> andrew dickson > +61 2 6272 2173 > adickson@abare.gov.au

energy

outlook for oil and gas, thermal coal and uranium to 2011-12

> alan copeland, chris rumley, kate penney and william mollard

oil and gas

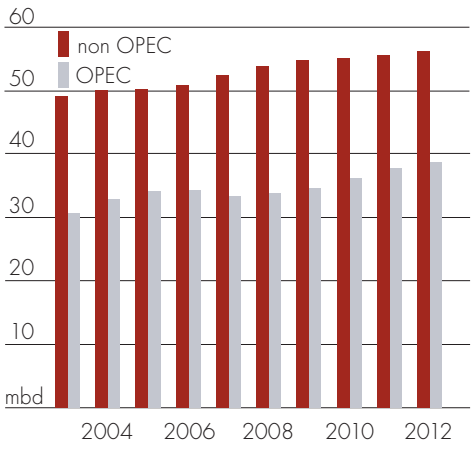
> alan copeland and chris rumley

The world price of West Texas Intermediate (WTI) crude oil averaged around US$66 a barrel during 2006, an increase of 17 per cent on 2005. Prices reached a record US$78 a barrel in July, reflecting strong growth in demand in the first half of 2006 and concerns over supply security from the Middle East associated with the conflict between Israel and Lebanon and tensions over Iran's proposed nuclear program. However, prices quickly retreated during the second half of 2006, as a result of some easing of tensions in the Middle East, and strong growth in non-OPEC supplies, including from the Gulf of Mexico where there was a relatively calm hurricane season. Demand for heating oil in the United States was also weaker than usual, reflecting unseasonably mild temperatures in the north east of the United States during November and December 2006. In response to falling oil prices in the latter part of 2006, OPEC twice cut production quotas by a total of 1.7 million barrels a day – or 5 per cent of its 2006 estimated oil production capacity. By mid-January 2007, oil prices in WTI terms were as low as US$50.30 a barrel.

Looking forward, world oil prices are forecast to continue to retreat from the records in 2006, reflecting higher production from non-OPEC countries and an increase in OPEC spare capacity. Growth in global oil consumption is also forecast to be moderate as increased demand in developing economies is partially offset by lower demand in the European Union and Japan. In 2007, the WTI oil price is forecast to fall by 13 per cent to US$57 a barrel, and remain close to that in 2008. Although there is potential for prices to fall further, OPEC is expected to manage production through adjustments to production quotas in order to provide support for prices.

In real terms (2007 dollars), prices of WTI crude oil are forecast to fall moderately to around US$45 a

world oil production



barrel by 2012. Growth in world consumption is projected to increase by around 1–2 per cent a year and is centred on developing Asia (including China), the Middle East and the Russian federation. The completion of new projects within OPEC is expected to increase the organisation's nominal spare capacity to a projected 5 million barrels a day by 2012. This increase in spare capacity is expected to reduce supply volatility and lead to a reduction in the large price swings of the past few years. In addition, significant new capacity is scheduled to be introduced in non-OPEC countries.

oil and gas outlook

	Unit	2005	2006	2007 f	2008 z	2009 z	2010 z	2011 z	2012 z
World									
Production	mbd	84.5	85.3	85.8	87.7	89.6	91.4	93.4	95.1
Consumption	mbd	83.6	84.5	86.2	87.7	89.6	91.5	93.5	95.1
Trade weighted crude oil price **b**									
– nominal	US$/bbl	49.57	60.21	52.73	51.29	50.50	48.75	47.38	46.03
– real **c**	US$/bbl	52.50	61.59	52.73	50.13	48.25	45.54	43.26	41.39
West Texas Intermediate crude oil price									
– nominal	US$/bbl	56.51	66.02	57.18	56.13	54.81	52.88	51.30	50.25
– real **c**	US$/bbl	59.85	67.53	57.18	54.86	52.38	49.39	46.84	45.19
		2004 -05	**2005 -06**	**2006 -07 f**	**2007 -08 z**	**2008 -09 z**	**2009 -10 z**	**2010 -11 z**	**2011 -12 z**
Australia									
Crude oil and condensate									
Production	ML	27 311	24 320	27 988	29 190	34 074	31 550	29 213	27 049
Export volume	ML	15 731	13 026	15 589	16 675	18 850	17 352	16 067	14 877
Export value									
– nominal	A$m	6 330	6 638	7 766	7 870	9 018	8 305	7 686	7 145
– real **d**	A$m	6 737	6 846	7 766	7 678	8 583	7 712	6 963	6 315
Imports	ML	26 054	24 416	23 688	22 235	18 633	20 178	21 562	23 381
Natural gas									
Production	Gm^3	41.3	42.2	45.2	50.1	56.2	60.2	62.9	66.0
LNG export volume	Mt	10.6	12.5	15.2	15.4	16.9	19.0	19.4	25.1
LNG export value									
– nominal	A$m	3 199	4 416	5 393	5 567	6 570	7 121	7 404	9 619
– real **d**	A$m	3 405	4 554	5 393	5 432	6 254	6 612	6 708	8 502
LPG									
Production **e**	ML	4 628	4 722	4 997	5 180	5 450	5 550	5 670	6 150
Export volume	ML	2 844	2 800	3 063	3 150	3 266	3 033	2 914	2 998
Export value									
– nominal	A$m	804	1 002	1 047	1 029	1 040	983	962	1 008
– real **d**	A$m	856	1 033	1 047	1 003	990	913	872	891
Petroleum products									
Refinery production	ML	40 202	36 274	36 876	35 200	33 375	32 707	32 053	31 412
Other **g**	ML	4 366	5 827	2 844	3 315	5 220	5 464	5 925	6 185
Exports **h**	ML	1 847	2 082	2 067	2 125	2 241	2 013	1 896	1 772
Imports	ML	11 188	15 124	18 827	21 200	22 370	23 491	24 739	26 020
Consumption – total net **i**	ML	54 017	55 151	56 510	57 590	58 724	59 650	60 821	61 845

a One megalitre a year equals about 17.2 barrels a day. **b** Official sales prices or estimated contract terms for major internationally traded crude oils. **c** In 2007 US dollars. **d** In 2006-07 Australian dollars. **e** Primary products sold as LPG. **g** Refinery swells and losses, stock changes, petrochemical byproducts and naturally occurring LPG for domestic consumption. **h** Excludes LPG. **i** Liquid petroleum products including refinery fuel, feedstocks and losses, and international ships and aircraft stores. **f** ABARE forecast. **z** ABARE projection.
Sources: Energy Information Administration (US Department of Energy); ABARE.

OPEC and non-OPEC production to continue to grow

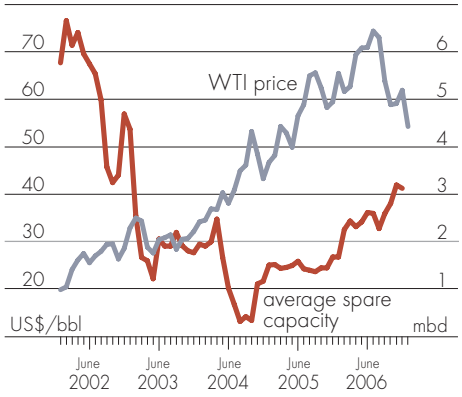
In recent years, production from non-OPEC producers has contributed significantly to the increase in world oil supplies. Over the period to 2012, production from non-OPEC suppliers is projected to grow at an average rate of 1.4 per cent a year. Production grew at an annual rate of 1.7 per cent between 2000 and 2006. A range of projects are well advanced in the Gulf of Mexico, the Russian Federation, the Caspian Republics (Azerbaijan and Kazakhstan) and Canada. In the Gulf of Mexico, production is still below that achieved prior to hurricanes Katrina and Rita in 2005. Nevertheless, output is expected to continue to increase as repairs to damaged production platforms are completed.

Over the outlook period, new projects within OPEC are also expected to increase production capacity by at an average rate of 2 per cent a year to around 3.4 million barrels a day by 2012. Capacity expansions are expected in most member countries, including Saudi Arabia, United Arab Emirates, Kuwait, Nigeria and Qatar. Reflecting a faster rate of production growth compared with non-OPEC suppliers, OPEC's share of world oil supply is projected to grow over the outlook period.

volatility in price movements to continue in the short term

Over the past few years world oil prices have been particularly sensitive to market perceptions about actual and potential supply disruptions and changes in spare production capacity. In particular there has been a strong relationship between increases in world oil prices and declines in spare oil production capacity. However, with OPEC cutting its production quotas and adding to its production base, OPEC's spare capacity is forecast to increase from 2 million barrels a day in 2006 to between 3 and 4 million barrels a day in 2007. While this amount of spare capacity is higher than in the previous two years, it represents only around 5 per cent of current global demand and is unlikely to be large enough to significantly reduce volatility in prices.

WTI vs OPEC spare production capacity
monthly, ended January 2007



World oil prices are expected to continue to remain sensitive to factors that may alter or disrupt future oil supplies. These factors include increased costs of production, associated with developing new projects, geopolitical and security risks and, over the longer term, reduced expenditure on exploration.

increased costs

Costs of developing new projects and production have increased universally across the world's minerals and energy industries over the past four or five years. Increased costs have been associated with an almost unprecedented increase in the demand for a range of inputs, such as equipment, materials, skilled labour and mining services, required to bring on new capacity. In some cases the available supplies simply cannot meet demand and the associated delays add further costs, reducing production and delaying the start up of new projects.

political and security risks may impede supply growth

In a number of oil producing countries, sovereign, geopolitical and security risks have the potential to adversely affect supply. In 2006, it is estimated that 10 per cent of production capacity in Nigeria was lost as a result of attacks on production facilities.

Sovereign risk, which includes significant changes to government policies or political interference, also creates uncertainty for oil supply. Recent examples include national governments changing agreements with oil companies or nationalising industries. For example, in the Russian Federation, Royal Dutch Shell and its partners, Mitsui and Mitsubishi were obliged to sell a share of their stakes in the Sakhalin project to Gazprom, the Russian government owned gas company. In Venezuela, the government is converting previous agreements with foreign investors into joint venture agreements in which the nationally owned PDVSA is required to hold a minimum 60 per cent interest. In addition, royalties and corporation taxes applied to the oil industry have been increased by 33 per cent and 50 per cent respectively. Such unpredictable changes to the regulatory and fiscal environment represent an important risk and have the potential to compromise foreign investment and limit significant expansions of supply.

Another area of concern for the oil industry over the longer term is the decreasing trend in exploration expenditure. According to the International Energy Agency, in 2005, 10 per cent of wells drilled were for exploration purposes, compared with 20–25 per cent in the 1990s. The implication is that an increasing proportion of capital is being spent on fewer, but larger oil and gas projects. To the extent that this suggests that there is less capital available for greenfield exploration programs, the long term growth of the global oil industry could be affected.

medium term prices depend on world oil supply

The projection of a decline in world oil prices (in 2007 dollars) over the next few years is based on the assessment that world oil production will continue to increase. Such a view is not universally accepted as some analysts have suggested that oil prices will continue to increase from current high levels because, in their view, global oil production has peaked. However, such arguments typically fail to properly recognise the effect of market forces, as reflected in price movements, in encouraging the development of new supplies and the cutting of consumption.

Many international agencies, including the International Energy Agency, OPEC and the International Monetary Fund, disagree that global oil production has peaked. They argue that only around a quarter of world oil reserves have been used and oil supplies will keep pace with demand. Oil reserves have been increasing, rather than declining, over the past decade and this growth in oil reserves is expected to continue. The US Energy Information Agency projects that world oil supplies in 2025 will exceed the 2001 level by 53 per cent.

technological progress to reduce oil dependency

On the demand side, technological progress is also expected to lead to a continued reduction in oil dependency. Despite the remarkable economic expansion over the past two decades, many major oil consuming countries have become much less dependent on oil than they were in the 1970s.

Energy conservation and substitution of other energy sources have resulted in a significant reduction in oil consumption, when measured in terms of per unit gross domestic product. For example, in major OECD countries the oil intensity of gross domestic product,

which is what is often referred to as oil dependency, is estimated to have declined by more than 50 per cent since the 1970s. The development and adoption of new fuel efficient technology, such as hybrid cars have the potential to produce even more rapid reductions in demand for oil.

Technological progress will also be critical to future increases in exploration success and recovery of oil from existing oil fields. According to the International Energy Agency, technological improvements have contributed to an increase in the success rate of oil exploration from about 20 per cent in the 1940s to over 40 per cent in recent years.

Technological improvements have also contributed to a long term decline in the average cost of oil production (in real terms). Even with recent high prices, and increases in the costs of many inputs, oil is still cheaper (in real terms) now than in the early 1980s.

increased production from oil sands and 'gas to liquids'

Relatively high oil prices in recent years have stimulated significant interest in the production of liquid fuels from alternative resources, such as oil sands, gas to liquids, and biofuels.

Synthetic oil production from oil sands is centred in the Canadian province of Alberta, where there are currently twelve oil sands projects under construction. Investment of around US$80 billion is projected for the next ten years. Canada's nonconventional oil production was around 1 million barrels a day in 2005 and has been estimated to be around 1.35 million barrels a day in 2006, rising to a forecast 1.42 million barrels a day in 2007.

A relatively small but growing proportion of total oil and gas investment has been going to 'gas to liquids' production (GTL), which converts natural gas into high quality petroleum products. There are three existing GTL plants in operation – Shell's 15 000 barrels a day plant in Bintulu, Malaysia; PetroSA's 25 000 barrels a day plant in Mossel, South Africa; and the joint venture 34 000 barrels a day Oryx plant built by Qatar Petroleum, Chevron and Sasol in Qatar, which was commissioned in early 2006. Another 34 000 barrels a day plant is being built by Chevron and the Nigerian National Petroleum Corporation at Escarvos in Nigeria.

Two further GTL plants are at an advanced planning stage – the Shell/QP Pearl plant in Qatar, with a final capacity of 140 000 barrels a day and Sonatrach's 36 000 barrels a day plant at Tinhert in Algeria. The GTL projects currently under construction or recently completed involve investment of US$24 billion and have the potential to add 280 000 barrels of petroleum products a day to world supply by 2010.

increases in biofuel production

Production of biofuels – liquid transport fuels derived from biomass – has increased in many countries. There are several types of biofuels and many different methods of production. Almost all biofuels currently produced around the world are either ethanol or biodiesel. Global production of biofuels amounted to around 0.65 million barrels a day in 2005 – equal to around 1 per cent of total road transport fuel consumption in energy terms.

Brazil and the United States together account for around 80 per cent of global production, but production in the European Union is growing rapidly in response to government incentives. While ethanol is the major biofuel produced in Brazil and the United States, the bulk of EU production has been biodiesel. Elsewhere in the world, China and India have also markedly increased their production of biofuels.

The growing interest in biofuels stems from perceived environmental benefits of its use relative to conventional fuels and the potential for lowering the costs of production through

technological advances. High production costs have been a critical barrier to commercial biofuel development. Outside of Brazil, the costs of producing biofuels with current technologies are generally higher than for conventional petrol or diesel, with producers reliant on government subsidies in various forms to be financially viable. Global biofuel production is estimated to have been around 0.8 million barrels a day in 2006, rising to a forecast 0.9 million barrels a day in 2007.

crude oil supply

In 2006, it is estimated that world oil production increased by around 1 per cent to average a little over 85 million barrels a day, reflecting increased production within OPEC, the Russian Federation and the Gulf of Mexico. In 2007, world production is forecast to increase by an average of 500 000 barrels a day to average around 86 million barrels a day. Increases in non-OPEC supply, primarily from north America and the Russian Federation is forecast to offset decreased OPEC output. Over the medium term, global oil production is projected to increase to 95 million barrels a day by 2012.

non-OPEC production increases

In 2006, non-OPEC oil production is estimated to have averaged 50.9 million barrels a day, an increase of 1.2 per cent compared with 2005. Over the outlook period, non-OPEC oil production is projected to account for just over half the growth in world oil production. In 2012, non-OPEC oil production is projected to average 56.3 million barrels a day and account for approximately 60 per cent of total world production.

In north America in 2007, oil production is expected to continue to recover following lost output from hurricanes Katrina and Rita. Complete recovery from the damage caused by the hurricanes in 2005 is not anticipated until 2008. In 2007, north American oil production is forecast to average 14.6 million barrels a day, and is projected to increase to around 15.1 million barrels a day in 2012. Over the medium term, increased Canadian output is expected to be supported by increased oil sands production, which is expected to remain economic, despite weaker oil prices. In the Gulf of Mexico, new projects such as Blind Faith, Neptune (2008), Shenzi, Great White and Clipper (2009) and Puma and Tubular Bells (2010) will offset declining production from existing oil fields.

Russian Federation and Caspian Republic to increase production and exports

Between 2000 and 2004, annual growth in Russian oil production varied between 6 and 11 per cent a year. However, since then, growth in production has been slowed by a combination of factors, including resource nationalisation, industry restructuring, uncertainty associated with political, fiscal and regulatory changes and decreasing capital expenditure on oil exploration and production. Nevertheless, there are now signs that investment in the upstream oil industry in the Russian Federation is starting to increase, with a number of new projects that include Sakhalin, Kharyaga, Salym and Vankor. The successful completion of these projects is projected to result in Russia's oil production capacity increasing on average by 2 per cent a year to approximately 11 million barrels a day by 2012.

Production from the Caspian region was an estimated 2.4 million barrels a day in 2006. The two main producers in the region are Kazakhstan (2006 production of 1.3 million barrels a day) and Azerbaijan (0.6 million barrels a day). Over the outlook period, production in these two countries is projected to increase to 1.7 million barrels a day and

1.4 million barrels a day respectively. Successful expansions of Caspian oil production capacity will be reliant on the completion of additional infrastructure necessary for the transportation of oil to export markets. Currently, there is a heavy dependence on pipeline infrastructure that passes through the Russian Federation. New pipelines that avoid Russian territory include the 1.0 million barrel a day Baku–Tiblisi–Ceyhan pipeline that commenced operations in 2006.

OPEC capacity to increase

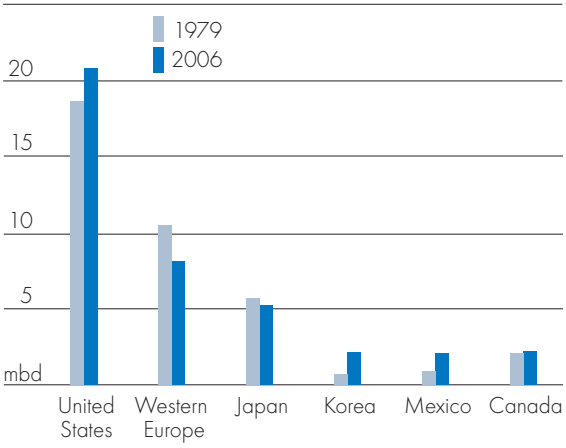
In 2007, oil production from OPEC members is forecast to decline by approximately 3 per cent, reflecting cuts to production quotas. In line with OPEC's objective to stabilise world oil prices within a price range of US$50–60 a barrel (WTI), OPEC production is projected to grow at an average rate of around 2.6 per cent a year between 2007 and 2012, with production reaching 38.9 million barrels a day in 2012.

In Saudi Arabia, production capacity is projected to increase by 18 per cent over the outlook period to 12.6 million barrels a day. Production from the Khursaniyah, Shaybah, Nuayyim and Khurais oil fields is expected to provide new capacity of 2 million barrels a day. Additional capacity in Algeria, Qatar and the United Arab Emirates is also projected to be brought on line over the outlook period, reflecting these economies' willingness to encourage foreign investment in their oil industries.

The potential for further increases in OPEC production is expected to be limited by sovereign risks in Iran, Nigeria and Venezuela. The Iranian Government has set targets to increase production capacity by 20 per cent over the medium term. However, there is a significant likelihood that these targets will not be met. Concerns over geopolitical tensions and the mandatory involvement of Iranian based companies could make foreign investors hesitant to commit to projects. There are also concerns over the marketability of some of the very heavy and sour crude oil that is currently produced in Iran. Increases in Iranian production will need to offset decreasing production from existing oil fields that are estimated to be declining at around 8 per cent a year.

In the Niger Delta, an important oil producing region of Nigeria, a lack of security presents a large downside risk to the Nigerian Government's target of increasing oil production capacity by over 25 per cent to 4 million barrels a day by 2010. Increased capacity from new offshore production facilities are currently being offset by production shutdowns ashore in the Niger Delta.

OECD oil consumption



world oil consumption

In 2006, global oil consumption is estimated to have increased by 1 per cent to 84.5 million barrels a day as high world oil prices began to influence demand. The growth in oil consumption reflects continued strong growth in China and developing Asia more broadly, and in the Middle East. Consumption growth in China is estimated to have been 5.8 per cent in 2006, following growth rates of 15 per cent and 3 per cent for 2004 and 2005, respectively. Partially

offsetting this growth was a decline in north American consumption. Lower oil consumption in north America in 2006 was caused by above average temperatures and record high oil prices during the middle of the year.

Global oil consumption in 2007 is forecast to increase to 86.2 million barrels a day. Higher oil consumption is forecast in China, Asia, north America and the Middle East. Over the medium term, global oil consumption is projected to increase gradually to 95.1 million barrels a day in 2012.

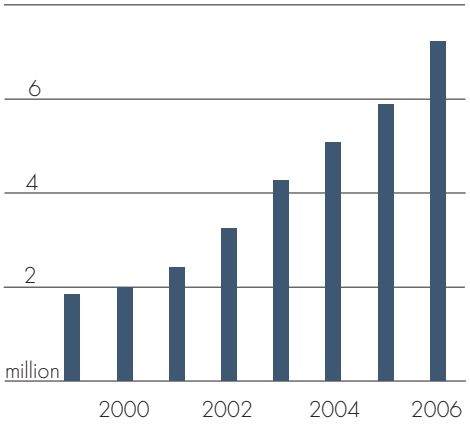
OECD consumption to grow moderately

Growth in demand from north America is projected to account for the majority of OECD oil consumption growth over the outlook period. Assumed strong economic growth in the United States and Mexico is expected to provide support for oil consumption, particularly as oil prices are expected to ease (in real terms) over the medium term. In Europe, growth in oil demand growth is projected to be modest in the medium term. In key consuming countries in Europe, such as Germany and Italy, substitution of gas for oil in electricity generation will reduce oil consumption. However, in some of the more rapidly developing economies of the European Union, such as Hungary and Poland, oil demand is expected to grow.

OECD Asian demand is projected to remain stable over the outlook period. Projected consumption growth in the Republic of Korea, Australia and New Zealand is expected to be offset by a reduction in demand from Japan.

In Japan, reduced oil consumption from the transport and electricity generation sectors is projected to be an important driver of lower overall oil demand. Over time, consumers are expected to continue to shift preferences toward smaller and more fuel efficient cars. Demand for oil for electricity generation has been steadily decreasing and this trend is expected to continue, as increased quantities of gas and nuclear power are used. While the utilisation of oil fired electricity generation is expected to continue to decrease, spikes in oil demand may continue to occur. In recent years, spikes in demand for oil have been associated with nuclear outages in 2003 and difficulties associated with Indonesian LNG supply in 2006.

vehicle sales in China



Chinese oil demand to continue to grow

China is the world's second largest oil consumer (behind the United States), accounting for over 8 per cent of global consumption. In 2006, Chinese oil consumption is estimated to have averaged 7 million barrels a day, an increase of 6 per cent from 2005. Growth in China's oil demand is projected to continue over the medium term, albeit at a more moderate rate. Fuel oil, which is used for electricity generation, has been an important driver of oil demand in the past. In the future, the importance of fuel oil is expected to decrease, replaced by lower cost alternatives such as natural gas and coal.

Over the outlook period, transport fuels are expected to become increasingly important in supporting demand growth. Vehicle sales, air travel and road transport are all expected to increase over

the medium term, associated with projected growth of the Chinese economy of around 8 per cent a year. China is now the world's largest market for new vehicles, with vehicle sales growing by around 25 per cent to 7.2 million in 2006. Reflecting the increasing wealth of China's middle class, vehicle sales growth has averaged over 40 per cent a year since 2000.

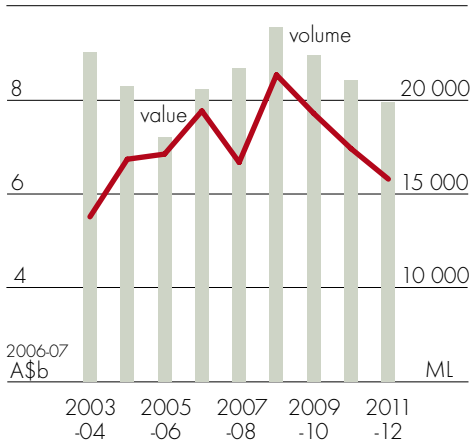
In 2006, it is estimated there were 160 million passengers carried on airlines in China, up 15 per cent from 2005. Reflecting further anticipated growth in air travel, Chinese airline companies are expected to receive 150 new aircraft in 2007.

China's oil consumption is projected to grow by 4 per cent a year over the outlook period, to average 9.8 million barrels a day in 2012. This growth rate will ensure China remains the world's fastest growing oil consumer and the second largest consumer.

Australian production and exports

Over the short term, Australia's production of crude oil is forecast to increase. New additions to production capacity will offset declining production from some mature fields. Additions to production capacity include the Puffin development, which is scheduled to commence in the second half of 2007, and the Vincent and Stybarrow fields, which are scheduled to be completed in early 2008. In addition, increased production is expected from the rampup of production at the Enfield and Basker and Manta projects, where production commenced in 2006.

Australian oil exports



Australia's oil production is forecast to increase by 15 per cent in 2006-07 and 4 per cent in 2007-08, respectively, before peaking at 34 gigalitres in 2008-09. In that year, it is anticipated that the five above-mentioned projects will be operating at combined full capacity of 250 000 barrels a day (14.5 gigalitres a year), accounting for around 40 per cent of Australia's production.

Beyond 2008-09, Australia's oil production is projected to decline as falling production from some mature fields offsets anticipated new additions to capacity. In 2011-12, Australian production of crude oil production is projected to be 27 gigalitres.

Australian oil exports are estimated to increase moderately over most of the projection period. With close proximity to Asian markets, it is assumed that additional production from fields such as Vincent and Stybarrow will be exported. In 2006-07, crude oil exports are forecast to total 15.6 gigalitres, increasing to 18.9 gigalitres in 2008-09 and then declining to a projected 14.9 gigalitres by 2011-12. Refecting the trend in export volumes, the value of Australia's crude oil and condensate exports is projected to increase to $8.6 billion (in 2006-07 dollars) by 2008-09, and then fall to $6.3 billion in 2011-12.

outlook for LNG

Global liquefied natural gas (LNG) trade is estimated to have increased by 10 per cent to almost 160 million tonnes in 2006. However, growth in trade in that year was constrained by a slow buildup of output from some newly commissioned production facilities and gas supply capacity problems at several gas liquefaction plants, including in Malaysia and

Indonesia. Recent increases in LNG demand and lower than expected production rates have resulted in LNG prices increasing rapidly.

In 2006, Australian exports accounted for the majority of increased LNG exports from the Pacific basin, and served to offset lower exports from Indonesia and Malaysia. Increases in Australian exports reflected additional capacity associated with the completion of the Darwin LNG plant in early 2006. Increased European imports in 2006 were sourced from Egypt, Trinidad and Tobago, and Nigeria, where significant new capacity was commissioned in 2005 and early 2006.

projected growth in the Pacific market

In the Asia Pacific market, growth in LNG demand is expected from a number of quarters, including Japan, the Republic of Korea, Chinese Taipei and China. The first three countries produce very little natural gas and rely on LNG imports, to meet gas demand. China has substantial gas fields but most of them are located in the western part of the country or offshore, a considerable distance from the main demand centres, which are located in the coastal regions in the east.

In Japan, increased gas fired electricity generation capacity over the medium term will be an important driver of increased LNG imports. The Tokyo Electric Power Company, for example, is expected to add a fourth unit (1520 megawatts) to the Futtsu power complex between 2008 and 20101, while Chubu Electric is proposing to add an additional unit to the Shin Nagoya plant by 2008 and the first unit at the Jouetsu plant by 2012. Japan's imports of LNG are likely to increase by around 5 million tonnes to 64 million tonnes by 2012.

In the medium term, gas consumption in Korea's residential and industrial sectors, which account for around two-thirds of Korea's total gas consumption, is expected to increase at around 5 per cent a year. In the industrial sector, higher oil prices have resulted in fuel switching away from oil to gas. In the domestic sector, increased gas consumption is expected to be driven by the increased use of gas fired heating and cooling systems.

Gas consumption in Korea's power sector is expected to remain at close to 2006 levels over the medium term. The lack of growth reflects Korea's increased electricity demand being met by additions to coal fired capacity between 2007 and 2009, and proposals to increase nuclear power generation capacity beyond 2010. However, there is potential for gas demand in Korea's electricity generation sector to grow beyond the outlook period, reflecting uncertainty about coal fired power stations associated with environmental concerns. The Republic of Korea's imports of LNG could increase to around 29 million tonnes by 2012.

In Chinese Taipei, LNG import capacity is expected to increase by around 3 million tonnes a year from 2008 following the completion of the Taichung LNG terminal. Around 1.7 million tonnes a year will be supplied to the 4000 megawatt Tatan gas fired power station. In 2008 and 2009, Taipower, the state owned power utility, will require an additional 1.5 million tonnes of natural gas to offset the delayed operation of its fourth nuclear power station. The commissioning of the power station has been delayed by three years because of high costs and shortages of construction inputs. Imports of LNG are expected to grow from 8 million tonnes in 2006 to about 12 million tonnes in 2012.

strong demand growth in less mature LNG markets in the Asia Pacific region

In 2006, China imported its first LNG cargo into the Guangdong receival terminal. The terminal, which has a capacity of around 3.7 million tonnes, will receive around 3 million tonnes a year from Australia's North West Shelf Venture for 25 years. Reflecting increased

demand for natural gas, China's LNG import capacity in the short term will be boosted with the rampup of capacity at the Guangdong terminal and the completion of a new terminal in Fujian. The Fujian terminal is expected to be completed during 2007 and will have a regasification capacity of 3 million tonnes of LNG a year. LNG for the Fujian terminal will be sourced from British Petroleum's Tangguh LNG project in Indonesia.

A third LNG import terminal, near Shanghai, could be in operation by the end of the outlook period, following a 25 year agreement between the owners of the project (including China National Offshore Oil Corporation and Shenergy) and Malaysia's Petronas. The agreement requires 3 million tonnes a year of LNG to be supplied by 2012. However, smaller amounts of LNG may be supplied if the LNG terminal is completed earlier.

There are also a number of other planned or proposed LNG import terminals. However, recent increases in LNG prices have delayed the approval of these projects as their proponents have been unable to agree to long term supply contracts with LNG suppliers.

By 2012, China could import around 13 million tonnes into LNG terminals near Guangdong, Fujian and possibly Shanghai, although there is considerable uncertainty around this figure. The majority of LNG is likely to be sourced from Australia, Indonesia and Malaysia under long term contracts.

In India, consumption and imports of natural gas are forecast to increase, associated with increased demand from the fertiliser industry and the domestic and industrial sectors. Increased natural gas imports are likely to be delivered through a combination of LNG and pipelines. Over the outlook period, there are plans to increase the capacity of the two existing LNG receival terminals, located on the west coast. The majority of increased imports by India are likely to be sourced from the nearby Middle East. However, there could be opportunities for Australian exporters of LNG if India seeks regional diversification of LNG supply.

There is also the potential for the west coast of the United States to become an important new market for Australian LNG producers. A number of LNG import terminals have been proposed on the US west coast. However, the approval process has been slow, in part because of strong public opposition to terminal siting, particularly in southern California.

US LNG imports to grow rapidly

Recently, the United States has emerged as an important driver of world LNG demand. In 2006, the United States consumed 22 000 billion cubic feet (bcf) of natural gas, making it the world's largest gas consumer. US imports of LNG were around 12 million tonnes or around 2.6 per cent of total US gas consumption in 2006. US imports of LNG are currently delivered to five regasification terminals, which are located on the east coast and in the Gulf of Mexico.

Reflecting lower imports of natural gas via pipeline, the United States Energy Information Administration projects that LNG imports will increase their contribution to total natural gas imports from 17 per cent in 2006 to 48 per cent by 2012. US imports of LNG are therefore projected to increase from around 12 million tonnes in 2006 to around 50 million tonnes by 2012. The majority of US LNG imports are currently expected to be sourced from suppliers such as Trinidad and Tobago, Egypt, Nigeria and Qatar, reflecting the location of current and proposed receival terminals on the east coast or in the Gulf of Mexico.

While increased demand for LNG on the east and gulf coasts of the United States will largely be sourced from suppliers located in the Atlantic Basin, there could also be opportunities for Australian exporters to increase sales into the region. The global LNG

market no longer comprises regionally isolated gas markets as was largely the case in the past. There is active arbitrage within and between both the Pacific and Atlantic markets for LNG, with LNG cargoes diverted between Asia, the United States and Europe.

challenges to global LNG supply growth

Factors such as higher raw material prices, longer lead times for equipment and difficulties in sourcing skilled labour in the majority of LNG exporting countries are expected to continue to constrain LNG project developments over the medium term. In Australia, for example, the economics of some projects have been adversely affected by higher material costs and limited supply of skilled labour. In addition, significantly increased capital costs of building new facilities (liquefaction plants, ships and regasification terminals) in the past two years has affected project economics. As a result of such developments, a number of LNG projects that are currently in the planning stage are potentially facing significant delays.

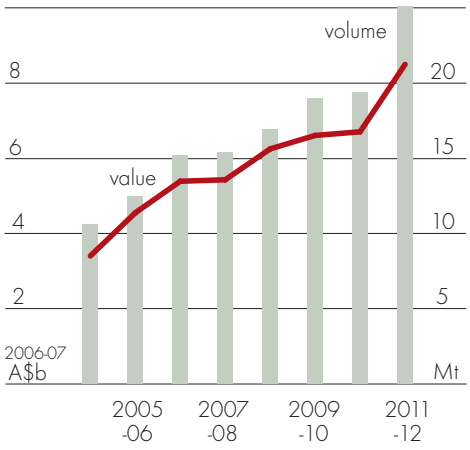
Furthermore, declining gas feedstock from mature fields – particularly in Indonesia and Malaysia – will partially offset expected LNG production increases in Qatar, Nigeria and Australia.

In the case of Indonesia, production shortfalls from LNG plants at Arun in Aceh and Bontang in east Kalimantan have resulted in a number of trains being mothballed and have resulted in a corresponding decline in output at those plants. Furthermore, Indonesia's government is planning to increase its domestic use of gas for industry, fertiliser production and power generation. Plans to pipe gas to east Java from east Kalimantan (gas that would otherwise go to processing trains at the Bontang liquefaction plant) may lead to a further reduction in LNG output at Bontang.

substantial expansion ahead for Australian LNG

Australian production and exports of LNG are expected to grow substantially over the medium term. The fifth train of the North West Shelf project is scheduled to be completed in 2008 and will result in additional production capacity of 4.2 million tonnes a year. The expansion of the North West Shelf is the only project in Australia currently under construction, but construction on a number of other projects is expected to commence over the outlook period. These include the Gorgon project, which could produce 10 million tonnes a year by 2011, and the Pluto project, which could produce 5–6 million tonnes by 2010.

Australian LNG exports



The Gorgon project has received all necessary government approvals and is now awaiting a final investment decision by proponents Chevron, ExxonMobil and Shell. It is estimated that the final cost of the project might exceed $15 billion, a significant increase in cost from when the project was initially proposed. The Pluto project has also received all government approvals and is awaiting a final investment decision by project owner, Woodside. It is expected that Woodside will proceed with Pluto following the company's decision to approve capital expenditure of $1.4 billion for preparation of site works.

Looking beyond 2012, Australian LNG production capacity could increase significantly. A number of projects are in the planning stages, although these projects are not expected to commence until after 2012, reflecting potential construction lead times of almost five years. These projects include Browse, Ichthys, Pilbara and potentially Sunrise. The timing and size of these projects will ultimately depend on the global demand for LNG and, more particularly, whether sufficient contracts can be secured with consumers to cover significant capital costs.

Australian exports of LNG in 2006-07 are forecast to total 15.2 million tonnes, up from 12.5 million tonnes in 2005-06. The increase in exports is attributable to the commencement of production at the 3.5 million tonne capacity Darwin LNG plant in early 2006. In 2008-09 exports are projected to increase to 16.9 million tonnes, reflecting additional capacity associated with completion of the fifth train at the North West Shelf. By 2011-12, exports are projected to reach 25.1 million tonnes under the assumption that production will have commenced at either or both of the Gorgon or Pluto LNG projects. The value of Australia's LNG exports is forecast to increase substantially. In 2006-07, the value of exports is forecast to be $5.4 billion. This figure is projected to grow to $8.5 billion (in 2006-07 dollars) in 2011-12, reflecting increased export volumes.

thermal coal

> alan copeland

In 2006, a combination of strong growth in coal fired electricity generation in Asia and a reduction in exports from China and Australia's Hunter Valley region resulted in spot prices for Newcastle thermal coal averaging US$49 a tonne, US$1 a tonne more than in 2005. At the beginning of 2007, spot prices for Newcastle thermal coal were above US$50 a tonne, reflecting strong seasonal demand in Asia, lower production in Indonesia associated with the wet season and a lengthy vessel queue off Newcastle.

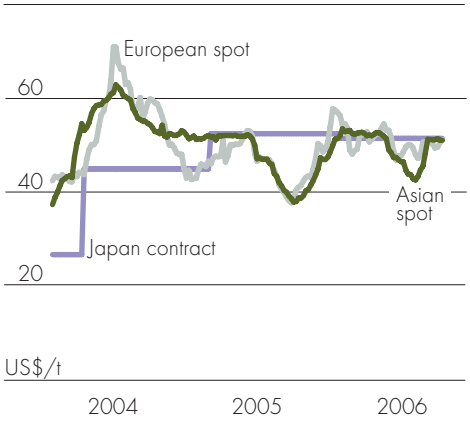
With this situation unlikely to improve before thermal coal contract prices are scheduled to be negotiated, and strong demand growth from Asia expected to continue over the short term, there are promising prospects for an increase in thermal coal contract prices for Japanese financial year 2007-08 (JFY, April–March).

Over the medium term, prices of thermal coals are expected to fall moderately in real terms. Increased production and infrastructure capacity in major thermal coal exporting countries, such as Indonesia, Australia, South Africa and Colombia, are expected to place downward pressure on prices. Factors likely to have a positive effect on prices over the next five years will be continued strong growth in demand, particularly across the rapidly developing Asian economies and the need to recoup increased production costs.

price outlook for the short and medium term

Negotiations between Australian suppliers and Japanese power utilities for JFY 2006-07 were not completed until June 2006. Traditionally, pricing negotiations are completed before the commencement of the year for which they are due to take effect; however for JFY 2006-07 Japanese utilities held off settling prices believing that spot prices would decline. In the first quarter of 2006, thermal coal spot prices increased by over 25 per cent to US$51.45 a tonne and remained at those levels until August. Reduced thermal coal exports from China and limited growth from Australia, coupled with strong import demand throughout Asia, provided strong support for thermal coal prices in the Asian market. Offsetting these factors was a substantial increase in exports from Indonesia during the first half of 2006.

thermal coal prices
weekly, ended 25 January 2007



Contract prices for the coming JFY 2007-08 are forecast to be moderately higher than for JFY 2006-07. Growth in thermal coal demand in Asia is expected to continue, particularly in China, India, the Republic of Korea and Malaysia. On the supply side, Indonesian exports are forecast to increase, albeit at a reduced rate compared with 2005 and 2006. Firm prices in China's domestic coal market are also encouraging Chinese suppliers increasingly to redirect coal supplies from export markets to the domestic (Chinese) market. The full supply benefits of upgraded transport and port infrastructure capacity in Australia are not expected to be delivered until 2008.

Over the medium term, real thermal coal prices are forecast to decline, reflecting increased production and export capacity in Australia, Indonesia,

South Africa and Colombia, as well as increases in coal sector productivity. However, price reductions are projected to be moderate, reflecting continued growth in demand for thermal coal in Asia, reduced exports from China and higher production costs, reflecting cost increases for inputs such as oil, equipment and labour.

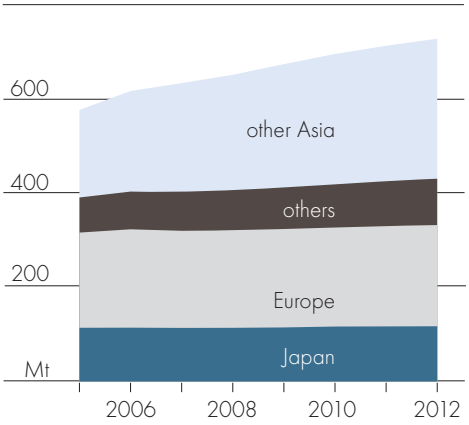
growth in world thermal coal trade

World thermal coal trade is estimated to have increased by 7 per cent in 2006 to 619 million tonnes, reflecting strong global demand, particularly from Asia. In 2007, thermal coal trade is forecast to increase by a further 3 per cent to 636 million tonnes. Over the remainder of the outlook period, global thermal coal trade is projected to increase at an average rate of around 3 per cent a year to total nearly 727 million tonnes in 2012.

The key drivers of growth in world thermal coal trade over the outlook period are expected to be increased imports by Asian countries such as China, India, the Republic of Korea and Malaysia. These countries have advanced plans to increase coal fired power generation capacity to meet increasing electricity demand. The United States is also expected to be an important driver of growth as it uses increased quantities of low sulfur Colombian and Indonesian coal in its power sector.

In other markets, such as Japan and Europe, thermal coal import growth is projected to be modest, although these markets are expected to continue to remain important in world thermal coal trade.

thermal coal imports, by region



Japan

Japanese imports of thermal coals are forecast to fall slightly to 114 million tonnes in 2007. In subsequent years imports are projected to grow at a modest average rate of 0.6 per cent a year, reaching 117.5 million tonnes in 2012. Despite the projected modest growth in thermal coal imports over the medium term, Japan is expected to remain the world's largest importer of thermal coal. The modest growth profile reflects Japan's stated intention to reduce greenhouse gas emissions as part of its commitments under the Kyoto protocol.

Net additions to coal fired power generation capacity in Japan over the outlook period are projected to total 2.25 gigawatts. This will result in a small decrease in the share of coal used for total electricity generation, although utilisation of existing thermal coal fired capacity is expected to remain high.

Republic of Korea

Korea's thermal coal imports are estimated to have increased by 5 per cent in 2006. In 2007, thermal coal imports are forecast to rise by a further 7 per cent to 63 million tonnes, reflecting increased electricity demand that will be supplied from coal fired electricity generation capacity commissioned in 2005 and 2006.

Over the rest of the outlook period, it is assumed that Korea's economy will grow at an average rate of 4–5 per cent a year. With thermal coal a preferred fuel for electricity generation because of its low cost (on a per unit of heat basis) and high reliability of supply,

an additional 6.3 gigawatts of coal fired electricity generation capacity is expected to be added in Korea between 2007 and 2009. Since Korea produces negligible quantities of hard coal, increases in thermal coal demand from the power sector will need to be met through imports. Korea's thermal coal imports are forecast to grow by an average of 5 per cent a year over the outlook period to 80 million tonnes in 2012.

China to become an important import market

China is the world's largest producer of thermal coal, with production in 2006 estimated to total around 2.2 billion tonnes. Although China's coal production has more than doubled since 2001, thermal coal imports have increased from 2 million tonnes in 2001 to an estimated 31.5 million tonnes in 2006. The rise in imports reflects, in large measure, the difficulties (and cost) associated with moving large quantities of coal from the north of China (where the majority of China's coal resources are located) to the rapidly developing manufacturing centres in the south east.

Thermal coal consumption in China is forecast to increase by around 150 million tonne in 2007, reflecting increased electricity demand associated with continued strong

world thermal coal outlook

	Unit	2005	2006	2007 f	2008 z	2009 z	2010 z	2011 z	2012 z
World									
Coal trade	Mt	578.0	619.1	635.5	652.4	674.4	695.5	712.2	726.7
Imports									
Asia	Mt	300.7	329.4	345.7	359.2	377.8	394.2	405.6	415.7
China	Mt	18.2	31.5	36.0	38.0	41.0	45.0	48.0	50.0
Chinese Taipei	Mt	56.8	58.7	60.0	60.6	61.2	61.8	64.0	66.0
India	Mt	18.2	23.5	26.0	29.0	32.0	35.0	38.0	41.0
Japan	Mt	114.3	114.5	114.0	114.2	115.0	116.9	117.2	117.5
Korea	Mt	56.2	58.9	63.0	67.4	75.5	79.2	79.7	80.2
Malaysia	Mt	10.0	12.1	13.7	15.7	17.6	19.5	20.3	21.1
Other Asia	Mt	27.0	30.2	33.0	34.4	35.5	36.7	38.3	39.8
Europe	Mt	202.6	209.4	206.7	208.1	209.4	210.7	213.6	215.4
European Union **a**	Mt	165.5	171.6	168.0	168.5	168.9	169.3	170.9	171.4
Other Europe	Mt	37.0	37.8	38.7	39.6	40.5	41.4	42.7	44.0
Other	Mt	76.4	80.3	83.1	85.1	87.2	90.5	93.1	95.6
Exports									
Australia	Mt	107.6	111.6	118.5	124.0	131.4	138.0	144.9	150.7
China	Mt	65.7	58.9	56.0	54.0	51.0	49.0	47.0	45.0
Colombia	Mt	54.6	58.0	65.0	70.0	75.0	80.0	85.0	90.0
Indonesia	Mt	123.3	158.0	168.0	175.0	183.0	189.0	195.0	200.0
Russian Federation	Mt	63.6	76.0	75.0	75.9	76.8	77.7	79.1	80.2
South Africa	Mt	71.9	69.0	71.0	77.0	81.0	84.0	87.0	89.0
United States	Mt	19.1	19.7	19.3	18.9	18.5	18.1	17.8	17.4
Other	Mt	72.2	67.9	62.7	57.6	57.5	59.6	56.4	54.4
		2004 -05	**2005 -06**	**2006 -07 f**	**2007 -08 z**	**2008 -09 z**	**2009 -10 z**	**2010 -11 z**	**2011 -12 z**
Australia									
Production	Mt	170.4	175.0	180.1	187.5	195.0	203.0	211.0	218.5
Exports									
Volume	Mt	106.4	110.8	114.6	121.1	127.7	134.7	141.5	147.8
Value									
– nominal	A$m	6 336	7 206	7 311	8 362	8 484	9 012	9 406	9 875
– real **b**	A$m	6 744	7 432	7 311	8 158	8 075	8 369	8 522	8 728

a Twenty five countries to 2006, then twenty seven countries from 2007. **b** In 2006-07 Australian dollars. **f** ABARE forecast. **z** ABARE projection.

economic growth. However, with the expansion of transport and port infrastructure in the main producing regions not expected to keep pace with demand growth, imports of thermal coal are forecast to increase by 14 per cent to reach 36 million tonnes.

The expectations of strong thermal coal demand and possible transport capacity constraints in 2007 have allowed Chinese suppliers to negotiate higher contract prices with domestic consumers. Domestic coal prices in China are now higher than international spot prices, with domestic contract prices for calendar year 2007 (for export quality coal) estimated to have increased by 10–15 per cent. Reflecting these higher prices, China's thermal coal exports in 2007 are forecast to fall by 5 per cent to 56 million tonnes as Chinese suppliers target the domestic market.

The Chinese Government is continuing to implement a number of policies aimed at rationalising the coal mining industry. Consolidation of China's highly fragmented coal supply industry is expected to lead to increased efficiency, including higher rates of mechanisation, and a reduction in mining accidents. However, recent attempts to close small and unsafe mines have been met with mixed success, with the rate of closure of small and illegal coal mines behind target. Nevertheless, China's State Administration of Coal and Mine Safety reports that deaths from mining accidents were below 4800 in 2006, down from 5900 in 2005, continuing a downward trend in mine site fatalities. Assuming that Chinese authorities continue to close small mines and consolidate the industry in general, coal production growth is likely to slow and imports rise.

China's thermal coal trade

An additional factor likely to support higher coal imports is the appreciation of China's currency, the renminbi, in recent times. Further appreciation of the renminbi relative to the US dollar would make imported coal more competitive and reduce the returns received by Chinese exporters.

Reflecting these developments, China's imports of thermal coal are projected increase by nearly 40 per cent to 50 million tonnes by 2012. Conversely exports are projected to decline over the outlook period by almost 20 per cent to 45 million tonnes. China is projected to become a net importer of thermal coal by around 2010 to 2011.

ASEAN

Economic growth throughout the ASEAN region is assumed to average around 4–5 per cent over the outlook period, resulting in strong growth in electricity demand and new electricity generation capacity. With a large proportion of new additions to generation capacity likely to be coal fired, thermal coal imports by the ASEAN region, particularly by Malaysia and Thailand, are projected to increase significantly. The growth in coal fired electricity generation capacity in Malaysia is supported by government policies aimed at diversifying fuel sources for electricity generation. Historically, much of Malaysia's electricity generation has been gas fired.

A number of coal fired power projects are in the final stages of construction and are scheduled to be in operation in the near future. The first unit of three 700 megawatt units of the Tanjung Bin power station (2100 megawatts) was commissioned in late 2006, while the remaining two units are expected to be commissioned during 2007. In 2008, the 1400 megawatts (two 700 megawatt units) Jimah power station is scheduled to be completed and commissioned.

Since Malaysia has poor domestic coal reserves and low production, additional demand for thermal coal will be met by imports. In 2012, Malaysia's imports are projected to total 21 million tonnes, up from an estimated 12 million tonnes in 2006.

India

India is the world's third largest producer of hard coal. However, much of the coal mined in India has a high ash content and imported thermal coals (particularly coal sourced from Indonesia) are used for blending to reduce the average ash content.

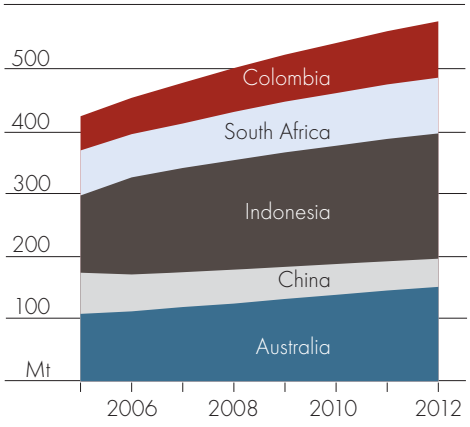
Domestic rail transport infrastructure in India is a major constraint to the efficient movement of coal from the principal domestic producing regions to the main consumption centres. Although the Indian Government is expected to invest heavily in rail, road and port infrastructure over the outlook period, the combination of distance and reliability often make it more cost effective for electricity generators to use imported coal.

India's imports of coal are forecast to increase by 11 per cent in 2007 to 26 million tonnes. Over the medium term, thermal coal imports are projected to increase by 61 per cent to 41 million tonnes in 2012. The majority of the projected increase in India's thermal coal imports is expected to be low calorific value coals sourced from Indonesia.

European Union

In 2006, EU thermal coal imports were estimated to have been around 172 million tonnes, an increase of 4 per cent from the previous year. Increased demand for thermal coal imports in 2006 was supported by higher prices for alternative fuels used for electricity generation (such as oil and gas) and reduced coal production in the United Kingdom. In addition, reduced availability of some nuclear and wind power generation during the summer months resulted in increased utilisation of coal fired electricity generation capacity. In 2007, thermal coal imports are forecast to fall to around 168 million tonnes as increased electricity demand will be met by expanded utilisation of gas and renewable energy electricity generation capacity.

thermal coal exports, by country



Over the remainder of the outlook period, the prospects for growth in EU thermal coal imports are mixed. Factors that may positively affect import growth are reduced domestic production in Germany and the United Kingdom, higher prices of other fuels (such as oil and gas) as well as concerns over the security of supply of these fuels. Conversely, countries within the European Union have made commitments to reduce greenhouse gases under the Kyoto Protocol. These commitments may limit the potential for any significant growth in thermal coal imports, as emphasis is placed on nuclear and

renewable energy sources to meet increased electricity demand. Balancing these factors, EU thermal coal imports in 2012 are projected to total around 171 million tonnes.

supply

The majority of the projected increase in the global demand for thermal coal over the outlook period is expected to be met by producers in Indonesia, Australia, South Africa and Colombia. Significant production and infrastructure capacity expansion plans to meet this demand are already well advanced in these countries.

Indonesia

Indonesian exports are estimated to have grown by 25 per cent in 2006 to 158 million tonnes, with Indonesian producers rapidly expanding production in response to the rapid demand growth in Asia. Over the medium term, growth in Indonesian exports will be challenged by a number of factors. These include competing demand from domestic coal fired generators, weak investment in exploration, increases in production costs associated with mining operations moving inland, and potential land rights issues.

Indonesia has plans to rapidly increase coal fired electricity generation capacity toward the end of the decade in order to meet forecast growth in domestic electricity requirements, and to replace existing oil fired power plants.

At present, most of Indonesia's coal production is located close to the coast or rivers, which are used to barge coal to ports for loading on to larger vessels. Over the medium to longer term the location of Indonesia's production is expected to move away from these waterways as currently mined deposits are exhausted. As a result, the transport of large quantities of coal will become more costly, particularly where the terrain includes dense jungle. In some coal producing regions, villagers' are prosecuting claims for compensation associated with the rights to mine on their land. Going forward, this continues to be an issue that has the potential to cause disruptions to supply. Despite the expected slowdown in the growth in Indonesian exports over the outlook period, Indonesia is still expected to remain the world's largest exporter of thermal coal over the outlook period. Exports are projected to grow at an average rate of 4 per cent a year to total 200 million tonnes in 2012.

Colombia

Thermal coal exports from Colombia are estimated to have increased by 6 per cent in 2006 to 58 million tonnes. Growth in Colombian exports in 2006 was disrupted by industrial disputes and heavy rainfall that affected production in the first half of the year. Assuming normal seasonal weather patterns and the absence of prolonged labour disputes, exports in 2007 are forecast to increase by 12 per cent to 65 million tonnes.

Over the medium term, significant investment is planned to expand production in Colombia, reflecting the relatively low cost of production and the high energy, low sulfur qualities of Colombian coal. In addition, Colombia's suppliers can take advantage of their proximity to the US market where imports are projected to grow rapidly.

South Africa

In 2006, South Africa's thermal coal exports fell by 4 per cent to 69 million tonnes as production was disrupted by wet weather and exports were hampered by a reduction in rail network availability (associated with outages and derailments). The vast majority of South Africa's thermal coal exports are loaded at the Richards Bay Coal Terminal, which

has an annual capacity of around 70 million tonnes. In 2007, exports are forecast to increase to around 71 million tonnes.

Over the medium term, South African exports have the potential to increase as new production and infrastructure capacity is brought into operation toward the end of the decade. Phase V of the Richards Bay Coal Terminal has now been approved and is due for completion in 2009. Annual throughput capacity at the port will be increased by 20 million tonnes to 91 million tonnes. Reflecting increased production and export capacity, exports from South Africa are projected to grow to 89 million tonnes in 2012.

Australia

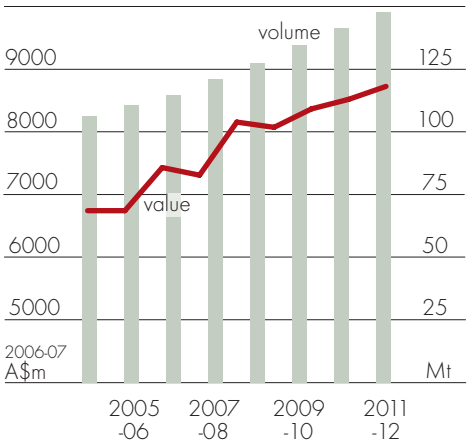
Since 2004, infrastructure constraints within the coal supply chains in New South Wales and Queensland have, to some extent, limited Australian exporters' ability to respond to the rapid growth in thermal coal demand in Asia. Infrastructure providers have responded by investing in projects designed to alleviate capacity constraints.

In New South Wales, upgrades to the rail and ship loading capacity of the Hunter Valley coal chain are expected to be completed in early 2007, increasing annual capacity to 102 million tonnes. At the port of Gladstone, Queensland's largest thermal coal export port, capacity is being progressively expanded from 40 million tonnes to 68 million tonnes by the end of 2007. The first effects of capacity expansions were seen at the Port of Gladstone in 2006, where coal loadings increased by 7 million tonnes as a result of a capacity upgrade.

While Australian coal loadings are forecast to increase in 2007, the full effects of the expansion programs are not expected to be seen until 2008.

In 2006-07, Australian thermal coal exports are forecast to total 114.6 million tonnes (valued at $7.3 billion), an increase of 3.8 million tonnes from the previous year. In 2007-08, an increase in exports to around 121 million tonnes is forecast to more than offset the effects on earnings of moderate contract and spot price decreases. The value of thermal coal exports in 2007-08 is forecast to rise by 14 per cent to $8.4 billion.

Australian thermal coal exports



New projects that have recently been completed or are under construction that are expected to contribute to increased Australian output of thermal coal over the medium term include Ashton underground, Boggabri, Dawson Valley and Moolarben. In addition, expansions are proposed to the Mount Owen, Ensham, Mount Arthur and Kogan Creek mines.

In 2011-12, Australian thermal coal production is projected to be 219 million tonnes, with exports accounting for 148 million tonnes. Increased volumes of exports and an assumed depreciation of the Australian dollar against the US dollar are both expected to offset the effects on earnings of a moderate fall in prices. Over the outlook period the value of Australian thermal coal exports in real terms (2006-07 dollars) is projected to increase to $8.7 billion.

uranium

> william mollard, kate penney, chris rumley

prices increased substantially in 2006

World uranium oxide (U_3O_8) prices averaged US$49.30 per pound in 2006, an increase of 73 per cent over the average 2005 price of US$28.50 per pound. From a low of US$5.97 per pound (in 2007 US dollars) in late 2000, real U_3O_8 prices have increased over twelvefold to US$85 per pound in February 2007. The dwindling supply of uranium stocks and increased concerns over the future supply of secondary sources of uranium, coupled with an improvement in the outlook for growth in global nuclear electricity generating capacity, were the major factors behind the substantial increase in uranium prices.

Also providing support for uranium prices, particularly in late 2006, was an announcement by Cameco Corporation that production from the Cigar Lake mine in Canada is expected to be delayed by at least a year following flooding in the mine shaft. The Cigar Lake mine had previously been expected to commence production in early 2008 at an annual rate of more than 8000 tonnes of U_3O_8 (around 10 per cent of global uranium requirements).

prices to increase further in the short term...

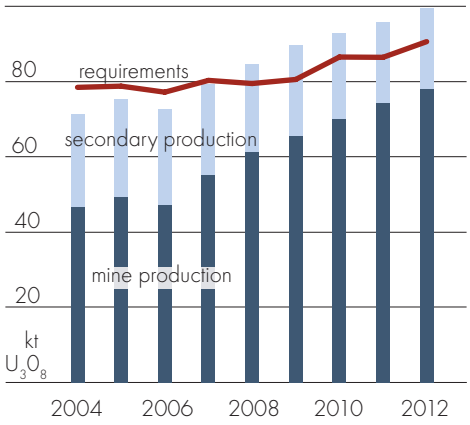
Despite a substantial forecast increase in global uranium mine production in 2007, the spot uranium price is forecast to increase by 91 per cent to average over US$94.2 per pound. With secondary uranium supply forecast to fall and global reactor requirements to increase, the current tight supply demand balance in the uranium market is expected to persist throughout 2007.

In 2008, the spot uranium price is forecast to increase by a further 10 per cent to average US$103 per pound (in 2007 dollars). Although total supply of uranium (mine production plus secondary sources of uranium) is expected to exceed consumption in 2008, uranium prices are expected to remain high until there is consistent evidence that mine production is sufficient to meet uranium requirements.

...but to ease over the medium term

From 2008, world uranium prices in real terms are projected to decline as the tight supply demand balance eases over the remainder of the outlook period to 2012. Substantial recent increases in global uranium prices have encouraged a large increase in expenditure on uranium exploration and the aggressive development of uranium projects, particularly in Kazakhstan.

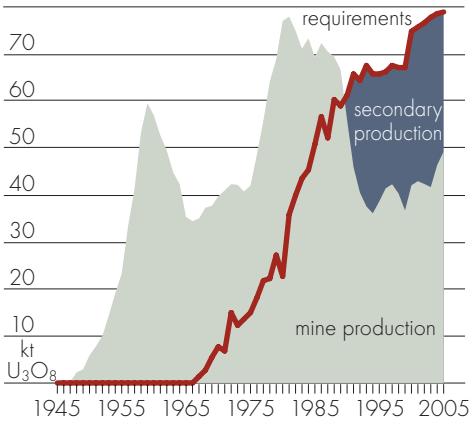
world uranium supply and requirements



world supply

The supply of uranium can be divided into two categories – primary mine production and secondary sources – with the latter including reprocessed spent nuclear fuel, blended down highly enriched uranium (HEU) from nuclear weapons and mixed oxide fuel (MOX).

world uranium



From the late 1950s to 1989, uranium production consistently exceeded commercial requirements. The excess supply was accumulated in nuclear weapons and uranium inventories. However, since 1990 global uranium requirements have exceeded mine production, with the gap filled by secondary sources of uranium.

secondary supplies to decline moderately over the outlook period

Overall, secondary supplies of uranium are expected to decline moderately over the projection period. Tech-snabexport (Tenex) – a representative of the Russian Federal Agency for Atomic Energy – has indicated that, from 2008, it will no longer export uranium from the Russian Federation. However, the continuation of the US–Russian HEU purchase agreement (see box) and additional secondary supplies from the United States will largely offset the expected decline in exports from the Russian Federation. The US–Russian HEU agreement is scheduled to end in 2013.

Over the projection period, there remains the potential for the United States and the Russian Federation to release additional inventories of HEU and plutonium, which are deemed to be surplus to military requirements. However, any further releases of HEU from stockpiles are likely to occur in a controlled manner in order to reduce the impact on the world uranium market.

secondary sources of uranium

The United States and Russian Federation have large stocks of HEU, which were previously used for military applications but are now downblended for use in nuclear reactors. Weapons grade uranium is highly enriched to over 90 per cent U-235 but can be blended with uranium containing low levels of U-235 to produce low enriched uranium (typically less than 5 per cent U-235). It is estimated that the dilution of HEU from weapons stockpiles replaces around 10 000 tonnes of U_3O_8 globally, or around 15 per cent of global reactor requirements.

United States–Russian Federation HEU purchase agreement

This agreement, commonly known as the 'megatons to megawatts' agreement, took effect in 1993. The aim of the program is to contribute to the nonproliferation of nuclear weapons by diluting 500 tonnes of HEU (equivalent to around 180 000 tonnes of U_3O_8) from the nuclear weapons stockpile of the Russian Federation for sale to commercial nuclear power plants over a twenty year period. As of December 2006, 292 tonnes of HEU had been downblended under the agreement. The Russian Government has indicated that it does not expect to extend the agreement, following its expiry in 2013.

HEU feed deal

In early 1999 another bilateral agreement, commonly known as the HEU feed deal, was signed between the United States and the Russian Federation, which provided for the creation of stockpiles of uranium in both countries. Stockpiles of up to 22 000 tonnes of uranium hexafluoride (UF_6) equivalent (or 26 000 tonnes of U_3O_8) will be held by both the Russian and US Governments until 2009. The day after the deal was signed, Tenex announced that it had signed a commercial deal with Cameco, Cogema and Nukem (known collectively as the Western Consortium) to have an exclusive option to purchase

secondary sources of uranium *continued*

the majority of the natural uranium component of the low enriched uranium (LEU) being delivered to the United States.

other sources of HEU

Aside from the supply of HEU under bilateral agreements between the United States and the Russian Federation, the US Government has also made available surplus HEU for use in nuclear reactors, following downblending. In September 2005, the US Department of Energy announced that 17.4 tonnes of HEU will be downblended to low enriched uranium fuel by 2010 as part of a Reliable Fuel Supply initiative. Under this initiative the United States will keep a reserve of low enriched uranium that, in the event of a market disruption, can be sold to countries that forgo the construction of enrichment and reprocessing facilities.

Also in late 2005, the United States Secretary of Energy announced plans to remove an additional 200 tonnes of HEU from the US nuclear weapons stockpile. Of this total, only 20 tonnes is currently designated for use in nuclear reactors. The remainder will be used for naval propulsion (160 tonnes) and space missions and research reactors (20 tonnes). For power reactors, the downblended HEU will become available over a 25 year period.

In 1996, the United States declared that 174.3 tonnes of HEU was excess to military requirements. The US Enrichment Corporation has downblended some of this material, with the first program (14.2 tonnes of HEU) completed in mid-1998 and the second program (50 tonnes HEU) completed in late 2006.

mixed oxide fuel (MOX)

MOX is a reactor fuel made from a mixture of uranium oxide and plutonium (which can be extracted from spent reactor fuel). MOX fuel, which is used in light water reactors, typically contains around 5 per cent plutonium. The use of MOX currently forms only a small part of the nuclear fuel market; as a result, it is not expected to have a significant impact on uranium demand over the outlook period.

Plutonium Management and Disposition Agreement

In September 2000, the United States and Russian Federation agreed to reduce their respective stockpiles of surplus plutonium. Under the agreement, the United States and the Russian Federation each committed to the disposal of 34 tonnes of surplus plutonium. The Organisation for Economic Cooperation and Development – Nuclear Energy Agency and International Atomic Energy Agency estimate that the 68 tonnes of weapons grade plutonium will displace 7000–8000 tonnes of uranium over the life of the agreement.

In early 2005, the US Nuclear Regulatory Commission (NRC) authorised the construction of a MOX facility at the Department of Energy's Savannah River site in South Carolina, which will convert the plutonium to fuel for nuclear reactors. However, this facility is unlikely to commence production before the end of the projection period.

US Enrichment Corporation stocks

USEC currently holds stocks of UF_6 from inventory transferred to the company by the US Department of Energy, following its privatisation in 1998, and from 'underfeeding' in the enrichment process. The majority of this inventory is committed under long term sales contracts. In late 2006, however, USEC indicated that sales of uranium from inventory will be largely completed by the end of 2007.

re-enrichment of depleted uranium tails

There is a substantial quantity of depleted uranium stocks that could potentially displace primary uranium production if re-enriched. However, the re-enrichment of depleted uranium is currently limited as a secondary source of uranium as it is only economically viable for centrifuge enrichment plants with spare enrichment capacity and low enrichment costs.

global mine production to increase significantly in 2007...

In 2007, global uranium mine production is forecast to increase by 17 per cent to 55 100 tonnes of U_3O_8, driven largely by higher expected production in Africa and Kazakhstan.

Initial production from Uranium One's Dominion mine in South Africa (1800 tonnes U_3O_8 a year) is expected to commence in early 2007, with the mine expected to reach full capacity in 2011. In addition, Paladin Resources' Langer Heinrich project in Namibia (1180 tonnes U_3O_8 a year) is expected to ramp up production during 2007, after being commissioned in late 2006.

In late 2005, Rio Tinto approved an extension of the operating life of the Rossing mine in Namibia to 2016. Work is currently being undertaken that will enable the Rossing mine to operate at its full production capacity of 4000 tonnes U_3O_8 a year within the next year. In late 2006, Anglo Gold Ashanti indicated that it plans to increase uranium production in South Africa by 40 per cent in 2007 largely through the reprocessing of tails.

In Kazakhstan, a number of in situ leaching (ISL) mines are expected to increase production progressively over the course of 2007, as they ramp up to full capacity, after being commissioned in mid to late 2006. An ISL uranium mine typically takes around three years to ramp up to full production. The Eastern Mynkuduk mine (1180 tonnes U_3O_8 a year) and Southern Moinkum mine (590 tonnes U_3O_8 a year) were both commissioned in mid-2006, with the Zarechnoye mine (590 tonnes U_3O_8 a year) commissioned in late 2006.

...and over the medium term

Over the medium term, global mine production is projected to increase significantly, particularly in Kazakhstan, Canada, the Russian Federation and Africa. Recent increases in

uranium outlook

	Unit	2005	2006	2007 f	2008 z	2009 z	2010 z	2011 z	2012 z
World									
Production	kt	49.3	47.2	55.1	61.3	65.5	70.0	74.4	78.1
Africa **a**	kt	8.2	8.3	10.3	11.1	11.5	11.7	12.6	12.6
Canada	kt	13.7	12.0	12.8	13.9	13.9	16.5	18.9	21.8
Kazakhstan	kt	5.1	5.8	8.4	10.2	13.3	14.8	16.5	18.0
Russian Federation	kt	3.9	4.0	4.2	4.8	5.4	6.4	6.5	6.5
Consumption	kt	78.8	77.2	80.3	79.5	80.6	86.6	86.5	90.7
China	kt	1.6	1.5	2.3	1.9	1.9	3.4	3.0	4.0
European Union **b**	kt	27.2	25.7	25.3	24.7	24.7	25.6	24.7	27.1
Japan	kt	9.7	9.6	9.7	9.7	10.3	9.9	12.8	11.7
Russian Federation	kt	4.0	4.1	4.8	5.5	5.0	7.5	6.7	7.8
United States	kt	24.8	23.2	25.4	25.1	25.1	25.1	25.2	25.2
Spot price	US$/lb	28.5	49.3	94.2	105.8	91.3	83.3	72.7	62.8
– real **c**	US$/lb	30.2	50.4	94.2	103.4	87.2	77.8	66.3	56.4
		2004-05	**2005-06**	**2006-07 f**	**2007-08 z**	**2008-09 z**	**2009-10 z**	**2010-11 z**	**2011-12 z**
Australia									
Production	t	10 964	9 974	10 357	11 534	11 882	11 800	11 540	11 060
Export volume	t	11 249	10 253	10 376	11 534	11 882	11 800	11 540	11 060
Nominal exp value	A$m	475	546	726	972	1 165	1 295	1 469	1 558
Real exp value **d**	A$m	506	563	726	948	1 109	1 203	1 331	1 377
Average price	A$/kg	42.2	53.2	70.0	84.2	98.1	109.8	127.3	140.9
– real **d**	A$/kg	45.0	54.9	70.0	82.2	93.3	101.9	115.3	124.5

a Includes Niger, Nambia, South Africa, Malawi and Zambia. **b** Twenty five countries to 2006, then twenty seven countries from 2007. **c** In 2007 US dollars. **d** In 2006-07 Australian dollars. **f** ABARE forecast. **z** ABARE projection.
Sources:Australian Bureau of Statistics; ABARE.

uranium prices have encouraged uranium exploration, the development of new mines from existing and newly discovered ore deposits and investment that prolongs the operating lives of existing mines. Reflecting this, world uranium production is projected to increase at an average annual rate of 9 per cent to exceed 78 000 tonnes in 2012.

production to rise strongly in Kazakhstan over the medium term

Uranium mine production in Kazakhstan is expected to increase strongly over the remainder of the projection period as a number of uranium mines continue to ramp up to full capacity and a number of new projects commence production. Kazatomprom has set a target for Kazakhstan's annual production to reach just under 17 700 tonnes U_3O_8 by 2010 – a threefold increase on 2006 production. Under the plans, there is around 10 300 tonnes of capacity scheduled to come on line in 2007 and beyond. However, regulatory constraints, skilled labour shortages and insufficient infrastructure, may result in some delays to these projects. Overall, Kazakhstan's uranium production is projected to increase at an average annual rate of 21 per cent to reach 18 000 tonnes in 2012. Production in Kazakhstan is expected to have a significant influence on world production growth over the medium term.

Cameco to expand production in Canada

Uranium production in Canada is expected to increase substantially toward the end of the projection period as production commences at Cameco's Cigar Lake mine. Initial production from Cigar Lake is now expected to occur in late 2009 or early 2010, following flooding in the mine in October 2006. The operation is expected to take three years to ramp up to full production capacity of more than 8000 tonnes U_3O_8 a year.

In addition, Cameco has applied for a licence to increase production by around 20 per cent at its McArthur River and Key Lake operations. The application is currently undergoing an environmental impact assessment. If the licence is approved, Cameco has estimated that it will take around two years to increase annual production to approximately 10 000 tonnes U_3O_8 (from current levels of around 8500 tonnes U_3O_8).

The Midwest project (2600 tonnes U_3O_8 a year), a joint venture between Areva and Denison mines, is currently subject to an environmental assessment. If the application to mine is approved, production is likely to commence in 2010.

Canada's uranium production is projected to increase at an average annual rate of 10 per cent to reach 21 800 tonnes in 2012.

production expansions to occur in the Russian Federation and Africa

TVEL, the Russian Federation's state run uranium mining company, has targeted an increase in uranium mine production from around 3800 tonnes U_3O_8 to 5000 tonnes U_3O_8 in 2010. In addition, first production is expected from the Yuzhnaya mine (1180 tonnes U_3O_8 a year), a joint venture between Mitsui and Tenex, in 2009. Full capacity is expected to be reached in 2015.

Uranium mine production in Africa is projected to increase to 12 600 tonnes by 2012, largely because of higher production in Namibia and South Africa, which together account for around 9 per cent of global uranium production. Paladin Resources' Langer Heinrich project in Namibia and SXR Uranium One's Dominion project in South Africa are expected to ramp up production over the medium term, after being commissioned in late 2006 and early 2007 respectively. A number of foreign companies are also planning to develop uranium mines in other African countries over the period to 2012. For instance, Paladin Resources' Kayelekera mine in Malawi (1000 tonnes U_3O_8 a year) is expected to commence produc-

tion in 2008. In addition, Denison Mines' Kariba uranium project in Zambia (680 tonnes U_3O_8 a year) is expected to commence production between 2009 and 2011.

world uranium demand

world demand for U_3O_8 to increase in the short term...

Growth in nuclear power generating capacity is the fundamental driver of growth in uranium demand. As at February 2007, there were 435 operating nuclear power plants globally, with a combined capacity of 367 788 megawatts electric (MWe). World consumption of uranium is forecast to increase by 4 per cent in 2007, largely because of the commencement of a number of nuclear reactors in India and China.

Commissioning a reactor (based on a 1000 MWe light water reactor) typically requires around 600 tonnes of uranium for its initial core, after which annual uranium requirements are lower as the reactor reaches a steady state level of operation.

In India, four reactors with a combined generating capacity of 1940 MWe are expected to commence commercial operation in early 2007. In China, unit 2 of the Tianwan nuclear power plant (1000 MWe) in Jiangsu Province is also expected to commence operations in early 2007. In the United States, unit 1 of the Browns Ferry nuclear power plant (1098 MWe) is expected to resume operation in 2007, after being idled since 1985. In addition, unit 2 of the Cernavoda reactor (706MWe) in Romania is expected to commence operation in 2007.

... and in the medium term

Over the medium term, additions to nuclear capacity in China, India, the Republic of Korea and the Russian Federation, as well as further power uprates (a power 'uprate' is the process of increasing the maximum power level at which a commercial power plant may operate) at existing nuclear power plants in the United States, are expected to be the major factors behind an increase in world uranium demand. Over the outlook period, world uranium consumption is projected to increase at an average annual rate of 3 per cent to around 90 700 tonnes U_3O_8 in 2012.

As at February 2007, there were 29 reactors under construction globally, with another 48 reactors planned. The majority of the reactors that are currently under construction are situated in India and China, where rapid economic expansion has underpinned strong increases in demand for electricity. The expansion of nuclear capacity in these countries has also been designed, in part, to address electricity supply concerns in areas where economic growth is high but that are located far from lower cost supplies of domestic fossil fuel.

While increases in the prices of non-nuclear energy sources and a growing desire by signatories to the Kyoto Protocol to reduce greenhouse gas emissions are expected to encourage the construction of new nuclear reactors in the United States and European Union, the major impact of these trends is expected to occur beyond the end of the projection period. Even if a number of new reactors were approved for construction in the short term, it typically takes five to seven years for a light water reactor to be constructed. As such, these policies are not expected to have a major impact on uranium demand over the medium term.

power uprates to increase nuclear energy output in the United States

As at February 2007, there were 103 operating nuclear reactors in the United States, the world's largest consumer of uranium. Over the outlook period, an increase in uranium

requirements in the United States is expected to reflect mainly power uprates and operating life extensions at existing reactors, rather than the construction of new nuclear reactors. While the *Energy Policy Act 2005* is expected to increase the incentive to construct nuclear reactors in the United States, its major effect is assumed to occur beyond the outlook period.

The move to increase nuclear generating capacity in the United States through power uprates has been occurring since the early 1990s. This has enabled considerable additions to nuclear generating capacity without significant additions to the number of reactors in operation. Power uprates allow the maximum power at which a nuclear reactor operates to be increased through the use of more highly enriched uranium fuel. The US Nuclear Regulatory Commission (NRC) has granted approval for an additional 4845 MWe of generating capacity through power uprates since 1977. A further 1057 MWe of generating capacity is currently pending approval. The NRC expects applications for a further 1383 MWe capacity through power uprates to 2011.

A number of reactors in the United States have also been granted operating life extensions. As at February 2007 the NRC had granted twenty year operating life extensions to 48 reactors. The NRC is currently reviewing seven other licence renewal applications. In early November 2006 the NRC granted a twenty year licence extension for the single reactor of the Monticello nuclear power plant in Minnesota (capacity 600 MWe).

nuclear output to increase in China, India, Japan and the Republic of Korea

Over the medium term, substantial additions to nuclear capacity are projected to occur in Japan, China and the Republic of Korea. In Korea, four reactors with a combined capacity of 3800 MWe are expected to be connected to the electricity grid over the outlook period.

Japan currently has 55 operating reactors, with a combined capacity of 47 700 MWe, or 30 per cent of total electricity generation capacity, with a further five reactors to be commissioned. Local opposition to new nuclear power plants remains an impediment to meeting Japan's nuclear energy targets over the medium term. However, nuclear generation capacity in Japan is expected to increase by 6216 MWe over the outlook period.

In China and India, rapid economic growth, rural–urban migration and substantial growth in expenditure on infrastructure development have supported strong growth in nuclear capacity over the past decade, albeit from a low base. In early 2007, China had ten operating nuclear reactors (combined capacity of 7587 MWe), the electricity from which accounts for around 2 per cent of China's total electricity generation. India currently has sixteen nuclear reactors in operation, with a combined capacity of 3483 MWe.

Given the typical amount of time required to construct a nuclear reactor, additions to nuclear capacity in China and India over the medium term will come from reactors that are either currently under construction or in the final stages of planning. China and India currently have five and seven reactors respectively under construction, with a combined capacity of 4533 MWe and 3380 MWe.

Russian Federation

Russia's nuclear generation capacity is expected to grow over the projection period despite the closure of a number of reactors that have reached the end of their operating lives. Over the medium term, nine reactors, with a combined capacity of 8225 MWe, are expected to commence production. A majority of existing nuclear reactors in the Russian Federation have aging technology; the 31 operating reactors have an average age of around 25 years, with Kalinin-3 and Volgodonsk-1 the only reactors commissioned in

the past decade. Further, only seven of these reactors have been operating for less than twenty years. As the working life of a nuclear reactor is considered to be around thirty years, a number of reactors are likely to be shut down over the outlook period unless lifetime extensions are granted.

nuclear output to decline in the European Union

Nuclear power has historically accounted for a significant share of total electricity generation in a number of EU member countries. However, despite the expected start of operation of the Olkiluoto 3-reactor in Finland in 2010 (1600 Mwe) and the Flamanville reactor in France in 2012 (1630 MWe), EU nuclear generating capacity is projected to decline over the medium term. This reflects the expected decommissioning of a number of nuclear reactors, particularly in the United Kingdom and Germany. In the United Kingdom, eight reactors with a combined capacity of 3824 MWe are expected to be decommissioned over the outlook period.

longer term drivers of nuclear generating capacity

Growth in nuclear generating capacity will be a key determinant of uranium consumption over the long term. The choice of fuel mix in electricity generation is expected to be driven by a number of factors, including energy security, environmental considerations and the relative cost of nuclear power generation.

Increases in population, coupled with an expanding global economy, are expected to support large increases in energy demand, particularly in countries where growth in gross domestic product per person is expected to be rapid.

energy security

Energy security has been an important element driving growth in nuclear power capacity over the past three decades. In a number of countries, particularly those with limited indigenous energy resources, nuclear power has enhanced energy security by diversifying the fuel mix in the electricity sector.

environmental considerations

Concerns about climate change and other environmental issues have renewed interest in the use of nuclear power as a means of addressing greenhouse gas emissions and localised pollution. The changing perception of nuclear power as a clean energy source in a number of countries has led to new nuclear reactors being proposed or under construction. However, in some regions, concerns about the negative environmental consequences of nuclear waste have deterred the use of nuclear power.

relative cost of nuclear power generation

The cost competitiveness of electricity generated by nuclear power compared with fossil fuels differs between countries, and is influenced by factors such as domestic fossil fuel endowments. The relative levelised cost of generating electricity (LCGE) is the most comprehensive measure of the relative cost competitiveness of alternative electricity generation technologies. The method is used to calculate a real price of electricity for each alternative technology that represents the price of electricity required over the life of the plant to cover all expenses.

The relative cost of nuclear power generation is typically dependent on a country's resource endowment and government policy on nuclear power. Coal and gas fired plants can typically be established faster and at a lower cost than nuclear power plants, but they incur relatively higher operating and maintenance costs (of which fuel is a significant proportion). Reflecting this, and in the absence of pricing for carbon emissions, nuclear power is less economic in regions with significant fossil fuel resources.

slow growth in enrichment capacity

Large commercial enrichment plants are currently in operation in France, Germany, the Netherlands, the United Kingdom and the Russian Federation. World enrichment capacity is expected to increase moderately over the outlook period as gaseous diffusion capacity begins to be phased out and replaced with centrifuge technology.

The United States and France are currently building enrichment plants with centrifuge technology to replace aging diffusion plants. The centrifuge plant in the United States is planned to have an annual production capacity of 3.5 million separative work units (SWU) and is expected to commence production in 2011. In France, initial production from the Georges Besse II plant is planned to commence in 2009 and is expected to reach its nominal capacity of 7.5 million SWUs around 2016.

An increase in global enrichment capacity can increase the opportunity to substitute enrichment for uranium, both via enrichers changing tails assays and the potential for the re-enrichment of tails material. The tails assay is a measure of the amount of fissile uranium (U-235) remaining in the waste stream from the uranium enrichment process. However, the extent to which a higher level of SWUs can be used in the enrichment process is currently limited, as enrichment facilities in western countries are already operating at close to full capacity. As such, demand for U_3O_8 over the projection period is expected to largely grow in line with nuclear power generation.

Australia's export earnings to increase in the short term

All of Australia's production of U_3O_8 is exported. In 2006-07 Australia's production of U_3O_8 is forecast to increase by 4 per cent to almost 10 400 tonnes largely from higher expected production from BHP Billiton's Olympic Dam mine in South Australia and Energy Resources of Australia's Ranger mine in the Northern Territory. In 2005-06, production at the Ranger mine fell by 6 per cent following heavy rainfall associated with cyclonic activity, while production at the Olympic Dam mine declined by 10 per cent, as BHP mined ore containing lower grades of uranium. With production and export prices both

enrichment

Natural (mined) uranium contains approximately 0.7 per cent U-235. Natural uranium cannot be used in light water reactors because the content of fissile U-235 is too low to sustain a nuclear reaction. Enrichment is the process of increasing the concentration of U-235, while decreasing the concentration of U-238. The majority of nuclear power reactors require low enriched uranium of between 3 and 5 per cent U-235.

The work required to perform enrichment is measured in terms of separative work units (SWUs). An SWU is a unit that expresses the energy required to separate U-235 and U-238. The amount of uranium enriched depends on: the quantity of uranium feed (UF_6) (uranium needs to be in a gaseous form to be enriched) at the beginning of the process; the amount of SWUs used in the enrichment process; and the concentration of U-235 left over (tails assay) at the end of the process. By varying the tails assay, a reactor operator can find the most economical combination of UF_6 feed and SWU required for enrichment.

As the price of uranium rises relative to the cost of enrichment, there is an increased incentive to lower the tails assay (and hence uranium requirements) by increasing the amount of SWUs used in the enrichment process (assuming spare capacity). As such, if the relative price increase of uranium is greater than the relative increase in the price of enrichment, the demand for mined uranium may decline as nuclear utilities seek to reduce tails assays.

expected to increase in 2006-07, Australia's export earnings are forecast to increase by 33 per cent to $726 million.

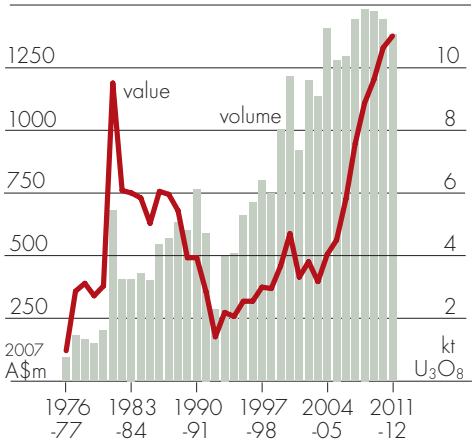
In 2007-08, Australia's mine production is forecast to increase by 11 per cent to 11 500 tonnes, stemming largely from the commencement of production at SXR Uranium One's Honeymoon mine. The Honeymoon mine is expected to commence production in the first quarter of 2008, and will eventually ramp up to an annual rate of 400 tonnes U_3O_8 a year.

In addition, Energy Resources of Australia is planning to construct a plant at the Ranger mine that will enable the processing of stockpiled lateritic ore (ore with high clay content). The new plant will enable the Ranger mine to produce an additional 400 tonnes U_3O_8 a year, with the first lateritic ore scheduled for processing in the first quarter of 2008.

Australian production to remain steady over medium term

Over the remainder of the projection period, Australia's uranium mine production is expected to be largely dictated by production from existing operations and, as such, is forecast to remain relatively steady at 11 000–12 000 tonnes a year. Only a number of relatively small projects such as Energy Metals' Bigrlyi project and Compass Resources' Mount Fitch project, both in the Northern Territory, have been included in the medium term projections for Australia's uranium production.

Australian uranium exports



There are a significant number of undeveloped uranium deposits in South Australia, Queensland and Western Australia. However, the current policy of governments in these states does not allow the development of additional uranium mines.

If state government policies on the development of new uranium mines were to change, projects such as Summit Resources and Paladin Resource's Valhalla project in Queensland, Mega Uranium's Ben Lomond project in Queensland, Marathon Resource's Mount Gee project in South Australia and Nova Energy's Lake Way and Centipede projects in Western Australia could be developed reasonably quickly. If there were an easing of current state policy constraints in the next year or two, Australian uranium production toward the end of the outlook period could be greater than projected.

BHP Billiton's Olympic Dam has the world's largest resources of low cost uranium (extractable at less than US$40/kgU). BHP is currently considering the potential to increase uranium production threefold (to 15 000 tonnes U_3O_8 a year) from 2013. Since the scheduled completion of the expansion is beyond the outlook period, it has not been included in the projection of Australian uranium production.

Australia's real export earnings are projected to reach $1.4 billion in 2011-12, reflecting increased export volumes and higher assumed contract prices.