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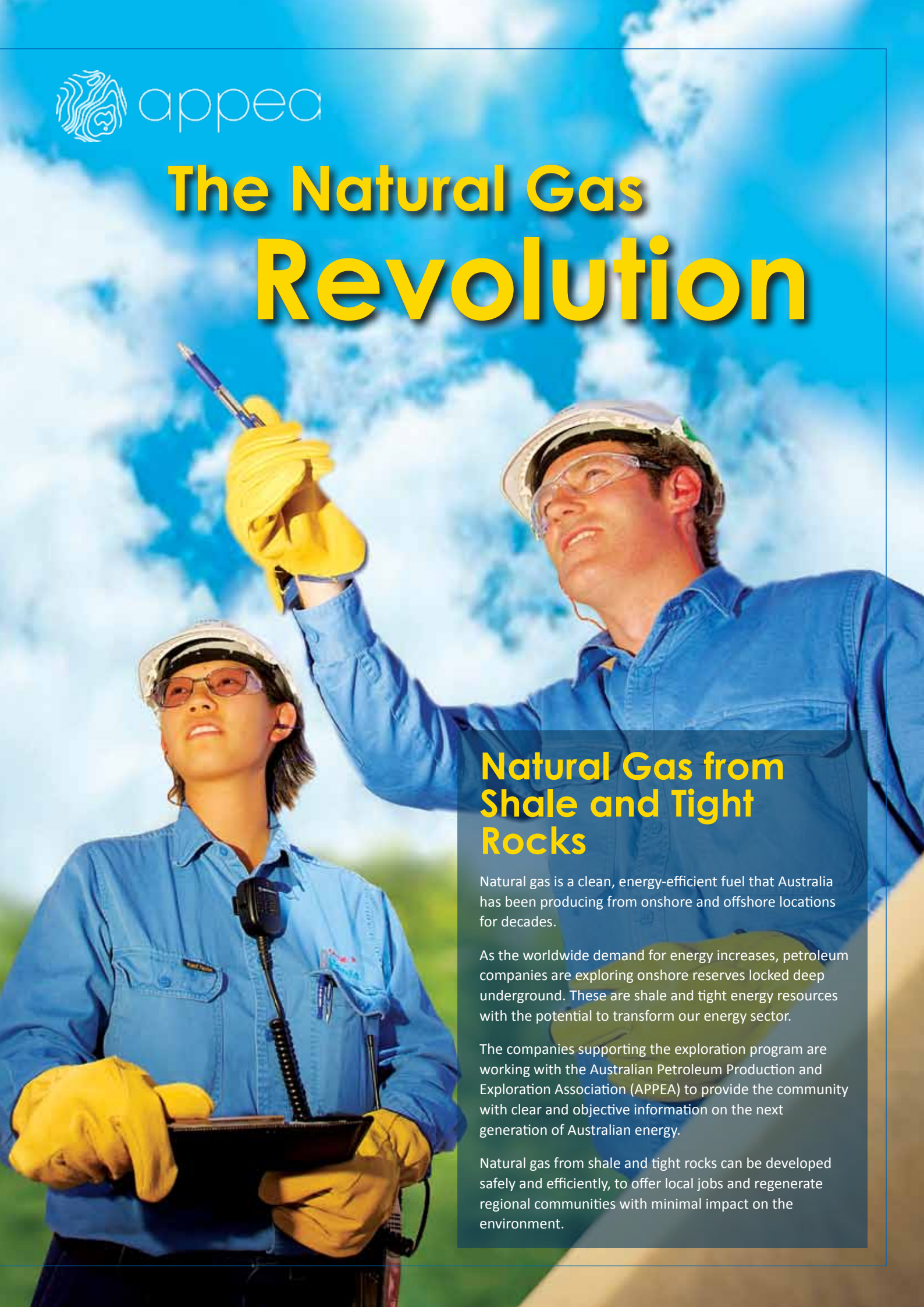
The Natural Gas Revolution



Natural Gas from Shale and Tight Rocks

Natural gas is a clean, energy-efficient fuel that Australia has been producing from onshore and offshore locations for decades.

As the worldwide demand for energy increases, petroleum companies are exploring onshore reserves locked deep underground. These are shale and tight energy resources with the potential to transform our energy sector.

The companies supporting the exploration program are working with the Australian Petroleum Production and Exploration Association (APPEA) to provide the community with clear and objective information on the next generation of Australian energy.

Natural gas from shale and tight rocks can be developed safely and efficiently, to offer local jobs and regenerate regional communities with minimal impact on the environment.

Natural Gas from Shale and Tight Sources
Benefits for Australia

Regional Development

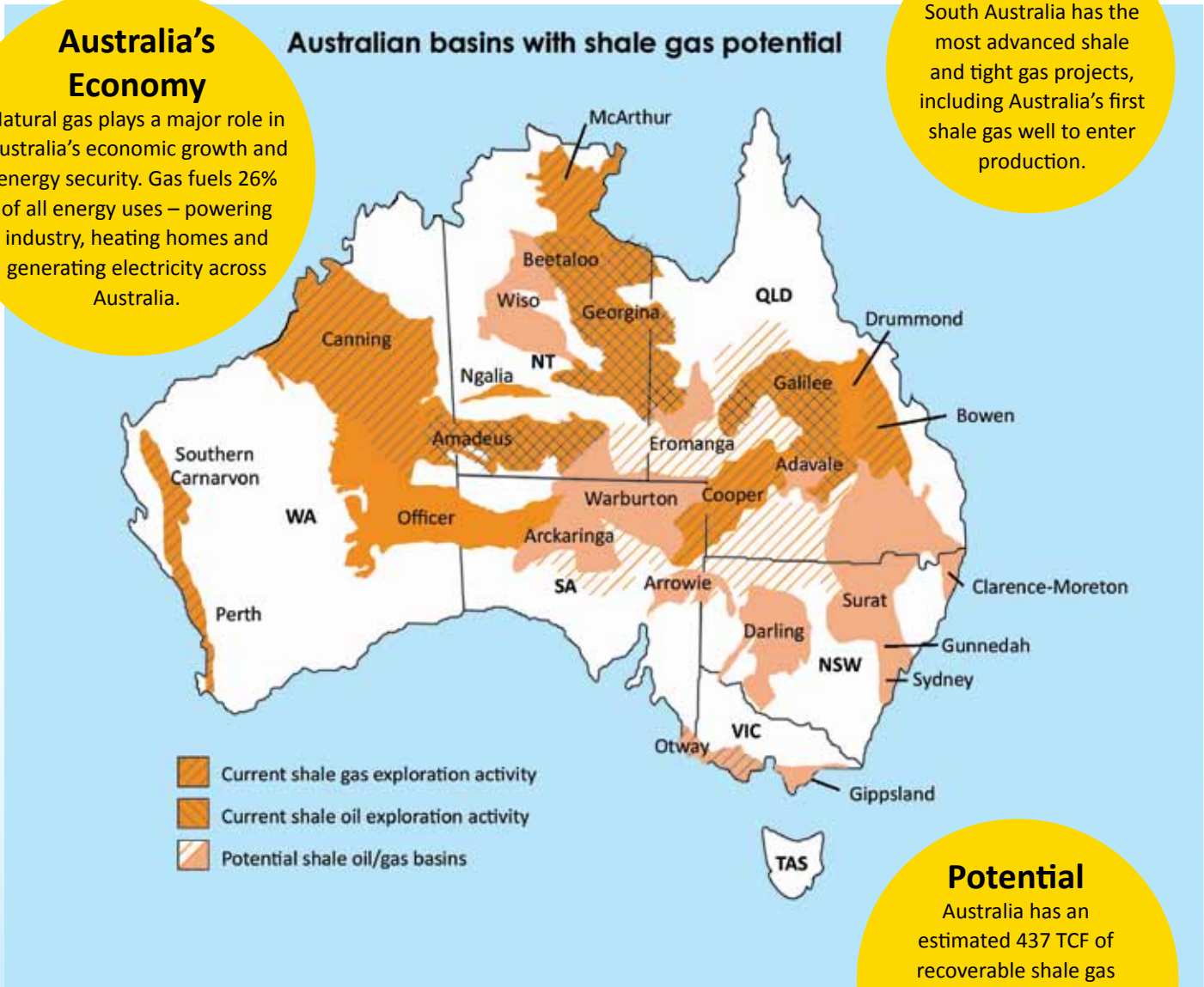
- Studies show that developing an Australian shale and tight natural gas industry will generate significant benefits in regional areas[1], employing thousands of people in construction, operations, infrastructure and support services.
- Many companies are investing in exploration and infrastructure for the next wave of natural gas development.
- The availability of additional natural gas from shale and tight rocks will stimulate the Australian economy, generating new job opportunities across a range of industry sectors.

Australia's Economy

Natural gas plays a major role in Australia's economic growth and energy security. Gas fuels 26% of all energy uses – powering industry, heating homes and generating electricity across Australia.

Production

South Australia has the most advanced shale and tight gas projects, including Australia's first shale gas well to enter production.



Potential

Australia has an estimated 437 TCF of recoverable shale gas reserves. 1 TCF is enough gas to power a city the size of Perth for 10 years.

1. Source: Engineering Energy: Unconventional Gas Production, Australian Council of Learned Academies (June 2013), Chapter 11: Community Amenity and Opportunity.

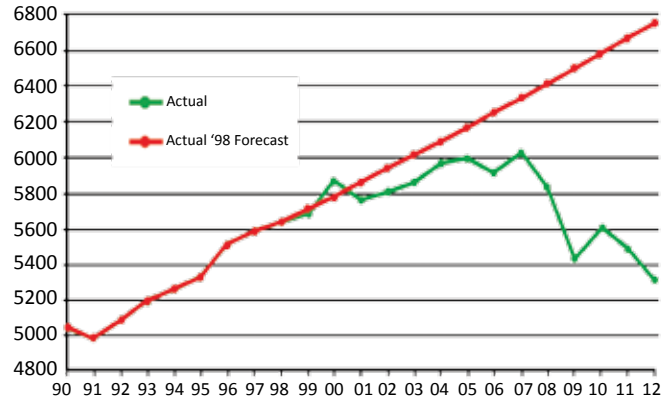
Learn more: www.appea.com.au

Secure Energy Supplies

- The first natural gas from shale and tight rocks in Australia is supporting the domestic market. This gas, from the Cooper Basin in Central Australia, is supplying homes and businesses in South Australia and New South Wales.
- Development of natural gas from shale and tight sources in Western Australia and the Northern Territory could also support the growing demand for domestic gas.
- Greater gas development in Australia will increase supply security and price competition as it has in the United States of America (USA).
- If the present exploration programs are successful, future development will be able to support secure and diversified domestic gas projects, with the potential to support liquefied natural gas (LNG) projects.

Clean Energy

- Natural gas currently offers the cleanest viable source of baseload and peaking power in Australia.
- Australia's natural gas resources can significantly reduce greenhouse gas emissions by replacing coal as a power fuel.
- Energy-related carbon dioxide (CO_2) emissions in the USA have dropped 12% between 2007 and 2012, their lowest level for a decade. A major factor influencing this reduction has been the increased use of natural gas, including shale gas, in place of coal for power generation.



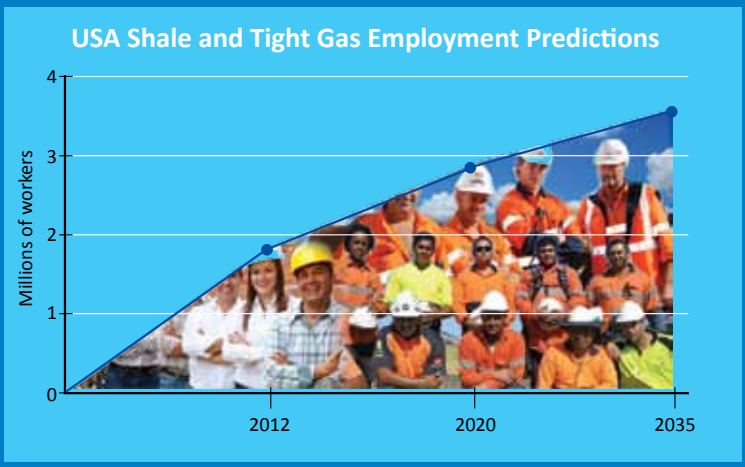
Data sourced from: EIA Data by Country, Carbon Dioxide Emissions and EIA estimates from 1998 that emissions would rise by 1.5% per year through to 2020.

USA 'Shale Revolution'

A rapid increase in low-cost shale gas production has breathed new life into the US economy. As the leading global producer of shale gas, the USA has revitalised its energy sector with major investment in natural gas production.

One recent study illustrates the extent of the transformation. It found that the resurgence in onshore gas exploration and production in the USA had created at least 576,000 jobs in Texas, 102,600 jobs in Pennsylvania, 96,500 jobs in California, 78,900 jobs in Louisiana, and 77,600 jobs in Colorado, totalling 1.7 million jobs in 2012 with estimated growth to 2.5 million jobs by 2015.

While employment has gone up, CO_2 emissions have come down.

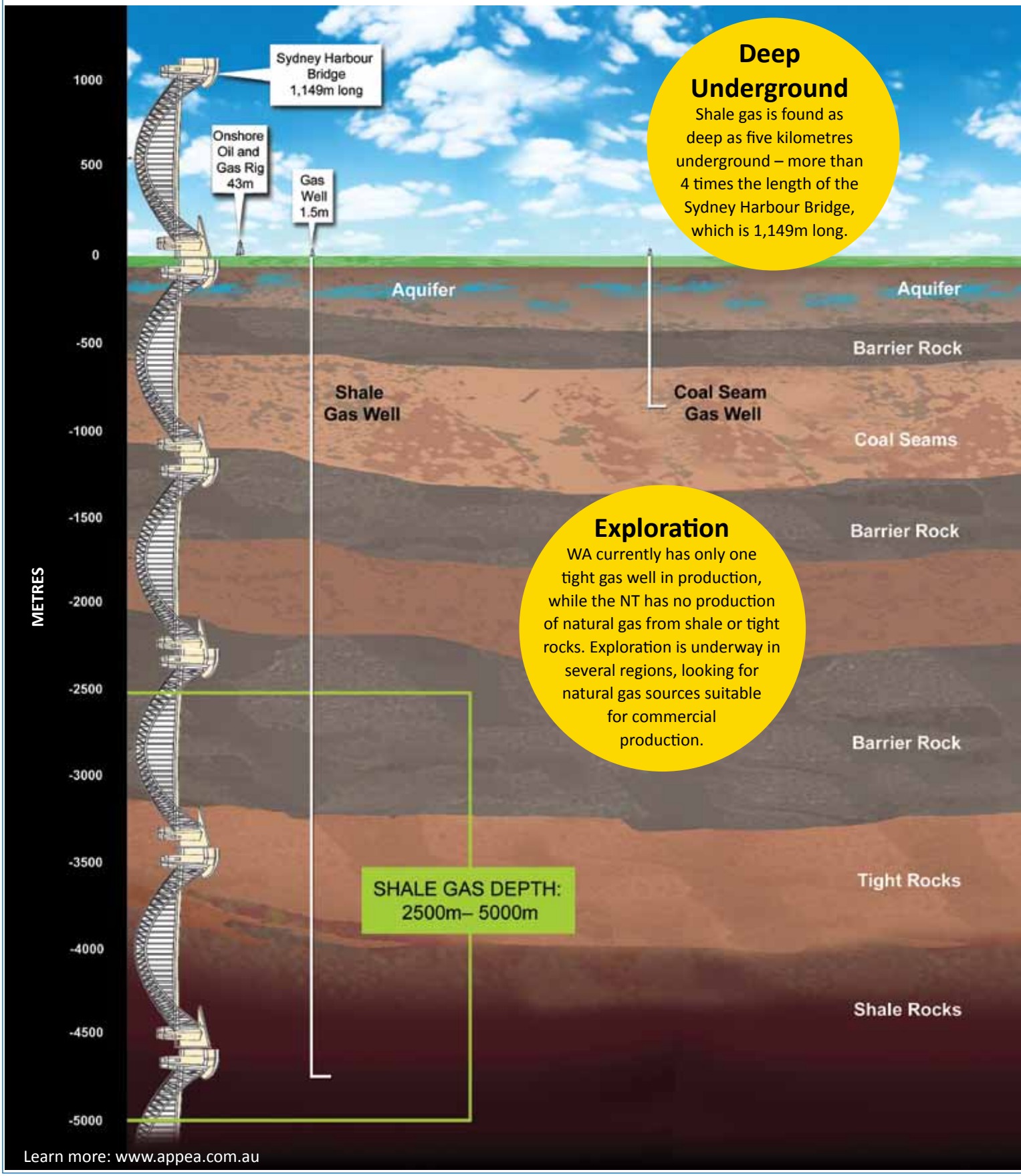


Employment figures sourced from: IHS Global Insight - America's New Energy Future, December 2012.

Learn more: www.appea.com.au

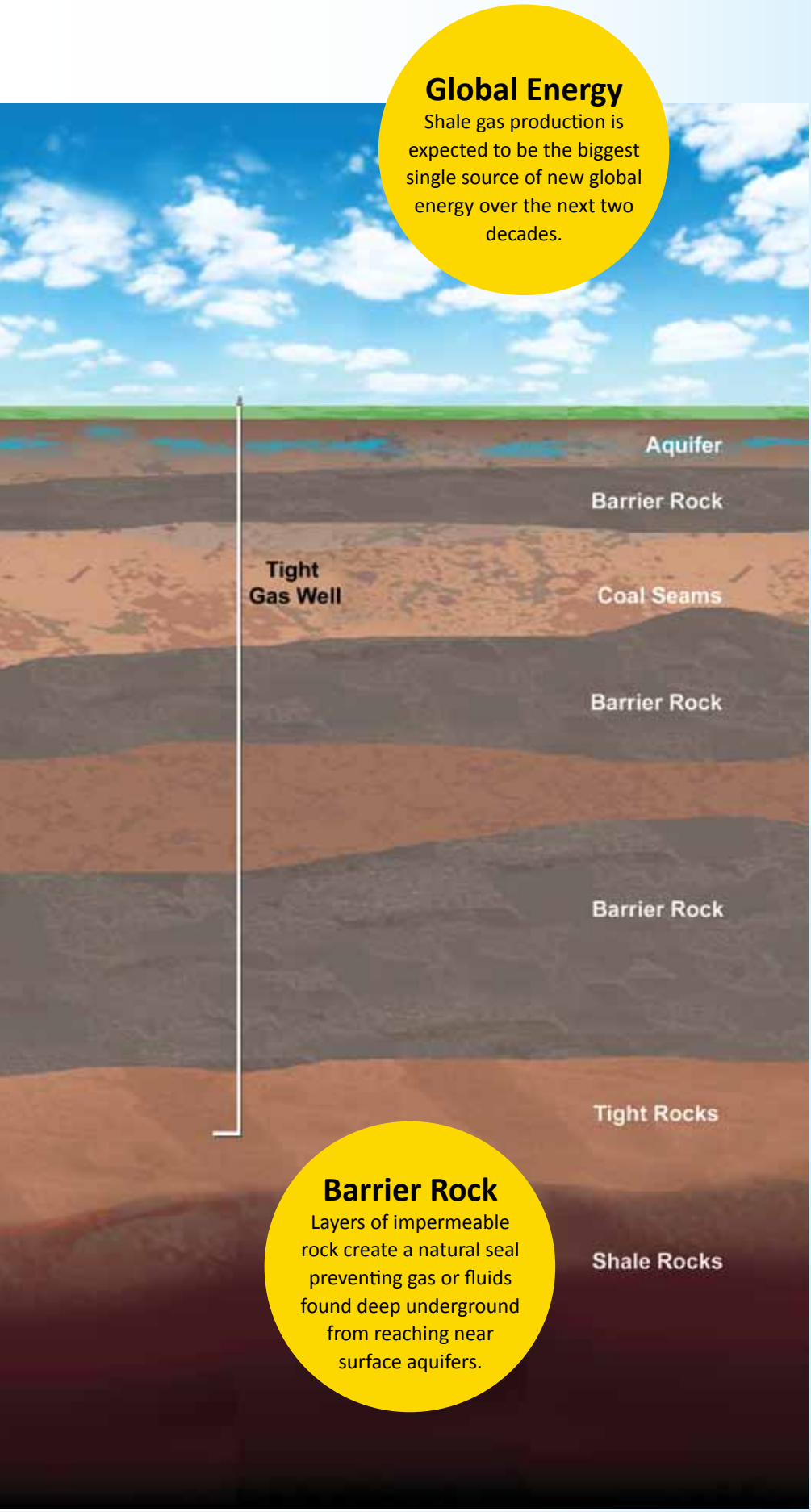
New Energy Underground

Natural gas is found in many forms of rock, including shale, coal seams and sandstone. Tight gas reservoirs are found in low permeability sandstones. Natural gas is used to fuel millions of households and businesses in Australia.



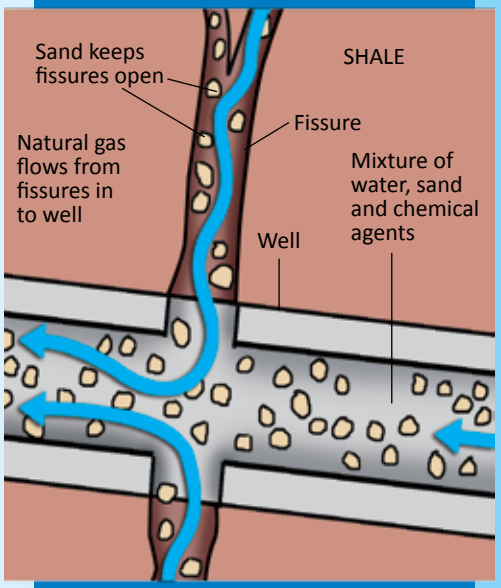
Learn more: www.appea.com.au

Natural Gas Resources Explained



Global Energy
Shale gas production is expected to be the biggest single source of new global energy over the next two decades.

Barrier Rock
Layers of impermeable rock create a natural seal preventing gas or fluids found deep underground from reaching near surface aquifers.



Natural gas from shale and tight sources are found trapped in layers of fine-grained rocks. Shale gas in shale rocks and tight gas in low permeability sandstone, is usually found two to five kilometres underground.

Advances in drilling technology have allowed the industry to extract this trapped gas using hydraulic fracturing (also known as 'fraccing') to create tiny 3-6mm cracks in the gas-bearing rock to help with gas flow.

Coal seam gas (CSG), also known as coal bed methane, is trapped by water pressure in underground coal seams. It is found closer to the surface at depths of 400-1000 metres. Hydraulic fracturing is sometimes needed to release gas from the coal seams.

Due to the natural geology across Australia, natural gas production in the western and central regions will most likely be supplemented by shale and tight sources, while on the east coast the focus is currently on natural gas from coal seams.

Learn more: www.appea.com.au

Natural Gas from Shale and Tight Sources
Stages of Development

1 Signing Leases and Securing Permits

Before any activity can take place, industry must first consult with pastoralists and Traditional Owners to obtain access to the land for exploration under agreed conditions.

Exploration companies also conduct environmental and heritage studies to identify areas for special management. This information is included in plans submitted for regulatory approval ahead of any industry activity.

3 Constructing the Well Site

Construction can only begin once regulatory approval is secured and the location for the well pad is agreed by the company, pastoralists and Traditional Owners.

Well pads vary in size, but during this phase between 2-5 hectares of land will usually be cleared. Drilling multiple wells from one well pad minimises land use and the number of roads needed.

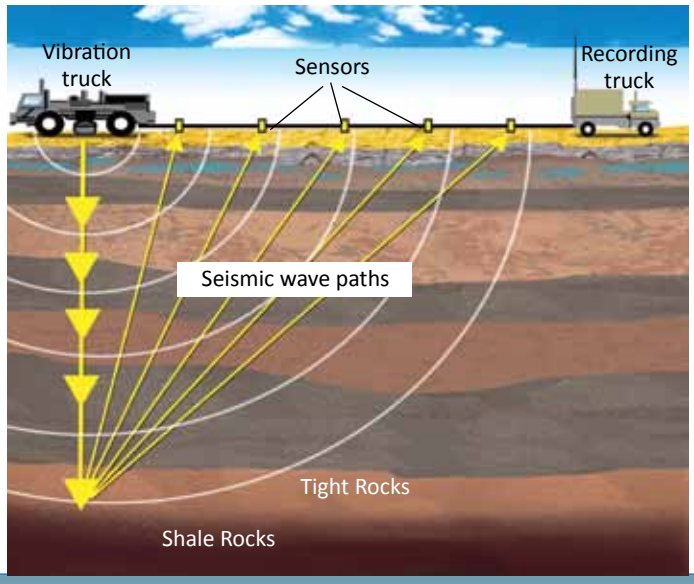
Many Uses

Hydraulic fracturing can also be used to stimulate groundwater wells to improve flow and is essential to produce energy from geothermal "hot rock" systems.

2 Gathering Seismic Data

Seismic imaging is used to help understand what lies beneath the earth. Soundwaves are bounced off underground rock structures and the echoes reveal possible oil- and gas-bearing formations.

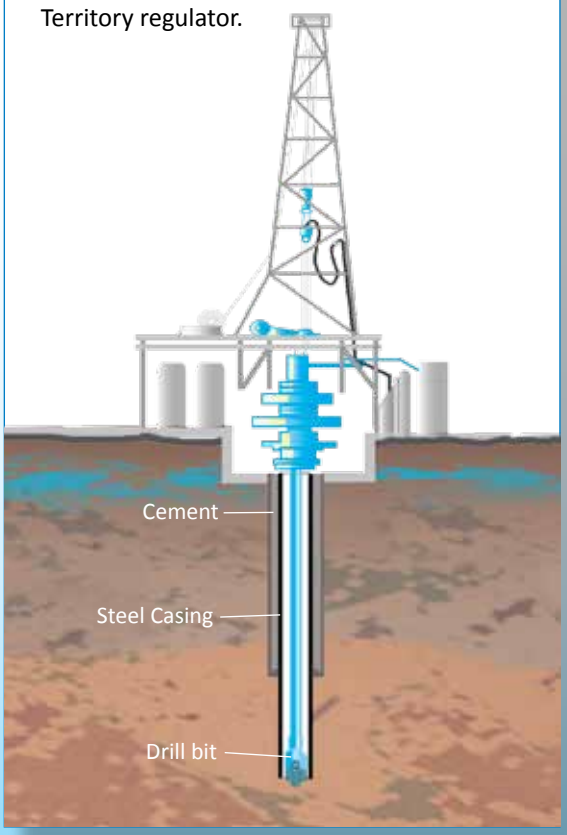
Earth scientists study the echoes to determine the best location for drilling and minimise the number of wells needed.



4 Drilling the Well

Vertical wells are drilled up to five kilometres below the earth's surface to reach tight or shale resources. To maximise access to the resource the wells may then be drilled about 600-2000 metres horizontally into the layer of rock containing the gas.

The well design and program is reviewed, approved and monitored by the State or Territory regulator.

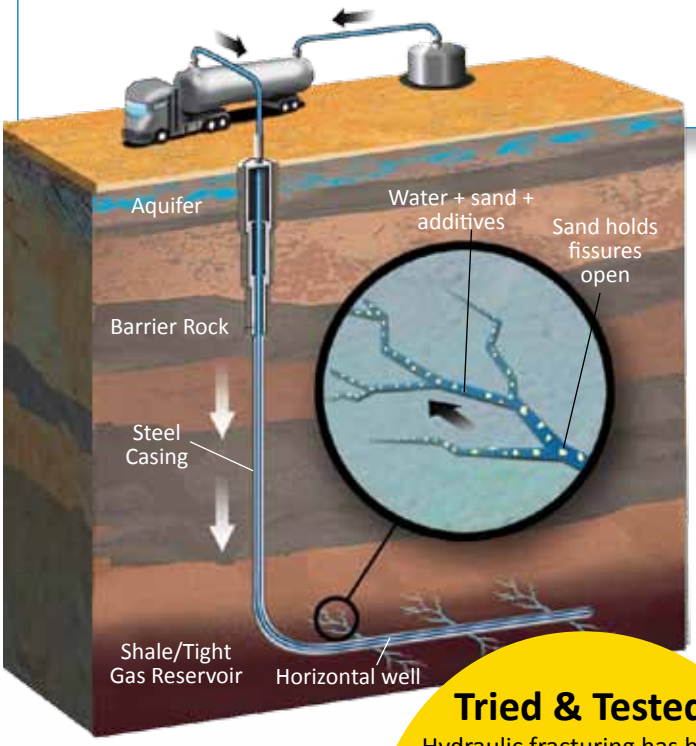


Learn more: www.appea.com.au

5 Hydraulic Fracturing

Before hydraulic fracturing can occur the program is reviewed by the regulatory authority.

If approved the operator will pump a fluid – typically 99.5% water and sand, and 0.5% chemical additives (see page 10) – down the well at a high pressure. This creates a network of tiny cracks in the rock. The sand helps to hold the cracks open, allowing trapped natural gas to flow to the well.



6 Testing

Once the well is in place and it can safely produce natural gas, an extended testing program may take place. These tests provide the operator with important information about the resource.

7 Building Natural Gas Pipelines

If the testing period is successful, a pipeline will be installed from the new well to an existing network. This natural gas is processed and can then be used for power generation, heating and cooking in homes and to meet a wide range of industrial energy needs.

Tried & Tested

Hydraulic fracturing has been used in Western Australia since the 1950s. More than 780 petroleum wells have been fractured in WA with no known adverse effects on the environment, water sources or public health.

Decades of Production

Natural gas wells that produce from shale and tight sources are expected to have a long production life spanning several decades.

8 Low Impact Production

It can take up to a year to build the well site, drill and complete the well. Throughout the well development process, the regulatory agency ensures compliance through regular inspections.

When the development of the well is complete, the company works with the pastoralists and Traditional Owners to restore the land around the well head back to its original state.

9 Producing Natural Gas for Decades

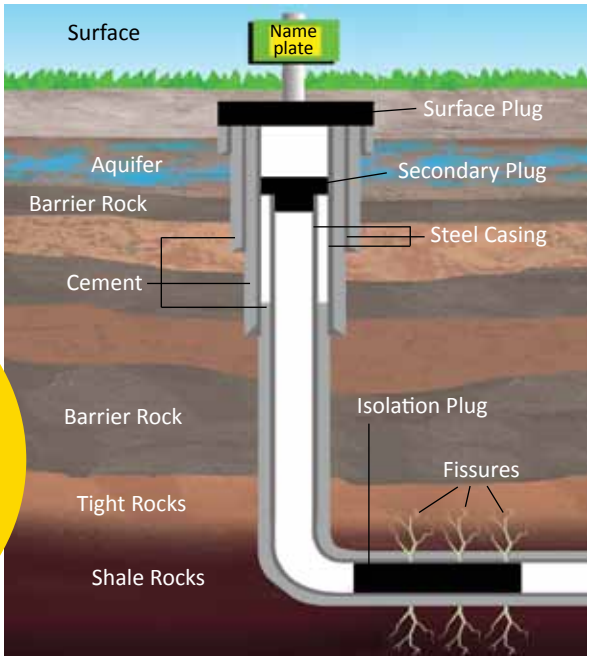
After the land at the well site is restored a small cleared area around each well head remains. The area includes a well head, a gas processing unit and one or two water tanks.

Wells typically produce gas for many years with little surface activity other than regular environmental checks.

10 Decommissioning of Wells

When a well is no longer required it is permanently sealed off by a series of cement plugs – a process called abandonment. This cement is a specially formulated mixture designed to be long-lasting and withstand high pressures.

The abandonment process is subject to strict conditions and is reviewed and approved by the State or Territory regulator.



RESPONSIBLE DEVELOPMENT
Sound environmental management

Protecting Groundwater

The industry is committed to safe and responsible operations and ensuring long-term groundwater protection. One of the most important groundwater protection measures is safe and effective well-design and construction. Other measures include independent research to understand underground fresh-water systems and the safe storage and treatment of fluids recovered at the surface.

The rigorous engineering standards are supported by continuous monitoring to make sure the controls are working effectively.

Hydraulic Fracturing

The same concept of high-standard engineering and ongoing monitoring is the basis of well-managed hydraulic fracturing, the process used to increase the production of tight and shale gas.

For shale and tight rocks hydraulic fracturing or 'fraccing' takes place between two and five thousand metres below the surface – that's up to five times the length of the Sydney Harbour Bridge (1,149m). The gas zone is separated from fresh water aquifers by hundreds of metres of impermeable rock – creating a natural barrier and preventing gas or fraccing fluids from leaking into shallow freshwater aquifers.

Water Use

Most of the water for tight and shale gas production is used in the hydraulic fracturing process. The International Gas Union estimates about 11 million litres of water – equivalent to four Olympic swimming pools – is used in this process. This is much less than is required for many pastoral and industrial uses.

About a third of this water will flow back to the surface with the initial gas production. This can be recycled and used to hydraulically fracture other wells.

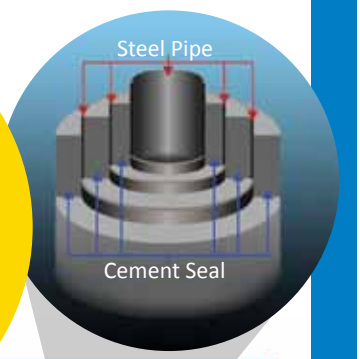
Water that cannot be recycled is placed in specially designed ponds for evaporation, leaving a small residue. This residue is tested and if necessary is safely removed and taken to a licensed disposal facility.

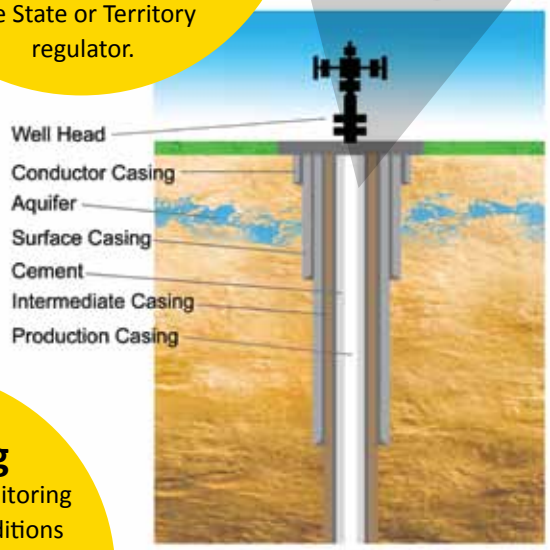
Water Management

The amount of water used for shale or tight gas operations is a small fraction of the water used for agriculture, industry or recreation.

Contained

Wells have as many as eight layers of steel casing and cement that form a continuous, protective barrier between the well and the surrounding rock. The well design and program is reviewed, approved and monitored by the State or Territory regulator.

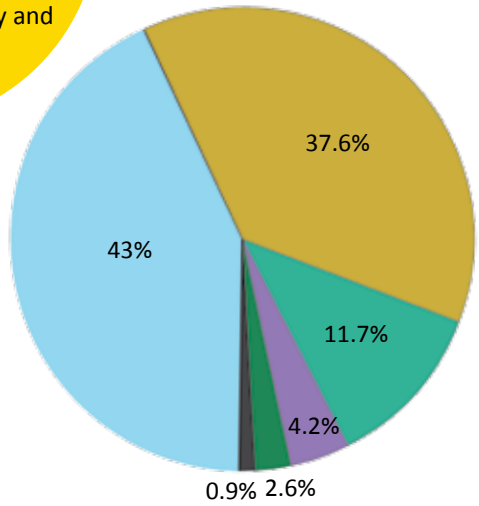




Monitoring

Regulators require monitoring and management conditions appropriate to each site during and after production. This includes monitoring the local groundwater quality and levels.

Water Usage



- Agriculture, forestry & fishing: 37.6%
- Mining: 0.9%
- Manufacturing: 4.2%
- Gas and electricity: 2.6%
- Municipal/domestic: 43%
- Other industry: 11.7%

Water volumes sourced from: Australian Bureau of Statistics – Australian Water Account, 2010-11

Air Quality

Reducing emissions from natural gas operations is a high priority for the industry. Wells are designed, constructed and operated to minimise emissions.

Several scientific studies agree that greenhouse gas emissions from shale gas-powered electricity – including the life-cycle emissions – are significantly lower than those from coal-fired power[1]. All natural gas production facilities in Australia, including wells and pipelines, are tightly controlled and monitored to minimise the risks of leakage.

CSIRO Research

Research into air quality and emissions from coal seam gas production is being undertaken by the CSIRO and the Federal Government. More information can be found on the CSIRO website.

Limited Surface Impact

Onshore tight and shale gas developments are designed to minimise impact on the ground surface and land use.

Horizontal drilling has helped reduce the footprint for shale and tight gas developments by allowing multiple wells to be drilled and operated from a single drilling pad, significantly reducing the surface footprint. Using this approach, producers can develop a field with one drill every 1-4 kilometres. Most of these drill pads can then be connected to a central processing facility by underground pipes.

Setting High Standards

Industry operators set and meet high standards, and strongly support government regulations that also expect high standards for shale and tight gas development. These high standards are expressed in the 'Golden Rules for the Golden Age of Gas' published by the International Energy Agency.

APPEA has developed or contributed to several codes of practice. These codes provide best-practice guidelines, reflect industry priorities for working with communities and are intended to improve the transparency of all the essential elements of the assessment and monitoring of industry activity.

Cleaner Energy

The US Environment Protection Authority states that: "Compared to the average air emissions from coal-fired generation, natural gas produces half as much carbon dioxide, less than a third as much nitrogen oxides, and one percent as much sulfur oxides at the power plant."[2]

Small Footprint

A multiple well pad, averaging between 4-8 well heads, would cover less than the size of a standard house block after land rehabilitation.

1. Source: Shale Gas: the facts about the environmental concerns, International Gas Union (June 2012), Section 7: Air emissions

2. Source: US Environmental Protection Agency, www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html

Learn more: www.appea.com.au

RESPONSIBLE DEVELOPMENT
Sound environmental management

Access to information

The industry is committed to open and transparent disclosure of the chemical additives used in exploration or production.

Planning for each well involves preparing an environmental plan management plan with details of any chemicals used in hydraulic fracturing and management strategies in place to protect the environment throughout the full lifecycle of a project. The industry supports disclosure and many companies make this information available on their websites.

Chemicals management

The fluid used in hydraulic fracturing is mostly made up of water and sand (approximately 99.5 per cent). The remainder is a mixture of chemical additives used to thicken the fluid to help carry the sand or beads (known as "proppants") which hold open the tiny hair-like fissures allowing the gas to flow more easily into the well. The chemicals reduce friction, remove bacteria and prevent scale from building up in the well.

Most of the chemical additives used are found in familiar household products.

Understanding Fracturing Fluid

The fluid from the hydraulic fracturing process is nearly 99.5% Water and Sand

Some typical additives used in fracturing fluid and common household items

Guar Gum 0-0.15%
Concentration in ice-cream **approx. 1%**

Acetic Acid 0-0.1%
Concentration in vinegar **5%**

Sodium Chloride 0-0.005%
Concentration in table salt **99%**

pH Stabilizer (MEA Borate) 0-0.1% Concentration in cosmetics **0.5%**

Disinfectant (Sodium Hypochlorite) <0.02%
Concentration in bleach 5%

Chemical Controls

The chemical additives in the hydraulic fracturing fluids are subject to the same strict regulations applying to responsible chemical use on farms or in factories.

Transparency

Companies must submit detailed plans for approval by the State or Territory government ahead of any hydraulic fracturing activity.

Common Chemicals

Many of the chemicals found in hydraulic fracturing fluids are also found in common household and commercial applications. They include guar gum used in jelly sweets, table salt, detergents and antiseptics – all of which are used in extremely low concentrations.

Learn more: www.appea.com.au

RESPONSIBLE DEVELOPMENT
Community partnerships

Working Together

The oil and gas industry recognises that success depends on long-term relationships built on integrity, transparency, fairness and respect.

The partnerships between communities and the industry have achieved important benefits, including:

- economic growth;
- local employment (including jobs for farmers and Traditional Owners);
- regional and indigenous business development;
- training;
- community development; and
- infrastructure.

Through co-operative community relationships and informed discussion, the industry and the government are ensuring the right approach is being taken to unlock the industry's potential and provide significant benefits to regional areas.

A partnership approach

Industry, government and CSIRO have jointly hosted community information workshops in Western Australia and Northern Territory. This important collaboration aims to work with local communities – listening to and addressing their concerns – and identify sources of information they can trust.

In South Australia the industry has been working closely with all stakeholders, in particular the South Australian Government, through the Roundtable for Unconventional Gas.

Science

The International Gas Union (IGU) has provided a good compilation of peer-reviewed science and best practices in relation to common environmental concerns. You can read more in the shale gas booklet available for download at http://www.igu.org/gas-knowhow/publications/igu-publications/

A Queensland Farmer's Story

Farmer Simon Drury has been on a journey with the coal seam gas (CSG) industry in Queensland for more than a decade. With his wife, Kylie, and four sons he owns and operates a 2,300 hectare property on the western Darling Downs. The farm grows various grains and supplies grain-fed beef to the domestic and international markets.

In 1997, Mr Drury was elected as local councillor to the Murilla Shire Council, this experience revealed to him that 10 years of continuous drought was taking its toll. Local businesses were struggling and many locals were sending their kids to the city to get a job. The local towns were shrinking.

In the early 2000s there was talk of CSG in the area. The Shire invited the industry to speak to them about the pros and cons of having CSG operations on their doorstep. Mr Drury said: "Of course, we had many questions, you know, what would it do to the aquifers that we all depended on for our stock, and domestic, and irrigation, landowners rights, would it devalue our land, etcetera."

A few years later Mr Drury agreed to allow Origin Energy to have access to his land to build four wells and an evaporation pond. The relationship between the farm and Origin grew, with the family taking part in the Working Together program, designed to allow farmers to monitor their wells on their own property. As part of the program Origin put the farm's staff through first aid, ChemCert and 4WD training, as well as a general gas induction.

Mr Drury said: "In the beginning, I was questioned by neighbours as to the wisdom of embracing CSG on our property. Now, I'm receiving more queries from landholders about how CSG could possibly benefit them.

"We were quite naive and didn't realise how big the scale of this development would be, not only on our property, but in the whole district.

"Our journey with CSG has been a positive one. We have seen doors open up, and at the end of the development, our business will be better for it."

To read more about the CSG industry see: www.naturalcsg.com.au

Find Out More

Below is a small selection of some useful reports and websites where you can learn more about natural gas from shale and tight rocks.

Websites

www.appea.com.au
www.csiro.au
www.waonshoregas.info

www.dmp.wa.gov.au
www.dmitre.sa.gov.au
www.minerals.nt.gov.au

www.gisera.org.au
www.iea.org
www.igu.org

Science

Shale Gas

Engineering Energy: Unconventional Gas Production, Australian Council of Learned Academies (June 2013)

Golden Rules for a Golden Age of Gas: Full Report, International Energy Agency (November 2012)

Shale Gas: the facts about the environmental concerns, International Gas Union (June 2012)

Hydraulic Fracturing

Shallow Groundwater Quality & Geochemistry in the Fayetteville Shale Gas-Production Area, US Geological Survey (April 2012)

Fact-Based Regulation for Environmental Protection in Shale Gas Development, University of Texas (February 2012)

Energy and Climate Change Committee Report on shale gas - Update, UK House of Commons (January 2012)

Energy and Climate Change Committee Report on shale gas, UK House of Commons (May 2011)

Health Impacts

Health Watch Study – a three-decade study of occupational health in the oil and gas industry, Monash University (Ongoing)

Water Management

Underground Water Impact Report (UWIR) for the Surat Cumulative Management Area, Queensland Government (July 2012)

Namoi Catchment Water Study – Independent expert final study report (July 2012)