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METALS IN THE LOW-CARBON ENERGY TRANSITION:
— HOW DO THEY AFFECT GEOPOLITICS?

Policy Brief
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Key Findings

- Ongoing expansion of renewable energy increases the demand for metals such as lithium, cobalt and rare earths.
- At present, production of some of these metals is concentrated in a small number of countries.
- Expanding renewable energy systems will require continued mining of these metals for many years to come.
- However, over the long term, increased recycling can reduce producers' market power, environmental impacts, and conflicts with other land uses.
- In terms of their economic value, these metals will represent a smaller portion of the economies in metal-rich countries than has been the case for the economic share of fossil fuels in countries where such resources dominate.

"Our research shows that better recycling conditions for materials in the long term will break unilateral dependencies, and reduce environmental impact and social conflicts linked to mining."

Introduction

The availability of energy has always been a key factor in the development of society. In the 20th century, the usability and flexibility of oil played important roles in the development of the efficient and globalized production systems that characterize our society today.

Dependence on energy and its great economic value give the sector geopolitical significance. The quest for energy security, which can be understood as having a well-functioning supply of energy at affordable prices, plays a central role in the policies of most countries. Economies with large energy resources – such as those of Saudi Arabia, Qatar and Russia – depend on demand for their energy resources at prices that are stable and sufficiently high.

The fossil fuel-based energy system significantly contributes to environmental and climate problems. In many countries, this issue is emerging as the most important factor affecting energy policy. Ambitious, climate-driven energy policies will certainly affect the geopolitics of energy.

Fact box 1: A perspective on geopolitics

Geopolitics refers to the ways international politics and international relations interact with geographical conditions. These conditions extend beyond geography itself to include economic and cultural aspects. Such conditions may involve, for example, the location of various natural resources, production facilities, and transport routes, but also relevant cultural and economic relationships, such as similar historical experiences and political institutions, and intertwined trade and investment networks. The climate's variation over time and space can also have geopolitical significance.

Photo (above): Charging an electric car with energy.
Photo: Andrea Lehmkuhl/Shutterstock

Links between energy and geopolitics

At least five different processes shape energy´s geopolitical role[1].

- Import-dependent countries strive to secure their energy supply.
- Resource-rich countries strive to secure revenues from the extraction and sale of their resources.
- Countries try to create secure trade flows for functioning energy markets.
- Regimes in resource-rich countries strive to utilize resources in order to increase political influence internationally and domestically.
- Resource availability can affect the stability of countries and regions. The term "resource curse" is often used to describe the negative outcomes experienced by some countries with a wealth of natural resources – particularly, but not exclusively, fossil fuel resources (see Fact box 2).

How does renewable energy affect geopolitics?

A central part of the climate-driven energy transformation is replacing fossil energy with renewable energy. This will have a number of consequences on energy security and geopolitics. Examples are:

- Dependence on the few countries that control most of the world's oil and natural gas resources will decline. This will affect geopolitical relations at both regional and global levels.
- New challenges for these fossil fuel rent-dependent states posed by the threat to export earnings will surface. National economies and governing regimes in many cases depend on these revenues, and losing them can increase the risk of instability (for good or ill, for different actors, and across different time horizons). Instabilities also affect importers as deliveries become more uncertain and prices more unstable.
- In many cases, renewable energy occupies large geographic areas, and then competes with other uses, such as agriculture. A transition to renewable energy can thus create winners and losers, and, in turn, increase the risk of conflicts.
- New technologies will increase the demand for certain metals and semiconductor materials. This, in turn, will create new trade flows and dependencies with the potential for cooperation and conflicts.

The main focus of this brief is this last issue – the coming evolution of geopolitical relationships of materials that will emerge with a global energy transition – a subject that has thus far received comparatively little research attention.

Fact box 2. The resource curse

The resource curse, also known as the paradox of plenty, is a term used to describe the plight of resource-rich countries in which the presence of natural resource wealth contributes to problems rather than generating widespread benefits. Resource-rich countries tend to have higher rates of conflict and authoritarianism, and lower rates of economic stability and economic growth compared to their non-resource-rich neighbours.

Expressions and causes of the resource curse vary. Among them:

- The possible financial gain from the resources can motivate different groups to fight for power.
- The financial income from the resources can contribute to the financing of ongoing conflicts.
- Large revenues from resource extraction can cause other sectors to lose competitiveness, for example through currency appreciation or higher domestic prices that crowd out other industries – a phenomenon often referred to as "Dutch disease". A heavy dependence on one industry makes the national economy vulnerable to changes in demand and prices.
- Unless the revenue from resource extraction is reasonably well distributed among citizens, inequalities and tensions in society can grow.
- When those in power do not depend on tax revenues, the need to develop well-functioning political institutions may decrease. The availability of resource revenue can also increase the risk of corruption.

The role of materials in climate change

Climate change mitigation requires major changes in society through increased energy and material efficiency, new technical solutions, and structural and behavioural changes. Material-intensive and energy-intensive industries (e.g., the steel and cement industries) are responsible for a large part of the greenhouse gas emissions. To achieve climate goals, extensive changes will be required along the entire value chain from extraction to end use. Minimizing material losses and increasing material recycling are central parts of any viable strategy. Limiting material use in the economy is sometimes highlighted as a radical strategy to limit the negative effects on climate and the environment.

Underground Platinum mining in Johannesburg, South Africa.
Photo: Sunshine Seeds/Shutterstock

At the same time, the technical solutions that will replace fossil fuels will increase the need for certain types of materials. These include traditional materials such as copper, steel and concrete for the construction of wind turbines, but also other types of materials used for more efficient motors and generators, for new energy conversion technologies such as fuel cells and solar cells, and for batteries. Batteries are important both to electrify transports and to facilitate integration of wind and solar power in electricity systems.

A study[2] conducted as part of the wider Mistra Geopolitics research programme identified 14 metals and semi-conductor materials as particularly important in the transformation to a renewable energy system. These resources differ in terms of their availability and concentration. Some materials, such as silicon, exist in virtually unlimited quantities. Others are relatively uncommon and are produced as by-products from the extraction of other resources (e.g., indium and gallium). Cobalt is usually produced as a by-product, but in the Democratic Republic of Congo, in particular, geological conditions allow for profitable small-scale cobalt extraction.

For other metals, the natural resources that are profitable to extract today are concentrated in a few countries. Two examples are lithium in South America and rare earth metals in China. The substances themselves can at the same time be abundant on earth, but in concentrations that are too low for commercial production at today's prices and technologies (e.g. lithium in oceans). Some other factors that restrict availability are regulations, such as bans on open pit mining and environmental regulations that increase production costs, and competing demand for scarce water resources from agriculture or other sectors. Climate change can make extraction in some places more difficult and costly in the future.

When energy systems change, the use of many metals and semiconductor materials will increase sharply compared to today. Initially, these metals must come from primary, raw materials because recycled materials will not be sufficient to meet the increased demand. As the diffusion of the new technologies increase and their use becomes established, the conditions for recycling will improve – provided that technological development and policies lead in that direction.

Materials and geopolitics

Increased demand for metals and other materials for renewable energy can mean that the countries that have the natural resources can have better conditions for economic development. Increased prosperity and political influence may follow, provided that the countries manage these increased incomes and ensure that the population benefits.

Despite these possible positive effects, discussions about materials and geopolitics largely focus on potential problems. Two paths dominate discussions:

• Concerns surround the potential for suppliers with high market share to use their dominance to wield influence in an inappropriate way. A frequently cited example stems from China's decision to block exports of rare earth metals to Japan during political conflict between the two nations, and its decision to impose tighter export quotas, which drove up prices.

Portraits of Chinese coal miners at a coal in Huaibei, Anhui province, east China. Photo: Frame China/ Shutterstock

Another concern involves the prospect for resource-rich countries with weak institutions facing a resource curse with increased conflict, impaired democratic development, and other outcomes that hamper their path towards sustainable development.

Although geopolitical development depends on a large number of factors, the concentration of certain resources, and the economic revenues that material markets generate are influential factors.

Resource Concentration

Our analyses indicate that the geographic concentration of several of the metals studied (e.g., cobalt, lithium, platinum group elements and rare earths) is high, even higher than for oil. However, it is not obvious that it will be possible to exploit this relationship for geopolitical purposes since such behaviour can create a driving force to replace the metals with different alternatives.

The geographical concentration stated in different tables generally reflects reserves, which are the resources that are profitable to extract with today's technology and at today's market prices. For example, if threats of conflicts lead to increased prices, new resources can become competitive and counteract the dominance of individual countries. If recycling becomes more important, the dependence on primary metal producers can also decrease.

Various disruptions in supply due to deliberate decisions by the producer to limit supplies, antagonistic attacks on supply systems, or natural events can lead to physical deficiencies and price shocks, but these are most likely to be limited in time. Substitutes have been available so far (such as neodymium-iron-boron magnets for samarium-cobalt magnets), but nothing guarantees that future systems will avoid new lock-ins.

The Resource Curse

The risk that large raw material reserves leads to a resource curse depends of the conditions in the individual countries. Historically, in principle, countries (such as Canada and Norway) with stable and well-functioning institutions have avoided the resource curse. Other countries have had major problems.

In our study, we note that in most countries, the materials studied are likely to generate revenues that are relatively small in comparison to the oil revenues in today's major oil economies. Only in the Democratic Republic of Congo, Cuba, Madagascar, Chile and Zambia do the annual value of the metals extracted exceed 5% of today's GDP [1]. Thus, in most cases, the impact on national economies is likely to be small. Nevertheless, the local impact can be significant.

In addition, a number of countries that have mineral resources used in renewable energy technologies also have weak institutions and low levels of political stability. This makes the pathway to transforming resources into beneficial economic development difficult. The Democratic Republic of Congo, where a wealth of mineral resources (e.g. cobalt) has not alleviated the poverty of its citizens, is often highlighted as a cautionary example of a country that lacks institutions to ensure that income from resources reaches wider population groups.

Metals and sustainable development

Mining operations often have a large local impact on the environment. The degree of impact depends on the choice of methods – for example, whether extraction takes place in mines or quarries, and whether and how land restoration follows. At the same time, the extraction provides job opportunities and can improve the local economy provided that other industries are not disproportionately affected. For example, environmental impacts of mining can impair agriculture and tourism. Social aspects can also differ between countries depending on, for example, existing labour regulations requiring local workers are used, and state capacity to prevent forced labour. Conflicts can also arise between mining and the interests of indigenous peoples.

Key factors for a sustainable and secure supply of material

Geopolitical discussions often treat dependencies as a problem. But dependencies are not a problem per se if they are reciprocal, and involve relationships between like-minded countries. However, a unilateral dependency is problematic if a country seeks to use it for a purpose of its own, in conflict with the interests of partners.

Examples of measures that reduce the risks of unilateral dependencies are:

- A diversification of both technologies and suppliers of different materials.
- The possibility of substitutions for critical metals.
- Stockpiling critical metals.
- Bilateral deals with key suppliers.
- Increased recycling.
- Efficiency improvements.

Our research shows that better recycling conditions for materials in the long term will have multiple benefits. This will help break unilateral dependencies, and reduce environmental impact and social conflicts linked to mining. When recycled materials gain market share as a source of supply, the location of the material production can occur closer to the consumer, and the environmental effects of mining can be minimized.

Technological development that reduces metal demand is also important in reducing negative dependencies and environmental intrusion. Historically, such development has occurred for many technologies but has not yet resulted in reduced demand overall.

This brief is based on key findings from the following:

1. Månberger, A., Johansson, B., 2019. The geopolitics of metals and metalloids used for the renewable energy transition. Energy Strategy Reviews 26, 100394. https://doi.org/10.1016/j.esr.2019.100394.

2. Månberger, A. and Stenqvist, B., 2018. Global metal flows in the renewable energy transition: Exploring the effects of substitutes, technological mix and development. Energy Policy 119, 226-241. http://dx.doi.org/10.1016/j.enpol.2018.04.056

MISTRA
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