nickel

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In 2006, nickel prices averaged US$24 250 a tonne, the highest (in real terms) since 1988. Prices are expected to average higher in 2007 as a range of supply constraints, such as long lead times in developing new mines, difficulties in sourcing skilled labour and materials, and strong demand continue to contribute to a tight supply–demand situation. Global stocks are forecast to fall in 2007, to just 1.8 weeks of consumption by year's end, less than half their level at the end of 2005.

In 2008 an easing in demand growth and some increase in mine production is forecast to result in stocks stabilising at around 1.5 weeks of consumption. With stocks staying low, prices are expected to remain high in 2008.

The combination of continued supply disruptions and delays in the development of new projects is expected to continue to constrain growth in world nickel production for a number of years. Beyond 2008 the commissioning of a number of new mines and the expansion of capacity at existing mines is projected to allow a slow rebuilding of nickel stocks and an easing in prices.

However, developments in the use of nickel pig iron in China to produce mainly low grade stainless steel have the potential to affect the price outlook. If increased Chinese use of nickel pig iron were to satisfy some of the demand more quickly than is currently expected to be the case, nickel prices could fall earlier and faster than projected.

prices to remain high over the short term

World nickel prices are forecast to average US$36 750 a tonne in 2007, 52 per cent higher than the average for 2006. Strong demand growth from stainless steel producers, particularly in China and India, coupled with labour strike threats at Xstrata's Sudbury mine in Canada, resulted in nickel prices reaching US$41 350 a tonne in late January 2007. Further concerns over falling stocks contributed to a new record of US$43 300 in late February. Growth in demand as well as constraints to supply are forecast to continue in 2007 and into 2008, contributing to high prices until at least late 2008. Additional nickel supply capacity is due to come online in the second half of the outlook period and is expected to prompt a drop in prices at that time. However, prices are still expected to remain high in historical terms.

Labour disputes have been a feature of the nickel industry for some years and current high prices continue to reinforce the bargaining position of labour unions. At Xstrata's Sudbury operation in Canada, strike action was averted at the end of January. Nevertheless, the potential for further disruption to supply across the industry will remain high until prices ease.

Over the medium term an increase in average production costs driven by a growing reliance on laterite ore bodies is projected to hold nickel prices above US$12 000 in real terms (2007 dollars). The

nickel pig iron

Nickel pig iron is a ferronickel pig iron containing 3–5 per cent nickel. It contains much less nickel than conventional ferronickel (25–40 per cent) and has higher concentrations of sulfur and phosphorous. China is currently producing nickel pig iron from low grade laterite ores imported primarily from the Philippines. The ore, containing 0.8–2 per cent nickel, is processed in small blast furnaces (300 cubic metres or less), previously slated to be closed by the Chinese Government. The resulting nickel pig iron is currently being used to produce 200 series stainless steels, with limited application to the 300 series. There is considerable upside potential for nickel pig iron to be used more widely in the production of 300 series stainless steels with improvements in technology.

laterites

Approximately 72 per cent of the world's nickel resources are held in laterite deposits. Unlike sulfide deposits that are found deep below the surface, laterite deposits have formed at the surface over millions of years. Leaching and weathering of complex surface rocks dissolve more soluble minerals and metals, leaving behind higher concentrations of valuable metals that would otherwise be in trace form.

Laterisation of surface rocks containing 0.2–0.3 per cent nickel form nickeliferous laterites, with overall nickel concentrations of 1–2 per cent. These laterites are predominantly found in tropical zones such as New Caledonia, Indonesia, Cuba and Brazil. Australia's laterite deposits are unique among this group as they are typically dry, have formed more slowly, and have more clay and lower nickel concentrations.

Laterite deposits usually have two layers – limonite and saprolite. The saprolite layer has the higher nickel content of the two and each layer needs to be processed differently. Extraction costs for laterites are lower than for sulfides; however processing costs are much higher and the technologies are still being developed.

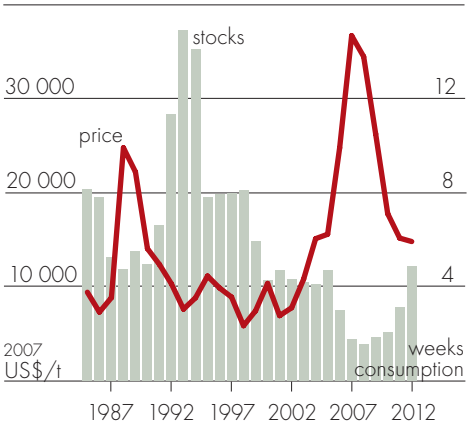
The potential methods for processing laterites are high pressure acid leach (HPAL), atmospheric leaching and heap leaching. HPAL is widely preferred because of its ability to process a blend of limonite and saprolite ores and its robustness. HPAL processes have been in operation for some time internationally, but were introduced in Australia for the first time at Murrin Murrin. While there are benefits to each of the processes, heap leaching is currently the only other option that yields a high metal content from a range of ore types. Capital costs for setting up either HPAL or heap leaching laterite processing are relatively high, in the range US$14–17 a pound, and operations may only be viable when cobalt can also be extracted from the ore to supplement revenue streams.

nickel outlook

	Unit	2005	2006	2007 f	2008 z	2009 z	2010 z	2011 z	2012 z
World									
Production	kt	1 293	1 349	1 433	1 526	1 620	1 701	1 820	1 948
Consumption	kt	1 243	1 388	1 463	1 530	1 609	1 691	1 781	1 878
Stocks	kt	112	81	50	45	57	67	107	177
– weeks consumption		4.7	3.0	1.8	1.5	1.8	2.1	3.1	4.9
Price LME									
– nominal	US$/t	14 742	24 252	36 750	35 313	27 500	19 063	16 650	16 500
– real **a**	US$/t	15 614	24 810	36 750	34 519	26 277	17 805	15 202	14 838
		2004-05	**2005-06**	**2006-07 f**	**2007-08 z**	**2008-09 z**	**2009-10 z**	**2010-11 z**	**2011-12 z**
Australia									
Production									
– mine **bs**	kt	192	183	202	238	274	340	370	385
– refined	kt	126	111	124	143	179	182	182	182
– intermediate	kt	115	99	102	106	116	116	116	116
Export volume **cs**	kt	218	202	224	262	305	319	337	348
Export value									
– nominal **s**	A$m	3 731	3 515	8 406	10 215	11 488	8 166	7 160	7 056
– real **ds**	A$m	3 971	3 626	8 406	9 966	10 935	7 583	6 486	6 237

a In 2007 US dollars. **b** Nickel content of domestic mine production. **c** Includes metal content of ores and concentrates, inter- mediate products and nickel metal. **d** In 2006-07 Australian dollars. **f** ABARE forecast. **s** ABARE estimate. **z** ABARE projection.
Sources: Australian Bureau of Statistics; International Nickel Study Group; London Metal Exchange; World Bureau of Metal Statistics; ABARE.

world nickel



cost of producing nickel from laterite ore is considerably higher than from sulfide ore. As a result, nickel metal production costs are rising and the continued expansion of production to meet growing demand is therefore reliant on prices over the longer term remaining high enough to cover the increased production costs.

world demand continues to grow...

World nickel consumption is forecast to increase by 5 per cent to 1.46 million tonnes in 2007. This growth is expected to occur as a result of strong demand for stainless steel, and is despite record prices and some movement to reduced nickel content in lower grade stainless steels. With world stocks forecast to decline to the equivalent of 1.8 weeks of consumption at year's end, the nickel market will be vulnerable to short term supply disruptions over the remainder of 2007.

The production of stainless steel is the dominant primary use of nickel because of the desirable properties of nickeliferous or austenitic stainless steels (stainless steels that contain nickel), including high heat and corrosion resistance. Typical applications for nickeliferous stainless steels can be found in the construction, food processing and motor vehicle manufacturing industries.

High prices and supply disruptions experienced in recent years have encouraged the use of scrap nickel in steel production and made low nickel content stainless steels more attractive. Reflecting this, the proportion of primary nickel used in the production of stainless steels declined from 65 per cent in 2005 to 61 per cent in 2006.

Adding to the effect of easing demand for primary nickel in stainless steel, year on year growth in global stainless steel production is set to moderate in 2007. With world stainless steel production growing by 14 per cent in 2006, producer stocks of stainless steel rose

stainless steels

Stainless steels are a group of corrosion resistant steels that contain at least 10 per cent chromium and other alloying elements such as nickel and manganese. The 300 series has the largest market share and contains around 8–12 per cent nickel. The high nickel content of the 300 series imparts superior thermal resistance properties to the steel. These steels tend to be used mainly in manufacturing and industrial applications, such as food preparation equipment, oil refining, power generation and the petrochemicals production.

The 200 series stainless steels contain a high level of manganese and only around 1–5 per cent nickel. The 200 series steels tend to cost less than 300 series steels, but generally have inferior corrosion and thermal resistance properties and poorer surface appearance. As a result, the use of 200 series stainless steel is concentrated in construction industries.

The 400 series stainless steels contain no nickel but have higher chromium content. These steels tend to have superior corrosion resistance properties compared with the other series and are used mainly in automotive exhaust systems.

in the second half of the year (particularly in the United States). In 2007, stainless steel production is forecast to grow by only 7 per cent as some of these stocks are worked off.

Demand for nickel from the nonstainless steel sector also remains strong. The aerospace industry is projected to continue its moderate growth in the medium term. The aerospace industry is the second largest end user of nickel (17 per cent). The industry uses nickel in jet engines because of its heat resistant properties when alloyed with other metals to produce superalloys. The use of nickel in batteries is also continuing to grow despite the gradual phasing out of nickel-cadmium batteries, and mainly reflects the rising popularity of electric and hybrid cars that use nickel metal hydride batteries.

...supported by strong growth in demand from China and elsewhere

China overtook the United States and Japan in 2002 as the largest consumer of stainless steel, and surpassed Japan in 2005 as the largest consumer of primary nickel. Continued large scale development, including construction of residential and commercial buildings in China, has contributed to average year on year increases in primary nickel consumption of 25 per cent in China over the past six years.

Many of China's cities suffer from high levels of air pollution that, when combined with moisture in the atmosphere, are a significant source of corrosion. Corrosion resistant stainless steels are thus an attractive and in some cases a necessary option for building and other construction.

The rural–urban migration of China's population will also continue to be a key driver of construction activity in China. According to the United Nations (*World Urbanisation Prospects: The 2005 Revision*, table A.2), China's urban population is projected to increase by 78 million people in the four years to 2010. Construction activity in China will need to continue at a rapid pace in order to accommodate this influx of people, providing a strong driver for nickel consumption over the medium term.

Urban incomes in China are also growing strongly (10 per cent in 2006) and are assumed to continue to grow. Such growth can be expected to feed rising demand for consumer goods such as motor vehicles, mobile phones and other electronic equipment, thus increasing the demand for nickel in applications such as batteries, stainless steel and nickel alloys.

Demand for nickel in north America and the European Union is forecast to continue to increase, albeit at a more modest rate than in China. Consumption of nickel in the United States grew by 11 per cent in 2006 to 150 800 tonnes and in the European Union by 10 per cent to 444 400 tonnes. Much of this growth is attributable to the demand for stainless steel from the residential and commercial construction sectors. Nickel demand in the United States is expected to moderate in 2007 following a slowing in residential construction activity. EU consumption growth is also expected to ease from last year's high.

world production constrained until 2009

World nickel production is estimated to have increased by 4 per cent in 2006. Most of the growth was in Asia, particularly China (a 39 per cent rise), and Indonesia (up 138 per cent). Production in Australia and New Caledonia in 2006 was lower than in 2005 after cyclone disruptions to BHP Billiton's Nickel West in the first quarter and strike action in New Caledonia in the second half of the year.

Looking beyond 2007, no large scale increases in mine capacity are expected during the first half of the outlook period. Few new projects are due to start before mid-2008 and those that are expected to come on line are relatively small. Lead times of over ten years

for major new mines effectively rule out any significant supply increases for another few years. Further, current exploration expenditure is not projected to yield increases in production until well beyond the end of the outlook period.

One factor that could have an effect on the supply–demand balance is the increased use of nickel pig iron in China. China is increasingly using nickel pig iron as a substitute for conventional primary and secondary nickel sources. Low grade laterite ores are being imported and processed to produce nickel pig iron, which to date is being used mainly in the production of 200 series stainless steels. It is uncertain how much of China's demand for nickel can or will be met via this source in the future. However, there is the potential for nickel pig iron to replace 20 000 – 30 000 tonnes of nickel if technology is developed to allow it to be widely used in the larger category of 300 series stainless steels. Such a quantity of primary nickel is roughly equivalent to the entire forecast production–consumption deficit in global nickel production in 2007.

Over the medium term, new nickel supplies will derive predominantly from laterite projects that are typically more expensive to develop. Existing sulfide deposits are rapidly being depleted. Almost 20 per cent of new sulfide production represents replacement feed as other sulfide mines wind down or close, while almost all new laterite projects will be additional supply. It is expected that by the end of the outlook period, production from laterite deposits will account for more than half of world output of primary nickel.

New capacity is projected to relieve some of the supply constraints around the middle of the outlook period. However, advanced laterite projects such as CVRD Inco's Goro nickel project in New Caledonia (60 000 tonnes a year) and BHP Billiton's Ravensthorpe project in Western Australia (50 000 tonnes a year) have experienced large cost increases, with startup delayed until late 2008. Construction activity at Goro continued in December and January despite a general strike in New Caledonia which is expected to have further delayed the project that is already over four years behind schedule.

Looking further ahead, additional production is likely over the longer term from countries such as the Russian Federation, Brazil and New Caledonia, where exploration and new developments are increasing. Norilsk Nickel and BHP Billiton announced plans in 2006 to jointly explore and develop Russia's mineral resources over the next few years and this, combined with other exploration projects, is likely to eventually result in further increases in Russian nickel production.

There is also potential for New Caledonian nickel production to increase with projects like Xstrata's Koniambo (60 000 tonnes) being developed. However, new projects are unlikely to go ahead in the region if strikes continue to disrupt the development and operation of mines and facilities.

major laterite project delays and costs

				startup		cost estimate	
project	country	company	capacity kt	initial	current	initial US$b	current US$b
Goro	New Caledonia	CVRD Inco	60	2004	2008	1.45	3.0
Vermelho	Brazil	CVRD Inco	46	Q3 2008	2009	1.2	1.6
Ravensthorpe	Australia	BHP Billiton	50	Q2 2007	Q1 2008	1.05	2.2
Koniambo	New Caledonia	Xstrata	60	2009	2009/ 2010	1.5	2.2–3.0
Caldag	Turkey	European Nickel	20	2007	Q3 2008	0.3	0.3
Onca Puma	Brazil	CVRD Inco	57	2008	2008	1.1	1.2

Several new projects in Brazil could also result in that country becoming a major world producer over the longer term. Three projects have already been approved, totalling 110 000 tonnes – CVRD Inco's Onca Puma (57 000 tonnes), Mirabella's Santa Rita (17 000 tonnes) and Anglo American's Barro Alto (36 000 tonnes) – while a fourth, with expected capacity of 46 000 tonnes is under consideration. These four projects, if completed, have the potential to make Brazil the world's fourth largest nickel producer, behind the Russian Federation, Canada and Australia.

Australian production and exports

High prices and a substantial rise in shipments of nickel are forecast to increase export earnings in 2007-08 by approximately 22 per cent after more than doubling in 2006-07. Record prices are expected to be the primary driver of most of the increase in returns for 2006-07 and 2007-08.

Export volumes are estimated to have increased by 22 000 tonnes in 2006-07, while the unit value of exports is estimated to have risen substantially. Beyond 2007-08, increases in export volumes as new projects come on line are expected to partially compensate for the effects of an easing in world prices. The value of exports is projected to fall by around 20 per cent to $6.2 billion (2006-07 dollars) between 2006-07 and 2011-12.

Mine production in Australia is forecast to increase by 36 000 tonnes in 2007-08 as a range of projects build output toward nominated capacities. These projects include LionOre projects Waterloo (4000 tonnes total capacity) and Black Swan (13 000 tonnes capacity), Western Areas' Forrestania (8000 tonnes), the startup of BHP Billiton's Ravensthorpe project (50 000 tonnes), Sherlock Bay Nickel Corporation's Sherlock Bay (12 000 tonnes) and Allegiance's Avebury (8000 tonnes) and the expansion of Sally Malay (19 000 tonnes) by Sally Malay mining.

The Ravensthorpe mine is expected to take around two years to achieve full capacity, thus providing production increases into 2009-10. Honeymoon Well, Nornico and the Gladstone Nickel Project are projected to come on line in the second half of the outlook period, with a combined capacity of 74 000 tonnes a year. Output from these mines is expected to more than offset the closure of the Blair and Long mines in Western Australia, which currently produce 11 000 tonnes of nickel a year in total.

The Ravensthorpe laterite project in Western Australia continues to suffer from delays and cost blowouts caused by problems with sourcing skilled labour and equipment. Current cost estimates are at $2.2 billion, 110 per cent up on its initial budget of $1.05 billion. There is potential for other major projects in the state to experience similar problems over the next few years given the relatively large numbers of major mining developments in the currently occurring in Western Australia.

Production of refined nickel is forecast to rise by approximately 12 per cent in 2006-07 as the Murrin Murrin, Kwinana, and Yabulu refineries expand their output. The expansion to Yabulu will increase the refinery's capacity from 31 200 tonnes to 76 000 tonnes and is expected to be completed by the end of March 2007.

Further increases in the production of refined nickel are expected to occur in 2007-08 and 2008-09, with total output projected to reach approximately 180 000 tonnes by 2010. Less than 1 per cent of the refined nickel is expected to be consumed within Australia.