

Elements of a Greener Economy

The dirty secret of the shift to a lower-carbon economy is that it will be really dirty: Creating the systems that underpin the transition will require digging up untold quantities of minerals. Batteries that power electric vehicles or store solar and wind energy depend on minerals such as lanthanide and silicon. A new generation of cars and electric grids will use millions of tons

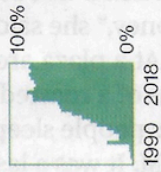
of copper. Magnets in electric motors are made with so-called rare earths. And the myriad electronic sensors that will keep it all humming will gobble up vast supplies of rhodium and palladium.

The economics and geopolitics of the shift are messy as well. In the global race for many of these commodities, China has become the dominant supplier or

processor. That's helped shore up its position as the leader in producing electric vehicles and forced countries such as Germany, Japan and the US to rely on it for scarce resources. In response, the Biden administration is seeking to bolster American supplies with legislation that includes billions of dollars in grants and tax incentives for suppliers. —*Joe Deaux and Filippo Teoldi*

China's Growing Dominance of Commodities

The country's estimated share of global production for selected elements, 1990 to 2018



Magnesium helps create the harder aluminum alloys needed to make lighter cars.

Light and able to withstand high temperatures, aluminum is central to the shift to EVs.

It's the root of the problem, but carbon is also a key component in the batteries we'll require.

H Hydrogen	Be Beryllium	Ca Calcium	K Potassium	Rb Rubidium	Cs Cesium	Fr Francium
Li Lithium	Mg Magnesium	Sc Scandium	Ti Titanium	V Vanadium	Cr Chromium	Mn Manganese
Na Sodium	Al Aluminum	Y Yttrium	Zr Zirconium	Nb Niobium	Mo Molybdenum	Tc Technetium
B Boron	Si Silicon	La-Lu Lanthanide	Hf Hafnium	Ta Tantalum	W Tungsten	Re Rhenium
C Carbon	Ge Germanium	Ac-Lr Actinide	Ra Radium	Sg Seaborgium	Bh Bohrium	Db Dubnium
N Nitrogen	As Arsenic	Pb Lead	Flerovium	Ds Darmstadtium	Rg Roentgenium	Cn Copernicium
O Oxygen	Se Selenium	Fl Fluorine	Nh Nihonium	Pt Platinum	Au Gold	Hg Mercury
F Fluorine	Te Tellurium	Cu Copper	Rh Rhodium	Pd Palladium	Ag Silver	Cd Cadmium
Ne Neon	Br Bromine	Ni Nickel	Ru Ruthenium	Co Cobalt	Fe Iron	Zn Zinc
Ar Argon	I Iodine	Pd Palladium	Rh Rhodium	Ru Ruthenium	Co Cobalt	Cu Copper
Krypton	Xe Xenon	Pt Platinum	Ru Ruthenium	Rh Rhodium	Fe Iron	Ni Nickel
Polonium	Livermorium	Pt Platinum	Ru Ruthenium	Rh Rhodium	Fe Iron	Ni Nickel
Bi Bismuth	Po Polonium	Pt Platinum	Ru Ruthenium	Rh Rhodium	Fe Iron	Ni Nickel
Moscovium	Fluorine	Pt Platinum	Ru Ruthenium	Rh Rhodium	Fe Iron	Ni Nickel

The solar industry relies on high-purity silicon for photovoltaic cells to harness the sun's energy.

The primary ingredient in steel and possibly the foundation for a cheaper battery technology.

DATA: US GEOLOGICAL SURVEY. PRODUCTION REFERS TO PRIMARY PRODUCTION OR MINE PRODUCTION. CHINA DOESN'T PLAY A SIGNIFICANT ROLE IN ELEMENTS WITH NO BARS. ELEMENTS NOT ASSESSED ARE SHADED LIGHT GRAY.

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