Produce or Procure?
Securing strategic minerals for India’s development
Executive summary

With the economic strides India has achieved in the past couple of decades, consumption, a key driver, has seen structural changes. Cars, televisions, mobile phones, etc. have seen increasing share in the growing consumption basket. Going ahead the growth momentum in consumer durables is likely to continue with a growing population and economic development. Modern gadgets use a variety of minerals such as cobalt, lithium, antimony, molybdenum, copper, gallium, etc. in addition to the traditional metals such as steel, copper, aluminum, zinc, etc. Technological advances in the field of transport, defense, energy, engineering, etc. are only going to enhance the need for minerals.

Through the Make in India program, the government has laid out ambitious plans for about 25 sectors including automobiles and components, aerospace and defense, electrical machinery, electronic systems, renewable energy and space, among others. The program targets to raise the manufacturing sector’s contribution to the GDP from the current ~16% to 25% by 2022. Amongst others, it also targets to add 227GW of renewable power by 2022 and electric vehicles (EVs) are expected to account for 30% of all new vehicles by 2030. New technologies and digitalization are transforming these sectors. For example, the introduction of EVs and telematics are changing the landscape of the automobile sector. Similarly, growth in renewables and technology for battery storage is transforming the power and utilities sector.

The growth however, is enabled by various components necessary for these sectors. For example, EVs are dependent on rechargeable batteries, solar energy is dependent on solar panels and solar cells, flat panel displays and LEDs are important components of the electronics and telecommunications industry. All of these components require minerals with very specific properties and characteristics, which enable their desired functionality. These minerals are thus essential to our developing economy and various technology dependent industries.

Such critical minerals or as we refer to them, “new world” commodities are central to the production of a variety of high tech and green technologies ranging from batteries, smart phones and laptops to advanced defense systems. The ‘criticality’ of a mineral changes with time with shifting needs of a modern economy as well as supply side changes. Lack of secured supply chain would thus substantially restrict the growth of the ‘new world’ industries.

Due to the very nature of the critical/strategic minerals and their relative smaller volumes, their market prices see large distortions triggered by demand-supply mismatch even for a small volume. These uncertainties impair the mining industry’s ability to confidently develop a sustainable project plan which in turn strains the supply sources.
Other aspects that have a bearing on the supply side include disruptions induced by producer country policies, their own socio-political environment, economic size of mine / processing, value of by-products and their markets.

In this report, we have touched upon sectors such as automobiles (electric vehicles), aerospace and defense, electronics and renewable energy which are a part of the Make in India policy and will also need most of the critical or rare minerals in some form. Most of these industries are still in nascent stages in India and thus their current consumption of these minerals is low. Additionally, for few of the industries, current focus appears to be sourcing and assembling components instead of indigenous production. It is expected the strategy will move towards more indigenous production and as that happens, the need for these critical minerals will increase exponentially.

Securing the supply chain is easier said than done. Known sources of minerals are finite and there is significant concentration of reserves in a few countries for many minerals. Majority production comes from a few countries thereby accentuating the concentration risk. Several such countries are in conflict zones. Risks are further compounded due to the governments of resource rich countries adopting a conservation approach for their own future needs. We have analyzed the global concentration of reserves and production and developed a supply confidence score for such sources. That, coupled with India’s import dependence for those minerals helps identify the real strategically critical minerals in the Indian context.

Like many other developed countries, India must take up this subject as a part of its strategic growth agenda. To ensure our modern economic growth is unhindered, the government, along with all stakeholders, should take various measures to ensure security of supply. Starting with understanding global mega trends, India’s development trajectory and assessing our own sector-wise demand for strategic minerals, it should also assess our own resources and supply gap. We shall need to create a favorable policy environment and strategic roadmap for taking us closer to resource securitization. Providing an impetus to domestic exploration, mining and processing sector as well as strategic acquisitions / joint ventures outside the country with off-take arrangements may be paths to explore and adopt. The government should also encourage R&D and provide incentives to develop a recycling industry to recover these minerals.

India will need a holistic and collaborative approach from policy makers, mining companies and user industry groups to achieve self-sufficiency or security. The journey to achieve this in some if not all critical minerals, is going to be an arduous one, but we must embark on this as it needs to succeed to achieve the country’s growth agenda. Delay, ambivalence or failure are not options.
Make in India program and the critical need of minerals
The government’s Make in India\textsuperscript{1} program will provide a huge impetus to the country’s manufacturing sector, which currently accounts for 16.6\% of the GDP. The target is for manufacturing to account for 25\% of the GDP by 2022.

The economic importance of a mineral is determined by its use in various sectors, its current importance and also future growth prospects of those sectors. The current volume of a mineral’s usage isn’t the key in determining its criticality. Country’s growth focus on certain strategic sectors may drive up consumption of related minerals, even if their current usage is negligible.

In the sections below we highlight a few industries that form important part of Indian government’s Make in India program and the key minerals critical to their indigenous growth.

Automobiles: Electric vehicles

In 2017, the government announced that India will shift to full electric mobility by 2030 to address the poor air quality issues and reduce dependence on oil imports. NITI Aayog has suggested that 40\% of personal vehicles and public transportation in the country should go completely electric by 2030. As a result, EV sales are expected to witness double-digit growth rates annually till 2020, though much of the Indian EV landscape is currently dominated by e-rickshaws and two-wheelers.

The central government has also taken up several fiscal measures to drive EV adoption in the country and has planned to invest INR5,500 crore over the next five years for wide scale EV adoption by offering subsidies, creating infrastructure and promoting the use of EVs.

Key minerals required for electric vehicles

The most important component of an EV is the lithium ion battery. There are various types of lithium ion batteries depending on the technologies they use such as Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Nickel Cobalt Aluminum Oxide (NCA), Lithium Iron Phosphate (LFP), Lithium Cobalt Oxide (LCO), etc. Each of these technologies use a different mineral chemistry and different proportion of minerals such as lithium, cobalt, nickel and graphite. Concurrently, the battery technology continues to evolve, which will continue to alter the importance of these minerals to the EV supply chain.

Another important component of an EV is the high performance electric motor, which uses a number of Rare Earth Elements (REEs) such as neodymium, dysprosium to make permanent magnets essential for these motors.

Increased adoption of EVs is also likely to lead to a slowdown in growth of internal combustion engine (ICE) vehicles, which will have a direct impact on metals such as platinum and palladium, used in catalytic converters of ICE vehicles.

Key minerals required for renewables

Most of the renewable energy sources such as solar, wind and nuclear depend on components such as solar photovoltaic cells, turbines (geared or direct drive) and reactor control rods for efficient functioning of equipment. These components in turn, are manufactured from various minerals including copper, indium, boron, dysprosium, neodymium and hafnium among others. With the Indian government being clear in its preference to manufacture components like solar panels locally, there will be a spike in demand for the associated minerals in near to medium term.

Development of clean energy resources remains a major focus area in India, given both, the need to curb carbon output and to tap the economic opportunity associated with sector growth. The renewables capacity has doubled over the last four years, supported by a strong government policy and an investment of US$42 billion in the sector. Improving cost competitiveness of solar and wind power has also resulted in increased adoption, boosting their share in the domestic energy mix.

India added 11.8 GW of capacity in FY18, bringing the aggregate installed capacity to 71.3 GW in June 2018. The sector remains on track and is likely to exceed its target of 175 GW installed renewable energy capacity by 2022.

Renewable capacity addition targets- 2022

Renewables are expected to account for 40% of the installed power capacity by 2030, in comparison to 18.2% in 2017, with solar energy being central to the expansion. While most of the projected growth will come from large-scale projects such as solar parks, there is also a strong need to ramp up small scale energy, such as rooftop solar, to penetrate areas not connected to the power grid.

Aerospace and defense

India’s status as one of the leading importers of conventional defense equipment highlights the need to enhance domestic output and cater to the demand opportunity. The government is focusing on boosting defense production, not only for import substitution but also to gain export market share. Thus, to facilitate and drive the vision of building an indigenous manufacturing base, the government announced several reforms including the Defence Procurement Procedure (DPP 2016) and FDI regulatory changes. Achieving targets, however, will also require higher capital investment and technological upskilling in the sector.
With already a defense spend of US$69.3 billion in 2017, a major part of the move to becoming self-sufficient, will be through higher private sector participation. India’s defense sector has historically been dominated by Defence Public Sector Undertakings (DPSUs) and Ordinance Factory Boards (OFBs), accounting for about 95% of the defense production and the industry was opened up to the private sector only in 2001. In order to enhance private participation the ministry, recently a strategic partnership policy was developed, according a special status to a pool of six Indian companies for defense manufacturing. These companies will have the opportunity to bid for mega production orders, worth over US$20 billion. In addition, continuing efforts to increase collaboration with foreign defense players, will not only improve capital availability but also close the technological gap and help optimize supply chain.

**Key minerals required for aerospace and defense sector**

The global aerospace industry consumes around 15% of beryllium, employing its high performance alloys for aircraft components, spacecraft and satellites. Thus it is likely to see a higher consumption in India’s growing defense industry. India’s ambition to emerge as the manufacturing hub for defense equipment will drive demand for minerals such as aluminum, rare earths, rhenium and cobalt.

**Key minerals required for electronics and IT sector**

The Indian electronics and hardware market is currently being driven by mobile phones and consumer electronics. Going forward, automotive electronics and industrial electronics are estimated to be high growth segments. Increasing safety, efficiency and entertainment needs will drive the automotive electronics market, while growth in smart city applications, new LED and solar PV projects will drive demand for industrial electronics. This will result in strong demand for key mineral commodities such as copper, nickel, chromium, aluminum, lead, silver, tin, silicon, antimony, bismuth, cobalt, fluorite, garnet, magnesium and talc, which are key to making electronic components.

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2 Government of India press release, 24 July 2018
3 "India joins World’s top five defence spenders," Bloomberg, 02 May 2018
4 Ministry of Electronics and Information Technology
Determining supply risk of minerals
The second key factor in analyzing the criticality of a mineral is understanding the supply side scenario, estimating the supply and assessing the associated risks. Several factors including geographical abundance, resource concentration, political and regulatory stability in the mining industry, etc. govern the supply risks for a mineral.

Factors influencing minerals supply

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<tr>
<th>Indicators and influencing factors</th>
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<tr>
<td><strong>Mineral endowment</strong></td>
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<td><strong>Geostrategic issues</strong></td>
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<tr>
<td><strong>Market dynamics</strong></td>
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<td><strong>Technological</strong></td>
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</table>

Source: EY analysis

Mineral endowment

Mineral endowment or the availability of a mineral in the earth's crust (referred to as mineral resources and reserves) as well as the current and forecast mining rates determine “life” of a particular mineral, i.e., how long it can be mined before the supply is exhausted. It is only an indicative information and can change depending on factors including mineral exploration and success rates, geology of mineralization, mineral grades and recovery rates and infrastructure access.

Geostrategic issues and market dynamics

While a mineral may have quality endowment and a high reserve to production ratio, its availability can still be constricted due to a number of reasons. For example, some countries may discourage export of minerals which they consider to be of strategic national importance. Similarly, many countries prefer and mandate local beneficiation of raw materials which limits the commodities’ availability outside the country, specifically impacting processing industries in other countries. Additionally, the uneven distribution of mineral resources globally impacts supply economics especially for long distance transportation. These geostrategic issues often require the country to depend on imports and to establish trade relations with mineral surplus countries.

Due to the very nature of the strategic minerals and their relative smaller volumes, the market prices see large distortions due to demand-supply mismatch even for a small volume. For example, the rare earth element (REE) mining industry saw high volatility upon some discoveries as well as when China adopted a policy of conservation in national interest. These uncertainties impair the mining industry's ability to have a sustainable project plan which in
turn constrains the supply sources. Other aspects that have bearing on the supply side include economic size of mine / processing, value of bye-products and their markets etc.

**Mineral endowment characteristics of critical minerals**

**Concentrated reserves and production**

Apart from an uneven distribution of mineral reserves, supply is also constrained by several factors such as technical challenges (in geology and extraction), politics, laws, environmental regulations, land restrictions, economics and infrastructure. Reserves, and therefore production, of many of the critical minerals are concentrated in only a few regions (Table: 1).

Regional concentration can lead to disruption in supply if the region witnesses political instability, regulatory changes or protest action by local residents. For example, in 2010, China, which mines almost 99% of the important REEs, imposed export quotas, which significantly impacted the Japanese high tech industry. Similarly, in 2012 and 2014, prolonged labor strikes at South African platinum mines impacted PGM supply to the global automotive industry. A similar issue can potentially happen in a mineral like cobalt which is primarily mined in the Democratic Republic of Congo (DRC), which faces governance issues. Stringent regulations on ethical sourcing of minerals can potentially disrupt the supply of cobalt, an important raw material to make lithium ion batteries, which powers EVs.

**Chinese control of production**

While mineral reserves and production is spread across regions globally, it is worth highlighting the level of control that China exerts in the critical minerals industry. Table 1 highlights various minerals where China has among the top three positions.

Over a period of time, Chinese state owned enterprises (SOEs) have stepped in to purchase and fund mines and downstream processing and even in the exploration of a number of minerals. Among lithium ion battery raw materials, China controls a significant portion of the global lithium supply and a higher share of the refined cobalt market than any other nation. Deals such as Tianqi/Talison (Australia, 2010), China Molybdenum/Tenke Fungurume (DRC, 2016), GEM/Glencore (DRC, 2018) and Tianqi Lithium/SQM (Chile, 2018) have enabled China to effectively control the lithium ion battery supply chain. Graphite, used in the anodes of lithium ion batteries, is already largely sourced from China. If China continues to gain commanding share of production of these minerals, it will be in a strong position to become the center of EV production, thus exporting vehicles to the rest of the world, as is the case in electronics manufacturing.

**Mineral endowment in India and geostrategic issues**

India produces about 88 minerals - four fuel-related minerals, 10 metallic minerals, 50 non-metallic minerals and 24 minor minerals. However, only about 10% of the eight lakh sq. km potentially resource-bearing area has been explored. Lack of sufficient attention to the sector in prior years and mineral exploration policies of recent years have not helped the country realize its mining potential and created import dependencies for a number of minerals.

**Critical minerals endowment in India**

India doesn’t have known resources of most of the critical minerals and hence is quite import dependent. Table 1 shows the resources position of various critical minerals and the country’s import dependency. India does have mineral resources for a few of those but does not produce most of such minerals.
**Import reliance and trade relations**

India has high degree of self-sufficiency in some minerals and metals including bauxite/aluminum, chromite, manganese, zinc, lead and refined copper (not mined copper) but is import reliant on many of the high value minerals and metals such as copper ore and concentrate, manganese ore, molybdenum and diamond among others. Data for many of the minerals important for strategic industries is not available easily or is not reported because they are very small in value terms. For most of those minerals, India appears to be almost completely dependent on imports to fulfil domestic needs.

Supply risks are likely to arise when the mineral has a geographic concentration of either reserves or production. Supply risk would also be dependent on the trade relations the importing country has with the supplying country and on export policies of the resource surplus country. This is worth noting that high import dependency does not necessarily mean huge supply risk. For example, India is significantly dependent on copper ore and concentrate imports but due to diverse sources of copper supply and from well developed markets, its associated physical supply risk is not deemed to be high.

While the country has good and stable trade relations with major mining regions, the sensitivities of each of these relations can influence supply chains such as fluctuations in the trust levels with China and the political instability in the case of the DRC. Such disruptions will consequently impact many strategic industries and programs in the country. For example, in the energy industry significant share of future production is likely to come from renewable energy. Scarcity of required minerals supply for the renewable energy industry is thus likely to impact the country’s energy security and its user industries.

Countries which own majority of these mineral resources may also pursue a policy to provide preferential access to their domestic companies. For example, should Indian downstream industries compete with Chinese industries, China will be in a position to provide preferential and cost competitive mineral access to its own domestic industries thereby rendering the Indian industry uncompetitive.

**Market dynamics**

Market dynamics such as shifts in adoption of minerals due to research and technological developments, fluctuating mineral demand, shifting competitiveness of consuming sector, volatile commodity prices, uncertainties around project viability and financing, financial health of mining sector and cost inflation (and hence cost of production) significantly impact current and future supply of minerals.

**Market dynamics of critical minerals**

| Investment trends of major miners |

Minor minerals are typically explored by smaller entrepreneurial mining companies. When these companies find a major resource, they look to partner with a major miner for both, technical expertise and capital for development. This however, hasn’t happened much in recent years as larger miners spent the last few years strengthening their balance sheets, return cash or taking a very conservative approach to allocating capital to new, high-risk businesses. Many mining majors have also shifted their focus away from risk prone mining regions such as Africa. This has shrunk the project pipeline despite significant potential.

Additionally, the mining sector is also balancing its focus between “old world” commodities (such as iron ore, coal) to enable traditional industries (steel/power plants) to “new world” commodities (lithium, rare earths) to enable modern industries (digital, batteries, charging infrastructure).

| Critical minerals production often dependent on major minerals |

A large number of the critical minerals are dependent upon production of other major metals as they are produced either as a by-product and/or a co-product of the major material. For example, about 99% of cobalt is produced as by-product of copper and nickel mining. Similarly, production of rhenium is dependent on the production of copper. Given that commodity markets typically work in cycles the downturn cycle for a major mineral will impact the production of its by-product, even if it has a strong demand and supportive market dynamics. It is unlikely that the price dynamics of the by-product will outweigh the weak market dynamics of the major mineral.

| Size of market opportunity |

The market volume of such new world commodities is tiny compared to that of the major commodities. For example, even in 2022, the total annual trade value of lithium and cobalt is estimated to be far less than a tenth of copper’s annual trade value.
Mining and processing infrastructure of new world commodities requires significant upfront investment. The size of their market opportunity also currently appears to be insufficient for global mining majors to commit significant resources to enter into new mineral portfolios. For example, many major global mining players are upbeat about increase in forecasted mineral demand due to increasing adoption of EVs but may rather invest in major minerals such as copper and nickel than one of the smaller battery raw materials.

**Constrained supply and pricing implications**

Supply of new world commodities has often lagged demand supporting considerable price rise. For example, cobalt prices have nearly tripled over the last two years. While rising prices have led to a positive supply response in several commodities, it has not always been possible to ramp up supply at a rate to meet demand.

**Lithium and cobalt prices (Index=June 2015)**

Additionally, small size of the market leads to an inefficient market structure where the pricing mechanism is not transparent due to insufficient volumes or liquidity for an index based system. This also results in prices being determined by just a few deals which may not be a true representation of the supply and demand dynamics of respective commodities.
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How market dynamics have played out in India

Lack of investment by global majors

Despite high mineral demand, significant mineral demand, resource endowment and low cost of labor, investment from global miners in the Indian mining sector has been negligible over the years. This lack of global interest has impacted growth of the domestic mining ecosystem particularly lack of opportunity for juniors to explore and develop the minerals portfolio.

Lack of investments by domestic miners

The structure and focus of Indian mining sector has impacted the market dynamics of critical minerals in the country. The sector has been dominated by captives (for bulk minerals/ metals) or state owned enterprises, who have focused on their captive needs and minerals of immediate demand. While Indian Rare Earth Ltd was set up in 1950, there has been little focus otherwise towards mining of critical minerals.

Technological advancements and preferences

Technological advancements and consumer preferences impact requirements of particular minerals too. The impact of this is most evident currently in EV and battery market where a gradual shift towards preference for EVs is having fundamental demand shift for a number of commodities. Similarly higher focus on solar energy (high indium, zinc demand) compared to wind energy (high neodymium demand) is likely to impact respective material demand.

Substitution and recycling in critical minerals

Substitution and recycling play key roles in certain materials usage and have often been important alternative sources of supply. In core industries, for example, downstream users rely on substitutes specifically as a way to arbitrage costs and on recycled commodities as a source of raw material.

Substitution of a material however, is not easy due to very specific properties and characteristics of strategic minerals. For example, even within rare earths, heavy rare earths are considered critical but light rare earths are not. Substitution is not easily possible even within various heavy rare earths. Additionally, the available substitute is likely to be a critical mineral itself. Evolving market needs and technology also play an important part in material substitution. For example, nickel is increasingly substituting cobalt in lithium ion batteries.

Recycling is dependent on a number of techno economic factors such as availability of recyclable stock, technology and a strong demand to justify capital investments and ongoing R&D. Focus on recycling is expected to increase as it directly supports circular economy initiative in various countries. Indeed various governments have framed regulations and incentives to promote recycling in their respective countries.

Recycling industry in India

The recycling industry in India focusses mainly on recovering conventional industrial minerals. In case of critical minerals, recycling industry is largely unorganized and small scale in nature. It often lacks the technical expertise to recover strategic minerals at a scale and in an economical and efficient manner.
<table>
<thead>
<tr>
<th>Mineral commodity</th>
<th>Downstream sectors</th>
<th>Regional production and mineral concentration risk</th>
<th>India strategic minerals scenario</th>
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Overview of India’s demand for critical materials and risk assessment

The table beside analyzes several minerals and metals (non-exhaustive), which find significant application in a number of strategic downstream sectors that are relevant for India’s developing and modernizing economy and hence are likely to attract higher interest from stakeholders.

To understand the global supply scenario of these minerals, we have analyzed the geographic concentration of reserves and also top three current producers. To start with, reserves concentration is assessed based on the share of top three countries in the reported global reserves. Further, to reflect the actual production scenario, commodities with more than 75% of production coming from three countries are, prima facie, considered to have a source of risk through any disruption of supply chain or even due to relative low bargaining power for the importer.

To even further refine the ultimate risk, the producer country’s mining sector investment environment, its political & regulatory stability has also been factored in. A combination of indices has been used to obtain a “Supply Confidence Score” of the producing country which can be a reflection of the relative sustainability of sourcing therefrom from the perspective of an importing country. A high confidence score can mirror the attractiveness of those countries for building a sourcing strategy with, or potential candidate countries for considering investments with off take arrangements for securing India’s resource needs.

The supply scenario for many of these critical minerals in India is not easily quantifiable, largely due to the lack of sufficient information on their endowment which may in turn may largely be due to insufficient exploration thus far.
Recommendations for national security of critical minerals
Our framework to identify critical minerals has used a detailed qualitative assessment of various industries of strategic importance to India for modern developing economy and their critical minerals inputs as well as the associated supply risks. The approach to secure a sustainable supply of such critical minerals will encompass various steps that can be taken to better understand the demand and to mitigate supply risk factors. The recommendations treat critical minerals as a homogenous group and are not mineral specific.

**Indicative strategic intervention timeframe for supply security of critical minerals**

<table>
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<tr>
<th>Period</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>0-3 years</td>
<td>Mega trends, sectoral demand and supply gap assessment</td>
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<td>3-5 years</td>
<td>Periodic strategic refresh</td>
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<td>5-10 years</td>
<td>Policies and regulations</td>
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<td>Mineral exploration and development</td>
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<td>Trade agreements</td>
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<td>Strategic sourcing/ stockpiling</td>
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<td>Mine acquisitions</td>
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<td>R&amp;D in processing and recycling</td>
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<td>Waste management program</td>
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*Source: EY analysis*

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1. **Make it a strategic agenda**

Various mega trends constantly influence the shape of development across the world and influence the nature of industrialization pursued by different countries, which are in-turn diverse in the nature and shape of their own industrial mix and economic development agenda. India has its own aspirations, goals, plans, programs and initiatives. Minerals and metals will indeed lead an important role in realizing such goals.

India’s domestic consumption of strategic minerals is currently small due to low levels of indigenous production of components for various user industries. However, this is likely to change due to government’s focus and ambitious plans for its Make in India program, national security, growth appetite and economic prosperity considerations. Ensuring supply security for strategic minerals needs to be a key agenda for all stakeholders including user industries, mining industry, policy makers and industry bodies.

1.1 **Scenario analysis on global and Indian demand**

Focus and clarity on several strategic industries is more advanced in many developed regions, whereas in India the topic may be in early stage of development. There is a need to understand how strategic industries have evolved globally, what would be India's trajectory and how various scenarios can impact those sectors / themes / initiatives over some timeframes. Based on these, some long range perspectives can be developed for their inherent minerals / metals demand.

1.2 **Multisector stakeholders collaboration for demand analysis**

There is a need for detailed collaborative studies by stakeholders to identify strategic industries, assess their future outlook and the mineral requirements. The classification of strategic industries, initiatives keep evolving as the country progresses. Similarly, various supply side factors that determine mineral availability also change over
a period of time. Changes in demand and supply equations both globally and within India will have a bearing on what is identified as a critical mineral in the Indian context. This necessitates such studies to be done at regular intervals. For example, the European Commission updates the list of critical raw materials every three years.

A detailed analysis of the demand side will help quantify mineral specific demand, which in turn is likely to result in more pointed policy interventions across various parameters discussed below.

Such an analysis will enable the government to take more informed decisions on which part of the value chain it wants to operate in. It may not always be feasible to aim for indigenous manufacturing of all components across industries. For example, in the current market dynamics of industries such as solar power and EVs, private players have preferred to import components and assemble it domestically instead of manufacturing it locally.

### 1.3 Setting up a strategic fund for overseas resource acquisition

The government can set up a fund to acquire resources overseas. This fund can provide soft loans and have special financing programs for companies that want to invest in strategic minerals overseas. The fund can also be used to encourage investment in particular stage of mining activity such as early stage exploration, development or operating mines by differentially incentivizing such activities.

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**US governments’ mandatory critical minerals development strategy**

Earlier in the year, the US government mandated critical minerals development strategy through an Executive Order. US Interior Department agencies are developing a strategic framework that will advance US critical mineral production.

The Executive Order states that for the United States, certain mineral commodities are "vital to the Nation's security and economic prosperity" and their dependence on foreign sourcing "creates a strategic vulnerability to United States industry and the military." It further states that the country has significant deposits of some of these minerals but are not mined due to a number of reasons such as "lack of accessible geological and geophysical data, permitting delays and the potential for protracted litigation".

The Executive Order aims to: **reduce the vulnerability to disruption of critical mineral supply by identifying critical minerals and new sources, increase activity at all levels of the supply chain, improve and ensure access to advanced topographic, geologic and geophysical mapping data and streamline leasing and permitting processes to expedite exploration, production, processing, reprocessing, recycling and domestic refining of critical minerals.**

*Source: US Department of the Interior, accessed on 03 Sep 2018*
Mine in India - enhance domestic resources through mining friendly policies

2.1 Encourage mineral exploration

The National Mineral Exploration Policy (NMEP) unveiled in 2016 incentivized the private sector in a bid to intensify mineral exploration in the country. However, mineral exploration has not really taken off with one of the primary reasons being allocation of mineral resources rights through the auction route without continuity of rights to the next stage.

There is a need to better engage with the industry and take ideas from global best practices in formulating the mineral exploration policy. A thriving exploration sector is the first step in identifying the country’s mineral potential and evaluating economically extractable reserves.

2.2 Ease of doing mining in India

Establishing resource potential is only the first stage, it is equally important to have a conducive environment for mining. Many projects in the country have stalled despite advanced exploratory studies, because of lack of various clearances related to environment and land acquisition. In addition the lengthy clearance window for obtaining licenses has not only delayed projects but also impacted potential investors’ interest.

Well laid out mining policies, supplemented by expertise and supported by collaborative execution on the ground will speed up projects and encourage more investments in the sector, consequently enhancing mineral production. Mining policies and expertise is the difference between having resources and the ability to exploit them for production. For example, Australia became the largest lithium producer overtaking the Latin American countries due to its mining expertise. The country is focusing on capturing more value in the supply chain by incentivizing development of processing facilities, which are largely controlled by China. Conversely, Bolivia does not produce lithium despite having the largest lithium resources.

Resource diplomacy to aid mineral trade and form mining partnerships

Resource diplomacy will enable the government and domestic players to engage with mining and metal companies in the host countries in a more structured way. Well-developed government relations become all the more important given that many of the producer countries are protective of their resources aspiring to benefit from growing future demand.
3.1 Strategic trade relations

While existing trade relationships with exporting countries that have stable mining resources and environment are to be nourished, government should also look to foster agreements with other resource rich countries. Bilateral trade agreements with resource rich countries will enable domestic firms to trade with host nations more reliably. These agreements can be in the form of free trade agreements, which will allow domestic companies strategic access to resources and a level playing field vis-à-vis its competitors.

3.2 Strategic stockpiling

Many governments have stockpiling programs to reduce import dependence for strategic mineral. For example, South Korea established a national stockpile program in 2005. China’s State Reserve Bureau (SRB) has a strategic mineral stockpiling program through which, it has often bought material in the open market for strategic purposes. The risk with stockpiling is that because strategic minerals are not widely traded in commodity exchanges and a whiff of such stockpiling decisions by governments is likely to spike the commodities prices.

3.3 Strategic mine acquisition and partnerships

Besides trade relations, the country should look to partner with and/or acquire mining assets and exploration opportunities in resource rich countries. This is a long term solution to securing mineral resources as many a times acquiring producing mines is likely to become a competitive and expensive situation. Similarly, while acquiring or investing in an exploration asset is easier, developing it into an operational mine is likely to take years. Indeed the government recently directed three state-owned mineral companies (Nalco, HCL and MECL) to form a venture to acquire strategic mineral assets abroad.

Government support is often very important in such endeavors as private players are likely to face difficulties in owning and operating mines in foreign countries. The government should aim to incorporate learnings from its similar venture to acquire coal and oil and gas assets abroad.

Countries such as China and Japan have every effectively deployed this model to acquire resources. China, for example, has invested in resources companies across the world during the last decade and now controls a majority of global lithium and cobalt production despite mining very little of it domestically.

4 Efficient minerals recovery through R&D in technology

Several of the critical minerals are produced either as a by-product and/or as a co-product of a major mineral. Recycling is another important way to source such minor minerals. Extracting these by-products and/or recycling of material for optimal mineral recovery rates requires sophisticated processing equipment and expertise, which may be currently very limited in the country. A successful recycling program also includes efficient collection and treatment of waste.

The government should invest in research and development of such technologies, invest in technology development fund, provide incentives to private players to invest, work with other partners for technology transfer and play a catalyst role in encouraging collection and treatment of waste.
Produce or Procure? | Securing strategic minerals for India’s development
Case study: Global EVs market and security of battery raw materials
Produce or Procure? | Securing strategic minerals for India’s development

The case study on EVs below shows how security of mineral supply is an important consideration for the battery dependent EVs sector. While the supply of raw materials required for batteries is not as constrained as many of the other critical minerals we discussed above, EV makers are increasingly concerned about future supplies and are taking various steps to secure raw material supply. The case study is limited to market dynamics of battery raw materials only and does not include various minerals essential to make electric motors and LCDs.

Context

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Growing in EVs

Going by various estimates, EV market is expected to grow exponentially with estimates of EV penetration rates ranging from 9.5% - 15.8% (excluding hybrids) in 2025. The forecasts for the EV uptake vary widely due to a number of factors such as battery capability in the future, available charging infrastructure, and regulatory regimes. Research by Bloomberg New Energy Finance projects that 55% of new car sales and 33% of the global car fleet will be electric by 2040. The chart below shows EV sales and growth scenario in the coming decade with a base case of 9.5% BEV and PHEV penetration.

A number factors contribute to the growth of EVs such as:

- Tightening emissions regulation, government incentives for cleaner technologies and rising compliance costs for internal combustion engines (ICE)
- Customer preference for environmentally responsible modes of transport.
- Improved battery range combined with lower cost of production
- Increased availability of battery charging infrastructure

Global EV sales volume growth

Note: Both BEVs and hybrids included
Sources: Analyst reports, LMC Automotive, EY analysis
Battery is the most important component of an EV

EV costs, range anxiety and availability of charging infrastructure are amongst the important factors that concern a potential EV buyer. All of these factors are dependent on the technical specifications and performance of the battery being used in the EV. Battery performance is highly dependent on the battery chemistry, which in turn is driven by its material composition. A high performance battery should have high stored energy, be lightweight and of a small size. It is not always possible to achieve all three attributes to the desired level. Various battery technologies are essentially aiming to get the right mix of structural stability and energy density. Lithium ion battery technology is expected to remain the dominant battery technology in the coming decade. The charts below show various lithium ion battery technologies currently prevalent and the weight and cost of raw material therein.

Raw material demand

EVs are expected to account for about 60% of cobalt and lithium demand in 2025 from about 20%-25% currently. Evolving battery technology and ongoing industry focus on NMC811 development as a way to increase vehicle range and reduce battery costs is likely to lower cobalt usage and increase nickel use.

The charts below show increase in demand for lithium, cobalt and nickel due to growth in EVs.

Source: Nomura, November 2017
Sufficient mineral resources exist but significant supply risks can impair availability

Battery raw material resources exist across a number of countries except for cobalt which is largely constrained in the DRC. Lithium mineral resources can last about 280 years and reserves about 90 years even at 2025 production rates (more than 4x current production rates). Similarly nickel production is spread across a number of countries.

On the other hand, supply risks exist across all the commodities. For example, despite significant nickel resources, production and LME stocks of nickel (class A) suitable for battery material requirements, it is expected to be in deficit due to fewer mineral resources available to produce the required grade of nickel. In the case of cobalt, most of it is mined in the DRC, which is politically unstable and has unsustainable mining practices. Further supply risks are perceived in the battery supply chain because China controls majority of processed lithium and refined cobalt market.

Reserve and production of key battery metals (2017)

Production dominated by China; India has significant graphite production; Turkey has significant reserves but little production

DRC and China largely control mine production/reserves and refined cobalt production respectively

Production profile is well split across geographies

Reserves are located in Chile, Argentina, Australia, China and Bolivia, Australia will be the largest lithium supplier as deposits in Chile/Argentina face issues in ramping up production

2017 Production level

Source: EY analysis, USGS

* - Reserves not reported
There exists a divergence between EV growth markets and regions where battery raw materials availability is high. For example, forecast EV demand from European countries such as Germany, France and the UK is high but availability of battery raw materials with them is very low.

EV makers have different strategies on whether they want to outsource batteries or make it themselves. For example, Nissan is outsourcing batteries but Tesla wants to manufacture its own. Our research suggests that most of the western automakers may not have “proper long-term contracts” for the supply of the battery raw materials.

Indicative EV demand Vs availability of battery raw materials

<table>
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<th>Source: EY analysis</th>
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The above chart shows that China is the only country which has high forecast EV demand and high availability of raw material. China is much ahead of other market players in securing supply of minerals that are critical for EVs.

**The crucial point of view is - whoever controls the raw material supply chain is likely to control the future of EV space.**

If you would like to discuss any aspects of this report please contact

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