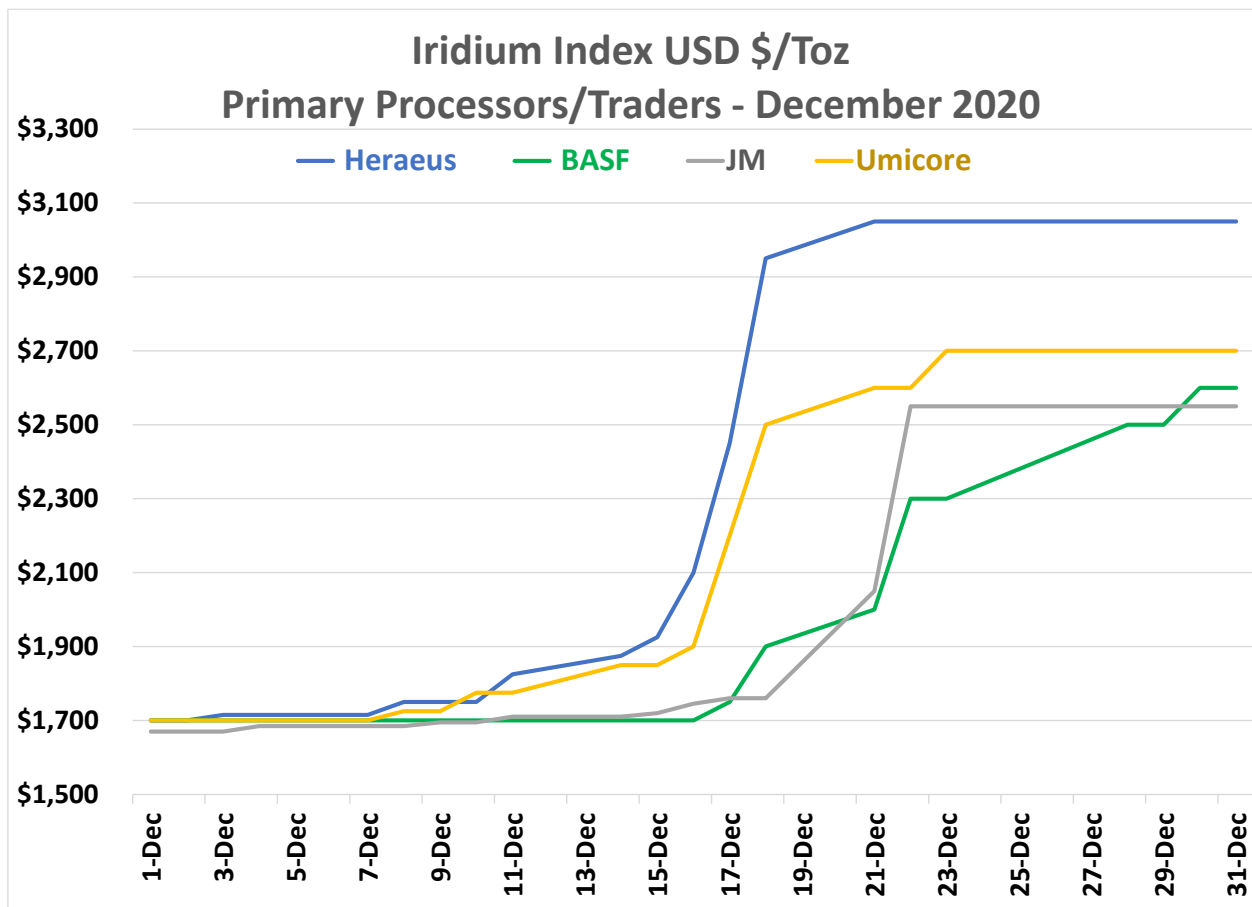


Iridium – The PGM Minor Metal Market Is Taking Flight Again

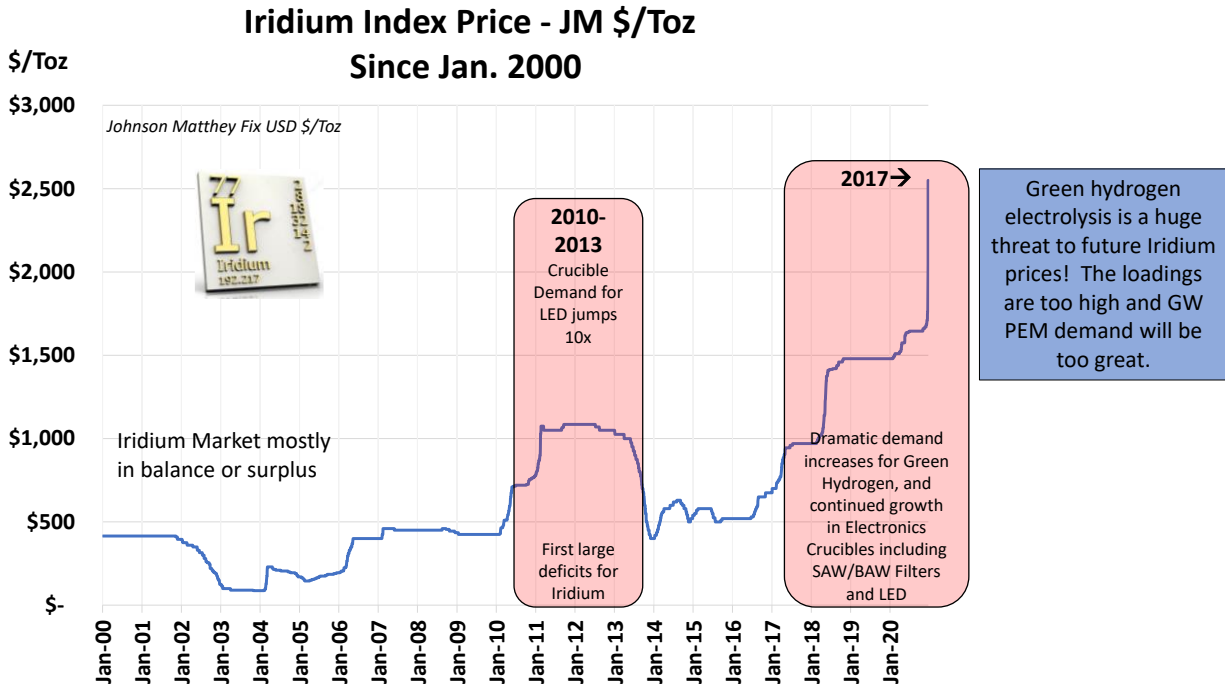
By: Matt Watson, Founder, Precious Metals Commodity Management

January 2, 2020

December of this year has witnessed the Iridium market take flight, again. Already this month the Iridium Index Price with the four major processors are showing anywhere from a +53% to +79% price climb.



A longer-term view of the Iridium market price reveals a history of new demand applications taking off, and pulling this scarce metal higher.



Of course, this prompts the question what is impacting Iridium so dramatically this month? I think there are several causes.

1. Reduced Supply.

- COVID-19 reduced mine output in the world's deepest South African PGM mines, where maintaining social distancing is an obvious concern.
- The Anglo-American ACP (Anglo Concentrator Plant) Phase A and Phase B units both failed earlier this year. Anglo is a primary supplier of this scarce PGM Minor Metal given its mining in the Western and Eastern Limbs of the South African Bushveld Complex. These are the regions in South African that tap into the all important UG2 and Merensky Reefs, which contain the highest composition of Iridium. Now Anglo's ACP failure is now well documented, and not mining disruptions have occurred, but processing of mined ore certainly has been. It will take Anglo time to recovery those previously missed final refining opportunities.

2. Increasing Industrial Demand. Iridium demand expansion continues, in spite of this year's supply disruption. This demand includes:

- Electronics Demand: LED uses Iridium crucibles, OLED uses Iridium Chloride compounds for OLED active matrix displays, SAW/BAW acoustic filters that use Iridium crucibles.
 - LED uses Iridium crucibles to process the sapphire LED's
 - Demand for OLED mobile phone and large TV displays is set for a record demand year in 2021. Apple has converted its entire portfolio over the

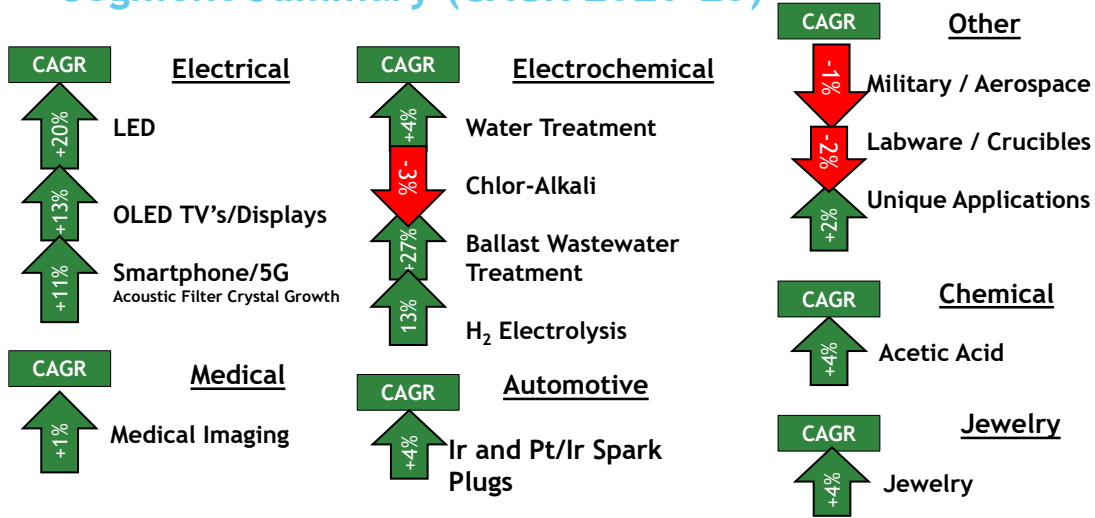
OLED, and now with large TV demand growth, OLED use of Iridium Chloride compounds is set for a banner year in 2021.

○ 3G, 4G and 5G devices use increasing frequency of SAW and BAW acoustic filters that use Iridium crucibles in the growth of the piezo electric materials those filters rely on.

- Electromechanical Demand: The Water Treatment, Chlor Alkali and Ballast Wastewater Treatment Systems industries all relies on Iridium and Ruthenium as a catalyst in those processes. Now emerging in significant scale is the use of Iridium and Platinum as a catalyst in Green Hydrogen Proton Exchange Membrane (PEM) Electrolyzer for splitting of water and generation of hydrogen with zero CO₂ emissions during creation of the hydrogen, and also during the consumption of that hydrogen.
- Automotive Demand: Iridium, and Platinum/Iridium tipped spark plugs are more expensive than conventional Copper, or Silver Core spark plugs. Their use is expanding though due to increased regulations on emissions. Using a \$14-\$16 Iridium or Platinum/Iridium tipped spark plug increases the probability of successful firing of the internal combustion engines pistons, reducing emissions, and also reducing the risk of downstream catalytic converter poisoning of the Platinum, Palladium, and Rhodium three-way auto catalyst housed within vehicles catalytic converter. These high-end spark plugs also enable longer intervals between vehicle tune ups. Most modern vehicles require service after 100,000 miles, and Iridium and Platinum/Iridium tipped spark plugs are extremely durable over time, requiring little service attention.
- Other Iridium Demands: The production of Acetic Acid, Medical Imaging Tools, Military and Aerospace applications, and even jewelry use Iridium

Below is a summary of the market 2020 through 2025 projected CAGR (Compound Annual Growth Rate) expectations for each of these respective market segments. As you can see, most of these segments are expected to grow substantially over the next 5 years.

Iridium Market Demand By Industrial Segment Summary (CAGR 2020-25)

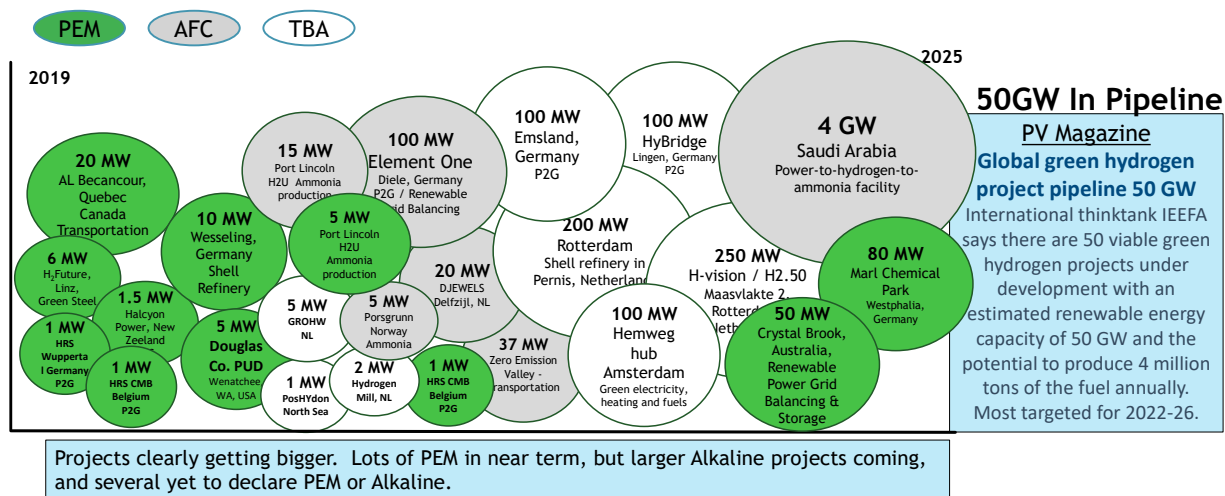


Emerging Demand Risks: The most notable emerging demand risk comes from Green Hydrogen Production using Proton Exchange Membranes (PEM's) for splitting water, and generating hydrogen with zero emissions. There are multiple electrolyser technologies that enable this process. Some use precious metals, some do not. PEM's use both Iridium and Platinum as a catalyst in these processes.

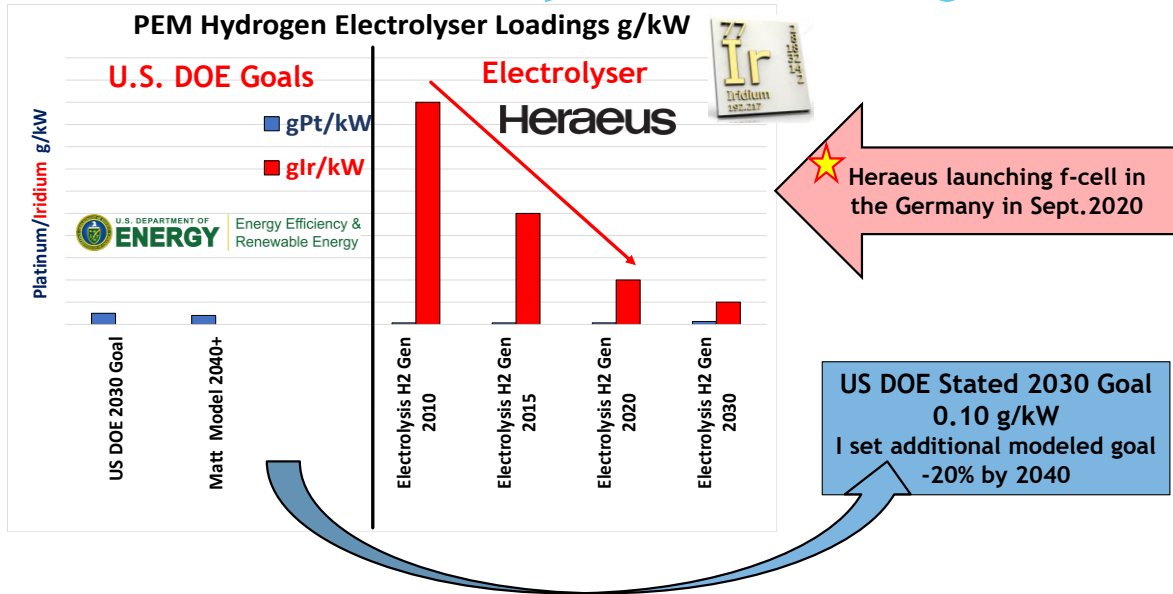
The PGM loadings in these PEM Electrolyzer are coming down over time, but still are fairly high. Frankly, the global scale of planned green hydrogen deployments are becoming larger in size, and more frequent and Australia and the EU lead the charge on the Green Hydrogen economic development.

Sampling of Electrolyser Deployments by 2025

10.76GW: Which ones will be PEM Vs. Alkaline?? 38/62



PEM Fuel Cell & Electrolyser PGM Loadings



Iridium Market - What to watch for in 2021:

- 5G device demand growth. Right now, Apple and Samsung are both forecast record numbers of 5G smartphone shipments.
- OLED further market growth. Again, 2021 is forecast to be a record year for global OLED demand.
- New membrane based Chlor-Alkali factory construction. Each new plant brings with it a new set of demands for both Iridium and Ruthenium.
- Keep an eye on further announced Green Hydrogen generating electrolyser deployments and how many are announced as Alkaline based technology (no PGM's or Alkaline + with limited Platinum) versus PEM based (using Iridium and Platinum).
- Anglo Platinum's full recovery of ACP Phase A and B units, and recovery of processing accumulated mined WIP materials.

I forecast 2021 for Iridium to average just over \$2,000/Toz, in route to \$3,000/Toz by 2027 with further hydrogen economy expansion. Given the sudden explosion in pricing, augmented by speculative buying, I now think we hit and hold \$3,000 by 2022.

44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver
76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold

Matt Watson, Founder and President
Precious Metals Commodity Management LLC

1694 Cairo Street, Livermore, CA 94550

Email MattWatson@PreciousMetalsCommodityManagement.com