

**ALFRED H KNIGHT**

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# MINING THE CIRCULAR ECONOMY

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# COP26 OBJECTIVES

Secure global net zero by mid-century and keep 1.5 degrees within reach

- Countries are being asked to come forward with ambitious 2030 emissions reductions targets that align with reaching net zero by the middle of the century
- To deliver on these stretching targets, countries will need to:
  - accelerate the phase-out of coal
  - curtail deforestation
  - speed up the switch to electric vehicles
  - encourage investment in renewables

# AN INCREASINGLY COMPLICATED AND REGULATED WORLD

- Phase out of fossil fuels as our primary energy source
- Rapid move toward alternative and distributed energy sources
- Impact on existing powers grids and energy storage systems
- ESG Reporting
- Investors appetite and ability to invest in “extractive industries” and new sources of primary production
- The real risk of investing in new or expanded mining or processing plant that may become a “stranded, low value asset”
- Large sectors of the population of both developed and developing countries demanding a more sustainable “circular economy”
- Governments and legislative bodies reacting to all these changes



# AN INCREASINGLY COMPLICATED AND REGULATED WORLD

- **Main law: WEEE Directive**
  - Entry into force: 13 August 2012
- **Connected topics:**
  - Chemicals
  - Circular economy
  - Restriction of hazardous substances in EEE (RoHS)
  - Waste and recycling
  - Battery Directive
- **Connected strategies: Circular economy action plan**
- **Connected Commission priorities: European Green Deal**



# A REBALANCING OF PRIMARY VERSUS SECONDARY SUPPLY?

And all this is happening now against a backdrop of high political risk, the formation of “regional trade blocks” and significant supply chain disruption

What does this all mean for the:

1. Sourcing and use of **Precious Metals?**
2. Sourcing and use of **Battery Metals?**

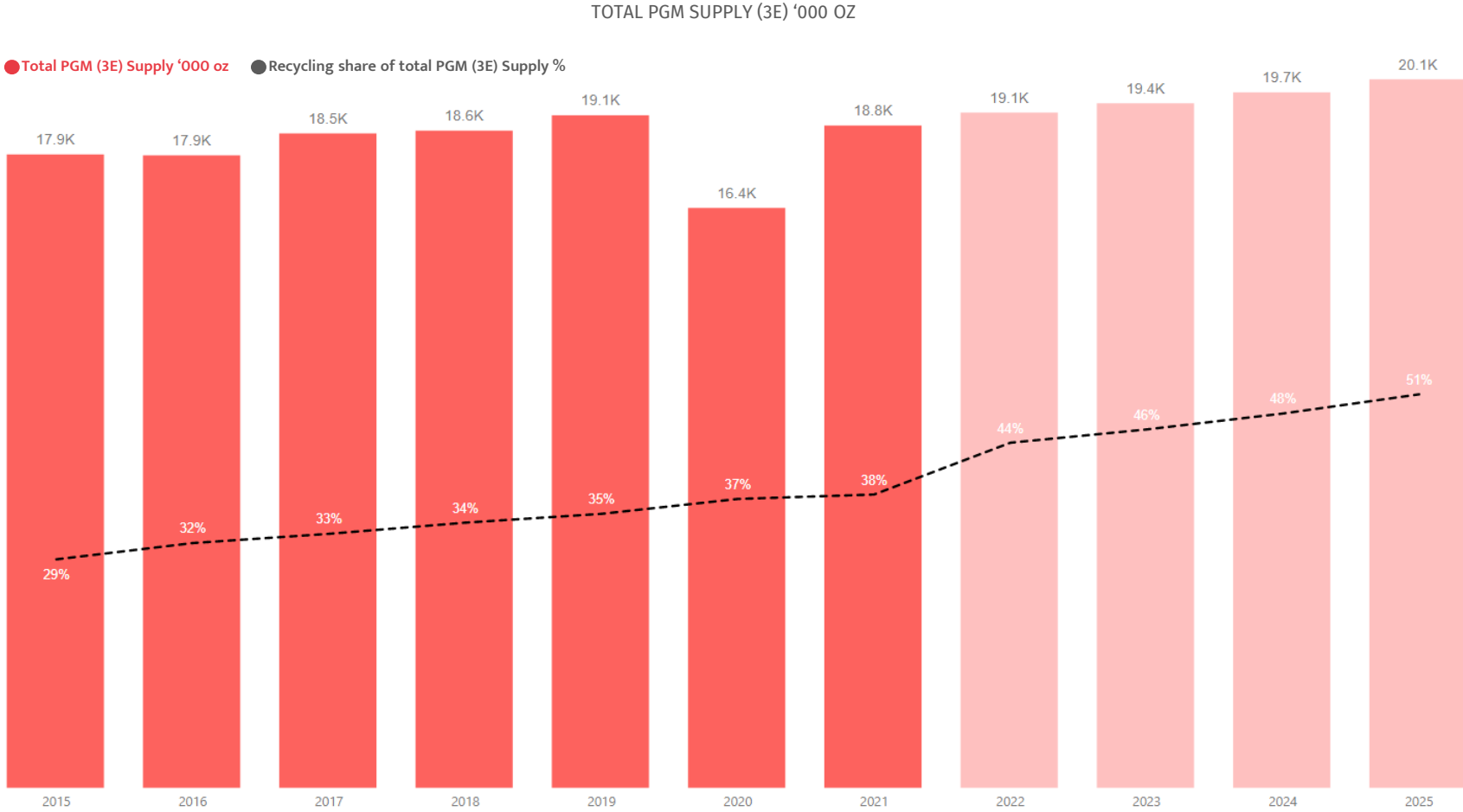
# PGM PRIMARY & SECONDARY SUPPLY

Recycling PGM (3E) is expected to continue increasing substituting primary feed streams.

This will be enhanced by an expected decline in PGM mining production.

This will create the need for recycling of more streams, which begs the question;

**Can Smelting and Refining Capacity keep up? And if it can, does it make sense economically to do so?**



Source: Heraeus, Johnson Matthey reports

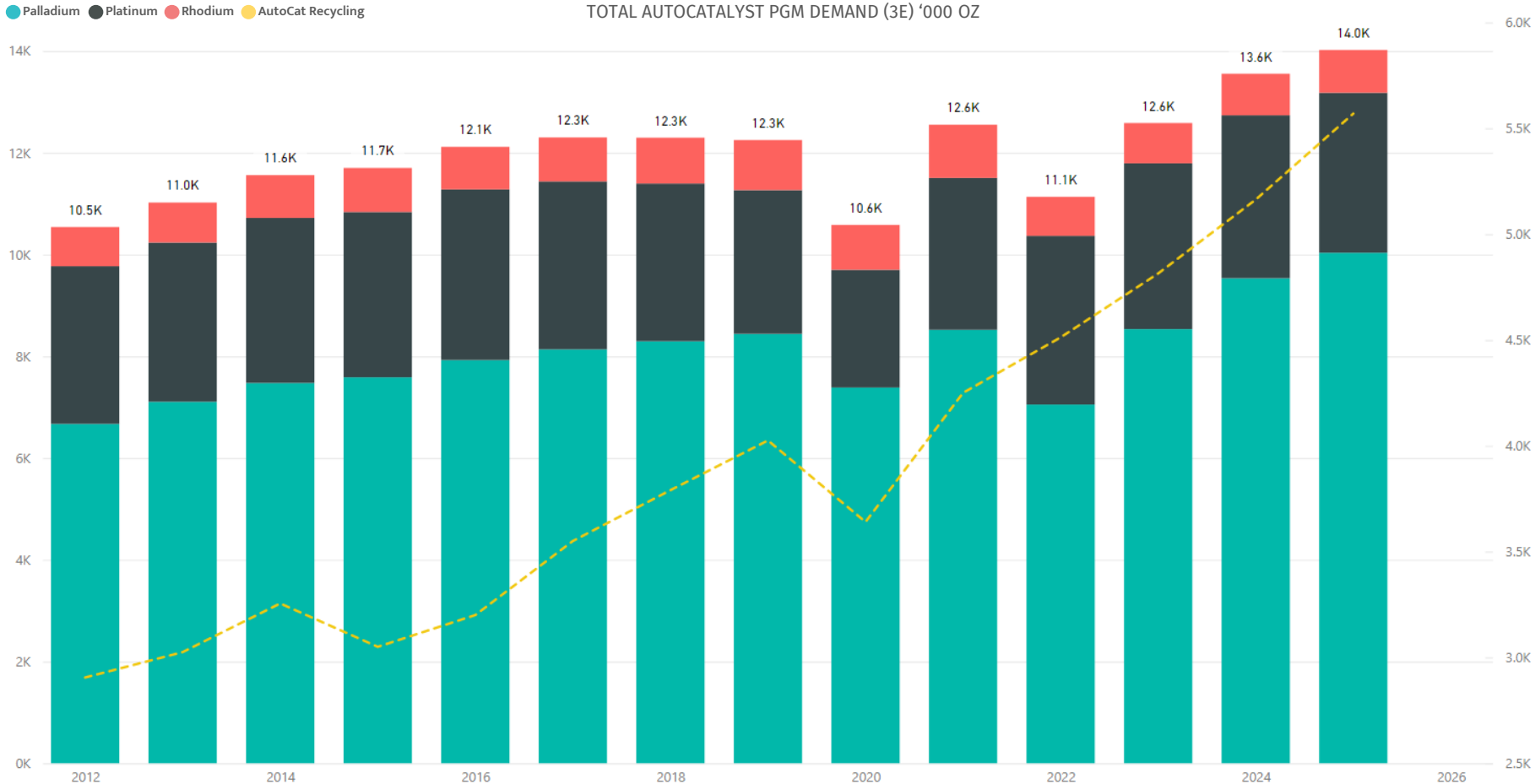
# PGMS AUTOCATALYST SUPPLY & DEMAND

Palladium is expected to continue dominating autocatalyst with varying levels of substitution as emission standards become more stringent.

The recycling is expected to increase especially with higher loadings.

As mentioned earlier capacity constraints can create potential bottlenecks and is important to see if the producers will choose to add more capacity or choose to diversify in other critical minerals and circular economy markets.

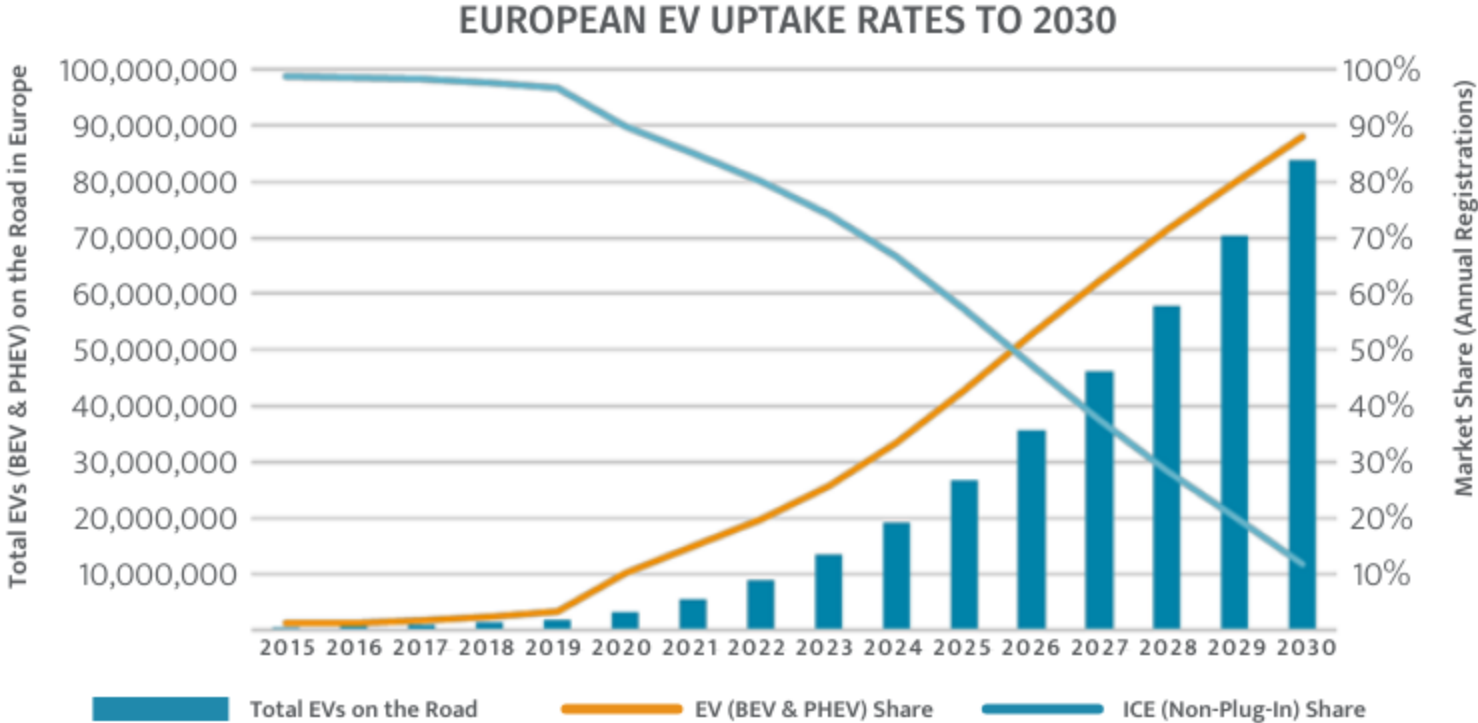
Source: Heraeus, Johnson Matthey reports



# PGMS AUTOCATALYST LONG TERM UNCERTAINTY?

ICE phasing out creates uncertainty in the long term regarding the availability of spent autocatalyst for recycling.

This in turns increases the risk of investment in new refining capacities.

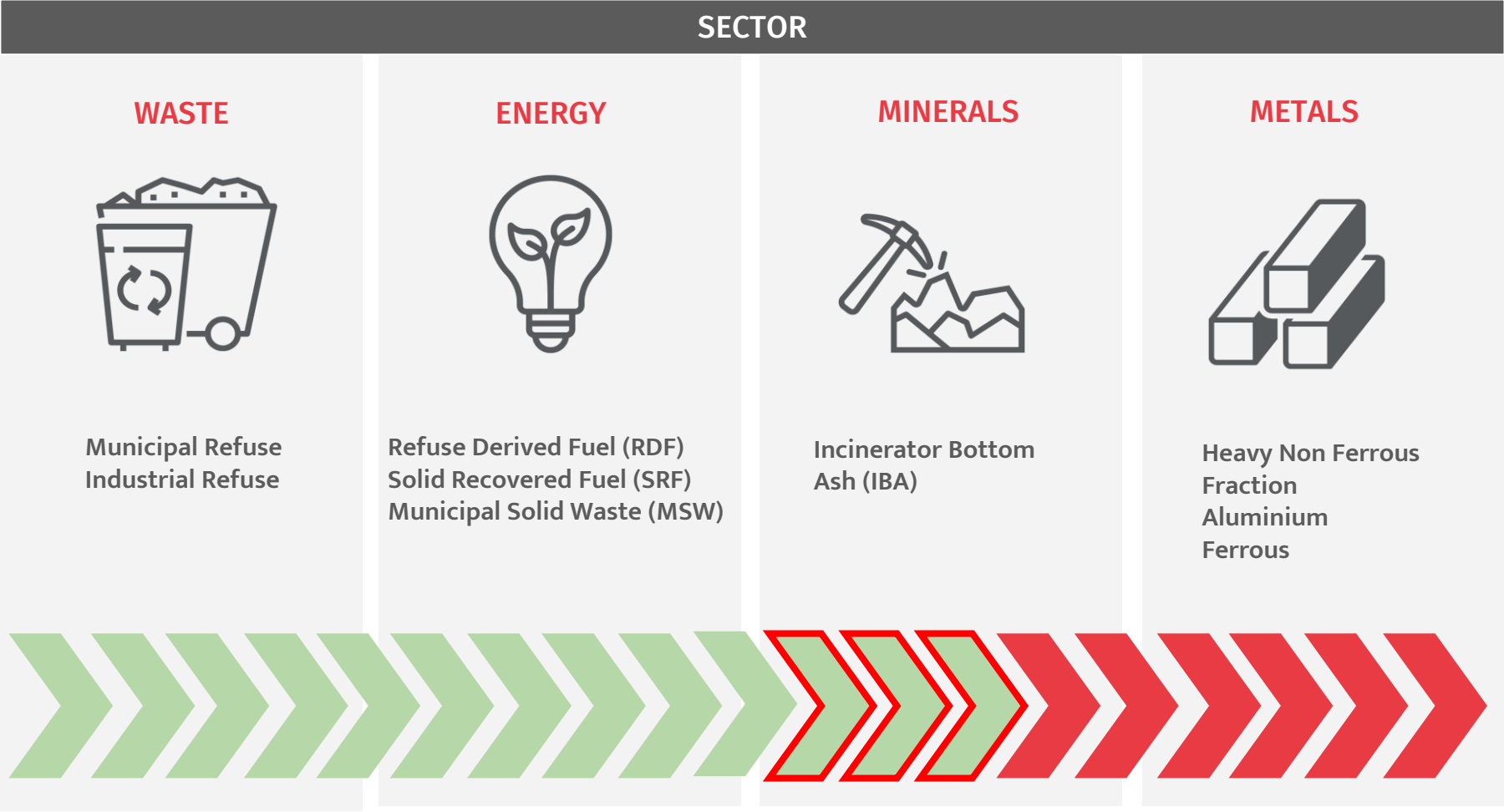


Source: Delta-EE & ACEA | Europe: EU + EFTA + UK | EVs: BEVs, PHEVs & eLCVs | Actual data: 2015-2020. Forecast date from 2021

Source: ICBR 2021



# URBAN MINING IS ALREADY REALITY



# GREEN ACTION BY CORPORATE ENTITIES

## Overriding factor & direction of corporate entities

- Net Zero Waste Obligation (No waste to landfill)
- Carbon Neutral
- Corporate Social Responsibility

**Sports & Events Stadia / Venues**

**Supermarkets / Fast Food Outlets (R&D)**

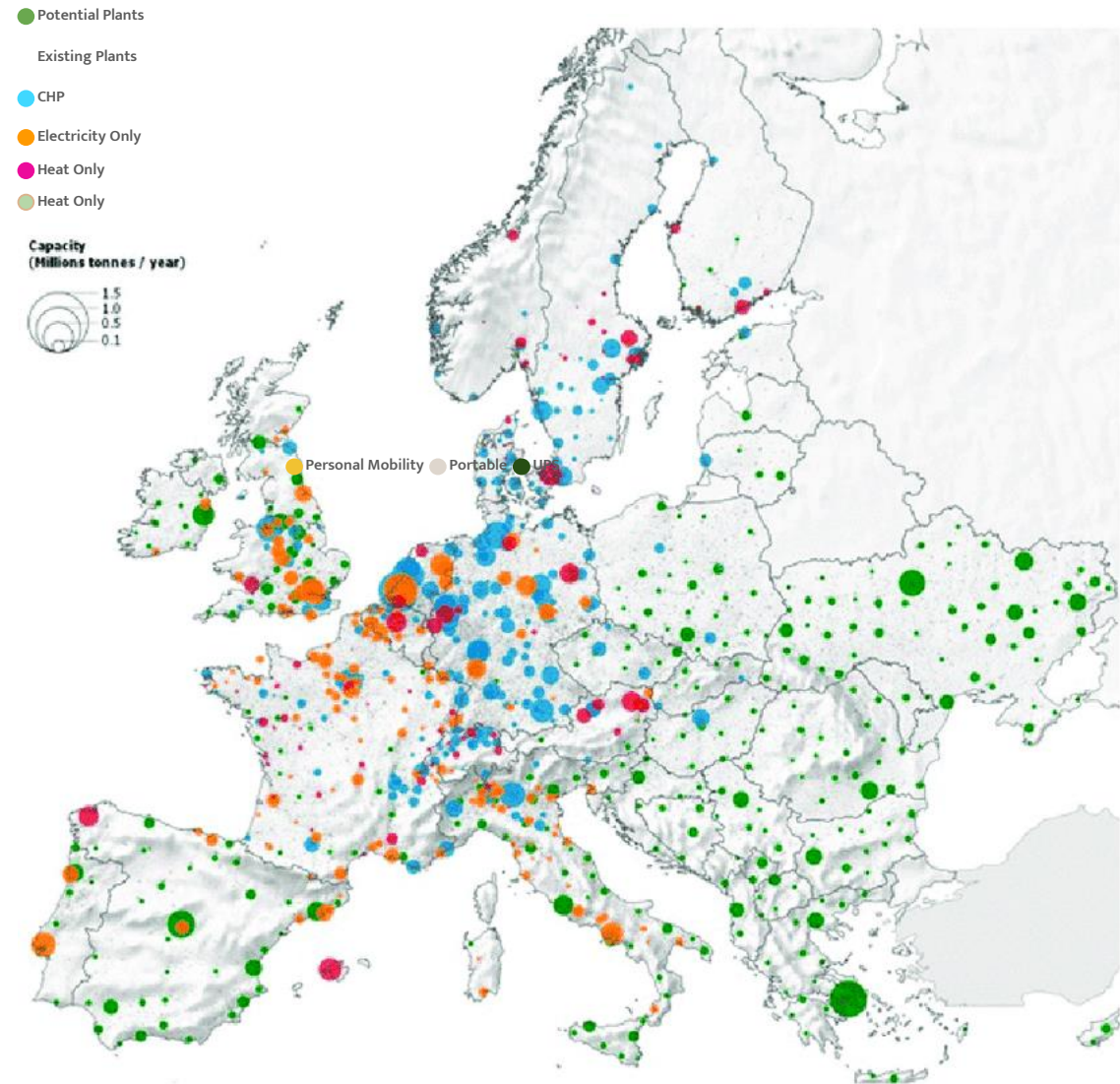
**Hotel Chains / Transportation Hubs (Air / Rail / Bus)**



# BOTTOM ASH

- Yearly production (EU28, 2018): circa 19 million tonnes of bottom ash (approx. 20% of the weight of the waste treated in the plants)
- Composition of bottom ash:
  - Mineral fraction: 80-85%
  - Metals: 10-12% (steel and non-ferrous metals)
  - Non-ferrous metals: 2-5% (of which 2/3 aluminium)
- Greenhouse Gas (GHG) savings due to metal recycling: 2,000 kg of CO2 eq. per tonne recycled metal and in total ca. 3.8 million tonnes of CO2 equivalent

CEWEP



Halkos, George & Petrou, Kleoniki Natalia. (2019). Analysing the Energy Efficiency of EU Member States: The Potential of Energy Recovery from Waste in the Circular Economy. *Energies*. 12. 3718. 10.3390/en12193718.

# ESG DEMAND **AUDIT SCHEMES**

## Material Provenance

- Mineralogical profiling

## Supply Chain Traceability

- Bag & Tag
- Scan at origin, during handling and destination
- Digital delivery platforms

## Re-use

- 2nd life audits e.g. ITAD

## Recycle

- Integrated collection & sampling hubs
- Mass balance checks



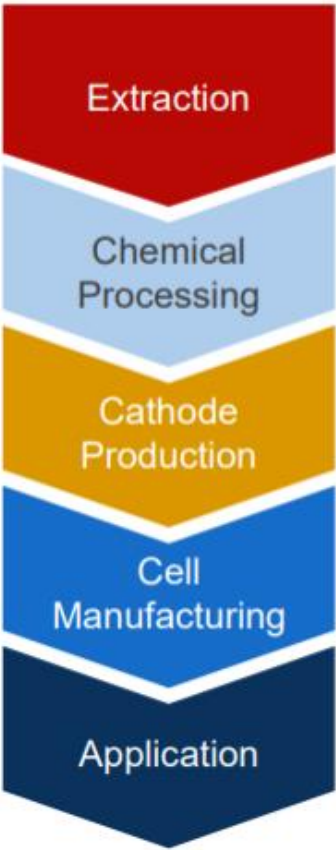


# BATTERY AND BATTERY RECYCLING PRIMARY SUPPLY

Demand for Co, Ni, Li, Mn as well as other metals is expected to grow exponentially over the next decades driven by the electrification of transport and the production of Lithium Ion Batteries.

The market is expected to enter considerable deficit over the next decade across all these commodities even when accounting for current recycling capacity.

The supply chains for these commodities as it stands are considered high risk, either from an operational, political or environmental perspective.



Source: Benchmark Minerals Intelligence

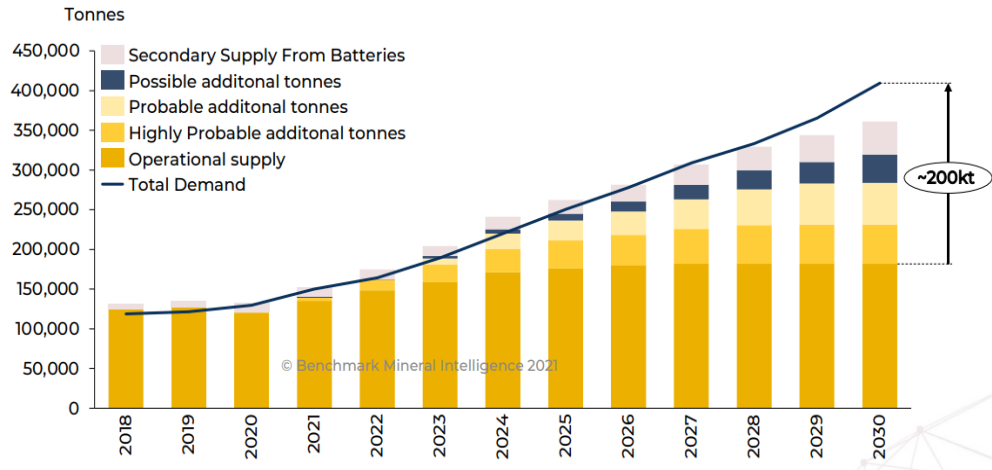


# BATTERY AND BATTERY RECYCLING: A PRIMARY SUPPLY DEFICIT IS EXPECTED

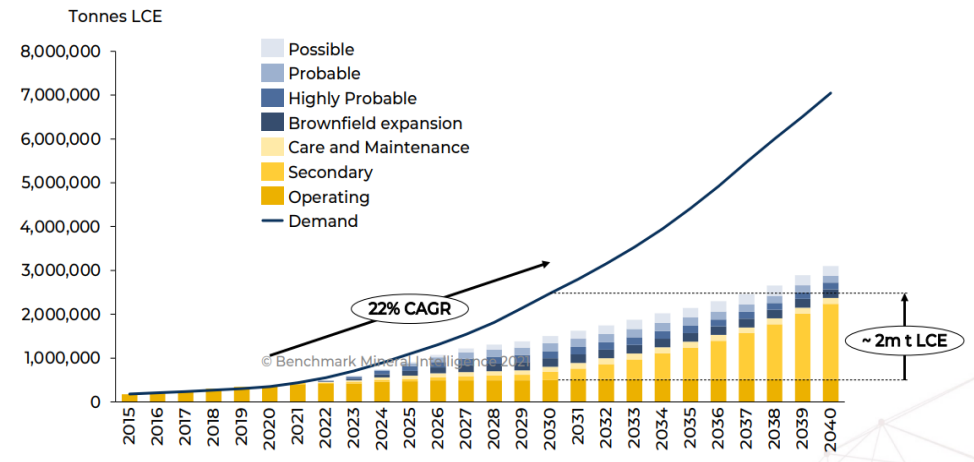
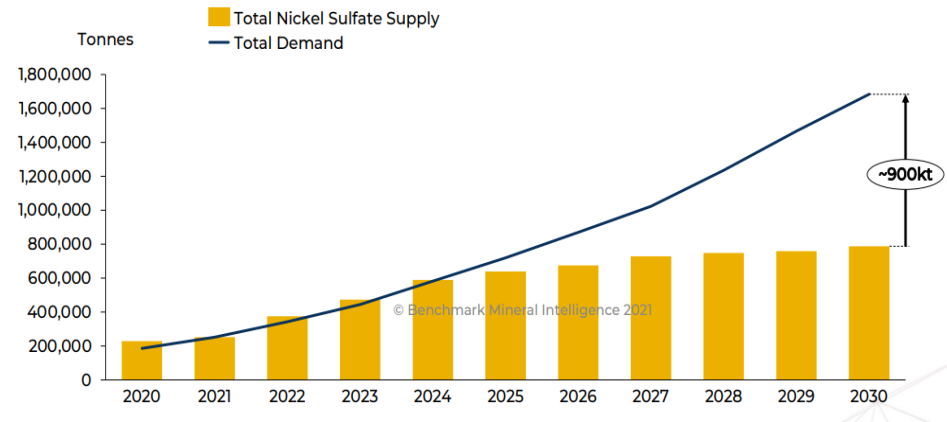
Scaling the supply chain in quality and quantity is the main challenge. There is no geological shortage of any key input but current capacity is limiting to growth and will lead to supply deficit across the board.

Recycling needs to step up and fill or reduce that gap as soon as possible

Source: Benchmark Minerals Intelligence



NICKEL AND THE GREAT RAW MATERIAL DISCONNECT



# BATTERY AND BATTERY RECYCLING

Energy transition and specifically electrification of transport so far has driven and will continue to drive LIBs production. The shift to a more circular economy creates the framework needed for collecting and recycling waste LIBs and cathode Scrap back into the supply chain.

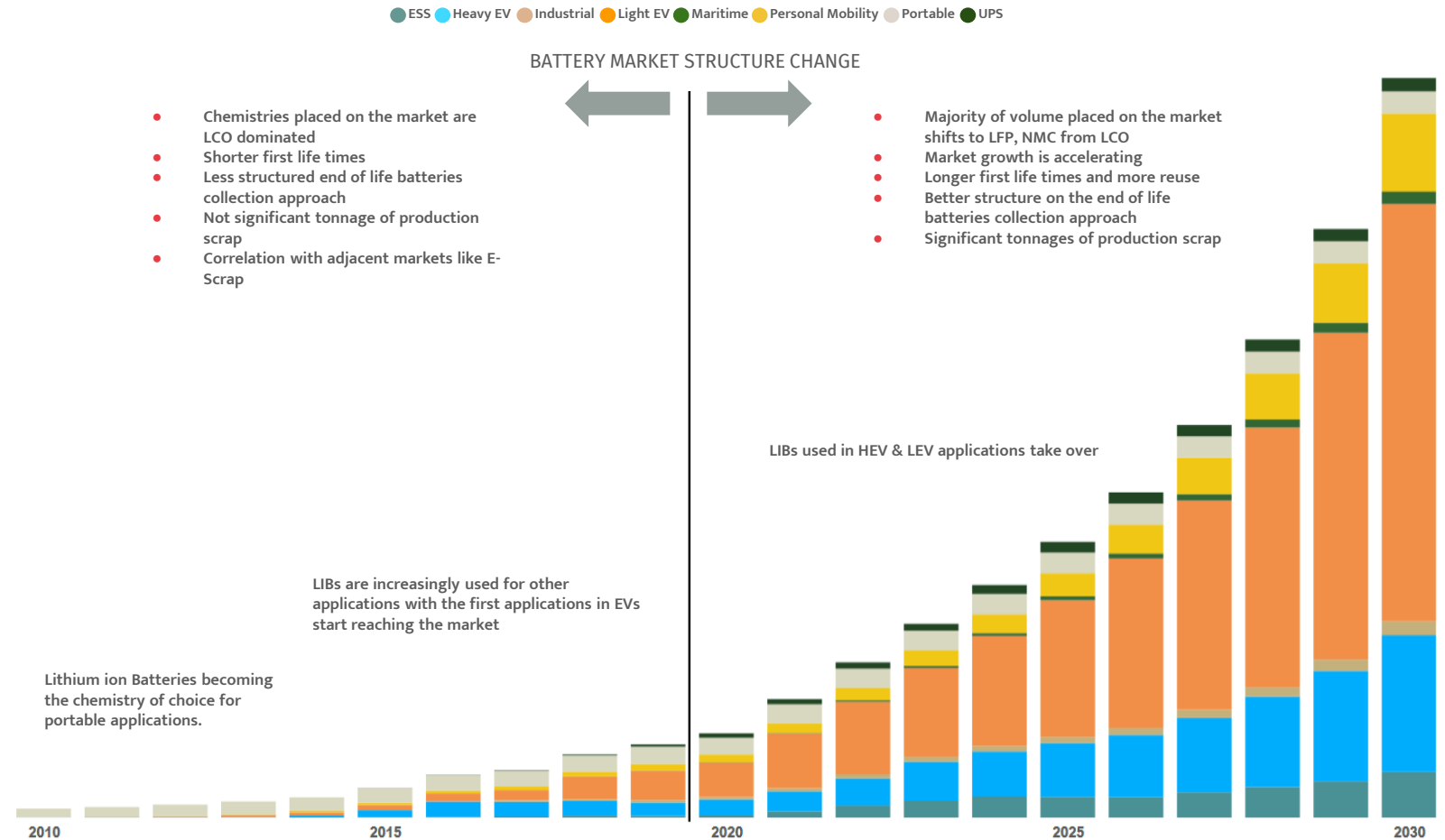
Black Mass is already a tradable product internationally, but the market is still in its infancy. There are no clear understanding of the different product qualities and variations which make the physical trade of black mass risky.

To minimise risk for the parties involved in the commercial transactions and facilitate global trade, AHK is on a journey to understand the physicochemical characteristics of black mass products in depth.

That includes quality and assaying, product behaviour during transport, sampling, moisture determination, phase characterization and others.

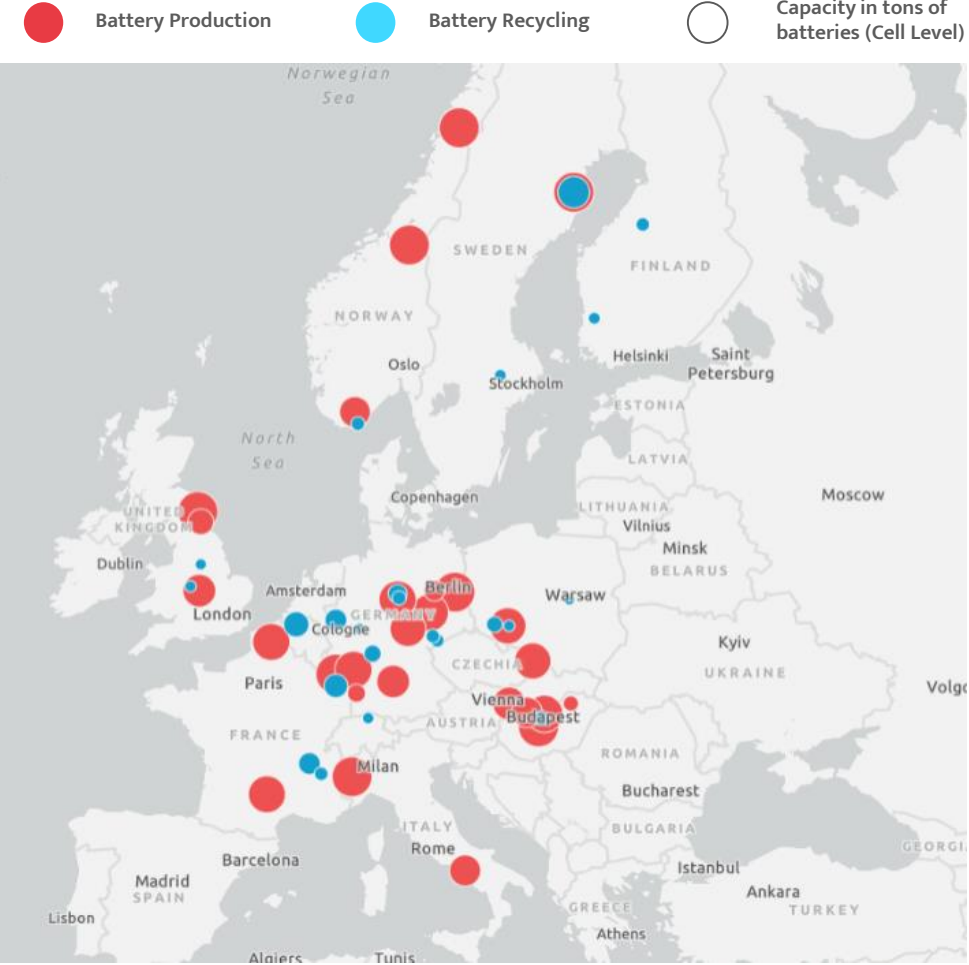
Source: Circular Energy Storage Online

LIBS PLACED AND EXPECTED TO BE PLACED ON THE MARKET (MTONS)



# BATTERY VALUE IN EUROPE CLOSING THE LOOP

Battery Production	Battery Recycling	Capacity Hub
Amte Power, British Volt, Envision AESC	JM, Sena Recycling, Fenix Recycling, RS Bruce	UK
Tesla, ACC, SVOLT, Verkor, LG, Innovate, SK Innovation, HE3DA, CATL, Microvast, FAAM, Farasis	Redux, Umicore, Euro Dieuze (Veolia), Accurec, SNAM, Duesenfeld, Royal Bee, Promesa, Sungeel, Volkswagen, Erlos, TES-AMM, Nickelhütte, Neometals, ERAMET, Kyburtz Group, Ecopro, Elemental Holdings, BASF	Central Europe (Plus Italy)
Northvolt, Panasonic, Freyur, Morrow	Revolt (Northvolt), Fortum, Accuser, Finnish Mineral Group, Glencore,	Northern Europe



# BATTERIES **BLACK MASS**

**Black Mass is an intermediate product in the processing of waste batteries back to refined metal.**

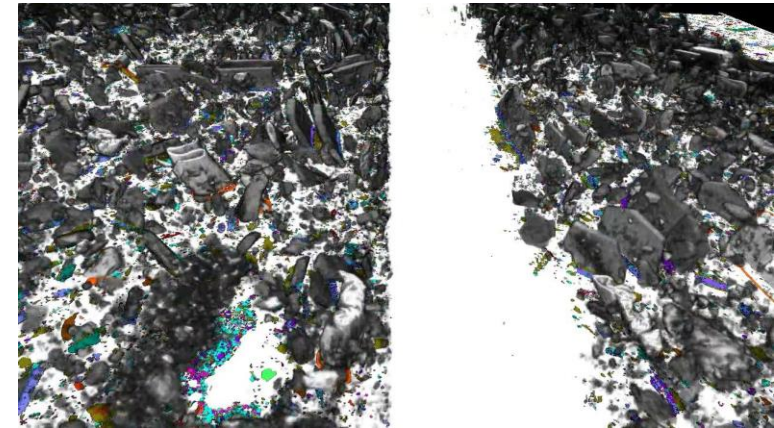
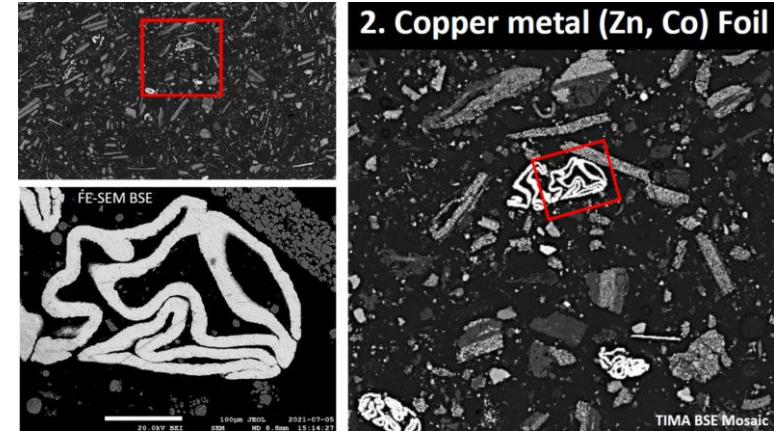
- After the discharging and shredding of waste Lithium ion batteries different fractions are obtained: Copper, Aluminum, plastic and Black Mass which contains the Cobalt, Nickel, Manganese and Lithium.
- Black Mass represents about 30% by weight of the original batteries and is a tradable feedstock for hydrometallurgical & pyrometallurgical refiners.
- The recovered metal can be returned for use in the production of new batteries for the likes of electric vehicles, phones and laptops.
- The recycling of batteries will be a key part in ensuring critical metals stocks are maintained in Europe.



# BLACK MASS CHARACTERISATION

Investigating the components, phases and textures of prepared and unprepared samples of Black Mass.

- Determine the mineralogy or phases and textures
- Identify metals of potential economic value (payables)
- Identify metals or other components that may be detrimental (penalty)
- Develop best practice for sampling, preparation & analysis.
- Explore the implications for metallurgical processing.
- Evaluate the H&S hazards and associated levels of risk.

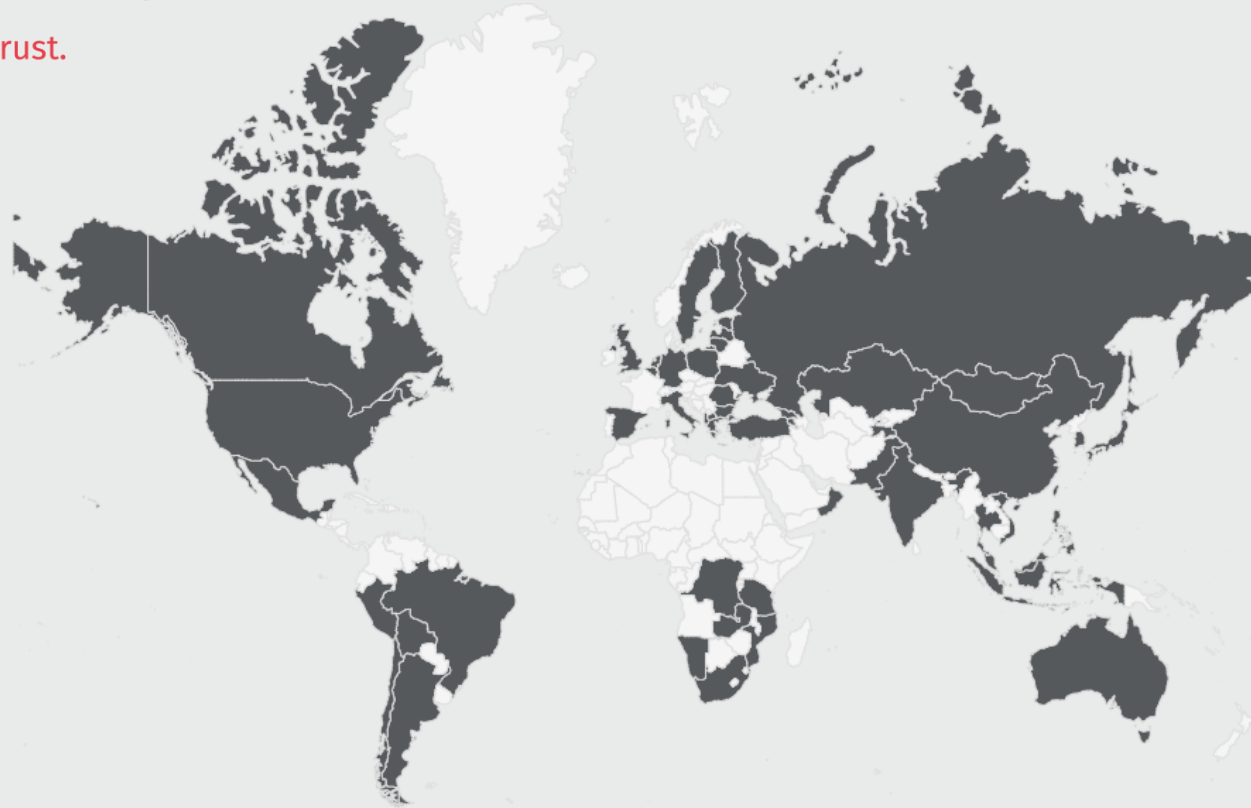




# THANK YOU QUESTIONS?

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 INSPECTION

 ANALYSIS

 TECHNICAL CONSULTANCY

 MINING INDUSTRY SUPPORT

# PGM MARKET BALANCE

2013 -2018, Market in deficit mainly driven by Palladium supply shortages.

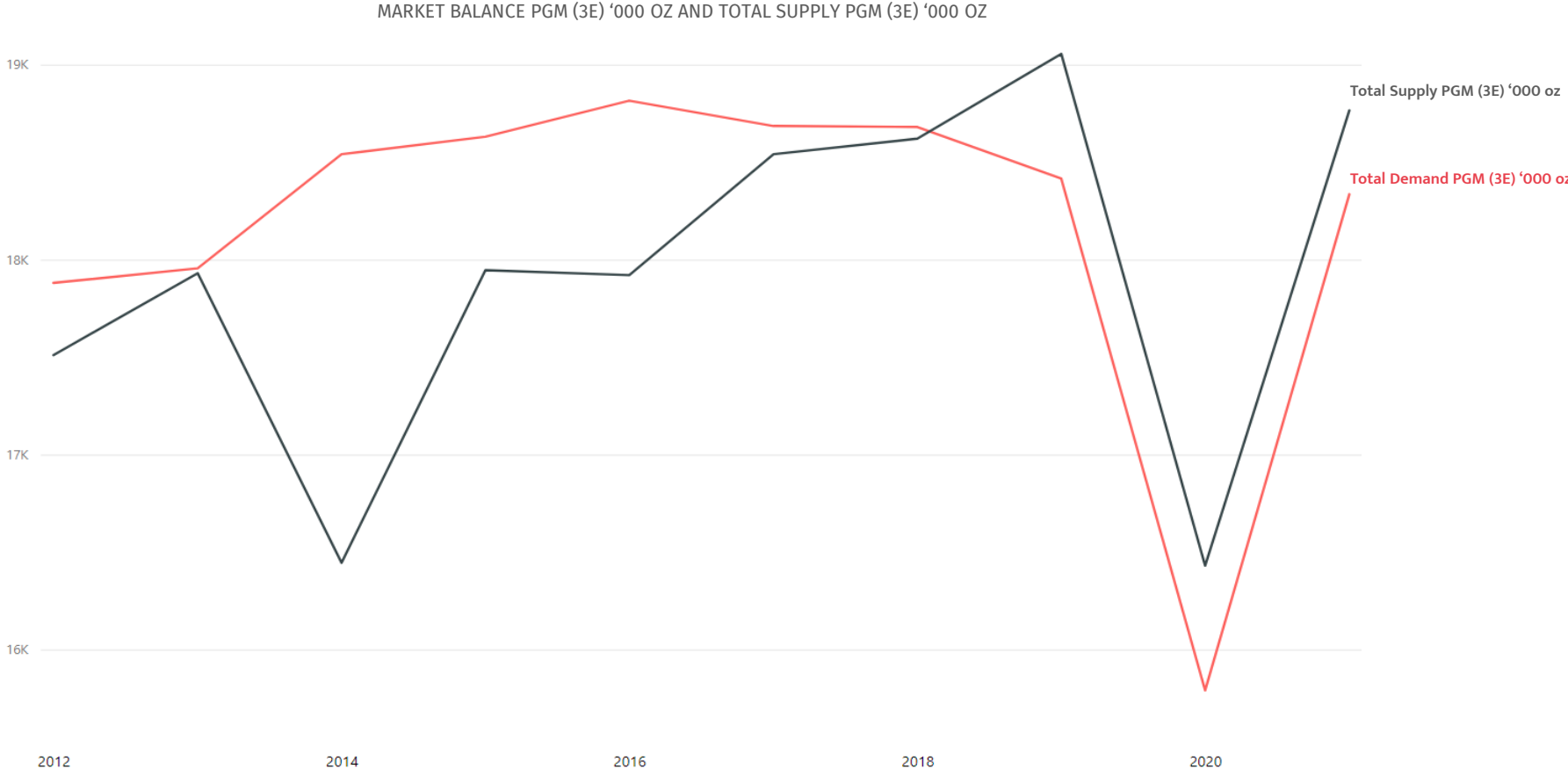
The reduction in supply due to Covid seems to have been balanced out by a more severe reduction in demand for PGMs

For 2021 supply is ramping up again in tandem with demand picking and moving the market closer to balance

Primary supply is expected to decline over the next 5 years and secondary supply to pick up the pace.

Demand for autocatalyst is expected to be affected with the phase out of ICE but the view is that demand will peak in 2028 -2034 before start declining.

Source: Heraeus, Johnson Matthey reports



# PGMS DEMAND DRIVERS

TOTAL PGM DEMAND (3E) '000 OZ

PGM demand drivers have to be grouped into short and long term.

The energy transition will bring structural changes in the autocatalyst market with the phasing out of ICE over the next decades.

That said in the short term the autocatalyst demand is expected to grow due to stricter regulations and higher loadings.



Source: Heraeus, Johnson Matthey reports