Joint briefing note

Platinum Group Metals (PGMs) - essential critical raw minerals for the hydrogen economy

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Platinum group metals are essential for the clean energy transition: the hydrogen case

A clean transition cannot occur without an ample, sustainable, and uninterrupted supply of critical raw materials. Clean hydrogen, recognized as a pivotal sector due to its role in achieving climate goals, enhancing EU competitiveness and ensuring strategic autonomy, is no exception.

In this context, electrolysers and fuel cells represent two fundamental pieces of equipment required for the hydrogen economy. They have extensive applications in hydrogen production, transportation, mobility, and end-use. Most technologies that underpin the hydrogen economy today rely significantly on specific metals, either directly or in their components or consumables supply chains. Particularly platinum group metals (PGMs), notably Platinum (Pt), Iridium (Ir), but also Ruthenium (Ru), Palladium (Pd) and Rhodium (Rh) are important industrial resources used along the hydrogen supply chain and will see increasing use in other energy transition applications.

Policymakers should be aware of the distinctive attributes of PGMs and the differences even within this material group. PGM supply is defined by their geological scarcity, geographic concentration in South Africa (which accounts for 71% of the world's primary platinum supply and 93% of Iridium[1], a by-product of Platinum mining), a highly evolved recycling industry, high production costs, and limited liquidity in the market. Given their unique characteristics and their application in automotive, chemical, electrochemical, solar, digital, high-tech, and jewelry industries, policymakers should promote the establishment of a comprehensive framework to prevent supply-demand mismatches during the scale up of the hydrogen production capacities.

Electrolysers are electrochemical devices that, with the input of electricity, convert water into hydrogen and oxygen. Although electrolysis currently contributes to only a small portion of hydrogen production (approximately 4%), its market share is anticipated to experience significant growth. According to IEA, the realization of all projects in the pipeline could lead to an installed electrolyser capacity of 170-365 GW by 2030[2], compared to the current 30 GW. In a future scenario where PEM technologies might represent around 50%[3] of the global electrolysis capacity, the primary raw materials used for their deployment, e.g., Iridium, could face constraints in the global market.

Fuel cells are electrochemical devices that convert the chemical energy of reactants, such as hydrogen and air, into electricity and heat. The primary use of fuel cells is in transportation (~75% of their applications) with the remaining devoted to stationary power and heat generation. Currently, there are two main market-relevant technologies: PEM and SO fuel cells. According to estimates from Hydrogen Europe, the market for fuel cell Heavy-Duty Vehicles (HDVs) is projected to grow to around 50,000 units in Europe alone by 2030[4]. Globally, more than 550 fuel cell-powered trains are expected to be deployed by the end of the decade.[5] Fuel cells will also play a significant role in smaller mobility sectors, including passenger vehicles and light commercial vehicles, as well as in other transport segments such as aviation and maritime.

[1] European Commission (2023). Study on the critical raw materials for the EU 2023 – Final report
[2] IEA. (2023) Electrolysers. https://www.iea.org/energy-system/low-emission-fuels/electrolysers
[3] Joint Research Center (2023). Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study
[4] Hydrogen Europe (2023). https://hydrogeneurope.eu/wp-content/uploads/2022/12/2022.12_HE-and-ACEA-letter-on-AFIR-ambitions-for-HDV-segment_fin-1e29c0a1bcb4b376e94d79b021f8c85e.pdf
[5] European Raw Materials Alliance (2023). Materials for Energy Storage and Conversion A European Call for Action

Four key facts for a competitive, safe and sustainable supply of PGMs

1. **Fewer concerns expected with PGMs current availability in the global market**

Platinum (Pt) today benefits from well-established mining plus recycled supply, with substantial above-ground stocks to further support availability. Pt jewellery demand has been in decline for the past decade, and in future platinum use in catalytic converters will decline with the phasing out of the internal combustion engine. Therefore, this metal is ready for a large new market: fuel cells and electrolysers will replace demand for Pt, supporting investment in continued supply. And, since over 90% of Iridium (Ir) supply is produced as a by-product of Pt mining, this will secure continued supply for electrolysers. Policies and initiatives facilitating the development of fuel cell-based mobility are therefore key to ensuring the availability of Proton Exchange Membrane (PEM) and other hydrogen technologies (Alkaline, Solid Oxide, Anion Exchange) to fuel the hydrogen economy.

2. **Mineral efficiency will improve, while loadings will decrease**

To ensure availability, Pt and Ir must be used efficiently: the loadings of these metals per unit of capacity must decrease. Because PGMs are valuable metals, research continually focuses on making the best use of them. Pt efficiency in fuel cells has improved by more than 90% since the 1990s, and further substantial reductions in loadings are expected. This dedicated research focus is also driving down Ir loadings in electrolysers, with order-of-magnitude improvements expected. Together with recycling, this will ensure that Pt and Ir use in fuel cells and hydrogen is on a sustainable footing. Policies and initiatives supporting the R&D and industrial deployment of higher-efficiency advanced materials for the hydrogen economy are therefore crucial. Already today, low loading solutions are available and their deployment in industrial applications should be incentivised. To make these incentives efficient, it will be important to focus on single metals rather than on the whole group. Iridium mining represents a small ratio of the PGMs mined per year, thus metal-individual regulation is necessary.

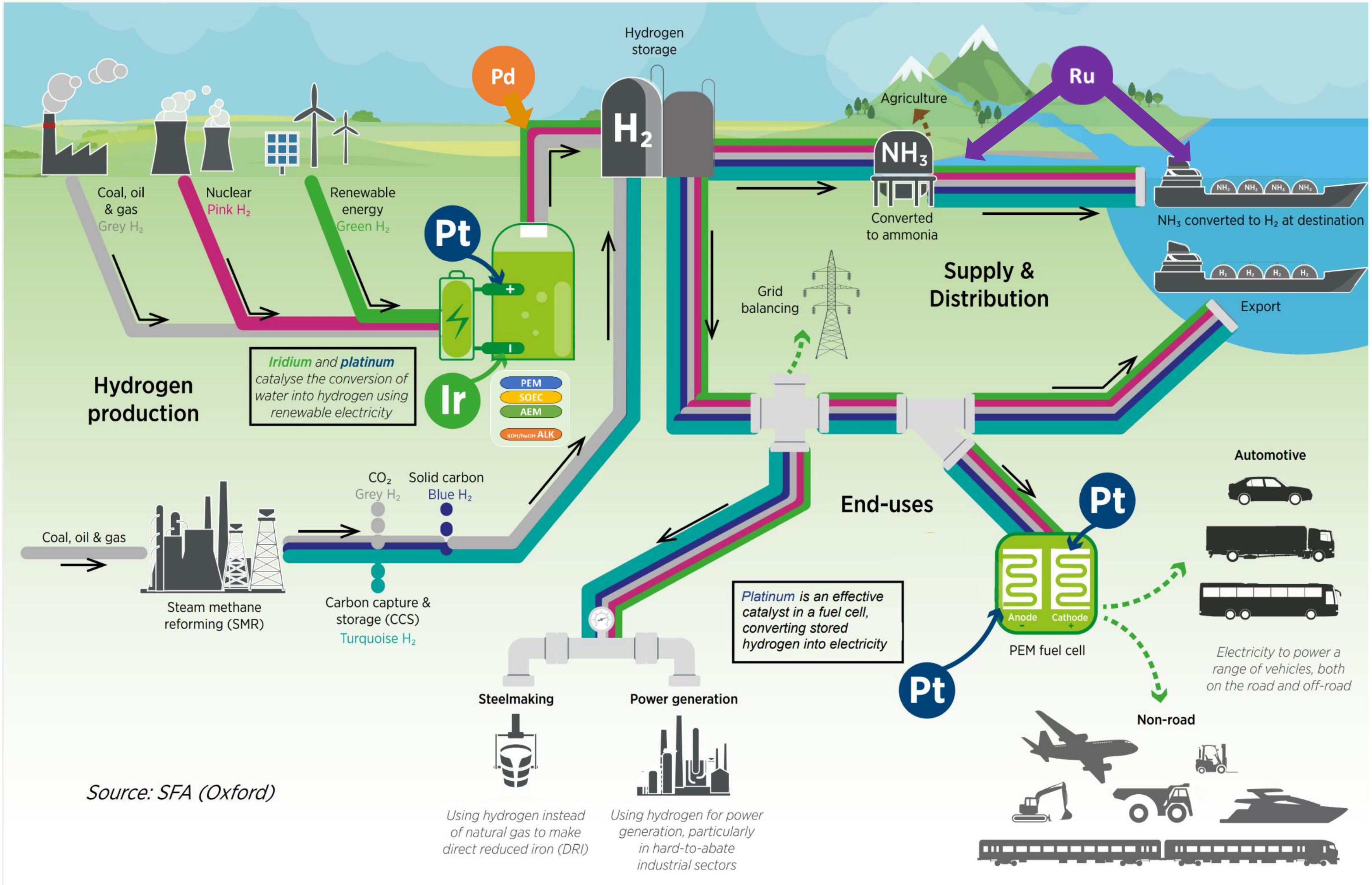
3. **End-of life strategies are key from the very beginning**

Circularity is already established in the PGMs industry: Pt and Ir are routinely recycled today, and recycled PGMs and virgin PGMs are completely fungible: this is crucial to ensure the sustainable use of PGMs. The existing global PGMs recycling infrastructure must be exploited to support the hydrogen economy as fuel cells and electrolysers scale up. Technical recyclability of PGMs is very high, so any significant metal losses usually occur due to inefficient collection. It is important to establish effective strategies for end-of-life management of equipment containing PGMs, to minimise collection losses and ensure every gram of Pt and Ir can be reused. There is also scope for improved collection of Pt and Ir from existing applications to boost the recycled supply of these metals. Policies improving the collection of end-of-life PGM-containing equipment are essential to help to maximise recycling.

4. **Stockpiling of PGMs is not the solution but rather a threat**

PGMs are supplied in small quantities relative to base metals – but, because they are used very efficiently and routinely recycled, they deliver significant industrial impact. The global PGM industry has established methods for managing availability of PGMs for their various industrial applications, and these proven strategies will be put to work for fuel cells and electrolysers. Stockpiling of PGMs and protectionist strategies may appear to be a solution but extreme caution of any such strategy is strongly advised. This is particularly true in the smaller and less liquid market for Ir: any attempt to procure large Ir volumes could lead to irrational price moves that would impact not only established PEM (and others) electrolysis and fuel cell market players that already rely on a steady supply of this material, which is often organized around a recycling loop, but also aspiring new entrants.

Annex I – the essential presence of platinum group metals (PGMs) in the hydrogen value chain: an overview



Source: SFA (Oxford)

Annex II – the essential presence of platinum group metals (PGMs) in the hydrogen value chain: the applications

Platinum Group Metals (PGMs) are important for the entire hydrogen value chain:

Water splitting

Pt Platinum | Ir Iridium | Ru Ruthenium

- Electrocatalysts for the **Water Electrolysis:** H2 and O2 generation
- O2-removal catalysts for the **purification of hydrogen**
- H2-removal Catalysts for the **purification of oxygen**

Hydrogen transport and storage

Pt Platinum | Pd Palladium | Ru Ruthenium

- **Green ammonia** – Synthesis, oxidation, cracking & emission abatement from NH3 fuel
- **Green methanol** – CCU of Co2
- **Synthetic Natural Gas** – Methanation of CO2
- **LOHC** – Hydrogenation and Dehydrogenation

Hydrogen utilisation

Pt Platinum | Pd Palladium | Ir Iridium | Rh Rhodium | Ru Ruthenium

- **Electrocatalysis** for PEM-FC
- Solutions for **bipolar plate coating**
- **Gas purification catalysts** (WGS, PROX…)
- **Reforming** catalysts & coatings for SOFCs
- Catalysts for **Gas sensors**
- Catalysts for **off-gas burners**
- And more…

Credits: Heraeus Group

Hydrogen Europe

Luca MARSILI
Officer, Industrial policy and trade
l.marsili@hydrogeneurope.eu

IPA
INTERNATIONAL PLATINUM GROUP METALS ASSOCIATION

Gabriele RANDLSHOFER
Managing Director
gabriele.randlshofer@ipa-news.com

Eurometaux

Chris HERON
Director for Communication & Public Affairs
heron@eurometaux.eu

EPMF
European Precious Metals Federation

France CAPON
Secretary General
france.capon@epmf.be