

# AMG'S CIRCULAR ECONOMY STRATEGY OF VANADIUM

AMG Vanadium, Zanesville, Ohio, USA

AMG is the world's largest recycler of vanadium-containing refinery waste in spent catalysts. Vanadium is an important critical material and is needed for the steel industry, the chemicals industry, and the rapidly growing industrial energy storage market. AMG's recycling strategy of vanadium reduces the CO<sub>2</sub> emissions by up to 85% compared to typical mining process.

## AMG - the Vanadium World Leader Based on Circular Economy

- AMG produces ferrovandium in Ohio, USA, an alloy for steel applications including rebar, bridges, automobiles, aerospace, national defense 100% from spent catalysts.
- In Zanesville, Ohio, USA, the new vanadium spent catalyst recycling facility started operating in 2022. The facility doubles AMG's production of ferrovandium to 60,000 tons annually.
- AMG invested \$325 million in the Zanesville facility – the largest AMG investment project ever, on time and on budget.
- AMG has completed the expansion of its vanadium oxide production in Nuremberg, Germany. Vanadium oxide is needed for vanadium batteries. 100% comes from gasification ash or spent catalysts.
- AMG Titanium, in Nuremberg, Germany, will also produce vanadium electrolyte to serve the electricity storage market. Production will start at the end of 2023.

## A Joint Venture for Recovery and Recycling of Metals in Saudi Arabia

The Supercenter "Metals Reclamation Complex"



- The Shell AMG Recycling joint venture signed an agreement with Saudi Aramco to construct and operate a "Metals Reclamation Complex".
- The supercenter for recovery and recycling of metals in the Jubail Industrial City will support the energy transition ambitions of the 'Saudi Vision 2030'.
- The circular economy will increase the penetration of renewable energy into Saudi Arabia's energy supply mix and improve energy efficiency for industrial users.

- Vanadium concentrate from the Jazan Integrated Gasification Combined Cycle Plant, licensed by Shell, will be processed by AMG to produce vanadium pentoxide.
- In project 4, AMG will take its Lithium Vanadium Hybrid Energy Storage System (LIVA HESS) into operation to further reduce energy costs and CO<sub>2</sub> emissions of the Supercenter.
- Construction planning began in December 2022.



"AMG Vanadium is widely acclaimed by global refineries as the industry leading spent catalyst recycler and has recycled over 425,000 tons of spent catalyst since the early 2000's."

Thomas Centa, President AMG Vanadium