How climate change policies affect the mineral industries

Climate change policies have long been part of the conversation in the EU, which set strong 20% reduction targets for 2020, but as *Vasili Nicoletopoulos** discusses, the push to go green has had an impact on the mining industry worldwide.

Energy is one of the most significant cash expenses for mines, contributing to approximately 30% of total operating costs.

That cost is expected to increase sharply over the next decade, driven by a confluence of volatile fossil fuel prices, carbon taxation and falling average ore grades.

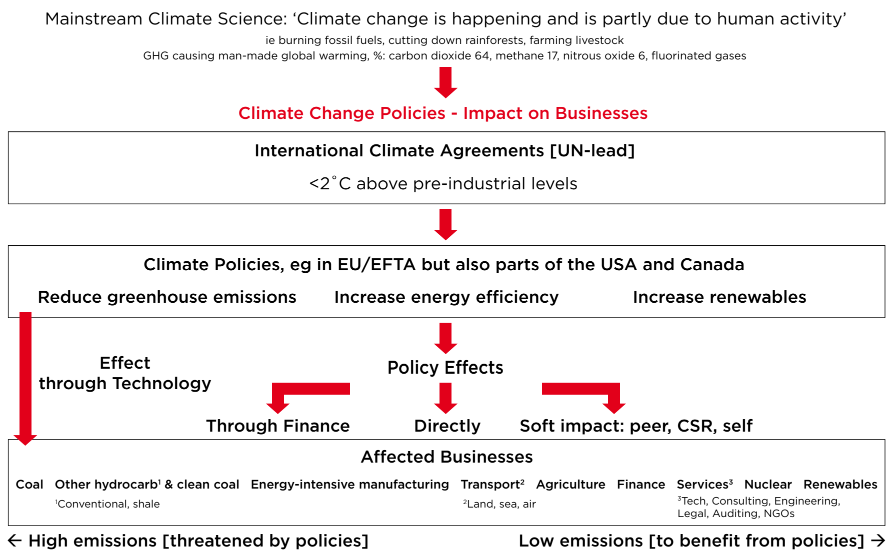
Links between the three pillars of reducing greenhouse emissions, increasing energy efficiency and increasing the use of renewables are demonstrated in Figure 1, which also offers a suitable framework for categorizing why and how climate change policies affect the mineral industries.

Reducing greenhouse gas (GHG) emissions

Greenhouse gases include:

- **Carbon dioxide (CO_2)** enters the atmosphere through burning fossil fuels, solid waste, trees and wood products, and also as a result of certain chemical reactions (e.g., cement manufacturing). Carbon dioxide is removed from the atmosphere (or, sequestered) when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH4)** is emitted during the production and transport of coal, natural gas and oil, and also results from livestock and other agricultural practices as well as by the decay of organic waste in municipal solid waste landfills.
- **Nitrous oxide (N2O)** is emitted during agricultural and industrial activities, as well as during the combustion of fossil fuels and solid waste.
- **Fluorinated gases** e.g., hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and nitrogen trifluoride are synthetic and are emitted from a variety of industrial processes. These are sometimes used as substitutes for stratospheric ozone-depleting substances (e.g., chlorofluorocarbons, hydrochlorofluorocarbons and halons).

Figure 1



Source: Natural Resources PC

Energy minerals

Roughly speaking, the energy mineral that is most negatively affected by policies that aim to reduce GHG emissions is coal, followed by oil. By way of example:

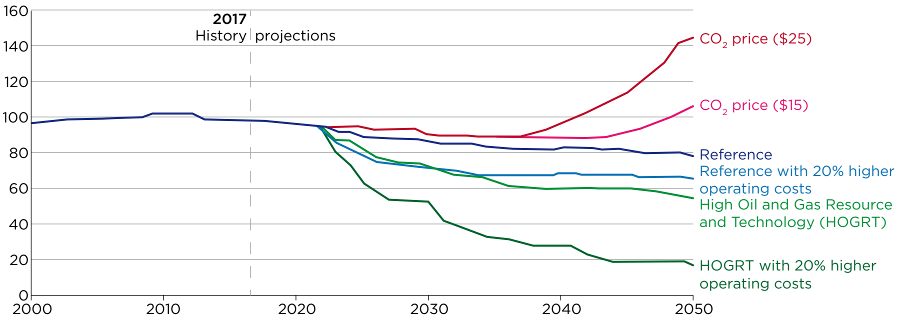
- A new UK coal mine is rejected on climate change grounds; Lloyd's coal policy is criticized for 'putting profits ahead of people'.
- Norway's Government & Shipowners Association want global shipping emissions to be halved by 2050.
- Allianz cuts back on coal insurance after environmentalist criticism,
- BP, Eni, ExxonMobil, Repsol, Shell, Statoil, Total and Wintershall have committed to reducing methane emissions from natural gas operations. The companies signed a Guiding Principles document in 2017, put forth by the Climate and Clean Air Coalition (CCAC), to address priority areas for action highlighted in the International Energy Agency (IEA) World Energy Outlook 2017.

The only solution on the horizon is 'clean coal', a term applied to many technologies, ranging from wet scrubbers, which remove sulfur dioxide from coal-generated gas, to coal washing, which removes soil and rock from coal before it's sent to a factory. Hypothetically, the term could be applied to anything that makes coal plants more efficient, such as digitization. Yet, when people talk about clean coal these days, they're typically talking about something called carbon capture and storage (CCS).

Gas, although a hydrocarbon itself, stands to benefit as a stopgap solution due to its lower GHG emissions compared to coal and oil.

Uranium and thorium, albeit problematic for other reasons, are climate-friendly due to their near-zero GHG emissions. In fact, the US Energy Information Administration (EIA) stated in May that the future of the US nuclear power fleet depends mostly on natural gas prices and carbon policies. Existing US nuclear power generating plants operate under increasingly competitive market conditions brought on by relatively low natural gas prices, increasing electricity generation from renewables and limited growth in electric power demand. Sensitivity cases prepared for the EIA's Annual Energy Outlook 2018 show the potential effects on the US nuclear power fleet of different assumptions for natural gas prices, potential carbon policies and nuclear power plant operating costs.

Figure 2: U.S. nuclear power generation capacity in several AEO2018 cases



Source: U.S. Energy Information Administration, Annual Energy Outlook 2018

Metal ores and industrial minerals

Metal ores bearing vanadium, rare earths and others used in catalytic converters are benefiting from the push to reduce GHG emissions.

Such converters, fitted in series with the exhaust pipe of gasoline-fueled vehicles, convert over 90% of hydrocarbons, carbon monoxide (CO) and nitrogen oxides (NOx) from the engine into less harmful carbon dioxide (CO_2), nitrogen and water vapor.

Rhodium is mostly used in automobile catalytic converters to reduce certain GHG emissions and atmospheric pollutants, as well as in glass reinforcement fiber and chemical catalysis.

The EU has committed to cut GHG emissions 40% below 1990 levels by 2030. Between 1990 and 2015, emissions decreased significantly in all sectors except transport, which increased 20%. Hence, more aggressive policies are needed to decarbonize the transport sector. A particular focus should be decarbonization of road transport because it's responsible for more than 70% of overall transport emissions. Electric batteries are used to store electricity for all electric vehicles- even ships.

A note by analysts McKinsey, released in May this year, called attention to, "surprising resource implications from the rise of electric vehicles".

The most surprising, probably, was that the impact of the move away from internal combustion engines (ICE) will only modestly affect demand for fossil fuels, according to the analysts. In fact, demand for natural gas fired power stations – all those EVs need to be charged after all – will increase 20% if half the cars on US roads were electric. Even coal would get a bump from EVs, McKinsey said.

The need for millions of public charging stations (China alone plans to build 4.8 million by 2030) could open up the possibility of a land squeeze because it takes, "multiple rapid 120-kilowatt charging stations with eight outlets to dispense a similar amount of range per hour as the standard-size gas station of today."

While concerns such as a "cobalt cliff" exist and demand implications could present a temporary speedbump, the constraints and uncertainties should be addressable.

Since battery costs make up 40–50% of your average vehicle, costs for the unit would have to fall to below $100 per kilowatt hour from $220–$225/kwh today to "achieve cost parity with ICE vehicles," McKinsey calculated.

Yet, transportation and utility companies face an uncertain future. Auto makers have to make extremely expensive choices. New manufacturing plants must be constructed for electrical hydrogen cell cars/SUVs/trucks, but the infrastructure (charging/repair stations) is not in place.

Some questions worth posing are:

- Does a customer want to buy an electric car that takes a few hours to charge?
- Will electric cars be company controlled (UBER, LYFT, General Motors, etc.) so that charging is not an issue?
- Will trucks use hydrogen cells instead of electricity?
- Are SUVs and trucks ready for electrification?
- Will sedans sell in quantity only if hybrids?

As an example, Hainan province, China, plans to have all vehicles running on new energy by 2030, provincial governor Shen Xiaoming said on April 9.

"We are considering island-wide use of new energy vehicles [NEVs] by 2030," Shen said at the Boao Forum for Asia annual conference. Government vehicles will be switched to NEVs first, then vehicles for public use and finally private cars.

Increasing energy efficiency

Three different sets of actions where minerals and metals are involved can be delineated below.

Energy-saving mineral products

These are used in various industrial processes including insulating industrial minerals such as wollastonite for mineral wool; magnesia and dolomite for refractory materials; alumina-silica for thermal insulation bricks used outside the metals industry; various ceramics etc.

A different case is the use of rare earths in several lighting applications, where europium phosphors are currently used in fluorescent bulbs.

In construction, associate professor Madhu Bhaskaran explains how she and PhD student Mohammad Taha have developed a vanadium oxide-based self-modifying material which will help smart glass to become greener and more automated. Prof Bhaskaran explains that their coating "doesn't require the input of energy, unlike existing technology, and responds directly to changes in temperature."

Reducing energy use in the mining and metals industry itself

This means energy efficiency in mineral and metal production. Energy conservation, energy saving and/or energy substitution can be achieved with new designs in milling equipment, in the case of processing. And in using insulating and refractory materials in metals production.

Results from life cycle assessments of the main, primary metal production processes, together with current and predicted global metal production rates, ore grade availability and grind or liberation size have been used in a broad analysis to indicate that improving energy efficiency will focus on the metal extraction stage, particularly for steel and aluminum.

The declining ore grades and more complex ore bodies expected in the future may significantly increase the energy required for metal ore comminution. This will present opportunities for improving the energy efficiency of primary metal production as well as during the metal extraction stage.

Recycling – the cyclical economy

So-called urban mining - the recycling of gold, rare earths and other minerals and metals - is becoming more widespread, although the diversity of materials involved, the relatively small scale and the price volatility of rare earths and gold often give questionable economic returns.

Increasing use of renewables

Renewable sources of electricity have been increasing in importance, not least because of the European Commission's Renewable energy directive, which set a binding 20% target for final energy consumption from renewable sources by 2020.

EU countries have already agreed on a new renewable energy target of at least 27% of final energy consumption in the EU as a whole by 2030, as part of the EU's energy and climate goals for 2030.

Power generated by wind, solar and biomass in the EU overtook coal for the first time in 2017. A year earlier, electricity produced from coal made up 21.5% of 3050000 GWh, while clean power accounted for 18.8%.

Figure 3 shows the advent of renewables in the EU. Wind and solar are the most important sources. In countries such as Brazil and the United States, biofuels are an important supplement in the mix.

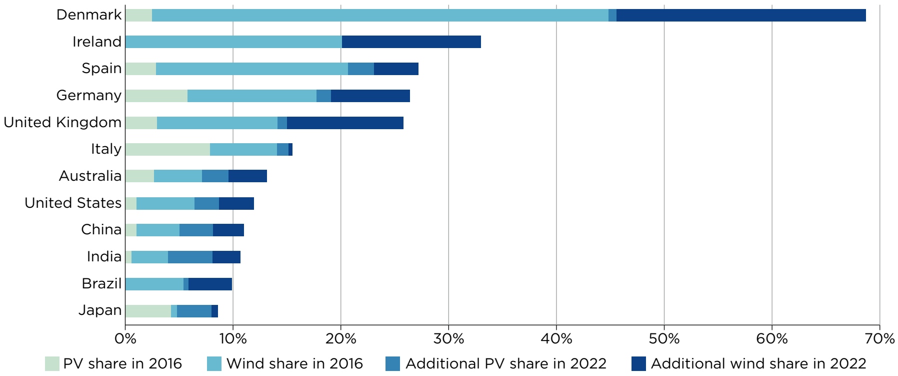
Yet in the EU, direct subsidies to renewables have been removed and tariffs are now being determined in competitive auctions. However, opponents to renewables point to 'hidden subsidies' such as payments for stand-by gas capacity etc.

Mineral extraction products benefiting from climate change policies

Energy Minerals	Metals	Industrial Minerals
Clean coal	Aluminium	Dolomite
Gas	Cobalt	Graphite
Thorium	Copper	Magnesite
Uranium	Gold	Perovskite
	Lithium	Phosphates
	Magnesium	Rare earths
	Nickel	Silica
	Rhodium	Wollastonite
	Silicon	
	Vanadium	

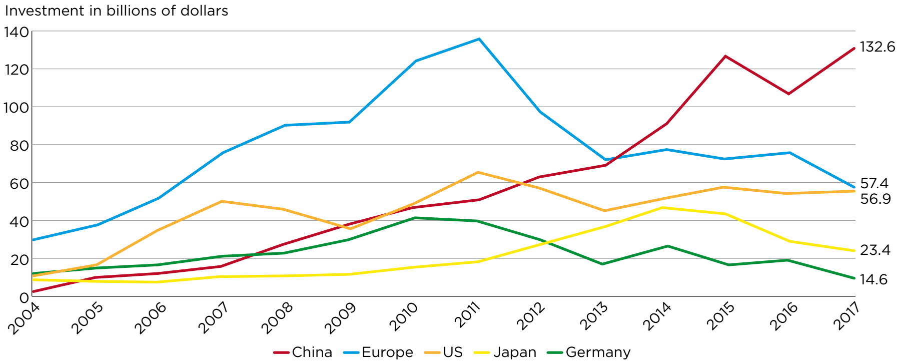
Source: Natural Resources PC

Figure 3: VRE share in annual electricity generation (Se;ected countries 2016-2022)



Source: Renewables 2017. IEA

Figure 4: China takes the lead on renewables



Source: Bloomberg New Energy Finance

In terms of *mining products*, it is characteristic that Germany's carbon emissions have declined due to more wind power. On the contrary, rare earths are increasingly applied in permanent magnets for wind turbines, silica and minor metals are used in photovoltaic cells, while it is crystalline minerals such as perovskites that are 'the undisputed leader' among emerging solar technologies — and other ideas for superior alternatives to standard silicon panels.

The real boom in renewables will come from the improved storage of electric energy, where mining products will be absolutely necessary. A world that relies on clean energy will also need a thriving mining sector, specifically for cobalt, copper, vanadium and lithium, as well as graphite and nickel.

Mining itself, especially in remote areas, is already benefiting from the advent of renewables or hybrid systems employing renewables and diesel and/or pumped storage hydro.

Biofuels are another form of renewable energy and are used to replace fossil fuels in the energy industry and the construction industry.

China and the future

Renewable energy development in China has attracted global attention in recent years. In 2012, China's installed wind capacity was 61GW and for solar power was 3.4GW, while the annual electricity generated by renewables was only 2.1% of China's total consumption. Compare that with 2017, when China's wind and solar power capacity increased to 168.5 GW and 130.1 GW, respectively, and renewables generated 5.3% of China's electricity supply.

At present, China leads the world in wind and solar power capacity and with large-scale industrial applications, the costs have fallen substantially. A good example is photovoltaic (PV) technology: the price of PV modules has been decreasing, dropping from about 30 yuan ($4.67) per watt in 2007 to about 10 yuan per watt in 2012, and down to 2 yuan per watt in 2017.

Figure 4 illustrates the investment in renewables in different areas of the world from 2004 to 2017, with China making the greatest investment.

**Owner of Natural Resources PC*