

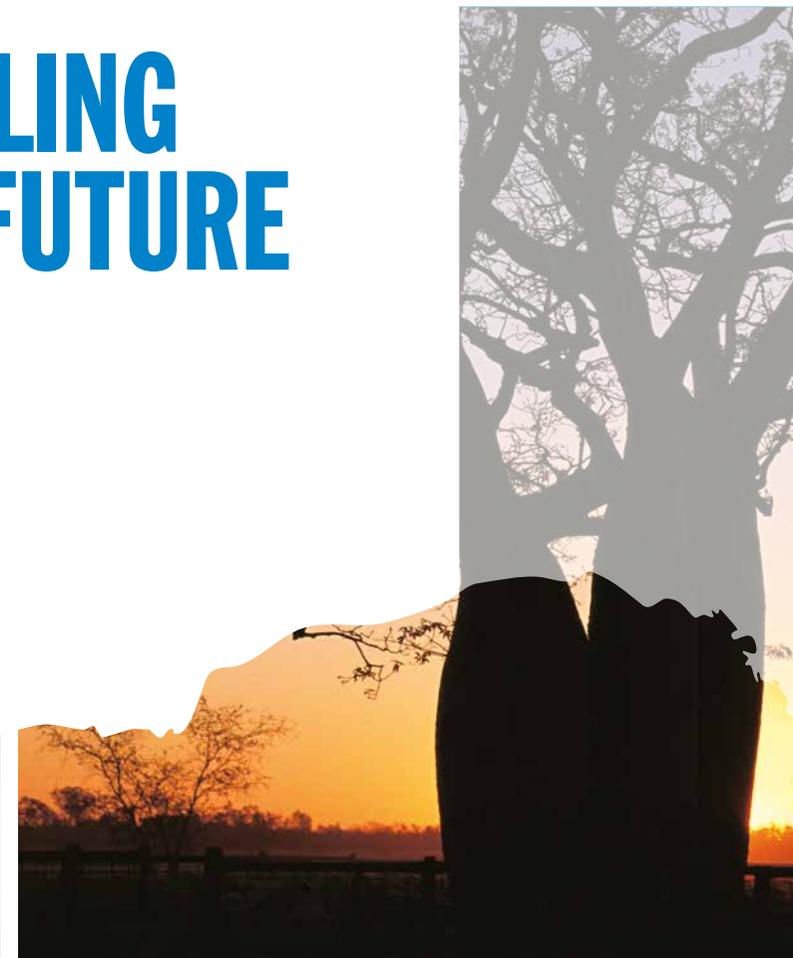


GOVERNMENT OF  
WESTERN AUSTRALIA



**WESTERN  
AUSTRALIA'S LNG:**

**FUELLING  
THE FUTURE**



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*North Rankin Complex,  
photo courtesy Woodside Energy*



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# PREMIER'S FOREWORD

Western Australia's liquefied natural gas industry is reaching a new phase of maturity as major projects reach completion. The State's annual production capacity of LNG is forecast to more than double from 20.6 million tonnes in 2014, to almost 50 million tonnes by 2018.

This production is set to make the State one of the world's largest exporters of LNG, creating opportunities in maintenance, research and technological innovation.

Our capital city, Perth, is already home to significant global innovation centres for companies including Chevron, Shell, GE Oil and Gas, KPMG and IBM, as well as more than 800 companies servicing the oil and gas sector.

Western Australia's LNG industry is also bolstered by our proximity to major consumers of LNG, including Japan, Korea and China, well-established trading relationships, and a shared business time zone with 60 per cent of the world's population.

The State Government is a strong supporter of the LNG industry, which plays a vital role in the community and economy, employing thousands and supplying vital gas.

Perth has also undergone a dramatic cultural transformation over the past decade, mirroring the rapid development of the resources sector. Major projects have redefined the city skyline and an influx of new bars, restaurants and public spaces have created a new vibrancy for residents and visitors.

As the Premier of Western Australia, I invite you to explore the opportunities our LNG industry and our State have to offer.



**Hon Colin Barnett MLA**  
Premier of Western Australia





Elizabeth Quay, photo courtesy George Nuich

# WESTERN AUSTRALIA

Western Australia is Australia's largest State, with a land area of 2.5 million square kilometres – almost seven times larger than Japan, and four times the size of Texas or France.

Our State is richly endowed with mineral resources, natural beauty and a diverse climate. With a Mediterranean climate in the south, desert in the east and tropical conditions in the north, Western Australia has something to offer visitors all year round.

Western Australia also presents constant economic opportunities with hundreds of billions of dollars committed to new resource projects across the State. Other areas of strength include medical research, marine studies, radio astronomy and agriculture, with more than 90 million hectares of agricultural land.

Much of Western Australia's vast land mass is sparsely populated, with about 78 per cent of the State's 2.6 million residents living in and around the capital city of Perth. Despite its relatively small population, Western Australia is highly diverse, with residents drawn from all over the world by our climate, lifestyle and economic opportunities.

More than one-third of Western Australia's population was born overseas, the highest proportion in Australia. Our residents represent 190 nationalities and speak 270 languages.



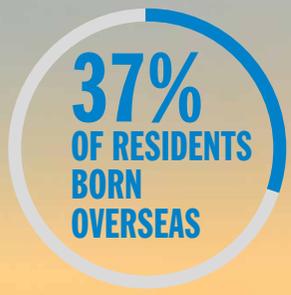
*Perth CBD view from Kings Park, photo courtesy Steve Kirk Photography*



**78%**  
OF WA RESIDENTS LIVE IN  
AND AROUND PERTH CITY

**2.6** RESIDENTS IN  
MILLION WESTERN AUSTRALIA

LAND AREA OF  
**2.5 MILLION KM<sup>2</sup>**



# THE WESTERN AUSTRALIAN ECONOMY

Western Australia's strengths extend beyond the resources sector to other industries such as:

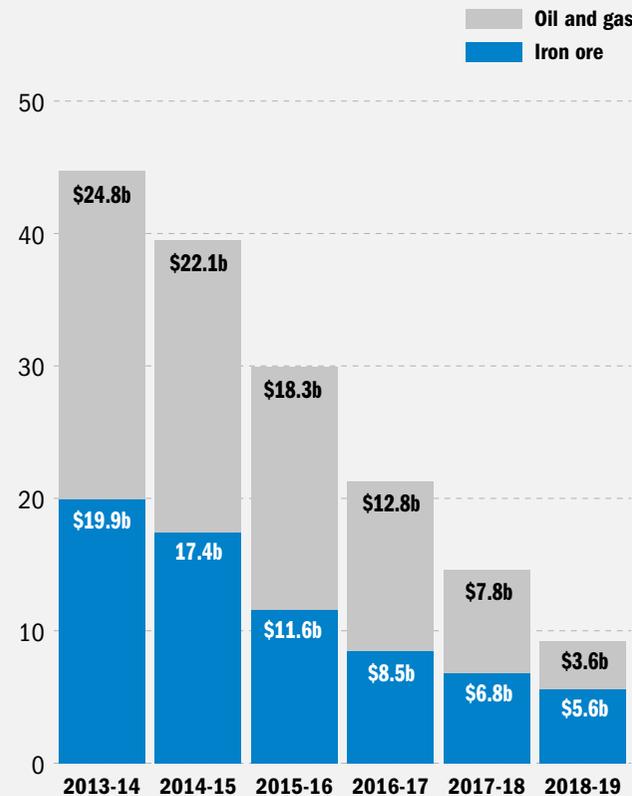
- Agribusiness
- Tourism
- Education
- Science and technology

With an average annual economic growth rate of 5.3 per cent over the past 10 years, Western Australia has experienced a period of unprecedented economic expansion.

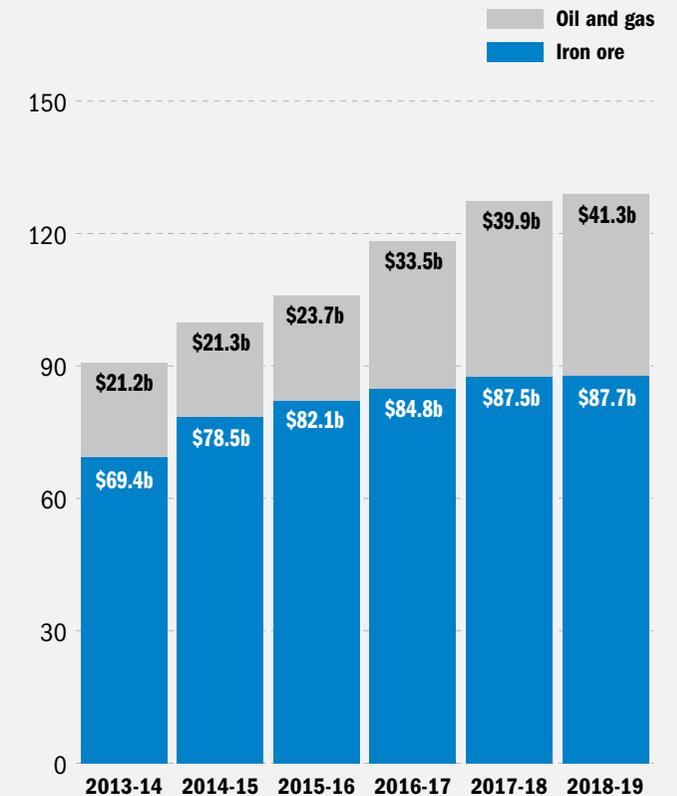
The resources sector has been central to this growth with \$99.5 billion in minerals and petroleum sales in 2014-15. Western Australia accounts for 63 per cent of Australia's natural gas production and 86 per cent of its LNG exports, supplied from the North West Shelf and Pluto Projects.

The State is also blessed with mineral resources – it has about 1000 mining projects producing more than 50 different commodities. Iron ore is the State's largest export item, accounting for 95 per cent of Australia's total production and 37 per cent of global production.

**Business Investment (Real 2012-13 dollars)**

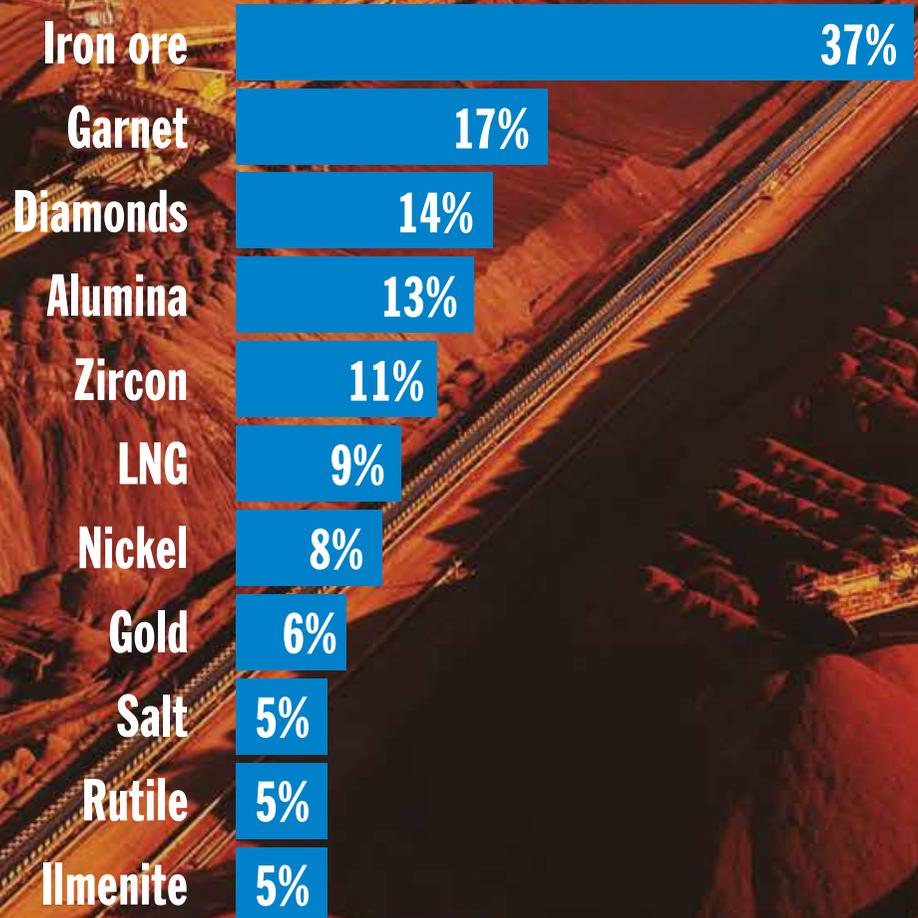


**Production (Real 2012-13 dollars)**



Source: Western Australian Department of Treasury via DSD Policy Division

## Western Australia's share of global commodity production

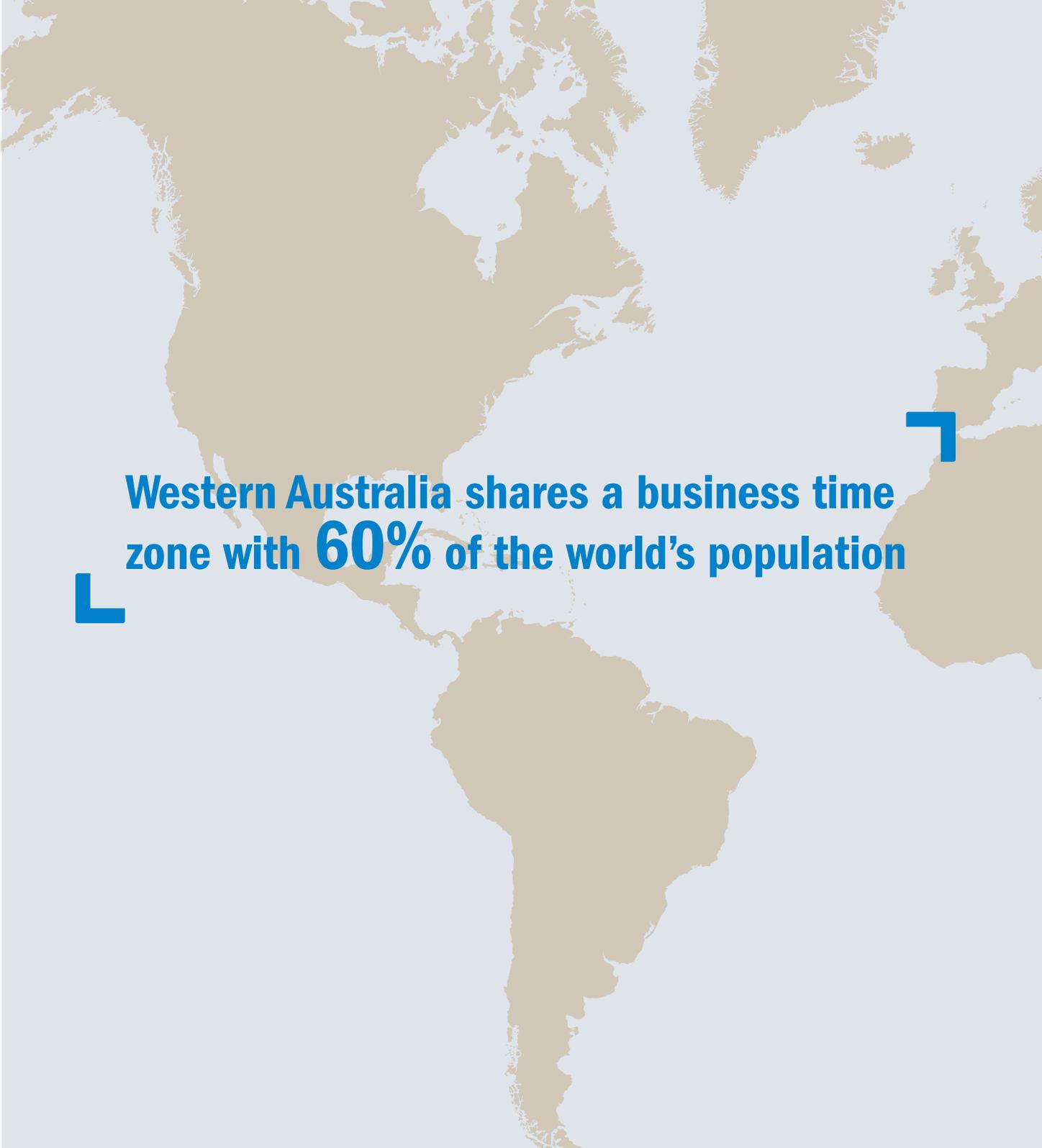


# STRATEGIC LOCATION

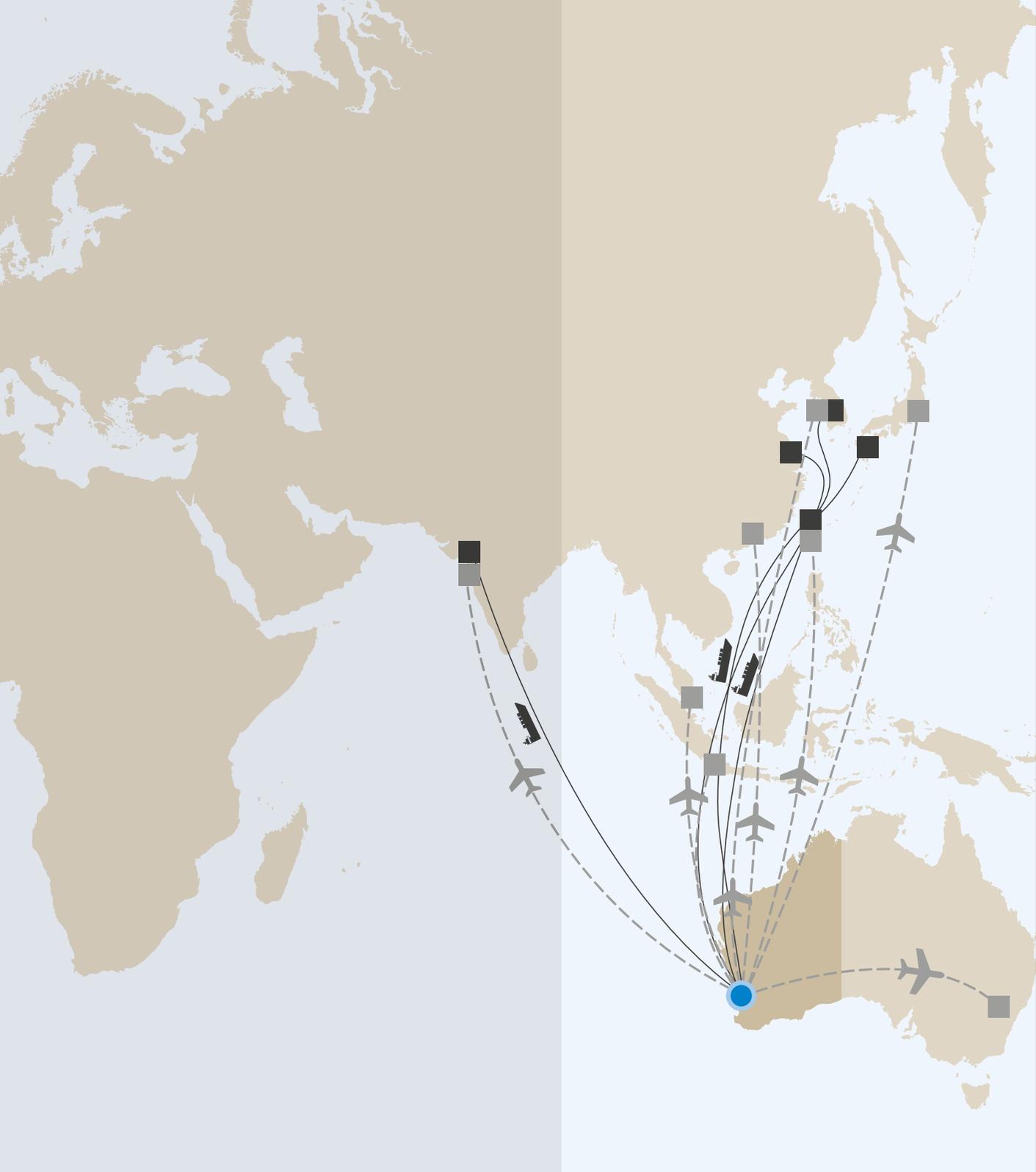
Perth is ideally placed for doing business worldwide, sharing a business time zone (plus or minus two hours) with most of the world's population, including some of the world's most populous and dynamic economies.

Australia's gateway to Asia and the Indian Ocean region is only a five-hour flight from Singapore or four hours from Jakarta.

Western Australia's advantageous global position, proximity and stability mean it is ideally placed to meet the needs of the increasingly affluent Asian region. The State has the capabilities to meet not just the resource and energy needs of countries like China, Japan and South Korea, but also their demand for premium food, tourism and quality education.



**Western Australia shares a business time zone with 60% of the world's population**



## Flight and shipping times from Western Australia to the rest of the world



Perth to	Flight time
Sydney	4.5 hours
Indonesia (Jakarta)	4.5 hours
Singapore	5 hours
China (Guangzhou)	8 hours
Taiwan (Taipei)	8.5 hours
India (Mumbai)	9 hours
Japan (Tokyo)	9.5 hours
Korea (Seoul)	11.5 hours

(direct unless otherwise stated)



Perth to	Shipping time
Taiwan	6 days (Basuo)
China	7 days (Shanghai)
Japan	8 days (Kyushu)
Korea	8 days (Incheon)
India	9 days (Hazira)

# PERTH — AN IDEAL PLACE TO LIVE

Perth is one of Australia's sunniest capital cities and a great place to live, work and visit. With an outdoor lifestyle, world-class beaches and an unbeatable Mediterranean climate, Perth is regularly ranked among the world's most liveable cities.

There has been a dramatic cultural transformation in Perth over the past decade, occurring in parallel with the rapid expansion of the LNG and mineral sectors. Major private and public projects have changed the city skyline, while dozens of small bars, restaurants and galleries offer new places for locals and visitors to relax and celebrate.

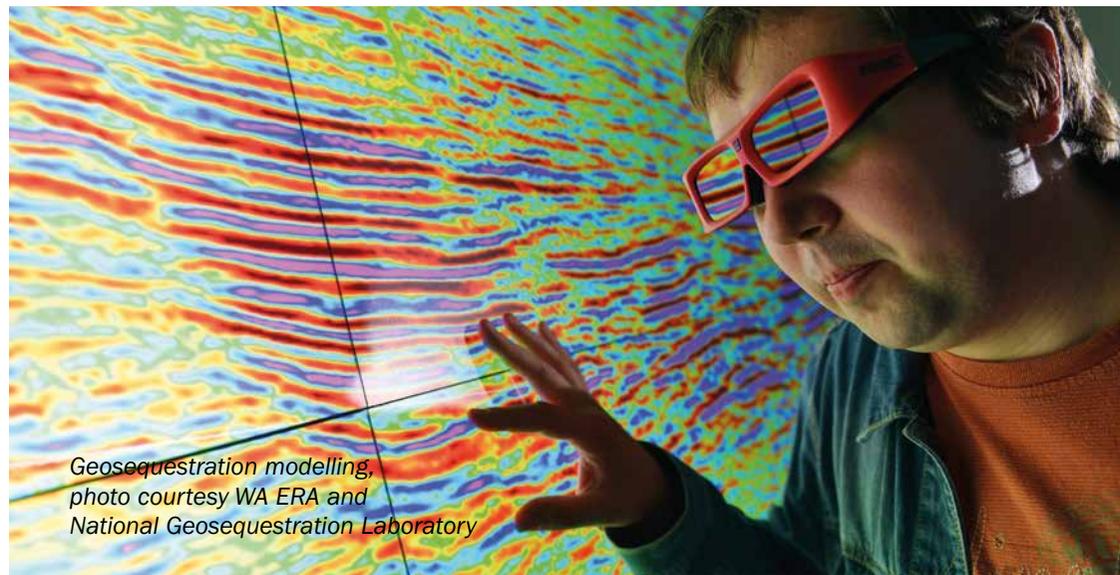


# A GLOBAL RESOURCE AND ENERGY CENTRE

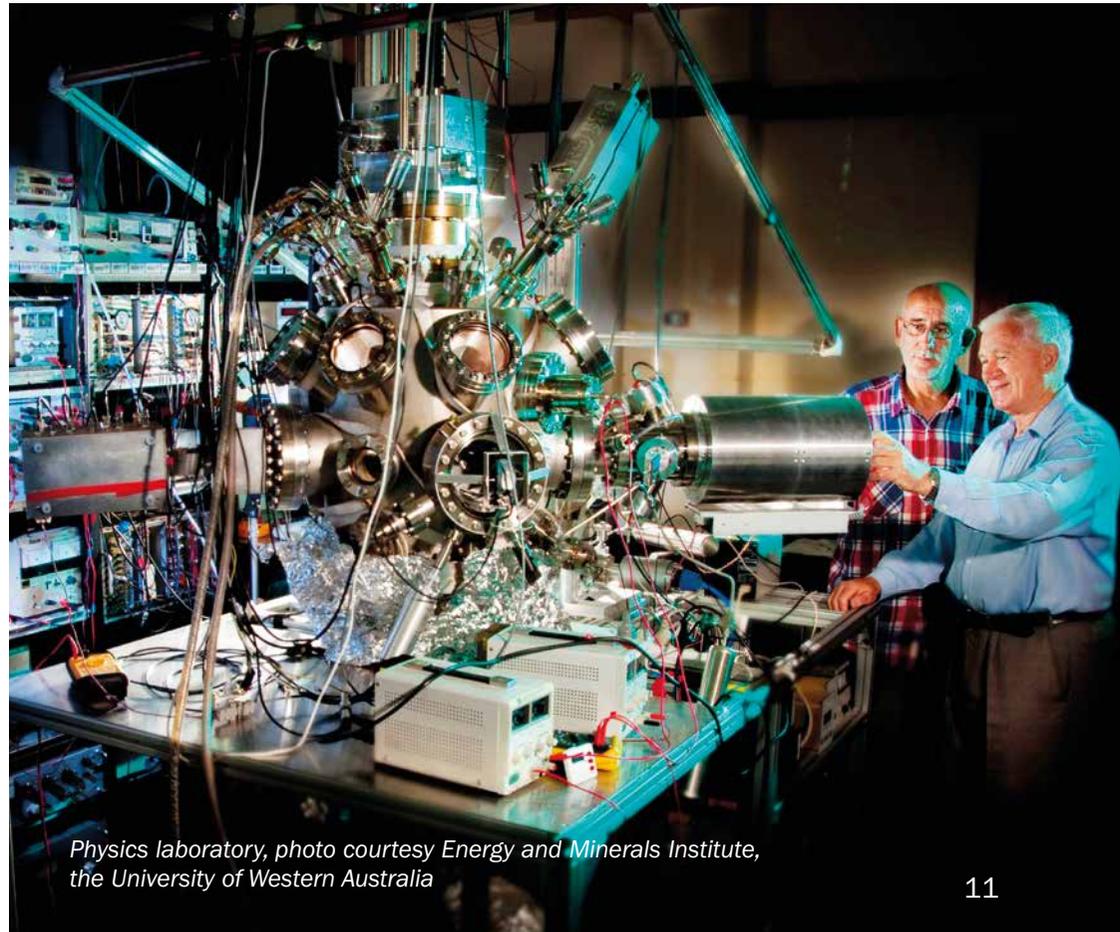
As one of the world's most significant mineral and petroleum provinces, Western Australia has established itself as a global resource and energy hub. Perth is Australia's only member of the World Energy Cities Partnership, joining established global centres like Aberdeen, Stavanger, Houston and Doha.

Perth has the largest concentration of global oil and gas company headquarters in Australia and is home to the Australian headquarters of major companies including Chevron, Shell and BHP Billiton. The city's selection to host the 18th International Conference and Exhibition on Liquefied Natural Gas (LNG 18) in April 2016 further cements its reputation as a major corporate and energy capital in the Asian region.

Western Australia has also developed as a global hub for scientific and technological innovation in the oil and gas sector, with our highly skilled workforce working in the areas of subsea exploration and production technologies, marine services, petroleum-related research, Front End Engineering and Design (FEED) and geophysical surveying. The emerging technologies of automation and data analysis will keep Perth at the forefront of energy innovation.



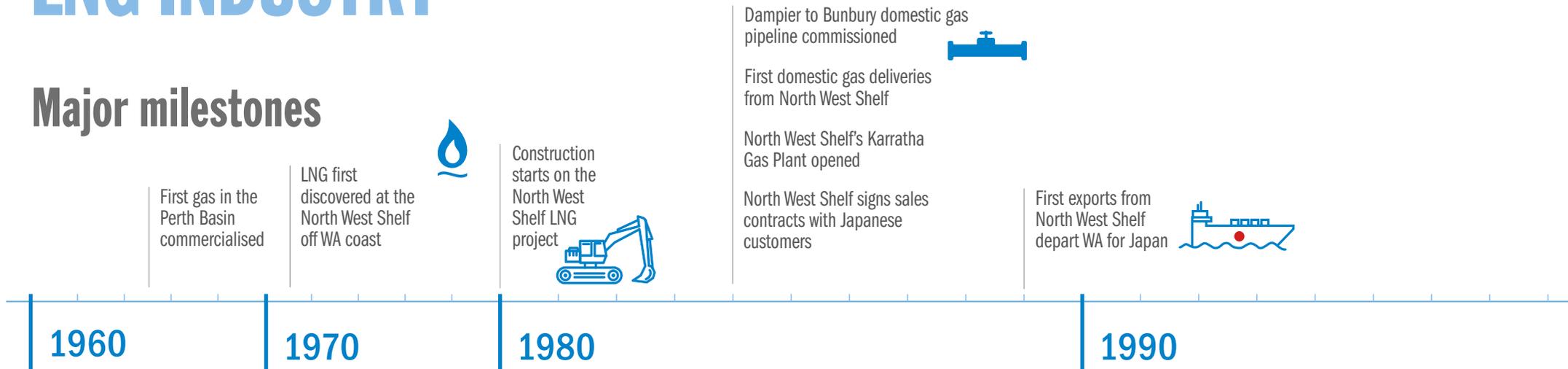
*Geosequestration modelling, photo courtesy WA ERA and National Geosequestration Laboratory*



*Physics laboratory, photo courtesy Energy and Minerals Institute, the University of Western Australia*

# WESTERN AUSTRALIA'S LNG INDUSTRY

## Major milestones



Western Australia is rich in petroleum resources, with 92 per cent of Australia's conventional gas resources held in basins along the State's coastline.

Western Australia's conventional gas reserves are calculated at 130 trillion cubic feet (tcf) while oil and natural gas liquid reserves are estimated at 1,700 million barrels. Recoverable onshore shale gas resources in the Canning Basin alone are estimated at between 70 and 150 tcf, with additional shale and tight gas resources in other onshore basins.

The North West Shelf, Australia's first LNG export project, began exporting gas in 1989.

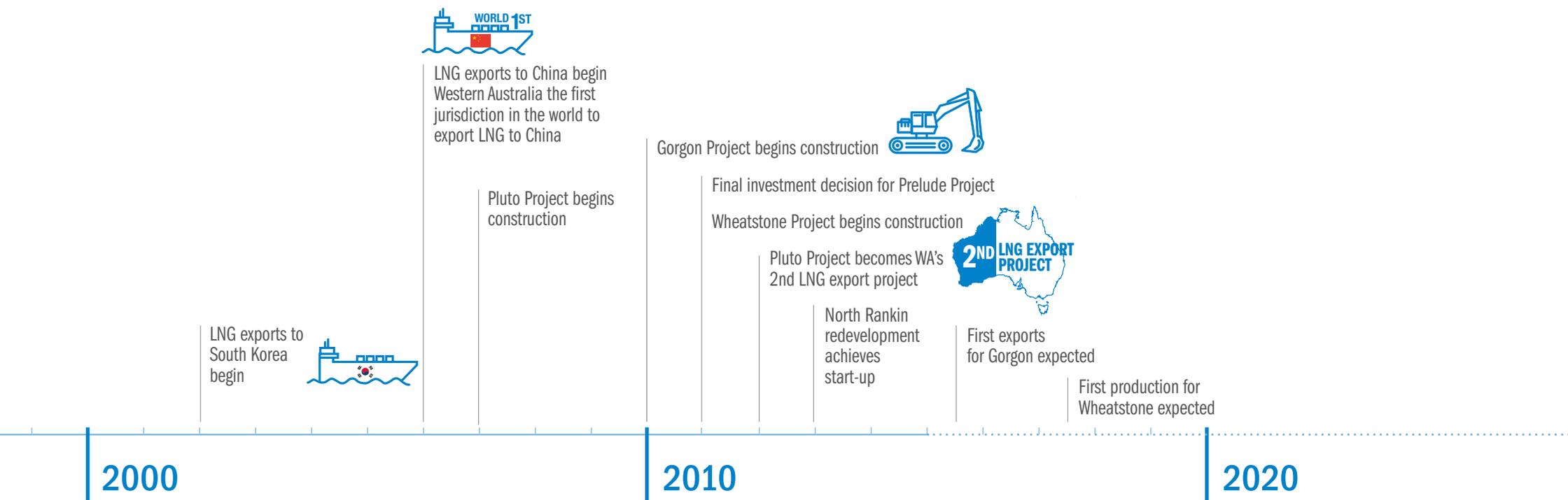
It was joined by the Pluto Project in 2012, and there are three more projects under construction in Western Australia: Gorgon, Wheatstone and Prelude.

These projects will contribute an additional 28.1 Million tonnes per annum (Mtpa) capacity by 2018. It is estimated that by 2017, Western Australia will be second only to Qatar in global LNG production.

Japan was the first customer for Western Australian LNG exports and it remains the largest consumer of Western Australian LNG. Western Australia also exports LNG to China, South Korea and Taiwan and will soon be supplying India.



*Pluto onshore gas plant, photo courtesy Woodside Energy*



# CONVENTIONAL AND UNCONVENTIONAL GAS

Western Australia's sedimentary basins, including the continental shelf, cover an area of approximately 2.5 million square kilometres. The State has seven major and several minor basins which are prospective for petroleum.

While this sector remains in the early, proof-of-concept phase, recent advancements in drilling technologies have made the production of onshore shale and tight gas resources more economically viable.

The State's largest and most prospective offshore basin is the Northern Carnarvon Basin, off the coast of Western Australia's remote Pilbara region. Oil was discovered in the northern Carnarvon Basin in 1953 with follow-up discoveries at Barrow Island in 1964 and gas fields in 1971.

North of the Carnarvon Basin is the Canning Basin, a large, mainly onshore basin in the remote northern Pilbara and southern Kimberley regions that is relatively unexplored.

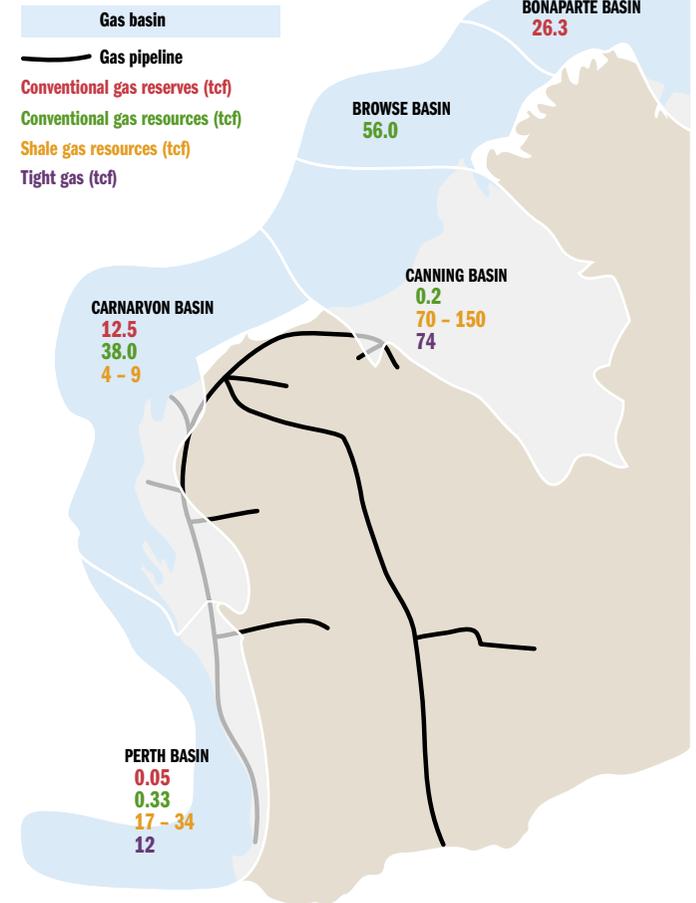
The Browse and Bonaparte Basins lie off Western Australia's north and north-west coasts, both mostly offshore and closer to Indonesia in the Timor Sea between Australia and Indonesia.

The Ichthys Project will draw gas from the Browse Basin and pipe it 889km east to Darwin to produce 8.9 million tonnes of LNG and 1.6 million tonnes of liquefied petroleum a year.

Northeast of the Northern Carnarvon Basin is the Canning Basin, a large, mainly onshore basin in the remote mainly Kimberley region. While the Canning Basin is relatively unexplored, the discovery in recent years of the Ungani oil field has improved the prospects for future developments.

While the onshore shale and tight gas resources sector remains in its early stages, advancements in drilling technologies may help make production viable in the future.

## LEGEND



# THE PETROLEUM TITLE SYSTEM

In Australia, petroleum rights are owned by the government, with State, Territory and the Australian Government jointly administering a regulatory regime which grants permits and licences to companies to explore, develop and produce petroleum in offshore areas.

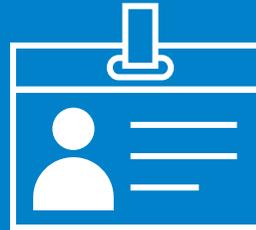
Offshore titles and activities in Australian waters adjacent to Western Australia are managed by a Joint Authority comprising the responsible Western Australian and Australian Government Ministers, who are advised by the National Offshore Petroleum Titles Administrator and by the Western Australian Department of Mines and Petroleum.

Onshore titles and those lying in State Waters are administered by the Western Australian Department of Mines and Petroleum.

Titles can be obtained by bidding for vacant acreage in exploration releases or farming into or purchasing existing titles held by oil and gas companies. The Department of Mines and Petroleum issues regular updates on acreage releases.

**131 OFFSHORE  
& 59 ONSHORE**

**STATE WATERS  
EXPLORATION  
PERMITS**



**ISSUED**

**53 OFFSHORE  
& 30 ONSHORE**

**STATE WATERS  
PRODUCTION  
LICENCES**



**ISSUED**

# INDUSTRIAL LAND

The Western Australian Government has established a number of Strategic Industrial Areas (SIAs) designed for investment in downstream processing and other heavy or strategic industrial activities. SIAs are close to Western Australia's abundant resources and well served by key infrastructure such as roads, rail and ports.

Investment in an SIA can provide proximity to some of the world's largest resource companies including Chevron, BP, Shell, Woodside and Alcoa.

Key SIAs for the LNG industry are the Browse LNG Precinct in the far north Kimberley region, the Burrup SIA near Karratha (home to the North West Shelf and Pluto Projects) and the Ashburton North SIA in the lower Pilbara region near Onslow, where the Wheatstone Project is under construction.

## **Browse LNG Precinct**

## **Boodarie SIA**

## **Anketell SIA**

## **Burrup (North West Shelf, Pluto)**

## **Maitland SIA**

## **Ashburton North SIA (Wheatstone)**

## **Mungari SIA**

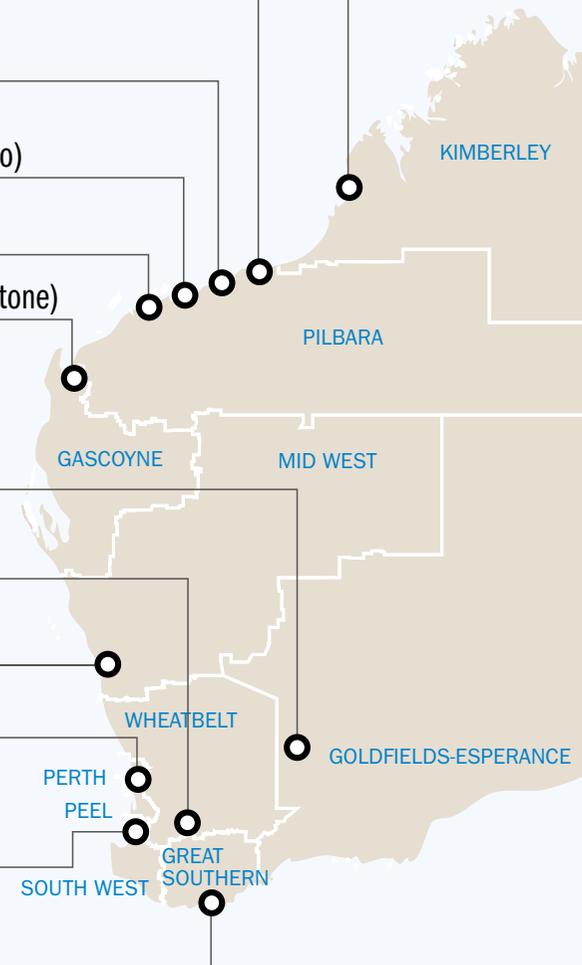
## **Shotts SIA**

## **Oakajee SIA**

## **Kwinana SIA**

## **Kemerton SIA**

## **Mirambeena SIA**



# THE INNOVATION EDGE

With some of the world's biggest LNG developments and the largest concentration of global oil and gas companies in Australia, Western Australia has established itself as a global solutions centre in oil and gas. Driven by the needs of industry, Perth has been chosen as the site for the National Energy Resources Centre, part of the Australian Government's \$248 million Industry Growth Centres initiative. It will work with the oil, gas, coal and uranium sectors to unlock commercial opportunities and drive innovation by building links between businesses and industry organisations and the science and research sector.

Major oil and gas companies like Chevron, GE Oil & Gas, and Shell have based major research and development centres in Perth, leveraging off the proximity of major projects and the presence of a skilled and experienced workforce.

Western Australia's academic sector is also working with government, industry associations and operating companies to address industry challenges and develop advanced technologies and innovative solutions, through the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Curtin University of Technology, the University of Western Australia and others.



O-Tube, photo courtesy of the Energy and Minerals Institute at the University of Western Australia

# NORTH WEST SHELF

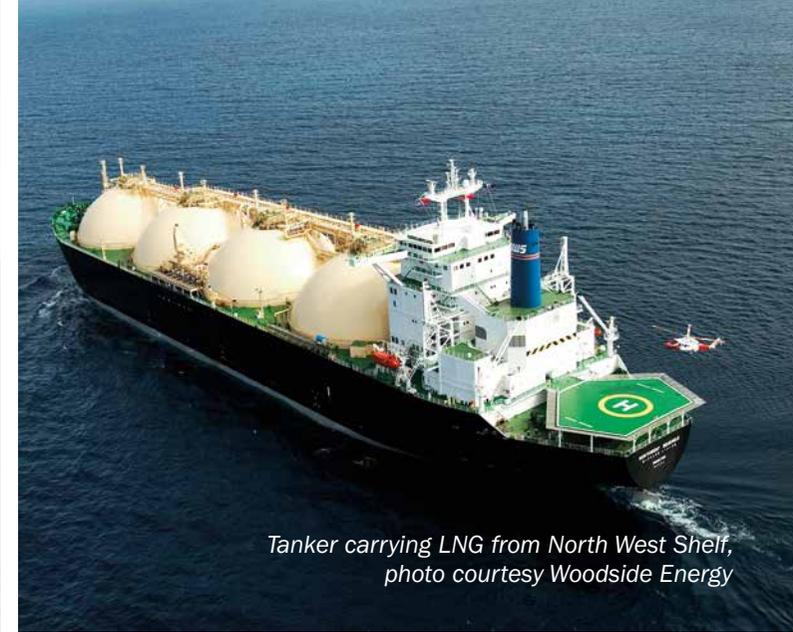
The North West Shelf Project was Australia's first LNG export project, and remains one of the world's largest.

Located 125km north of Karratha, the Woodside-operated North West Shelf Project started with the discovery of vast natural gas reserves in the Carnarvon Basin in the 1970s. Major project works began in 1980, with domestic gas flowing to Western Australian consumers in 1984. The first shipment of LNG to Japan took place to great celebration in 1989.

Since then, the North West Shelf Project has grown, with three additional trains taking its total to five and boosting LNG production to 16.3 Mtpa.



Goodwyn Platform, photo courtesy Woodside Energy



Tanker carrying LNG from North West Shelf, photo courtesy Woodside Energy

**The North West Shelf Project has been Western Australia's supplier of domestic gas for more than 30 years.**

# AUSTRALIA-CHINA NATURAL GAS TECHNOLOGY PARTNERSHIP FUND

The Australia-China Natural Gas Technology Partnership Fund was established in 2002 as part of the North West Shelf joint venture's bid to secure the world's first LNG export contract with China. The fund is a joint initiative of the Australian Government, the Western Australian Government and North West Shelf Australia LNG.

The aim of the fund is to strengthen the relationship between Australia and China, encourage long-term partnerships within the energy sector that create positive economic outcomes, and increase knowledge and skills through training and research.

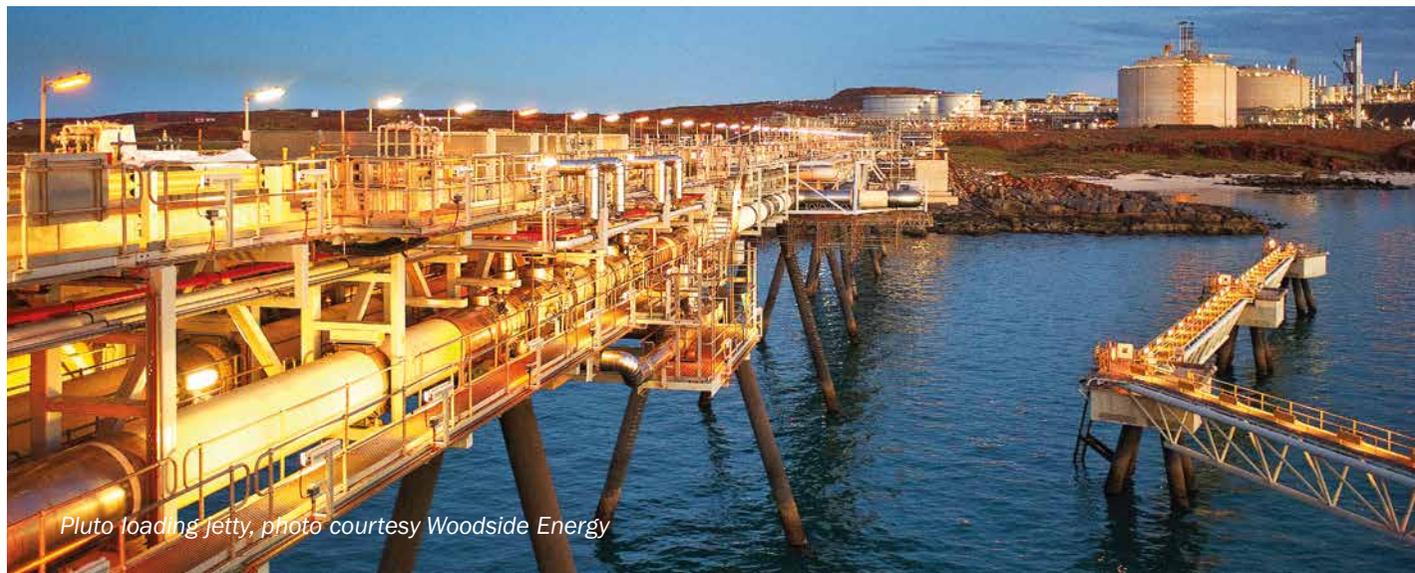


Field trip, photo courtesy Australia-China Natural Gas Technology Partnership Fund

# PLUTO

The Woodside-operated Pluto Project began construction in 2007 and came online in 2012, just seven years after the original resource was discovered 190km off the coast of Karratha in the Carnarvon Basin. The Pluto and Xena gas fields contain approximately 5 tcf of dry gas.

Onshore infrastructure comprises a single LNG processing train with production capacity of 4.3 Mtpa, as well as two LNG storage tanks, three smaller condensate tanks and an LNG and condensate export jetty.



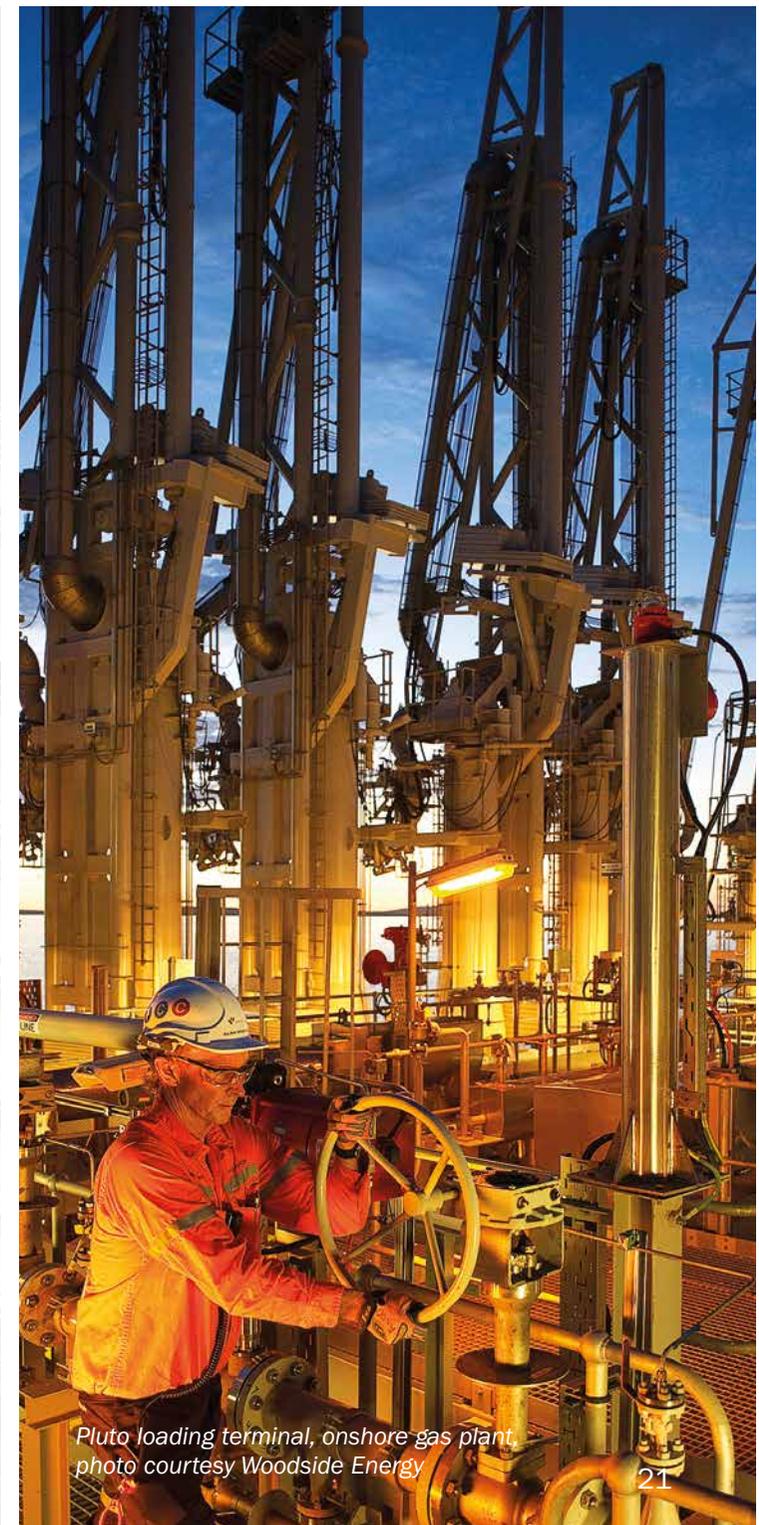
*Pluto loading jetty, photo courtesy Woodside Energy*



*First LNG cargo leaves for Japan, photo courtesy Woodside Energy*



*Pluto onshore Gas Plant, photo courtesy Woodside Energy*



*Pluto loading terminal, onshore gas plant, photo courtesy Woodside Energy*

# GORGON

The Chevron-operated Gorgon Project is one of the world's largest natural gas projects and the largest single-resource development in Australia. The project is based on Barrow Island, 60km off the Western Australian coast, and will develop 40 tcf of gas reserves found in the Gorgon and Jasnz-los gas fields.

The project comprises three LNG trains capable of producing 15.6 Mtpa of LNG per year and a domestic gas plant supplying up to 300 terajoules of energy per day. Exports will be loaded via a 2.1km jetty while domestic gas will be piped 90km onshore to the Dampier to Bunbury Natural Gas Pipeline.

The Gorgon Project includes a carbon dioxide injection project to design, construct and operate facilities to inject and store carbon dioxide in a deep reservoir unit known as the Dupuy Formation, more than 2km beneath Barrow Island.



*Gorgon jetty, photo courtesy Chevron*



*Gorgon aerial view, photo courtesy Chevron*

# WHEATSTONE

In late 2011, construction began on the Chevron-operated Wheatstone Project, 12km west of Onslow in the State's Pilbara region. Gas resources will be gathered from Wheatstone, Iago, Brunello and Jumar Reserves.

Once it begins operations, the project will include an onshore processing facility in the Ashburton North Strategic Industrial Area. The initial project comprises two LNG trains with a combined capacity of 8.9 Mtpa with approval to expand to 25 Mtpa of LNG over time, as well as a domestic gas plant with a capacity of 200 terajoules per day.



*Wheatstone offshore infrastructure, photo courtesy Chevron*



*Wheatstone offshore infrastructure, photo courtesy Chevron*



*Wheatstone subsea manifolds, photo courtesy Chevron*

# ICHTHYS

In the Browse Basin 220km offshore from Western Australia, the Ichthys gas field is the largest discovery of hydrocarbon liquids in Australia in more than 40 years, containing at least 12 tcf of gas and 500 million barrels of condensate.

With operations due to start in early 2017, the INPEX-operated Ichthys Project includes the construction of advanced infrastructure with significant offshore and onshore processing facilities and an 890km pipeline. Once complete, the project is expected to produce 8.9 Mtpa of LNG and 1.6 Mtpa of LPG, as well as 100,000 barrels of condensate per day at peak.



*Ichthys RSS tower launched at field, photo courtesy INPEX*



*Ichthys FPSO, photo courtesy INPEX*

# PRELUDE

The Prelude Project will be operator Shell's first deployment of floating LNG technology (FLNG) which allows for the production, liquefaction, storage and transfer of LNG at sea. The FLNG facility will operate in the Browse Basin more than 200km off the Kimberley coast and remain moored for 25 years.

Being built in Geoje, South Korea, the FLNG facility will be 488m long, 74m wide and weigh more than 600,000 tonnes. Once complete, the facility will produce approximately 3.6 Mtpa of LNG, 1.3 Mtpa of condensate and 0.4 Mtpa of LPG for export.

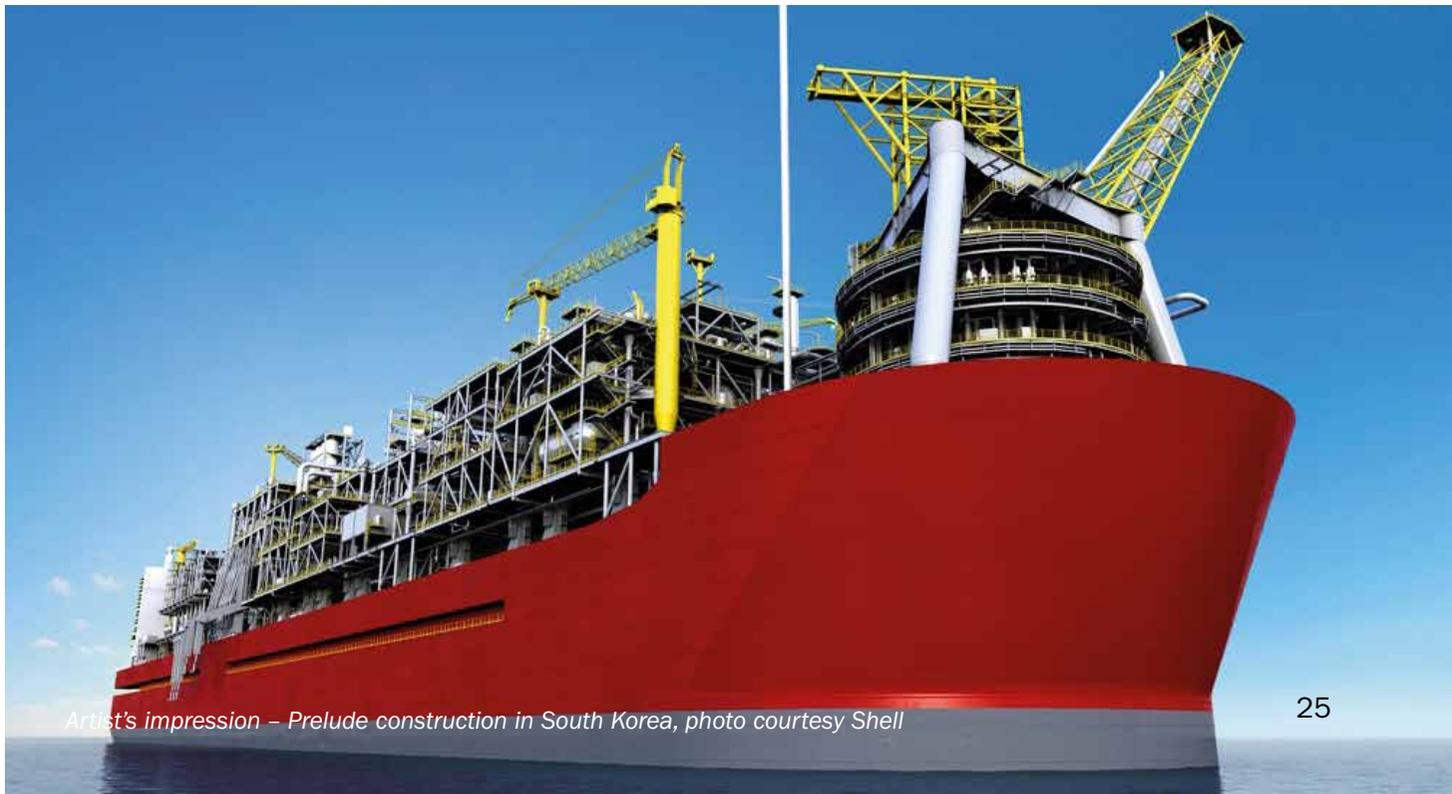
The Prelude gas field, discovered in 2007, and the Concerto gas field, discovered in 2009, have combined reserves of about 3 tcf.



*Prelude construction in South Korea, photo courtesy Shell*



*Prelude construction in South Korea, photo courtesy Shell*



*Artist's impression – Prelude construction in South Korea, photo courtesy Shell*

# PROPOSED PROJECTS

## Browse FLNG

The Browse Project comprises the development of the Brecknock, Calliance and Torosa fields off the coast of Broome in Western Australia's Kimberley region using FLNG technology. The three fields are estimated to hold a combined 15.4 tcf of dry gas and 453 million barrels of condensate.

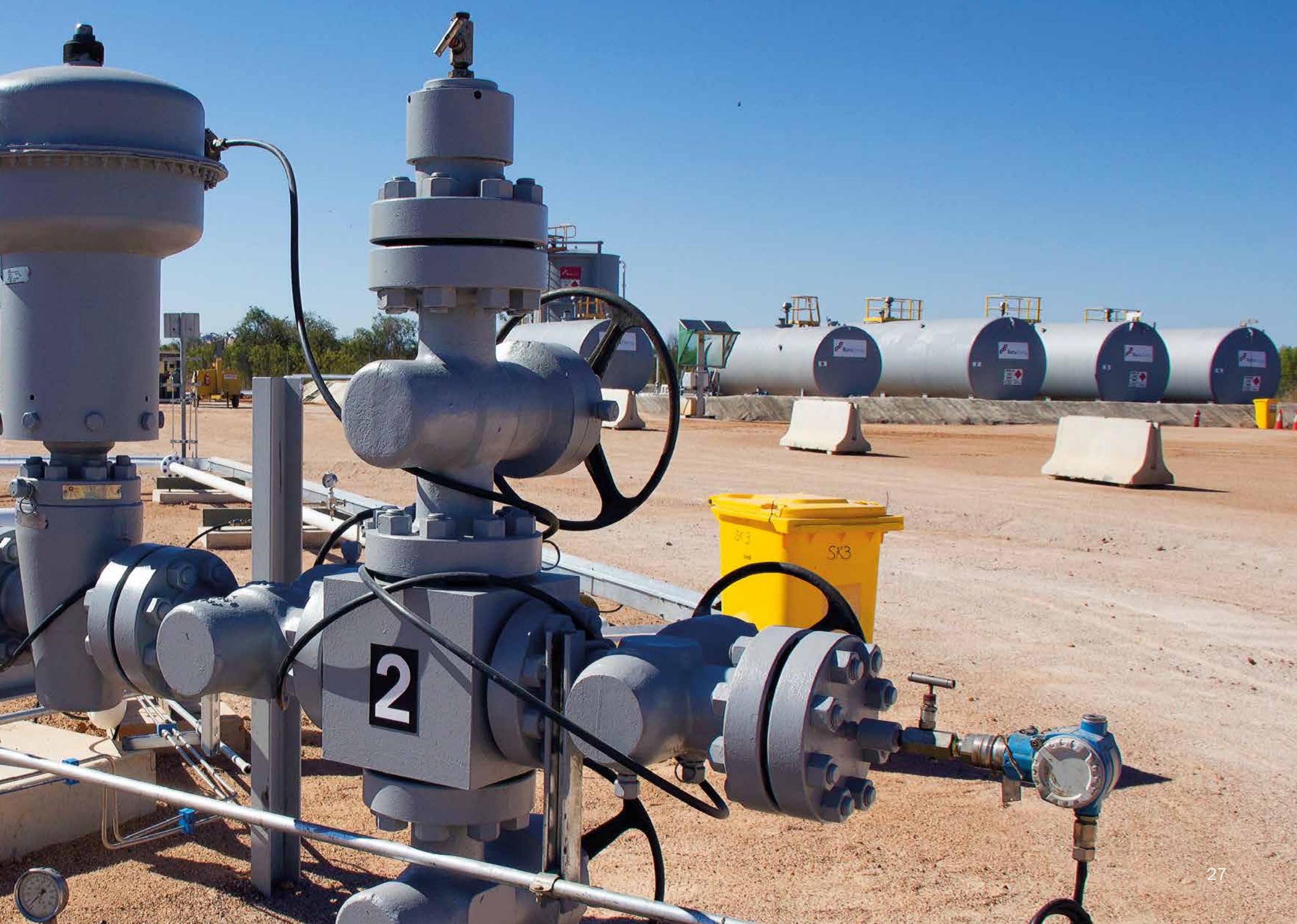
Project partners include Woodside (operator), Shell, BP, Japan Australia LNG and PetroChina. At March 2016, the Browse Joint Venture is in the Front End Engineering and Design phase.

## Canning Basin

Buru Energy and Mitsubishi are appraising the development of a domestic gas plant and LNG export project in the onshore Canning Basin in Western Australia's far north. The joint venture is conducting a pilot hydraulic fracturing program to test the commercial potential of the resource.



Ungari oil field, photo courtesy Buru Energy



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EUROPE

MIDDLE EAST

AFRICA

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INDONESIA

SOUTH KOREA

JAPAN

CHINA

PERTH  
WESTERN AUSTRALIA



*Elizabeth Quay, photo courtesy George Nuich*