USAID
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GREEN ENERGY MINERAL: KEY FACTS

Vanadium

US CRITICAL MINERAL?	YES

MAIN USES IN GREEN ENERGY TECHNOLOGY

Energy storage

KEY DEVELOPMENT ISSUES IN MINING

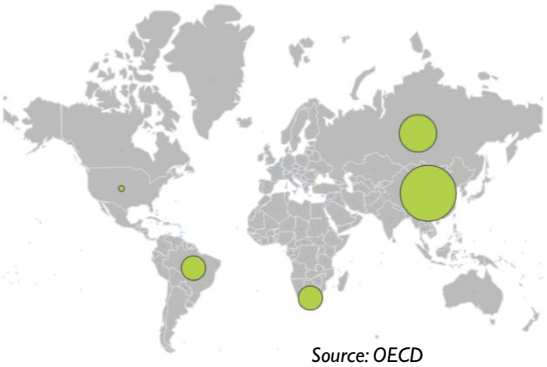
Environment

Governance

DEMAND PROJECTIONS

Vanadium is an alloy agent used in specialty steels as well as titanium alloys used in aerospace. In renewables, the vanadium redox flow battery technology is used in grid storage. Vanadium redox batteries have several advantages including no risk of fire, little charge capacity degradation over time, and no risk of damage if left uncharged for long periods. Vanadium batteries are too large and bulky for use in electric vehicles, at least in their current form. Based on projected use of vanadium redox batteries, 138,000 tons of vanadium will be used in renewables by 2050, a 189% increase over 2018 annual production (Hund et al., 2020).

PRODUCTION/RESERVES



Source: OECD

Vanadium is usually found in other ore bodies, including bauxite and phosphate rock, but most comes from titaniferous magnetite, which is a form of iron ore. As such most vanadium (around 60%) is a co-product of steel production (VANITEC, n.d.). **China** is the largest producer of vanadium with 53,000 metric tons produced in 2020, or 60% of worldwide production. Most of this was a co-product of steel production using titaniferous magnetite. China is followed by **Russia** with 18,000 metric tons and **South Africa** with 8,200 metric tons. **Australia** has reserves and exploration projects but no production yet. In the US, vanadium has been mined as a by-product of uranium mining in Utah, but new primary vanadium mining may begin in the near future (Associated Press, 2020). Vanadium's price has varied between $3.38 and $16.4 per pound in the last five years. At the time of writing vanadium was around $9 per pound, and ferrovanadium used in steel was trading around $40 per kilo.

MINING IN USAID-PRESENCE COUNTRIES

South Africa is the third largest producer, mainly with primary vanadium mining operations (as opposed to refining vanadium from steel slag). Brazil is the fourth largest producer. Exploration projects are ongoing in Guinea (Africa Intelligence, 2018a), Namibia (Bromby, 2021), and Mozambique (Syrah Resources, n.d.b).

MAJOR INDUSTRIAL COMPANIES

In China, the largest vanadium producers are **Pangang Group Vanadium Titanium & Resources** and **HBIS Chengsteel** (PR Newswire, 2018). In Russia, **Evraz** is the main producer. In South Africa, **Bushveld Minerals** and **Glencore** are the key operators. In Brazil, US company **Largo Resources** (Costa, 2021) is the main vanadium producer at present.

ARTISANAL AND SMALL-SCALE MINING (ASM)

None

ISSUES IN USAID-PRESENCE COUNTRIES

The metallurgical processes used in extracting vanadium are energy-intensive and can release toxic elements into the environment. However, vanadium mining has been largely under the radar until recently and there is little information on issues in USAID-presence countries. The speculation and resource scramble for vanadium and other minerals could increase risks of corruption and governance challenges.

MINE DEVELOPMENT AND SUPPLY CHAIN DYNAMICS

Vanadium has been tied to steel industry dynamics, which has contributed to its price volatility. However, as demand for vanadium increases for renewables, vanadium mine development is being increasingly decoupled from steel production. In addition, new rules in China's steel industry related to environmental controls as well as a ban on the import of vanadium slag is projected to decrease supply. China's steel industry is also becoming more reliant on imported iron derived from hematite, which does not contain vanadium, and the steel industry tends to run at capacity which limits its ability to respond to vanadium supply changes (Bushveld Minerals, n.d.). As such there is significant speculation and exploration with respect to primary vanadium production.

ORGANIZATIONS AND INDUSTRY GROUPS

There are no vanadium-specific industry groups.