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Dirty Rare Metals: Digging Deeper into the Energy Transition

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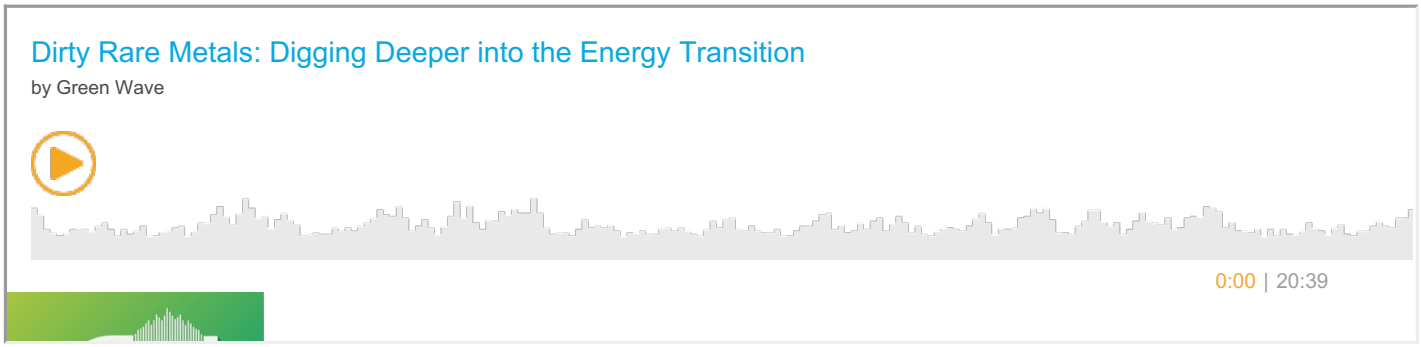
Having been dependent first on coal and then on oil, European society, as it transitions to renewables, will in future be constrained by the availability of rare metals. The central role of rare metals in green and digital technology has important consequences not only for the environmental transition but also for geopolitics and industrial policy in Europe and across the world.



They are the next 'black gold'. Without them, all sorts of green technology from wind turbines to electric cars and solar panels would not work. Rare metals are a family of thirty or so raw materials with often exotic names, like tungsten, cobalt, tantalum, indium, and gallium. They include a class of 17 metals known as rare-earth elements, such as samarium, europium and neodymium. Rare metals are far less abundant in the Earth's crust than materials such as iron, copper or zinc. Indeed, there is on average 1200 times less neodymium and up to 2650 times less gallium than iron on Earth. However, the properties of these metals make them, just like coal in the 19th century and oil in the 20th, indispensable resources for energy transition. So intense is our need for rare metals that, between now and 2030, demand for germanium is expected to double, palladium quadruple, and cobalt increase 24-fold.

Having reported on rare metals for six years across a dozen countries, it has become evident to me that any relative emancipation from fossil fuels could well lead to a new and equally problematic dependency. It is time to face this troubling reality. The challenges posed by the energy transition are just as formidable as those it is supposed to overcome.

The dirty job of extraction

The extraction and refinement of rare metals causes immense environmental damage. To employ these metals in green and digital technologies, enormous quantities of rock must be extracted using huge amounts of acids. Purifying one tonne of rare-earth elements requires 200 cubic metres of water. In the process, this water is contaminated with heavy metals and ends up untreated in rivers, soils, and aquifers.

The extraction of rare metals has become one of China's most polluting industries. A world leader in their

production, China's approximately 10 000 mines scattered all over the country have helped ruin its environment. Contamination incidents have been numerous and serious. In 2006, 60 companies producing indium, a metal used in the manufacturing of solar panels, poured tonnes of chemicals into the river Xiang, polluting the supply of drinking water for local people. In the Inner Mongolia Autonomous Region, where most of the rare-earth elements needed for new technologies are extracted, mining areas have become hellish places. Close to the city of Baotou lies the Weikuang Dam, an 85-million cubic metre artificial lake filled with toxic waste from surrounding refineries. In Dalahai, a small village on its banks, 54-year-old Li Xinxia starkly recounts its impact on local people: "Many of us are ill. Cancers, strokes, hypertension… We've performed tests and our village has become known as the "the cancer village". We know that the air we breathe is toxic and that we haven't got long to live."

Kazakhstan is afflicted too by the pollution caused by rare metal extraction. 14 per cent of the chrome consumed worldwide is produced in the country. The mining of this metal, prized by the aerospace industry, is responsible for the contamination of Syr-Daria, the longest river in central Asia, and has rendered the water unusable, even for irrigating crops. It's the same story in the Democratic Republic of the Congo, which supplies 60 per cent of the world's cobalt. Essential for making the lithium batteries in electric cars, cobalt mining takes places in the most primitive of conditions. According to studies conducted by Congolese doctors, cobalt concentrations in the urine of people living near the Lubumbashi mines in the Katanga province are up to 43 times higher than control samples.

Extracting these minerals from the ground is an intrinsically dirty process. But, up to today in most producer countries, extraction has been conducted in such an unethical manner as to tarnish the virtuous aims of energy and digital transition. But proponents of the energy transition remain confident, arguing that the efficiency of green technologies will considerably improve once coupled with digital technologies.

Green tech: a miracle cure?

The American essayist Jeremy Rifkin goes even further. According to Rifkin, the combination of green technologies with new information and communication technologies already enables each of us to produce and share our own green electricity, cheaply and in abundance.[1] In other words, smartphones, iPads and computers are in place to be the essential drivers of a more environmentally friendly economic model. Rifkin expects that, by creating a new "collaborative commons" communicating over the Internet, digital tools will kick out the age of ownership and usher in a new age of access.[2] Nothing will need to be owned because, in return for payment, online we will be able to share any product.

For Rifkin, we are already witnessing such a cultural revolution in car travel, as seen in the emergence of Blablacar, Drivy, and Zipcar with all their potential consequences for the automotive industry. He claims that 80 per cent of sharing site users sell their cars. So imagine the sharp drop in the number of vehicles that can be expected in this new age of access, and the raw materials and carbon emissions to be saved as a result. Rifkin's prophecies are so compelling that he now has the ear of numerous heads of state and is advising the French region of Hauts-de-France on new energy models.

> information and communication technologies consume one tenth of the world's electricity

But the digital technology that underpins these predictions requires considerable amounts of metals. Every year, the electronics industry consumes 320 tonnes of gold and 7500 tonnes of silver. It accounts for 22 per cent of world mercury consumption (some 514 tonnes) and up to 2.5 per cent of that of lead. Making computers and mobile phones alone gobbles up 19 per cent of global output of rare metals such as palladium and 23 per cent of cobalt. Not to mention the 40 other metals contained in the average mobile phone. Beyond materials, a US study has recently estimated that information and communication technologies consume one tenth of the world's electricity and produce greenhouse gases equal to half of those emitted by civil aviation globally. According to a report from

Greenpeace report: “If the cloud were a country, it would have the fifth largest electricity demand in the world.” While the march towards a new digital age is supposedly blissful, in reality it depends on an ever greater physical impact on the planet.

The Western public is largely ignorant of the invisible pollution from green and digital technologies. Of course there is a clear reason for this: since the 1980s, their governments have put an end to most mining activities. Because rare metals are not, in fact, that rare. Deposits have been found all over the planet. Until the 1980s, the United States was the world’s leading producer of rare-earth elements, extracted from the Mountain Pass mine in California. But environmental damage led the Molycorp Group, which ran the mine, to stop all operations in 2002. Even French chemical giant Rhône-Poulenc (now Solvay) shifted its radioactivity generating refining of rare elements to China in the 1990s. “There was shit that we didn’t want”, a former Rhône-Poulenc executive crudely admits.

The boomerang effect of the dirty mine

Western industries have deliberately offshored the production of rare metals and its associated pollution, only to bring these metals back onshore once cleansed of all impurities to incorporate them into intangible ‘green’ technologies. This division of labour, between those who sacrifice their health and environment to supply components and those who enjoy the benefits of green and digital ‘clean tech’ echoes Herbert George Wells’ science fiction novel *The Time Machine*. Published in 1895, Wells portrays a world where work and poverty have disappeared from the Earth’s surface, but underneath the crust lies a grim subterranean realm of slaves toiling in darkness and stench.

With rare metal production abandoned in the West, a handful of countries have gained a stranglehold on strategic resources. First among them is China, which enjoys a virtual monopoly on a profusion of metals critical for the energy transition. China supplies 82 per cent of the world’s bismuth, 87 per cent of antimony, 87 per cent of magnesium, and up to 95 per cent of some rare-earth elements. Fully aware of the powerful lever at its disposal, Beijing began to restrict rare metal exports at the turn of the millennium. Exports fell from 65 000 tonnes in 2005 to 32 500 today. This strategy culminated in 2010 with an embargo on rare-earth element exports to Japan and the United States. Today the deal imposed by the Chinese Communist Party verges on blackmail. Foreign high-tech firms can enjoy unlimited access to raw materials so long as they offshore their manufacturing sites — and associated technology — to China. Coerced or enticed, significant numbers of firms have moved production to the Middle Kingdom, thus advancing the Chinese policy of capturing evermore of the mining value chain. Nowhere is this more evident than the city of Baotou, in Inner Mongolia. Lying close to mines, the “rare-earth capital” has morphed itself into a hub for technologies using raw materials. The city has attracted over three thousand companies —fifty of which backed by foreign capital — and generates annual revenues of 4.5 billion euro.

> China is the number one producer of photovoltaic systems, the largest investor in wind power, and the principal market for renewable-fuel cars.

“We are no longer content to simply supply raw materials, but want to produce more sophisticated products too”, confirms Sun Yong Ge, the government official in charge of the Baotou Rare Earth High-Tech Industrial Development Zone. The results are stunning. In 2018, China is the number one producer of photovoltaic systems, the largest investor in wind power, and the principal market for renewable-fuel cars. One of the most polluted countries on the planet is now a giant of green industry. And China only intends to consolidate its dominant position in green tech, sucking up green jobs from Europe, Japan, and the United States along the way.

The US government has realised that its defence industry too is dependent on Beijing. Rare metals are indispensable for military hardware such as the Lockheed Martin F-35 fighter jet or Boeing’s JDAM smart bombs.

The challenges of the energy transition are therefore geopolitical too. In 2012, the US administration was even forced to authorise the import of rare-earth element magnets from China, required for the radar, landing gear, and IT systems used in the F-35. This measure is highly unusual given that a 1973 law prohibits the purchase of certain arms components from foreign suppliers. But the administration is beginning to react. In December 2017, on the grounds of national security, the White House ordered that production of certain metals considered "critical" by the federal government be resumed. As recommended by the late Senator John McCain, in August 2018 President Donald Trump signed a law prohibiting the import of Chinese rare-earth element magnets.

Secure in the knowledge that domestic demand is guaranteed, such measures should boost activity in the mining sector. Given that global consumption of rare metals is growing at a rate of 3 to 5 per cent a year, it seems necessary. According to a study published in 2015 by France's energy research body, between now and 2050 we will need to dig up more rare metals than in the rest of human history. For now on, supplies will need to be increased from places such as the Democratic Republic of the Congo, rich in cobalt, Argentina with its large lithium reserves, as well as South Africa and Russia, with their plentiful deposits of platinoids. New mining frontiers are opening up too. The potential of the Pacific floor, with its abundant polymetallic nodules, has sparked a literal race to the bottom.

The need for a realistic response from European Greens

There are stirrings of political action to halt this headlong rush to expand mining in the name of clean energy. In Europe, Green parties are pushing for ecodesign, an end to planned obsolescence, and the development of alternatives to and the recycling of rare metals. The reuse rate of rare metals like indium, germanium, tantalum, gallium and certain rare-earth elements is no more than 3 per cent.

But European green parties must face up to the full extent of the environmental impact of shifting towards a greener world. While it is understandable for Yannick Jadot, the French Green MEP, to have declared recently that "It's better to depend on the sun and the wind […] than to depend on Russian gas and Saudi oil", this approach to the energy transition overlooks how it is first and foremost a metallic transition. The more we look to the skies for energy solutions, the deeper we will have to dig too.

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A comprehensive political approach to the energy transition requires that every European citizen knows the link between consumer goods and natural resources. Globalisation and the growing complexity of technologies and logistics infrastructure have increased ignorance of what lurks beneath key environmental shibboleths. Giving consumers more information, such as life-cycle assessments for smartphones and electric cars, can help combat such ignorance. Labelling products with information on 'material footprint', the resources used in production, should be mandatory. How are we supposed to take action if we don't know that a 120-gramme phone requires the processing of 70 kilos of raw materials, 600 times the weight of the finished product?

Equally, European Green parties are going to have to take a stance on the thorny issue of re-opening rare and strategic metal mines in Europe. By onshoring the entire energy production process, Europe could more effectively monitor resource origins, take positive action on mining conditions, and improve green technology's carbon footprint. A policy to relaunch raw-material extraction supported by European Green parties would be altruistic and courageous as it would share the energy transition's mining burden with the poorest countries. It would also provide European green tech companies with the stable supply of raw materials necessary to drive investment in innovative technology. Diplomatically, it would boost the credibility of EU member states in climate change negotiations in the eyes of those countries to which we have exported our pollution and are now lecturing on the environment.

In short, the political approach to the energy transition must be systematically re-evaluated and re-invented to take account of its dependence on rare resources. The growing importance of mineral resources in our energy policy, the new mining diplomacy of producer states, and the rise of China provide European Green parties with an opportunity to devise a new strategic, altruistic, and realistic approach.

[1] Jeremy Rifkin, *The Third Industrial Revolution : How Lateral Power Is Transforming Energy, the Economy, and the World*, Palgrave Macmillan, 2011. En français : *La Troisième Révolution industrielle*, Les Liens qui Libèrent, 2012.

[2] Jeremy Rifkin, *The Zero Marginal Cost Society : The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism*, Palgrave Macmillan, 2014. En français : *La Nouvelle Société du coût marginal zéro : l'Internet des objets, l'émergence des communaux collaboratifs et l'éclipse du capitalisme*, Les Liens qui Libèrent, 2014

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