feasibility assessment. Vanadium projects also show substantial potential, with 5 projects with a value of \$2.5–3.5 billion currently at the feasibility stage. The heavy mineral sands project pipeline is also healthy, with 8 projects worth \$2.6–4.6 billion currently undergoing feasibility assessment.

Overall, our outlook for mining investment indicates significant opportunities are emerging for Australia’s resources and energy sector, particularly in the new energy economy.

Table 2.2: New and expansion projects by likelihood of FID, as at 31 October 2022, excluding hydrogen projects

	New project	Expansion/Reactivations
Unlikely		
A\$ billion	85.7 - 102.5+	3.4 - 4.2
Number	61	10
Possible		
A\$ billion	84.9 - 109.0+	11.5 - 16.7
Number	92	30
Likely		
A\$ billion	48.6 - 59.4+	11.3 - 13.3+
Number	47	20
Committed		
A\$ billion	44.6	38.4
Number	37	45
Completed		
A\$ billion	6.3	6.9
Number	9	20

Source: Department of Industry, Science and Resources (2022)

3. Hydrogen

Hydrogen project pipeline continues to increase

Hydrogen projects make up the largest single component by value in this year's report. They have almost doubled from an estimated range of \$133–185 billion in 2021 to \$230–303 billion in 2022 — corresponding to some 48 projects, or 32 more than in the previous year. This does not include 4 regional “hubs” with a combined estimated worth of nearly \$1 billion, which have been classified as hydrogen-related infrastructure.

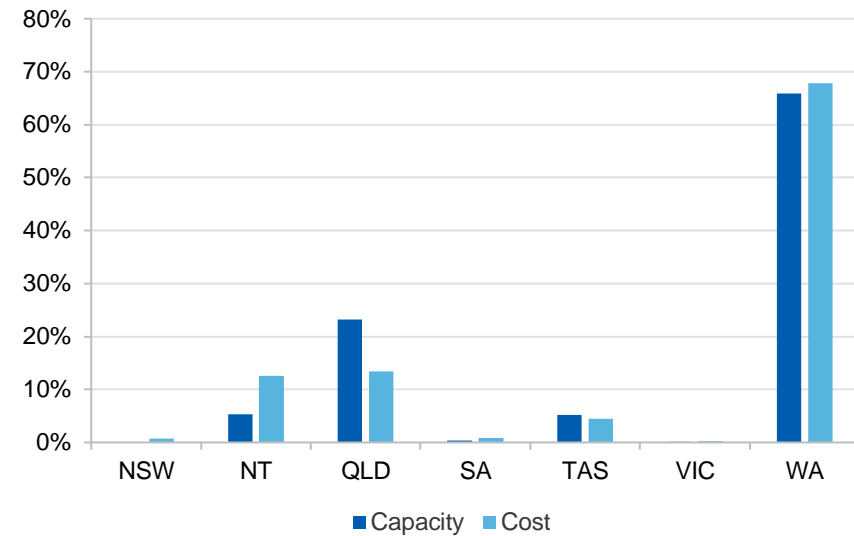
Only one committed project: high uncertainty for individual projects

Hydrogen is a new field and, while progress can be expected for the industry as a whole, the landscape of projects is expected to change rapidly. The availability of (public) seed funding has allowed many early feasibility studies to be conducted. However, only 3 out of 16 projects included last year have progressed — of which one was a pilot program. These circumstances are not unusual in the resources sector, especially in a field where dominant technologies are not yet established.

Most feasibility studies have concluded that significant government support is still required for low-carbon hydrogen projects to be commercially viable. This applies even in a context of high prices for the current major source of (high-carbon) hydrogen (steam-reformed natural gas). While this government support may well be available, many projects are likely to be undergoing re-scoping and adaptation following initial appraisal.

To maintain consistency across information sources in this rapidly changing space, DISR coordinates closely with HyResource (a joint initiative between Australian industry and government organisations) which lists currently active projects.

Figure 3.1: Distribution of hydrogen investments by state and territory



Source: Department of Industry, Science and Resources (2022)

Western Australia, Queensland, and Northern Territory are expected to attract most of the investment and production

Three States and Territories are currently expected to attract some 94% of investment (WA: 68%, Queensland: 13%, Northern Territory: 13%) and, accordingly, future production of hydrogen (Figure 3.1). Of the three projects that have progressed, two are in Western Australia and one is in Queensland.

These jurisdictions are characterised by large availability of land and high levels of solar irradiation. These are essential assets considering the scale of new wind and solar capacity often associated with renewable hydrogen projects.

Wind and solar are expected to power over 95% of projects in the pipeline

Apart from one project — which utilizes waste or biomass — all the renewable energy projects rely on electrolysis. Electrolysis uses electricity (generated predominantly from dedicated wind or solar projects) to split water molecules into hydrogen and oxygen.

After the completion of the Hydrogen Energy Supply Chain pilot phase in Gippsland, Victoria — with the successful shipping of a small amount of hydrogen to Japan — there has been limited follow-up on similar fossil-fuel-based hydrogen generation.

Ambitious megaprojects in Western Australia

Two projects have reported estimated costs of \$150 billion, more than 50% of the hydrogen total, and by extension, a large proportion of the total in this report. These are the \$100 billion Western Green Energy Hub (WGEH) and the Asian Renewable Energy Hub (AREH), which is currently estimated at \$50 billion. Both are significantly larger than the next largest project in the *Resources and Energy Major Projects* list, which sits at an estimated \$30 billion.

As currently reported, WGEH and AREH are aiming to add 50 GW and 26 GW, respectively, of renewable generation to produce hydrogen by electrolysis. By way of reference, total installed electricity generation capacity in the National Electricity Market (Australia excl. Northern Territory and WA) in June 2022 was 56.2 GW, including coal (22 GW), wind (8.3 GW), utility scale solar (6.3 GW) and all other forms of energy. Total installed PV across the country (incl. Northern Territory and WA) — whether utility-controlled or not — was 25.3 GW.

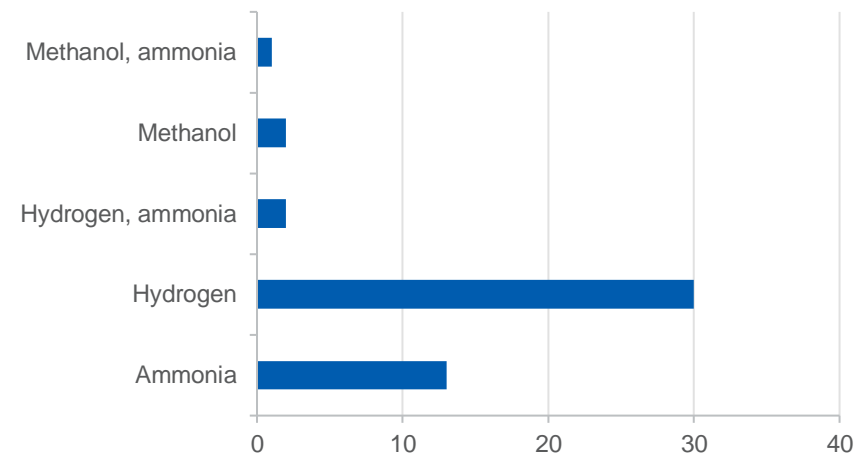
These hydrogen megaprojects are likely to be split into different stages, but the details of the breakdown are not available yet.

Most projects to produce either hydrogen (63%) or ammonia (27%)

Many Australian projects have an eye on capturing the export market, taking advantage of the aforementioned availability of land and isolation. However, the best option for transporting hydrogen is currently unclear —

particularly over long distances — both from an economic and a technological perspective. Liquefying hydrogen comes with very significant energy costs. Ammonia is more stable and easier to transport, but is not easily transformed back into hydrogen — if that is what is required at the destination. Methanol is touted as another alternative being investigated. Nevertheless, changes in technology and end-use requirements are possible, and could add further changes to the investment pipeline. Figure 3.2 below illustrates the current expectations as revealed by the announced outputs by project.

Figure 3.2: Expected outputs from hydrogen projects



Source: Department of Industry, Science and Resources (2022)

4. Critical minerals

Critical minerals projects build momentum

Australia's critical minerals major project pipeline comprised 81 projects in this year's report, with an estimated value of \$30–42 billion (Table 4.1). This was an increase from last year when there were 71 projects worth an estimated \$22–36 billion in 2021. More than half of all critical minerals' projects — in terms of both project numbers and investment value — were located in WA. The remaining projects were distributed around most Australian states and territories, with NSW, the Northern Territory and Queensland accounting for most of the remaining investment.

Around a quarter of this year's critical minerals projects are at the publicly announced stage, worth \$6.5–11.6 billion. Projects at the feasibility stage account for more than half of all critical minerals' projects — worth \$16.3–22.9 billion. A total of 13 projects were at the committed stage (\$6.7 billion), and 3 projects with a capital value of \$800 million were completed during the year.

Battery and new energy minerals drive project pipeline

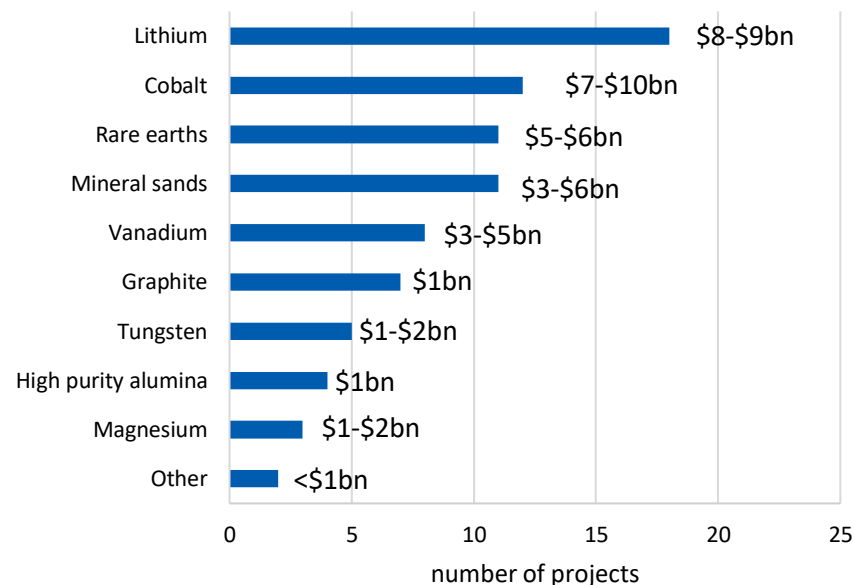
Critical minerals are metals and non-metals that have important economic functions, cannot be easily substituted and face some degree of supply risks. Supply risks can stem from geological scarcity, geopolitical issues, trade policy or other factors, resulting in critical mineral lists differing by jurisdiction.

Australia's critical minerals list currently comprises 26 minerals or mineral groups. However, investment in major critical minerals projects is driven by five key commodities — lithium, cobalt, rare earths, heavy mineral sands and vanadium. Combined, these minerals accounted for over 80% of total investment (Figure 4.1).

Over two thirds of the critical minerals projects on this year's list are new energy projects. Expectations of higher demand for key battery metals are driving interest and investment in mine capacity and processing facilities, including in several major nickel, cobalt and graphite projects. Studies are

also progressing for some large rare earths projects. Several vanadium projects are also under consideration, with products from mineral concentrates to vanadium electrolyte for rechargeable vanadium redox flow batteries.

Figure 4.1: Critical mineral projects in the pipeline



Notes: See notes to Table 4.1.

Source: Department of Industry, Science and Resources (2022)

Global demand for electric vehicles drives new lithium projects

In recent years, rising production of electric vehicle batteries has seen global lithium demand surge, lifting prices to record levels as supply struggled to keep up. Companies in Australia and overseas have accelerated plans to bring additional production online. Several major Australian lithium projects achieved key milestones over the past year.

FID was taken by Pilbara Minerals for a \$300 million incremental 100 thousand tonnes per annum (ktpa) capacity increase for the Pilgan

plant in the June quarter 2022, which will bring production up from 580 ktpa to 680 ktpa. The 'P680' Project includes \$50 million of pre-investment capital to assist with the proposed next phased expansions — with a targeted production capacity of up to 1 million tonnes per annum (Mtpa).

Pilbara Minerals announced a new project, in partnership with Calix, to develop a demonstration-scale chemicals facility to process fine, lower-grade spodumene to create a low carbon, concentrated lithium salt using renewable energy. The project is being supported through an Australian Government grant under the Modern Manufacturing Initiative.

Liontown's Kathleen Valley project near Kalgoorlie also received FID in the June quarter 2022. The project is expected to deliver about 500 ktpa of spodumene concentrate in the first year, rising to about 700 ktpa, with production expected to start in mid-2024. Talison Lithium's Greenbushes tailings retreatment plant was completed this year and is now in commercial production. Mineral Resources' Wodgina Processing Plant also commenced commercial production during 2022.

Following the commencement of trial production in late-2021, the Kwinana lithium hydroxide refinery completed commissioning in the September quarter 2022. Commercial production of Train 1 was achieved in November 2022, after the 31 October cutoff for this publication. Product qualification with offtake partners continues. In late November 2022, joint venture partner IGO noted that significant progress has already been made on Train 2, with the FID expected imminently. Kemerton Train 1 lithium hydroxide plant (Albermarle, Mineral Resources) is commissioning and is expected to produce qualification samples by the end of 2022. Stage 2 has achieved mechanical completion and is transitioning to commissioning.

High purity alumina projects on the rise

The addition of high purity alumina (HPA) to Australia's critical minerals list in 2022 reflects its broad-ranging economic and strategic importance. HPA is used in the automotive and aerospace sectors and is an important

component of high-performance electronics and optics. HPA is also a key input for ensuring the stability of lithium-ion batteries. As the world's second-largest producer, and world's largest exporter of smelting grade alumina, Australia is well placed to build capacity in HPA.

There are 4 HPA major projects in this year's report, with a total estimated capital cost of around \$800 million. Phases 1 and 2 of the \$200 million HPA refining project in Kwinana (jointly funded by Alcoa and FYI Resources) progressed to the committed stage following completion of feasibility work. Phase 3 of the project, which would bring an additional 9 kt of annual capacity, is currently at the feasibility stage. King River Resources' 9 ktpa capacity HPA project, also in Kwinana, is currently at the feasibility stage. Another new HPA project included in this year's report is Alpha HPA's proposed Gladstone facility. With an estimated capacity of 10 ktpa of HPA, this project has an estimated capital cost of around \$300 million and the proponents estimate that it would employ around 300 workers in the construction phase and require around 120 ongoing employees in the operating phase.

Table 4.1: Summary of critical mineral projects in the investment pipeline as at 31 October 2022

	Publicly Announced		Feasibility		Committed		Completed		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Cobalt	5	1.8 - 2.8	6	5.5 - 7.5			1	0.1	12	7.4 - 10.3
Graphite	1	0.1 - 0.2	6	0.5 - 0.7					7	0.6 - 1.0
High purity alumina			3	0.8	1	0.1			4	0.8
Lithium	1	0.7	7	1.6 - 2.5	8	4.6	2	0.7	18	7.7 - 8.6
Magnesium	3	1.1 - 2.0							3	1.1 - 2.0
Heavy mineral sands	2	0.5 - 1.0	8	2.6 - 4.6	1	0.3			11	3.3 - 5.9
Other	2	0.2 - 0.4							2	0.2 - 0.4
Rare earths	3	0.8 - 1.7	6	2.4 - 2.9	2	1.7			11	4.9 - 6.3
Tungsten	1	0.5 - 1.0	3	0.4	1	0.1			5	1.0 - 1.5
Vanadium	3	0.8 - 1.7	5	2.5 - 3.5					8	3.3 - 5.2
Total	21	6.5 - 11.6	44	16.3 - 22.9	13	6.7	3	0.8	81	30.4 - 42.1

Notes: A number of projects included in the total are mixed operations, such as nickel-cobalt mines, where a substantial proportion of the investment is expected to be directed to nickel extraction and refining. Other category includes manganese, magnesium and platinum group metals. Vanadium includes vanadium oxide projects, with outputs including ilmenite, titanium oxide, ferro-vanadium and iron oxides. Tungsten includes tungsten trioxide, molybdenum, tin and other metals. Heavy mineral sands include zircon, ilmenite, niobium, leucoxene, hafnium, leucoxene, rutile and other heavy mineral concentrates.

Source: Department of Industry, Science and Resources (2022)

5. Exploration

Exploration encompasses expenditure aimed at improving knowledge about the location, type, quantity and quality of deposits. This spending helps inform future development. Before deciding to undertake exploration, companies balance the benefits of exploration with a range of factors, including commodity prices, the regulatory environment, geological prospects and tax/royalty arrangements.

Exploration expenditure increased in 2021–22

Australian exploration expenditure increased by 20% to \$5.0 billion in 2021–22 (Figure 5.1). This growth was driven by non-energy mineral exploration, a trend consistent with previous years. Non-energy mineral exploration increased by 24% to \$3.6 billion, while petroleum exploration (which includes gas) increased by 15% to \$1.1 billion. Exploration in other energy commodities (coal and uranium) fell.

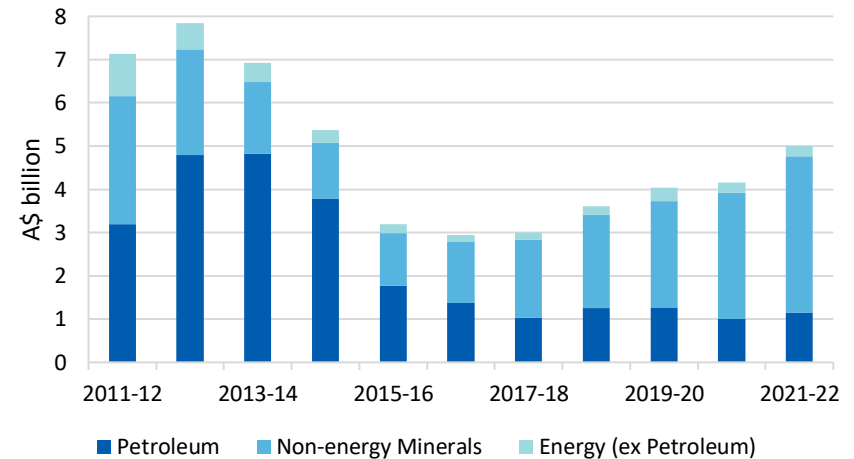
In 2021–22, mineral exploration expenditure was primarily on existing deposits. While expenditure on new deposits also increased, its share of total expenditure fell for the fourth consecutive year to 32% in 2021–22.

Gold continues to draw the largest interest in mineral exploration

For the last seven years, gold has attracted the most mineral exploration expenditure, overtaking iron ore in 2015–16. In 2021–22, gold expenditure increased by 4% to \$1.6 billion, accounting for over 40% of Australia’s mineral exploration expenditure (Figure 5.2). Exploration activity has been encouraged by high Australian dollar gold prices.

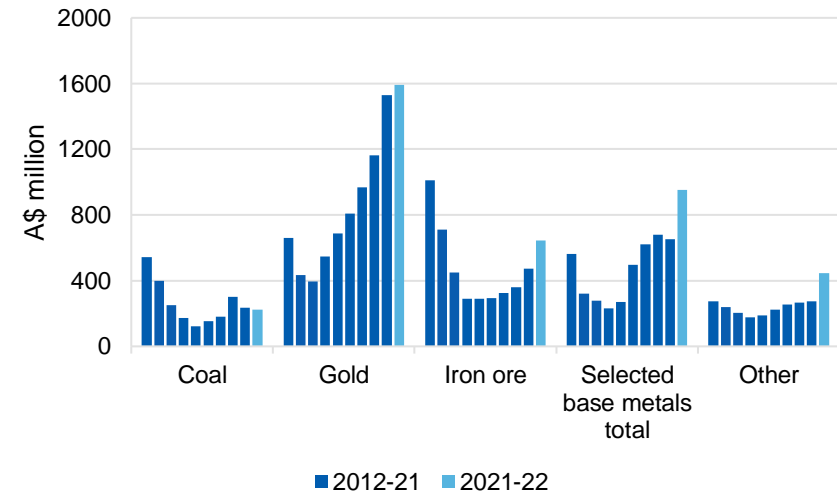
Coal exploration expenditure decreased by 4% to \$225 million in 2021–22. Despite the decline, this value is still higher than the levels of coal exploration expenditure in the four years prior to 2019–20 (Figure 5.2). Iron ore expenditure rose by 36% to \$646 million in 2021–22, following a year of strong growth of 31% in 2020–21. While far from the peak of \$1.2 billion attained in 2011–12, this is the highest level of exploration expenditure since 2013–14.

Figure 5.1: Mineral and energy exploration expenditure



Source: ABS (2022) Mineral and Petroleum Exploration, Australia, 8412.0

Figure 5.2: Annual exploration expenditure by commodity



Notes: Base metals also include silver and cobalt.

Source: ABS (2022) Mineral and Petroleum Exploration, Australia, 8412.0

High iron ore prices over the first half of the year — driven by expectations of a Chinese infrastructure stimulus boom — encouraged exploration in mineral-rich areas of WA. However, prices and expectations have receded in recent months.

Base metals exploration expenditure increased by 46% to \$951 million in 2021–22, following three years of relatively stable expenditure. Elevated prices over the period drove a broad-based increase in expenditure. Copper exploration increased by 55% over the year to \$586 million, the largest percentage increase since 2018–19. Nickel and cobalt exploration increased by 31% over the year to \$275 million, the largest percentage increase since 2017–18. Silver, lead and zinc increased by 40% over the year to \$91 million.

Offshore petroleum exploration increased in 2021–22

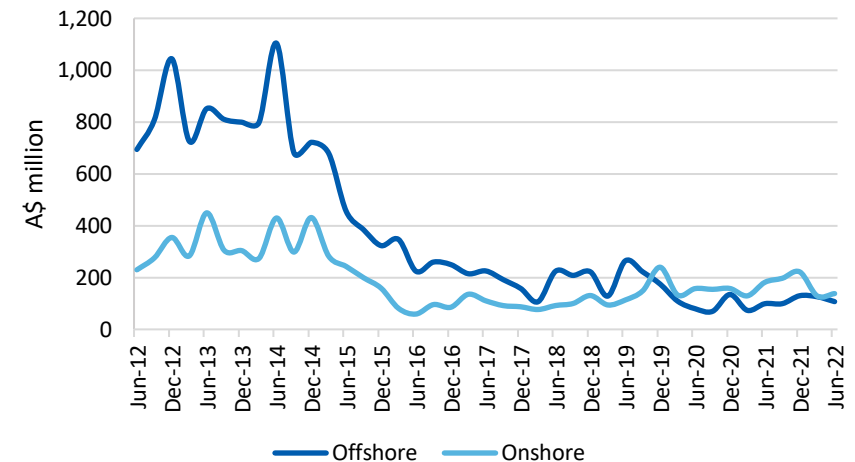
Petroleum (oil or gas in solution) expenditure rose by 14% in 2021–22 to \$1.1 billion. The increase is driven by expenditure on offshore exploration, which rose by 23%, while onshore expenditure grew by 10%. Onshore exploration expenditure has exceeded offshore expenditure since December quarter 2019 (Figure 5.3). Onshore exploration tends to have a more consistent profile with an ongoing need for exploration to maintain existing coal-seam gas production. The fallout from the Russian invasion of Ukraine has driven global gas prices to elevated levels, which supports growth in petroleum exploration.

Western Australia leads exploration expenditure

Exploration expenditure in WA rose by 22% in 2021–22 and accounted for 61% of total exploration in 2021–22. Growth of exploration expenditure in WA drove overall exploration expenditure from a decade-low in 2016–17 (Figure 5.4). The increase in 2021–22 was driven by increases in iron ore and base metals exploration. In 2021–22, expenditure in Queensland rose by 5%, and New South Wales rose by 9%.

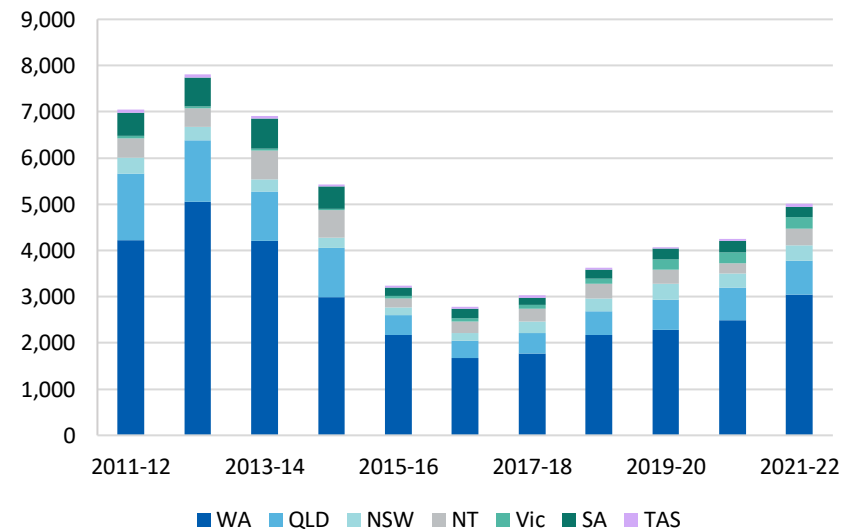
For Australia overall, a total of 12.5 million metres was drilled in 2021–22, up from 12.4 million metres the previous year, around a third of which occurred in new deposits.

Figure 5.3: Petroleum exploration expenditure, quarterly



Source: ABS (2022) Mineral and Petroleum Exploration, Australia, 8412.0

Figure 5.4: Exploration expenditure by state and territory



Source: ABS (2022) Mineral and Petroleum Exploration, Australia, 8412.0

6. Projects at the publicly announced stage

Almost 30 per cent of all projects are at the ‘publicly announced’ stage

Of the 423 projects on this year’s list, 118 are at the ‘publicly announced’ stage. The value of these projects is estimated at \$224–267 billion, and hydrogen projects make up the majority of project value (see *Hydrogen* section). Around one third of publicly announced projects are in WA, with the highest value projects involving hydrogen, iron ore or gas. As is typically the case, many projects at the publicly announced stage remain uncertain and may or may not progress.

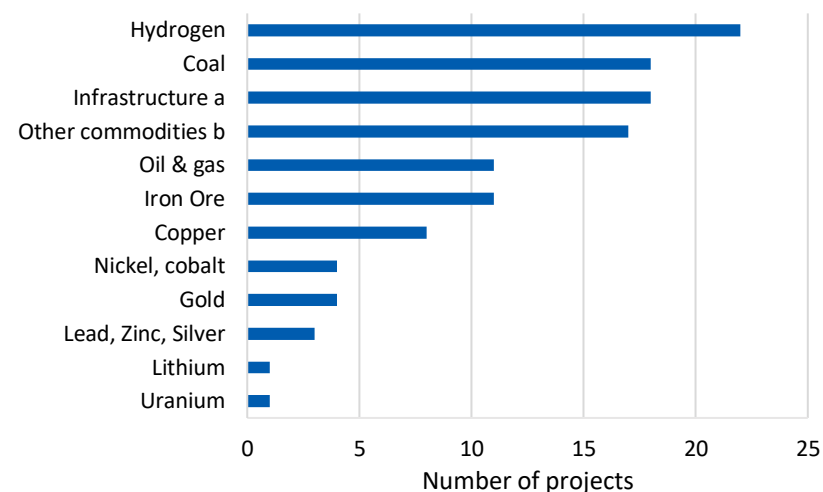
Almost 50 per cent of projects are in our largest commodity exports

There are 11 iron ore projects at the publicly announced stage, with a value estimated at \$18–29 billion (Table 6.1). New projects announced this year are expected to add more than 100 million tonnes (Mt) in new production capacity over the next decade, and include Rio Tinto’s recently announced Western Range project and Rhodes Ridge.

There are 18 infrastructure projects at the publicly announced stage, with a value estimated at \$21–26 billion. Two projects announced this year aim to lower carbon emissions throughout the iron ore supply chain. Alinta Energy’s Port Hedland Solar Project is expected to halve emissions from BHP’s iron ore port facilities by the end of 2024, and Fortescue’s \$5 billion Uaroo Renewable Energy Hub project is intended to cut the company’s annual GHG emissions by at least 1.5 Mt by the end of the decade. Additionally, there are 5 gas pipeline projects, all located in the East Coast gas market.

A total of 11 oil and gas projects with a combined estimated value of \$18–20 billion are at the publicly announced stage. They reflect the ongoing interest in generating additional gas for export and domestic markets. Six of these publicly announced projects are located in Victoria and Tasmania, four in Western Australia and the Northern Territory, and one in Queensland.

Figure 6.1: Number of projects at the publicly announced stage



Notes: **a** Infrastructure is limited to resources and energy infrastructure projects (e.g. pipelines), including CCS projects. **b** Other Commodities is limited to resources and energy commodities not elsewhere identified.

Source: Department of Industry, Science and Resources (2022)

The 18 coal projects at the publicly announced stage have an estimated value of \$18–19 billion. Significant projects in this category include BHP’s Blackwater South expansion, BHP/Mitsubishi’s Saraji East project, and New Hope Coal’s North Surat projects. Several coal projects have also been withdrawn or cancelled: these include Peabody Energy’s Codrilla mine (which has sold its land to a cattle farm) and BHP’s Mount Arthur mine (which is expected to close in 2030 following the cancellation of extension plans). Peabody has recently announced plans to redevelop its North Goonyella asset, but the timing of this announcement falls outside the period of coverage for the 2022 *Resources and Energy Major Projects*. This project will be included in the next edition.

There are 17 other commodity projects at the publicly announced stage. While the number of projects is large, the value is estimated to be relatively small, at \$5–9 billion. There have been a number of announcements of new projects across a range of critical minerals this year, including rare earths, vanadium and magnesium.

Table 6.1: Summary of projects at the publicly announced stage, as at 31 October 2022

	NSW		Vic		Qld		SA		WA		Tas		NT		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite																
Coal	5	1.1 - 1.3			13	16.4 - 17.4									18	17.5 - 18.7
Copper	1	0.1 - 0.2			1	0.5 - 1.0	1	0.3 - 0.5	4	2.0 - 2.3			1	0.2	8	3.0 - 4.2
Gold					1	0.1 - 0.2			2	0.1			1	0.1 - 0.2	4	0.2 - 0.6
Hydrogen	1	0.2	3	0.3	3	10.5 - 19.1+	2	1.3 - 1.8	3	101.1 - 101.2	6	5.1 - 8.6	4	20.8 - 24.3+	22	139.2 - 155.5+
Infrastructure ^a	2	0.7 - 0.9	1	0.1 - 0.2	6	7.8 - 8.6+	3	0.4 - 1.0	5	11.6 - 14.6+	1	0.1 - 0.2			18	20.6 - 25.6+
Iron Ore							1	0.1	9	17.7 - 28.9+			1	0.3 - 0.5	11	18.0 - 29.5+
Lead, Zinc, Silver					1	0.3 - 0.5					1	0.3 - 0.5	1	0.1 - 0.2	3	0.6 - 1.2
Lithium									1	0.7					1	0.7
Oil & gas			5	1.1 - 1.3	1	0.5			3	12.6 - 15.1	1	0.5	1	3.0	11	17.7 - 20.4
Nickel, cobalt	1	0.1 - 0.2			1	0.6			2	0.5					4	1.2 - 1.4
Other Commodities ^b			4	1.6 - 2.7	2	0.3 - 0.7	1	0.1 - 0.2	8	2.4 - 4.5			2	0.4 - 0.6	17	4.7 - 8.9
Uranium					1	0.6									1	0.6
Total	10	2.1 - 3.0	13	3.0 - 4.6	30	37.5 - 49.2+	8	2.0 - 3.6	37	148.7 - 168.0+	9	5.9 - 9.9	11	24.8 - 29.1+	118	224.0 - 267.3+

Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. Several gas pipelines span across more than one state but have been allocated to one state for reporting purposes. **b** Other Commodities is limited to resources and energy commodities not elsewhere identified. **c** Totals may not add due to rounding at commodity level.

Source: Department of Industry, Science and Resources (2022)

7. Projects at the feasibility stage

Almost 50 per cent of projects are at the feasibility stage

Of the 423 projects on this year's list, 192 are at the 'feasibility' stage. The value of projects at the feasibility stage increased in 2022 to \$251–341 billion. Amongst the commodities, hydrogen projects are the largest contributor to project value (see *Hydrogen* section). Around 40 per cent of these projects are in WA, with the highest value projects involving hydrogen, gas, or iron ore. Queensland has around a quarter of Australian projects at the feasibility stage, with the highest value projects involving hydrogen, coal, and gas (Table 7.1).

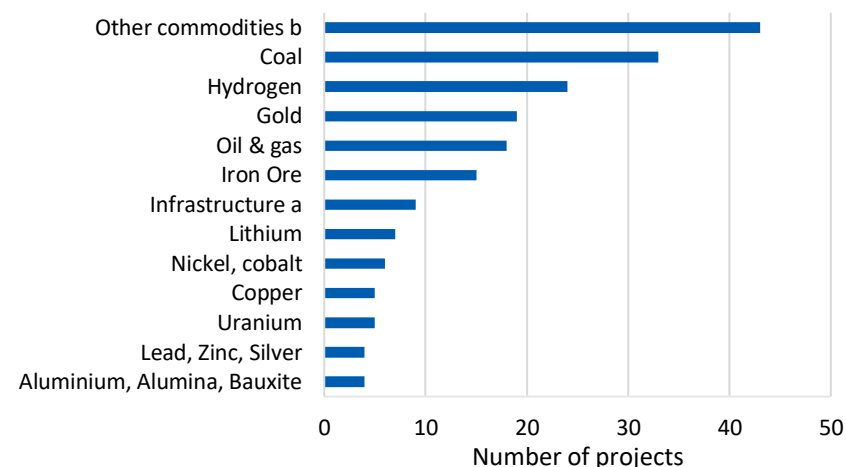
Around 40 per cent of all projects are in our largest commodity exports

There are 18 oil and gas projects at the feasibility stage, with a value estimated at \$55–58 billion (Table 7.1). The largest is the Browse to North West Shelf backfill proposal. The Dorado oil project also remains at the feasibility stage, after a final investment decision was delayed due to inflation and high supply chain costs. Finally, the Hunter gas pipeline forms part of these projects at the feasibility stage. The pipeline is intended to facilitate higher gas supply between Northern and Southern markets on Australia's east coast.

There are 33 coal projects at the feasibility stage, with a value of \$44–51 billion. Many coal projects have been stalled at this stage for many years, and several have been cancelled in 2022. These include Yancoal's Ashton South-East opencut, and South32's Dendrobium Extension.

There are 15 iron ore projects at the feasibility stage, with a value of \$18–31 billion. Six projects which progressed into the stage will be developing magnetite resources, with an expected production capacity of 26 Mt per year. Magnetite production is expected to contribute to the global low emissions transition. It can be processed into high quality products that can be used in processes such as Direct Reduced Iron.

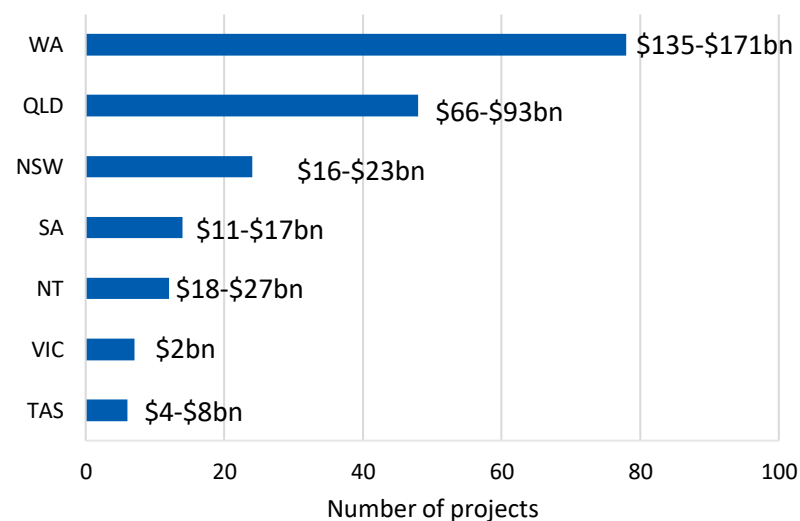
Figure 7.1: Number of projects at the feasibility stage



Notes: ^a Infrastructure is limited to resource, energy infrastructure projects including CCS. ^b Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Science and Resources (2022)

Figure 7.2: Value of projects at the feasibility stage by state and territory



Source: Department of Industry, Science and Resources (2022)

Around 10 per cent of all projects are in gold, as price drives development

There are 19 gold projects at the feasibility stage, with a value estimated at \$6.6-7.5 billion. A new project addition to the feasibility stage is Ausgold's Katanning Gold Project, which confirmed a maiden probable ore reserve of 1.28 million ounces in August 2022. Several companies have updated feasibility studies for upcoming projects, such as Newcrest's Cadia PC 1-2 project in NSW, and De Grey Mining's Mallina Gold Project in WA. Newcrest released an updated feasibility study for the Cadia PC 1-2 project on 11 November 2022, with total capex now expected to be \$1.6 billion. Since this update occurred after 31 October, this is not reflected in the data. A definitive feasibility study is expected for Newcrest and Greatland Gold's \$529 million Havieron gold project in WA in early 2023. Northern Star Resources also released a pre-feasibility study in June 2022, proposing three options for mill expansion at their KCGM gold operations in WA. Combined capex estimates for the three options range from \$440 million to \$1.4 billion.

There are 43 other commodity projects at the feasibility stage, with a value estimated at \$13–17 billion. The highest value projects in this category are for rare earths, heavy mineral sands, potash and vanadium. A number of relatively smaller projects progressed into the feasibility stage this year, the largest of which is the Australian Vanadium Project, with an estimated value of about \$600 million.

Table 7.1: Summary of projects at the feasibility stage, as at 31 October 2022

	NSW		Vic		Qld		SA		WA		Tas		NT		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite					2	1.6			2	0.5					4	2.0
Coal	4	1.1 - 2.0			28	40.8 - 43.9	1	2.5 - 5.0							33	44.4 - 50.9
Copper			1	0.3	1	0.8	2	1.8	1	0.1 - 0.2					5	3.0 - 3.2
Gold	2	1.5					1	0.1	13	3.7 - 4.6			3	1.4	19	6.6 - 7.5
Hydrogen	3	1.4 - 1.9			5	9.7 - 32.0+	2	1.0	10	67.7 - 90.9+	2	3.5 - 6.5	2	7.5 - 14.3+	24	90.7 - 146.5+
Infrastructure ^a	2	1.1 - 1.7			5	1.5 - 2.4							2	6.0 - 7.5+	9	8.5 - 11.7+
Iron ore	1	2.5 - 5.0					3	4.5 - 8.0	10	10.9 - 17.0	1	0.5 - 1.0			15	18.4 - 31.0
Lead, Zinc, Silver	1	0.2			1	0.1	1	0.1	1	0.2					4	0.6
Lithium									7	1.6 - 2.5					7	1.6 - 2.5
Oil & gas	3	4.1	3	0.7	3	9.7	1	0.3 - 0.5	8	40.6 - 43.3+					18	55.4 - 58.3+
Nickel, Cobalt	2	2.1 - 3.1			1	1.0 - 1.5			3	2.4 - 2.9					6	5.5 - 7.5
Other Commodities ^b	6	1.9 - 3.3	3	0.6 - 1.2	1	0.2	6	0.5	19	5.8 - 7.3	3	0.5	5	3.2 - 3.7	43	12.5 - 16.6
Uranium					1	0.4			4	2.0					5	2.3
Total	24	15.9 - 22.9	7	1.6 - 2.3	48	65.6 - 92.5+	17	10.7 - 17.0	78	135.2 - 171.4+	6	4.5 - 8.0	12	18.1 - 26.9+	192	251.5 - 340.8+

Notes: ^a Infrastructure is limited to resource, energy infrastructure projects including CCS. Several gas pipelines span across more than one state but have been allocated to one state for reporting purposes. ^b Other Commodities is limited to resource and energy commodities not elsewhere identified. ^c Totals may not add due to rounding at commodity level.

Source: Department of Industry, Science and Resources (2022)

8. Projects at the committed stage

The value of ‘committed’ projects increased by more than 50 per cent

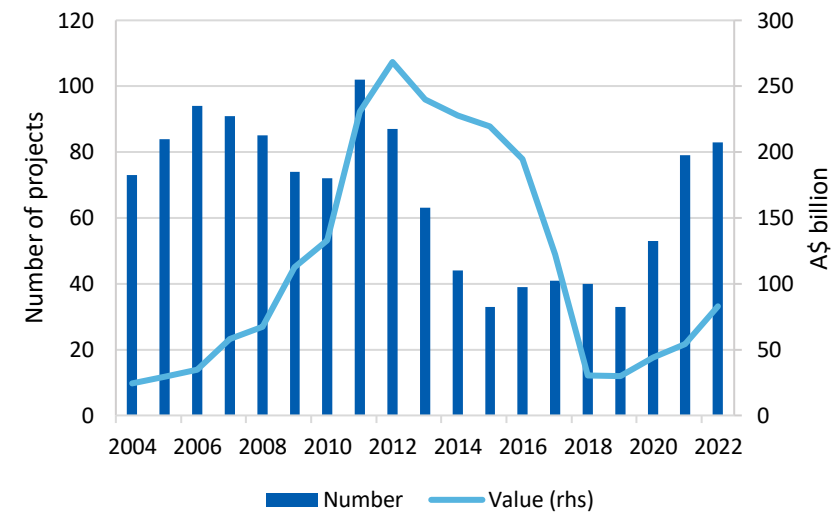
The value of projects at the ‘committed’ stage increased over the year to October 2022 from \$54 to \$83 billion (Figure 8.1). Australia’s three largest export commodities — iron ore, coal and gas — account for around 80% of investment at the committed stage (Figure 8.2, Table 8.1). Lithium is becoming an increasingly large part of the committed pipeline (See *Critical Minerals* section). The majority of committed projects are located in Western Australia, and these projects have an estimated value of \$63 billion (Image 8.1).

Our largest commodity exports dominate the ‘committed’ stage

Oil and gas projects accounted for the largest share of committed projects by value (Figure 8.2). There are 15 projects at the committed stage, with a value estimated at \$46 billion, reflecting increasing oil and gas prices. Of the projects which progressed from the feasibility stage, the largest of these projects is directed towards the continued development of the northwest offshore resources of Western Australia and the neighbouring area of the Northern Territory. The remaining projects are based in Queensland’s southeast.

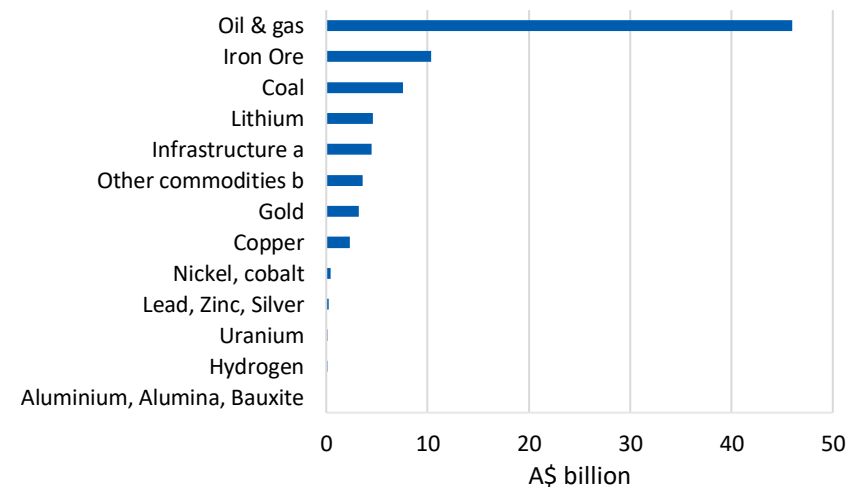
There are 4 iron ore projects at the committed stage, with a total value estimated at \$10 billion. Two projects progressed to the committed stage this year, with an estimated value of \$3.6 billion. This includes Mineral Resources’ 35 million tonne per annum Ashburton Hub, which received a Final Investment Decision (FID) in August 2022. Fortescue’s new 22 million tonne per annum Iron Bridge project is also expected to start production in the March quarter 2023, delivering high grade 67% Fe magnetite.

Figure 8.1: Number and value of committed projects



Source: Department of Industry, Science and Resources (2022)

Figure 8.2: Value of committed projects by commodity



Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. **b** Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Science and Resources (2022)

There are 15 coal projects at the committed stage, with a total value estimated at \$7.6 billion. Projects progressing to the committed stage include Malabar Coal's Maxwell Underground mine and Whitehaven Coal's Stage 3 extension at Narrabri.

There are 8 lithium projects at the committed stage, with a total value estimated at \$4.6 billion. Two projects progressed to the committed stage this year, with an estimated value of \$0.8 billion — Pilbara Minerals' 100 ktpa capacity increase for the Pilgan plant, and the Lontown Kathleen Valley deposit near Kalgoorlie, both of which received FID in the June quarter 2022.

Other critical minerals projects at the committed stage include Lynas' Kalgoorlie Rare Earths Processing Facility, King Island Scheelite's Dolphin Project (tungsten trioxide), and Strandline Resources Coburn ilmenite project. Iluka Resources Eneabba Rare Earths Processing Plant progressed to the committed stage during the year.

There are 13 infrastructure projects at the committed stage, with a total value estimated at \$4.5 billion. This includes projects which are expected to deliver lower emissions across the iron ore supply chain, such as the Fortescue's US\$700 million Pilbara Energy Connect Program, which will utilise gas-fired and solar generation to power its new Iron Bridge Magnetite Project operations.

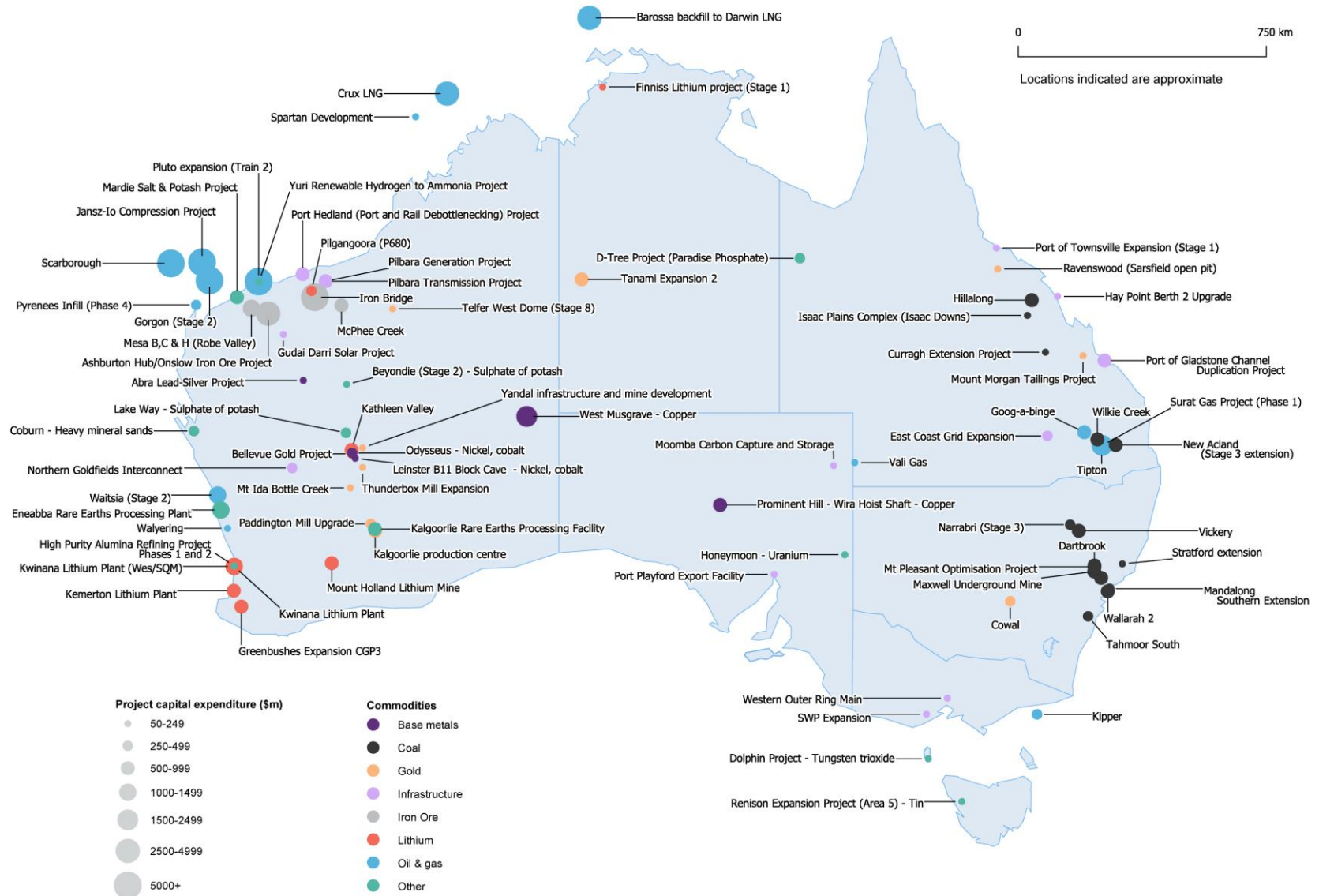
The infrastructure projects also included two gas pipeline projects committed in the 12 months to the end of October 2022. These will reinforce the eastern seaboard gas grid. They are the Western Outer Ring Main around Melbourne (VIC) and the East Coast Grid expansion, which links the hub at Moomba and its coal-seam gas to Sydney. The projects have an estimated value of \$400 million.

Table 8.1: Summary of projects at the committed stage, as at 31 October 2022

	NSW		Vic		Qld		SA		WA		Tas		NT		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite									1	0.1					1	0.1
Coal	10	5.5			5	2.1									15	7.6
Copper							1	0.6	1	1.7					2	2.3
Gold	1	0.4			2	0.3			7	1.7			1	0.9	11	3.2
Hydrogen									1	0.1					1	0.1
Infrastructure ^a			2	0.2	4	1.4	2	0.3	5	2.6					13	4.5
Iron ore									4	10.3					4	10.3
Lead, Zinc, Silver									1	0.2					1	0.2
Lithium									7	4.5			1	0.1	8	4.6
Oil & gas			1	0.4	4	2.9			9	37.9			1	4.8	15	46.0
Nickel, Cobalt									2	0.4					2	0.4
Other Commodities ^b					1	0.3			6	3.2	2	0.1			9	3.6
Uranium							1	0.1							1	0.1
Total	11	5.9	3	0.6	16	6.9	4	1.0	44	62.8	2	0.1	3	5.8	83	83.1

Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. Several gas pipelines span across more than one state but have been allocated to one state for reporting purposes. **b** Other Commodities is limited to resource and energy commodities not elsewhere identified. **c** Totals may not add due to rounding at commodity level.

Figure 8.3: Location of projects at the committed stage, as at 31 October 2022



Source: Department of Industry, Science and Resources (2020)

9. Projects at the completed stage

Number of completed projects rose in 2022

Over the year to October 2022, 30 projects with a total value of \$13.6 billion were completed, rising from \$10.1 billion in the previous report (Figure 9.1). Completed projects by State and commodity type are shown in Table 9.1. Iron ore had the highest value of completed projects, while coal, oil & gas, and gold also contributed.

There were 6 iron ore projects completed with a value of \$5.1 billion. This includes Rio Tinto's 43 Mtpa Gudai Darri project — the company's first greenfield iron ore project in over a decade — which delivered its first ore in June 2022. The company also completed its Western Turner Syncline Phase 2 (32 Mtpa) in late 2021. This was one of three brownfield projects for Rio Tinto (along with West Angelas and Robe Valley), replacing around 90 Mtpa of depleted mines elsewhere.

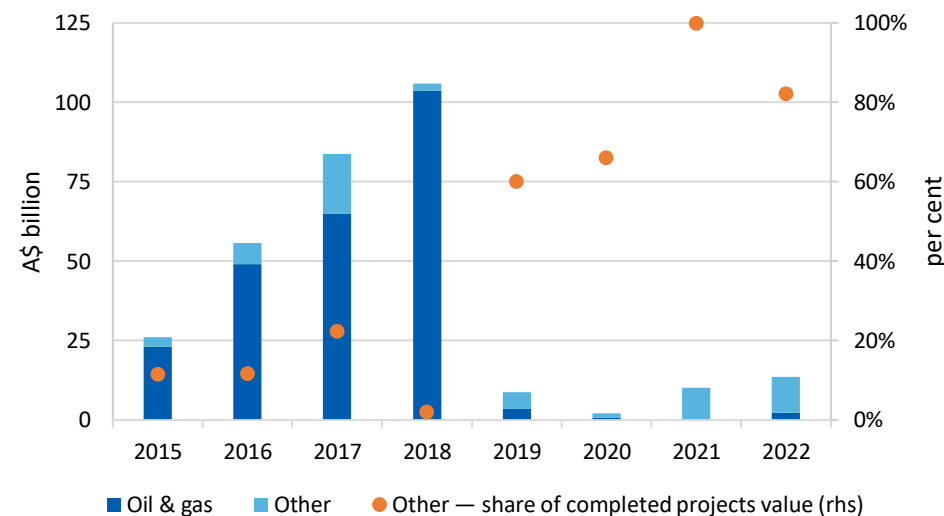
Several coal projects are now producing. These include the Aquila project owned by Anglo-American and Mitsui & Co, and Bravus's Carmichael mine in Queensland, though the latter has a considerable ramp-up yet to come.

There are 5 oil and gas projects completed with a value of \$2.4 billion. Five projects are classed as “expansions” in our framework, but they all are doing so to maintain rather than increase production. The only new project is the Pyxis Hub. There is also one gas infrastructure project — the Pluto-KPG interconnected project — that will help relieve excess capacity at KPG through the export terminal at Pluto.

There are 9 gold projects completed with a total value of \$2.1 billion. Red 5 Limited's 5.5 tpa King of the Hills gold project achieved first gold in 2022, alongside Norseman and Pantoro's 3.4 tpa Norseman gold project, Calidus' 3.3 tpa Warrawoona.

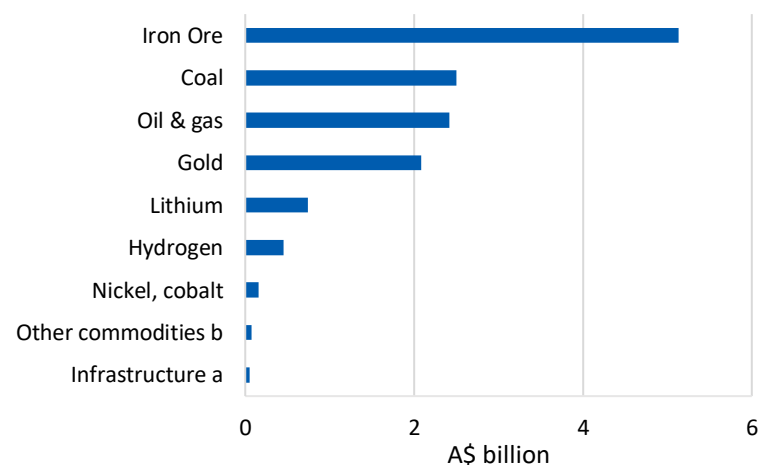
Two lithium projects were completed during the year to 31 October 2022 (see *Critical minerals* section).

Figure 9.1: Value of completed projects



Source: Department of Industry, Science and Resources (2022)

Figure 9.2: Value of completed projects by commodity



Notes: **a** Infrastructure is limited to resource, energy infrastructure projects including CCS. **b** Other Commodities is limited to resource and energy commodities not elsewhere identified.
Source: Department of Industry, Science and Resources (2022)

Table 9.1: Summary of projects at the completed stage, as at 31 October 2022

	NSW		Vic		Qld		SA		WA		Tas		NT		Total	
	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b	No. of projects	Value A\$b
Aluminium, Alumina, Bauxite																
Coal					3	2.5									3	2.5
Copper																
Gold	2	0.9							7	1.2					9	2.1
Hydrogen			1	0.5											1	0.5
Infrastructure ^a									1	0.1					1	0.1
Iron ore									6	5.1					6	5.1
Lead, Zinc, Silver																
Lithium									2	0.7					2	0.7
Oil & gas			1	0.1					4	2.4					5	2.4
Nickel, Cobalt									2	0.2					2	0.2
Other Commodities ^b					1	0.1									1	0.1
Uranium																
Total	2	0.9	2	0.5	4	2.6			22	9.7					30	13.6

Notes: ^a Infrastructure is limited to resource, energy infrastructure projects including CCS. Several gas pipelines span across more than one state but have been allocated to one state for reporting purposes. ^b Other Commodities is limited to resource and energy commodities not elsewhere identified. ^c Totals may not add due to rounding at commodity level. Source: Department of Industry, Science and Resources (2022)

10. Methodology

Each year, we collect information about the investment pipeline for major resources and energy projects. Information is gathered from several sources, including government departments and agencies, industry associations, company websites, Australian Stock Exchange reports, and media releases.

Although there is substantial investment by mining and energy companies in replenishing equipment, plant and other property, the focus of this report is on 'major' investments — those that can be confidently valued at over \$50 million based on publicly available sources. Smaller scale operations are also an important contributor to the sector and the broader Australian economy. But public information, particularly on early-stage projects, can be scarce or difficult to find — including projects undertaken by private companies, who have fewer obligations to report project progress. This report therefore may omit some projects for which we could not identify key parameters. Each year we seek to improve the coverage and data quality of the report, including through incorporating relevant project information that may not have been identified in previous years.

Developers of resources and energy projects often use different planning processes and assessment methods to support an FID. Thus, there is no standard project development model with clearly defined stages and terminology that can be applied to every resource and energy project.

To broadly represent the general life cycle of a project, we use a four-stage approach to categorise resources and energy projects along the investment pipeline. Earlier stages of developing mining and energy projects, such as identifying deposits and exploration activities, are not included in the list. While these activities remain important, it is beyond the scope of this report to assess exploration activities on a project-by-project basis. Instead, a summary and analysis of aggregate exploration expenditure is provided.

The four stages in our investment pipeline are:

1. Publicly announced
2. Feasibility
3. Committed
4. Completed

(1) Publicly announced stage

Projects at the publicly announced stage are usually very early in their development and are typically undergoing an initial feasibility study to assess the commercial aspects of developing an identified resource. To have a project on the list at this stage, preliminary information on the project schedule, planned output or cost, must be publicly available.

As they are still in the early planning stage, projects at the publicly announced stage may not have finalised the engineering designs or estimates of construction costs. Where cost estimates have not been disclosed by the company, projects are classified into cost bands using company disclosures and industry averages for similar construction activities. The cost bands we use in this report are:

- \$50 – \$249m
- \$250m – \$499m
- \$500m – \$999m
- \$1,000m – \$1,499m
- \$1,500m – \$2,499m
- \$2,500m – \$4,999m
- \$5,000m+

(2) Feasibility stage

This stage of the project development cycle is when the initial feasibility study for a project has been completed and the results support further development. Projects that have progressed to the feasibility stage have undertaken initial project definition studies and commenced more detailed planning work. This work includes Front-End Engineering Design (FEED) studies, Bankable Feasibility Studies, developing the final project scope,

commercial plans and environmental surveys (in support of finalising an Environmental Impact Statement).

While there is an opportunity to progress projects at the feasibility stage to the committed stage, this is not guaranteed to occur, as the evaluation of commercial prospects has not yet been finalised and all regulatory approvals are yet to be received. Projects at the feasibility stage have not been committed to and are only potential investments that may occur under the appropriate conditions. Therefore, the total value of projects at the feasibility stage cannot be directly compared to the value of the projects at the committed stage in order to forecast the future of capital investment.

(3) Committed stage

Projects at the committed stage have completed all commercial, engineering and environmental studies, received all necessary government regulatory approvals, and finalised the financing of the project to allow construction. Such projects are considered to have received a positive FID from the owner(s). In most cases, projects at this stage of development have already started construction, as there are typically pre-works undertaken as part of exploration and design activities.

Projects at the committed stage typically have cost estimates, schedules, and mine outputs that are well defined and often publicly released. Most projects that progress to the committed stage will eventually commence production. Nevertheless, post-FID, there are still technical and financial risks that, if realised, can result in delays, scope changes and cost overruns, or even affect the commercial viability of a project and possibly lead to its cancellation.

(4) Completed stage

As many projects include multiple stages and scope elements that can be independent of each other, the timing around when a project reaches the completed stage can be difficult to assess. Under our framework, we consider a project reaches the completed stage when all construction and

commissioning activities are completed, and the operation has reached commercial production.

New projects, expansions and reactivations

Our framework classifies projects as “new”, “expansion” or “reactivation”. New projects are those that were not active at the same location before the first announcement recorded in our research. Expansions correspond to those that are already existing and are taking their operations to neighbouring fields. In many cases, the goal of the “expansion” is merely to maintain output. There is no implication that output is increasing. Reactivation indicates a project that was announced, then officially abandoned, but has since been returned to the drawing board.

Aggregated likelihood profiles and the outlook for project investment

Because not all projects that are initiated end up being progressed through to construction, the *Resources and Energy Major Projects* report provides an aggregated profile of possible future investment based on likelihood.

For the purposes of constructing this profile, individual projects at the feasibility and publicly announced stages are categorised as ‘unlikely’ (broadly with a probability of 0 – 20%), ‘possible’ (20 – 60%) or ‘likely’ (60 – 100%) to progress to the committed stage. Projects that have been categorised as ‘unlikely’ to proceed are not included in the profile of the value of future investment.

This categorisation is based on a range of publicly available information, including market conditions and company commentary. It does not reflect our view about the viability of specific projects and is simply a mechanism employed to present aggregate information about the potential profile of future investment. For example, for a given commodity some projects at the publicly announced and feasibility stages would need to be arbitrarily categorised as unlikely if aggregate output for all projects would exceed expected demand for that commodity. To avoid any misinterpretation, we do not publish our categorisations at a more disaggregated or individual project level.

11. Further information and resources

Department of Industry, Science and Resources

Resources and Energy Major Projects

Resources and Energy Major Projects provides a review of the mining, infrastructure and processing facilities projects that increase, extend or improve the output of mineral and energy commodities in Australia.

<https://www.industry.gov.au/remf>

Resources and Energy Quarterly

The Resources and Energy Quarterly contains the latest data, analysis and forecasts for the value, volume and price of Australia's major resources and energy commodity exports.

<https://www.industry.gov.au/data-and-publications/resources-and-energy-quarterly-all>

Outlook for Selected Critical Minerals 2021

The outlook includes economic data to help facilitate investment in Australian critical minerals projects and greenfield opportunities. The report covers rare earths, cobalt, graphite and vanadium.

<https://www.industry.gov.au/data-and-publications/outlook-for-selected-critical-minerals-in-australia-2021-report>

Australian Trade and Investment Commission

Australian Critical Minerals Prospectus 2021

The prospectus includes technical, commercial and geological data to help facilitate investment in Australian critical minerals projects and greenfield opportunities. The 2021 prospectus highlights 44 projects currently seeking investment or offtake agreements and present an extraordinary opportunity for partners.

https://www.austrade.gov.au/ArticleDocuments/5572/Australian_Critical_Minerals_Prospectus.pdf.aspx

Geoscience Australia

Australia's Identified Mineral Resources

Australia's Identified Mineral Resources is an annual assessment of Australia's mineral reserves and resources for all major, and some minor, commodities. It provides useful indicators of potential resource life and future supply capability, comparisons of world rankings, and insights into the distribution of Australia's resources and industry developments.

<https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/aimr>

Geoscience Australia Portal

This provides users with a single point to access Australia's geoscience data, including a range of assessment tools such as Economic Fairways.

<https://portal.ga.gov.au/>

Minerals and Mines Maps

Geoscience Australia produces a number of annual maps on resources and industry activity across the country. They include the operating status of the different mines and deposits, along with major infrastructure. The most recent versions of these maps can be accessed via these links:

Australian Operating Mines Map 2020:

https://d28rz98at9flks.cloudfront.net/144658/144658_00_0.pdf

Australian Critical Minerals Map 2020:

https://d28rz98at9flks.cloudfront.net/144155/144155_00_0.pdf

Australian Mineral Exploration Review 2018-19:

https://d28rz98at9flks.cloudfront.net/133031/133031_00_0.pdf

Australia's Energy and Mineral Resources Investor Guide 2020

The Australia's Energy and Mineral Resources Investor Guide 2020 is a guide for investors interested in Australian resources opportunities.

http://d28rz98at9flks.cloudfront.net/133857/133857_00_0.pdf