

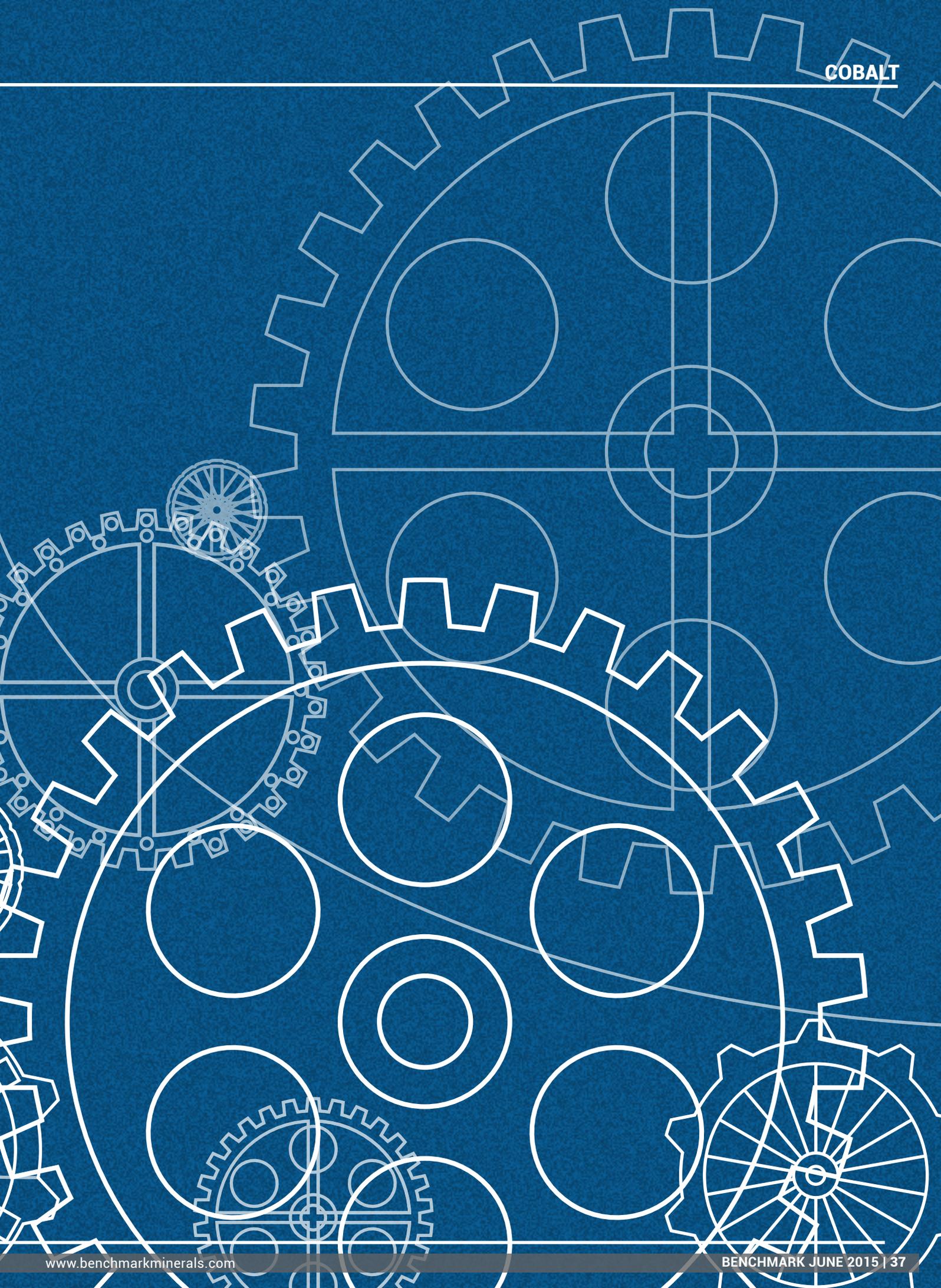
Cobalt's hi-tech blueprint

By Andrew Miller

During the past five years, the battery sector's hunger for cobalt has increased three-fold and prices have reacted in a volatile way. New battery megafactories using cobalt-based cathodes are being built, yet the industry is still divided on how far lithium-ion batteries can really go.

With these emerging hi-tech markets threatening to unbalance an industry that relies on the Democratic Republic of Congo for over half of its raw material, the need for new supply is rising in an environment where mining finance is grinding to a halt.

With demand increasing and future supply uncertain, can cobalt afford another price shock that would derail its role in the lithium-ion revolution?



The cobalt industry is a split camp. On one side you have traditional cobalt metal manufacturers selling to produce superalloys, binders, catalysts to mature, industrial markets that have struggled to offer any significant growth in recent years.

In the other corner, you have cobalt's chemical manufacturers supplying a fast-growing new market, the battery sector.

The industry is further fragmented by believers and non-believers of the lithium-ion revolution, a surge in battery applications outside of smartphones, power tools, laptops and tablets.

Cobalt's future growth as a key component in lithium-ion batteries relies on vehicles, homes and the commercial world using energy storage in ways never seen before.

New markets and new demand is a challenge for the well-established cobalt industry to consider and, most importantly, invest in.

Despite a compound annual growth rate in production of over 5% since the mid-1980s, the sector's traditional end-market, metal production, has been slowing, pushing supplies into surplus.

The growing needs of the battery sector – which grew by over 9% in 2014 – has insulated the cobalt industry from the slowdown in industrial demand. However, slower than expected uptake of large-scale battery applications, namely electric vehicles, has left many industry players sceptical over the further growth potential of batteries.

Experienced cobalt participants are asking: How much further can batteries really go?

Scepticism is deep-rooted among producers who, despite rallying calls from major battery consumers, remain wary of depending on an evolving market with a variety of battery chemistries, some of which do not use cobalt as part of the cathode makeup.

While these fears may carry some weight in the longer-term, consumption patterns are likely to dictate that battery uncertainties can no longer be swept under the carpet.

Over the past five years alone, cobalt's battery grade consumption has increased threefold, and this growth looks set



“The stability in price will be a key factor in cobalt's usage in batteries.”

Munehisa Ikoma, Senior Executive Engineer, Panasonic Corp



to continue considering the battery megafactories in the pipeline.

With this growth will come further disruption to the traditional market structures that have developed in cobalt over the last 30 years.

In short, a new, more secure supply chain for the modern era will need to be created, a task that includes new mines, new refineries, and a more transparent supply chain.

Cultivating a new end-market

Over the last 24 months, batteries have seen a renaissance. Not since the late-1990s and the mid-2000s have associated industries been this excited about growth in the market.

And this time it is not just about electric vehicles but also home and commercial energy storage. It's a subject that is no longer just the elephant in the room but a prospect that is on the table.

Tesla Motors Inc has again put itself at the forefront of these developments by announcing the launch of a utility storage line of products – the Powerwall and Powerpack – which hold the promise to revolutionise how we store and distribute energy on both a residential and commercial level (pp24-25).

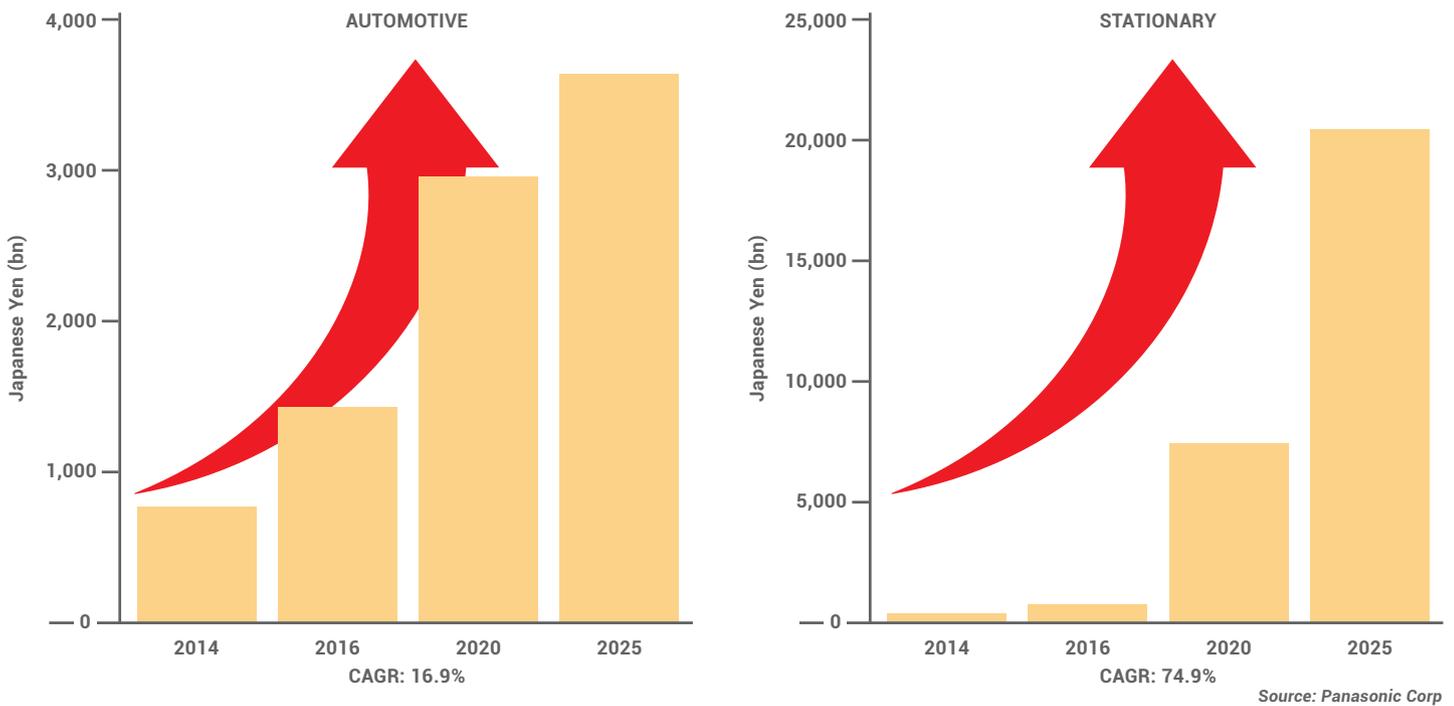
Panasonic Corp, Tesla's battery supplier, is expecting considerable growth in its battery output over the coming decade, forecasting a CAGR in demand of 16.9% from the automotive sector and 74.9% from the utility storage industry to 2025.

Although the company concedes that its cathode chemistries vary, Senior Executive Engineer, Munehisa Ikoma recently emphasised that cobalt would be an important element in all of Panasonic's lithium-ion technologies.

This is a message that has been echoed across the industry, with major battery producers and consumers alike, emphasising that cobalt-based chemistries have become the industry standard and are likely to remain this way for the foreseeable future.

If cobalt-based cathodes remain the status quo then the industry will require substantial new volumes of material to support a sector that is growing not only in the amount of batteries used but also in the size of the batteries being adopted.

PANASONIC'S FORECASTED GROWTH IN LITHIUM-ION BATTERIES



With today's cobalt supply structure inflexible to any quick changes or shocks to the system, satisfying the demand for a major new industry, and ensuring the sustainability of cobalt's role in the market, will pose the biggest challenge to producers.

In 2014, the world's cobalt production was 90,000 tonnes with the battery sector estimated to account for between 40-45,000 tonnes of the market. Batteries were by far the number one consuming sector for cobalt, while superalloys accounted for a further 16% of demand.

The requirements of Tesla's Gigafactory alone is likely to see this figure increase by 15-20% when it reaches its planned capacity in 2020. This is without taking into account further expansions within China which will at least match this demand.

Expanding cobalt capacity to meet this demand will be paramount in keeping prices stable. A stable and reasonable price is critical for end users aiming to implement large projects that are conducive to lowering battery unit costs to the holy grail of sub-\$250/kWh.

If the price of raw materials escalates to such a level that any cost savings in

mass producing batteries are negated, the lithium-ion revolution will begin to unravel.

Price pressure points

Moving forward, raw material supply itself will pose a direct challenge to battery producers, but the impact this new demand has on prices will also have an indirect bearing on the cost savings these companies are able to achieve.

Supply in the cobalt market is already showing signs of tightening with rising battery demand in addition to supply restrictions including the suspension of ENRC's Chambishi mine in Zambia.

As a result prices are expected to rise throughout H2 2015 at a time when demand is set to spike with the start of Tesla's Gigafactory and Chinese battery expansions that could take up much of the domestic Chinese supply usually destined for export.

It was only at the end of May that LG Chem signed a contract to supply EV batteries to the country's largest SUV producer - a deal which will see LG's orders

▶ from the Chinese market exceed 200,000 units by 2017 (pp27). Add to this further incentives by Beijing to get its residents to switch to electric vehicles and it becomes apparent that demand will soon outpace supply – a situation that could have a knock-on effect on prices, something consumers will want to avoid.

“The stability in price will be a key factor in cobalt’s usage in batteries,” explained Panasonic’s Munehisa Ikoma.

In 2008, high grade cobalt metal prices soared to over \$50/lb before the effects of the global economic crisis forced prices back below the \$20/lb mark in 2013.

If a price cycle on this scale was to occur again, battery producers could be forced to move towards non-cobalt cathodes like lithium manganese oxide (LMO) or lithium iron phosphate (LFP).

However, the reality is that it would require substantial and sustained price rises for battery producers to totally abandon the technology they have developed over the last two decades – especially as they now stand on the precipice of a new era in demand.

Lessons can be learned from rare earths, which has experienced a more extreme yet similar situation. In 2010, prices escalated to all-time highs on the back of supply restrictions in China. While the price of some rare earth elements rose by over 700% in 12 months, large end users such as Siemens AG and Boeing were reluctant to stop using the raw materials. They did, however, ramp up research in substitute materials that could have an impact in years to come.

In a sense, necessity is the mother of invention and cobalt would want to avoid a rare earths situation by forcing its consumers to look at cobalt alternatives.

Shifting away from a cobalt cathode, as of today is neither realistic nor conducive to the development of new end markets.

In order to avoid this type of obstacle, the cobalt market will be required to develop new resources – a tough ask considering the state of public markets today.

Mapping a sustainable future

Cobalt’s evolving supply-demand balance means new supply is needed as we approach 2020.

Few existing producers have the ability to

IN NUMBERS

16.9%

BATTERY DEMAND GROWTH EXPECTED
IN THE AUTOMOTIVE SECTOR BY
PANASONIC CORP

74.9%

BATTERY DEMAND GROWTH EXPECTED
IN THE UTILITY SECTOR BY
PANASONIC CORP

Source: Panasonic Corp

substantially increase output in the medium term and with the vast majority of existing supplies being mined as a by-product of either nickel or copper operations, global supply remains largely subject to developments in these sectors.

Furthermore, with the bulk of mined cobalt concentrate originating from the Democratic Republic of Congo (DRC), this output remains susceptible to changes in the geo-political environment, particularly considering the steps western governments have taken in recent years to limit sourcing from conflict areas. (See pp14-15)

Despite these concerns, funding for the few exploration stage cobalt companies seeking to develop new mines remains subject to public markets, which tend to be guided by macroeconomic trends rather than the specialised requirements of these niche sectors.

Nevertheless, this has failed to dampen the appetite of companies seeking to benefit from these market developments.

“The increasing demand for cobalt in electric vehicle and stationary battery sectors [means] cobalt is anticipated to enter into a deficit situation sooner rather than later – possibly as early as 2016,” Rick Honsinger, Vice President of Canada-based exploration company Formation Metals explained to Benchmark.

It is this potential that the company is looking to capitalise on with the development of the Idaho Cobalt Project in the US, where the company is seeking to produce 1,300 tpa of battery-grade material.

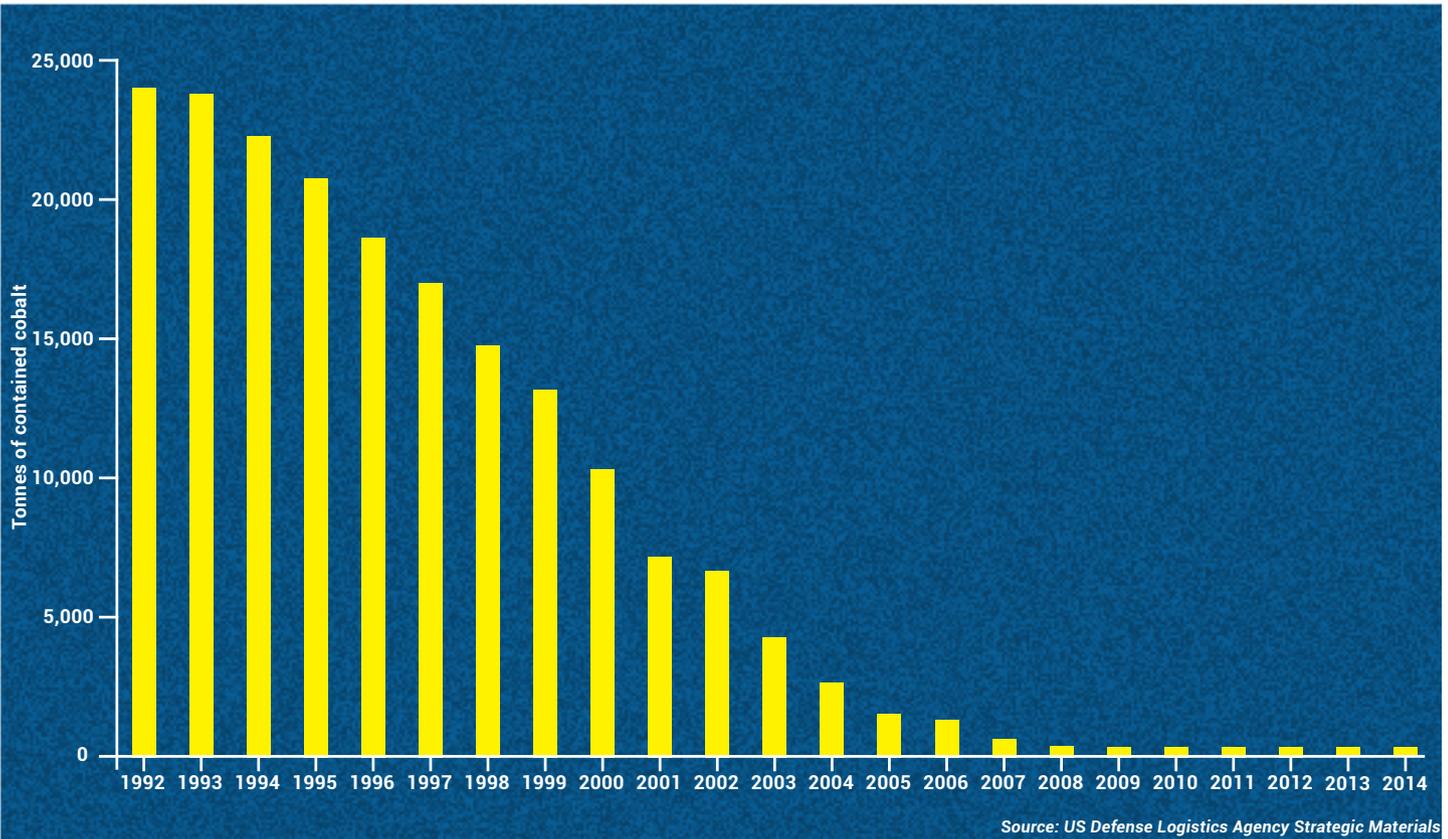
Despite completing two of the three stages of construction at the mine and mill, financing for their final stage operations remains challenging, according to Honsinger.

The company believes the North American location of the mine, combined with the demand outlook, will compel the industry to fund the project and bring the mine on stream in the near term as battery manufacturers rapidly expand operations on the continent.

The strategic advantages of developing a mine in North America, including supply security and the potential for lower cost logistics, are strong selling points for other exploration miners.

Fortune Minerals Limited, also a Canada-

US' DWINDLING STOCKPILES OF COBALT



based mining and development company, is aiming to bring a 1,600 tpa cobalt project online in 2017.

"[Being North America based we] should command significant market attention from battery manufacturers in Canada, the US and Europe," Robin Goad, President of Fortune Minerals explained in an interview.

"[Close to] 60% of mined cobalt supply comes from the DRC and poses a number of risks including political instability, new regulations, higher royalties, export taxes and depletion of readily available surface oxide ores," Goad said.

Mining of easily accessible minerals and metals is an important point to stress. In niche industries like cobalt, graphite and rare earths, many of the active mines today have been operational for decades with many having to go deeper underground or shift to lower grade resources to maintain output.

In addition, many of these mines are in higher risk countries for the west: cobalt comes primarily from the DRC while graphite and rare earths are predominately from China.

In addition to supply security, the economics of these old mines versus new ones must be addressed.

Global Cobalt is developing two North American projects in Ontario, Canada and Idaho, US. The company's flagship project, the Karakul Cobalt Deposit in the Republic of Altai, Russia, is looking to sell into the Chinese market.

"[The project] is located near the Chinese border and as such is ideally located to take full advantage of China's rapidly expanding battery materials marketplace," Erin Chutter, President and CEO, explained to Benchmark.

The need for new supplies globally is something the company is looking to address, with proposals already in place for the company to create a spin-off entity – Global Energy Metals – which will "focus on the acquisition of additional cobalt projects globally that are located in mature, stable and prolific mining jurisdictions," she added.

► Supply chain conflict

As companies outside of China seek to insulate themselves from external disruptions to their supply chains, the development of these new projects will become imperative.

With the needs of cobalt consumers increasing, both in terms of quantity and the consistency of product, end users require greater visibility of upstream markets to ensure the security of their supply chains.

A major issue that is rising in prominence is one of conflict minerals: the sourcing of raw materials that fund rebel groups in conflict areas of the world. The US has already enacted the Dodd Frank legislation which forces public companies to disclose where they use conflict minerals, while Europe is going down a similar track (pp14-15).

At present, the 3TGs of tin, tantalum, tungsten and gold sourced in central Africa are classified as conflict minerals, while cobalt is not, despite being sourced in a similar way. Pressure on the use of these controversial sources is increasing, with the European legislation likely to expand to include more countries and more minerals in the future.

Today, major consumers such as the US remain heavily dependent on the export markets of China and the DRC. In 2014, imports accounted for between 75-80% of the US' total refined consumption, which is estimated to have reached close to 14,000 tonnes.

With these volumes likely to increase in the medium term as battery capacity expansions accelerate, the security of supplies into the country has become an issue of national importance – so much so that from this year onwards, the Defense Logistics Agency is expected to commission purchases of cobalt products for the National Defense Stockpile.

In the early 1990s the US National Defense Stockpile had inventories of over 24,000 tonnes of cobalt; however, sales of these stockpiles were authorised between 1993 and 2011, leaving almost all of these stockpiles depleted today.

This has left the world's biggest economy largely at the mercy of countries with different socio-political environments that are arguably not aligned with US economic objectives.

As well as the security of these supplies

the country's consumers are also having to consider the sustainability of importing from unstable regions such as the DRC.

Although cobalt was a notable exemption from the US conflict mineral provisions, the brand management of emerging green energy consumers is limiting the areas that companies can acceptably seek to acquire these materials from.

Furthermore, these ethical issues will only be compounded by greater domestic consumption in countries such as China as it shifts towards a hi-tech economy.

In 2014, China is estimated to have consumed around 37,000 tonnes of cobalt, a figure which is forecast to increase by over 16% to 43,000 tonnes in 2015 alone.

The majority of this demand will be met domestically by a group of 10 cobalt smelters that control 90% of the country's output after a period of consolidation.

The major risk factor with relying on China for the majority of ready-to-use, processed cobalt is the growth of its domestic market, which is likely to outpace its supply-side expansions leaving less raw material available for export.

An overreliance on China saw dire consequences for the rare earths industry.

Even abroad, China's presence in the industry is growing. Chinese subsidiaries abroad are estimated to have produced up to 10,000 tonnes of cobalt in 2014 and are likely to direct further resources back into the country.

The need for countries such as the US to secure supplies in the longer term is reaching a critical level. Then there is the case of raw material competition.

Although the industrial metal markets have contracted over the past 12 months, a global rebound of some form is expected. This means future competition between the old and new for the same cobalt concentrate will intensify in the future.

As this demand competition increases, an increase in vertical integration – end users buying or taking a stake in mining or refining projects – is likely as companies seek to de-risk their supply chains.

Major battery companies are already looking into these types of investments and although none have yet come to fruition, tightening market conditions will see this become a priority for major end users.

The question is how far upstream end users are willing to go? Owning a mine has usually been a step too far.

Securing these deals will become increasingly difficult over the coming years with a supply being squeezed.

While there is an acceptance that greater coordination within the supply chain will be required, existing producers with an established set of clients will have little incentive to commit major volumes to longer-term contracts considering the existing market dynamics.

As a result the need for new supplies of not only cobalt but also a range of other battery precursor materials will remain of paramount priority.

Filling the void

In the minerals and metals space, recycling is usually a buzz word that comes and goes with the ebb and flow of demand. The likely result of the discussion is that recycling does not make good economic sense.

In cobalt, like many other industries such as lithium and rare earths, recycling is under discussion. But unlike these industries, it is already placing consumable volumes into the market.

In 2014, China was the leading producer of recycled material, accounting for around 5,000 tonnes of their total supply.

Elsewhere in the world, however, recycling has been limited despite calls from major consumers for developments in this sector.

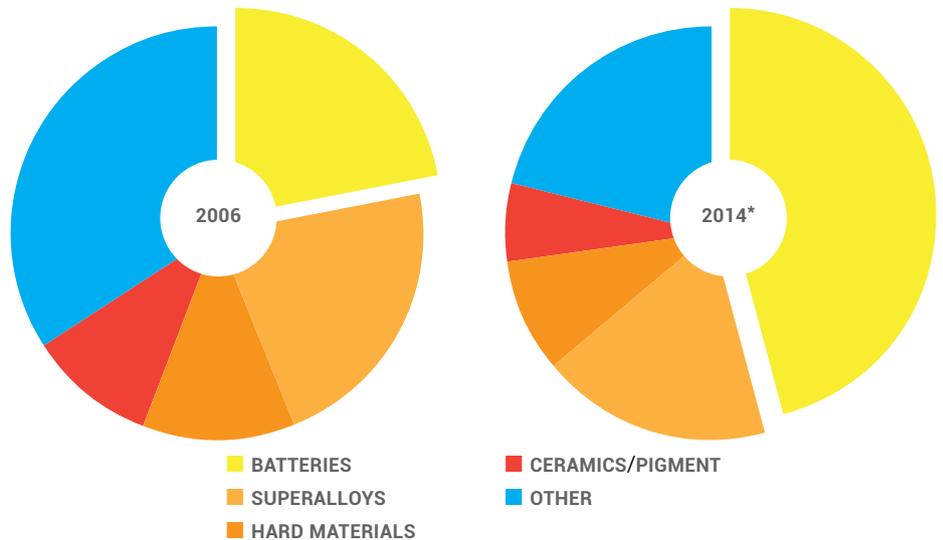
Although the concept of recycling cobalt is not a new one, there are a number of inefficiencies the sector will have to overcome in order to forge a bigger role in the supply chain.

Today, the storage and safety of recycling products such as lithium-ion batteries presents a major challenge to this area of the industry, but as prices rise and supplies tighten, these processors are likely to have an increasingly important role to play – particularly in the short term.

End users, such as portable power tool manufacturer Stanley Black and Decker Inc, have already voiced their hopes that cobalt recycling will develop over the coming years and allow them to sustain their use of lithium-ion technologies.

THE RISE OF BATTERY GRADE COBALT

During the past decade batteries have developed a clear lead as cobalt's number one consuming market by volume



*Last full year of production
Sources: Darton Commodities, Cobalt Development Institute

Calls from these types of major end users illustrates the growing awareness throughout the supply chain that recycling will play an important role in sustaining growth in new end markets.

But while recycling could play an important role in bridging the deficit in supplies in the short term, it will not replace the need for new primary cobalt supply.

As the cobalt industry enters a new period of growth, it needs a major player to take a leading role and lay the foundations for a new generation of demand. But with new mines requiring significant sums of investment – money that is not forthcoming – focus will turn to major producers and major end users.

Will major battery producers be willing to invest in their own mines? Would major producers be willing to expand existing capacity without certainty there will be a market for it?

The prospects of hi-tech applications are well established in the cobalt industry, but as of yet neither side of the market has been willing to break the standoff and lay the foundations for this growth.

The hope will be that one side takes the lead before cobalt's next price crisis – for which the course is set.