

## 10 Cobalt Supply & Demand 2010

### Supply

Although cobalt is fairly widespread in the Earth's crust and makes up .002% of it on average (ranked element No. 33), its low concentration usually means that it is produced as a by-product of another metal. Almost all land-based deposits contain cobalt in combination with nickel or copper and a few with arsenic and silver. Until recently, world supply was predominantly African from the Copper Belt of the Democratic Republic of Congo and Zambia but in the last few years, changes in the supply characteristics of cobalt have occurred. Other important cobalt producers include Australia, Brazil, Cuba, Russia and China. Cobalt as a by-product of nickel operations has increased significantly with the development of several important nickel laterite projects and with the advent of innovative technology there is greater possibility now to develop cobalt as a primary metal. A rough split of cobalt production arisings would currently be:

Nickel Industry	-	~55%
Copper Industry & Other	-	~35%
Primary cobalt operations	-	~10%

**Table 1**  
**Where Cobalt is Currently Mined and/or Refined**

Country	Mined	Refined	Approx. Refined Qty
Australia	√	√	4,100
Belgium		√	2,600
Botswana	√		
Brazil	√	√	1,400
Canada	√	√	4,700
China	√	√	33,000
Cuba	√		
Finland		√	9,300
France		√	300
India			1,200
Japan		√	1,950
Morocco	√	√	1,550
New Caledonia	√		
Norway		√	3,200
Russia	√	√	2,450
South Africa	√	√	500
D.R. of Congo	√	√	4,200
Uganda		√	600
Zambia	√	√	<u>5,000</u>
			<u>76,050 (tonnes)</u>

Refining can be from newly mined ores or from older slags, by-products and scrap. The definition is that "new" cobalt is produced.

Cobalt can also be derived as a by-product of precious metal mining, for example, in South Africa (usually as sulphate) and is produced as the primary product from concentrates and tailings in Morocco. Here CTT commissioned a refinery in 1999 which produces refined metal and oxide.

The list of potential new sources of cobalt is large, ranging from huge new cobalt-containing nickel and copper deposits in Canada, Western Australia, the Democratic Republic of Congo (DRC), Zambia, Madagascar, not to mention deep-sea nodules and discoveries of cobalt containing polymetallic minerals in Yemen. The main development has been the increase in mining activity in the DRC where, until recently, significant volumes of ore and concentrate were being mined for refining elsewhere, mainly China. The DRC Government put restrictions on the export of ores and concentrates in 2006/08 in order to encourage greater development of downstream processing in the country and has also been reviewing and in some cases re-negotiating mining contracts in that country.

Going forward it would appear that developments in the DRC will be an important factor in cobalt production and going forward the CDI calculated that new cobalt production would probably arise as follows:

<b>Africa</b>	<b>~65 %</b>
<b>Americas</b>	<b>~15 %</b>
<b>Australasia</b>	<b>~15 %</b>
<b>Asia</b>	<b>~ 5 %</b>

In spite of the global financial crisis which hit all markets in 2008/09, the cobalt market has maintained its resilience, recording a CAGR growth rate of about 5% (according to the CRU), notwithstanding that there was a fall in demand in 2008/09. The supply side was also adversely affected by the fall in cobalt price, but since 2009 production of refined cobalt, most particularly in China, continued to increase and the market recorded significant growth of refined cobalt production in 2010. The USA Defence Logistics Agency who has been

selling stockpiled material into the market for over 20-years has now ceased sales for the time being, but even so at the 31st December 2010 the uncommitted cobalt inventory in the US DLA stockpile stood at 301 tonnes.

Higher prices during the period 2006 to 2008 saw seen a flurry of interest in cobalt and numerous new projects were planned in Africa (DRC, Zambia, Madagascar), Australasia (Australia, New Caledonia, PNG), Asia (Indonesia), the Americas (Brazil, USA, Mexico). However, though the onset of a global recession and subdued prices in 2008/09 caused some dislocation, we find that most of these projects are moving forward, and are generally associated with nickel laterite development.

Because cobalt is essentially a by-product metal in primary nickel and copper operations, the price of cobalt is usually of limited relevance to the viability of the project. However, the viability of primary cobalt operations is critically dependent on the price of cobalt and so strong project economics are important here.

Table 1 is a guide to 2010 world output. In the past, we have tried to estimate global cobalt resources in the ground, but these are continually being revised as new and richer ores seem to appear and prices change. There seems to be enough known land sources of cobalt to last for at least 100 years and for another 200 or 300 years when deep sea resources are taken into account. So we confident that cobalt is not running out, but its availability will depend upon many factors such as price, demand, technological development and global economic growth.

Global reserves of cobalt are of the order of 7.1 million tonnes according to the USGS and the CDI calculate that the reserves are dispersed as follows:

<b>Africa</b>	~52 %
<b>Americas</b>	~17 %
<b>Australasia</b>	~24 %
<b>Asia</b>	~ 7 %
	<u>100 %</u>

**Table 2 – Refined Cobalt Production/Availability (Rounded Tonnes)**

<b>Europe</b>	<b>Production/Supply</b>	<b>Source of Feed</b>
Belgium	2,600	Various secondary/Australia/DRC
Finland	9,300	New Caledonia/Africa/Australia/Others
France	300	Nickel by-product New Caledonia
Norway	3,200	Canada/Africa/Australia/Russia/Others
<b>Africa</b>		
Morocco	1,550	Domestic
South Africa	500	Domestic
D.R. of Congo	4,200	Domestic
Uganda	600	Domestic
Zambia	5,000	Domestic
<b>Americas</b>		
Brazil	1,400	Domestic
Canada	4,700	Domestic/Australia/Cuba/Secondary
<b>Asia</b>		
China	33,000	Domestic/DRC
India	1,200	Domestic/Cuba/DRC
Japan	1,950	Australia/Philippines
<b>Others</b>		
Australia	4,100	New Caledonia/Domestic
Russia (Export)	2,450	Domestic
DLA (Deliveries) _____	8	Stock Release (via DLA stock report)
<b>TOTAL</b>	<b>76,042</b>	<i>NB: Availability figures rounded for illustration</i>

## Production

In 2001, the CDI re-examined its methodology for determining cobalt statistics. It has been recognised that in the past, production statistics have contained a varying degree of double counting as some CDI members' figures included material sent to other members for further refining. The Institute has drawn up a definition for refined production which we believe removes this discrepancy such that, as of 1998, all double counting was eliminated.

World refined cobalt production has been defined as **“all cobalt units, whether in metal or chemicals, derived from feed requiring further refining”**. For the purposes of this definition, the following sources of material shall not be counted as feed: a) DLA and other stockpile releases; b) Russian; c) Likasi, DRC; d) Lower grade Moroccan.

Using this definition, Table 2 illustrates 2009 availability of refined cobalt. The origin is where the refinery is located. The feed sources can be from many other places, not necessarily domestic. One should also be clear that we are talking about “available new” cobalt, which should not be confused with “sales”. We include refining in Belgium from so-called secondary feedstocks (old slags and cements), and stock releases from the DLA. The inclusion of “secondary” material refining is subject to some comment. The Belgium tonnage includes Umicore’s production in China. Hence the 23,000 tonnes reported for China excludes Umicore’s production in China which is estimated at about 1,500 tonnes per annum. In 2007 Norilsk of Russia announced that it was disposing of its cobalt units to OMG Group and so the production attributed to Russia has reduced in 2008/09 and that for OMG Group (Finland) has increased according to the bilateral agreement. As of 2009 Norilsk is no longer a Member of the CDI. Taking these comments into consideration, Table 3 illustrates refined cobalt production from CDI members from 2003 to 2009.

**Table 3 – CDI Member Refined Cobalt Production (Tonnes)**

Producer	2004	2005	2006	2007	2008	2009	2010
BHPB/QNPL, Australia.	1,900	1,400	1,600	1,800	1,600	1,700	2,141
Chambishi, Zambia	3,769	3,648	3,227	2,635	2,591	235	3,934
CTT, Morocco	1,593	1,613	1,405	1,591	1,711	1,600	1,545
Eramet, France	199	280	256	305	311	368	302
Gécamines	735	600	550	606	300	415	745
ICCI (Canada)	3,325	3,391	3,312	3,573	3,428	3,721	3,706
OMG (Finland)	7,893	8,170	8,580	9,100	8,950	8,850	9,299
Sumitomo, Japan	429	471	920	1,084	1,071	1,332	1,935
Rubamin, India*	0	0	0	0	0	0	517
Umicore, Belgium	2,947	3,298	2,840	2,825	3,020	2,150	2,600
Vale Inco, Canada	1,562	1,563	1,711	2,033	2,200	1,193	940
Xstrata (Norway)	4,670	5,021	4,927	3,939	3,719	3,510	3,208
<b>TOTAL</b>	<b>29,022</b>	<b>29,445</b>	<b>29,328</b>	<b>29,491</b>	<b>28,901</b>	<b>25,074</b>	<b>30,872</b>

- Rubamin joined CDI in 2010

Cobalt production from other producers, deliveries from the DLA and other stockpiles from 2004 to 2010 are shown in Table 4.

**Table 4 – Other Refined Cobalt Production/Availability (Tonnes)**

	2004	2005	2006	2007	2008	2009	2010
Brazil	1,155	1,136	902	1,148	994	1,012	1,369
China*	8,000	12,700	12,700	13,245	18,239	23,138	32,930
India**	545	1,220	1,184	980	858	1,001	670
Kasese, Uganda	457	638	674	698	663	673	624
Katanga Mining, DRC	0	0	0	0	749	2,535	3,437
Mopani Copper+Zambia	2,022	1,774	1,438	1,700	1,250	1,300	1,200
Minara, Australia	1,979	1,750	2,096	1,884	2,018	2,350	1,976
Norilsk, Russia	4,524	4,748	4,759	3,587	2,502	2,352	2,460
RSA	300	214	257	307	250	236	833
<b>TOTAL</b>	<b>18,982</b>	<b>24,180</b>	<b>24,010</b>	<b>23,549</b>	<b>27,523</b>	<b>34,597</b>	<b>45,499</b>
DLA Deliveries	1,632	1,199	294	617	203	180	(8)
<b>TOTAL</b>	<b>20,614</b>	<b>25,379</b>	<b>24,304</b>	<b>24,166</b>	<b>27,726</b>	<b>34,777</b>	<b>45,491</b>
DLA Sales	1,077	888	256	553	203	180	0
DLA Sales cumulative	22,129	23,017	23,905	24,458	24,661	24,841	24,841
DLA deliveries cumulative	20,886	22,085	22,379	22,996	23,199	23,379	23,379

\*Chinese production excludes that produced by Umicore in China which is included in their figure in Table 3

\*\*Rubamin joined CDI in 2010

+ Estimates

The total refined cobalt available from 2004 to 2010 is shown in Table 5.

**Table 5 – Total Refined Cobalt Availability (Tonnes)**

	2004	2005	2006	2007	2008	2009	2010
CDI Members	29,022	29,445	29,328	29,491	28,901	25,074	30,872
Others	20,614	25,379	24,304	24,166	27,726	34,777	45,491
<b>Total</b>	<b>49,636</b>	<b>54,824</b>	<b>53,632</b>	<b>53,657</b>	<b>56,627</b>	<b>59,851</b>	<b>76,363</b>

Availability should not be confused with sales, as we make no recognition of stocks which may have changed in 2010. Not all “primary” production is from freshly mined ore. The supply figures merely indicate material which **could** come onto the market as new cobalt. “Re-use”, recycling – e.g. remelting superalloy scrap as a source of cobalt – is another matter and no account of that type of recycling is considered here, apart from that treated by the major cobalt producers.

## Demand

The most difficult part of interpreting the supply/demand equation is to quantify accurately the figures collected and it is generally recognised that figures based on official reports are lower than actual figures.

The CDI has continued to analyse critically cobalt import/export data over the last year in an attempt to improve its demand statistics. Each year it publishes a statistics book jointly with the World Bureau of Metal Statistics (WBMS) which includes apparent cobalt demand by geographical location calculated from import/export data. This publication can be purchased from the CDI or the WBMS. Published data suggest that worldwide cobalt demand in 2010 was about 61,000 tonnes, a decrease of about 9% over that in 2009.

**Table 6 – The Cobalt Market (2010) - approx**

Market	%	Cobalt Materials Possibility
Superalloy (Ni/Co/Fe/Cr...)	19.0	Metal, recycle
Hardfacing/HSS & Other Alloys	6.0	Metal & mesh powders, recycle
Magnets All Types	7.0	Metal, powders, recycle
Hard Materials – Carbides, Diamond Tooling	13.0	Powders – Fine and very fine
Catalysts	9.0	Salts – carbonate, sulphate, nitrate, acetate, metal
Colours – Glass, Enamels, Plastics, Ceramics, Artists Colours, Fabrics	10.0	Oxide, + some sulphate, hydroxide, carbonate
Feedstuffs, Anodising, Recording Media, Electrolysis.	4.0	Mainly sulphate, but some carbonate and hydroxide
Batteries	27.0	Hydroxide, powder, LiCoO <sub>2</sub>
Tyre Adhesives, Soaps, Driers (paint/ink)	<u>5.0</u>	Soaps & complexes made from metal starting point
	100	

The increases noted over recent years have resulted almost exclusively from substantial increases in demand in China and SE Asia.

Superalloys is the end-use sector that has historically been the major user of cobalt and though there has also been a significant increase in cobalt demand in this application over the past four years with the sector improving markedly from the reversals seen after September 2001, it has now been overtaken by rechargeable batteries as the main end-use sector. Further increases are projected over the next decade in line with increases in battery demand, particularly for portable devices and for the new generation of Hybrid Electric Vehicles (HEV) and all Electric Vehicles (EV). Demand for superalloys is driven by the number of new commercial aircraft being manufactured, defence procurement and demand for gas turbines to produce electricity. Growth is a factor of the global economy, but demand for batteries appears buoyant and the aviation sector has generally proved resilient to economic factors in the longer term.

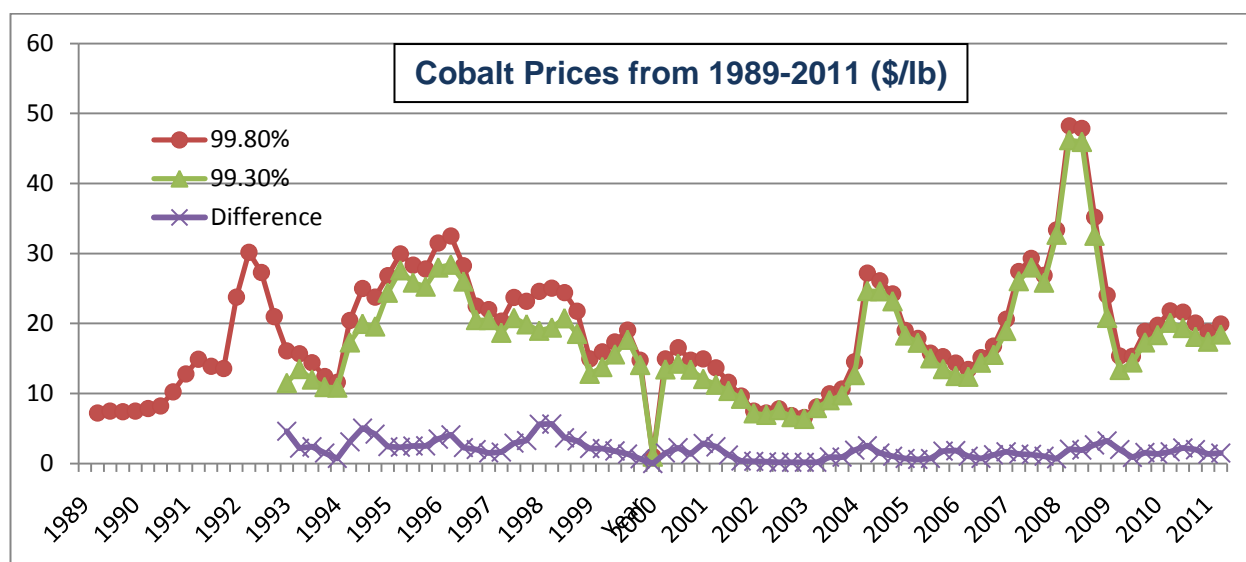
Over the past 8–10 years, there have been two major shifts in cobalt demand patterns. First, there was a significant shift in demand from the USA and Western Europe to Asia. The apparent demand in Asia has increased significantly since 2002, whereas demand in the USA and Western Europe has remained relatively steady. Second, the increase in demand resulted almost exclusively from increases in chemical applications, most notably rechargeable batteries and catalysts. In 2010, it is estimated that chemical applications accounted for about 55% of worldwide cobalt demand and balance 45% in metallurgical applications

Demand estimates in the individual market segments are shown in Table 6.

## Price

During 2000, a major fundamental change in marketing cobalt occurred. In 1999, WMC (now BHP Billiton) began selling cobalt on its website (the Cobalt Open Sales System - COSS) and in September 2000 it was joined by OMG who began selling its briquettes in this manner. In addition to these producers, a number of trading companies began to offer a buying and selling service through the Internet. However, at the end of 2008 BHP suspended the COSS.

The London Metal Exchange (LME) started the trading of cobalt (minimum Co content 99.3%) in February 2010 and turnover has been encouraging for this new contract. Up until now the main price reference has been the London Metal Bulletin free-market quotation. The LME offers a fully regulated market with which to trade spot and future cobalt contracts.



The graph illustrates the change seen in the average quarterly London Metal Bulletin (LMB) free-market price quotation for cobalt since 1989 for 99.8% (HG) and 99.3% (LG) minimum cobalt. Based on quarterly averages, the graph does not show short-term price fluctuations.

As can be observed from the above graph there was a dramatic fall in cobalt prices at the end of 2008, along with all other commodities and global company stock values, heralding the worst global recession in 60-years. From the 2009 price lows we have seen a modest recovery to today's levels.

The cobalt price (**average Metal Bulletin bid/offer**) opened 2010 at US\$21.50/lb (HG) and US\$20.63/lb (LG) with the market rally slightly to a high of US\$23.50/lb (HG) and US\$21.75/lb (LG) in April of that year before gradually drifting to US\$18.95/lb (HG) and US\$17.25/lb (LG) by the end of the year. The 2010 average LMB price for cobalt HG was US\$20.56/lb and US\$18.74/lb for LG cobalt. By comparison the LME average cash price for the year (average daily bid/offer cash price) from May 24<sup>th</sup> 2010 when the quotation first traded, was US\$17.55/lb – this is an in-warehouse price.