

SUN SHINES AT DEGRUSSA

Mid West mine solar project

PROSPECT





Western Australia has experienced unprecedented growth during the past decade, creating new opportunities in resources development and strong partnerships for the future.

Recent expansion of the resources sector in the State's Pilbara region has produced a broader mix that will support continued growth and further development of sustainable communities, and see the region maintain its position as an important contributor to the Western Australian and national economies (story page 14).

The Liberal National Government is focused on building on strong partnerships and opening up future development opportunities.

Expanding opportunities in resources, agriculture and our trading relationships were the focus of a recent Ministerial trade visit to China, our State's largest trading partner (story page 9).

Western Australia has strong trade relationships with our regional neighbours and there are many opportunities to expand our relationships in the State's growth areas, including agribusiness, education and training, and technology, as well as our internationally-renowned resources sector.

The strength of the State's resources sector is based on successful partnerships – between Government, industry and our communities.

The inaugural Community Partnership Resource Sector Award (story page 13) puts these partnerships in the spotlight and provides an opportunity to acknowledge and celebrate our strengths while showcasing the outstanding partnerships which have resulted in mutual and lasting benefits for Western Australia.

Bill Marmion
MINISTER FOR STATE DEVELOPMENT

Sean L'Estrange
MINISTER FOR MINES AND PETROLEUM

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Cover photo: The DeGrussa Solar Power Project was commissioned in June (story page 2).
Photo: Sandfire Resources.

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The DeGrussa Solar Power Project was commissioned in June 2016. Photo: Sandfire Resources.

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SOLAR FLAIR SHINES AT DEGRUSSA

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Western Australia is globally recognised for its ability to develop mineral and petroleum resources.

More than 50 different commodities are mined across the width and breadth of the State.

However, a different type of resource production has more recently captured the attention of the resources industry.

In June, one of the world's largest off-grid solar photovoltaic projects was commissioned at Sandfire Resource's DeGrussa copper-gold mine in the State's Mid West.

The A\$40 million DeGrussa Solar Power Project incorporates 34,080 solar panels and 400 lithium-ion batteries, and will generate more than 10 megawatts (MW) of energy at full capacity.

The solar panels sit on a single-axis tracking system which allows them to move to track the sun during the day.

The panels cover 20 hectares and will help provide 15 per cent of the mine site's power needs.

Sandfire Managing Director Karl Simich said the completion and successful commissioning of the DeGrussa Solar Power Project was a significant achievement.

"This is the largest integrated off-grid solar and battery storage facility in Australia," Mr Simich said.

"It draws together a number of technologies which are widely expected to have a transformational impact on the global economy over the next decade."

This is the first time the technology has been used in a remote location.

Construction of the 10.6MW solar power plant started last year and its completion marks a significant milestone in the use of renewable energy in the mining industry.

"The project has already attracted a significant amount of interest from within the mining industry in Australia," Mr Simich said.

"I would not be surprised to see more facilities like this built over the next few years, as the benefits and potential of solar power become increasingly recognised across the resources industry."

The project is expected to reduce the mine site's annual diesel consumption and cut carbon emissions by more than 12,000 tonnes of carbon dioxide (CO₂) annually.

Mr Simich said this was a reduction of more than 15 per cent.

The project is owned by French renewable energy firm Neoen, and Juwi Renewable Energy was responsible for the project development.

Constructed by OTOC Limited, the project was financed by the Clean Energy Finance Corporation and received A\$20.9 million in funding support from the Australian Renewable Energy Agency (ARENA).

Clean Energy Finance Corporation CEO Oliver Yates said the project demonstrated the potent combination of solar and battery storage and the benefits this brings to remote regions.

“DeGrussa has delivered a unique combination of an off-grid high capacity solar power array and battery storage fully integrated with an existing diesel-fired power station,” Mr Yates said.

“While this development also benefited from grant funding, the project shows the clear economic potential for off-grid renewables in regional and remote Australia.

“With this project now operational, and given the price reductions we are seeing in solar and batteries, the economics of remote solar and storage are becoming attractive even when oil prices are low.”



The project will supply power to the DeGrussa copper-gold mine. Photo: Sandfire Resources.

ARENA CEO Ivor Frischknecht said the successful commissioning marked a turning point for the use of renewable energy in off-grid industries.

“This is a clear example of renewables providing substantial, reliable results for one of Australia’s largest industries,” Mr Frischknecht said.

“The project has achieved a series of firsts. It’s the largest off-grid solar PV system in the world and one of the largest solar plants providing peak power load to a mining operation.

“The project was constructed in 10 months and delivered on budget, despite being located in remote Australia.”

Sandfire’s Managing Director Karl Simich said the successful completion and delivery of the project was a great achievement by the consortium that was formed to finance, develop and implement this state-of-the-art project.

The solar power station is fully integrated with the existing diesel-fired power station to ensure power requirements at the processing plant and underground mine can be met. ■

The DeGrussa Solar Power Project

- 34,080 solar PV panels and 4700 supporting posts installed, covering 20 hectares
- 10.6MW solar generation
- 6MW battery storage
- Full integration with 19MW diesel power station
- Over 70km of electric cable
- Diesel consumption reduced by approximately five million litres per year
- CO₂ emissions reduced by 12,000 tonnes per year



Photo: Sandfire Resources.

DIRECTOR GENERAL TAKES A NEW ROAD



Richard Sellers has been appointed as the new head of the Department of Transport.

The Department of Mines and Petroleum (DMP) has farewelled Director General Richard Sellers after he was appointed as the new head of the Department of Transport.

Mr Sellers said the decision was a difficult one and came with mixed feelings.

“I have enjoyed my time at DMP and it is a great department to work for, but at the same time I am very happy to have been offered the role with the Department of Transport,” he said.

“A move was not something I was actively pursuing, so I was very flattered to be asked to consider it, and it does present as a very suitable next challenge for me.

“Being in a position to be part of delivering big things for the people of Western Australia was the main driver for me to accept the role.

“As Western Australia continues to grow, meeting the State’s transport needs will be increasingly important. I am looking forward to the challenge this presents.

Mr Sellers started his new position with the Department of Transport on 12 September.

Acting Director General Dr Tim Griffin said Mr Sellers had left an indelible mark on DMP.

“Richard has made a significant contribution in his time at the department and has been responsible for delivering critical reforms for Western Australia’s resources sector,” Dr Griffin said.

“This includes reforms to safety and environmental regulation, approval assessments, and online services, amongst others.

“His leadership has been recognised by a number of awards, individual as well as for the department, and his broad experience will be well suited to leading the Department of Transport.” ■

FIRST LIGHT AT THE END OF THE TUNNEL FOR AUSTRALIA’S GEOSCIENTISTS

The jobs outlook for Australia’s geoscientists has shown the first small signs of improvement in two years according to the Australian Institute of Geoscientists (AIG).

AIG figures show that the number of professional geoscientists in Australia seeking work, or unable to secure satisfactory self-employment, fell in the June quarter compared with the preceding period.

AIG President Mike Erceg said this was the first sign of any improvement in the sector since September 2014 and was the first decline in the unemployment and under-employment rates for geoscientists since then.

On a state by state basis, decreases in unemployment and under-employment were evident in all states except South Australia where unemployment remained static.

“The results confirmed the importance of the junior mining and exploration sector, and small consulting/contracting groups which provided 27.1 per cent and 19.6 per cent of roles respectively – almost 47 per cent of all geoscientist jobs in Australia,” Mr Erceg said.

Major exploration and mining companies employ only 19 per cent of geoscientists in Australia – significantly fewer than their junior competitors.



Karratha Gas Plant, North West Shelf Project, Western Australia. Photo: Woodside Energy Ltd.

NEW ERA FOR DOMESTIC GAS MARKETING IN WA

A new gas-supply deal between Synergy, Western Australia's largest energy retailer and generator, and Woodside has signalled a new era in domestic gas marketing in Western Australia.

In July, Synergy and Australian-based oil and gas company, Woodside reached agreement for a spot gas purchasing contract, which provides flexibility between the parties.

State Development Minister Bill Marmion said it was the first direct sale agreement Woodside had executed utilising North West Shelf (NWS) Project gas facilities.

"Since 1984, when domestic gas sales from the NWS started, all gas marketing and

sales have been conducted jointly by the owners of the NWS domestic gas facilities," Mr Marmion said.

"This deal marks a new era for domestic gas marketing in WA as Woodside is now marketing its share directly to larger industrial, commercial and mining gas users from the Woodside-operated NWS Project."

Energy Minister Mike Nahan said there was significant benefit for the State-owned Synergy to be able to enter into short-term agreements directly with Woodside.

"Synergy is able to further strengthen its gas supply position on an as-required basis without having to commit to extensive gas supply agreements," Dr Nahan said.

"It is fitting that Synergy, the NWS Project's first domestic gas customer, is now able to be a counterparty in a first of its kind supply agreement directly with Woodside.

"The State Government welcomes this increased level of competition, which will benefit gas market consumers because there are new sellers in the market. It will also lead to more efficient markets and the best available contract terms and conditions."

The Western Australian Government's domestic gas policy ensures liquefied natural gas (LNG) export projects also make gas available to local consumers. ■



CITIC Pacific Mining CEO Chen Zeng at the Sino Iron project. Photo: CITIC Pacific.

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SINO SIGNALS THE NEXT GENERATION OF IRON ORE FOR WA

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Featuring a 51 gigalitre desalination plant, a 450 megawatt gas-fired power station, a bulk export port and more than 1000 permanent employees, Citic Pacific’s Sino Iron project is a Western Australian magnetite mega-project at Cape Preston, 100 kilometres southwest of Karratha. *Prospect* takes a look at the latest developments of this ground-breaking project.

In July, CITIC Pacific’s Sino Iron project celebrated a significant milestone – the completion of its sixth production line. Each line has nameplate capacity of about four million tonnes per year.

CITIC Pacific Mining CEO Chen Zeng said the company had realised a dream with the completion of the lines.

“This project will deliver significant benefits and value not only to our shareholders but, more importantly, to the Australian iron ore industry and to Western Australia,” Mr Zeng said.

“We still have a lot of work to do but with the significant investments and efforts of the team we have a very solid foundation.”

In building that foundation, the company was required to embark on a significant construction program.

More than 4000 people were involved in building the Sino Iron project.

“We built a large desalination plant with a 51 gigalitre capacity, a state-of-the-art 450 megawatt gas-fired power station and the first greenfield port in the Pilbara for 40 years,” Mr Zeng said.

Then there is the open pit mine and processing facility, but it is the integrated nature of the project that makes it unlike other Western Australian iron ore mines.

“What you see (with the Sino project) is not a typical mine,” Mr Zeng said.

“I recall when coming to this project two-and-a-half years’ ago I would tell my team it’s a manufacturing business.”

While there were undoubtedly challenges in the early days of the project, its more recent progress has been significant.

“With the experience we have learnt, the lines five and six have been completed much quicker and under budget,” Mr Zeng said.

The last two lines were completed more than 200 days ahead of schedule and labelled “a fantastic achievement” by Mr Zeng.

“When construction started, it was the peak of the market and there was a shortage of skilled labour,” Mr Zeng said.

“Our costs were going through the roof, but we were not alone in experiencing those difficulties.

“We have been through that and we have learnt a lot. We also have a team that is very strong and very capable.”

A Sino the times

For 50 years iron ore production has been synonymous with Western Australia’s Pilbara region.

Much of that history has been built on mining hematite, which is exported as direct shipping ore, or DSO.

The Sino Iron project mines magnetite, which is a significant point of difference.

While some believe there are questions about magnetite, Mr Zeng said there were some important advantages, particularly in China where almost 80 per cent of Western Australia’s iron ore is exported to.

“Over the past four decades the grade of Australian iron ore has come down significantly,” Mr Zeng said.

“In the 1970s we were looking at grades in the high sixties (per cent), today we look at high fifties (per cent) on average.

“In the meantime the competition has grown, so Australia is not the only source of iron ore. It is competing with many suppliers.”

Mr Zeng said magnetite offered benefits by providing a consistent grade and a low-impurity product.



The Sino Iron processing facility. Photo: CITIC Pacific.



The bulk export port developed for the Sino Iron project. Photo: CITIC Pacific.



More than 4000 people were involved in building the Sino Iron project. Photo: CITIC Pacific.



Citic Pacific Mining CEO Chen Zeng.

- The project is China's largest-ever investment in the Australian resources sector and is owned by Hong Kong-based CITIC Limited.
- At peak construction, over 4000 people were employed building the project.
- There are more than 1000 permanent employees during operation.
- Production of magnetite concentrate started in late 2012 and the first shipment was sent to China in 2013.
- The Sino Iron project will generate around A\$75 billion in direct revenue to the Australian economy, and A\$3.3 billion in royalties for Western Australia.

“This is a pioneering project CITIC has invested in and, in my view, it will encourage other investors to do similar things.”

“To a certain extent, the high grade of the product can be maintained through the beneficiation process,” he said.

The low-pollutant nature of the concentrate provided another important differential when compared to DSO.

“Pollution is a critical issue for the Chinese economy, and China as a country, but so too is steel production,” Mr Zeng said.

Mr Zeng believes magnetite is one way for China to maintain steel production and still decrease pollution.

Time is right for magnetite

Mr Zeng said while magnetite will not replace DSO, it will be an important part of overall iron ore exports from Australia.

“The Sino iron project delivers a new generation of iron ore production – the size and scale are very meaningful,” he said.

“It also introduces downstream processing and, if you look at the expertise needed to run this plant compared to other typical

iron ore mines, we need very strong manufacturing expertise to manage, maintain and operate this equipment.

“These are the benefits that CITIC brings to Western Australia's iron ore industry.”

Mr Zeng sees Sino Iron as unlike any previous Western Australian iron ore projects.

“Projects like Sino Iron will extend the life of the Pilbara,” Mr Zeng said.

“With the decreasing DSO grade and impurity increase, if Western Australia wants to keep and maintain its competitiveness in global iron ore trading, it needs magnetite mining and processing.

“This is a pioneering project CITIC has invested in and, in my view, it will encourage other investors to do similar things.

“Over time we will see just how much value CITIC has delivered and brought into the iron ore industry in Western Australia.” ■



Media representatives at a special event marking the completion of the sixth production line. Photo: CITIC Pacific.



Agriculture and Food Minister Dean Nalder, State Development Minister Bill Marmion and Assistant to General Manager, China National Petroleum Corporation (CNPC) Wang Shihong, at the premises of CNPC, Beijing.

PROMOTING CLOSER TIES WITH CHINA

Two-way trade between Western Australia and our largest trading partner, China, was valued at A\$58.4 billion last financial year, with the State's exports to China dominated by resources including iron ore.

The valuable two-way trading relationship between Western Australia and China has a long history based on strong ties and partnerships between the two economies and has continued to grow, presenting new opportunities in expanding markets.

Resources, agriculture and promoting closer ties were the focus of State Development Minister Bill Marmion's recent visit to China with Agriculture and Food Minister Dean Nalder.

During the five-day trade visit in July, the ministers met with senior representatives and business leaders in what was their first visit to China since taking up their respective portfolios earlier this year.

Mr Marmion and Mr Nalder visited Ningbo, a port city in China's east, before travelling to the capital, Beijing, for a series of high-level meetings with government and industry.

"While currently our exports are dominated by resource products such as iron ore, there are many opportunities to expand our relationship in areas like agribusiness, education and training and technology," Mr Marmion said.

China is currently Western Australia's largest market for international students, accounting for 12.1 per cent of all international student commencements in Western Australia in 2015.

For the year ending March 2016, the Chinese market was Western Australia's second largest in terms of visitor expenditure and the State's sixth largest in terms of visitor numbers.

China was also Western Australia's largest market for agricultural exports in 2014-15, with agricultural exports to China valued at A\$1.7 billion in 2014-15, led by barley, wool, canola and wheat.

Mr Nalder said the visit to China provided an insight into how Chinese companies viewed Western Australia as a supplier of quality, safe and reliable food.

"Ningbo lies in the Zhejiang Province, which has been a sister state of Western Australia for almost 30 years," he said.

"A number of companies in Zhejiang are working with the cattle supply chain in WA to commence beef exports into China."

While in Ningbo, the ministers toured a construction site where quarantine farms and an abattoir for processing live cattle imports from Western Australia are to be established. They also learned about developments in the Hangzhou Bay New Area and visited Yiheng's facility for live cattle imports from Western Australia.

In Beijing, the ministers met officials from key Chinese ministries including Commerce and Agriculture, as well as representatives from the State-owned Assets Supervision and Administration Commission.

During the visit, Mr Marmion and Mr Nalder also met major Chinese petroleum, resource, agricultural and finance companies investing in, or supporting investment in, Western Australia.

The Western Australian Government operates trade and investment offices in China. For more information visit www.dsd.wa.gov.au ■

WA China trade

- More than half of Western Australia's total merchandise exports went to China in 2015-16. Top export items included iron ore, gold, copper and petroleum.
- Iron, steel and aluminium structures overtook railway vehicles in 2015-16 to become Western Australia's largest import from China.
- Imports of iron, steel and aluminium structures increased from A\$15.3 million in 2005-06 to A\$492.5 million in 2015-16 – due to mining companies and other rail operators importing materials from China.

WA'S MINERAL TREASURE REVS UP INTEREST IN CHINA



Richard Sellers and Gaomai Trench field questions at the Department of Mines and Petroleum booth at the 2016 China Gold Conference.

There was standing room only when Department of Mines and Petroleum (DMP) Director General Richard Sellers stepped up to the podium at a mining investment forum in Beijing in July.

"It was like being a rock star with all the cameras and smart phones being held over people's heads to take photos of the slides we were presenting," Mr Sellers said.

"It would have been a real eye opener for people used to audiences where people politely sit and listen and even frown if someone is chatting.

"If a Chinese audience is keen on what you're presenting, everyone is pointing and taking photos and there's a constant murmuring going on."

Mr Sellers, who travelled to China with DMP Mineral Promotion Manager Gaomai Trench for three days of conferences, forums and meetings, said the country clearly had a growing appetite for Western Australian gold and other mineral resources such as lithium, rare earths, copper, nickel and lead.

The tumultuous reception the Director General received at the Belt and Road Countries Mining Investment Forum on 28 July followed a speech he gave the day before at the opening ceremony of the 2016 China Gold Conference.

"China is the largest gold producer in the world, producing somewhere in the vicinity of 400-450 tonnes of gold annually, but its total consumption is about 950 tonnes, so it needs a lot of gold from other sources," Mr Sellers said.

"If you regard Western Australia as a country rather than a State, it would be the fourth biggest producer of gold in the world.

"We produce about 200 tonnes of gold a year and we are the biggest gold province in the world, so we're sitting on a treasure chest.

"That was what we put on a slide we used in the presentation: Western Australia – the biggest individual gold province in the world – and it certainly captured the audience's attention."

While in Beijing, Mr Sellers attended meetings with private companies and government entities, including the China National Nuclear Corporation, Stone Resources Australia Limited and the China Coal Exploration Bureau.

Underscoring China's shift away from coal, the bureau meeting discussed a wide range of opportunities presented by Western Australia.

The powerfully resourced coal exploration bureau has diversified its interests since it first invested in Australian coal.

"The bureau was tasked with finding enough energy for China, internally and externally, so they invested in some of the massive coal mines on the east coast of Australia," Mr Sellers said.

"Now their focus has grown much wider and they're looking at all energy and industrial minerals, particularly gold and lithium.

"We were only meant to be there for about an hour but we ended up having a two-and-a-half hour meeting."

Mr Sellers said the members of the bureau were very interested in Western Australia's lithium deposits.

"China has massive lithium reserves that are mainly lake-based, but we've got the spodumene hard rock deposits and that is a highly attractive alternative source," Mr Sellers said.

"There was also great interest in our rare earth elements, copper, lead, zinc and particularly nickel, because they see it as being at the bottom of its price curve and ready to rise again."

Mr Sellers said the bureau had obviously done its homework on Western Australia before the meeting, but its members had been surprised by the richness of the State's copper deposits.

"The bureau really appreciated the opportunity to talk to us about a range of investment issues including due diligence, how to select the right project, and how investment is protected through low sovereign risk," he said.

"This is a big, highly resourced organisation employing about 50,000 people and they will definitely be coming here to look at what Western Australia has to offer.

"At the end of the trip, I felt incredibly positive about every single one of the meetings we went to. There could be some very significant investment flowing into Western Australia as a result." ■



PILBARA PROCESSING FACILITY ADDS VALUE AND JOBS

Yara Pilbara Plant Manager Rob Stevens (left) describing the plant to the Premier and Orica's Alberto Calderon. Photo: Yara.

The Western Australian Government is celebrating a major investment in downstream processing, with Premier Colin Barnett opening the Yara Pilbara Nitrates technical ammonium nitrate (TAN) plant in late August.

Mr Barnett said the plant employed more than 500 workers on site during construction and would require about 70 employees for ongoing operations.

"Yara Pilbara has also invested more than A\$50 million in Karratha for residential housing for employees and their families, demonstrating its commitment to the community," he said.

The Premier said the innovative \$US800 million plant integrated with the neighbouring Yara Pilbara Fertilisers plant.

"This new TAN plant will take ammonia from the fertiliser plant and use it to produce up to 330,000 tonnes of ammonium nitrate each year," he said.

"This type of value-adding industry is essential to future economic development of the Pilbara, creating employment and securing local supply of ammonium nitrate for the mining industry."

Located in the Burrup Strategic Industrial Area (SIA) near Karratha, State Development Minister Bill Marmion said the project showed Western Australia remained an attractive place for large-scale international investment.

"Projects can invest with confidence and proceed without unnecessary delays," Mr Marmion said.

"I'm hoping to soon see other value-adding industries develop in the Burrup SIA."

Yara Pilbara Nitrates Pty Ltd is a joint venture between Norway's Yara International ASA (55 per cent) and Orica Ltd (45 per cent).

Ammonium nitrate is a key component of explosives used in the mining and construction industries.

The Burrup SIA is also home to the Yara Pilbara Fertilisers plant, the North West Shelf Venture and the Pluto LNG Project. ■



The Yara Pilbara Nitrates plant. Photo: Yara.

ENGAGING WITH COMMUNITIES



Department of Mines and Petroleum Environment Team Leader Brad Jakowyna (centre) speaking to locals at the Shire of Capel Open Day.

An open day in the South West and an expo in the Mid West of Western Australia were the latest opportunities for the Department of Mines and Petroleum (DMP) to meet with local communities regarding onshore petroleum activities.

Representatives from DMP, Department of Water, petroleum operators, and conservation non-government organisations met with community members in July at the Shire of Capel's Community Open Day.

DMP's Petroleum Executive Director Jeff Haworth said the department was committed to community engagement across the State.

"It is important that local communities are given the opportunity to have open and honest conversations with DMP staff to ensure they have the information they need about the regulation

of petroleum operations throughout the State," Mr Haworth said.

"It is also an opportunity for the department to build a greater awareness of the concerns and questions the community might have."

The Mingenew Mid West Expo in August provided another opportunity for DMP staff to meet with local community members.

"The department hosted an onshore oil and gas information booth at the event which included staff from DMP's Petroleum and Environment Divisions," Mr Haworth said.

"It is particularly important that the Mid West community has information regarding the State's multi-agency regulatory framework around petroleum activities, particularly as much of the State's onshore exploration and production currently occurs within the region."

The Capel Open Day and the Mingenew Mid West Expo both gave the department fresh insights into the key concerns of stakeholders regarding petroleum activities.

"Generally, communities were most interested in land owner rights, impacts on groundwater and the environment, and how the industry is regulated," Mr Haworth said.

This information helps strengthen our assessment and compliance activities and improve our communications with stakeholders.

"We are strongly committed to leading practice regulation of all onshore petroleum development in Western Australia," Mr Haworth said.

"That is why continued stakeholder engagement is a key focus for the department to ensure that communities are consulted and updated regarding proposed activities in their area." ■

WA RESOURCES INDUSTRY LEADERS SHINE UNDER AWARDS SPOTLIGHT

Western Australian resources companies that go well beyond their environmental and social obligations will be in the spotlight at this year's inaugural Awards for Excellence presented by the Department of Mines and Petroleum (DMP).

The Awards for Excellence event in October brings together the prestigious Golden Gecko Environmental Awards for Excellence, established 24 years ago, with the new Community Partnership Resources Sector Award recognising constructive community partnerships providing positive outcomes.

Deputy Director General Michelle Andrews said that by recognising exceptional performance and innovation throughout the resources sector, the department aims to put the spotlight on the best performers and thereby encourage higher standards across the board. Maintaining community confidence in the sustainability of mineral and petroleum activities is critical.

"There is growing public expectation that the resources sector is developed and managed responsibly and sustainably, and that industry is required to adopt world-best practice and operate to high standards that ensure health, safety and the environment are not compromised," Ms Andrews said.

"The Golden Gecko Awards have recognised outstanding environmental excellence for almost a quarter of a century and have been very successful in promoting leading practice and innovation in environmental management.

"For the first time we are now providing a platform to recognise those unique partnerships with the community, which leave a positive legacy and lasting benefits for all involved that extends well beyond gaining a social licence to operate.

"This year's inaugural award has attracted 26 submissions from a variety of unique statewide resource sector and community

partnerships and we are very hopeful this excellent response will see the new award become an equally sought after recognition by industry."

The winner of the new Community Partnership Resources Sector Award will be chosen by the selection committee comprising the DMP Director General and three prominent community leaders:

- Malcolm McCusker AC CVO QC, former WA Governor, barrister and well known philanthropist
- Jan Stewart PSM, former Lotterywest CEO and current board member of several organisations
- Dr Erica Smyth, Chairman and non-executive Company Director who has had 40 years' experience within the mineral and petroleum sectors.

Ms Andrews said the well-respected judges were each in their own right very passionate about community partnerships and social responsibility.

"We are very fortunate to have such a high calibre committee for the 2016 inaugural award, which will be presented on the evening by Minister for Mines and Petroleum Sean L'Estrange. It is set to be a very special event that will set a new bar for the resources sector."

The community partnership award nominations were shortlisted by an assessment panel of representatives from DMP and various State Government departments, universities and the Commonwealth Scientific and Industrial Research Organisation.

The 2016 Awards for Excellence evening will be held on Thursday 27 October 2016 at the Pan Pacific Hotel with finalists' presentations starting at 3pm, followed by the awards presentation from 5pm.

For bookings for the Awards for Excellence or more information about the awards go to www.dmp.wa.gov.au/AwardsForExcellence ■



The Community Partnership Resources Sector Award selection panel Dr Erica Smyth, Malcolm McCusker AC CVO QC and Jan Stewart PSM.



Aerial view of the port of Port Hedland, which now has the largest throughput of Australia's ports. Photo: Pilbara Ports Authority.

EXPANSION AND GROWTH IN THE PILBARA

Despite declines in commodity prices, easing business investment and lower employment levels on some projects across the State as they shift from construction to operation, Western Australia's Pilbara region continues to shine.

Speaking at the recent Hedland Economic and Resources Forum held in Port Hedland, State Development Minister Bill Marmion said the Pilbara was set to maintain its economic growth through the region's natural strengths such as agriculture, aquaculture and tourism, as well as its mineral resources.

Mr Marmion was invited by the Port Hedland Chamber of Commerce to give the opening address at the forum, which was attended by more than 200 business, community and government representatives.

The Minister said the Pilbara region remained vital to Western Australia's economy, with its gross regional product of more than A\$17 billion in 2013 – four times what it was a decade ago.

"While the Pilbara is in the midst of an economic adjustment due to the decline in commodity prices, the growth in diversity of its economic base over the past decade means the region is well positioned to ride out these changes," he said.

"Between 2005 and 2015, more than 10,000 new residents moved to Port Hedland and Karratha, adding their skills and expertise to local industries.

"As of March this year, the Pilbara's unemployment rate of three per cent was still well below the State average, highlighting the resilience of this region's economy."

During the past few years, the Pilbara has attracted a large amount of investment in

The Pilbara region generated A\$69.5 billion of mineral and petroleum sales in 2015

infrastructure, with industry investing in rail, ports and other infrastructure to connect new mines to overseas markets.

The Liberal National Government has supported the ongoing development of the Pilbara, including commitments from resource companies through state development agreements, Royalties for Regions and the A\$1.7 billion Pilbara Cities initiative.

Mr Marmion said investment and the subsequent expansion of assets in the Pilbara had placed the region in a strong position to ride out a period of economic adjustment and maintain growth in the future.

“The Pilbara will continue to be a very important regional economy, the vast majority of Western Australia’s iron ore and liquefied natural gas (LNG) production increases will still come from the Pilbara,” he said.

“As new projects commence operations, iron ore exports from the Pilbara will increase by 86 million tonnes from 2014-15 to 2019-20, after growing by 12 per cent a year over the past decade.

“Port Hedland port now has the largest throughput of Australia’s ports, achieving a record annual tonnage of 446.9 million tonnes in 2014-15.

“The State’s LNG capacity will grow from 26.2 million tonnes a year up to 50 million tonnes a year by 2018 as new projects like Wheatstone and Prelude reach completion.”

Mr Marmion said other resource-related industries were emerging to support the operations of the Pilbara’s expanded

iron ore and LNG sectors, such as specialist manufacturing, equipment and maintenance.

“Commodities will continue to be the mainstay of Western Australia’s – and the Pilbara’s – economy, as the State and the region still have a comparative advantage in minerals and energy,” he said.

“However, increased exports, operational employment, maintenance and services will now play a bigger role.”

Mr Marmion acknowledged that despite its challenges, the economic downturn had brought some benefits to the Pilbara.

“The lower exchange rate that has accompanied falling commodity prices is improving the competitiveness of exports, including those from the non-resource sector,” he said.

“Businesses outside of the resources sector no longer need to compete as strongly for labour and other inputs. This is creating opportunities in other sectors where the region is internationally competitive, including agriculture, aquaculture and tourism.”

Mr Marmion said the high level of mining activity in the Pilbara had created opportunities in technological innovation, construction, and technical and engineering services.

He cited the Woodie Woodie mine dewatering program as an example – where water from dewatering at the mine is being used to irrigate agriculture projects in the region.

Mr Marmion also spoke about his recent visit to Rio Tinto’s Pilbara operations where the company’s advanced

automation work is helping the company to remain one of the world’s most efficient producers of iron ore.

“More than 70 automated trucks are currently working across Rio’s Pilbara operations, and are cutting hauling costs by 13 per cent,” he said.

“Seven fully autonomous drills are also used across the company’s Pilbara operations, using GPS technology to perform precise drilling 24 hours a day.”

Mr Marmion said the use of sophisticated technology in the Pilbara provided an indicator of how well the region was doing and what sort of future could be expected.

“The Pilbara region is experiencing the challenges of the transition from a competitive strategy based on expansion and increased supply, to a competitive strategy based on productivity improvements, cost reduction and innovation,” he said.

“Despite current challenges, I see the Pilbara as having exceptional potential as an increasingly desirable place to live and work.

“The recent expansion of the resources sector has provided a legacy for the Pilbara, which the region can build on to maintain its position as an important contributor to the State and national economies.

“While the resources sector will continue to be the mainstay of the economy for many decades, the region will develop a broader mix of sectors and will continue to grow and develop sustainable communities.” ■

Opportunity abounds in Pilbara agriculture and aquaculture

The United Nations Food and Agriculture Organisation has projected that world food production needs to increase by 70 per cent by 2050 to meet global demand.

State Development Minister Bill Marmion said the Pilbara’s close proximity to Asia, coupled with its long history of livestock production and existing role supplying cattle to Indonesia and Malaysia, meant the region was well positioned to supply an expanding beef export market.

Mr Marmion said the State Government was supporting the expansion of the agricultural sector in the Pilbara into different agricultural products, including through the A\$12.5 million Pilbara Hinterlands Agricultural Development Initiative, as well as a Pilbara Algae Site Study.

“The Pilbara has a suitable climate for aquaculture and good conditions for algae production means there are opportunities to expand the aquaculture sector,” he said.

“The Pilbara Algae Site Study identifies seven Pilbara sites for commercial aquaculture projects, including three in Port Hedland.”

More information on agriculture and food investment in Western Australia is available on the Department of State Development website at www.dsd.wa.gov.au



Rio Tinto's West Angelas operation. Photo: Rio Tinto.

NEW IRON ORE DEPOSITS TO BE DEVELOPED

The Western Australian Government recently approved two proposals by mining giant Rio Tinto to develop new iron ore deposits in the Pilbara region, which will prolong the life of existing mining operations, help maintain production levels and boost job numbers.

State Development Minister Bill Marmion said the projects would deliver both short and long-term benefits for the State.

"This is great news for the resources sector and great news for jobs," Mr Marmion said.

"These approvals will allow Rio Tinto to maintain its current level of production at two sites, Yandicoogina and West Angelas."

The Minister gave approval under the *Iron Ore (Yandicoogina) Agreement Act 1996* for Rio Tinto Group company Hamersley Iron-Yandi Pty Ltd to mine and develop the

Oxbow deposit, with ore to be processed at its existing facilities at Yandicoogina.

Mr Marmion said this would extend the Junction Central, Junction South West and Junction South East deposits so that operations could be sustained at around 60 million tonnes per annum.

"This represents a capital commitment of \$247 million and the project will have a peak construction workforce of 220 people," he said.

"The interesting thing about the Yandicoogina mine is that it actually uses autonomous trucks.

"These trucks are controlled out of the company's operations centre at Perth Airport, resulting in less downtime and reduced risk of injuries, giving iron ore production in Western Australia an edge."

Rio Tinto has 71 autonomous trucks in the Pilbara, which helps make Western Australia one of the most cost-effective producers of iron ore in the world.

The Minister also gave approval for the Rio Tinto and Robe River Iron Associates joint venture to mine Deposit F at West Angelas.

"I was pleased to also approve under the *Iron Ore (Robe River) Agreement Act 1964* for Rio Tinto and its Japanese joint venture partners, Mitsui Iron Ore Development, Nippon Steel Australia and Sumitomo Metal Australia, the West Angelas extension to move to deposit F, which extends deposits A, B and E," Mr Marmion said.

"This will maintain operations at 35 million tonnes per annum.

"It is very important to extend West Angelas because it contains a Marra Mamba ore. This type of ore is important in the blending

process to maintain a high-quality iron ore product through to the Japanese and Chinese markets," he said.

The Minister said this \$120 million project would create 120 construction jobs and an extra 20 positions once operational.

Yandicoogina began operations in 1998 and is located 90 kilometres northwest of Newman. West Angelas, located between Newman and Tom Price, began operations in 2002.

Mr Marmion said the two Rio Tinto proposals together are worth \$367 million in capital expenditure, will create 340 construction jobs and help maintain the sustainability of the two mine sites into the future.

Western Australia is the largest iron ore producer in the world, accounting for 37 per cent of global production and 49 per cent of global iron ore exports in 2014.

The Pilbara region accounted for 94 per cent of Australia's iron ore production in 2015.

China is the world's largest steel producer and iron ore consumer and Western Australia's largest export market (accounting for 81 per cent of the State's iron ore exports in 2015), followed by Japan (9 per cent), Korea (7 per cent) and Taiwan (2 per cent). ■



Yandicoogina, Pilbara. Photo: Rio Tinto.



West Angelas, Pilbara. Photo: Rio Tinto.

The two Rio Tinto proposals together are worth \$367 million in capital expenditure, will create 340 construction jobs and help maintain the sustainability of the two mine sites into the future.



One of Rio Tinto's autonomous trucks. Photo: Rio Tinto.

RESOURCES DATA PROVIDES A DETAILED PICTURE

Analysis of longer term data paints a more detailed and complex picture about the state of Western Australia's resources industry. This is in contrast to recent media headlines highlighting job losses, drops in revenue and the "end of the mining boom".

Take employment for example. In 1995 the total number of people employed in Western Australia's mining industry was 35,191.

In 2015 it reached 105,381 or almost triple the number employed in the industry just two decades ago. (See chart 1)



Chart 1. The number of people employed in WA's mining industry 2001-2015.

Western Australia's population has also grown significantly in that time. In 1995 the State's population was 1.7 million and the number employed in the mining sector represented two per cent of the total population.

In 2015 Western Australia's population reached 2.5 million and the number employed in the mining sector had doubled to four per cent of the total population.

This is testament to the amount of growth the industry has seen, particularly in the last 10 years. It also provides some context to commentary around the current state of employment in the mining industry.

Similar trends can be found when analysing royalties, exploration expenditure and the value of resource production.

In 2000, royalties contributed just over A\$1 billion to State revenue. Last year, it was A\$5.17 billion. (See chart 2)

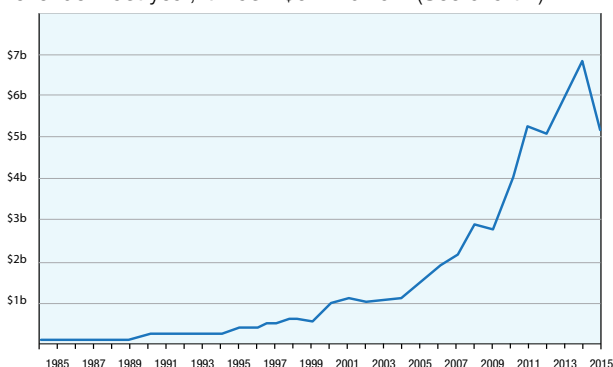


Chart 2. WA mining and petroleum royalty revenue 1984-2015 (\$A).

Although exploration expenditure has dropped across the board, Western Australia is still, by far, the leading State for attracting exploration dollars despite the recent drop in overall expenditure. (See chart 3)

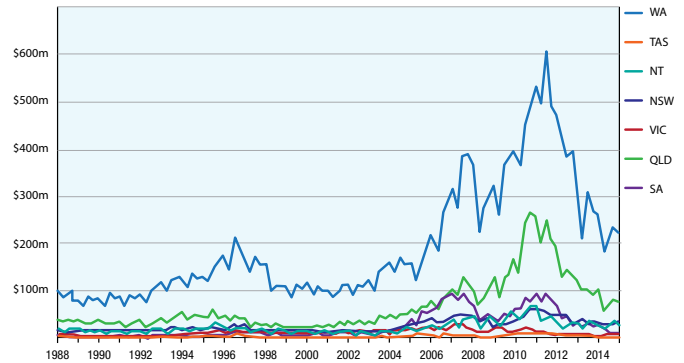


Chart 3. Australian exploration expenditure 1988-2015 (\$A).

The value of minerals and petroleum produced in Western Australia is another reminder of the contribution of the resources sector to our economy.

In 1995, the value of mineral and energy production in Western Australia was A\$14.6 billion. In 2015, it was A\$91.3 billion. (See chart 4)

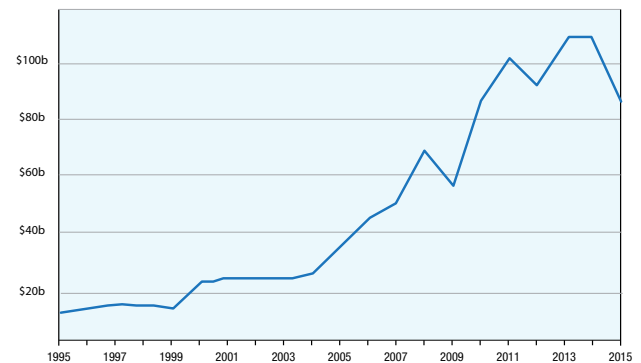


Chart 4. Value of mineral and petroleum production in WA 1995-2015 (\$A).

While there is no doubting the impact of low commodity prices on Western Australia's resources industry, longer term statistics show just how much growth there has been, particularly over the past two decades.

It is also an indication of the relative historical strength of Western Australia's current position, despite the challenging economic conditions confronting the industry.

All the statistics used in this article are available from the Department of Mines and Petroleum website at www.dmp.wa.gov.au/lateststatisticsrelease ■



Mine closure short course delegates at the Pro-Force abandoned mine site near Coolgardie.

AFRICAN DELEGATION FOCUSES ON MINE CLOSURE AND REHABILITATION IN WA

Western Australia's regulatory framework for mine closure and rehabilitation was a key focus for 25 delegates from 14 African nations visiting WA in July.

The delegates were taking part in a seven-week international short course on mine closure funded through the Australian Government as part of the Australia Awards scholarships and fellowships program.

The Department of Mines and Petroleum (DMP) was actively involved in the course delivered by Murdoch University in collaboration with Curtin University, The University of Western Australia, and North West University in Potchefstroom, South Africa.

DMP Environment Executive Director Dr Phil Gorey, who joined the delegates on a tour of mine sites facilitated by the department, said the course had been tailored for mid-career mining professionals from Africa working for government, industry and non-government organisations.

"The course exposed participants to cutting edge practice in socially and environmentally responsible mining," Dr Gorey said.

"The training course is designed to develop understanding of mine closure planning and implementation across the life cycle of mining activity.

"Western Australia is well-placed for the course to be delivered, given its leading practice in the regulation of mine closure."

The visiting government and environmental regulators came from Cameroon, Côte d'Ivoire, Ghana, Kenya, Lesotho, Liberia, Madagascar, Malawi, Niger, Nigeria, South Africa, Tanzania, Zambia and Guinea.

Dr Gorey said that the delegation's four-week stay in Western Australia coincided with preparations for Africa Down Under, the annual Africa resources conference held in Perth at the beginning of September.

"DMP has built strong ties with Africa underpinned by a Memorandum of Understanding signed between Western Australia and the 19-member regional trading bloc, the Common Market for Eastern and Southern Africa (COMESA), in January 2014," Dr Gorey said.

"We're working with African nations to develop their mining laws, tenement systems, and environmental and safety standards to levels similar to those in Western Australia."

While in Western Australia, the delegation toured Hansen's Gaskell basic raw materials mine in north metropolitan Perth, Tronox's Coojarloo mineral sands operations and Newmont's Boddington gold mine.

"The delegates greatly appreciated the companies' involvement and being able to see leading practice in mine closure in action and to discuss the integration of mine closure planning directly with industry," Dr Gorey said.

Dr Gorey also joined the visitors for a tour of the Pro-Force abandoned mine site near Coolgardie, now being made safe and rehabilitated through the Mining Rehabilitation Fund.

A second three-week part of the course will take place in South Africa in November. ■

A SHIFTING WORLD



Google testing a self-driving car in 2014.

In fifteen million years from now the Australian continental tectonic plate will have travelled about one thousand kilometres to the north.

That might seem many years away, but Australia is moving northeast by about seven centimetres each year, colliding with the Pacific Plate, which is moving west about 11cm each year.

Because of moving tectonic plates, geospatial coordinates measured in the past continue changing over time.

And that has ramifications for anything that relies on GPS, including driverless cars and mining trucks, satellite farming and, of course, mining exploration licences.

As a result, adjustments are required to the Australian datum and coordinate system.

The spatial representation for exploration licences is a geographical coordinate set using the Geocentric Datum of Australia 1994 (GDA94), comprising latitudes and longitudes.

Rather than a continuous change, datum changes are made at certain agreed times.

A change of around 200 metres occurred in 2000, when Australia changed from the Australian Geocentric Datum 1984 to the GDA94 datum.

Another change of 1.8 metres is currently being planned for introduction in 2017 with coordinates based on geospatial position estimates in 2020.

The Department of Mines and Petroleum's Mineral Titles Division has begun preparing for the introduction of this new GDA2020 spatial datum.

The GDA2020 will be an update from the current GDA94 datum and will compensate for the geological movement of the Indo-Australia tectonic plate forecast to its position in the year 2020.

This movement is very slow, about as fast as your fingernails grow.

Over time this very slow movement will result in significant distances, which degrades the accuracy of locations described using an old datum.

This type of datum update is small at only 1.8 metres, compared to the 200 metres shift in the year 2000.

As the datum shift is much smaller, and looking to the future where location precision and accuracy are becoming ever more important, the department's Mineral Titles Division will investigate whether a similar approach to the datum shift, as in the past, is appropriate to repeat, or if there is a better way.

The GDA2020 datum update will affect how tenements are referenced.

The Mineral Titles Division's top priorities are managing the update smoothly and maintaining certainty of tenure for all tenement holders.



Surveyors will need to use the new coordinate system.

The department will soon be seeking input from stakeholders about the datum upgrade and the options being considered to manage it, and will continue to keep stakeholders informed at key stages as the project progresses.

Leading the implementation of the new datum is the Intergovernmental Committee on Surveying and Mapping's (ICSM) GDA Modernisation Implementation Working Group.

The Working Group consists of representatives from Geoscience Australia, the Royal Australian Navy, and State Government agencies, working closely together to formulate the modernisation of Australia's datum, thus closing the gap and avoiding problems in the future.

This time around, technology is playing a big role.

At the moment smart devices, including mobile phones, have to adjust everything because the current information doesn't line up with the actual physical position.

With the applications that are coming for intelligent transport systems, like driverless cars and mining trucks, if you are 1.5m out then you're in another lane – the consequences are obvious.

If driverless cars and trucks are to become more commonplace the datum has to be updated.

Other areas that will require the new coordinate system are precision agriculture – or satellite farming – and surveying.

The new datum will seek to future proof Australia by using coordinates of its projected 2020 location.

If you would like more information on datum modernisation, visit www.icsm.gov.au/.

If you need further information on the department's involvement please email the Mineral Titles Division at gda2020@dmp.wa.gov.au ■



An autonomous haul truck in the Pilbara. Photo: Rio Tinto.



GSWA PLAYS IMPORTANT ROLE IN INTERNATIONAL SCIENTIFIC DISCOVERY

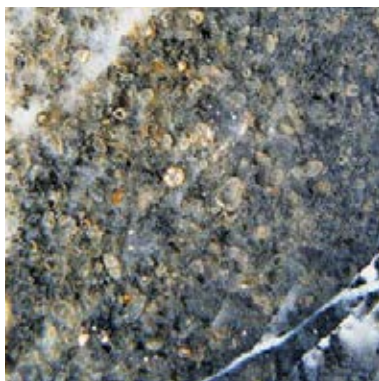
Dr Arthur Hickman and a slide from Marble Bar showing a band of asteroid impact spherules that can be seen clearly under a microscope.

Proof of an unrecorded ancient asteroid impact with Earth caused intense academic interest and media excitement around the world earlier this year, making headlines in publications as diverse as Science Daily and the Daily Mail.

The Geological Survey of Western Australia (GSWA) was closely involved in the discovery of the event which occurred 3460 million years ago and figured prominently in a scientific paper on the breakthrough.

Veteran senior geoscientist Dr Arthur Hickman, who found the Hickman Crater in the Pilbara in 2007, and the paper's lead author Dr Andrew Glikson of the Australian National University (ANU), discovered evidence of a massive unrecorded asteroid strike while the pair examined drill core at GSWA's Core Library in Perth.

The asteroid is the second oldest known to have hit the Earth and is one of the largest.



A thin section (about 3cm wide) of the spherules.

The evidence in the core, taken from a collaborative drilling project in Marble Bar in 2003, is seen as layers of tiny glass spherules, similar to beads.

"Finding the spherules was just the first step because we then had to prove they were formed by an asteroid impact," Dr Hickman said.

"Scientific analysis of the spherules also involved GSWA's Chris Kirkland (now at Curtin University) and Sandra Romano, and took more than a year to complete."

Other scientists from Curtin, Geoscience Australia, ANU, and Seoul National University, also worked on the study.

"In the end, all the evidence revealed that the Marble Bar spherules were formed by the impact of a giant asteroid between 20 to 40km across", Dr Hickman said.

"By comparison, the asteroid that wiped out the dinosaurs 66 million years ago was quite small.

"If an asteroid 20 to 40km across, such as the largest present asteroid Eros, hit the Earth today it would have catastrophic effects, not only at the impact site but globally.

"In the first few seconds it would form a crater hundreds of kilometres across and tens of kilometres deep.

"It could break through Earth's crust, resulting in massive volcanic eruptions.

"All across Earth it would trigger major earthquakes, fires, and giant tsunamis hundreds of metres high.

"The Earth would then remain in total darkness for many months and most life would be extinguished, probably all life on the surface."

Dr Hickman said that no-one knew the site of the original impact.

"These impact spherules are formed in the atmosphere by crystallisation of the condensed rock and asteroid vapour produced by the impact and they were deposited globally, so the impact could have been anywhere on Earth," he said.

"When an asteroid crashes into the Earth – everything sprays up and gets in the atmosphere – like volcanic dust after a big eruption."

Dr Glikson, who has been hunting ancient asteroid impacts for more than 20 years, was drawn to the notoriously hot area west of Marble Bar, ironically named North Pole, because he believed impact spherules would be found in sedimentary rocks there.

However, as Dr Hickman points out, rather than braving the heat ("I've been there when it was 50 degrees in the shade") and tough conditions at Marble Bar, it made more sense to drive to the suburb of Carlisle and look at the drill core.

"We couldn't have done it without the core library," Dr Hickman said.

"The only place to see these impact spherules is at Carlisle, because if you go to Marble Bar where the main outcrops of chert (sedimentary rock) are, the level with the spherules is not exposed.

"It probably explains why nobody has found them before, because geologists and tourists have been swarming over the chert outcrops at Marble Bar for a hundred years looking at the rocks for all sorts of reasons, but never found any spherules."

Dr Hickman, fellow GSWA senior geoscientist Dr Sandra Romano and former GSWA officer Dr Chris Kirkland, now an Associate Professor at Curtin University, worked on the paper published in the July 2016 issue of Precambrian Research. ■



NEW BIODIVERSITY INSTITUTE PROMISES CLARITY

Protecting Western Australia's rich biodiversity while enabling economic development should be easier in the future thanks to a new scientific institution.

The Western Australian Biodiversity Science Institute (WABSI) is a partnership between government departments, industry, and research bodies.

WABSI Chief Executive Officer Peter Zurzolo said the institute would provide a way for improved access to good information, which would lift the level of public debate and discussion about biodiversity conservation.

"One of the most exciting things about WABSI is that it has been created with broad consultation across all interested parties and its formation has been welcomed by all," Mr Zurzolo said.

"The Australian continent is one of the most biologically diverse areas on Earth, and Western Australia hosts the majority, and some of the most important, of Australia's biodiversity assets.

Western Australia is home to eight of Australia's fifteen declared biodiversity hotspots, including the South West which is an internationally recognised biodiversity hotspot.

"There are vast numbers of species in WA, with more being discovered and formally named all the time. For example, there are about 13,000 species of native plants in the State," Mr Zurzolo said.

There are more than 500 reptile and 1600 fish species, as well as hundreds of thousands of invertebrate species.

"Our biodiversity is not only rich in number, but also in uniqueness – of the 141 species of mammal found in WA, 25 are found nowhere else, while around 60 per cent of our plant species are unique to WA," Mr Zurzolo said.

"Protecting this natural wealth while enabling the State's vibrant mining and agricultural sectors to flourish is a challenge – a challenge that often leads to controversy and conflict.

"Yet all major stakeholders – researchers, industry, conservationists and government – agree that improved access to good information is the key to more constructive debate and better decision making.

"WABSI will provide the knowledge platform required to enable the delivery of more targeted and timely advice to prioritise and manage WA's terrestrial biodiversity.

"Development and biodiversity can co-exist, but only with robust scientific information that can be used by decision makers to avoid and minimise impacts and, where necessary, develop complementary management strategies."

WABSI has been established as an independent entity, overseen by a representative board and administered by a small executive team.

The State Government, through the Department of the Premier and Cabinet, is providing start-up funds for the institute. Its initial funding is for five years.

Foundation partners in the collaborative venture are The University of Western Australia, Curtin University, Murdoch University, Department of Parks and Wildlife, CSIRO, Environmental Protection Authority, Department of Mines and Petroleum, Botanic Gardens and Parks Authority, and WA Museum. ■

MODELLING CCS IN THE SOUTH WEST

The South West Hub Carbon Capture and Storage (CCS) project reached another important milestone with the completion of storage modelling and simulation studies.

The project is investigating the potential to inject captured carbon dioxide deep into the ground for long term storage.

Focussing on areas in the Harvey and Waroona Shires, Department of Mines and Petroleum Carbon Strategy Coordinator Dominique Van Gent said the project had generated a lot of interest.

“Validation of the South West Hub storage concept will substantially increase the number of geological sites that can be considered for safe storage around the world,” Mr Van Gent said.

“There is significant international interest in the project field and research activities.”

It has been a long journey to get to this stage. The department first started investigating the potential for CCS in the South West in 2007.

In 2011, the project was designated as a ‘flagship project’ by the Commonwealth Government.

Mr Van Gent said that while the technology of carbon storage was proven, it was critical to increase our knowledge of the local sub-surface geology.

“While we know CCS works, we need to be able to prove that it works in this particular geological setting,” he said.

“We have taken a methodical approach to investigating the local geology to determine if it is suitable for CCS,” he said.

The project has been divided into distinct phases.



Geological Survey's Senior Geologist Sarah Martin compares core against logging data.

Building a geological model

To build the model for the South West Hub project, the following evaluations were undertaken:

- Detailed petrophysics studies for the four available wells, with integration of core data
- Geomechanical rock property analyses and considered the rock properties, the stress field and fault orientations. Results were used to define injection pressure constraints for the Dynamic Models
- An image log interpretation for determining the facies or geobody orientation that was used in the Static Model
- Well correlation panels were prepared for facies, porosity and permeability.

“The project can only move onto the next phase once we are confident that the current phase demonstrates the continued scientific viability of the project,” Mr Van Gent said.

The first phase of the data acquisition program involved gathering new geological data through a 100km 2D survey and the drilling of a deep exploration well to 2945 metres.

“The analysis of this data supported CCS,” Mr Van Gent said.

The next phase of the development program acquired 3D seismic data over 115km² and three wells were drilled to further enhance geological data.

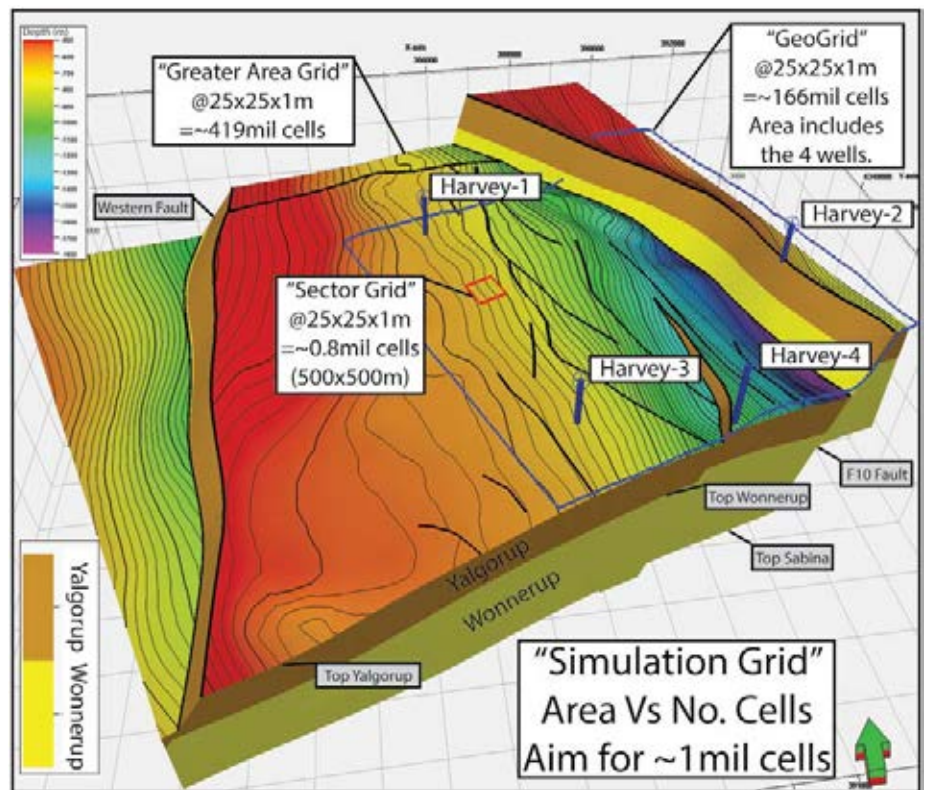
Following the acquisition of the data and core from the seismic and drilling programs a detailed geological model was developed.

Mr Van Gent said that once the model was constructed it was critical to run simulation studies to help visualise how any CO₂ injected in the future may move within the storage area.

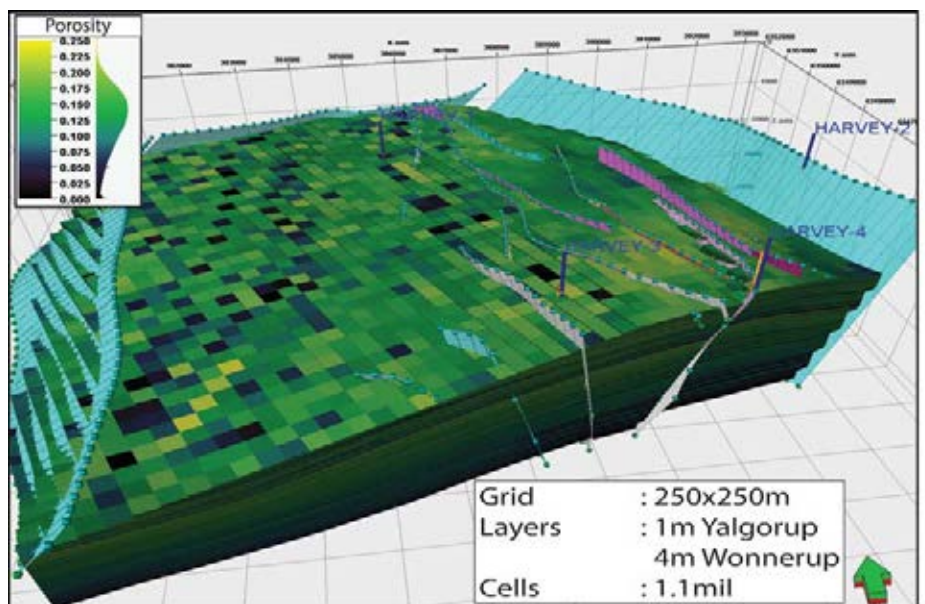
“The result of these studies provides confidence that CO₂ will stay within the storage complex for at least 1000 years,” Mr Van Gent said.

“The results of the modelling show that it could be feasible to inject and safely store 800,000 tonnes per year of CO₂ over 30 years.”

Mr Van Gent said that while further work needs to be undertaken to address remaining geological uncertainties, the feasibility of the project continues to be demonstrated by the work that has been done to date. ■



Construction of a modelling grid. Source: Odin Reservoir Consultants Pty Ltd.



Coarse scale model showing porosity distribution. Source: Odin Reservoir Consultants Pty Ltd.



The Tropicana Gold Mine was one of the first Lead Agency Projects to start production.

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FOLLOW THE LEADER

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Western Australia is currently positioned as a highly attractive investment destination for the resources industry, much of which can be attributed to significant improvements and reform to the State's approvals processes during the last seven years.

It all started in late 2008 when the newly elected State Government identified problems with resource sector project approvals and announced a range of approval reform initiatives to address them.

An Industry Working Group was established to identify these problems and make recommendations to government.

The group's chair was former Resources Minister Peter Jones and the final report was delivered to the government in April 2009.

Mr Jones was blunt in his assessment of the State's approvals system.

"It has deteriorated to where it is criticised for taking too long, being too costly, too bureaucratic, "process driven" rather than being focused on outcomes, and not always representing the objectives of the elected government," he said.

"We can no longer boast of our approval system being the best in Australia."

Mr Jones' views were backed up by Western Australia's slide down the Fraser Institute's Annual Survey of Mining Companies.

Western Australia was once ranked as a national leader, but by 2009 it had fallen behind the likes of South Australia, Queensland and the Northern Territory in the Institute's annual survey.

The State was also identified as a "high risk" for investment in industry publication Resource Stock's 2009 World Risk Survey.

Department of Mines and Petroleum Senior Advisor Graham Cobby worked closely with Mr Jones and the working group that was reviewing the approvals process.

"There was a lot of uncertainty surrounding the State's approvals processes at the time," Mr Cobby said.

"The main criticisms were about the lack of clarity, the lack of certainty, the absence of a whole of government approach and the amount of time it was taking to go through the approvals process.

"When the current government came into power in late 2008, reforming the approvals system was high on its agenda."

The working group handed down its report in April 2009 and recommended sweeping changes.

Approval timeline targets, tracking and a review of existing collaboration between government agencies were all part of the group's recommendations.

So too was the development of the lead agency concept.

"The Lead Agency Framework offers a single point of entry and assigns one department to assist and coordinate approvals for a project," Mr Cobby said.

"In the beginning people didn't quite understand how it worked.

"That's why we put a lot of effort towards providing clarity around responsibilities."

The Department of Mines and Petroleum was subsequently recognised as the lead agency for mining, petroleum and geothermal, and carbon capture and storage projects.

This meant the department provided approval coordination support across government.

Resource projects were assessed against set criteria and ranked as either a level one, two or three project.

“Ninety-five per cent of projects were typically level one,” Mr Cobby said.

“This meant they were relatively straight forward and were provided with online approvals tracking and other basic assistance from the department.

“Level two and three projects have increased complexity and strategic significance to the State – so they require additional assistance.”

Since the Lead Agency Framework was announced in 2010, there have been 22 projects assessed as level two or three.

This assessment is not necessarily based on the size of the project or the commodity being targeted.

“One example would be Tropicana,” Mr Cobby said.

The Tropicana gold mine in the Eastern Goldfields poured its first gold bar in 2013 and in late 2015 celebrated its one millionth ounce of gold production.

It was also one of the first designated lead agency projects.

“There are a lot of gold mines in Western Australia so that alone is not particularly significant,” Mr Cobby said.

“But a gold mine that is 330 kilometres east of Kalgoorlie and has the potential to open up resources in a highly underexplored region is strategically significant.”

It also helped that it was one of the State’s largest greenfields discovery for a number of decades and today is Australia’s fourth largest gold mine.

Another Lead Agency project Mr Cobby highlights as strategically significant is the recently completed Eastern Goldfields Gas Pipeline extension.

“A piece of infrastructure like the Eastern Goldfields pipeline – that’s a very significant piece of infrastructure,” Mr Cobby said.

“Not only does it deliver gas to Tropicana, it also provides opportunities for other mines and projects which otherwise might not be viable without access to a low-cost energy supply.

“It’s the kind of project that opens up more opportunities for Western Australia.”

Over the six years that the Lead Agency Framework has been in place, the most important aspect has been ensuring good relationships throughout the process.

“The Department of Mines and Petroleum helps coordinate approvals, it doesn’t tell the other agencies what to do,” Mr Cobby said.

“We have to work across agencies for a lot of projects so we have to have good relationships – from the proponents to the lead agencies and the approval agencies.

“In many ways, the lead agency role is a role of diplomacy.”

Part of that diplomatic role is managing expectations.

“Once a project is assessed as a level two or three project, we hold a decision-making authority meeting,” Mr Cobby said.

“This brings together the relevant decision making authorities and the project proponents to map out the project approvals that are required.

“It allows all the information to be upfront and creates clear expectations around who is responsible for what.”

Projects are then monitored to assess if it is in front, on or behind schedule.

“It is important to have a system of accountability behind it and allows us to address potential resourcing issues and identify priorities,” Mr Cobby said.

Reviewing the project once it’s completed has also been critical.

“Once a project has been completed we get together with the proponent to discuss what was good and what could have been done better,” Mr Cobby said.

“This has been positive and, importantly, has given us constructive feedback about how we can do things better.”

In the seven years since the State Government announced its plans to reform approvals, Western Australia has now returned to its nation-leading position for investment in the resources industry.

Earlier this year the Fraser Institute Annual Survey of Mining Companies ranked Western Australia the number one global jurisdiction for attracting investment.

“It is an indication that we have made considerable improvements to Western Australia’s approvals system,” Mr Cobby said.

“The Lead Agency Framework is one part of those reforms, and it is important we continue to look at ways to make further improvements and not rest on our laurels.” ■



A seismic survey being conducted as a part of the South West Hub Carbon Capture and Storage Project, one of the projects that has benefited from the Lead Agency Framework.



Professor Russell Jones, Dr Martyn Cross and Dr Marcus Cattani from Edith Cowan University are using safety data from the Department of Mines and Petroleum in a series of research projects.

MINING DATA TO IMPROVE SAFETY

A series of innovative research projects analysing mining industry incident data will enhance our understanding of the causes and associated mitigating controls.

Department of Mines and Petroleum (DMP) Investigation Services General Manager Dr Colin Boothroyd said the department was keen to find out what extra knowledge and lessons could be gleaned from this data.

“Edith Cowan University (ECU) has proposed three projects,” Dr Boothroyd said.

“One intends to analyse the data to identify types and frequencies of injuries and use this to shape the education curricula for emergency response in aeromedical retrieval and, from 2017, occupational paramedicine.”

This project, led by ECU Professor Russell Jones, will analyse the incident data to assist the development of training for mine site paramedics and Royal Flying Doctor Service personnel.

Professor Jones leads the Emergency Services Research Group and said he was delighted to have access to this data.

“It represents the actual needs of industry for the training of paramedics and emergency personnel,” he said.

“We will see the benefit of this research in our new and updated courses straight away”.

ECU researchers also intend to develop statistical models from the safety data that will assist industry to forecast the risk of injuries.

Dr Marcus Cattani is developing and testing a series of analytical processes which aim to make use of the historical data to model the current and potentially the future likelihood of incidents.

“I think our research project offers some new ways of interpreting the data, which we are optimistic will benefit health and safety performance in this industry,” Dr Cattani said.

Analysis of incident data to assist industry identify preventative strategies is the subject of the research project being conducted by the third ECU researcher, Dr Martyn Cross.

Dr Boothroyd said the department had provided ECU and the University of Western Australia (UWA) with the same data set that was analysed in the serious injury report published by DMP in 2015. All company and personal identifiers have been removed to make the data anonymous.

Based on this initial data set UWA are proposing to obtain insights into hazards, injuries and contributing factors by analysing the text in the narrative descriptions.

The project at UWA is led by Professor Mark Griffin and Dr Wei Liu and will apply recent advances in the analysis of large text databases to provide new insights about safety from written accident reports.

The analysis will also provide guidelines about the kind of information that is most useful to include in reports.

"Extremely rich information is contained within the descriptive reports of accidents and incidents," Professor Griffin said.

"However, different ways of describing similar events, and the complexity of natural language, have made it difficult to extract useful information from these reports.

"Recent advances in language processing are now unlocking this potential and will be useful for all those interested in improving safety.

"While the proposals are still being finalised, the final research and findings will be presented to industry as part of the continual improvement of safety in the industry."

Dr Boothroyd said the department was also developing a Hazard Register.

"This will summarise information from the 64 fatalities that have occurred since 2000 and identify hazardous tasks and the 12 occupational groups most at risk," he said.

"This information will also be communicated to industry."

Mines and Petroleum Minister Sean L'Estrange has welcomed the collaborative projects.

"I am particularly interested in data analysis which could identify trends in causes of mine deaths and near misses, so we can further improve our mines safety inspection regimes," Mr L'Estrange said. ■

- For more information about the ECU research contact Professor Russell Jones – russell.jones@ecu.edu.au or Dr Marcus Cattani – m.cattani@ecu.edu.au or Dr Martyn Cross m.cross@ecu.edu.au
- For more information about the UWA research contact Professor Mark Griffin – mark.griffin@uwa.edu.au



Serious Injury Analysis report

In August 2015, the Department of Mines and Petroleum released an analysis of more than six hundred serious mining injuries to improve our understanding of injury risks and causes in Western Australia's mining industry.

The department analysed 658 serious injuries, including three fatalities, reported by the mining industry during a six month period from 1 July to 31 December 2013.

The analysis follows on from the department's review of 52 fatal accidents in the mining industry between 2000 and 2012.

The key objective of both these reports was to develop a better understanding of the injury risk profile of the State's mining industry.

The serious injury review and the fatal accident review both have independently identified the three main hazards for all employees.

They are falling while working at height, being in the line of fire for objects or suspended loads, and being struck or crushed by machines and heavy components.

Selected serious injury data was shown to be statistically consistent over a period of ten years, and will be used to establish baseline standards for monitoring the effectiveness of fatality prevention strategies.

Both reports are available to download on the department's website at www.dmp.wa.gov.au.

AGRICULTURE**East Kimberley – Ord – Ord/East Kimberley Expansion Project****WA STATE GOVERNMENT**

The State Government has invested \$322m to construct irrigation channels, roads and off-farm infrastructure to encourage private investment in irrigated agriculture on the Ord lands in the East Kimberley Region. Kimberley Agricultural Investment (KAI), a subsidiary of China's Shanghai Zhongfu Group, is developing 13,400ha of irrigation land in the Goomig and Knox Plain areas. KAI is seeking to establish a sugar industry in the Kununurra region, subject to future land availability, and in the short term is producing chia and sorghum. The State has recently released a further 5,000ha of Ord West Bank and Mantinea lands to KAI and TFS, established producers of sandalwood.

Expenditure: \$322m.

AMMONIUM NITRATE**Pilbara – Yara Pilbara Nitrates****YARA INTERNATIONAL ASA**

Yara Pilbara Nitrates Pty Ltd (YPN) is an incorporated joint venture between Yara International ASA (Yara) and Orica Limited (Orica). YPN has executed an Engineering, Procurement and Construction contract for the construction of a world class circa 330,000tpa Technical Ammonium Nitrate (TAN) plant located on the Burrup Peninsula. Ammonia feedstock will be supplied from Yara Pilbara Fertilisers Pty Ltd which owns and operates its facility directly adjacent to the proposed location for the new TAN plant. Yara will be the operator of the TAN plant and Orica will manage the product sales and distribution of the TAN product. It is intended that the manufactured product will be sold into the Pilbara region.

Expenditure: \$800m.

Employment: Construction: 500; Operation: 65

IRON ORE**Pilbara – Roy Hill Iron Ore Mine & Infrastructure****ROY HILL HOLDINGS PTY LTD**

The Roy Hill Iron Ore Project is located 115km north of Newman and owned by Roy Hill Holdings Pty Ltd, a private company majority owned by Hancock Prospecting Pty Ltd, with key international investment partners. Capital expenditure for the project was \$10b. Roy Hill took operational control of the mine, rail and port infrastructure from EPC contractor Samsung C&T on 4 February 2016, and signed off on project practical completion on 27 May. Roy Hill is currently ramping up to full name plate production capacity of 55Mtpa, with shipments steadily increasing and achievement of the 55Mtpa target is anticipated by the end of 2016. The project is planned to produce high grade ore for 20 years following ramp-up. The project consists of a multiple pit mining operation, mine processing infrastructure, a 344km heavy haul railway, and significant new port facilities at the Port Hedland inner harbour.

Expenditure: \$10b.

Employment: Construction: 5300; Operation: 2000

IRON ORE PROCESSING**Pilbara – Cape Preston – Sino Iron****CITIC PACIFIC**

The Sino Iron project is located at Cape Preston, 100km south west of Karratha. When completed, it will be the largest magnetite mining and processing development in Australia, with a mine life of more than 25 years. The first shipment of magnetite concentrate to China occurred in late 2013. Since then, optimisation of the first four production lines has occurred. Line commissioning of lines five and six commenced in May 2016. On completion, the project will comprise in-pit crushers, a 29km slurry pipeline, a pellet plant and annual capacity to produce up to 24 million tonnes of magnetite concentrate. The downstream processing facility has required significant investment in dedicated supporting infrastructure including a new port facility, a 51 gigalitre desalination plant and a 450 megawatt combined cycle gas fired power station.

Expenditure: \$11.1b.

Employment: Construction: 4000; Operation: 1000

OIL & GAS DEVELOPMENTS**Carnarvon Basin – Greater Western Flank Phase 1****WOODSIDE ENERGY**

The Greater Western Flank Phase 1 Project will develop the Goodwyn GH and Tidepole fields, via a subsea tie-back to the existing Goodwyn A Platform. First gas was produced from the Goodwyn GH field in late 2015 with further production from the Tidepole field expected from early 2017.

Expenditure: \$2.5b.

OIL & GAS DEVELOPMENTS**Carnarvon Basin – Greater Western Flank Phase 2****WOODSIDE ENERGY**

The Greater Western Flank Phase 2 Project will develop 1.6 trillion cubic feet of raw gas from the combined Keast, Dockrell, Sculptor, Rankin, Lady Nora and Pemberton fields via a 35km subsea tie-back to the existing Goodwyn A platform. Initial project start-up is expected in the second half of 2019.

Expenditure: \$2.8b.

Carnarvon Basin – Persephone Project**WOODSIDE ENERGY**

Woodside Energy Ltd, as operator of the North West Shelf Joint Venture is developing the Persephone gas field. The development involves two subsea wells and an 8km subsea tieback to the existing North Rankin Complex.

Fabrication activities and offshore brownfield work has commenced, with start-up expected in early 2018.

Expenditure: \$1.2b.

Carnarvon Offshore Basin – Barrow Island – Gorgon Project**GORGON JOINT VENTURE**

The Gorgon Foundation Project on Barrow Island, now in its seventh year of construction, is a three train LNG development with a nameplate capacity of 15.6Mtpa and includes a domestic gas plant capable of delivering at least 300TJ/d of gas to the mainland. Cost estimates for the project construction are expected to total more than A\$55b. The project involves the processing of gas from both the Gorgon and Jansz/lo gas fields and includes potentially the largest commercial CO₂ geosequestration project in the world. Train one start up and first shipment of LNG commenced in March 2016 with trains two and three being commissioned later in the year.

Expenditure: \$55b.

Employment: Construction: 8000;

Operation: 300

Pilbara – Wheatstone LNG Development**CHEVRON AUSTRALIA PTY LTD**

Chevron Australia Pty Ltd as Operator of the Wheatstone Project is currently working towards the construction of two LNG trains, a domestic gas plant and port facilities at the Ashburton North Strategic Industrial Area near Onslow.

The Project will initially produce 8.9Mtpa of LNG and have a 200TJ per day domestic gas plant connected to the Dampier-to-Bunbury Natural Gas Pipeline. The Project is targeting first LNG by mid-year 2017.

Expenditure: \$29b.

Employment: Construction: 7200;

Operation: 400

POWER STATIONS**Boodarie Industrial Estate – South Hedland Power Station****TRANSALTA**

In July 2014, TransAlta Energy (Australia) Pty Ltd announced it will build, own and operate a 150 megawatt power station in South Hedland's Boodarie Industrial Estate. The plant will consist of a combined cycle gas plant, featuring both natural gas and steam turbines. The A\$570 million investment will help meet the future energy needs of the region through a 25-year agreement with both Horizon Power and Fortescue Metals Group. The plant is being designed to allow for expansion and there is a possibility that other customers may be added in the future. Construction activities are on schedule and the commissioning phase of the project has started, with an expected completion of mid-2017.

Expenditure: \$570m.

Employment: Construction: 250; Operation: 20

AGRICULTURE

East Kimberley – Project Sea Dragon

SEAFARMS GROUP LIMITED

Seafarms Group is a Queensland based producer of farmed prawns. Seafarms proposes to invest up to US\$1.45b over the next eight years in Project Sea Dragon, a large scale, integrated, land based aquaculture project to produce black tiger prawns for export markets in Asia. The aquaculture component of the project will be located in the Northern Territory and is planned as a staged development commencing with Stage 1, 1,000 hectares of ponds and supporting infrastructure with an estimated capex of A\$150million. In Western Australia a founder stock and quarantine centre is proposed for Exmouth, a processing plant is proposed for Kununurra, and subject to competitive tender Wyndham port will be utilised for export and import. The project will create approximately 300 jobs in the Kimberley during construction, 150 direct jobs at Stage 1 building to 700 direct jobs when fully operational. A Final Investment Decision on Stage 1 of the project is expected at the end of 2016 and financial close shortly thereafter.

HEAVY MINERAL SANDS

Shark Bay – Coburn Zircon Project

STRANDLINE RESOURCES LIMITED

Strandline proposes to develop the Coburn zircon project, located south of Shark Bay and approximately 250km north of Geraldton. It contains total ore reserves of 308Mt at an average grade of 1.2 per cent heavy minerals, all of which lie within the portion of the project area that has received government environmental approvals for mining. At a mining rate of 23.4Mtpa, the project is expected to produce 49,500tpa of zircon, 109,000tpa of chloride ilmenite and 23,500tpa of a mixed rutile-leucocoxene over its 19 year mine life. The company has secured all of the approvals required to commence mining and processing operations at Coburn, and is continuing to pursue discussions with parties interested in becoming a strategic partner in the project. Expenditure: \$173m.

Employment: Construction: 170; Operation: 110

INFRASTRUCTURE

Bunbury – Multi-User Bulk Terminal Facility – Port of Bunbury

LANCO RESOURCES AUSTRALIA PTY LTD

Lanco Resources Australia Pty Ltd proposes to construct a 15Mtpa multi-user bulk terminal facility located at the Berth 14A site within the inner harbour of the Port of Bunbury. The facility will include ship loading for up to 85,000 tonnes, fully covered and dust suppressed conveyor galleries, a storage shed, with internal stacker reclaimer, up to 750m LOA, 140m wide and 40m high. The train unloading and rail loop load in facility will be able to accommodate coal, iron ore, bauxite and other bulk ore materials. The Terminal will have capacity to expand. Environmental approvals have been obtained for the project.

Expenditure: \$400m.

Employment: Construction: 750; Operation: 100

Dampier Peninsula – Browse LNG Precinct

WA STATE GOVERNMENT

The State Government is developing the Browse Liquefied Natural Gas (LNG) Precinct approximately 60km north of Broome. By focussing development at a suitable location, the Precinct will minimise the environmental footprint of gas processing and any social impacts in the region while maximising opportunities for the local community to benefit from development of the Browse Basin gas fields. The Precinct will have the capacity to accommodate at least two LNG processing operations, with a combined capacity of up to 50Mtpa. The State Government has acquired the land for the Precinct and will secure all relevant approvals to ensure the Precinct is 'project ready'.

IRON ORE

Pilbara – Balla Balla Infrastructure Project

BALLA BALLA JOINT VENTURE

The Balla Balla Infrastructure project proposes to construct and operate a 165km railway connecting the Flinders Mines Ltd's Pilbara Iron Ore Project, located in the central Pilbara as its foundation customer, to a proposed transshipment and stockyard facility at Balla Balla, situated midway between Karratha and Port Hedland.

Expenditure: \$2.8b.

Pilbara – West Pilbara Iron Ore Project

API MANAGEMENT PTY LTD

The Australian Premium Iron Joint Venture is proposing to develop the West Pilbara Iron Ore Project. Stage 1 of the project is based on the production of 40Mtpa of direct shipping iron ore from deposits, including Red Hill and Mt Stuart deposits, located 35-80km south west of Pannawonica. The ore is proposed to be transported by a 282km heavy haul railway for export via the proposed multi-user port at Anketell. State and Federal environmental approvals for the mine, rail and port elements of the project are in place. Subject to the successful completion of feasibility studies, and receipt of final regulatory approvals, the company anticipates construction to commence following a decision to proceed by the joint venturers and completion of funding arrangements.

Expenditure: \$6.8b

Employment: Construction: 3500; Operation: 900

OIL & GAS DEVELOPMENTS

Canning Basin – Buru Canning Basin Tight Gas

BURU ENERGY

The Buru Energy/Mitsubishi joint venture (JV) is appraising the commercial potential of the Laurel Formation, a large onshore natural gas resource located in the Canning Basin. Following the successful completion of the 2015 tight gas stimulation program on and near Noonkanbah Station, Buru commissioned DeGolyer and MacNaughton, a specialist tight gas and unconventional resource assessment consulting group to undertake an independent assessment of the gas and liquids potential of the Laurel Formation in the Valhalla area. This independent assessment has confirmed that the region contains a nationally significant multi TCF wet gas accumulation. Future on ground works will provide additional contracting, employment and training benefits to Noonkanbah Community who have been heavily involved in on-ground works to date.

Expenditure: \$40m.

Employment: Construction: 100; Operation: 30

URANIUM

Northern Goldfields – Yeelirrie – Yeelirrie Uranium

CAMECO AUSTRALIA PTY LTD

Cameco Australia proposes to develop the Yeelirrie project in the North-eastern Goldfields, near Wiluna. The project entails open cut mining of shallow deposits of uranium ore, treatment in a plant to be established at the site, and development of associated infrastructure. The project will process up to 2.4Mtpa of uranium ore over about 17 years. The resultant uranium oxide will be transported to South Australia by road for export to overseas markets. The environmental assessment process is in progress. Cameco will advance the project at a pace aligned with market conditions.

Employment: Construction: 500; Operation: 225



Significant resource projects in Western Australia

Western Australia continues to lead the way as Australia's premier resources investment destination. There are more than A\$120 billion worth of projects either committed or under consideration for the State during the next few years. These would create more than 30000 construction jobs and more than 5000 permanent jobs.

This section is intended as an overview and does not constitute an exhaustive list of projects within the Western Australia resources industry. Based on company announcements.

Significant Projects as at September 2016

	Project Value (estimated A\$m)	Employment	
		Construction	Permanent
Iron and Steel			
API Management Pty Ltd – West Pilbara Iron Ore Project	6800	3500	900
CITIC Pacific – Cape Preston Mine & Processing Projects	11100	4000	1000
Roy Hill Holdings Pty Ltd – Roy Hill Iron Ore Mine & Infrastructure	10000	5300	2000
Sub Total	27900	12800	3900
Oil, Gas and Condensate			
Browse LNG Precinct	n/a	n/a	n/a
Buru Energy – Buru Canning Basin Tight Gas	40	100	30
Chevron – Wheatstone LNG	29000	7200	400
Gorgon Joint Venture Gas Processing Project	55000	8000	300
Woodside Energy – Greater Western Flank Phase 1	2500	n/a	n/a
Woodside Energy – Greater Western Flank Phase 2	2800	n/a	n/a
Woodside Energy – Persephone	1200	n/a	n/a
Sub Total	90540	15300	730
Other			
Cameco Australia – Yeelirrie Uranium	n/a	500	225
Lanco Resources Australia Pty Ltd – Multi-User Bulk Terminal Facility – Port of Bunbury	400	750	100
Ord East Kimberley Expansion Project	322	n/a	n/a
TransAlta – South Hedland Power Station	570	250	20
Yara International ASA – Yara Pilbara Nitrates	800	500	65
Sub Total	2092	2000	410
TOTAL	120532	30100	5040

All currency figures are in Australian dollars unless otherwise specified.

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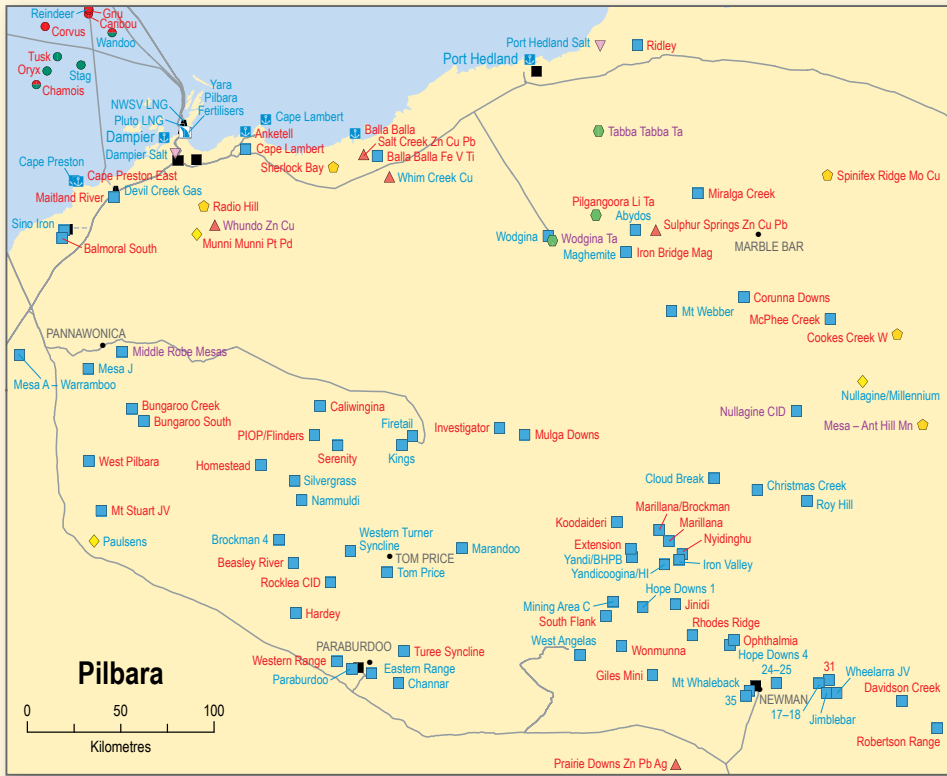
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Abbreviations Key

b	billion	m	million
EPC	Engineering, Procurement and Construction	Mt	million tonnes
GL	gigalitres	Mtpa	million tonnes per annum
ha	hectares	MW	megawatts
JV	joint venture	t	tonnes
km	kilometres	THM	total heavy mineral
LNG	liquefied natural gas	TJ	terajoules
LOA	length overall	tpa	tonnes per annum



Mineral symbols		Commodities	
◆ Precious metal	Au (or as shown)	Ag..... Silver	
◆ Steel alloy metal	Ni (or as shown)	Au..... Gold	
◆ Speciality metal	Ti-Zr (or as shown)	Chert..... Chert	
▲ Base metal		Cu..... Copper	
▲ Iron		Fe..... Iron	
▲ Alumina	All sites are bauxite	Hem..... Hematite	
● Coal and lignite		K..... Potassium	
▽ Industrial mineral		Li..... Lithium	
▲ Processing plant		LNG..... Liquefied natural gas	
— Oil / gas pipeline, operating		LPG..... Liquefied petroleum gas	
- - - Oil / gas pipeline, proposed		Mag..... Magnetite	
■ Power plant		Mica..... Mica	
■ Irrigation / water / desalination		Mn..... Manganese	
■ Port		Mo..... Molybdenum	
		Ni..... Nickel	
		Pb..... Lead	
		Pd..... Palladium	
		Phos..... Phosphate	
		Pt..... Platinum	
		REE..... Rare earth elements	
		Sid..... Silica sand	
		Ta..... Tantalum	
		Ti..... Titanium	
		Tlc..... Talc	
		V..... Vanadium	
		W..... Tungsten	
		Zn..... Zinc	
		Zr..... Zirconium	

Data for offshore Commonwealth controlled waters is up-to-date as of February 2016. Enquiries for latest information for Commonwealth controlled waters is available from the National Offshore Petroleum Titles Administrator (NOPTA) at <info@nopota.gov.au>

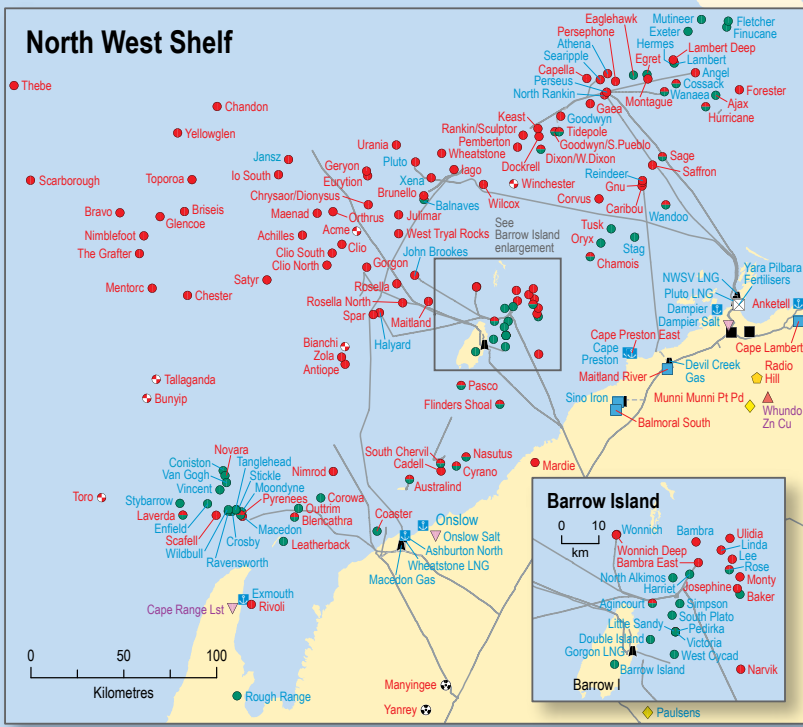


Project labels:
 Projects operating or currently under development with an actual or anticipated value of production greater than A\$10 Million are shown in blue
 Proposed or potential projects with a capital expenditure greater than A\$20 Million are shown in red
 Projects under care and maintenance are shown in purple



Kwinana-Rockingham	
⊠	Alumina refinery
⊠	Ammonium nitrate
⊠	Bulk terminal
⊠	Cement and lime
⊠	Chlor alkali
⊠	Desalination
⊠	Fused alumina
⊠	Fused zirconia
▲	LNG
▲	LPG
▲	Nickel refinery
▲	Oil refinery
▲	Power plant
▲	Sodium cyanide
▲	Titanium pigment
▲	Zirconia

North West Shelf



Major Resource Projects

September 2016

Project labels:

Projects operating or currently under development with an actual or anticipated value of production greater than A\$10 Million are shown in blue

Proposed or potential projects with a capital expenditure greater than A\$20 Million are shown in red

Projects under care and maintenance are shown in purple



Commodities

- Ag..... Silver
- Au..... Gold
- Co..... Cobalt
- Cu..... Copper
- Dmd..... Diamond
- Fe..... Iron
- Fl..... Fluorite
- Gp..... Gypsum
- Gr..... Graphite
- Grt..... Garnet
- K..... Potassium
- Kn..... Kaolin
- Lst..... Limestone
- LNG..... Liquefied natural gas
- Mag..... Magnetite
- Mn..... Manganese
- Nb..... Niobium
- Ni..... Nickel
- Pb..... Lead
- Pd..... Palladium
- PGE..... Platinum group elements
- Pt..... Platinum
- REE..... Rare earth elements
- Ti..... Titanium
- V..... Vanadium
- W..... Tungsten
- Zn..... Zinc
- Zr..... Zirconium

Mineral symbols

- ☆ Precious mineral
- ◇ Precious metal
- ◇ Steel alloy metal
- ◇ Speciality metal
- ▲ Base metal
- Iron
- Alumina
- Coal and lignite
- Uranium
- ▽ Industrial mineral
- ⊠ Processing plant

Petroleum symbols

- Gas field
- Oil field
- Oil and gas field
- Significant gas discovery
- Significant oil and gas discovery
- ▲ Processing plant
- Oil / gas pipeline, operating
- Oil / gas pipeline, proposed

Infrastructure

- Power plant
- ▽ Irrigation / water / desalination
- Port

Data for offshore Commonwealth controlled waters is up-to-date as of February 2016. Enquiries for latest information for Commonwealth controlled waters is available from the National Offshore Petroleum Titles Administrator (NOPTA) at <info@nopta.gov.au>



Government of Western Australia
Department of Mines and Petroleum