VIEW POINT

KEEPING AN EYE ON A GREENER FUTURE - IS THE CORE OF ENERGY IN THE WORLD SHIFTING FROM AN OIL-AND-GAS-CENTRIC SUPPLY CHAIN TO A METALS-AND-MINING-CENTRIC SUPPLY CHAIN?

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Introduction

Enabling clean or carbon-free renewable energy is one of the main frontiers in the world's transition towards a greener future.

Global investment in clean energy is expected to reach US $1.7 trillion in 2023.[1] Apart from helping companies and countries reduce greenhouse gas emissions, clean energy also reduces dependence on traditional energy sources. Fluctuating prices, pressure to meet the United Nations Sustainable Development Goals (UNSDGs), and cheaper alternatives enabled by technological advances are some of the reasons why organizations are keen to reduce their dependence on fossil fuels and carbon-heavy energy sources.

Enabling clean energy systems of the future will be closely coupled with the evolution of the metals and minerals supply chain. The metals and mining supply chain will be a key enabler of the transition to clean energy because of the pivotal role metals and minerals play in clean energy technologies.

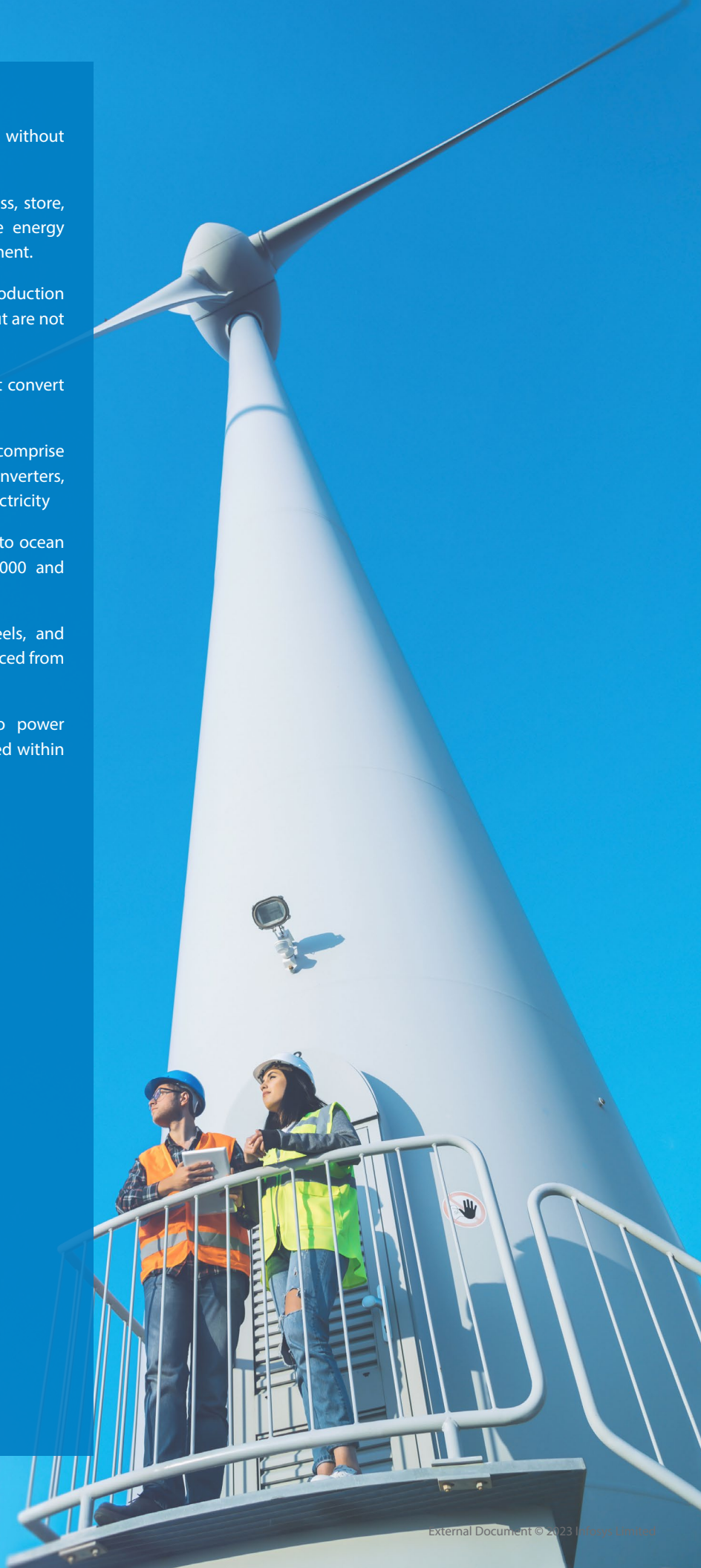
Clean Energy and its Technologies

Clean energy refers to electricity that is produced without generating harmful greenhouse gases (GHGs).

Tapping into clean energy means finding ways to harness, store, and distribute the power of renewable or carbon-free energy sources. This requires special types of systems and equipment.

Clean energy technologies are systems that power the production of clean energy from renewable sources. These include but are not limited to:

- Solar technologies like photovoltaic (PV) panels that convert sunlight and solar radiation into electricity
- Wind energy conversion systems (WECS) that comprise mechanical components such as turbines, converters, interconnectors, etc., to convert wind energy into electricity
- Wave energy converters and tidal turbines to tap into ocean energy resources that can generate between 45,000 and 1,30,000 terawatt hours of electricity per year.[2]
- Energy storage systems such as batteries, flywheels, and pumped hydro technologies that store energy produced from renewable sources for later use
- Electric vehicles, which use electromagnetism to power electric motors using renewable energy that is stored within a battery



Critical Metals Used in Clean Energy Technologies

The manufacturing of clean energy technologies requires critical metals and minerals owing to their stability, density, weight, conduction, low carbon consumption, etc.[3] Some of these metals and minerals are:

- Silicon for solar panels – Solar PV panels require high-purity silicon, which is obtained from quartzite or other silica-rich minerals. Mining operations extract the raw materials and undergo subsequent processing to produce the silicon used in solar panels.[4]
- Copper for electrical infrastructure – Clean energy technologies, such as wind farms and solar power plants, require significant amounts of copper for electrical wiring and transmission infrastructure, nearly 6 times more than traditional systems.[5] Due to its significance in decarbonization technologies, global demand for copper is expected to double by 2050.[6]
- Rare earth elements for wind turbines and electric vehicles – Wind turbines utilize permanent magnets made from rare earth elements such as neodymium, praseodymium, and dysprosium. These elements are sourced by mining from mineral deposits. According to a report by the European Commission, demand for rare earth elements is significant for electric vehicles and wind turbines. While the eventual maturity of these two sectors depends heavily on political ambitions of each country, the demand for rare earth elements is expected to increase from 90,000 tons in 2030 to 150,000 tons by 2050.[7]
- Aluminum for wind turbine blades – Aluminum, a lightweight and durable metal, is used in wind turbine blades to maximize efficiency through its high strength and low weight. It is also used in solar installations and lithium-ion batteries.[8] It is sourced from bauxite ore, which is mined and refined to extract alumina, and subsequently processed into aluminum.
- Lithium for batteries – Lithium is primarily obtained through mining operations that extract it from lithium-rich minerals or from underground brine reservoirs. Lithium-ion batteries are a key component of electric vehicles (EVs) and energy storage systems, making it a high priority for high-tech enterprises, automotive manufacturers, and lithium-ion battery (LIB) producers. The year 2017 saw the sale of 10 million EVs and some predict that this market will grow to US $221 billion by 2024.[9]
- Cobalt and nickel for energy storage – Cobalt and nickel are mined from deposits containing these metals, such as cobalt-rich ores like cobaltite or nickel-rich ores like pentlandite. Nickel is critical in driving the transition to clean energy thanks to its applications in Li-ion batteries and EVs due to its high-density properties. As mentioned earlier, the LIB market is expected to grow sizably, spurring global demand for nickel.[10]

Sustainable Practices in Metals and Mining Supply Chains

With the world moving toward reduced reliance on oil and gas, it is important to look to other, greener supply chains and inculcate responsible practices in those rapidly expanding supply chains.

Looking at the metals and mining industry, we see examples of sustainable mining, recycling, circular economy principles, waste reduction, and more. For example, nickel recycling, being very highly efficient, is quite lucrative. Nickel can easily return to its original state and hence nearly 68% of nickel from consumer products and e-waste is recycled. [11]

Some are looking to reduce carbon emissions from mining processes, as in the case of Antofagasta, one of the world's largest copper producers. Antofagasta's copper production is now 100% powered by renewable energy, a combination of hydro, wind and solar energy sources.[12] Further, many studies are underway to ascertain how to decarbonize primary aluminum production. A report by the European Commission recommends low carbon electricity sourcing as a way to reduce the carbon footprint of aluminum mining.[13] According to some, aluminum is the preferred material for high and extra-high voltage submarine transmission cables, which could drive a more liquid electricity market that transports renewable energy.[14]

Mining equipment, technology, and services (METS) businesses can help introduce and implement next-gen technologies in mining processes and production to make them more energy-efficient. For instance, these can drive targeted discovery and exploration of high-grade ores.[15]

While there are many challenges involved in revamping supply chains to account for clean energy transitions, the metals and mining industry remains determined to execute these shifts for a greener future.

Role of Technology in Enabling Sustainable Metals and Mining Supply Chains

With every passing year, it is becoming more challenging to produce the commodities required for enabling renewable energy. The pressure to use less resources and minimize harm to the environment is mounting ever so fast. While this has given rise to the need for sustainable supply chains in the resources sector, the industry is optimistic and looking to leverage more advanced and powerful technologies. This will help ensure safer and more productive as well as responsible supply chain practices.

Metal and mining firms generate copious quantities of data. When this data is captured, collected, distilled, analyzed, and stored in a systematic way, it can be used to enhance operations and streamline supply chains. By building mining ecosystems, businesses can collate huge amounts of data. With the help of new technologies, they can improve their operations in multiple ways such as developing minerals systems models, accelerating resource characterization, and ensuring more accurate targeting of drillholes.

These data inputs can also be leveraged by programs based on artificial intelligence and machine learning (AI/ML) to enhance ore processing and grade recovery. For example, BHP, a global mineral resources leader, uses data sources to capture movements of ore across the supply chain in real-time to map the ore grade coming from the mine. Then they use an application to maintain a 3D model of the material in the stockyard, to improve their loading operations.[16]

Truck automation for greater safety, decision-making using real-time data feeds, and autonomous haulage for decarbonization are just a few of the innumerable instances where technology can support the resources industry in achieving its sustainability goals. Technologies and capabilities based on them such as big data, AI/ML, automation, dynamic modelling, and digital twins hold immense potential to ensure more sustainable and responsible operations.

Conclusion

Decarbonization is now a global imperative. The path to a greener future will be created by the scaling up of the metals and minerals supply chain and how it leverages technology to improve efficiency, reduce carbon footprint, and drive innovation at scale for sustainable operations.

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