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THE BATTERY REVOLUTION: BALANCING PROGRESS WITH SUPPLY CHAIN RISKS

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ABOUT THIS PAPER

The lithium-ion (Li-ion) battery is set to fuel a revolution in electric vehicles (EV), home energy storage and even the powering of entire cities. Yet, increasing demand for the Li-ion battery is revealing and amplifying a wide spectrum of risks associated with the materials that make up the battery itself.

As new battery technology transforms consumer markets, there is a growing realisation that the transition to electric is not without social and environmental impact in the countries where battery materials – specifically cobalt, lithium, nickel, graphite and manganese – are mined and chemically processed into battery grade materials.

These risks present significant reputational, legal, compliance and commercial concerns for major industries harnessing the battery revolution including automotive, electronics and utilities infrastructure. For local communities, the risks represent impacts that could exacerbate or even cause environmental and social problems ranging from air pollution to child labour to conflict.

Companies within these sectors are faced with the twin challenge of mitigating the major sourcing risks across these battery metals while simultaneously responding to the rising external pressure factors compounding their impact.

This paper explores this twin challenge and, for the first time, provides a coherent picture of the responsible sourcing challenge the battery industry faces over the next decade.

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1. THE LITHIUM-ION BATTERY AND THE GROWTH IN EV AND ENERGY STORAGE

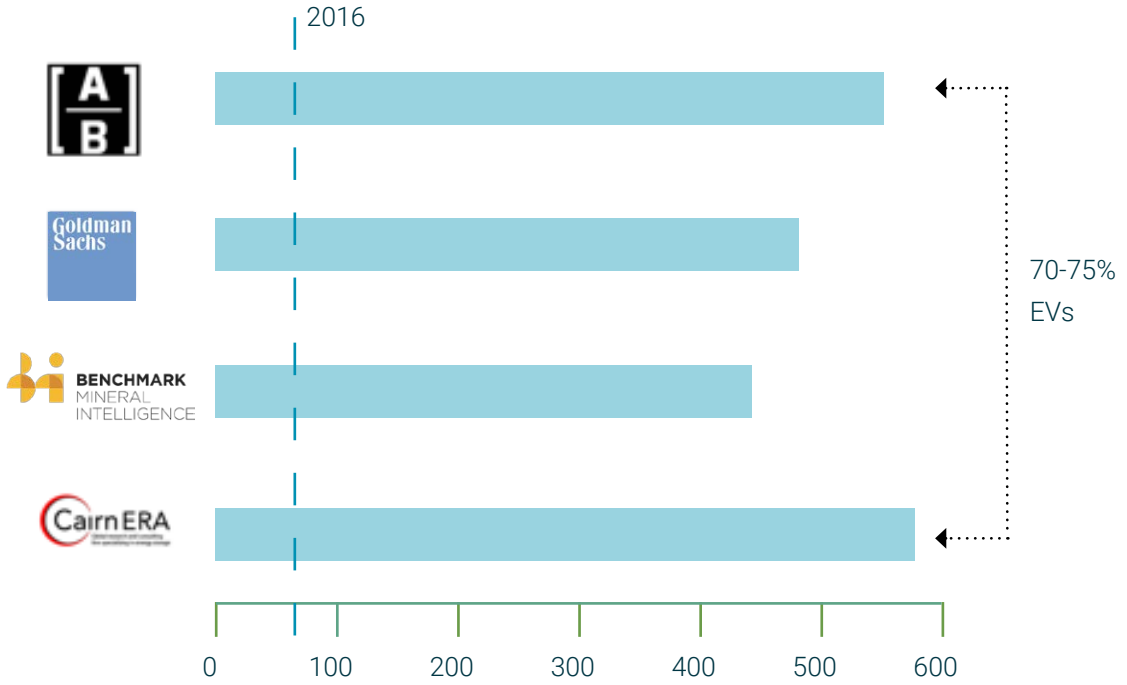
While some analysts question the Li-ion battery's long-term market position, its dominance over the next decade is assured due to significant recent progress on price and performance.

The cost of a lithium-ion battery pack has plummeted from $1300pKh in 2011 to between $250pKh and a low of $139/kWh today while mass market producers are securing lithium-ion batteries at an even lower rate[1].

This price drop has been matched by a major technological breakthrough with the new range of lithium-ion batteries finally allowing electric cars to reach the symbolic mark of 200 miles (320km) per charge. Major producers such as Volvo have announced that by 2019 all new vehicles will be at least part electrified[2].

Overall, it is predicted that there will be 140 million electric cars on our roads by 2030[3] with the wider Li-ion battery market expected to more than double by 2025[4] due to EV demand complemented by the growth of the residential and utility scale battery storage market. The development this year of the world's largest lithium-ion battery in South Australia marks the first of several utility and residential storage projects currently in progress globally.

Lithium ion battery demand expectations by 2025 (GWh)



Data from Benchmark Mineral Intelligence.
BNEF Forecast @ 240GWh for EVs & Stationary of 240GWh + Benchmark's mobile technology forecast of 60GWh

1 Gerard Reid, http://energyandcarbon.com/why-the-future-of-storage-belongs-to-lithium-ion-batteries/

2 https://www.ft.com/content/471cd6e2-60bc-11e7-91a7-502f7ee26895

3 https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

4 http://www.visualcapitalist.com/explaining-surging-demand-lithium-ion-batteries/

LEAD ACID BATTERIES: ON THE WAY OUT?

Before the rise of the lithium-ion battery 25 years ago, lead acid batteries were the dominant form of rechargeable batteries. Lead acid batteries are mostly used for the batteries of non-electric cars, which still occupy the clear majority (about 99% in the United States, for instance) of the automobile market, but also stationary storage and hospital equipment. While the upfront cost of lead acid batteries is still lower than lithium-ion batteries, factors including lower energy density, shorter cycle life, weight and higher true cost considering lifespan and performance contribute to expectations that growth in lead acid batteries will be restrained in comparison to its lithium-ion competitor. Furthermore, environmental and health concerns persist around the high lead content, battery disposal, and lead sourcing.

2 DECONSTRUCTING THE LI-ION BATTERY: WHAT ARE THE MOST PREVALENT MINERAL INPUTS?

What materials are in play when discussing the lithium-ion battery?

The anode in most lithium-ion batteries is predominantly made up of graphite which acts as host for the lithium ions. For example, there are 54 kg of graphite in the battery anode of each Tesla Model S5.

In contrast, the make-up of the cathode varies widely with mineral compositions changing as researchers look to improve energy efficiency and safety. But while multiple variations exist, there are currently three typical lithium-ion batteries used commercially:

1 LITHIUM COBALT OXIDE (LCO)	'Traditional' Li-ion battery consisting of around 60% cobalt oxide and 40% lithium predominately used for mobile technology.
2 LITHIUM NICKEL MANGANESE COBALT (NMC)	Traditionally a 1:1:1 chemistry using equal parts of nickel, magnaese and cobalt. This is moving towards a new 5:2:3 formula (5 parts nickel, 3 parts manganese and 2 parts cobalt) and R&D from cathode majors is pushing for the adoption of a 8:1:1 blend (8 parts nickel, 1 parts manganese and 1 parts cobalt). Used by most companies in the consumer technology and EV markets and where most research and development (R&D) focus lies. The goal of the R&D is to reduce the cobalt oxide content and increase the nickel content. However, substantial mainstream adoption on that front is currently at least 5 to 7 years away. The NMC is likely to become the standard for electric vehicles thanks to its long-lasting charge and adoption by nearly all major battery cel producers besides Panasonic.
3 NICKEL COBALT ALUMINIUM (NCA)	'Panasonic/Tesla battery', in which aluminium replaces manganese, typically using 80% nickel, 15% cobalt and 5% aluminium all in a non-metallic, chemical form.

In the three types of battery outlined here, and in the varying other versions on the market, five prevalent materials[6] emerge, which we refer to as the core "battery metals"[7]:

- Colbalt
- Graphite
- Lithium
- Nickel
- Manganese

Using these five 'battery metals' as the core focus, this paper unpicks the risks in these supply chains and outlines how they can be identified, managed and mitigated.

5 https://electrek.files.wordpress.com/2016/11/battery-series-raw-materials.jpg

6 Aluminium is not part of these 'prevalent materials' due to its relatively marginal use in only one of the cathode types mentioned above. Furthermore, although copper is a crucial component to EVs, it is not present in the lithum-ion battery.

7 Graphite is not a metal. However, it is often referred to as one of the 'battery metals' in the Li-ion battery industry. We use the phrase 'battery metals' to include graphite in this paper to reflect this industry phraseology.

3. THE DUE DILIGENCE RISK AND IMPACT FROM THE UPSTREAM TO THE MIDSTREAM

Responsible sourcing is becoming a focal point for battery buyers, investors, regulators, and the advocacy community as demand for the product increases. Yet the complexity and multiplicity of Li-ion battery supply chains makes the process hugely challenging.

The graphic below shows the supply chain of just one of these battery metals – cobalt – from source to battery and illustrates this complexity.

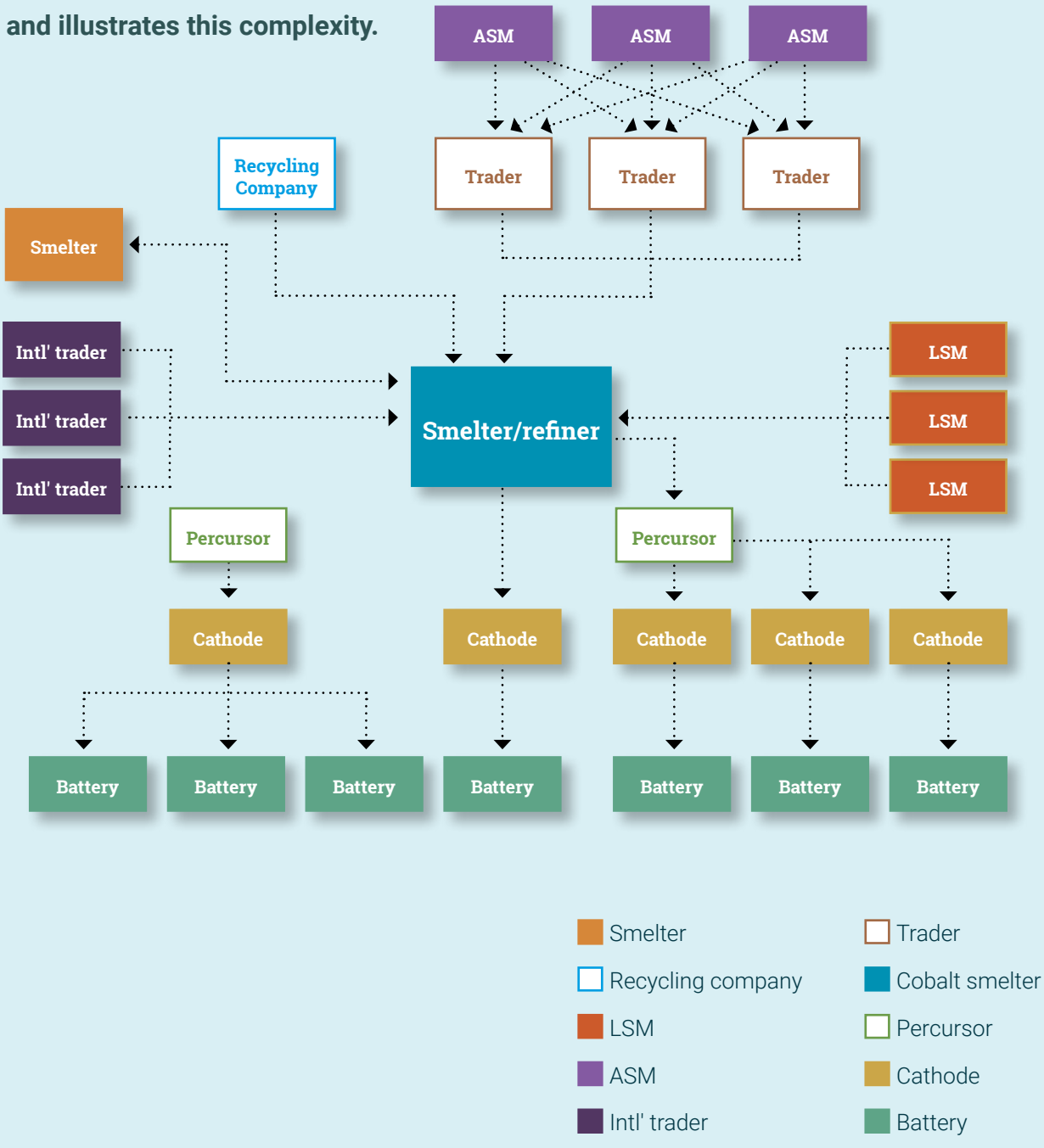


Figure 1: The core stages the cobalt battery supply chain

The presence of 'due diligence risk' occurs at ALL levels of the supply chain and is compounded by market forces and public scrutiny. What is more, there is no easy, one size fits all solution.

We define 'due diligence risk' as any combination of negative reputational, commercial, legal, and operational consequences associated with the issues described below.

3.1. Potential non-compliance with upstream production standards

Sourcing and upstream production standards and market expectations have emerged in recent years driven by the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. The Guidance emphasizes

- serious human rights abuses,
- child labour specifically,
- and risks related to provenance from conflict-affected and high-risk countries.

Most sustainable mining standards, including the International Council on Mining and Metals (ICMM) 10 Principles, also focus on miners':

- environmental impact,
- community relations,
- and occupational health and safety (OHS).

Based on information reported in the public domain[8], RCS Global primary research and expert insight, and information obtained as part of engagements in mineral supply chain due diligence, we have mapped and codified the risks related to the six areas outlined above and ranked the potential likelihood of them being present in each battery metal supply chain.

Clearly product, brand, or supplier-specific investigations may reveal different risk levels. Furthermore, none of the supply chains highlighted below – with the exception of cobalt – have been fully investigated by any research organization or advisory firm; the more investigation happens, the more risks will likely emerge.

Yet this grid represents the first attempt to map the full spectrum of due diligence risks associated with the main inputs in a lithium-ion battery.

THE CHALLENGE OF SEPARATING ASM AND LSM PRODUCTION

Artisanal and small scale mining (ASM) and industrial, large scale mining (LSM), especially in cobalt, often happen in the same areas. There are also continuing examples of blending between ASM and LSM mined materials in the upstream part of the trading chain, which makes ensuring responsible supply chains challenging.

While many LSM companies actively do not buy, or use it, there is a continual risk that ASM material will enter or contaminate an LSM supply chain. The ideal scenario is not a boycott of ASM but the adoption of chain of custody and assurance programs that can both identify ASM and – where possible - prove such material meets the same rising standards being met by LSM. This would also allow industrial miners who did not use ASM material to be able to prove they were not doing so, while allowing others to assess ASM inputs against their own responsible sourcing standards.

Several new programs are launching to respond to this upstream challenge with the CFSI approved Better Sourcing Program (BSP) having already passed proof of concept phase.

8 Public sources include mainstream and industry media and reports by international organizations. The full list of sources will be available online at battery.rcsglobal.com

Risk	Likelihood of presence in supply chain					Total
	Cobalt	Graphite	Lithium	Nickel	Manganese	
Level of reporting / investigation	***Good***	***Poor***	***Poor***	***Poor***	***Poor***	
Human rights abuses associated with artisanal mining	3	0	0	1	2	6
Child labour in artisanal mines	3	0	0	1	1	5
Provenance from conflict-affected / high-risk countries; political insecurity (excl. China)	3	2	2	2	1	10
Environmental damage around industrial mines	2	3	3	3	2	13
Poor community relations and disrespect for human rights around industrial mines	3	1	3	1	2	10
Poor occupational health and safety (OHS) in industrial mines	2	3	1	1	3	10
Total	16	9	9	9	11	

Figure 2: The RCS Global Battery Metal Risk Matrix shows the likelihood of presence in each battery metal's supply chain.

The degrees are defined as follows:
Likelihood

3 = Certain

2 = Present in certain supply chains

1 = Rare or not widely reported

0 = Not widely reported

Brown signifies risks associated with artisanal mining

Grey signifies risks associated with industrial mining.

Many of the risks emphasized by internationally recognized standards are present in Li-ion battery metal supply chains. The most prevalent are environmental risks, followed by poor community relations, poor OHS conditions, and provenance from high-risk countries.

Child labour and human rights abuses exist in cobalt supply chains, while there is the possibility that they may also surface in nickel and manganese. These issues have received overwhelming media attention in recent months.

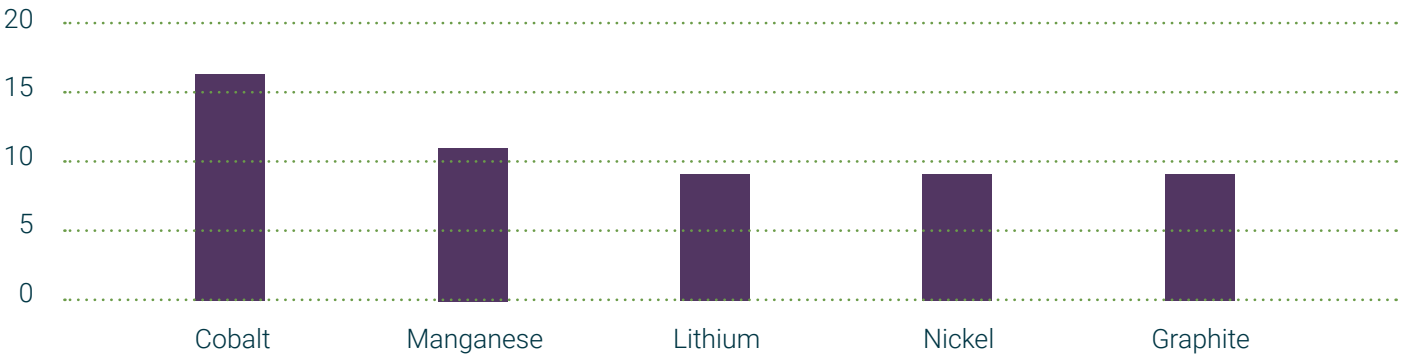
Thus, while they may not be present in all battery supply chains, stakeholders will likely demand relatively greater due diligence on these perceived risks.

Given that cobalt is the 'riskiest' battery metal, while at the same time being the only one with a well investigated supply chain, it is likely that the risk levels associated to the other battery metals will change in the future – including a potential increase in publicly perceived risk.

Likelihood of presence in supply chain

In terms of the metals, cobalt remains the primary risk within the lithium-ion battery supply chain as highlighted in our 2016 paper on "The Emerging Cobalt Challenge". Across most metrics, it scores poorly. This may simply be due to the fact that cobalt has a more investigated supply chain as a result of the growing awareness around upstream risks associated with that metal. Yet risks loom across all five metals.

Risk ranking per metal



The risks in context

Human rights abuses associated with artisanal mining

Artisanal and Small-scale Mining (ASM) refers to mining by individuals, groups, families or cooperatives with minimal or no mechanization, often in the informal sector of the market[9]. It is estimated that there are around 100 million artisanal miners globally. The informal and largely ungoverned and unregulated nature of ASM poses myriad social risks, including forced labour, sexual violence, and ease of capture by corrupt elite interests or non-state groups. ASM is particularly prevalent in cobalt and cobalt occurs as a by-product of nickel. Thus, ASM production of cobalt and nickel is likely to reach market, while there are also reports of manganese deposits in the Democratic Republic of Congo (DRC) that are artisanally mined[10].

Child labour in artisanal mines

Child labour risks exposed in the DRC's cobalt sector over the past year have inflicted reputational damage on brands and have led companies to terminate business relationships with potentially affected suppliers. It has also focussed attention on an uncomfortable truth: that child labour is still prevalent in minerals mining, especially in Africa and India. Reports about child labour in nickel-rich areas have started emerging as well[11] and manganese's exposure to ASM could also lead to child labour.

Provenance from conflict-affected/high-risk countries and political insecurity

For downstream companies, the issue of provenance from high-risk countries is fundamentally an issue of assurance against minimum standards of production and trade and reputation. Companies are linked and responsible (either legally or via reputation/their own commitments) to the issues at source in a high-risk country even if they source from regions within those countries that may not be affected by instability. This may expose other risks listed here as well as perceived links to disreputable governments such as Zimbabwe (lithium), Afghanistan (lithium), Madagascar (cobalt), the DRC (cobalt), or Mozambique (graphite). For example, the resurgence of violent conflict in Mozambique's graphite mining region may raise concerns[12].

Environmental damage around industrial mines

The challenge of environmental damage spans across all battery metals supply chains and all geographies. It can incorporate water, air and soil pollution, waste management and longer-term issues such as reclamation. Examples include air pollution in India[13] and China[14] water contamination in the South American 'lithium triangle'[15] and in Guatemala[16] and Indonesia[17] due to

9 Hentschel, Thomas; Hruschka, Felix; and Priester, Michael. 2003. Artisanal and Small-Scale Mining: Challenges and Opportunities.

10 http://www.aljazeera.com/indepth/features/2016/01/blood-minerals-profits-conflict-drc-160118124123342.html

11 http://www.irinnews.org/news/2010/10/14/mining-industry-attracts-child-labour-economy-picks

12 https://web.archive.org/web/20160802180455/http://www.ibtimes.co.uk/negotiations-between-frelimo-renamo-suspended-mozambique-war-escalates-1573691

13 http://www.deccanherald.com/content/516198/graphite-indias-soot-shoots-up.html

14 https://www.washingtonpost.com/graphics/business/batteries/graphite-mining-pollution-in-china/

nickel mining. Illegal deforestation also often occurs to make room for nickel mines as is happening in the Philippines[18]. Environmental damage often serves as a flashpoint for community grievances and if un-addressed can lead to other serious impacts based on conflict including human rights abuses.

Another issue that has been flagged is the high carbon footprint of lithium mining and processing[19]. Environmental issues can be particularly damaging to Li-ion battery supply chains due to the perceived 'green credentials' of EVs. The World Bank's recent report 'The Growing Role of Minerals and Metals for a Low-Carbon Future' underlines this point, calling for a debate on how to balance the potential low-carbon gains from lithium-ion with the potential socio-environmental impact of rising battery metal demands[20].

Poor community relations and disrespect for human rights around industrial mines

Mining operations can violate indigenous peoples' rights and/or traditions, as is occurring in the lithium-rich areas of Argentina, for instance. Forced evictions around cobalt mines in the DRC[21] or local community protests over manganese mining in Burkina Faso[22] are further examples. Poor community relationships can contribute to a loss of mining companies' social license to operate, making it more costly or impossible for companies to guarantee the security of operations.

Poor occupational health and safety (OHS) in industrial mines

OHS problems feature prominently in many companies' battery supply chains. Inadequate protective equipment or exposure to pollution can cause workers' health problems and deadly accidents. Poor OHS conditions have been highlighted in graphite mining and processing in China, nickel transportation in the Philippines[24], and manganese mining in Namibia[25] . Additionally, strikes due to poor working conditions can have negative impacts on large miners' bottom lines and supply commitments. Should those impacts be reported on, as they have in graphite, manganese and cobalt, they can cause substantial harm to the companies purchasing from those entities.

15 https://www.washingtonpost.com/graphics/business/batteries/tossed-aside-in-the-lithium-rush/

16 http://www.nbcnews.com/news/latino/two-latinos-win-prestigious-prize-grassroots-environmental-heroes-n750441

17 http://www.eco-business.com/news/will-changes-to-indonesias-mining-law-hurt-or-help-the-environment/

18 https://www.nytimes.com/2017/04/27/world/asia/philippines-mining-environment.html?_r=0

19 http://www.reuters.com/article/us-philippines-mining-idUSKBN17T0FW

20 The Growing Role of Minerals and Metals for a Low-Carbon Future', The World Bank, June 2017.

21 http://www.telesurtv.net/english/news/Argentine-Indigenous-Accuse-Govt-of-Violating-Their-Rights-20160223-0034.html

22 http://globalinitiative.net/wp-content/uploads/2014/11/afr620032014en.pdf (Amnesty International)

23 http://fpif.org/manganese-burkina-fasos-new-resource-curse/

24 http://www.tradewindsnews.com/casualties/1246346/new-moisture-alert-over-philippines-nickel-ore-exports

25 http://www.namibian.com.na/index.php?id=113829&page=archive-read

3.2. A global snapshot of risks in battery metals in the upstream

The following non-exhaustive map offers a global snapshot of incidents related to the above-mentioned risks covered by mainstream media outlets over the last two years. Purely showing some of the kinds of incidents which have reached public attention over this period – the map illustrates the multiplicity in geography and risk type that companies are facing.

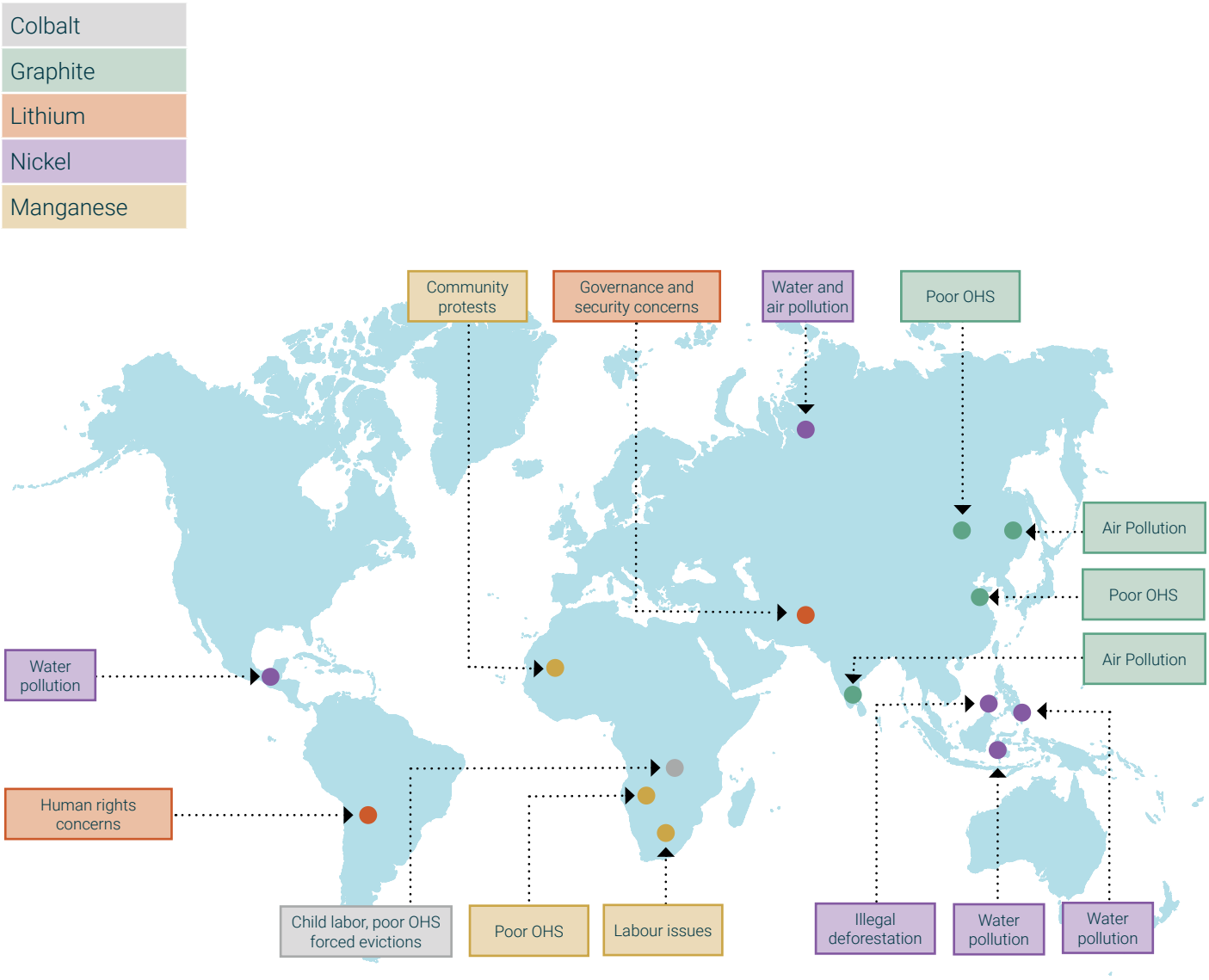


Figure 3

What this means for companies in the battery supply chain: Incidents are occurring in battery supply chains that are in non-compliance with recognized industry standards on responsible sourcing. We project that as lithium-ion demand grows, so will the volume of incidents and issues within the core battery metal supply chains.

3.3. The 'China processing risk'

But risk is not only present in the upstream. The pivotal role China plays as the fulcrum for virtually all lithium-ion battery production has significant implications for downstream industry compliance.

As the figures below indicate, China is the largest global importer of cobalt, nickel and manganese. It is also the world's largest importer of lithium whilst having large reserves of its own. Additionally, China is the world's largest producer of graphite.

Value of Chinese cobalt, graphite and manganese imports.

	Cobalt $	Nickel $	Manganese $
China	$1.3 billion	**$9.9 billion**	**$2 billion**
US	$303 million	**$2.5 billion**	**$868 million**
Japan	$285	**$2.5 billion**	

Li-ion battery production	Latest data (2016)	2020 Projection
	28 GWh	174 GWh
China	16.5	**96.5**
US	1	**38**
South Korea	10.5	**18**
Poland	0	**5**

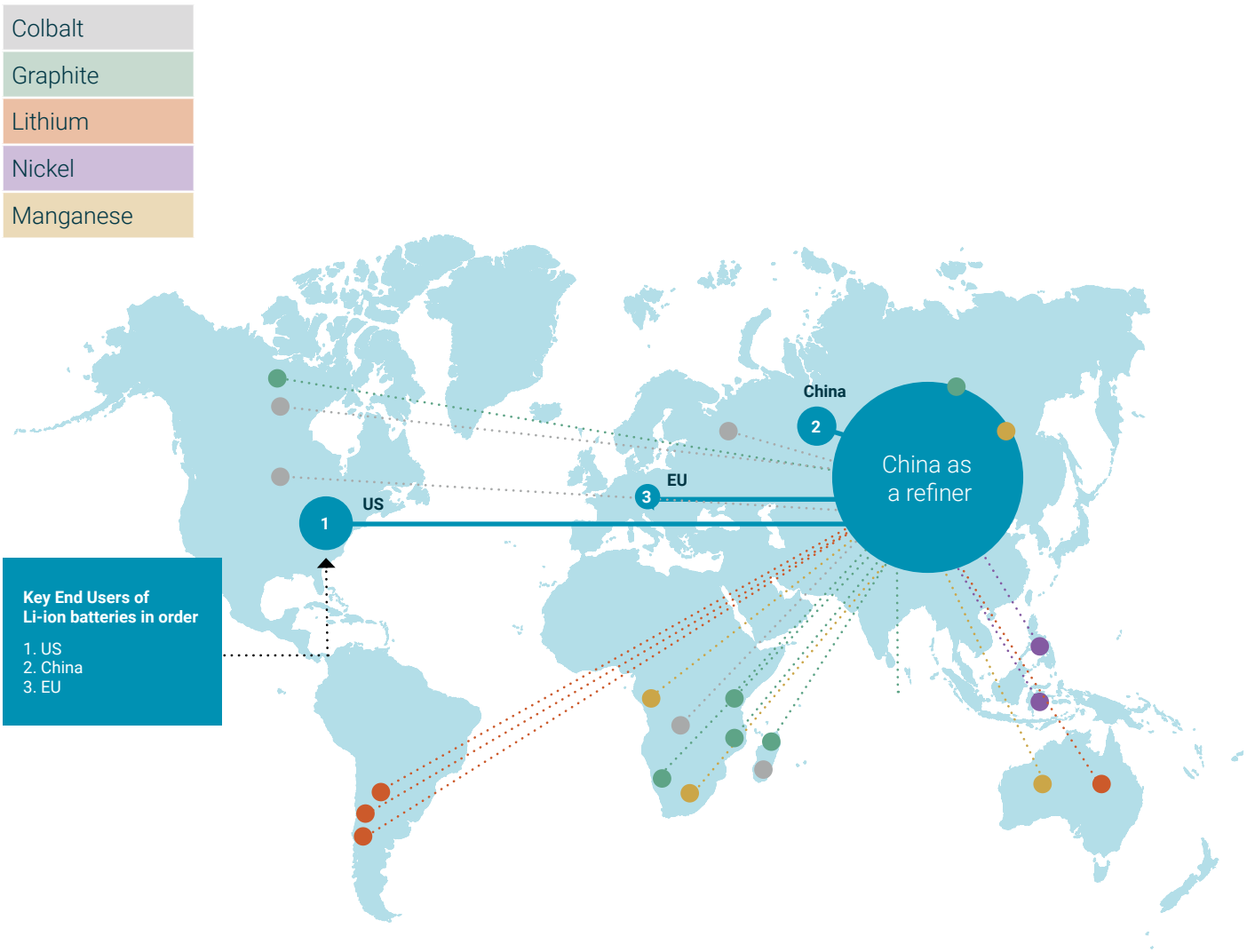


Figure 4

Chatham House Resource Trade Earth: https://resourcetrade.earth/
Li-ion battery production data from Benchmark Mineral Intelligence.

There are a group of responsible sourcing risks associated with the minerals processing and industrial sector in China:

- Lack of corporate transparency
- Involvement of government in business
- Poor working conditions
- Poor environmental standards

Some Chinese mines have even been shut down due to growing scrutiny around environmental and labour practices. For example, in 2013, up to 55 graphite processors and miners in the province of Shandong – making up 20% of China's graphite supply – were ordered by the local government to halt production on environmental ground[26].

An improving risk environment

However, the China story is nuanced. Far from being completely regressive, China has also seen advances in responsible sourcing and production across several areas. For instance, the China Chamber of Commerce of Metals Minerals & Chemicals Importers & Exporters (CCCMC) launched the Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains in 2015 and was instrumental in launching the Responsible Cobalt Initiative (RCI) in 2016.

From an RCS Global perspective, we have also seen a significant increase in engagement from Chinese producers and processors aiming to bring company practices in to line with global good practice standards. For example, RCS Global is currently advising the CCCMC on the development of responsible sourcing due diligence protocols.

What this means for companies in the battery supply chain: Given that it is extremely difficult to avoid China due to its dominance in the processing and manufacturing market, it is difficult to avoid the 'China processing risk'. This means ongoing and significant engagement with Chinese manufacturers and the government is needed to achieve responsible sourcing objectives.

26 http://www.indmin.com/Article/3290097/Shandong-China-ordered-to-halt-flake-graphite-production.html

3.4. The dangerous unknowns of battery metal supply chains, including recycling

Unpredictable actors entering the supply chain

As demand for battery metals increases, it is likely that there will be a growing number of new companies entering the market in the upstream and mid-stream. Already in lithium, most new supply is coming from smaller companies and non-mining companies.

Analysts fear that these comparatively smaller producers or traders either do not have the budgets to properly manage responsible sourcing challenges and compliance or simply do not have the will to respect regulation and good practice. This issue may be further exacerbated in areas where environmental codes and social conditions are not protective or inclusive.

Lack of unified producer assessment criteria

Another important factor is the 'quality' of mining companies dominating each of these metals. Internationally-listed and reputable mining companies may at first glance decrease risk. However, there are no widely agreed upon responsible sourcing standards or reporting frameworks for battery materials (RCS Global is currently developing the first responsible sourcing framework for the cobalt industry with the Cobalt Institute). Thus, producers must be assessed against supply chain-specific criteria that may reveal due diligence challenges even in larger mining companies.

Lack of fully investigated supply chains

At present - with the exception of cobalt – none of the above-mentioned battery metal supply chains have been fully investigated and some lack any tangible investigation at all.

The last year has seen significant progress in cobalt with RCS Global among organizations who have effectively completed investigations the cobalt supply chain. However, nickel and manganese, for instance, have virtually no comprehensive traceability.

'Hidden' problems may also exist in countries with governance deficits and conflict potential

As explained in the section on upstream risks related to conflict-affected countries, sourcing countries for battery metals include several developing countries with governance deficits and conflict potential. Conflicts or hostile governments affecting mineral supply and natural resource governance can occur unsuspectedly in countries like Afghanistan (lithium), Zimbabwe (lithium), Madagascar (cobalt), Tanzania (graphite), or Mozambique (graphite).

The recycling challenge

Several producers of end products and battery components have started to examine ways to reduce their reliance on mining by increasingly sourcing from recycled material. In some areas, the recycling industry for lithium batteries is well established and closed loop cycles are a reality for metals such as nickel, cobalt and lithium. However, working conditions and environmental impacts related to certain metal and battery recycling is largely outside of public scrutiny and unknown. However, working conditions and environmental issues relating to battery recycling are largely unknown to the public.

The lead acid battery recycling market is already under scrutiny for labour and environmental concerns and several analysts and campaigning organisation have begun to now look to the Li-ion battery as well. Further potential risks for recycling are the potential reliance on a small number of suppliers in the largely undeveloped recycling market and the absence of common industry standards and regulation.

What this means for companies in the battery supply chain: The more you look into risks, the more issues you may find. A company may not know what risks are hidden in its supply chain. There may be substantial risks beyond the ones identified earlier, including suppliers that refuse to be transparent on potential risks. It is also premature to consider heavily relying on recycling for battery inputs in the short term. A gradual shift may be more recommendable.

4. WHY IT IS DIFFICULT TO AVOID THESE RISKS: RISK MULTIPLIERS

In addition to the risks identified above, there are rising external pressures that act as risk multipliers and are further bringing the issue of responsible sourcing in to sharp focus and driving the need for action.

4.1. Supply shortages and concentrated production

First, the growing demand and competition for battery metals, not least in cobalt and lithium, will further constrict downstream actors' ability to be selective when establishing supply chains.

Analysts project the cobalt supply deficit to increase by 83% to 5,340 tonnes between 2018 and 2020[27]. A compounding factor for supply bottlenecks is the long lead time in developing new mines (development can take up to 10 years[28]).

Automotive industry representatives have also stated that supplies of lithium are of the greatest concern to carmakers, as production struggles to keep up with demand. Annual lithium production would need to grow by 94% over the next 20 years to satisfy the projected demand from the EV market[29]. What is more, lithium production is dominated by only four companies. Some experts see a potential risk of cartels developing in lithium and cobalt[30].

Mismatches between supply and demand in the short and medium-term could increase producer leverage while weakening the downstream's ability to re-direct supply chains away from high-risk producers.

What is more, the production and reserves of battery metals are either concentrated in a small number of countries, come from countries that have been identified as sources of responsible sourcing risks in earlier (see the Map in Figure 3), or both.

27 Maquarie, http://www.reuters.com/article/us-cobalt-demand-investors-idUSKBN15T1VR

28 http://energypolicy.columbia.edu/sites/default/files/energy/CGEPTheGeopoliticsOfRenewables.pdf

29 https://www.ft.com/content/90d65356-4a9d-11e7-919a-1e14ce4af89b

30 http://energypolicy.columbia.edu/sites/default/files/energy/CGEPTheGeopoliticsOfRenewables.pdf

KEY PRODUCING COUNTRIES ACROSS THE FIVE CORE BATTERY METALS	
COBALT	The Democratic Republic of Congo (DRC) supplies more than half of the world's cobalt mine production and holds almost one-half of the world's known reserves. Other main production countries include Russia, Cuba, and Madagascar.
LITHIUM	While production is still dominated by Australia, the 'lithium triangle' that overlays Bolivia, Argentina and Chile holds 54% of the world's lithium resources and Zimbabwe is the 5th largest producer and holds the 4th largest reserves.
GRAPHITE	During 2016, China produced 66% of the world's graphite came from China. Production decreased in Canada and increased in Madagascar, while new deposits are being developed in Mozambique, Namibia, and Tanzania. (Artificially produced – not mined – graphite exists and is used in some Li-ion batteries but natural graphite is used predominantly.) India is also an important producer.
NICKEL	In nickel, the picture is a bit more balanced, but the Philippines still produced 22% of global production in 2016. Indonesia is another important producer.
MANGANESE	76% of manganese production comes from only four countries: South Africa, China, Australia, and Gabon. South Africa alone holds almost 30% of the world's manganese reserves.

What this means for companies in the battery supply chain: Due to supply shortages, it will be difficult for companies to be selective and easily avoid potentially high-risk suppliers and pressure will remain on the supply side to produce. Due to the concentrated production, it is furthermore likely that companies are sourcing from – and will continue to rely on – the countries mentioned above. Strikingly, several of these countries have been identified earlier as potential sources for responsible sourcing risks, including the DRC, China, Russia, the Philippines, the 'lithium triangle' in South America, Namibia, and South Africa.

4.2. Increasing public scrutiny

The lithium-ion battery market is also facing rising pressure directed at their responsible sourcing practices by the media, campaigning NGOs, a growing number of trade, regulatory and legislative bodies, and consumers themselves.

And public scrutiny – and with-it stakeholder awareness – around the responsible sourcing risks associated with battery metals will continue to increase:

- A growing number of articles from internationally reputable news sources are focusing on risks in battery supply chains, including the Washington Post (cobalt, graphite, lithium), the New York Times (nickel), NBC (nickel), The Guardian (nickel), the Financial Times (nickel, cobalt) and Forbes (nickel).
- **Leading downstream companies** such as Apple have started internally re-classifying cobalt as a 'conflict mineral' and treat it with the same scrutiny as tin, tantalum, tungsten and gold (3TG), which are subject to conflict minerals legislation in the United States and the EU
- **Investors and investment analysts** are also increasingly factoring due diligence risk in to investment assessments.
- New **responsible sourcing initiatives** are focusing on batteries and already count amongst their members large electronics and car companies:
  - The World Economic Forum's Clean Battery Alliance;
  - The Responsible Battery Coalition and the Electronic Industry Citizenship Coalition's (EICC) Responsible Raw Materials Initiative (RRMI);
  - The Cobalt Institute, which represents the world's major cobalt producers, processors, and traders, is currently developing – with assistance from RCS Global – a responsible sourcing framework.
- **Mining companies in the upstream**, such as ERG, are – with assistance from RCS Global - actively working on putting the management systems in place to ensure their risk exposure is minimized and their production complies with the market expectations of downstream industries.
- The **OECD** is preparing to publish a handbook on risks associated with the production of natural resources which will cover, amongst other raw materials, cobalt, lithium, nickel, and manganese. The OECD's 'soft law' approach towards norms and standards is increasingly becoming actual regulation and law in many countries, including the EU, Colombia, Turkey, the United Arab Emirates, and the United States.
- Recent **legislation**, such as the US Trade Facilitation and Trade Enforcement Act, France's corporate vigilance law, or the UK's Modern Slavery Act could be applied to problems such as child labour in mineral supply chains.

COBALT: AN EXEMPLAR OF RISING PUBLIC SCRUTINY

January 2016	Amnesty International cobalt report
September 2016	Washington Post cobalt investigation published
October 2016	Apple re-classifies cobalt as conflict mineral
November 2016	Cobalt supply chain risk report published by RCS Global Electronic Industry Citizen Coalition (EICC) launch Responsible Raw Materials Initiative (RRMI) to expand responsible sourcing beyond 3TG
January 2017	Launch of Responsible Cobalt Initiative (RCI), including Apple, Samsung SDI, Chinese companies
February 2017	Sky News report on working conditions within the upstream in DRC
March 2017	Apple temporarily stops buying cobalt from ASM sites in DRC
May 2017	OECD report on 22 raw materials, including cobalt, plans to extend due diligence guidelines EPRM begins to consider cobalt as a 'conflict mineral'

Figure 5: Cobalt's emergence as a public concern.

Based on our experience in conflict minerals and the lessons learnt in the cobalt sector since January 2016 the following predictions can be made about battery metals:

The first three steps are already happening in battery metals. It is thus likely that more standards and initiatives specific to battery metals will appear, followed by increased debate on legislation.

What this means for companies in the battery supply chain: If sufficient due diligence is not conducted, a company may risk not complying with increasingly strict industry standards (which may result in loss of business relationships and reputational damage) or, worse, international and domestic laws (which may result in loss of business licenses or lawsuits).

5. RECAP: A COMPLEX, SELF-COMPOUNDING RISK ENVIRONMENT

In sum, having assessed each of the five main battery metals, three risk levels emerge, all of which are amplified by growing external scrutiny and pressure:

Due diligence risks and compounding factors in the Li-ion battery supply chain

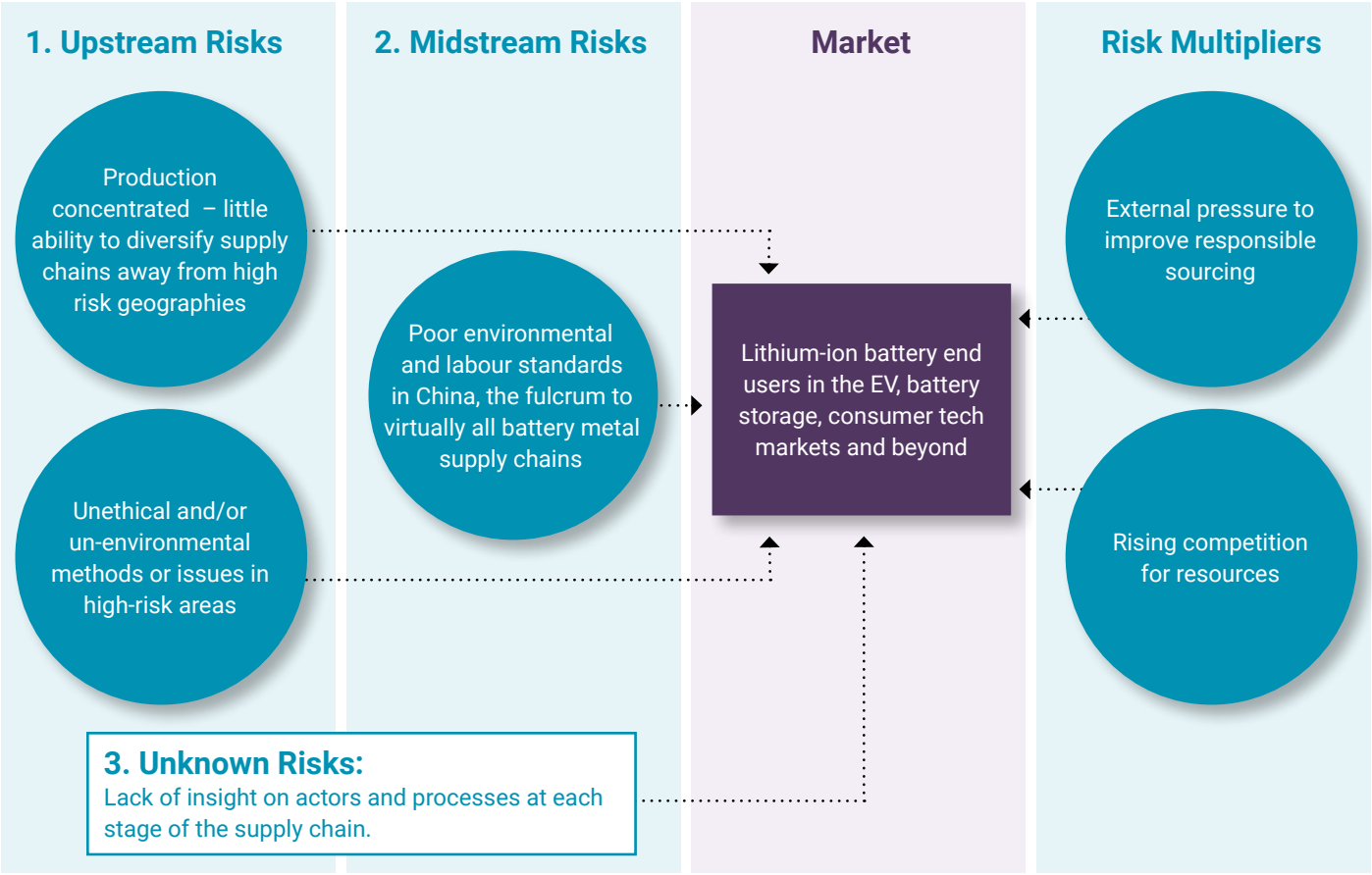


Figure 6

5.1. The present and potential commercial impact of these risks

Many of the risks identified above are of a humanitarian nature and companies have a social responsibility to address them, but responsible sourcing is not only a corporate social responsibility (CSR) issue.

Not responding to these risks can have potential reputational, commercial, legal, and operational consequences for businesses in the battery supply chain which can affect the bottom line:

- **Reputational:** Brand deterioration, permanent reputational loss, large-scale negative media / NGO campaigns
- **Commercial:** Customers and business partners terminate business relationships (loss of market share), loss of investors, a drop in share price
- **Legal:** Loss of business license, lawsuits
- **Operational:** Antagonistic community relations, loss of social license and loss of political license to operate, staff safety no longer guaranteed

6. WHAT TO DO ABOUT IT. OPTIONS FOR RISK MANAGEMENT

6.1 Disengagement is no longer an option

As we have established, disengagement from specific battery metal supply chains is not an option given heightened demand and competition plus the comparatively concentrated supply. A company simply cannot redirect its supply chain away from high risk producers or regions in the upstream. Equally in the midstream, disengagement with China is also impossible given its dominance within battery metal processing.

Companies have to act.

6.2 Three options for response: baseline compliance, active engagement, industry leader

From an external stakeholder perspective, and that of a growing number of companies in the supply chain, basic "box ticking" and "just enough" approaches to compliance are no longer sufficient. There is also an increasing gap between this approach and the consensus forming around adherence to the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

The completion of relevant supply chain audits and initial mapping exercises remain critical processes. Indeed, they are the tool to prove core due diligence has been undertaken and an excellent foundation for building a more comprehensive future due diligence program. For companies looking to begin participating in responsible sourcing – auditing and supply chain mapping is the gateway to doing so.

But market expectations are moving towards more active engagement in the supply chain as evidenced by the trend in cobalt over the last year. Equally, many companies are simply becoming jaded by due diligence processes that meet base-level compliance requirements but deliver little new information or structural improvement in the supply chain itself.

Having established compliance through industry audit programs and supply chain mapping, more and more companies are now looking to move beyond compliance, towards active participation. Given this context, three broad stages or "steps" are emerging for downstream businesses looking to establish responsible sourcing, not least in battery metals:

THE THREE STAGES TO RESPONSIBLE SOURCING LEADERSHIP			
	Foundation Stage *Meet responsible sourcing obligations*	**Active Participation Stage** *Align with OECD Guidance*	**Industry Leader Stage** *Set/lead standards and good practice*
Strategic approach	Adhere to minimum regulatory/ reporting requirements. Use compliance process to explore future options on improving your supply chain. Begin speaking to peers and industry experts.	Adopt proactive approach - beyond minimum reporting. Actively engage with industry/ regulatory groups. Leverage audit and supply chain mapping processes to pre-empt risk and influence change.	Adopt disruptive approach. Aim to deliver positive industry-wide change in battery supply chain. Become a focal point and reference point for external debate.
Potential outcomes beyond addressing supply chain risks	Good entry point for companies looking to establish/prove responsible sourcing and move towards OECD good practice.	Can lead to significant improvement in supply chain management, compliance, and in external relations. Positions business as actively adhering to OECD Due Diligence Guidance.	This approach can lead to significant reputational gains and brand improvement beyond the responsible sourcing industry as several leading consumer tech businesses are now witnessing
Actions	Undertake minimum box-ticking required. Ad-hoc responses to customer requests. Commission/report on supply chain audits as required. Commission and publish supply chain mapping when required.	Know what you source and where you source it from. Establish strong company due diligence management systems. Think about innovative solutions for traceability. Exchange insight and information with industry peers through forums.	Develop new, tailored programs aimed at setting industry best practice to be adopted by peers. Report risks and responses. Communicate which risks may exist and your company response. Act as a convenor and thought-leader for industry and beyond.
RCS Global's position and how we can help	World leading auditors in mineral supply chains. Accredited with every industry and regulatory body within core battery metals. Clear, responsive approach to supply chain mapping. Expert advisory practice supporting partners in moving to "active participation phase."	Unique position as bridge between client and every major global industry/ regulatory body in battery metals. Client-specific risk assessment (matrix developed for this paper applied to client's context). Risk monitoring and traceability solutions, including chains of custody and geotraceability.	Recognised thought-leader across responsible sourcing. Specific industry-leading position on responsible cobalt. Strategic partner to responsible sourcing leaders in consumer electronics sector. Partner to all regulatory/ industry standards bodies including the OECD.

7. ABOUT RCS GLOBAL

RCS Global is a world leading advisory, audit and training company specializing in the responsible sourcing of natural resources. We empower upstream, midstream and downstream operators to meet and go beyond market and stakeholder expectations in responsible supply chain due diligence, product traceability and regulatory compliance.

Over the last ten years we have established an unrivalled position as the bridge between actors at each stage of the value chain from major EU, US regulators and Chinese industry bodies, to corporations and global manufacturers, mining companies and artisanal mining communities.

We have advised companies along the supply chain and industry initiatives including the Cobalt Institute, the Conflict-Free Smelter Initiative (CFSI) and the China Chamber of Commerce of Metals Minerals & Chemicals Importers & Exporters (CCCMC) and the OECD). In addition to the information above we offer the following services:

- Supply chain mapping
- Client-specific risk assessment (matrix developed for this paper applied to client's specific context)
- Analysis of reputational, commercial, legal, and operational risk exposure
- Design of due diligence programs and management plans
- Development of risk monitoring and traceability solutions, including chains of custody and geotraceability
- Recommendation and adaptation of most client-appropriate good practice standards
- External stakeholder engagement
- Reporting and communication support

Specifically, we have advised mining companies in the upstream with the following services

- Developing and implementing Artisanal Mining Management Plans
- Setting up closed-pipe responsible cobalt supply chains
- Developing chain of custody systems
- Developing communication plans
- Research

To speak to the RCS Global Research team about any aspect of this report or to learn more about how we can help your responsible sourcing activity in battery and beyond, please get in touch.

8. ABOUT THE AUTHORS

Harrison Mitchell

Ranked as one of the top 100 global influencers on conflict minerals, Harrison leads RCS Global's advisory work in responsible sourcing for a range of industry associations and leading global corporations. He is also leading the expansion in to new commodities including cobalt, gold and battery metals while also overseeing the company's successful move into the China market. Harrison has also worked extensively on transparency and anti-corruption compliance. He is a widely-published author and quoted expert in publications including the Financial times, Wall Street Journal and BBC.

Ferdinand Maubrey

Ferdinand has advised some of the world's largest mining, electronics and manufacturing companies on risk management in complex environments, including in Southern and West Africa and Haiti. He has regularly consulted with the World Bank on natural resource governance. Having contributed to establishing Eunomix, an economic consulting firm, prior to joining RCS Global, Ferdinand is an experienced project manager, who has worked on corporate strategy development, and efficient stakeholder engagement. He speaks French, German, and English fluently, has worked on projects in 10 different countries, and is a published economics researcher.

Sam Hardy

Sam has over 12 years of in-house and agency experience in policy research and communications. He has previously been Head of Communications for The Tony Blair Africa Governance Initiative and for Chatham House in London. He has also held senior roles in a major UK PR agency. He has a specialisation in natural resources, international development and sustainability, and foreign policy.

Nicholas Garrett

Nicholas is an internationally recognised expert in RCS Global's core work areas including supply chain due diligence and conflict mineral compliance. He has worked on more than 50 projects over the last decade and has advised a wide range of organisations including Nokia, AngloGold Ashanti, the OECD, the World Bank, and several national governments. He regularly speaks in the media and at international conferences and has contributed directly to stakeholder initiatives including the EITI and the OECD Due Diligence Guidance for Responsible Supply Chains.

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