

# Mining's climate accountability

Mineral extraction will play an important role in climate change mitigation and green technologies. But ensuring that the net effect of mining is beneficial requires careful monitoring of greenhouse gas emissions and environmental impacts.

Human populations have been defined by the technologies they use and the resources they exploit. In pre-history Europe and west Asia there were the Stone, Bronze and Iron Ages; in modern times the Industrial Age is more universal. Fuelled by hydrocarbons, industrialization has led to rising concentrations of greenhouse gases in the atmosphere, with unintended but well-documented changes in climate and environment. In response, governments now aim to keep the average temperature increase to less than 2 °C, as agreed in Paris, 2015. Among a number of strategies to decarbonize the global economy, green technologies such as renewable energy generation and storage will require an expansion in mining. However, mineral extraction uses a lot of energy<sup>1</sup> and, as highlighted in a [Perspective](#) by Azadi and colleagues, is associated with greenhouse gas emissions from numerous sources. In order to evaluate and implement climate mitigation strategies, accurate accounting of energy usage and greenhouse gas emissions is needed.

Analysis by the World Bank suggests that renewable energy generation will increase from 14% to 44% of the overall energy supply under a 2 °C scenario<sup>2</sup>. In the United States alone there is ambition to generate at least 80 GW of offshore wind power by 2050<sup>3</sup> (compared with the 0.03 GW of operational offshore wind power in 2018<sup>4</sup>) and electric, battery-reliant cars will increase from 1.2 million on the world's roads today to over 900 million by 2050<sup>5</sup>. Importantly, the complex mix of metals<sup>2</sup> that these green technologies rely on cannot be produced at current capacity. For example, in 2050 the global demand for lithium (a key component in batteries) is projected to be as much as 900% of current production<sup>6</sup>.

More efficient recycling and re-use can probably absorb some of the demand. However, recycling leads to lower-grade materials and the current standing stock of metals falls below future requirements, so a sizeable gap remains to be filled. Overall, secondary resources are unlikely to meet the needs of modern societies, at least on the current trajectory. More mining is inevitable.

The environmental damage associated with mining is well-known, in terms of land clearing, ecosystem degradation, or water pollution. However, its effect on



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climate is less frequently considered. This means that conversations about the future implementation of green technologies — many of which are heavily mineral-reliant — are oversimplified because they fail to take into account the full impact of mining, which includes greenhouse gas emissions. The sources of carbon dioxide associated with mining are varied and specific to each mineral, method of extraction, and region. There are direct emissions from the fuel and electricity used<sup>7</sup>, but there are also indirect emissions that have largely been ignored. These indirect emissions can even result from the actions taken to mitigate local pollution. For example, Azadi and colleagues highlight that the carbonate minerals used to neutralize mining waste also release carbon dioxide into the atmosphere during the neutralization process and weathering.

At the moment, the world's economy appears inextricably linked to resource extraction: the rate of which is three-times faster now than 50 years ago, while the global population has only doubled in that time<sup>8</sup>. Likewise, for every 1% increase in gross domestic product between 1995 and 2013, metal ore extraction increased by up to 1.9%<sup>9</sup>. For a sustainable future, it is necessary to use resources more efficiently by, for example: avoiding waste; designing simple products that minimize materials; building repair, re-use, and recycling into

products; and keeping things in use for longer<sup>10</sup>. But this will not suffice.

Mining has long been an integral part of human civilization. It has provided raw materials not just for technological and industrial development but also for art and culture. However, the benefits must be balanced against the mark that mining operations leave on the environment; public health; and conflicts. The Earth's mineral resources will not run out but we must use them wisely. Full and fair accounting of, and accountability for, unwanted impacts is required if mining is to do more good than harm. □

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