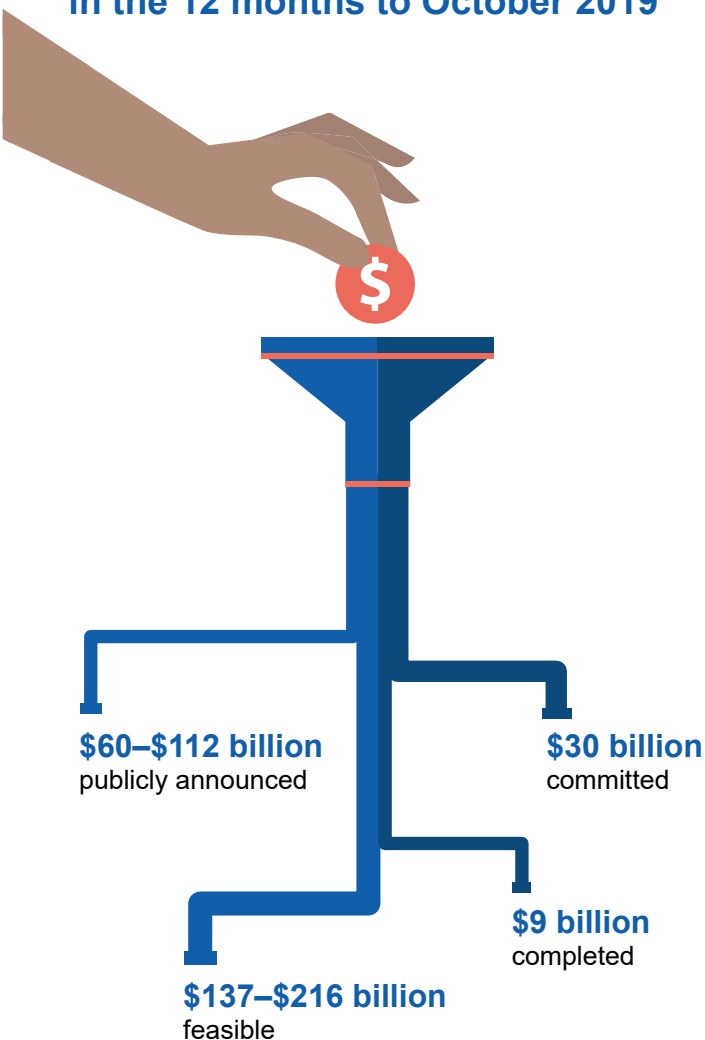


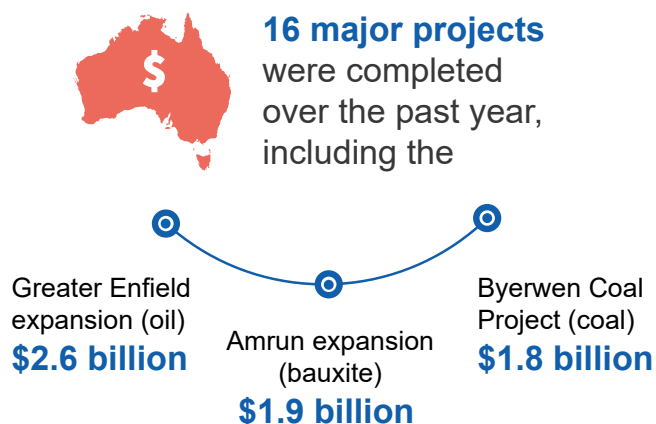
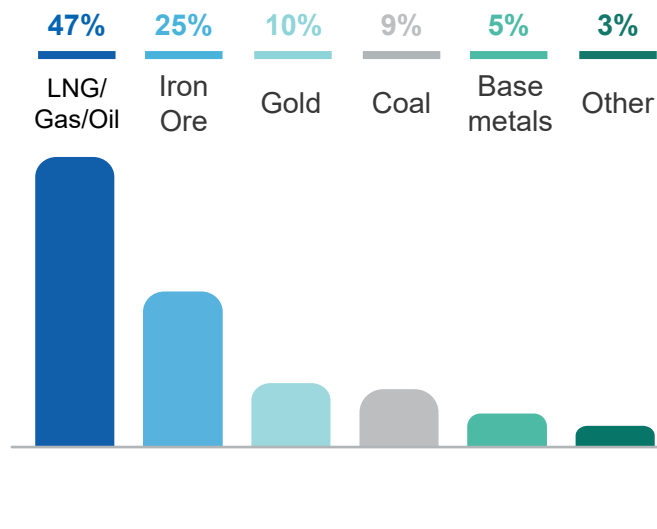
Major Projects

Resources and Energy Quarterly December 2019

Value of resource and energy projects in the investment pipeline in the 12 months to October 2019



Per cent share of value of committed projects by commodity groups



Major projects coverage includes over **30 different commodities**



16.1 Introduction

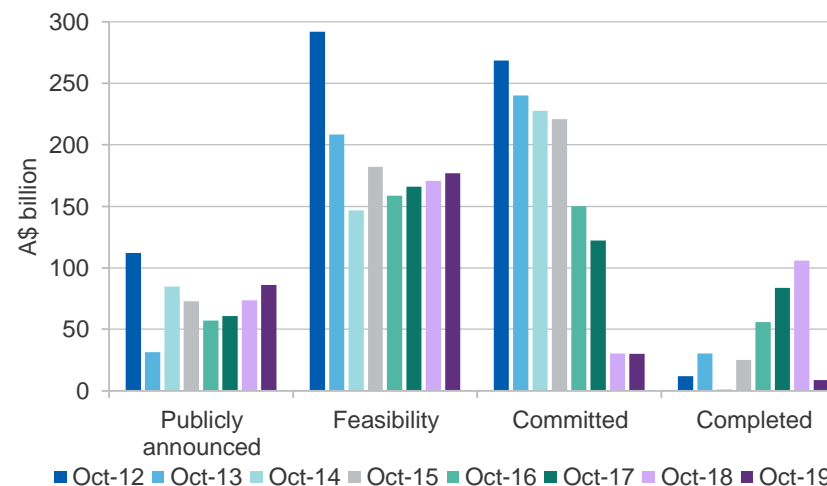
Resources and Energy Major Projects was first published in 1997. The publication is a review of projects which plan to extend, increase, or improve the quality of mineral and energy commodity output in Australia. These projects include new mines, mine expansions, processing facilities, and other connected infrastructure. Its purpose is to measure the value of current and potential investment in the resources and energy sector, and to provide an analysis of key trends and issues. This edition of the report presents an update on project developments over the 12 months from the start of November 2018 to the end of October 2019. Our list of Australia's major resources and energy projects this year features 281 projects. This report is accompanied by a [detailed project listing](#).

16.2 Overview and outlook

A year on from the release of our last publication (December 2018), and after six years of decline, the value of 'committed' resource and energy projects — those where a final investment decision (FID) has been taken and construction activity is likely underway — has stabilised (Figure 16.1). The value of committed projects in October 2019 stood at \$30 billion, almost unchanged from the level recorded in the year to October 2018. Our outlook for resources and energy investment suggests that this may be near the bottom of the mining investment cycle.

A number of major resources and energy projects were completed during the twelve months to October 2019, including the Greater Enfield oil project, the Amrun bauxite mine expansion and the Byerwen coal project. The decline in the value of committed projects resulting from these completions has been largely offset by FIDs for a number of new projects, including the Adani Carmichael coal mine and five new gold projects and expansions — representing an estimated \$3.3 billion of investment. The gold projects have progressed to the committed stage this year, encouraged by record high gold prices in Australian dollar terms, and by the possibility of further gold prices rises (on the back of a highly uncertain outlook for the global economy, largely due to US-China trade tensions).

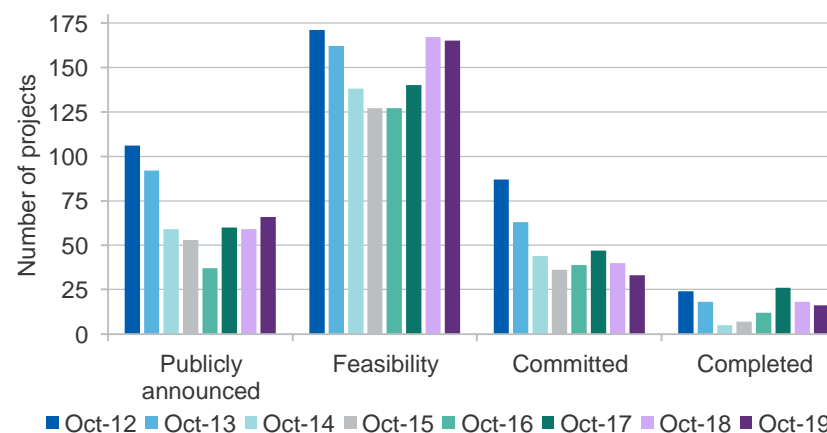
Figure 16.1: Value of projects in the investment pipeline, 2012–19



Notes: Value of publicly announced and feasible projects estimated as the range mid-point.

Source: Department of Industry, Innovation and Science (2019)

Figure 16.2: Number of projects in the investment pipeline, 2012–19



Source: Department of Industry, Innovation and Science (2019)

There has been an increase in both the number of new and expansion projects on the list (Table 16.1). However, this year there is a greater distribution of projects ranked as ‘unlikely’ or ‘possible’, rather than ‘likely’ (Table 16.2). This may reflect recent low prices in some markets or uncertainty around market expectations.

While some projects have progressed, the flow of projects from the feasibility to the committed stage remains slow in some areas, particularly coal (Figure 16.2). There are 46 coal projects at the feasibility stage — a combined total of more than 390 million tonnes of new capacity — many of which have long been delayed (Table 16.3).

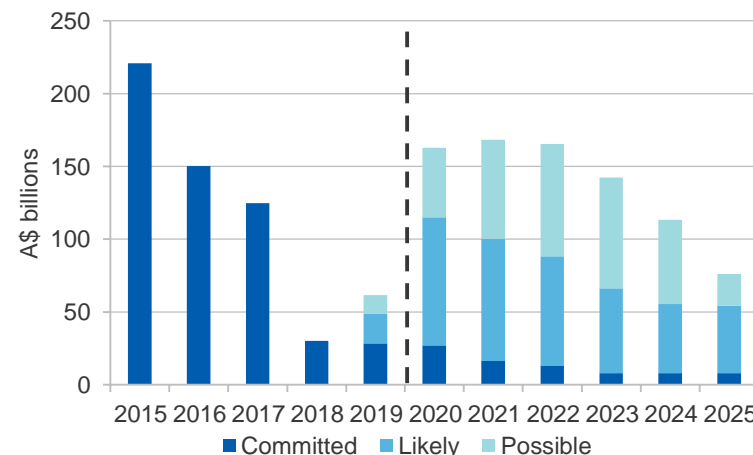
There appears to be a growing reluctance to commit to greenfield coal projects, and an expanding list of lenders/investors have announced they will no longer finance thermal coal projects. Pension and equity funds are also divesting from coal, community opposition to coal mining is growing, and strict regulatory conditions are also impacting on investment decisions. The recent downturn in both metallurgical and thermal coal prices may weigh further on future investment decisions.

There has been a lift in activity at the early stages of the investment pipeline, with the value of projects at the feasibility stage increasing for a third straight year in 2019 (Figure 16.1). This pick-up in investment activity likely reflects the impact of relatively strong commodity prices in Australian dollar terms, and growing confidence about the long-term outlook for global (particularly Asian) commodity demand. These same factors have driven an increase in exploration expenditure, particularly across base and precious metals. Gold now accounts for around a quarter of all exploration expenditure — its highest level on record. Project proponents are increasingly willing to tackle more difficult deposits across a range of mineral commodities. The lift in activity represents a marked turnaround from the period of 2015 and 2016, when low prices forced companies to delay exploration and new projects and instead focus on cost cutting.

There is potential for a modest uptick in resource and energy investment next year, and a further recovery in the early 2020s looks likely. There are over \$240 billion of projects at the publicly announced and feasibility

stages that we consider ‘possible’ or ‘likely’ to receive an FID (Figure 16.3). The bulk of this potential investment — over \$170 billion worth — comes from projects at the feasibility stage (Table 16.2).

Figure 16.3: Outlook for project investment



Source: Department of Industry, Innovation and Science (2019)

However, this potential investment depends heavily on the progression of just 12 mega projects (projects involving over \$5 billion of investment), nine of which are at the feasibility stage. Together, these 12 projects account for half of the value of projects in the investment pipeline. By far the largest of these is the \$36 billion Browse Basin gas project. Other mega projects include the Scarborough gas project on the west coast, the Surat gas project on the east coast, the Alpha coal project in the Galilee Basin, and the West Pilbara iron ore project.

Australia’s largest export commodities — namely LNG/gas, iron ore and coal — account for around \$200 billion of the potential \$240 billion of projects in the investment pipeline. LNG/gas projects are the largest of these. The majority of the large gas projects at the feasibility stage are backfill projects that utilise existing LNG export infrastructure — rather than new greenfield developments of the type seen over the past the decade (as part of Australia’s US\$200 billion LNG investment boom).

Iron ore projects account for more than \$40 billion of the potential investment expenditure, mostly with new projects at the publicly announced and feasible stages. There has been little progress in iron ore development projects over the past year, as markets are well established and the more challenging projects remain in the pipeline.

There are around \$28 billion of precious metal, base metal and other commodity projects at the publicly announced and feasible stages that are rated as likely or possible to receive an FID. Nickel, cobalt, rare earths and lithium account for more than a third of this \$28 billion. Demand for these commodities is being driven by a range of new applications, such as for batteries in energy storage and electric vehicles, as well as for consumer electronics and numerous other high-tech applications. In rare earths, a window of opportunity appears to have opened, while market conditions for lithium producers have become more challenging on the back of price sharp falls (Box 16.1).

Overall, our outlook for mining investment suggests that, while we will not see a return to the levels seen during the last investment phase (which peaked in 2012 with \$268 billion in committed projects), there are some significant opportunities for Australia's resources and energy sector.

Table 16.1: New and expansion projects by rating, as at 31 October 2019

	Unlikely	Possible	Likely	Committed	Completed
New project					
A\$ billion	37	123	80	8	4
Number	45	115	30	15	12
Expansion					
A\$ billion	2	26	15	22	5
Number	6	24	12	18	4

Notes: Restart projects are included as expansions.

Source: Department of Industry, Innovation and Science (2019)

Table 16.2: Number of projects by stage of investment and rating, as at 31 October 2019

	Unlikely	Possible	Likely	Committed	Completed
Publicly announced	15	46	5	0	0
Feasible	36	93	37	0	0
Committed	0	0	0	33	0
Completed	0	0	0	0	16

Notes: Projects at the publicly announced and feasibility stages are rated as either 'unlikely' (0 – 20%), 'possible' (20 – 60%) or 'likely' (60 – 100%) to progress to the committed stage.

Source: Department of Industry, Innovation and Science (2019)

Table 16.3: Summary of projects in the investment pipeline as at 31 October 2019

	Publicly announced		Feasibility		Committed		Completed	
	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, Bauxite, Alumina			1	0.05			1	2
Coal	13	10-17+	46	58-76+	2	2	1	2
Copper	6	4-8+	5	1-2+	1	1	1	0.1
Gold	2	0-5	15	3+	12	3		
Infrastructure	10	10-17	3	1+	2	0.3	1	0.1
Iron ore	13	11-12+	12	19-25+	4	7	1	0.1
Lead, Zinc, Silver	1	0-0.2	4	0-1	1	0.2	2	0.2
LNG, Gas, Petroleum	9	21-38+	17	40-89+	5	14	4	3
Nickel	5	3-5	3	1-2	3	0.4		
Uranium	1	2-3+	5	2+				
Other Commodities	6	0.5-1.0	55	13-24+	3	0.8	5	1
Total	66	60-113+	166	137-216	33	30	16	9

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

Source: Department of Industry, Innovation and Science (2019)

16.3 Exploration

Exploration is a key stage in the mining project development cycle. It is an investment in knowledge about the location, type, quantity and quality of deposits, which helps to inform future development. Before making the decision to undertake exploration activities, resources and energy companies consider a range of factors to ensure that the benefits of exploration activities exceed the costs. Factors to be considered include prevailing and expected commodity prices, the regulatory environment, geological prospects, tax and royalty arrangements.

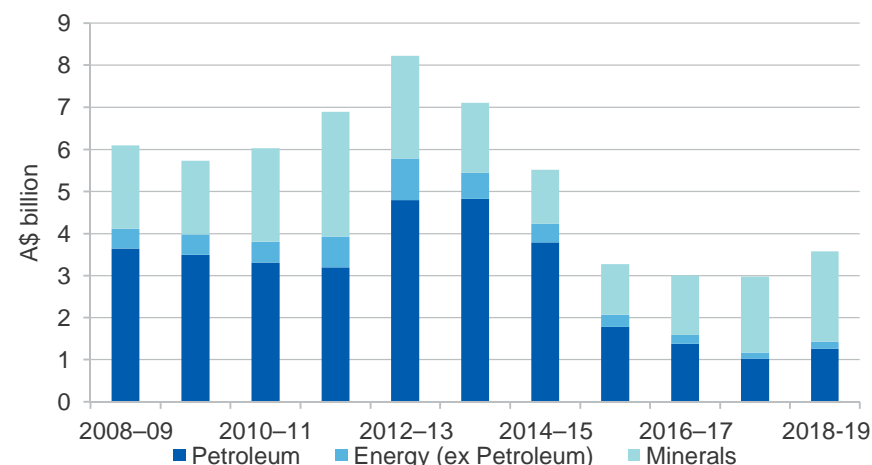
Exploration expenditure increased in 2018–19

Australian exploration expenditure increased by 20 per cent in 2018–19, to \$3.6 billion (Figure 16.4). As with 2017–18, the main contributor to the increase was expenditure on mineral exploration, which increased by 19 per cent to \$2.2 billion. However, positive growth in exploration expenditure was experienced across all the petroleum, energy, and minerals groupings.

Mineral exploration expenditure was primarily on existing deposits. However, the share of expenditure on new deposits again increased, to reach 39 per cent of total mineral exploration expenditure — the highest it has been since 2007–08 (Figure 16.5). Minerals exploration expenditure represented 60 per cent of total expenditure in 2018–19, a substantial rise from only four years prior, when it represented 24 per cent of total expenditure.

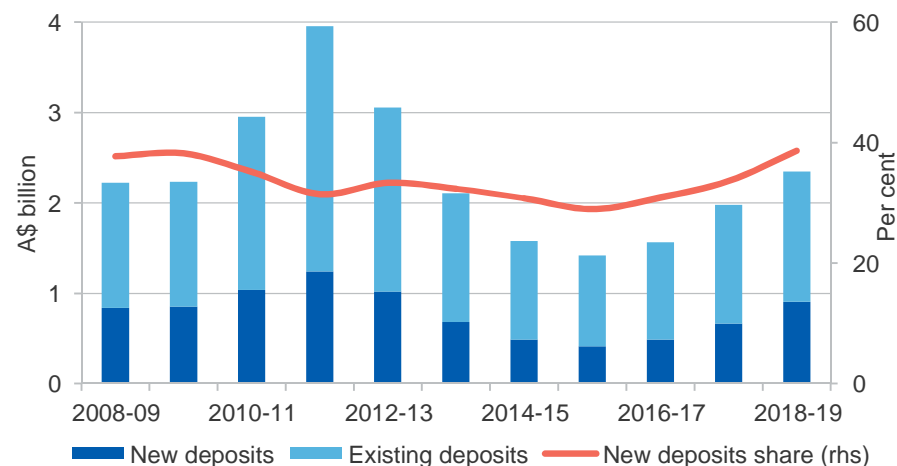
Gold exploration expenditure increased by 19 per cent in 2018–19 to \$967 million — accounting for 45 per cent of Australia's total minerals exploration expenditure over the year (Figure 16.6), as well as the second largest contribution to growth in overall exploration behind total petroleum expenditure. Exploration activity has been encouraged by strong Australian dollar gold prices and the potential for further gold price rises on the back of an uncertain global economic outlook.

Figure 16.4: Mineral and energy exploration expenditure



Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0

Figure 16.5: Mineral exploration by deposit type



Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0

Base metals exploration expenditure rose by 25 per cent in 2018–19 to \$621 million, driven by relatively high (but volatile) commodity prices. (Figure 16.6). Though not as high as the 83 per cent increase achieved in 2017–18, it is still a substantial rise in base metal exploration, which had been in decline over the four years to 2015–16. The increase in base metals exploration was driven overwhelmingly by expenditure on copper exploration, which increased by 70 per cent. Some projections anticipate an impending shortage, as heightened demand — brought about by increasing electrification — overtakes supply.

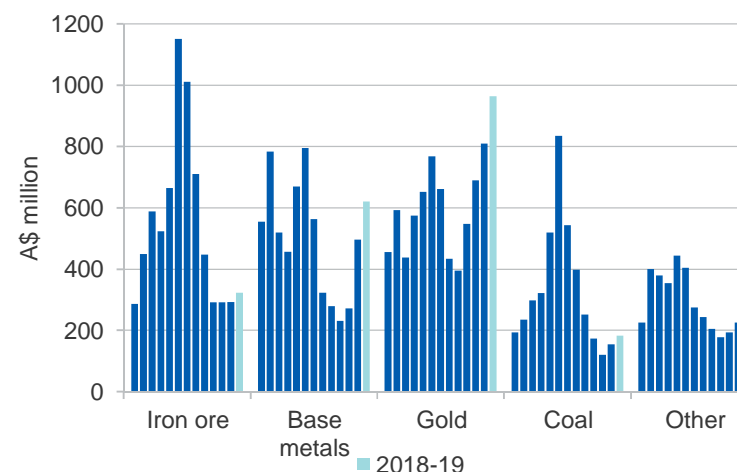
Coal exploration increased for the second year in a row — rising by 18 per cent to \$182 million — reflecting record high metallurgical coal prices. The increase nonetheless follows a longer-term decline from the peak of coal exploration expenditure; current expenditure is only about 20 per cent of levels reached in 2011–12. (Figure 16.6).

Iron ore exploration picked up after a lacklustre 2017–18, increasing by 11 per cent to \$324 million in 2018–19. While far from the peak of \$1.2 billion attained in 2011–12, it is the highest level of exploration expenditure since 2014–15. Iron ore exploration may soon benefit from the surge in prices early in 2019, resulting from constrained Brazilian supply and robust demand from key markets including China (Figure 16.6).

After more than doubling from 2016–17 to 2017–18, nickel and cobalt expenditure was subdued in 2018–19, rising from \$200 million to \$203 million. Silver, lead and zinc fell by 14 per cent to \$89 million, after making a decade-long high of \$103 million in 2017–18, when zinc prices spiked.

Petroleum (oil or gas in solution) expenditure ceased its six year decline, rising from \$1.0 billion to \$1.3 billion in 2018–19. Both offshore and onshore petroleum expenditure remain around decade lows, however, there are signs of a recovery (Figure 16.7). Western Australia was the largest contributor to the rise in petroleum expenditure, which suggests producers may be eyeing possible sources of backfill for large-scale LNG projects. Exploration around the Dorado oil field in the Canarvon basin has also contributed to exploration expenditure in Western Australia. (Figure 16.8).

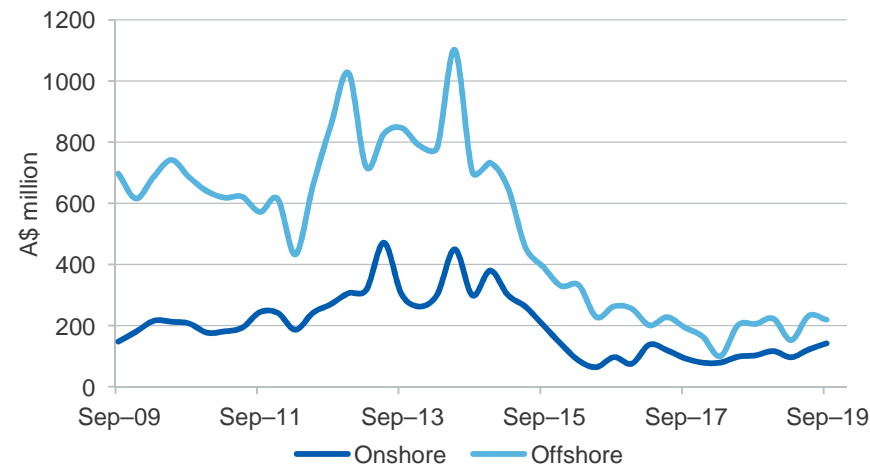
Figure 16.6: Exploration expenditure, 2007–08 to 2018–19



Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0

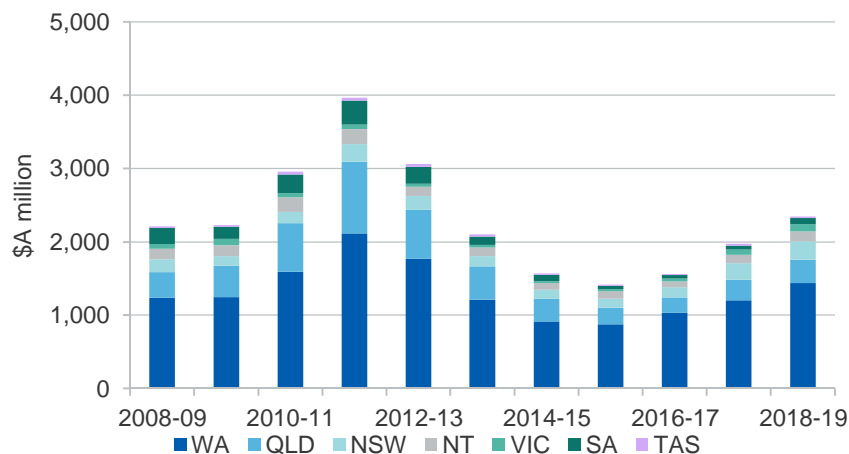
Notes: Base metals also include silver and cobalt.

Figure 16.7: Petroleum exploration expenditure, quarterly



Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0

Figure 16.8: Exploration expenditure by State

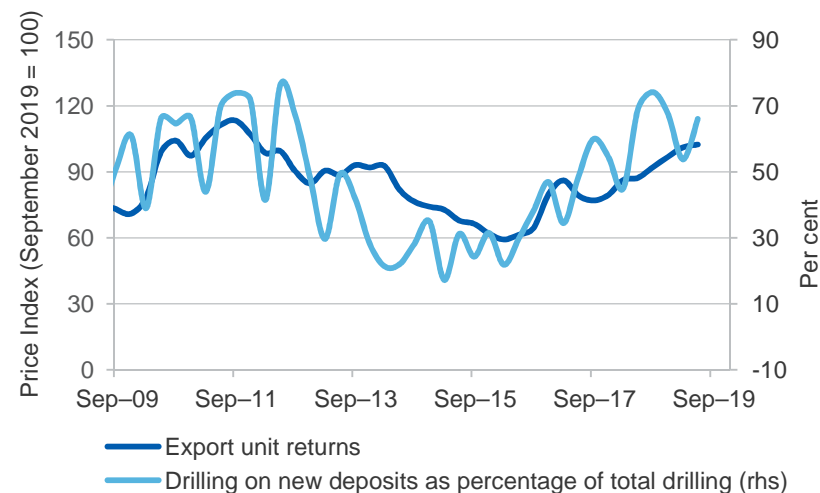


Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0

Market conditions lead to stronger drilling results

A total of 10 million metres was drilled in 2018–19, 13 per cent higher than in 2017–18, and the highest amount since 2011–12. As a percentage of total metres drilled, new deposits tended to decline from 2003 to 2015, but have since picked up. This reflects higher commodity prices, which have likely raised producers' risk appetite (Figure 16.9).

Figure 16.9: Drilling on new deposits versus commodity prices



Source: ABS (2019) Mineral and Petroleum Exploration, Australia, 8412.0. Department of Industry, Innovation and Science (2019)

16.4 Projects at the publicly announced stage

Around a quarter of all projects are at the publicly announced stage

Of the 281 projects on this year's list, around a quarter were at the publicly announced stage. The value of the 66 projects at the publicly announced stage in October 2019 is estimated to be between \$60 billion and \$112 billion. Around a third of these projects are in Western Australia, and the majority of coal projects are in Queensland (Table 16.4).

Many projects at the publicly announced stage remain uncertain, or at the very least are unlikely to progress in the near term. This is the case for a number of large LNG/gas, iron ore, coal and infrastructure projects — the predominant commodities classified as being at this stage (Figure 16.10). The lack of movement in projects at this stage of the investment pipeline partly reflects the low costs associated with taking a project to this stage of development — which, unlike the feasibility stage, does not require major investment in activities like FEED.

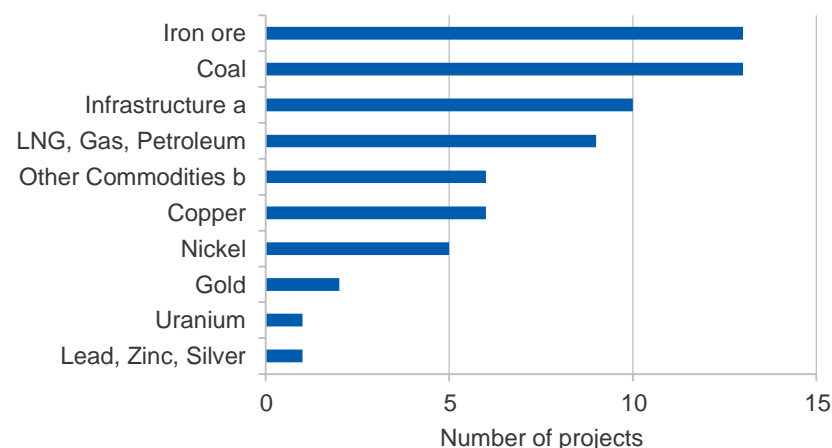
A large share of nickel development projects at the publicly announced stage are focused on nickel and cobalt sulphate projects. Most production is intended for export to Asia (to be used in battery manufacturing), however Pure Minerals' Townsville Energy Chemicals Hub in Queensland is intending to import ore from New Caledonia and feed to the prospective Imperium3 battery factory in Townsville.

16.5 Projects at the feasibility stage

Significant investment potential with projects at the feasibility stage

The value of projects at the feasibility stage increased from an estimated \$170 billion to \$196 billion in the 12 months to October 2019. The increase comes despite a number of projects regressing from the feasibility stage to publicly announced, and others taking FIDs and moving to committed. Over 160 projects are listed at the feasibility stage — around 60 per cent of our Major Projects list this year (Table 16.5). There are several major gas projects at the feasibility stage (Figure 16.11).

Figure 16.10: Number of projects at the publicly announced stage



Note: **a** Infrastructure is limited to resource and energy related infrastructure projects. **b** Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Innovation and Science (2019)

The largest of these — and the largest project on our Major Projects list — is Woodside's \$36 billion Browse to North West Shelf project. The project involves the connecting the Brecknock, Calliance and Torosa fields in the Browse Basin off the coast of Western Australia to the existing North West Shelf LNG facility via a 900 kilometre pipeline. Woodside is targeting an FID for the project in the first half of 2021. Another major gas development at the feasibility stage is Woodside's Scarborough gas project in the Carnarvon Basin off the coast of Western Australia. Woodside is proposing to bring gas from Scarborough to market via a 430 kilometre pipeline to the Pluto LNG plant, where an additional train — in the 4-5 million tonne per annum range — would be added. An FID for the Scarborough project is expected in 2020.

There are several other major gas projects at the feasibility stage that would provide backfill for LNG plants, as output from existing fields falls. These include the Santos Barossa gas project (which looks likely to provide backfill for Darwin LNG) and Shell's Crux project (which will provide backfill for Prelude LNG). Western Gas, which is developing the

Equus gas project, is currently proposing a standalone, near-shore small-scale floating LNG facility (2 million tonnes per annum), but has also flagged that the resource presents an opportunity for other resource owners who have access to spare capacity in existing infrastructure.

In the eastern gas market, the largest new potential investment is Arrow's \$10 billion Surat Gas project. The project — which would bring 240 petajoules per annum of gas to market at peak production in 2026 — missed its 2018 FID target, and may now have difficulties achieving its original 2020 target for starting production.

The number of coal projects at the feasibility stage increased over the 12 months to October 2019, with 46 projects listed worth an estimated \$61 billion in total (Table 16.5). Of these, 34 are in Queensland. This significant investment potential is dependent on price expectations, company priorities and government approvals.

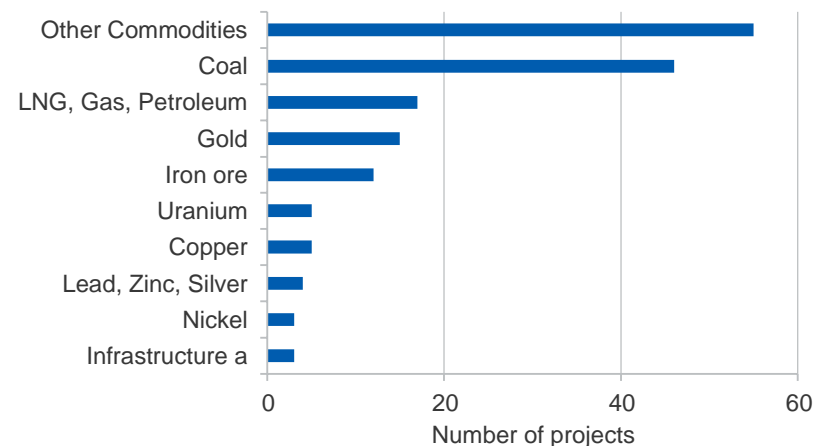
Market conditions in lithium have become more challenging over the past year, with implications for Australia's emerging lithium sector (Box 16.1). As lithium prices have fallen, projects under feasibility have been delayed or curtailed. Greenbushes' CGP3 expansion has been delayed, along with the corresponding stage 2 of the Kwinana Lithium Hydroxide Plant (stage 1 was completed in September 2019). Mt Holland and its associated lithium processing plant are pending an FID in 2020, after Wesfarmers' takeover of Kidman. Pilbara Minerals' Pilgangoora stage 2 has also been delayed.

Further on the battery materials front, high grade spherical graphite for battery usage is being progressed at Siviour (north-east of Port Lincoln) with feasibility results pending.

Offtake agreements are key to underwriting project development in opaque markets such as rare earths, where a window of opportunity has opened for project developers (Box 16.1). Offtakes are often with manufacturers who understand these raw materials inputs. Nolans' rare earths engineering has progressed, with offtake at the memorandum of understanding (MOU) stage. Yangibana rare earths (north-east of

Canarvon) has made rapid progress, with an MOU on a 10 year offtake to be finalised within 6 months with Schaeffler of Germany.

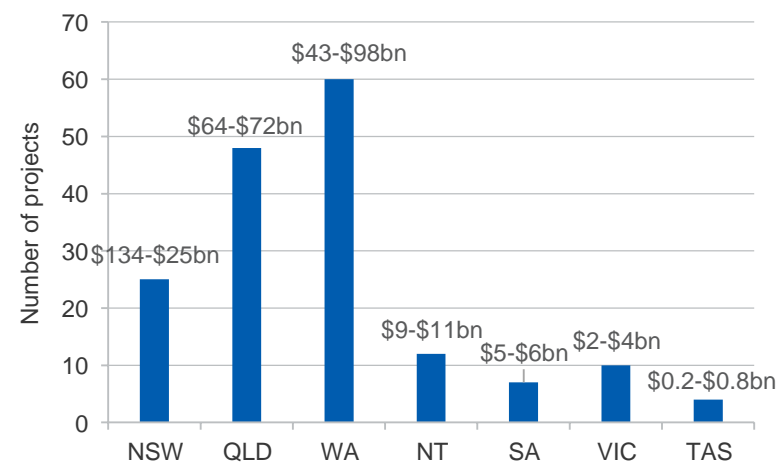
Figure 16.11: Number of projects at the feasibility stage



Note: a Infrastructure is limited to resource and energy related infrastructure projects.

Source: Department of Industry, Innovation and Science (2019)

Figure 16.12: Projects at the feasibility stage, by State and Territory



Source: Department of Industry, Innovation and Science (2019)

Cyclone Zircon (300km from Warburton) has now morphed into a critical minerals project after positive Hafnium assays; owners Diatreme Resources are now re-evaluating the project direction.

Other critical minerals projects have progressed financing. Ammaroo Phosphate (south of Tennant Creek) has gone to UK private equity to fund the \$434 million capital needed. Lake Way Potash, south east of Wiluna, (capital cost \$254 million) released its feasibility in October, and has partial funding contingent on completion of feasibility studies and other conditions. The Dolphin Tungsten Project (redevelopment of the old open cut) recorded positive feasibility results and has secured an offtake agreement. Tellus Holdings' hazardous containment facilities at Chandler Salt are progressing, after having already committed for Sandy Ridge Kaolin hazardous containment facility near Laverton.

The largest proportion of projects at the feasibility stage are in Western Australia, including a number of prospective nickel-cobalt projects (Figure 16.12, Table 16.5). Expectations of higher demand, supported by growing battery manufacturing, are supporting investment in mine capacity and processing facilities. A number of these projects have high quality deposits, like Ardea Resources' Goongarrie project in Western Australia. Price volatility and uncertainty around the timing of market growth make project planning difficult. Projects have accommodated these difficulties by using staged capacity investment, or modifying production plans to prioritise particular metals.

16.6 Projects at the committed stage

The value of committed projects appears to have stabilised after seven years of decline

The value of projects at the committed stage remained broadly unchanged over the 12 months to October 2019, at around \$30 billion (Figure 16.13). Australia's three largest export commodities — iron ore, coal and gas — account for around 80 per cent of investment at the committed stage (Figure 16.14, Table 16.6). The location and value of projects at the committed stage are shown in Image 16.1.

A number of projects advanced to the committed stage over the 12 months to October 2019, after receiving FIDs. In November 2018, Adani Australia announced that a scaled-down Carmichael mine and rail project will be financed entirely by the Adani Group. The Carmichael Project was redesigned to be a 10 million tonne per annum mine and 200 kilometre railway, with Adani Mining expecting first output in 2021.

Iron ore development projects account for the second largest share of committed projects by value (Figure 16.14). Several large iron ore projects are moving closer to completion: Fortescue's Eliwana, which is set to commence production in December 2020 and produce 30 million tonnes per year, and BHP's South Flank, set to produce 80 million tonnes annually and replace existing production from the Yandi operations from 2021. Rio Tinto's Koodaideri is also progressing, and is expected to commence in late 2021 and produce 43 million tonnes per year.

Five gold projects have also progressed to the committed stage over the past year, including Newcrest's \$685 million Cadia Stage 1 Expansion project, and Resolute Mining's \$134 million Ravenswood expansion project. Together, these projects are expected to add around 37 tonnes of new production — around 12 per cent of Australia's current output.

Two nickel projects have also received FIDs. BHP's Mt Keith Satellite project will expand mine capacity over multiple stages, as BHP takes advantage of growing nickel use in battery manufacturing. The Stage 1 upgrade at BHP's Kwinana facility will add 100,000 tonnes of nickel sulphate capacity, and is expected to start production in 2020.

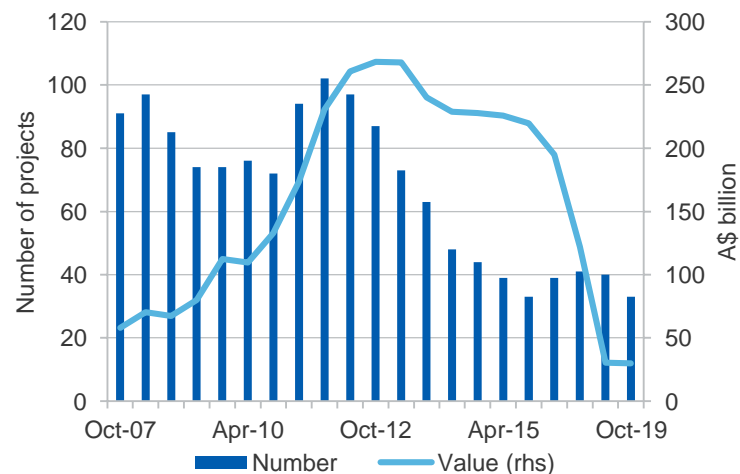
On the rare earths front, licensing requirements for processing of materials have changed in Malaysia. As a result, Lynas has been required to relocate the early part of its Malaysian processing facilities back to Western Australia by mid-2023. Media reports have put the capital cost at around \$500 million, with possible locations including Kalgoorlie or Laverton.

In lithium, the previously committed Wodgina Spodumene Processing Plant has been placed on care and maintenance, amid tough market

conditions. The project was being undertaken in three phases, and was going to feed into Kemerton Processing Plant. Construction is mostly complete and, prior to the announcement, Stage 1 was being commissioned.

Beyondie Potash (south-east of Newman) is committed and in construction, after offtake agreements were secured; ramp-up is scheduled for 2021.

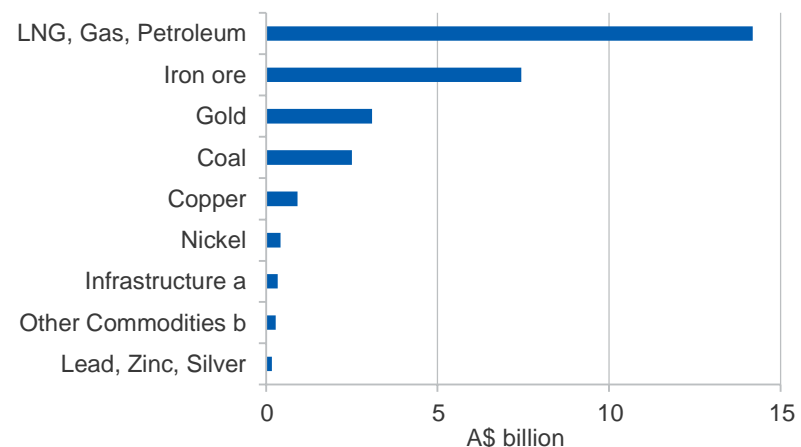
Figure 16.13: Number and value of committed projects



Note: The Major Projects was formerly a biannual publication released in April and October, but became an annual report in 2016.

Source: Department of Industry, Innovation and Science (2019)

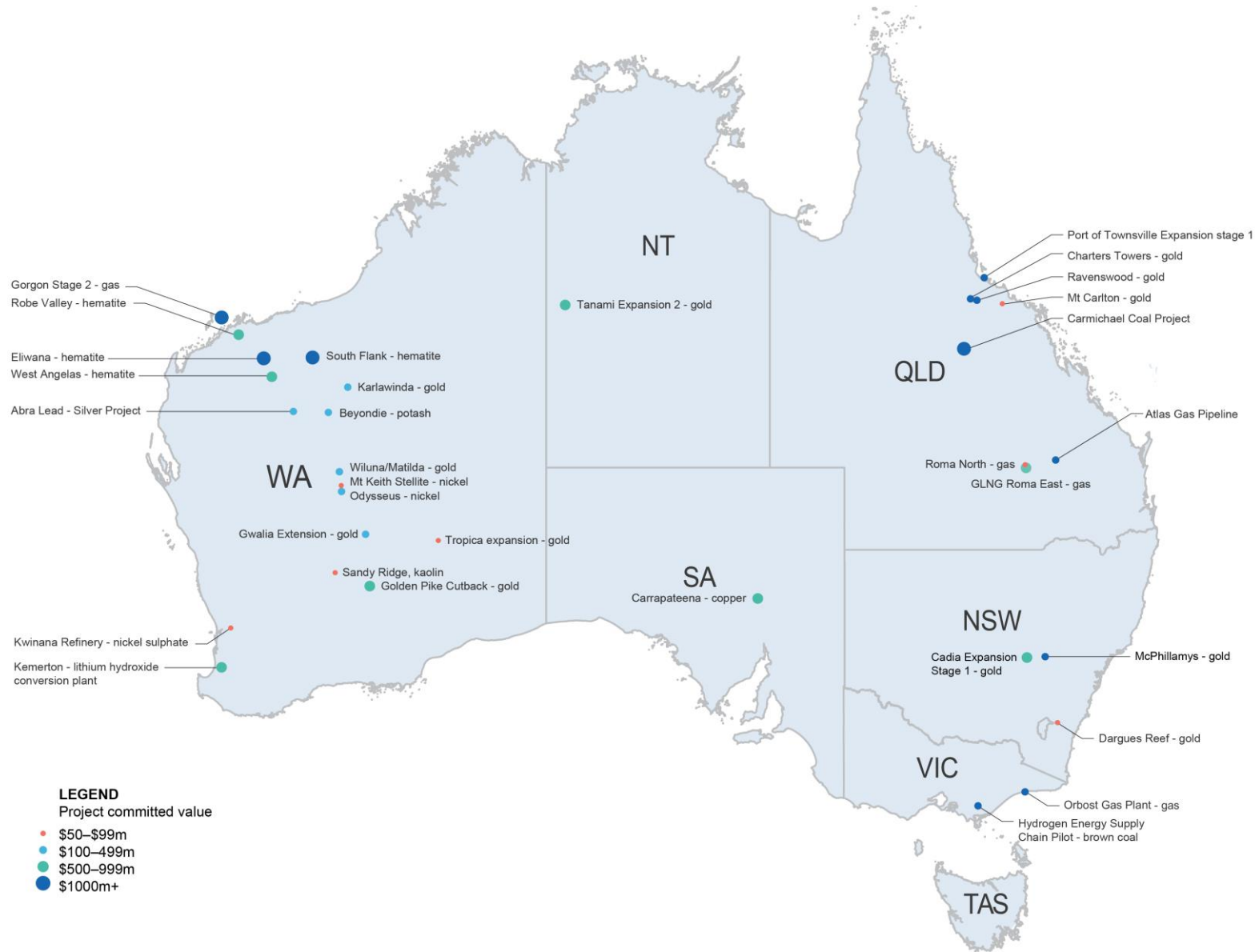
Figure 16.14: Value of committed projects by commodity



Note: **a** Infrastructure is limited to resource and energy related infrastructure projects. **b** Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Innovation and Science (2019)

Image 16.1: Location of projects at the committed stage, as at 31 October 2019



Source: Department of Industry, Innovation and Science (2019)

16.7 Projects at the completed stage

The value of projects at the completed stage declined sharply, as mega LNG projects leave the project pipeline

The value of projects at the completed stage fell sharply, from \$106 billion to just \$9 billion, over the 12 months to October 2019 (Figure 16.15). The decrease in the value of completed projects is due the removal of the last three remaining LNG mega projects from the completed stage — Ichthys, Prelude and Wheatstone — which together represented \$100 billion in investment. Completed projects by state and commodity type are shown in Table 16.7.

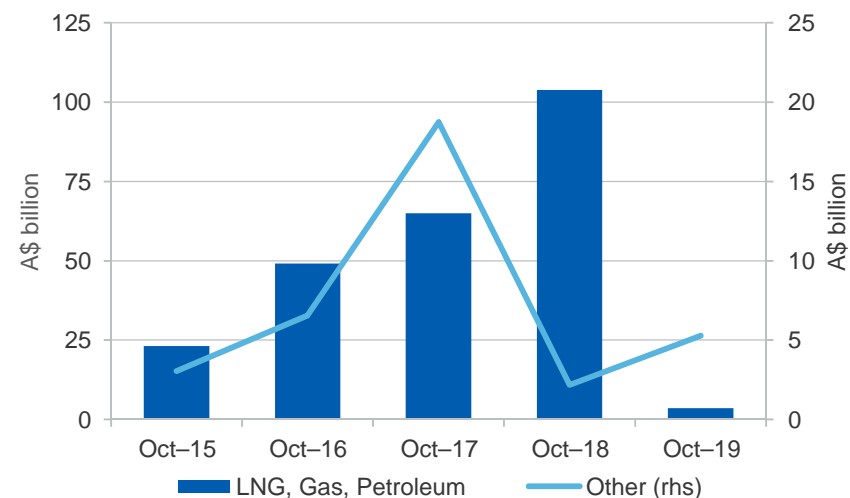
Sixteen resource and energy major projects were completed over the past 12 months (Figure 16.16). The largest of these was Woodside’s \$2.6 billion Greater Enfield oil project, which started producing oil in August 2019. This project is estimated to produce 41,000 barrels a day, roughly 10 per cent of 2018–19 Australian oil production. Another significant completion was Rio Tinto’s \$2.6 billion Amrun bauxite mine in Queensland, which begun production ahead of schedule at the end of 2018.

One gold project that reached completion over the past year was the Gruyere gold project, a joint-venture between Gold Road and Gold Fields, with an estimated capacity of almost 8.4 tonnes a year. OZ Minerals’ Carrapateena copper mine in South Australia also reached substantial completion.

Kwinana Lithium Hydroxide Processing Plant and its associated Greenbushes CGP2 expansion were completed in September 2019. Costs for the Kwinana Plant were understood to be in excess of budget but were not specified. Iluka’s Cataby Sands Project was delivered on time and on budget, whilst Image Resources’ North Perth Basin Project delivered better than expected zircon grades and tonnages. With increased profitability, mine life may now extend beyond five years.

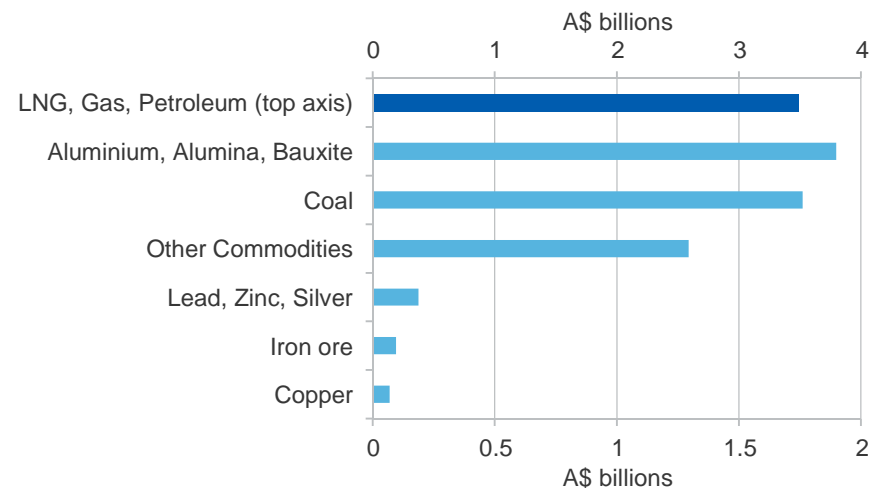
One coal project reached completion, the Byerwen Coal project. It started production in September 2019.

Figure 16.15: Value of completed projects



Source: Department of Industry, Innovation and Science (2019)

Figure 16.16: Value of completed projects by commodity



Note: a Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Innovation and Science (2019)

Table 16.4: Summary of projects at the publicly announced stage, as at 31 October 2019

	NSW		Qld		WA		NT		SA		Vic		Tas		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	2	0.5-1+	11	10-16											13	10-17+
Copper	1	0-0.2			3	1-2+			2	3-5					6	4-8+
Gold					1	0-0.2	1	0-0.2							2	0-0.5
Infrastructure	2	1-2	5	3-5	2	4-7	1	2+							10	10-17
Iron ore					8	8-15+	1	0-0.2	3	4-7			1	0-0.2	13	11-22+
Lead, Zinc, Silver	1	0-0.2													1	0-0.2
LNG, Gas, Petroleum			2	2-3+	5	14-30+	1	5+	1	0-0.2					9	21-38+
Nickel	1	2+	1	0.3-0.5	3	1-2									5	2-5
Other Commodities	1	0-0.2+			2	0.5-1+	2	0.3-1+			1	0.3-0.5			6	1-3+
Uranium			1	0.5-1											1	0.5-1
Total	8	3-6+	20	15-16+	24	28-58+	6	7-9+	6	6-12	1	0.3-0.5	1	0-0.2	66	60-112+

Note: Infrastructure is limited to resource and energy related infrastructure projects. Other Commodities is limited to resource and energy commodities not elsewhere identified. Totals may not add due to rounding at commodity level.

Source: Department of Industry, Innovation and Science (2019)

Table 16.5: Summary of projects at the feasibility stage, as at 31 October 2019

	NSW		Qld		WA		NT		SA		Vic		Tas		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	12	6-10+	34	51-57+											46	58-67+
Copper			1	0.2-0.5	1	0-0.2	1	0.2+	1	0.3-0.5+	1	0.3			5	1-2+
Gold	1	0.2	1	0.1	10	1-2	2	1+	1	0.1					15	2-3
Infrastructure			1	0.3-0.5					1	0.6	1	0-0.2			3	0.9-1
Iron ore	1	3-5			9	12-16+			2	4+					12	19-25+
Lead, Zinc, Silver	1	0-0.2			2	0-0.5	1	0-0.2							4	0-1
LNG, Gas, Petroleum	3	3-6	2	10+	7	21-66	1	5-6			4	0.5-1+			17	40-89+
Nickel			1	0.5-1	2	0.7									3	1-2
Other Commodities	7	2-4+	6	1-2+	25	7-11+	7	3-4+	2	0-0.5+	4	1-2+	4	0.1-1+	55	13-24
Uranium			1	0.4	4	2+									5	2+
Total	25	14-25+	48	64-72+	60	44-98+	12	9-11+	7	5-6+	10	2-4+	4	0.1-1+	166	138-217+

Note: Infrastructure is limited to resource and energy related infrastructure projects. Other Commodities is limited to resource and energy commodities not elsewhere identified.

Source: Department of Industry, Innovation and Science (2019)

Table 16.6: Summary of projects at the committed stage, as at 31 October 2019

	NSW		Qld		WA		NT		SA		Vic		Tas		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			1	2							1	0.5			2	2
Copper									1	0.9					1	0.9
Gold	3	1	3	0.4	5	0.9	1	0.7							12	3
Infrastructure			2	0.3											2	0.3
Iron ore					4	7									4	7
Lead, Zinc, Silver					1	0.2									1	0.2
LNG, Gas, Petroleum			3	9	1	5					1	0.2			5	14
Nickel					3	0.4									3	0.4
Other Commodities					3	0.8									3	0.8
Uranium																
Total	3	1	9	12	17	15	1	0.7	1	0.9	2	0.7			33	30

Note: Infrastructure is limited to resource and energy related infrastructure projects. Other Commodities is limited to resource and energy commodities not elsewhere identified. Totals may not add due to rounding at commodity level.

Source: Department of Industry, Innovation and Science (2019)

Table 16.7: Summary of projects at the completed stage, as at 31 October 2019

	NSW		Qld		WA		NT		SA		Vic		Tas		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	2											1	2
Coal			1	2											1	2
Copper					1	0.1									1	0.1
Gold																
Infrastructure							1	0.2							1	0.2
Iron ore					1	0.1									1	0.1
Lead, Zinc, Silver	1	0.1	1	0.1											2	0.2
LNG, Gas, Petroleum			2	0.5	1	3					1	0.4			4	3
Nickel																
Other Commodities					5	1									5	1
Uranium																
Total	1	0.1	5	4	8	4	1	0.2			1	0.4			16	9

Note: *includes the Northern Gas Pipeline from Tennant Creek in the Northern Territory to Mount Isa in Queensland. Infrastructure is limited to resource and energy related infrastructure projects. Other Commodities is limited to resource and energy commodities not elsewhere identified. Totals may not add due to rounding at commodity level.

Source: Department of Industry, Innovation and Science (2019)

Box 16.1: Windows of Opportunity for Lithium & Rare Earths

Windows of opportunity can open and close quickly in fast changing resource commodity markets. Australian firms have made prudent use of these opportunities in the past. Western Mining seized the initiative with the initial development of the Kambalda nickel mines, south of Kalgoorlie, and more recently, Fortescue achieved very rapid initial ramp-up of Pilbara iron ore.

At present, a window of opportunity exists for Australia in rare earths development, while lithium has undergone contraction and consolidation after price falls. Long-term offtake agreements underpin the development of opaque minerals markets, and have been used by Japan and others in the past. Rare earths markets currently present an opportunity for Australian firms to secure such agreements, and a number of foreign governments and companies have been positioning to lend support.

A window of opportunity has opened in rare earths

Rare earth prices are still strong with forecasts of ongoing strength. But seizing the opportunities presented by volatile commodity prices can be challenging. There are trade-offs to be made in the initial development of projects, in order to capture the window of opportunity on the commodity price. If the initial window is missed, due to complex rather than simpler processing, then the later opportunities for value adding are foregone as well as the initial development. However, simpler processing may not be possible for rare earths, depending on the deposit and customers product requirements.

Hasting Technology has taken advantage of the opportunity of a simpler processing route to get their rare earths project, Yangibana (northeast of Carnarvon), progressed commercially and have secured offtakes with German government backed finance via a proposed offtake partner, Schaeffler. Northern Minerals have also secured German offtake with Thyssenkrupp.

Meanwhile, Arafura Nolans Project (north of Alice Springs) has secured MOU's with Chinese parties for offtake, and is actively seeking additional agreements. Engineering is advancing strongly, and six phases of pilot testing have been completed, with one additional stage of pilot testing to be completed. Iluka's Wimmera minerals sands and Alkane's Dubbo projects are at prefeasibility and pilot plant construction stages.

Initial lithium window of opportunity closing

Developments in the lithium market show how quickly market conditions can become more challenging. The lithium development space has undergone considerable contraction and consolidation as the price for spodumene concentrate has declined by 25-30 per cent over the past 12 months. Greenbushes' CGP2 expansion was completed in September 2019, but further expansion has been delayed. The corresponding Kwinana Lithium Hydroxide Plant (Stage 1) (Tianqi) was completed, but Stage 2 is on hold, after unspecified cost over runs on Stage 1.

Kidman Resources was taken over by Wesfarmers, and the further development of the Mt Holland Mine and the corresponding site at Kwinana for the Lithium Hydroxide Plant face development decisions in early 2020 by Wesfarmers / Sociedad Química y Minera de Chile. Media reports suggest Wesfarmers were recently in discussions with long term offtake partners: LG, Mitsui and Tesla.

Mineral Resources Limited de-risked by selling down Wodgina to Albemarle in a 60/40 Albemarle/Mineral Resources Limited deal. However, operations have now been placed on care and maintenance.

Any window needs to be viewed in the context of Rio Tinto's surprise announcement of a proposed pilot plant to recover 'waste lithium' at its USA Boron Mine. While a pilot plant may add a small supply initially, if successful the approach may be tried elsewhere. Although recycled supply could grow, the possible applications are also growing, as is often the case in emerging fields.

16.8 Methodology

Each year, we collect information about the investment pipeline for major resource and energy projects. Information is gathered from a number of sources, including company websites, Australian Stock Exchange reports, media releases, and from direct contact with company representatives. 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 valued at over \$50 million. Smaller scale operations are also an important contributor to the sector and the broader Australian economy, however gathering data on such projects is challenging, as many are undertaken by private companies, which have fewer obligations to report progress.

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 model of the investment pipeline to measure the potential investment in Australia's resource and energy sectors. Earlier stages of developing mining and energy projects, such as identifying deposits and exploration activities, are not included in the assessment. 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. To qualify for the major projects list that accompanies this report, there must be evidence of project activities that support the likelihood that the project will progress to an FID within the next five years.

The four stages in our investment pipeline model are:

(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. Projects that have stalled in progressing towards an FID, and which are investigating alternative development options, are also classified as Publicly Announced to reflect their longer planning times.

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. To reflect this uncertainty, project costs are quoted as a cost band in the Major Projects list. In most cases, this is based upon an estimate we developed using industry averages for similar construction activities. The cost bands we use in this report for publicly announced projects are:

- | | |
|-----------------------|-----------------------|
| ▪ \$0 – \$249m | ▪ \$1,500m – \$2,499m |
| ▪ \$250m – \$499m | ▪ \$2,500m – \$4,999m |
| ▪ \$500m – \$999m | ▪ \$5,000m+ |
| ▪ \$1,000m – \$1,499m | |

(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 in Australia's resources and energy sectors.

Project ratings

Projects at the publicly announced and feasibility stages can only be viewed as potential investments, as not all projects will progress through to construction.

Resources and Energy Major Projects employs a project-level analysis to provide a profile of future investment. Projects at the feasibility and publicly announced stages are rated as either 'unlikely' (0 – 20%), 'possible' (20 – 60%) or 'likely' (60 – 100%) to progress to the committed stage.

This assessment is based on a range of internal and external factors, as well as market and company commentary. Where data is available, projects are assessed based on their position on the relevant commodity's production cost curve. The timing of when projects are likely to progress to the committed stage is based on schedules announced by the project's developers. Projects that have been assessed as 'unlikely' to proceed are not included in the forward projection of the value of committed investment.

Although assessments are made at a project level, these are not made public in the Resources and Energy Major Projects data set, because some of the information used is treated as commercial in confidence.

(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.

In 2019, we introduce a change to our methodology for tracking capital expenditure associated with Queensland's three LNG projects based around coal seam gas (CSG). Each year, hundreds of CSG wells are drilled in order to sustain gas production to support LNG exports — sometimes this drilling activity is announced as a specific project, but other times it is not. We therefore estimate a level of 'sustaining capex' associated with Queensland's LNG facilities that can be considered 'committed' by virtue of being required to maintain LNG production. This estimate accounts for capital expenditure associated with CSG production that is not already covered by specific projects, such as Arrow's Surat Gas Project.

(4) Completed stage

A project reaches the completed stage when construction and commissioning activities are completed. 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.