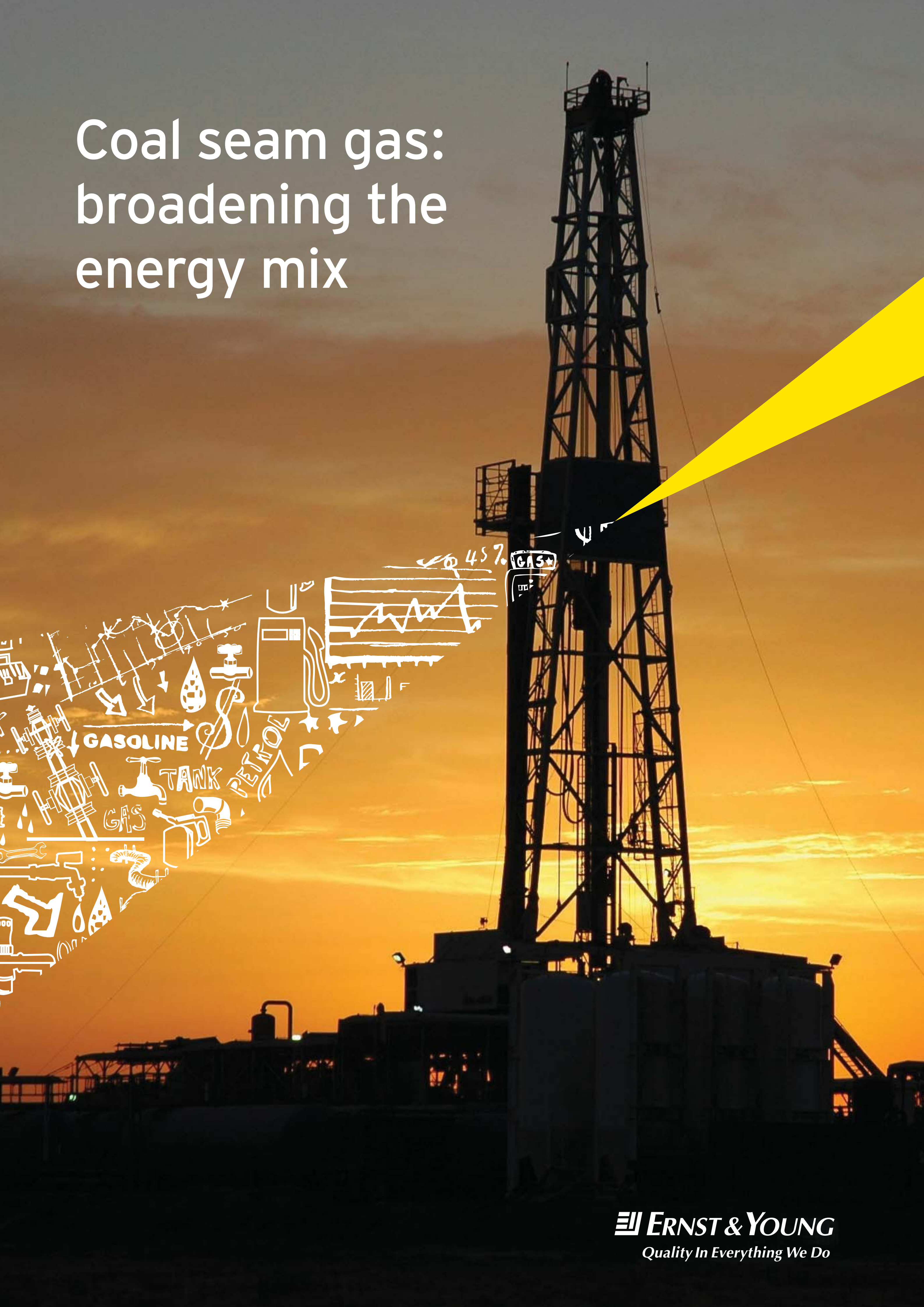
Coal seam gas: broadening the energy mix



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contents

Introduction and overview

Long a risk, but increasingly a reward with new risks and challenges

Coal seam gas (CSG), also known as coal bed methane (CBM), is a form of natural gas recovered from coal mines and coal beds. The presence of the gas has historically been well-known in underground coal mining, where it has long been a safety risk (e.g., the "canary in the coal mine" whose demise typically warned of the presence of deadly methane gas). More recently, however, CSG has been seen as an important source of energy in many countries. It is usually (but not always) produced from coal seams that are either too deep or of insufficient quality to be mined commercially.

CSG can be seen as an energy source that is often environmentally more acceptable than the mining and combustion of coal. It can displace some coal with a cleaner-burning fossil energy source, and it can reduce venting of methane gas into the atmosphere as a result of coal mining activities (methane is more than 20 times more potent a greenhouse gas than is CO2). It also sometimes occurs where other conventional resources of oil and gas are not present.

Production of CSG has historically been led by the US, where production began in the early 1970s. Other notable producing countries include Australia, Canada, China and India, while another handful of countries produce small volumes of CSG, with production usually tied to local, on-site or nearby power generation or industrial use projects. Historically, Australian CSG development has typically been part of an integrated power generation effort and/or focused on local retail gas distribution. But more recently, the engine of growth for CSG has shifted to Australia, where there are hopes and plans to link the country's well-known and readily accessible reserves and resources to the expected strong demand growth for natural gas in Asian markets.

The broader global medium-term gas market (i.e., the next 3–5 years) does, however, present a fundamental challenge for CSG development. Global gas markets are trending toward surplus, with strong growth in production capacity from shale gas and from new liquefied natural gas (LNG) liquefaction capacity, as well as from expanded pipeline delivery infrastructure into Europe and Asia, all in the face of only modest demand growth. Despite being in the region with the strongest gas demand growth, expanded CSG supplies in Australia and elsewhere in Asia will face intense gas-on-gas competition, not only from other Australian gas/LNG projects but from other Southeast Asia sources as well as from the Middle East and Russia.

Challenges for CSG also involve the broader regulatory structure, including mineral ownership rights and land access issues, as well as the general tax and fiscal incentive structure. Fiscal incentives for CSG can be a strong positive driver for development. Most importantly, from an environmental standpoint, there are issues concerning the disposal of the large volumes of water produced from CSG wells in a way that is environmentally acceptable and yet economically feasible. Relatedly, there are broader concerns surrounding the potential effects of CSG development on local water supplies and water quality.

Other challenges and risks include operational ones, such as complicated drilling and technology requirements due to geologic complexity, rig and trained staff shortages, and infrastructure requirements/bottlenecks (e.g., sufficient pipelines, storage capacity and gas export facilities). Economic challenges and risks include the lack of liquids in the gas to support project economics, artificially low or controlled gas prices in some countries, an expected return of cost escalation, and the fact that with limited long-term proved reserves, project developers may be forced to offer equity as a deal sweetener in order to overcome buyer reluctance to sign long-term contracts. This practice comprises what some observers have called "back-door price cuts."

Long a risk, but increasingly a reward with new risks and challenges (continued)

The "size of the prize" with CSG is considered to be immense, but only in a few countries — such as the US, Canada and Australia — has the resource base been carefully quantified. The chart below summarizes the identified and estimated CSG resources in the countries with major coal resources. Notable from the chart is the lack of consistency in estimating CSG reserves and resources across countries, the dramatic inconsistency between known coal reserves and potential CSG resources, and for many key countries the unavailability of some data, and in several instances, the lack of any estimates at all.

Coal and coalbed methane/coal seam gas reserves

	Coal reserves (million tonnes)	Identified CBM/CSG resources	Estimated CBM/CSG resources (billion m^3)	Notes*
Global coal reserves: 20 largest				
US	238,308	Yes	556	(2008 - P1)
Russia	157,010	Yes	75,000-80,000	(2005 - P3?)
China	114,500	Yes	35,000	(2008 - P3?)
Australia	76,200	Yes	198	(2007 - P2)
India	58,600	Yes	2,000	(2002 - P3?)
Ukraine	33,873	Yes	1,700	(2002 - P3?)
Kazakhstan	31,300	Yes	650-830	(2001 - P3?)
South Africa	30,408	Yes		
Poland	7,502	Yes	425-1,450	(1997 - P3?)
Brazil	7,059			
Colombia	6,814	Yes	??	
Germany	6,708	Yes	2,800	(1997 - P3?)
Canada	6,578	Yes	5,000-13,000	(2005 - P3?)
Czech Republic	4,501			
Indonesia	4,328	Yes	10,000	(2004 - P3?)
Greece	3,900			
Hungary	3,302	Yes	155	(2006 - P?)
Pakistan	2,070			
Bulgaria	1,996	Yes	85	(2001 - P2)
Turkey	1,814	Yes	3,000	(2004 - P3?)
Other coal reserves				
Mexico	1,211	Yes	??	
New Zealand	571	Yes	13	(2004 - P3?)
Romania	422	Yes	??	
United Kingdom	155	Yes	2,900	(2005 - P3?)
Vietnam	150	Yes	??	

*Notes - year of estimation; P1 = proved reserves; P2 = probable; P3 = possible/potential

Sources: BP plc, *BP Statistical Review of World Energy* 2010 and Methane-to-Markets Partnership, *Global Overview of CMM Opportunities*, January 2009.

Australia

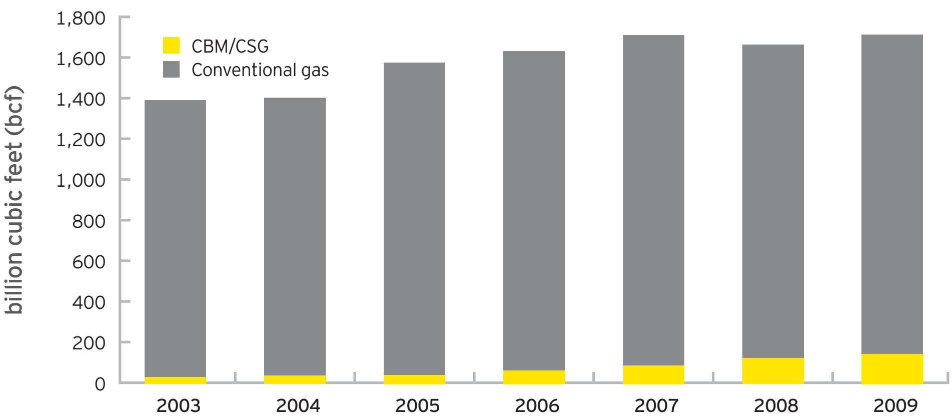
A resource rediscovered

Overview. There is growing commercial utilization of Australia's resources of coal seam gas, with most of these resources located in the black coal deposits of Queensland and New South Wales. The presence of methane has been known since coal mining began in Australia, but separate commercial production of CSG is a relatively recent step. CSG exploration began in 1976 in Queensland's Bowen Basin but it was not until 1996 that the first commercial CSG operation commenced with a methane drainage project at the Moura mine in Queensland. Later in the same year at the Appin and Tower underground mines, a methane recovery operation was used to fuel an on-site power generator. The first stand-alone commercial production of CSG in Australia began in December 1996 at the Dawson Valley project (then owned by ConocoPhillips), adjoining the Moura coal mine.

Two coal basins in Queensland host most of Australia's CSG production: the Bowen Basin and the Surat Basin. In neighboring New South Wales, there is also some production from the Sydney Basin. CSG production began in Queensland in the 1990s, but it has really only been in the past five years that it has ramped up. The Bowen Basin covers a large area in Central Queensland, while the Surat Basin extends through southern Queensland. Proximity to pipeline infrastructure and ease of access to markets in southern Queensland has encouraged exploration and development of the coal seam gas resources in the Surat Basin. In addition, coal seams in the Surat Basin are generally not as thick or as laterally continuous as seams in the Bowen Basin and the gas contents are usually lower.

Production of CSG has increased significantly in the past seven years, with its share of total Australian gas production increasing from 2% in 2002 to about 9% in 2009. CSG production reached almost 140 billion cubic feet (bcf) in 2009, with more than 96% of that total from Queensland. Notably, CSG accounts for about 80% of the Queensland domestic natural gas market.

Australian natural gas production



Source: Australian Department of Energy, Resources and Tourism, *Energy in Australia* 2010, April 2010

A resource rediscovered (continued)

The Australian government's Department of Energy, Resources and Tourism, in its most recent annual assessment, *Energy in Australia 2010*, forecasts that, at the current rates of production, the proportion of economic demonstrated reserves (EDR not repeated) to current production is estimated at 100 years for coal seam gas, as compared to 63 years for conventional gas.[1]

Recent developments and key projects. CSG accounts for about 80% of the Queensland domestic natural gas market, with the gas primarily used in power generation. It is expected that a significant proportion of eastern Australia's CSG will continue to be consumed domestically, supporting the projected growth in gas-fired electricity generation and the planned shift away from coal-fired generation. But from 2015, it is expected that the growth of CSG will be driven by conversion to exportable LNG.

There are currently several proposed CSG-LNG projects with a potential combined capacity of up to 40 million tonnes of LNG (almost 2 trillion cubic feet) per year. The four major projects are summarized in the table below.

Major Australian CSG-LNG projects

	Partners	Capacity	Status	FID	First LNG	Capex*	Sales agreements
Queensland Curtis LNG	BG Group: 93–94% CNOOC: 5% Tokyo Gas: 1–2%	8.5 mtpa (2 trains)	FID	2010	2014	~$15–20	>100% CNOOC, Tokyo Gas, others
Gladstone LNG	Santos: 30% Petronas: 27.5% Total SA: 27.5% Kogas: 15%	7.8 mtpa (2 trains)	FID	2011	2015	~$16	90% Petronas, Kogas
Australia Pacific LNG	ConocoPhillips: 42.5% Origin Energy: 42.5% Sinopec: 15%	9.0 mtpa (2 trains)	FEED	2011	2015	~$18–20	50% Sinopec
Arrow Energy LNG	Shell: 50% PetroChina: 50%	8.0 mtpa (2 trains)	FEED	CY 2012	>2016	~$15	100% Shell, PetroChina

* estimated capex in US$ billion - possible expansions are excluded

As the table shows, there has been considerable success in securing LNG off-take from Asian LNG buyers. Sellers are thought to have been successful in maintaining pricing for long-term contracts tied to the Japan customs-cleared oil price (otherwise known as the Japan crude cocktail or JCC), thereby securing oil price indexed revenue — perhaps in part due to the trend of offering corresponding equity participation in the upstream.

The economics of developing a two-train project have proven challenging in the face of cost escalation in the industry. Adding a third and fourth train are considered likely outcomes in order to benefit from economies of scale and thereby improve project economics. Future consolidation among the joint ventures is possible, but is not currently being publically discussed.

[1] Australian Department of resources, Energy and Tourism, *Energy in Australia 2010*, April 2010.

New fiscal framework. On 2 July 2010, the Australian government announced its plans to expand Petroleum Resource Rent Tax (PRRT) to cover onshore oil and gas projects on the North West Shelf. A policy transition group composed of representatives from industry and government was formed and, following a period of consultation with industry leaders, detailed recommendations were made to the government on 21 December 2010.

While legislation is yet to be finalized, the key elements of the regime are currently expected to be implemented as follows:

- Start date of 1 July 2012
- Headline tax rate of 40% (income tax deductible)
- No de-minimis threshold
- An immediately deductible starting base to shelter pre-committed projects
- A credit for state royalty and federal excise
- Consolidation for projects with common upstream or downstream infrastructure
- Augmentation and carry-forward of surplus starting base and royalty

Including income tax, the nominal tax rate for onshore oil and gas projects will increase from 30% to 58%, although the economic impact for existing projects is expected to be lower, given creditability of state royalty and the deductibility of the starting base. Companies transitioning into PRRT should start to consider the implications today. Critical issues include:

- Scheduling of expenditure: outcomes may be different for expenditure incurred before and after start-up
- Commercial transactions: economics, timing, structure and contractual terms could all be affected
- Starting base selection and measurement: this could have a material impact on project economics
- PRRT compliance and reporting: significant changes to systems and processes are likely
- Legal review of contracts: joint operating agreements and general services agreements may require amendment

A tax partner in the Ernst & Young Australian practice commented that the introduction of PRRT for onshore oil and gas increases the nominal effective tax rate for Australian oil and gas companies operating in the sector and therefore increases the government take relative to other oil and gas producing countries. This is particularly important in the context of global competition for development of unconventional oil and gas resources. We see a significantly lower rate for gas production in China and more in terms of incentives in countries such as India with comparable rates. Further review is needed to establish the likely impact of the changes, including changes to corporate income tax rate, exploration incentives and carbon tax, in order to better understand the impact on this important industry.

Specific issues and challenges. Challenges for CSG in Australia include a new, fairly complicated tax structure, parts of which are still being finalized, along with large associated infrastructure requirements and potential bottlenecks (i.e., lack of sufficient pipelines, storage capacity and gas export facilities). Economic challenges and risks include the lack of liquids in the gas to support project economics, competition with other sources of domestic natural gas, an expected return of cost escalation, and as previously mentioned, the fact that with limited long-term proved reserves, project developers may be forced to offer equity as a deal sweetener — the back-door price cuts — in order to overcome buyer reluctance to sign long-term contracts.

Most importantly, from an environmental standpoint, there are issues concerning the disposal, in an environmentally acceptable and yet economically feasible manner, of the large volumes of water that are produced from CSG wells. Additionally, broader concerns exist surrounding the potential effects of CSG development on local water supplies and water quality.

Prospects and challenges in other key countries

Canada. Canada may hold as much as 450 trillion cubic feet (tcf) of CSG reserves, with the Western Canada Sedimentary basin and essentially the province of Alberta holding the vast majority of the reserves. Until recently, 90% of the CSG development in Canada occurred in the Horseshoe Canyon coal zone. CSG production is still at a nascent stage in Canada, with the first well drilled in 1997. In 2009, around 1,848 CSG production wells were completed, and more than 14,000 wells are currently producing natural gas from CSG reserves in the country. A total of 318 bcf of gas was produced from CSG reserves in 2009, up 6% from 2008. According to Alberta's Energy Resources Conservation Board, production is expected to reach 533 bcf by 2019, contributing 20% of total Alberta marketable gas production, compared with 7% in 2009. Overall, CSG production in Alberta is regulated by the Alberta Energy and Utilities Board and all existing regulations for conventional natural gas development apply to CSG. The key development challenges are the environmental issues around water management, while other challenges include high finding and development costs due to weather-related constraints, and high pipeline tariffs on natural gas production exported to the major eastern markets in the US.

China. According to the International Energy Agency (IEA), China has as much as 1,300 tcf of CSG resources, ranking third after Russia and Canada. China produced about 257 bcf of CSG in 2009, and in 2010, production was estimated to be about 350 bcf. By 2015, production is expected to reach 700 bcf. The Chinese central government plans to support a total of 17 CSG projects over the 2006–2020 period, including 10 research projects, five demonstration projects and two equipment manufacturing localization projects. Current activity in CSG is dominated by the large national oil and gas companies (NOCs). Mineral resources are owned by the state and unless otherwise specified, the stipulations formulated by the Ministry of Finance, the State Administration of Taxation and the Offshore Petroleum Taxation Bureau concerning taxes for the development of oil resources are also applicable to the development of onshore CSG resources. Currently, China's biggest CSG challenge is that its infrastructure is incomplete. The natural gas industry started relatively late, and its supporting transmission and distribution network has lagged. Currently, only a few areas have regional gas transmission pipeline networks, limiting large-scale CSG commercial development. Although many of China's reservoirs contain high amounts of gases, reservoir pressure and permeability are low, and gas production rates are also low. In addition, investing in China's energy sector is also subject to regulatory risk; it is highly regulated and fragmented, and clear-cut guidance is often not readily available. The approval process for CSG projects can also be lengthy. CSG is a relatively immature industry compared to oil, and a more established legal framework and coordinated incentives are required to foster the development of market infrastructure.

India. India holds the fifth largest proved reserves of coal. India holds about 65.2 tcf of potential CSG resources, of which only 8.4 tcf of reserves have been established. Four CSG bidding rounds for exploration activities have been held, but commercial production of CSG in India has only commenced in the Raniganj (South) CSG block in West Bengal. Of the 33 blocks awarded so far, 25 blocks (including recently awarded blocks in CSG IV) are under exploration phase, three blocks are under development, three blocks have been relinquished after initial exploration and two blocks await approval to commence exploration. Among the companies, Oil and Natural Gas Corporation (ONGC), the state-owned upstream company, leads the group with ownership in nine blocks. To boost investments in CSG, the Indian government offered attractive terms during the initial rounds of CSG bidding, but in the latest bidding round, it substantially reduced the incentives for CSG and tightened environmental standards. CSG development is hindered by the lack of clarity around legal and regulatory issues as well as by the operational challenges from infrastructure bottlenecks.

Indonesia. Indonesia possesses CSG potential of more than 450 tcf from 11 identified basins spread across the country. The coal seams of Indonesia are considered to be the thickest and most continuous coal seams, with the lowest ash content (<10%) in the world. Most of the CSG reserves in Indonesia are estimated to be found at an optimal depth of 3,000 feet for development with about 94–98% of methane content. Although, commercial production of CSG is yet to begin, consultants Wood Mackenzie anticipates 22 million cubic feet per day (mmcf/d) of production rate in 2013 (approximately 8 bcf), with production expected to further increase to 900 mmcf/d by 2020 and 1,300 mmcf/d by 2025

(330 bcf and 475 bcf, respectively)[2]. Under Indonesian law, CSG operations are treated as oil and gas operations. Any company that intends to commercialize CSG in Indonesia needs to enter a contract with the executive or regulatory agency, BPMIGAS. According to Mineral Resources regulation, coal rights holders and holders of oil and gas production sharing contracts (PSCs) will have the first rights to undertake CSG operations in their concession areas. Since May 2008, the Indonesian government has awarded 21 PSC awards and anticipates that some of the CSG blocks will begin production by as early as 2011. For contracts signed in 2010, the government offered two options on the development CSG blocks: the investors could choose between the net production sharing contract or gross production sharing contract (GPSC). The new GPSC provisions would grant operators freedom to commercialize the gas produced during dewatering, which can be much before the development plan is approved, but would neither provide for cost-recovery before production-split, nor would it allocate 10% to the government as in PSCs. The government currently offers a 55–45 production split in its favor and a ceiling of 90% cost recovery. As it is elsewhere, Indonesian CSG development is challenged by regulatory uncertainty, infrastructure bottlenecks and by the technological challenges of early pre-commercial development.

Russia. Russia is estimated to have 2,996 tcf of CSG resources. To date, CSG was extracted in Russia as a by-product from the existing coal mines through the mine degassing systems. Direct CSG production is not yet commercialized in Russia; however, Gazprom is in the process of initiating CSG production. In February 2010, Gazprom began construction of its first CSG production facility at the Taldynskoye field in the Kuzbass region, from which it expects to begin CSG production starting in 2016. Presently, there is not much clarity on the policy and tax framework for CSG production in Russia. Moreover, there are no incentives in the form of tax holidays or subsidies for the CSG producers in the country. The policies also lack provision for obtaining licenses for CSG production. As elsewhere, development is further challenged by infrastructure bottlenecks and the technological challenges of early pre-commercial development.

Ukraine. The CSG reserves of Ukraine are expected to be as high as 60 tcf. However, there has been no commercial production of CSG in Ukraine to date. In Ukraine, coal mines and coal resources are owned by the government and a company intending to develop the CSG resources needs separate licenses to develop the resources. Currently, Ukrainian laws on licensing of resources allow a company to obtain a development license for a five-year period (after fulfilling certain requirements) before obtaining a production license for the project. Both the development and production licenses include a fee, which is paid to the government. CSG reserves in Ukraine are operated through PSCs, which lay down the standards for operational, financial and institutional performance. The gas produced from the degasification of the methane content in coal seams is recognized as the right of the permit holder of the coal mine or of any legal entity who has sought the prior approval of the permit holder. CSG development currently suffers from a lack of adequate government support and an inadequate legal framework to promote foreign investment in CSG development. The methane rights are not easily transferrable in the country and the tax structure is seen as highly complicated.

United States. According to US Geological Survey (USGS), the US is estimated to hold more than 700 tcf of CSG reserves, out of which 160 tcf is economically recoverable using the current technologies. At the end of 2009, the US had 18.6 tcf of CSG proved reserves. CSG production started in 1989 and, with the support of the government (in the form of subsidies and funding support), grew significantly during the 1989–2003 period. In 2009, CSG accounted for about 6.8% of total gas reserves and 8.9% of gas production in the country. To date, the majority of the CSG production has come from the Rocky Mountain region encompassing Colorado, Montana, New Mexico, Utah and Wyoming. The San Juan Basin (in Northern New Mexico) and Southern Colorado are the most extensively developed CSG basins in the region, while the Powder River Basin in eastern Wyoming and southeastern Montana is currently the fastest-growing basin for CSG development. By and large, the regulations that control conventional natural gas development also apply to CSG exploration and production. The greatest concern and controversy associated with CSG development in the US involves the environmental issues around the disposal of the large quantity of water produced during CSG production. Relatedly, another emerging concern is the US Environmental Protection Agency's (EPA's) study of and potential regulations involving disclosure of fluids used in hydraulic fracturing.

[2] Wood Mackenzie press release, 15 September 2010

The fundamental challenge and risk

Getting to the long term

The current and longer term global gas economics remain very unclear, due to several factors:

- Globalization of the gas market has slowed or halted, and seemingly been overtaken by a "re-regionalization."
- Worries about shortages of supply have been replaced by worries about the lack of demand.
- Sustained growth in gas demand in the US and Europe has been thwarted by sluggish economic recovery.
- Gas demand is not particularly elastic at low prices in the US and Europe and just as importantly, gas demand is not particularly elastic at high prices in Asia, a reflection of cost pass-through capabilities of buyers as well as strategic oil displacement objectives.
- There have been major oilfield service technology advances in the last 10–20 years (e.g., horizontal drilling, hydraulic fracturing); what might the next generation hold?
- Leasehold stipulations have driven sub-economic behavior in many shale gas plays in the US (over-drilling and over-supply); how long can this continue?
- There are rising environmental concerns with unconventional gas (shale gas and CSG) that largely involve water use, disposal and potential contamination; how restrictive might the regulatory reaction be?
- Wavering government commitments to greenhouse gas (GHG) emission reductions may slow the predicted increase in long-term gas demand. In the US, strong gas-on-gas and coal-on-gas competition keeps pressure on spot prices; the situation in Europe is mixed with some oil-indexed priced gas competing with other gas, while Asia is dominated by price-insensitive buyers willing to commit to oil-indexed supply.
- LNG will "swing" between/among markets; notably, it generally has very low marginal cash costs (<$2/million BTUs), with some Middle East gas "essentially free" when natural gas liquid (NGL) economics are considered.

According to Deutsche Bank, in conjunction with Wood Mackenzie, global gas demand is set to grow at more than 3.5% per year between 2010 and 2015, led by demand growth in Asia at more than 7.5% per year. The IEA's more conservative forecast sees demand growth at less than 2% per year. But even with stronger growth, the medium-term market will be challenged by ample supply capacity, owing to the shale gas boom in North America and recent/expected surge in LNG liquefaction capacity. In 2010, Deutsche Bank/Wood Mackenzie estimated the current excess supply capacity to be around 10 bcf/d (compared to global demand of ~300 bcf/d), with that excess set to grow substantially in 2011 as LNG capacity additions, notably in Qatar, Peru and Yemen, outstrip any gains in demand. As a result, spot gas prices are expected to remain relatively soft, particularly in North American markets.[3]

Beyond 2015, however, the market balance is expected to turn. Assuming even conservative demand growth assumptions, such as those of the IEA or the US Department of Energy, which estimate demand growth of 1.5% per year, the supply cushion will quickly disappear. According to the IEA in its most recent World Energy Outlook, under its "central" or most-likely New Policies Scenario, over the 2015–2035 period, global gas demand is expected to grow by a trillion cubic meters or almost 100 bcf/d.[4] With most of the world's conventional gas supply in decline after 2015, strong developers with quality projects and competitive costs will be well-positioned as markets tighten.

[3] Deutsche Bank Global Research, *Global Nature Gas — Battlefield Analysis*, 13 September 201

[4] International Energy Agency, *World Energy Outlook 2010*, November 2010

Addressing the issues and potential pitfalls

How can Ernst & Young help?

Ernst & Young has established a global network of more than 8,300 dedicated oil and gas professionals in more than 100 countries, supported by 12 Global Oil & Gas Centers. Our professionals assist companies operating in or looking to participate in the CSG industry with a daunting array of challenges, risks and issues including:

Access to reserves. Unconventional resources such as coal seam gas are becoming an important part of oil and gas companies' portfolios as technology makes them cost-effective and the world's need for energy makes them an important part of the supply mix. Particularly in a region such as Asia, where long-term demand growth is expected to be strong, the reserve potential of CSG presents tremendous opportunities.

The larger, more technically challenging and capital-intensive projects are being conducted using increasingly complex joint venture models, which are necessary to help the companies involved share the associated risks, technology and capital. Ernst & Young supports companies in the identification, implementation and management of these strategic partnerships and acquisitions, helping them to minimize risks, dilute costs, gain access to markets and take advantage of these opportunities in a timely manner.

For example, in several countries, smaller or "junior" producers are actively proving up CSG reserves in their own right. Historically, share prices have responded well to increased reserves announcements but in recent times, investors are also looking to a strong commercialization plan. This reflects the recognition that the CSG majors may not need those reserves in the short term to deliver on their projects. Ernst & Young is working with junior producers to raise necessary capital, identify strategic partners and develop innovative structures to facilitate the commercialization of reserves.

Cost and risk management. Globally, oil and gas companies are again seeing significant increases in drilling, service, production and operating costs. The increasing levels of upstream capital expenditure that are being seen across the industry are a further incentive for leading organizations to optimize their costs and working capital. Companies have to manage cost-cutting concerns as well as the pressure for rapidly maturing opportunities in an environment that demands huge investments and flexibility to overcome technological and operational challenges.

For example, in the Australian CSG sector, the tension between cost management and operational performance is no less stark. A small difference in the standardized costs per well can make a significant difference to total project costs, given the number of wells to be drilled. Ernst & Young's advisory services and supply chain management teams have focused on individual processes, such as procurement, to identify inefficiencies and deliver significant savings.

Managing capital projects. The large number of megaprojects around the world currently in the process of being implemented or awaiting Final Investment Decision (FID) has cast a spotlight on the need for world-class project management. This is no different for the major coal seam gas joint ventures. The capital budgets of these projects have become so large and the business process and procurement processes so complex that the difference between average project management and leading project management processes can be many millions of dollars. It is vital to adopt leading management and governance practices for project support and management processes to avoid the emergence of "cost bubbles" and inefficiencies that would undermine the economics of the expansion plan and even threaten safe, efficient and effective operations.

Ernst & Young's Capital Project Management team is working on oil and gas megaprojects to develop and implement industry leading project management models.

Regulatory assessment and compliance. Recent years have seen both an increase in regulation and an increased focus on regulatory compliance. Companies have had to increase their efforts to ensure compliance with both existing and new regulations and to manage the transition to International Financial Reporting Standards (IFRS) in certain geographies. The pace of change in this area is likely to accelerate with the passage of US financial reform legislation (also known as the Dodd Frank bill), the UK Bribery Act and the Extractive Industries Transparency Initiative. These initiatives, as well as a host of increasingly stringent new environmental regulations, will add to the workload of the compliance functions, finance departments and the broader organization.

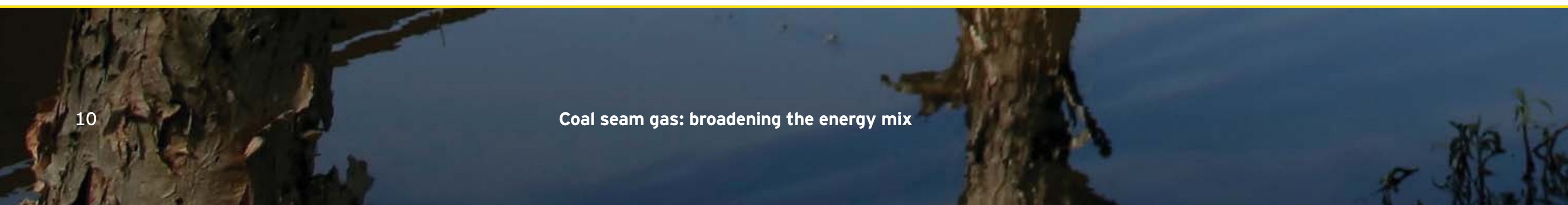
In addition to various global regulations, the CSG sector is often subject to a broad array of industry-specific domestic regulations. The regulatory issues that are particularly important in CSG development include water management, where local environmental concerns will continue to be a primary management focus; changing national or state fiscal terms, structure and reporting requirements; as well as new reserve reporting requirements.

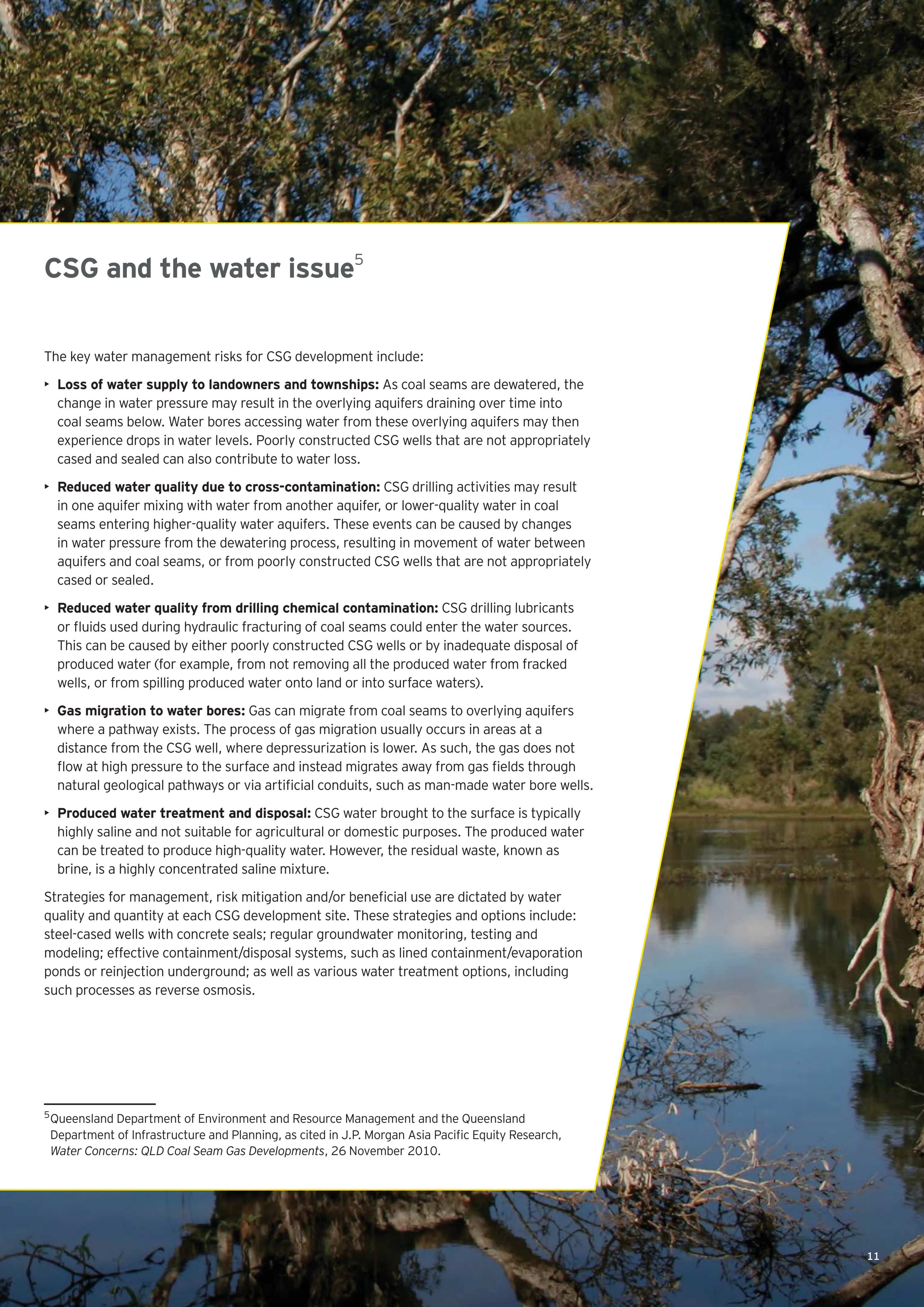
The simple (or not so simple) issue of ownership of the gas

Ill-defined gas property rights and a lack of clarity regarding the ownership of the CSG in many countries serve as obstacles to gas development and gas utilization projects. The entities engaged in CSG project development need to have a uniform regulatory framework establishing ownership. The fairly simple question of who "owns" or has rights to the methane adsorbed to a particular coal estate does not always have a straightforward answer. Thus, one can see a large variety of legal forms and instruments in this sphere, adapted to specific conditions throughout countries that are the largest producers of coal in the world. Disputes or judicial examinations may take place if existing laws do not clearly regulate the arising legal relationship between stakeholders (surface and project owners, the government and gas leaseholders), further impeding CSG project development. For example:

- In Ukraine, coal gas falls into a mineral resource category regulated at the national level, and the people of Ukraine own the country's mineral wealth. Thus, the standard mineral licensing procedure has to be applied to CSG. However, while coal seam degassing is performed during coal production in line with specific mining safety rules, these safety rules do not relate methane extraction to mineral wealth extraction. Therefore, degassing system methane emissions can be regarded as production waste, owned either by the mine owner or, possibly, nobody. This legal peculiarity creates some uncertainty toward methane ownership and has a negative impact on resolution of the licensing issue.
- In the UK, the government owns the methane associated with coal and regulates the rights to the gas. The government passes its ownership to the licensee when methane is recovered. Because mine gas is considered a petroleum product, the regulation of rights does not rest with the Coal Authority, and under the Petroleum Act of 1998, the Department for Business Enterprise & Regulatory Reform awards Petroleum Exploration and Development Licenses (PEDLs) that cover coal-associated methane. However, the government also issues a Methane Drainage License (MDL) to operating coal mines in order to regulate methane drainage for safety reasons. An MDL usually covers smaller areas than a PEDL and it does not grant exclusive rights, so it can overlap geographically with one or more PEDLs. In practice, these kinds of licensing arrangements may lead to situations when several interested parties are likely to have pretensions of methane extraction and its recovery in the same area.
- In the United States, there is controversy regarding the ownership of methane produced from coal seams, as carbon-based mineral rights come under different jurisdictions. The coal lessee has the right to capture and discharge methane without holding a gas lease supplementary to the coal lease. Also, there is no need to pay royalties if mine gas is vented to the atmosphere to keep mining operating conditions safe. If a mining company wants to utilize extracted CSG, it must follow the federal leasing procedures and pay royalties to the government. Although some states have attempted to clarify the ownership issue through legislation, the US government has not done so. Therefore, these disputes are settled on a case-by-case basis.

In most countries, a coal leaseholder does not obtain rights to CSG automatically, and separate licensing for mine gas recovery and utilization is required. Additionally, several coal mining countries that have federal forms of government lack a national legislative framework regulating CSG extraction and recovery activities. For example, in Australia, each state has its own legislation and licensing arrangements. A similar situation occurs in Canada, where the provinces own and can sell the rights to develop CSG at their discretion. By contrast, in Germany, the Federal Mining Authority is responsible for the administration of all activity related to CSG exploration, extraction and processing. Ownership rights are transferred to a coal mining company for the duration of a coal mining license, after which the capture of mine gas requires a renewed license in its own right for at least another 30 years.





CSG and the water issue[5]

The key water management risks for CSG development include:

- **Loss of water supply to landowners and townships:** As coal seams are dewatered, the change in water pressure may result in the overlying aquifers draining over time into coal seams below. Water bores accessing water from these overlying aquifers may then experience drops in water levels. Poorly constructed CSG wells that are not appropriately cased and sealed can also contribute to water loss.
- **Reduced water quality due to cross-contamination:** CSG drilling activities may result in one aquifer mixing with water from another aquifer, or lower-quality water in coal seams entering higher-quality water aquifers. These events can be caused by changes in water pressure from the dewatering process, resulting in movement of water between aquifers and coal seams, or from poorly constructed CSG wells that are not appropriately cased or sealed.
- **Reduced water quality from drilling chemical contamination:** CSG drilling lubricants or fluids used during hydraulic fracturing of coal seams could enter the water sources. This can be caused by either poorly constructed CSG wells or by inadequate disposal of produced water (for example, from not removing all the produced water from fracked wells, or from spilling produced water onto land or into surface waters).
- **Gas migration to water bores:** Gas can migrate from coal seams to overlying aquifers where a pathway exists. The process of gas migration usually occurs in areas at a distance from the CSG well, where depressurization is lower. As such, the gas does not flow at high pressure to the surface and instead migrates away from gas fields through natural geological pathways or via artificial conduits, such as man-made water bore wells.
- **Produced water treatment and disposal:** CSG water brought to the surface is typically highly saline and not suitable for agricultural or domestic purposes. The produced water can be treated to produce high-quality water. However, the residual waste, known as brine, is a highly concentrated saline mixture.

Strategies for management, risk mitigation and/or beneficial use are dictated by water quality and quantity at each CSG development site. These strategies and options include: steel-cased wells with concrete seals; regular groundwater monitoring, testing and modeling; effective containment/disposal systems, such as lined containment/evaporation ponds or reinjection underground; as well as various water treatment options, including such processes as reverse osmosis.

[5] Queensland Department of Environment and Resource Management and the Queensland Department of Infrastructure and Planning, as cited in J.P. Morgan Asia Pacific Equity Research, *Water Concerns: QLD Coal Seam Gas Developments*, 26 November 2010.

How can Ernst & Young help? (continued)

Ernst & Young's Climate Change and Sustainability team is familiar with the upstream and downstream regulatory issues facing the oil and gas sector and specifically CSG companies, and assists companies in mapping and managing relevant regulatory requirements. Additionally, the Ernst & Young Fraud Investigation and Dispute Services team works closely with clients to develop policies that align with global and local regulation and to the audit and operation of key controls.

Portfolio management. For several years, the oil and gas industry has seen higher transaction levels as major joint ventures have been formed and both international and national oil companies (IOCs and NOCs) have rushed to ensure that they were positioned to participate in the sector. Globally, recent record levels of upstream capital investment are also driving portfolio rationalization across the industry and the large number of megaprojects in the upstream industry has created a record number of major new joint ventures, particularly ventures involving CSG.

For example, Ernst & Young's oil and gas leader in Australia for Transaction Advisory Services, Roger Dartnell, states: "The size of these CSG megaprojects and the need for off-take have given rise to multi-party joint venture arrangements; this has, in part, helped to endorse the sector in the eyes of Asian investors and allowed small and medium-sized coal seam gas companies to tap new pools of strategic investors. Therefore, while the CSG majors are both unlikely to consolidate in the near term or seek to buy-in additional reserves, access to these new sources of funding will reduce illiquidity issues in the domestic equities market. The sector remains on course for strong growth."

Combining these issues with a fast-changing regulatory, tax and economic environment means that developing and implementing strategic investment and divestment plans has never been more complex, or more important. In this regard, preparing and adapting processes, people and systems to this new upcoming partnership and integration model is a critical factor. It is important to develop the best strategies to support business growth and to overcome the challenges posed by infrastructure, skilled labor shortages, taxation and local regulations. In addition, it is imperative to implement an efficient supply chain that considers the tax and environmental impacts. Ernst & Young's experienced, accessible and locally connected transaction advisory support team is a key differentiator and enabler.

Operational challenges. Operational challenges for the coal seam gas industry have grown significantly over the past year, due mainly to the increased focus on driving exploration and production in a frontier environment. Oil and gas companies are continuing to adopt new technologies to mitigate the risk of losing their competitive advantage. This process includes a strategic commitment to research and development (R&D), ongoing investments to upgrade existing facilities and the development of joint ventures with technology providers. In Australia, Ernst & Young's tax team is working closely with companies to help them understand the incentives available for research and development and to assist with development of their R&D initiatives and claims.

In addition, the technological, managerial and logistical challenges of the new energy frontiers are as significant as their potential. Producing companies and their partners will face a business and operational environment with increasing demands for adopting leading management, planning and control practices. Ernst & Young is helping these companies overcome key logistical challenges, such as:

- Navigating and complying with complex tax systems (such as the introduction of the new PRRT in Australia)
- Raising and managing capital
- Optimizing working capital (including reviewing joint venture billing arrangements)
- Assessing and managing human capital requirements

Human resource issues. As is inevitable in a fast-growing new sector, skills shortages are quick to materialize and slow to resolve. This is acutely true in relation to some of the big CSG projects in Australia. For example, Energy Skills Queensland forecasts that several thousand new jobs will be required in the coming years as the sector continues to grow toward its first LNG export. In Australia, as is often the case elsewhere with large energy developments, many in the new workforce will need to come from overseas. Critical to success is to plan immigration, remuneration and retention packages that attract and retain the right skills. Ernst & Young's Human Capital team provides full services across the spectrum, including immigration, salary and retention packaging to support its clients in the industry.

Ernst & Young's oil and gas professionals are organized within four service lines: assurance, tax, transactions and advisory. They bring both breadth and depth of oil and gas industry experience to the table, built on extensive experience with the major industry players, including international as well as national oil companies. Our experience and services offerings particularly relevant to the oil and gas sector and industry include:

- Statutory accounting and compliance services, including external audit and other assurance-related services, such as HS&E, climate change and sustainability reporting services; accounting advisory services; and fraud investigation and dispute services
- Tax planning, advisory and compliance services, including in-bound tax compliance services; transaction tax services; and tax-efficient supply chain advisory services
- Transaction advisory services, including partnership planning and optimization; portfolio planning and evaluation services; strategic financing assessments; transaction due diligence; asset valuation and business modeling; and transaction integration services
- Performance improvement and risk management advisory services, including internal audit services and internal controls design and evaluation; planning, budgeting and forecasting optimization; business process innovation, transformation and governance; project life cycle management services and Project Management Office (PMO) implementation and operation; and strategic risk assessment, management and remediation

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How Ernst & Young's Global Oil & Gas Center can help your business
The oil and gas industry is constantly changing. Increasingly uncertain energy policies, geopolitical complexities, cost management and climate change all present significant challenges. Ernst & Young's Global Oil & Gas Center supports a global practice of over 8,000 oil and gas professionals with technical experience in providing assurance, tax, transaction and advisory services across the upstream, midstream, downstream and oilfield service sub-sectors. The Center works to anticipate market trends, execute the mobility of our global resources and articulate points of view on relevant key industry issues. With our deep industry focus, we can help your organization drive down costs and compete more effectively to achieve its potential.

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