Achieving American Leadership in the Platinum Group Metals Supply Chain

Summary

Platinum group metals (PGM) are critical for today's energy sector industrial base and will play a key role in tomorrow's decarbonized economy. Catalysts based on PGMs are used in a variety of applications such as chemical manufacturing, automotive catalytic converters, and petroleum refining. They are also central to emerging decarbonization technologies such as water electrolyzers for green hydrogen production and fuel cells for vehicles and stationary energy storage.

The six PGMs are among the least abundant elements on earth and occur in only a few countries worldwide, with the majority of production and reserves in South Africa and Russia. To secure the supply chains for these clean energy technologies, as well as green hydrogen and chemical manufacturing, the United States needs to invest in its domestic resources and in innovations in PGM substitutions, material efficiency, and recycling.

PGM Catalyst Uses

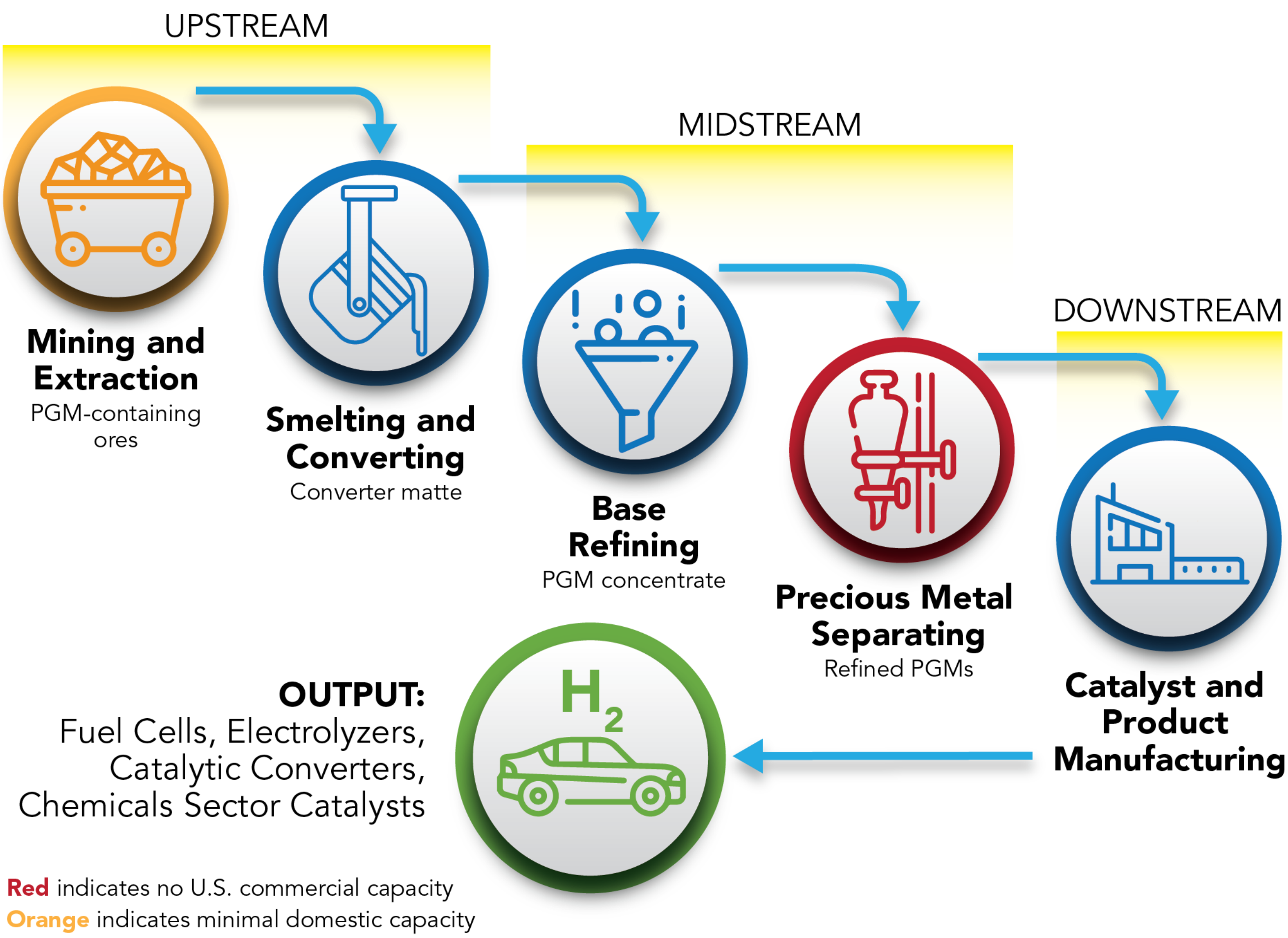
Catalysts based on PGMs ("PGM catalysts") are particularly useful in widespread industrial applications, including the production of high-volume chemicals such as ammonia, acetic acid, nitric acid, and the refining of crude oil into petroleum products. Within the energy industrial base, PGM catalysts improve the energy and materials efficiency of petroleum refining and chemical industry processes and reduce energy consumption in manufacturing. PGMs are particularly well-suited as catalysts due to facilitating high product yield and selectivity. PGMs are also robust catalysts due to long lifetime and regeneration capability.

Within the energy sector industrial base, PGM catalysts are critical components of many decarbonization and energy technologies, including catalytic converters used to reduce pollutants from internal combustion engines, natural gas fuel cells, fuel cells for grid energy storage, fuel cell electric vehicles, thermal catalytic reactors with advanced catalysts, electrochemical reactors for chemical production, and electrolyzers to produce green hydrogen using the polymer electrolyte membrane (PEM) water electrolysis process.

Decarbonization Focus

Green hydrogen has widespread potential for decarbonizing industrial processes, including chemical manufacturing (in particular, green ammonia production, which has many downstream uses), low carbon emissions steel manufacturing, petroleum refining, and biofuels (including renewable diesel and sustainable aviation fuels).

Industrial processes, including energy use, contributed 23% of U.S. greenhouse gas emissions in 2019, and many of these processes are emissions intensive. For example, for each ton of steel produced, approximately 1.85 tons of CO_2 are emitted. To meet the nation's goal of net-zero carbon emissions by 2050, decarbonization of these energy and emissions intensive processes will be crucial. PGM catalysts, and the green hydrogen produced with them, can enable dramatic emissions reductions in these hard-to-decarbonize industrial sectors.



Key Findings and Opportunities

Several vulnerabilities in the PGM catalyst supply chain, if left unresolved, could hinder the success of important technology pathways and solutions, the ability of the United States to meet its climate and decarbonization goals, and potential future domestic prosperity and economic growth:

- **Limited Supply Chain Data.** Limited data for characterizing and assessing PGM catalyst supply chains and their applications remains a barrier to future decarbonization goals. The U.S. has an opportunity to compile detailed information on the PGM catalyst supply chain and manufacturers, with particular focus on catalysts supporting decarbonization technologies and efficient chemical production.
- **Iridium Challenges.** Current technology for energy-efficient PEM water electrolysis depends on iridium supply, one of the rarest minerals in the world for which the United States relies 100% on imports. The country has an opportunity to emphasize the development of substitutes for Iridium-based catalysts in PEM water electrolyzers and to support the chemical and catalyst industries through their decarbonization transitions.
- **Recycling, Mining, and Refining Challenges.** Immature technologies for the recovery and recycling of PGM from water electrolyzers and fuel cells present technical, operational, and economic challenges for recovering PGM from end-of-life products. To meet these challenges, the country should expand research into PGM recovery and recycling, as well as domestic mining and refining efforts, subject to strict environmental and sustainability standards.

Policy Next Steps

Improve tracking and forecasting: Develop a standardized approach to characterize catalyst material content, particularly in the chemical sector, to enable more robust tracking and forecasting of PGM material flows across multiple sectors to inform future policy directions.

Catalyze innovation: Expand RD&D funding to alleviate vulnerabilities from critical material dependence by developing PGM collection and recycling technology for electrolyzer, fuel-cell, and chemical processing applications, developing substitutes that do not contain iridium, and reducing PGM loading in catalyst applications.

Incentivize capacity expansion: Develop incentives to support domestic manufacturing along the PGM catalyst supply chain. ■

Download the full document and the corresponding other documents that are part of the DOE response to the supply chain executive order at: www.energy.gov/policy/supplychains

U.S. DEPARTMENT OF ENERGY

February 24, 2022
DOE/OP-0010-1