

# CRITICAL MATERIALS FOR A SUSTAINABLE PLANET

ODDO BHF Forum Presentation | January 2024



AMG CRITICAL MATERIALS N.V.

*Lithium Hydroxide Battery-Grade Refinery – Bitterfeld, Germany*



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# AMG OVERVIEW



# AMG: A CRITICAL MATERIALS COMPANY

## GLOBAL TRENDS

CO<sub>2</sub> emission reduction, circular economy, population growth, increasing affluence, and energy efficiency

## DEMAND

Innovative new products that promote CO<sub>2</sub> reduction, including materials with higher energy density and higher temperature resistance, as well as products that are lighter and stronger than competing materials

## SUPPLY

AMG sources, upgrades, purifies, and supplies the critical minerals that the market demands





# AMG PROVIDES CRITICAL MATERIALS AND RELATED PROCESS TECHNOLOGIES TO ADVANCE A LESS CARBON-INTENSIVE WORLD

## A GLOBAL IMPERATIVE FOR THE 21<sup>ST</sup> CENTURY

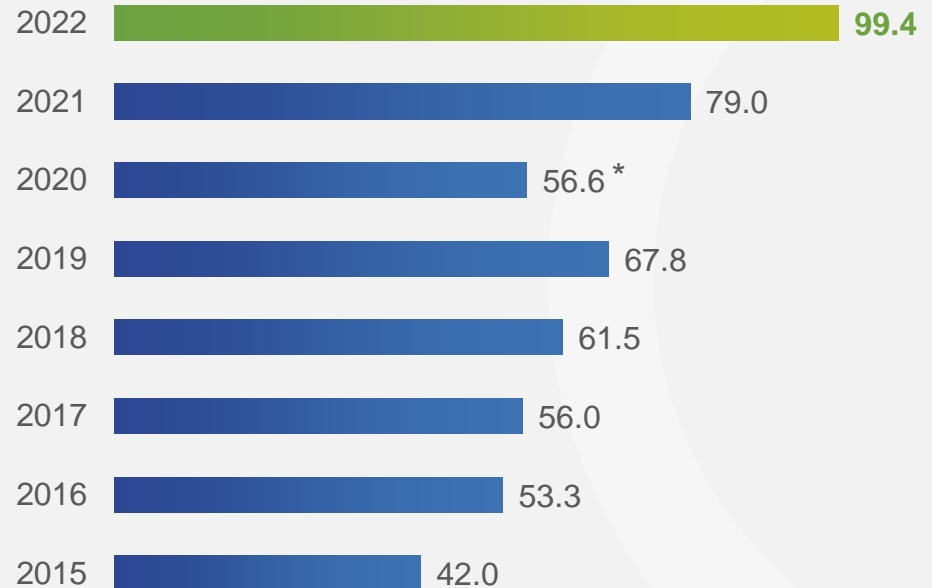
### AMG: ENABLING TECHNOLOGIES

Products and processes saving CO<sub>2</sub> emissions during use (e.g., light-weighting and fuel efficiency in the aerospace and automotive industries)

### AMG: MITIGATING TECHNOLOGIES

Products and processes saving raw minerals, energy and CO<sub>2</sub> emissions during manufacturing (e.g., recycling of ferrovandium)

## AMG'S ENABLED CO<sub>2</sub> EMISSION REDUCTIONS (Million MT)



\* 2020 decrease due to the global pandemic significantly impacting volumes in our aerospace exposed businesses

# AMG NEW BUSINESS SEGMENTS

## AMG LITHIUM

- AMG's Lithium segment spans the lithium value chain, reducing the CO<sub>2</sub> footprint of both suppliers and customers.
- AMG Lithium operates a value chain starting with mining and including solid state lithium batteries in Germany.
- Composition:
  - AMG Brazil
  - AMG Lithium GmbH
  - AMG Lithium Portugal
  - Zinnwald Lithium PLC

## AMG VANADIUM

- AMG Vanadium is the world's market leader in recycling vanadium from oil refining residues.
- It is the only US ferrovanadium producer and is expanding in the Middle East with the Supercenter project in the Kingdom of Saudi Arabia, through Shell & AMG Recycling BV.
- Composition:
  - AMG Vanadium
  - AMG Titanium
  - AMG Chrome
  - Shell AMG BV

## AMG TECHNOLOGIES

- AMG Technologies is the established world market leader in advanced metallurgy and provides equipment engineering to the aerospace engine sector globally.
- Composition:
  - ALD
  - LIVA
  - AMG Silicon
  - AMG Graphite
  - AMG Antimony

# STRONG FUNDAMENTALS, ADAPTIVE TO GLOBAL DISRUPTION

## OPTIMIZED CAPITAL STRUCTURE

- In November 2021, AMG entered into a new \$350 million 7-year senior secured term loan B facility (“term loan”) and a \$200 million 5-year senior secured revolving credit facility (“revolver”). The total facility amount of \$550 million replaced AMG’s prior credit facility and extended the term loan maturity from 2025 to 2028 and revolver maturity from 2023 to 2026.
- AMG Engineering entered into €140 million of long-term bilateral unsecured performance-based guarantee facility agreements in January 2022, which replace the existing ones.
- On July 11, 2019, the Company entered into a \$307 million 30-year term municipal bond which finances 100% of the ferrovanadium expansion in Zanesville, Ohio. The bond has a coupon rate of 5.0% and matures on July 1, 2049.

## BUSINESS RESILIENCE

- Focus on operational efficiency
- Reduction of operating costs and capital expenditures
- Momentum on positive business gains, strong backlogs into early 2023

## DISCIPLINED APPROACH TO GROWTH

- AMG Brazil’s spodumene production expansion will solidify AMG’s low-cost position
- AMG Lithium’s refinery, under construction in Germany, is Europe’s first lithium hydroxide refinery
- New vanadium spent catalyst recycling facility in Ohio is a clear manifestation of AMG’s industry leadership in the recycling of hazardous refinery waste globally

○ The fundamental positions of our businesses are sound, and **AMG remains focused on disciplined, sustainable growth**

# STRATEGY

AMG's strategy is to build its critical materials business through industry consolidation, process innovation and product development

## EXPANSION OF EXISTING HIGH-GROWTH BUSINESSES

Pursue opportunities in high-growth areas within the existing product portfolio

## PROCESS INNOVATION & PRODUCT DEVELOPMENT

Continue to focus on process innovation and product development to improve the market position of AMG's businesses

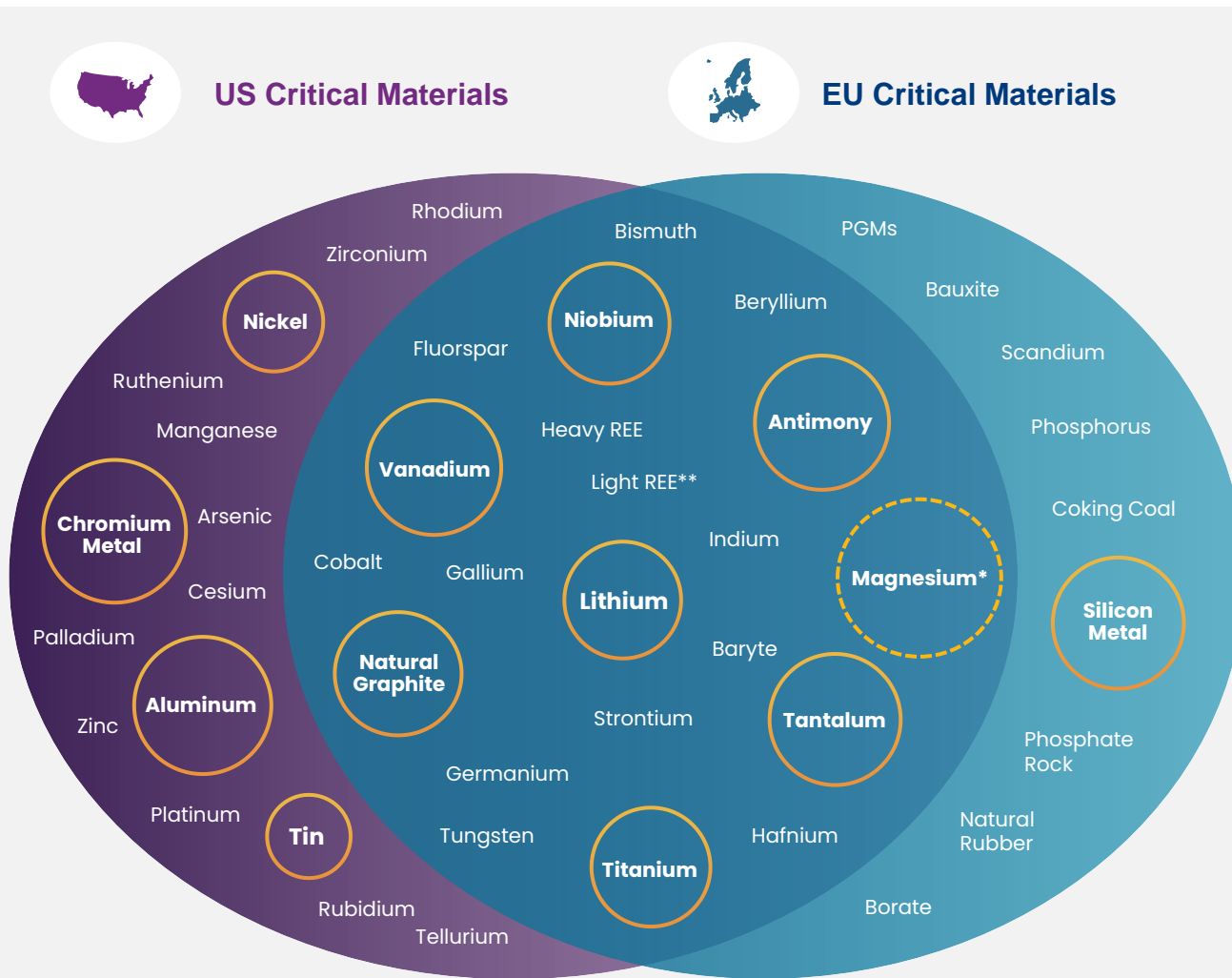
## INDUSTRY CONSOLIDATION

Pursue opportunities for horizontal and vertical industry consolidation across AMG's critical materials portfolio

- AMG's overriding strategic objective is to **achieve industry leadership** while being the **low-cost producer**



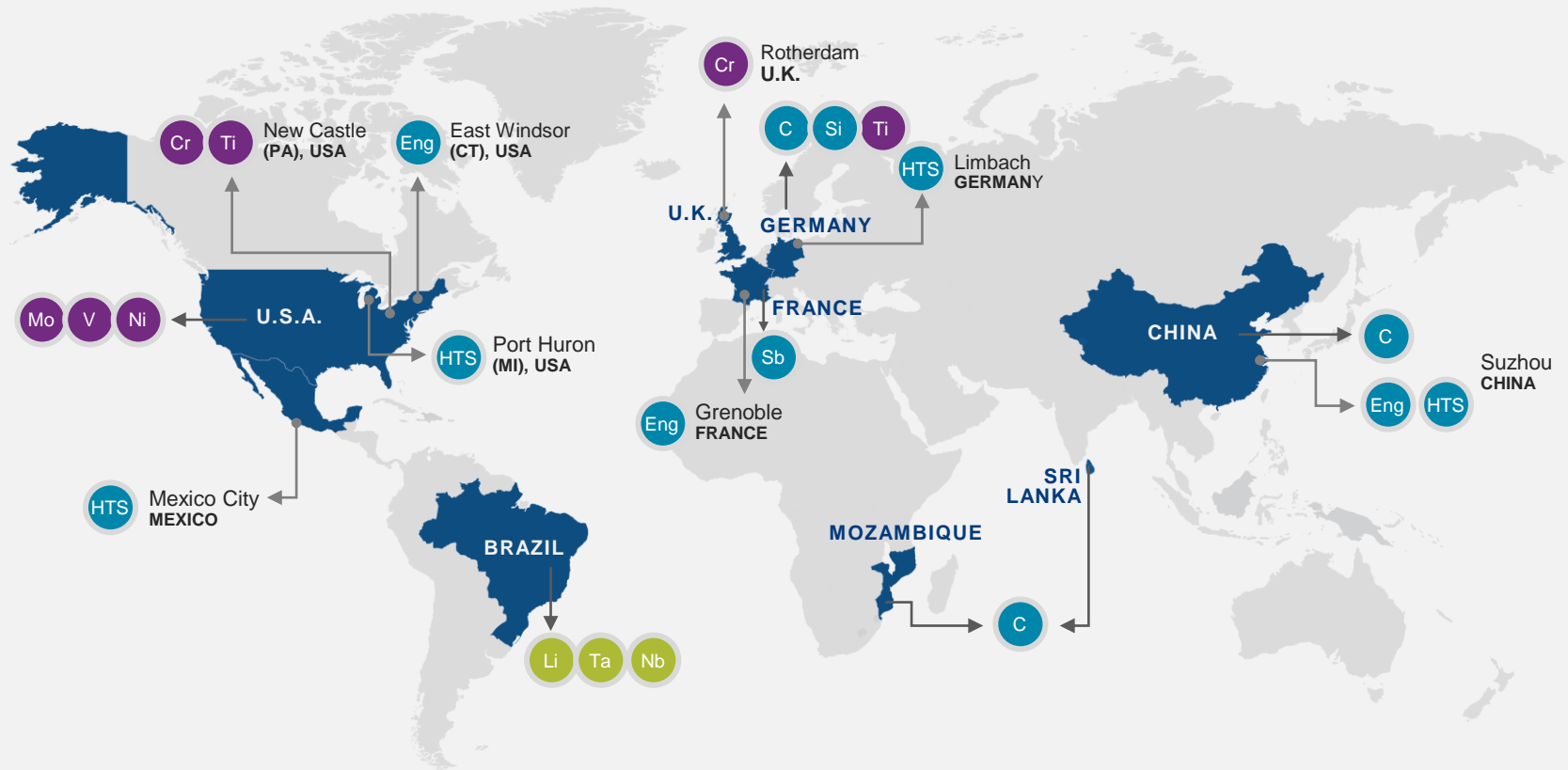
# CRITICAL RAW MATERIALS: AMG PRESENCE



AMG has a unique critical materials portfolio comprised of 9 EU critical materials and 12 US critical materials

The EU identifies 30 total critical raw materials, the US 50\*\*

# AMG GLOBAL FOOTPRINT



LITHIUM	Li Lithium	Ta Tantalum	Nb Niobium			
VANADIUM	V Ferrovandium	Ti Titanium	Cr Chromium Metal	Mo Molybdenum	Ni Nickel	
TECHNOLOGIES	Eng Engineering	HTS Heat Treatment Services	Sb Antimony	C Natural Graphite	Si Silicon Metal	

# HEALTH AND SAFETY

	LOST TIME INCIDENT RATE		TOTAL INCIDENT RATE	
2013	<div></div>	1.95	<div></div>	3.30
2014	<div></div>	1.19	<div></div>	2.23
2015	<div></div>	1.12	<div></div>	2.02
2016	<div></div>	1.06	<div></div>	1.68
2017	<div></div>	0.82	<div></div>	1.31
2018	<div></div>	0.63	<div></div>	1.26
2019	<div></div>	0.80	<div></div>	1.46
2020	<div></div>	0.62	<div></div>	1.05
2021	<div></div>	0.39	<div></div>	1.08
2022	<div></div>	0.46	<div></div>	0.95
2023 (YTD)	<div></div>	0.52	<div></div>	1.00

YTD Sept 2023 results demonstrate a 13% increase in lost time rate and an 5% increase in total incident rate from 2022 year-end. As a benchmark, the most recent NAICS primary metal producer lost time incident rate for was 1.2 and the recordable rate was 4.1.



# AMG LITHIUM



# AMG LITHIUM

## AMG Lithium Ground Base

- Mine in Brazil, from 90 ktpy to 130 ktpy
- Experienced Lithium team
- Commissioning first European 20 ktpy Battery Grade Lithium Hydroxide (LiOH BG) refinery in Germany
- Further investments in Lithium Modules in Europe, up to 100 ktpy
- State-of-the-art Lithium R&D lab
- Vertical value chain integration ongoing
- Development and upscaling of All Solid-State Battery materials

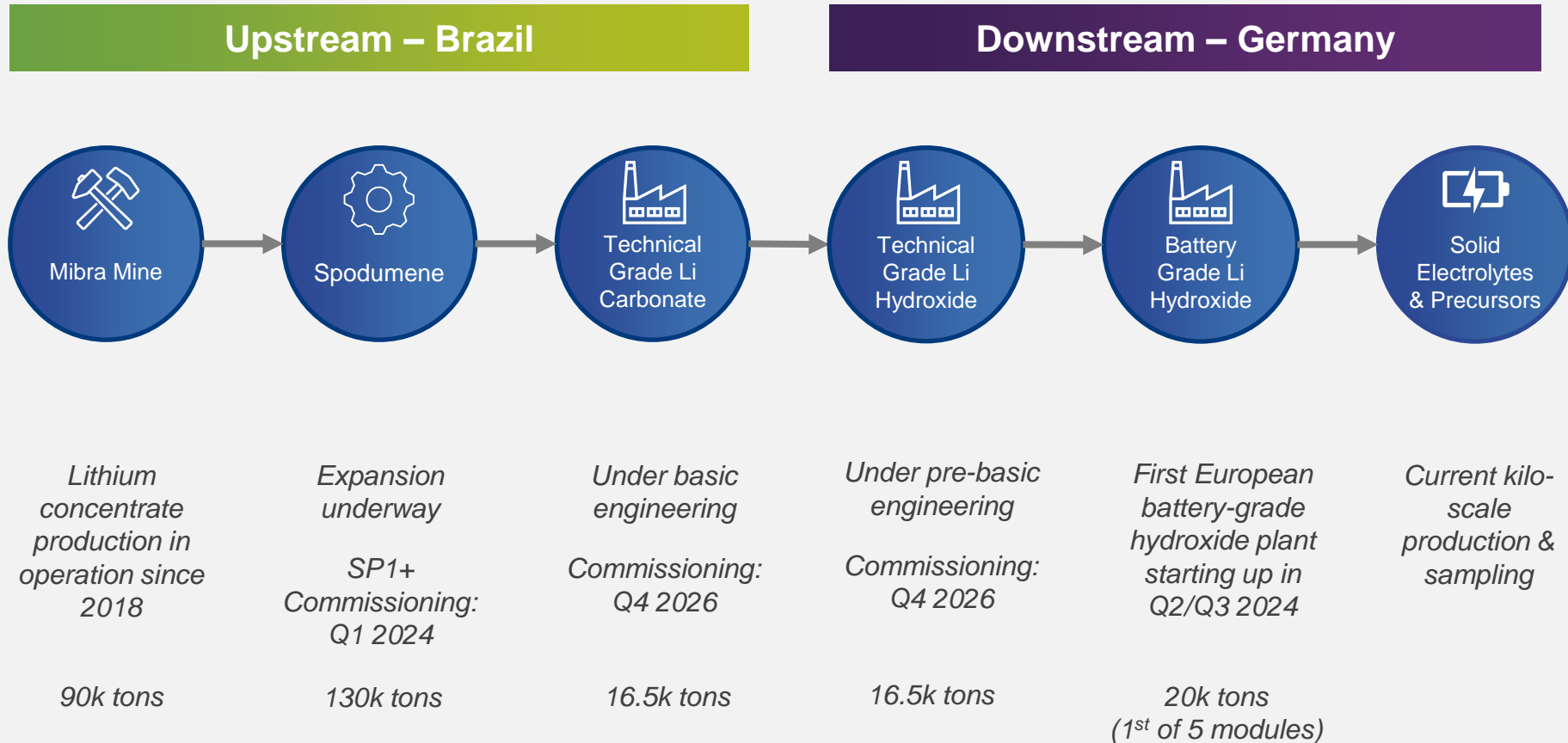
## AMG Lithium Strategy

- We seek to engage with strategic partners on the resource side and thereby bring upstream and downstream value to the European EV supply chain.

## Why AMG Lithium

- First Refinery in Europe and access to European EV battery market
- Downstream know-how to shorten time to market and technical risk reduction
- Access to EU and German backed financing
- AMG focus on CO<sub>2</sub> reduction

# AMG LITHIUM HAS A SIGNIFICANT FIRST MOVER ADVANTAGE IN EUROPE



○ From mining through to next generation lithium products



# THE MIBRA MINE, BRAZIL



## AMG IS A LOW-COST SPODUMENE PRODUCER

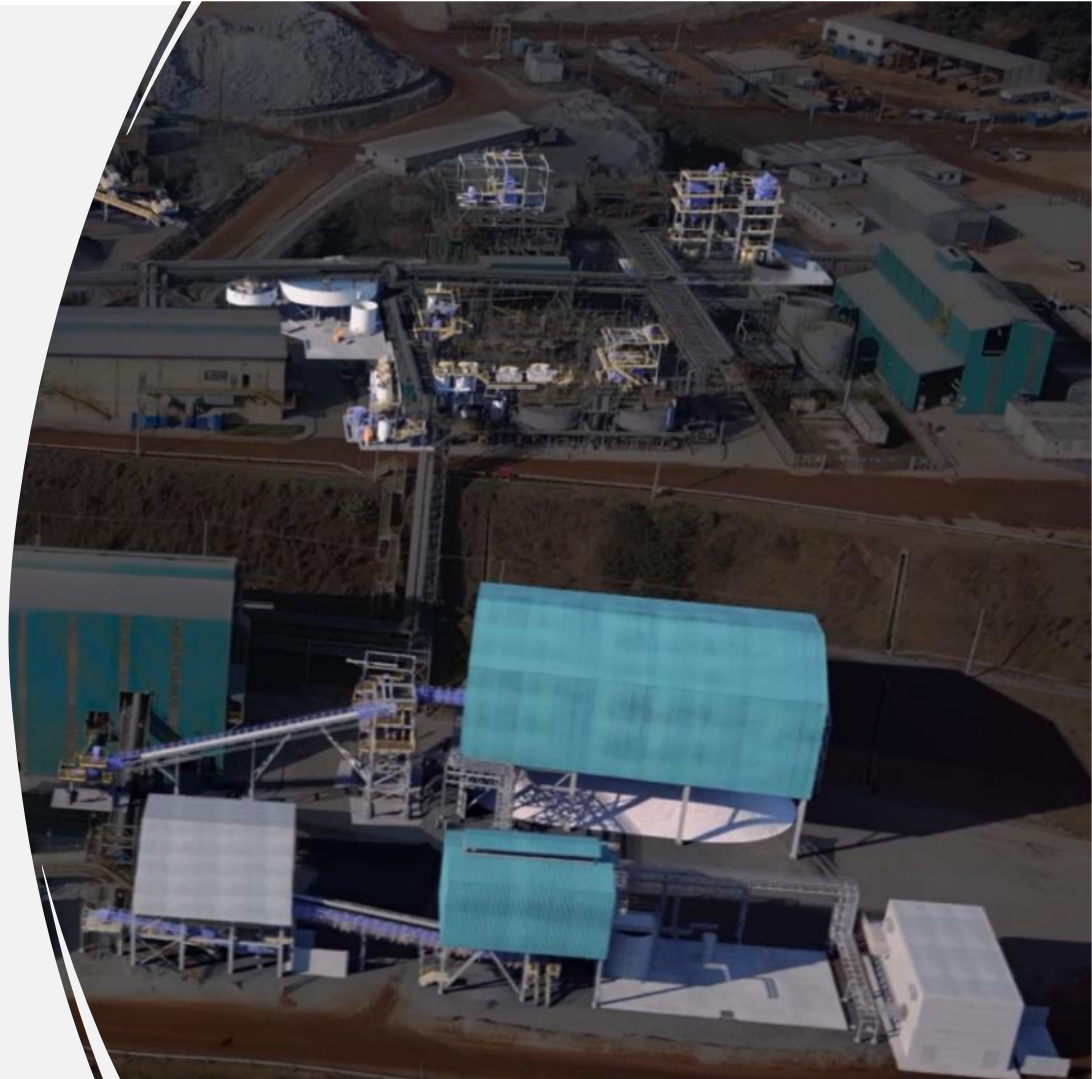
\$468/mt YTD September 2023 cost per ton delivered to China, net of tantalum, feldspar and tin by-product credits

- The Mibra mine is a long-term tantalum concentrate producer and is the largest conflict-free producer of tantalum in the world
- Mibra's tantalum production will expand to 370K pounds per year, in combination with the spodumene expansion
- Life-of-mine strategic partnership with JX Nippon Mining & Metals Corporation for 100% of the tantalum concentrate production
- 2024 cost per ton will be negatively impacted by ramp-up costs as well as lower tantalum volumes relative to spodumene volumes, as the tantalum expansion does not start up until 2025.
- The expansion of the Spodumene plant not only delivers higher output, but also operational improvements and therefore a more robust and effective production



# SPODUMENE EXPANSION (SP1+)

- Increase production capacity 45% to 130k mt per year
- Focus on process optimization to improve lithium metallurgical recovery
- Enhanced robustness to address naturally occurring mine variations
- Reduce material handling downtime
- The three-week shutdown of the lithium concentrate plant to facilitate the expansion from 90,000 tons to 130,000 tons will take place in Q1 2024
- We expect the full run rate to 130,000 tons will begin in Q3 2024

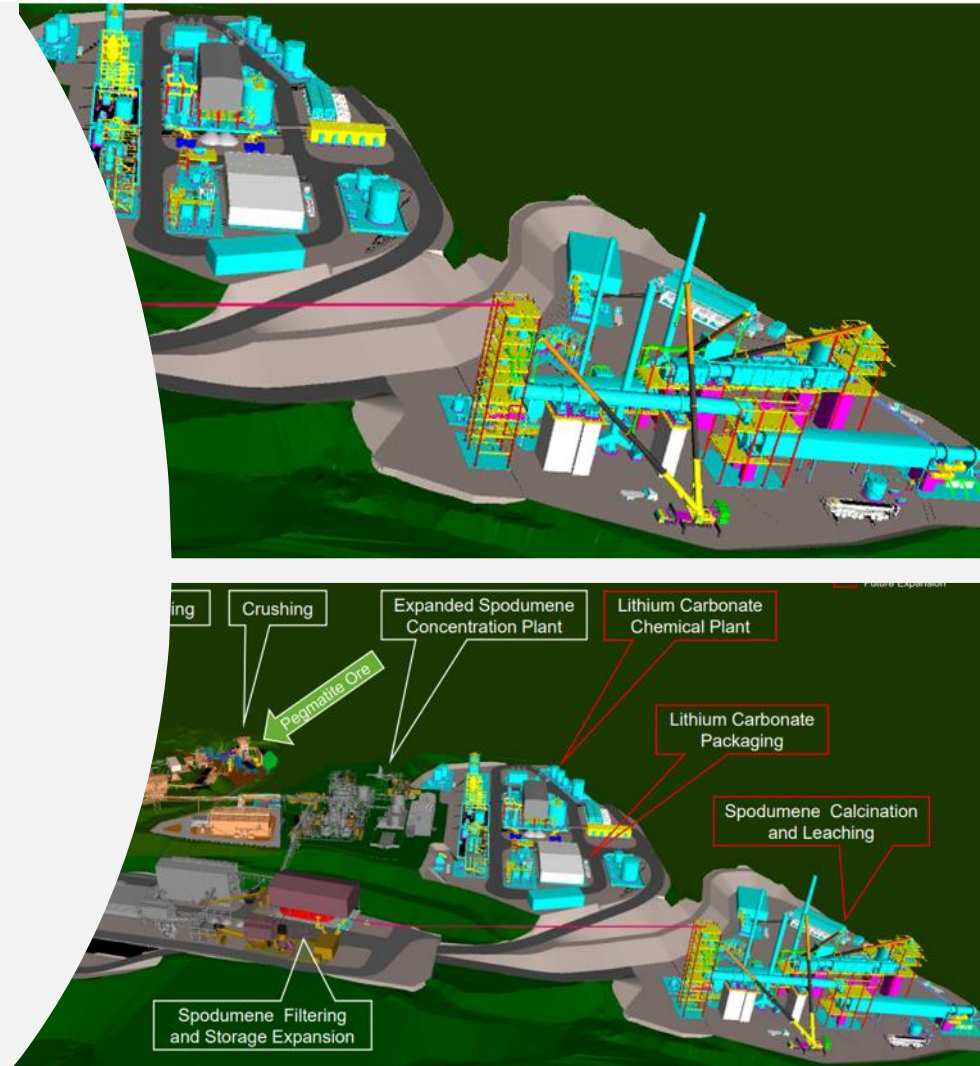




# TECHNICAL GRADE LITHIUM CHEMICAL PLANT

## Preliminary Estimates

- Investment: \$300M
- Commissioning: End of 2026
- Capacity: 16.5k mt Technical Grade Lithium Carbonate per annum
- Delivered cost to Germany less than \$10,000 /mt; assuming spodumene at cost for conversion in Brazil
- TG Lithium Carbonate from Brazil vs Upgrading in China results in annual freight savings of ~\$15M and ~90k mt reduction in CO<sub>2</sub>



# AMG BRAZIL'S MIBRA MINE IS A LEADER IN SUSTAINABILITY PRACTICES

## Lost Time Rate and Recordable Rate

Across all Brazil sites, Lost Time Rate of 0.00\* and Recordable Rate of 0.17\* compare favorably to Bureau of Labor Statistics Industry Benchmarks

## Contribution to a Sustainable World

In 2021, AMG Brazil was awarded a Recognition on Good Suppliers Practices Prize from Novelis

## Energy Self Sufficient

In 2022, AMG's owned hydroelectricity plant produced 18.2 GWh to cover 48% of our total power needs

## CO<sub>2</sub> Footprint Reduction

Preserving the environment is part of the essence of AMG Brazil which, with its production, contributes globally to the reduction of CO<sub>2</sub> emissions



# SHOWCASING AMG BRAZIL'S LOCAL COMMUNITY

**Local culture, building a relationship of trust and mutual respect, and hiring locally are AMG priorities**

- More than 70% of employees in Brazil operations are local hires
- The Young Apprentice Program, a partnership with SENAI, Nacional Service of Industrial Learning, is an internship based on the commitment of local labor development and professional possibilities
- Partnerships with local universities focusing on personal and professional development of young people and adults entering the job market
- Since 2015, AMG Brazil has trained more than 70 individuals for the job market, directly hiring almost 40%





# LITHIUM HYDROXIDE BATTERY-GRADE REFINERY BITTERFELD, GERMANY

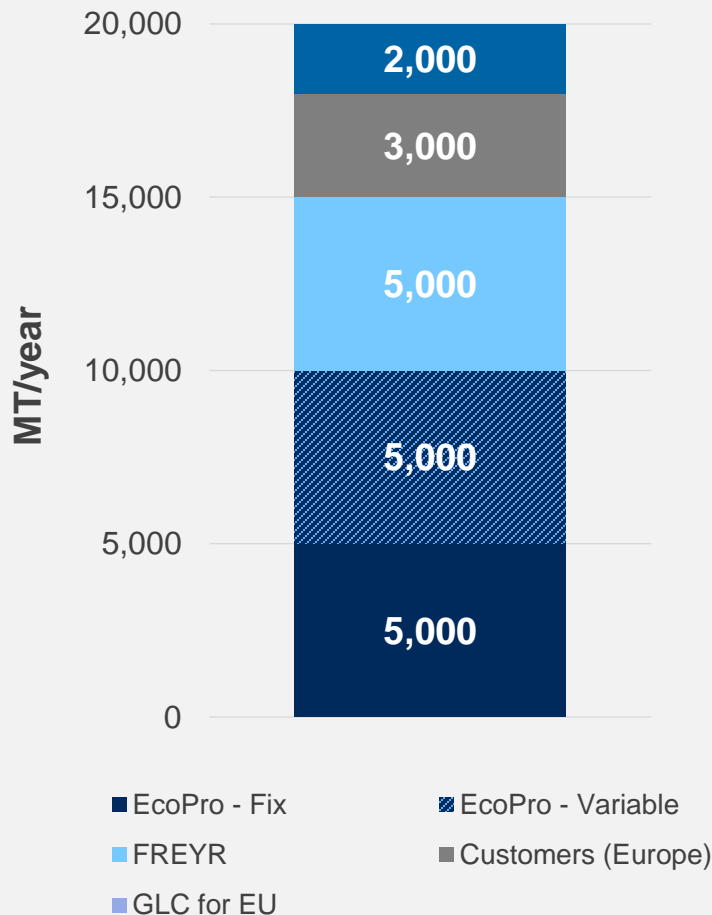


- Production of highly-refined, battery-grade Lithium hydroxide
- Module 1 with 20,000 MT/yr capacity, further modules up to 100,000 MT/yr in total
- Located in Bitterfeld, Germany: access to all required energies and infrastructure
- Commissioning began in November 2023
- USD 150 million expenditures on time and on budget



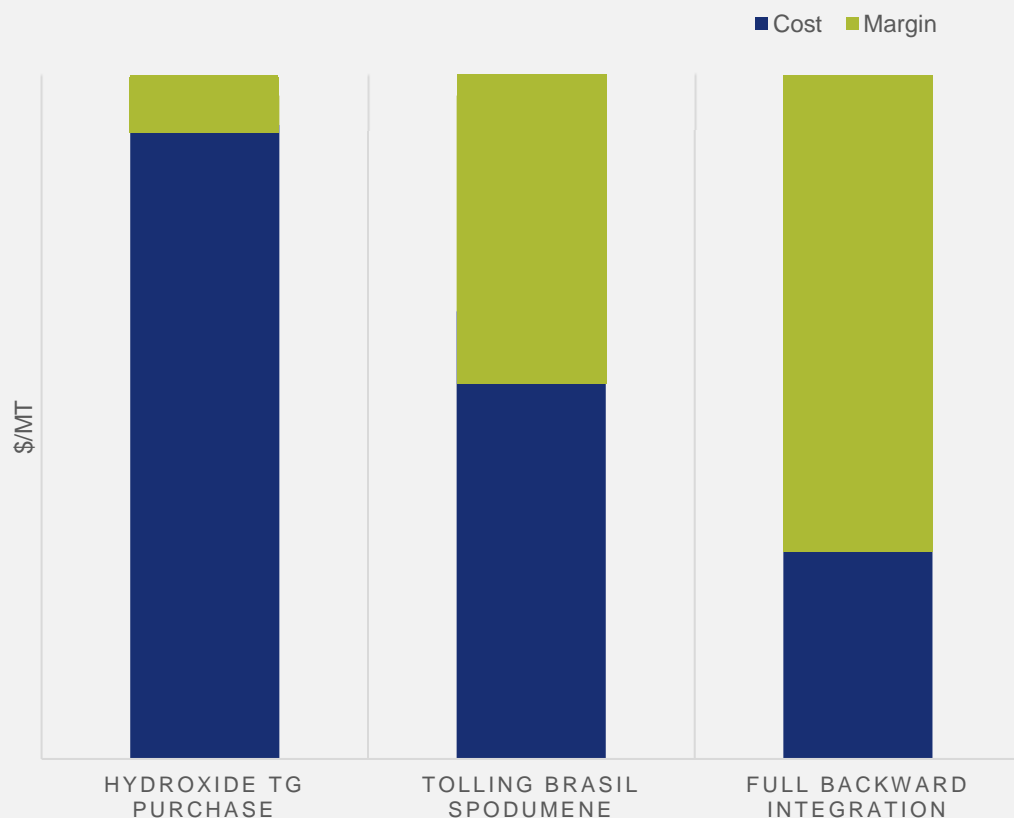
# MODULE 1: LITHIUM HYDROXIDE OFFTAKE

## Existing offtakes at runrate 2025



- AMG has signed a binding supply agreement with Korean **EcoPro** for an initial three-year term to deliver a binding 5,000 MT/yr plus an optional 5,000 MT/yr to EcoPro BM's CAM-facility in Debrecen-Hungary.
- AMG executed a MOU with **FREYR** for an offtake of up to 5,000 MT/yr.
- AMG executed further MOUs with different customers.
- AMG has an agreement in place with General Lithium for an offtake of up to 2,000 MT/yr for their EU needs.

# INDICATIVE MARGIN DEVELOPMENT TO A FULLY BACKWARD INTEGRATED LITHIUM COMPANY



## Technical Grade Purchase:

Represents the margin of the Bitterfeld plant assuming the open market purchase of technical grade hydroxide.

## Tolling Brazil Spodumene:

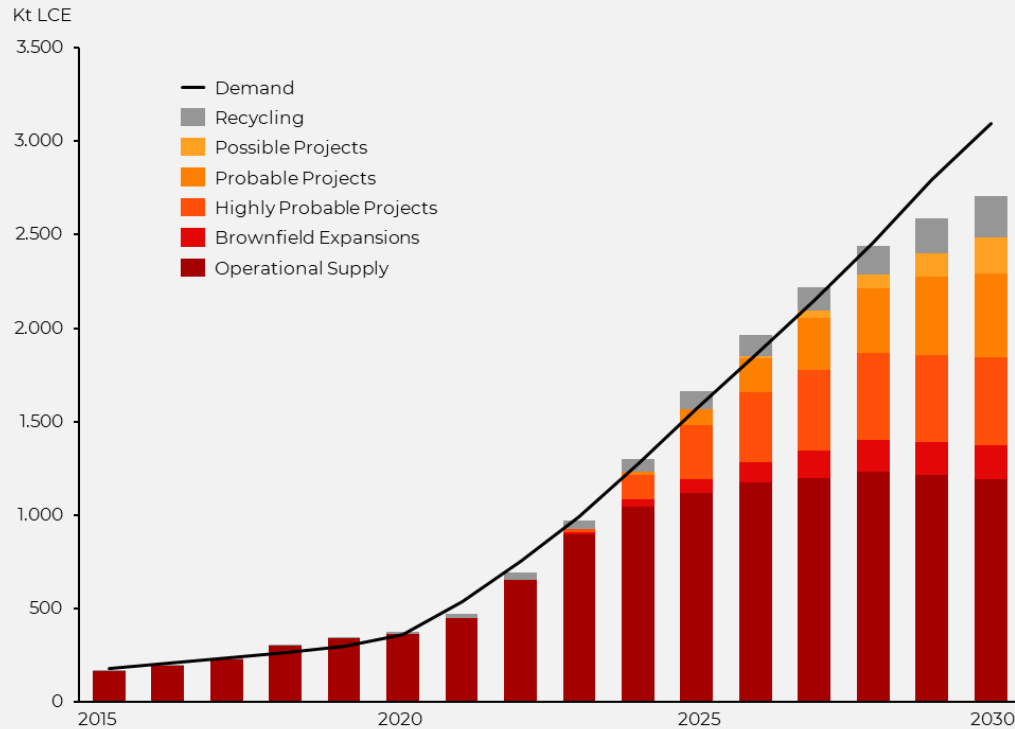
Represents the margin available to Bitterfeld via tolling Brazil spodumene in China and delivering technical grade hydroxide to Germany.

## Full Integration:

Represents the delivery of technical grade carbonate to Germany direct from the Brazilian technical-grade plant.

# BIG INVESTMENTS ON NEW SUPPLY IS REQUIRED TO MEET DEMAND

## Lithium supply-demand forecast

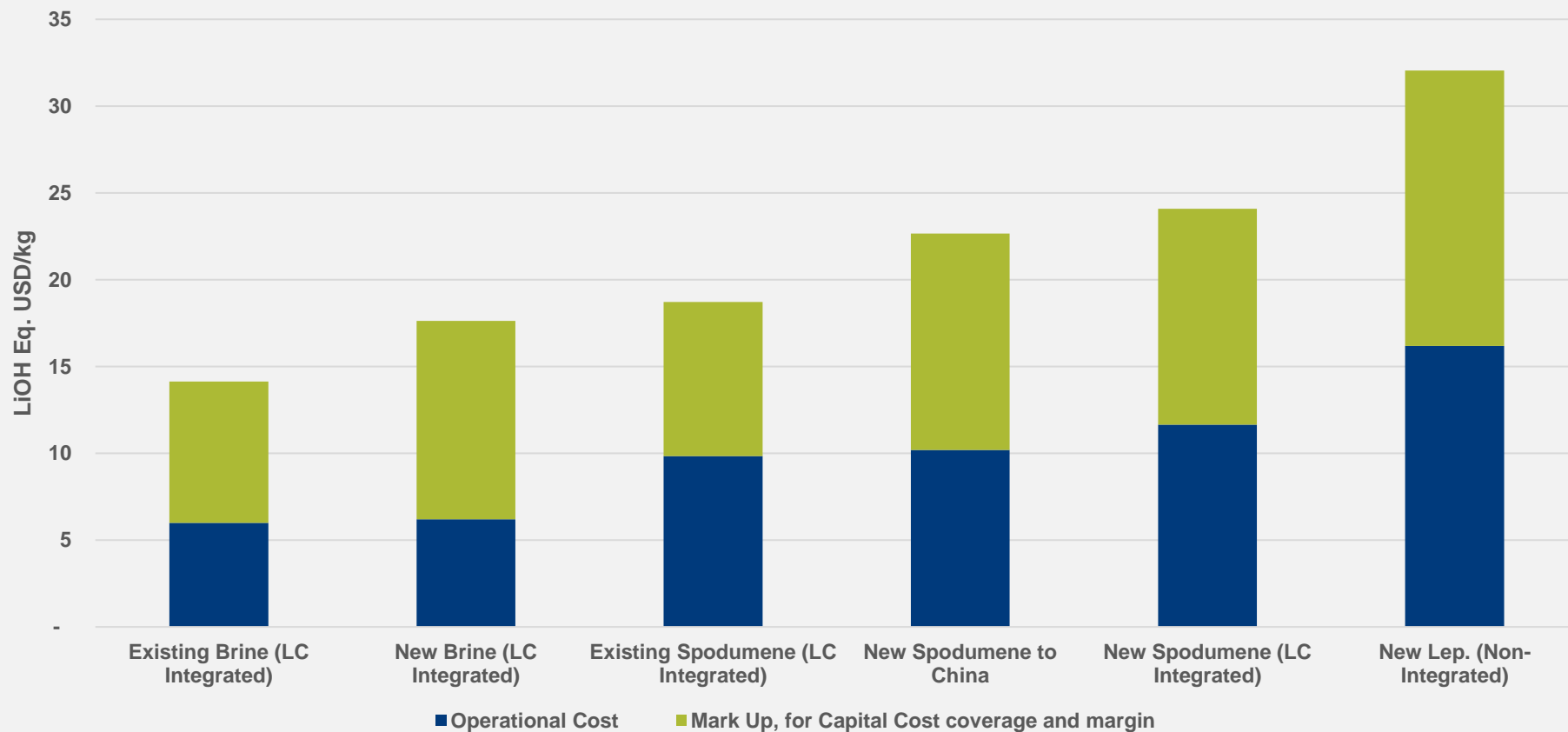


- There is no significant oversupply to be expected in this decade, especially not in the next five years. The surpluses and deficits are marginal and should not lead to low prices automatically.
- In 2023 the supply increase was driven by brownfield expansions.
- Going forward, incremental supply will come from new greenfield projects.
- Ongoing uncertainty on direct lithium extraction and African projects coming to market
- Currently the investment sentiment around finalizing and funding new resource projects is very poor.
- The pace of starting up new supply is highly dependent on Lithium market prices.



# LIOH COST AND PRICE ANALYSIS

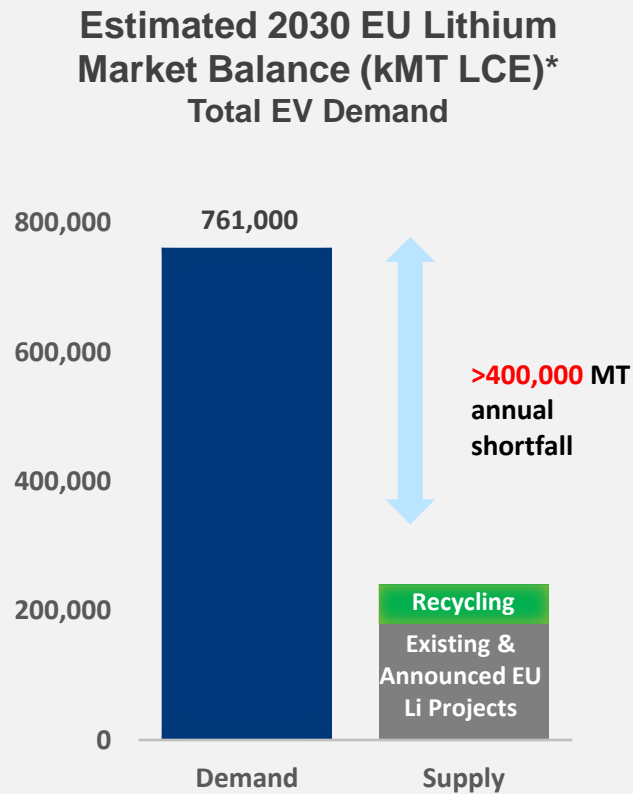
New LiOH Converter: Price Model to LiOH BG



Source: AMG Lithium internal Q4 2023, considering, IRR: 20%.

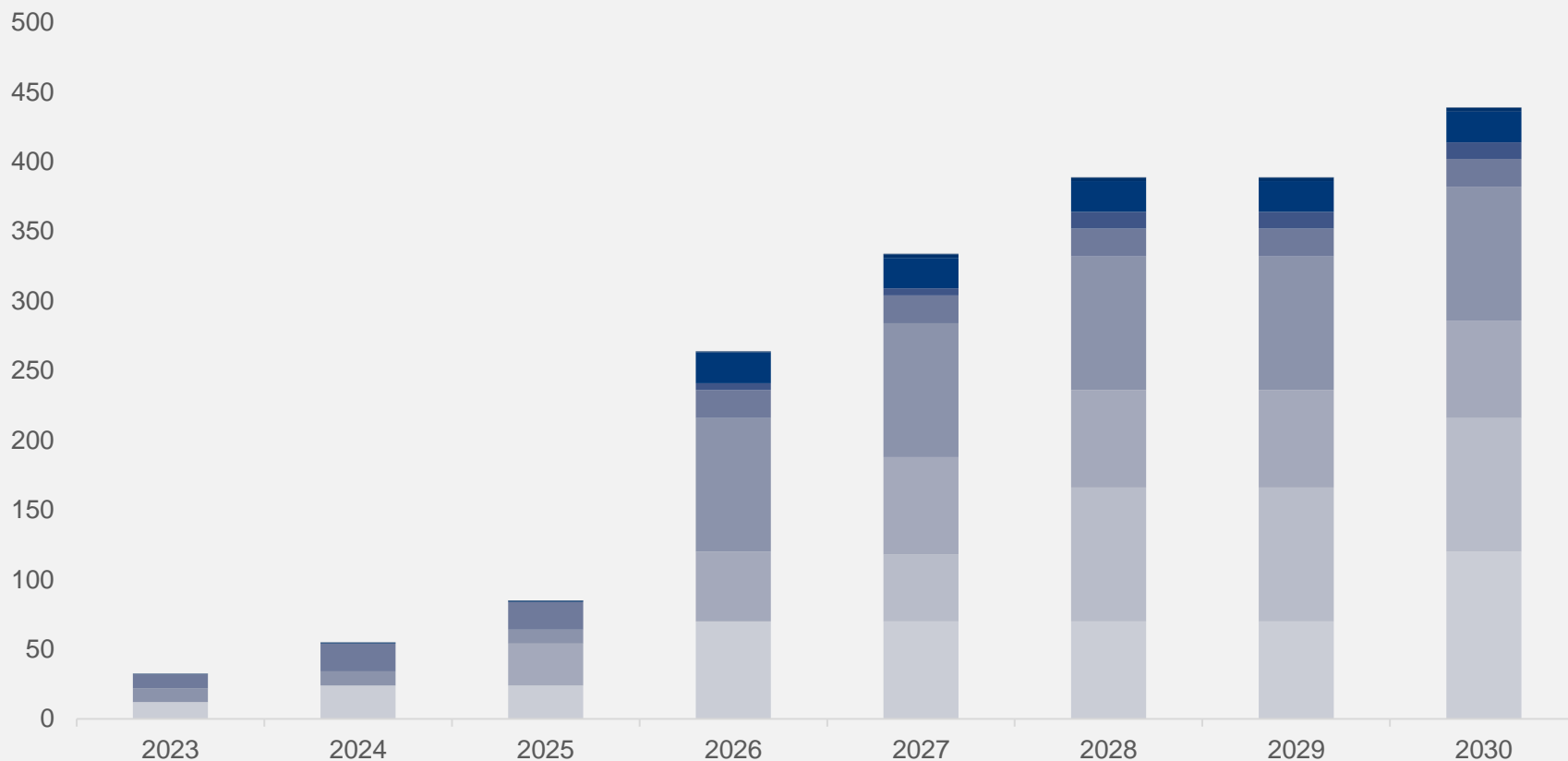
# WHY EUROPE?

## EU REQUIRES LARGE VOLUMES LITHIUM HYDROXIDE BG



# ANNOUNCED CATHODE ACTIVE MATERIALS PRODUCTION AND PROJECTS SITES IN EUROPE

**Cathode Active Materials LCE Demand ('000) mt in EU**





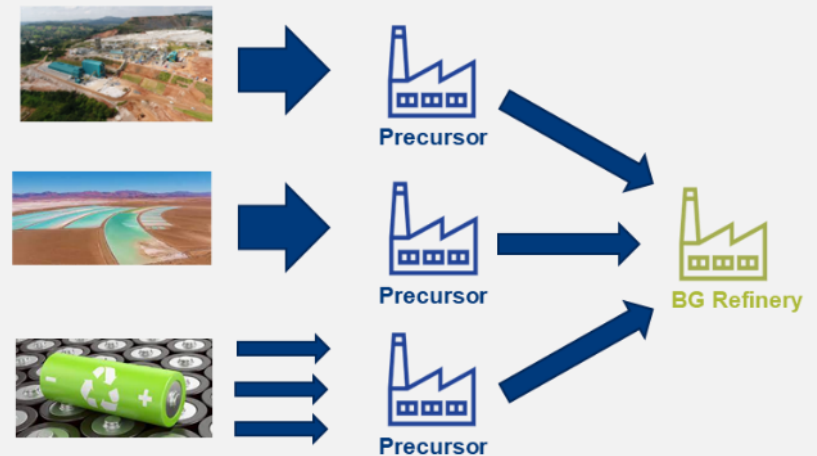
# GAME CHANGER: AMG MULTI-PLANT CONCEPT

## CURRENT



- High project complexity & underestimation of technical hurdles
- One mine – one BG plant: Supply risk
- BG offtakes always subject to qualification

## AMG'S MULTI-PLANT CONCEPT



- Facilitating financing through robust offtake
- Time to market
- De-risking overall project
- Supply Security

**Project  
Enabler**

# AMG LITHIUM DOWNSTREAM GROWTH STRATEGY

## Lithium hydroxide / carbonate Technical Grade Feed

Diversified sources

AMG Lithium Brazil

Market

Global Lithium projects

Lithium battery  
recycling

## Lithium hydroxide Battery Grade Production

Modular plant concept  
for up to 100,000 tpa of LiOH

AMG module 1  
(20,000 tpa)

AMG module 2  
(20,000 tpa)

AMG module 3  
(20,000 tpa)

AMG module 4  
(20,000 tpa)

AMG module 5  
(20,000 tpa)

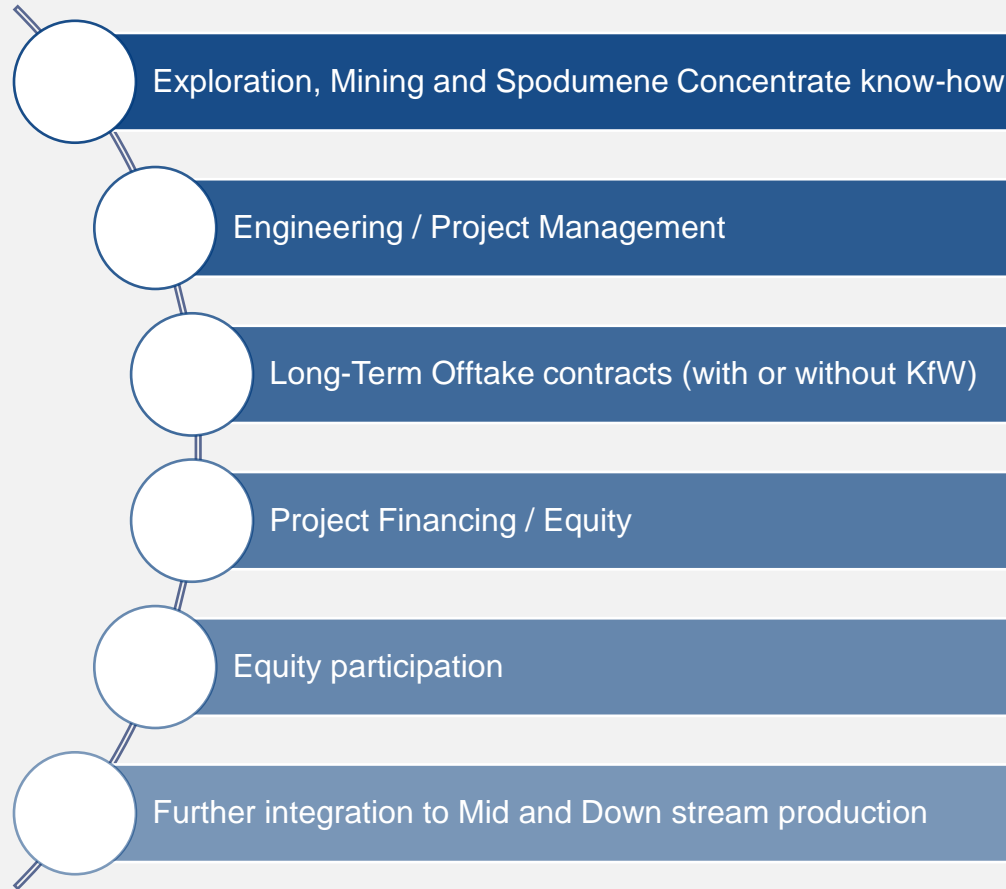
## Lithium hydroxide Battery Grade Consumers

Targeting customers producing in  
Europe

EUROPE

# AMG'S RESOURCE DEVELOPMENT STRATEGY

## AMG Resource Development as a Strategic Partner



- AMG is engaging in resource projects to grow the Lithium story in Germany
- AMG approach is a combination of **Equity**, **Debt Financing** and **Technical Support** when needed, in exchange of a long-term offtake agreements



# LAGOA: AMG BRAZIL SIGNS MOU FOR DEVELOPMENT OF LITHIUM CONCENTRATE PRODUCTION

## Lagoa

- Location: Portugal.
- Production:  
Est. 150K mt/year  
spodumene concentrate

- Located in Northern Portugal, next to the Savannah Lithium Project
- AMG signed an MoU with Grupo Lagoa to concentrate lithium minerals to Spodumene Concentrate
- The partnership intends to concentrate the lithium minerals contained in the pegmatite to produce commercial-grade lithium concentrate
- From present data, we conclude the plant will confirm the main assumptions for the construction of a 150,000-ton lithium concentrate plant at the site
- AMG Brazil's project with Grupo Lagoa will begin basic engineering in December 2023
- AMG has performed comprehensive metallurgical tests on a laboratory scale and confirmed a viable mineral processing route to convert a representative sample of 1.1% Li<sub>2</sub>O yielding an output of 5.6% Li<sub>2</sub>O at 15.5% mass recovery and 76.2% metallurgical recovery
- Additional geological studies are being conducted to confirm present estimates of the size and quality of the resources.

# ZINNWALD LITHIUM: AMG'S 25% SHAREHOLDING

## Zinnwald

- **Location:** Germany.
- **Production:**  
Est. 12k mt/year of LiOH

- In March 2023, AMG became a 25% shareholder of Zinnwald and is supporting the Zinnwald Board to accelerate the development of its lithium project in Eastern Germany
- Zinnwald's integrated operation planned to produce battery grade LiOH
- A brownfield project with core mining license valid until 2047
- Situated in the east of Germany on the border with the Czech Republic
- Preliminary economic assessment published September 2022
- Plan to produce ~12ktpa of LiOH with on-site processing
- Revised mining concept that will take advantage of existing infrastructure
- Mine life of >35 years
- There are potential synergies with other AMG Lithium activities

# AMG'S SUPPLY CHAIN ROUTES & CO<sub>2</sub> FOOTPRINT

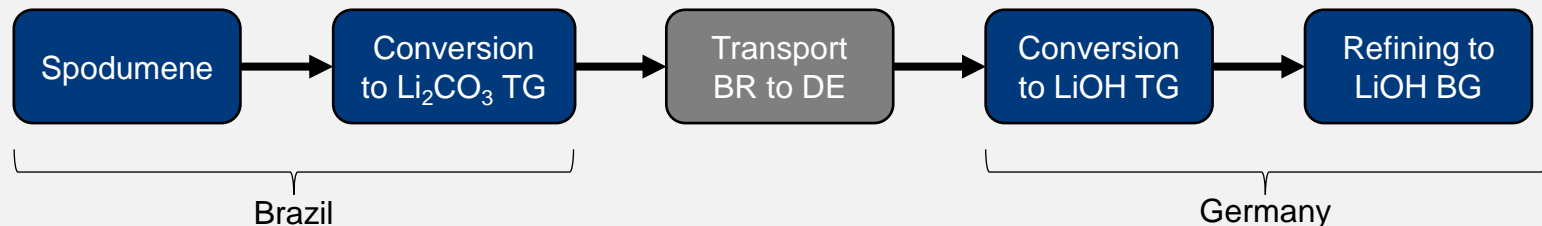
## Transitional: Tolling in China



➤ AMG's global warming potential: **16.3 tons CO<sub>2</sub>** per ton of LiOH BG

Source: Life Cycle Assessment of AMG finished in January 2022 performed by Minviro

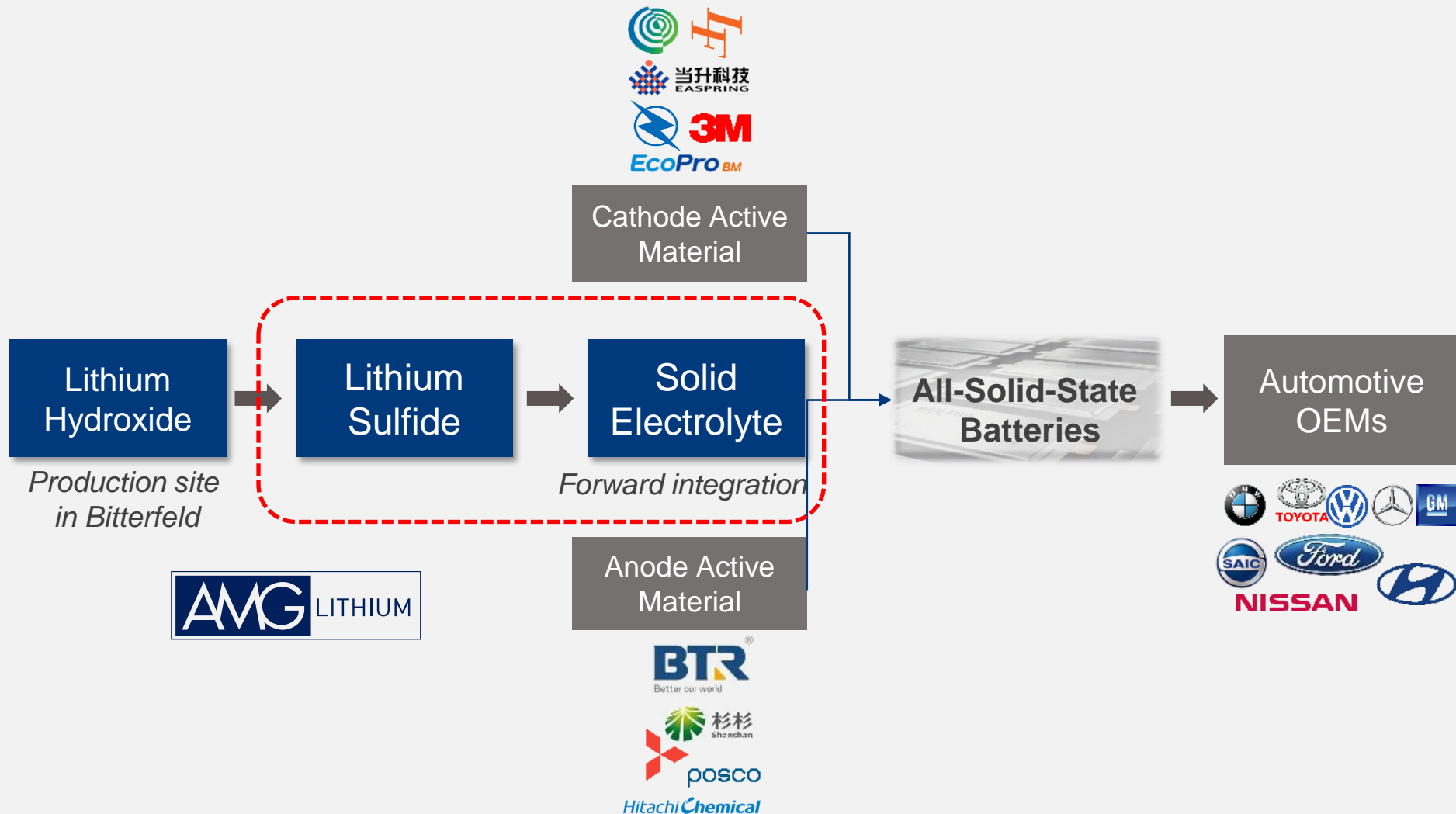
## Target: Fully integrated Brazil/Germany



➤ AMG's global warming potential target: **<10 tons CO<sub>2</sub>** per ton of LiOH BG

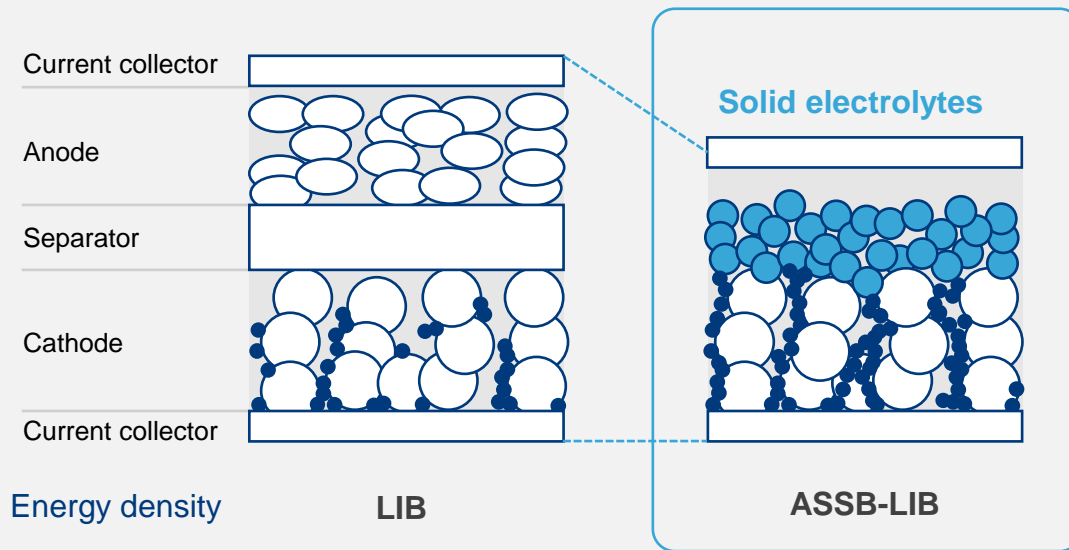
Source: Life Cycle Assessment work-in-progress at Minviro

# AMG LITHIUM FORWARD INTEGRATION IN THE VALUE CHAIN

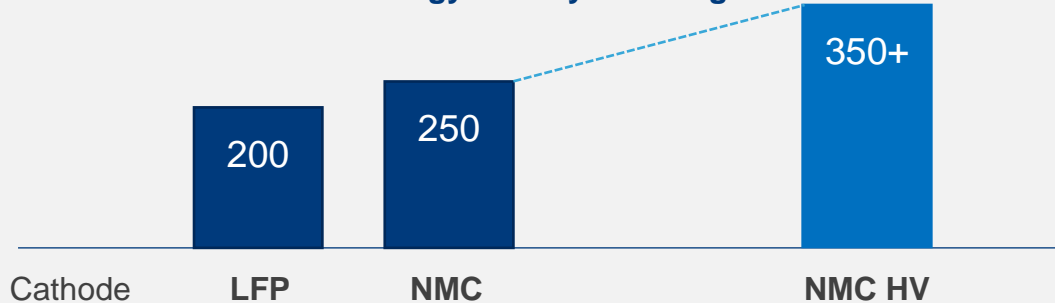




# NEXT GENERATION AUTOMOTIVE BATTERY TECHNOLOGY: ALL-SOLID-STATE BATTERIES (ASSB)



Energy density in Wh/kg



## Application & Market:

- All-Solid-State batteries (ASSB) are next step in automotive battery technology
- Energy density of ASSBs significantly increased compared to state-of-the-art Li-ion batteries; higher energy density allows for more capacity in the same installation space and therefore for longer driving ranges
- ASSBs facilitate faster charging rates and increased operational life

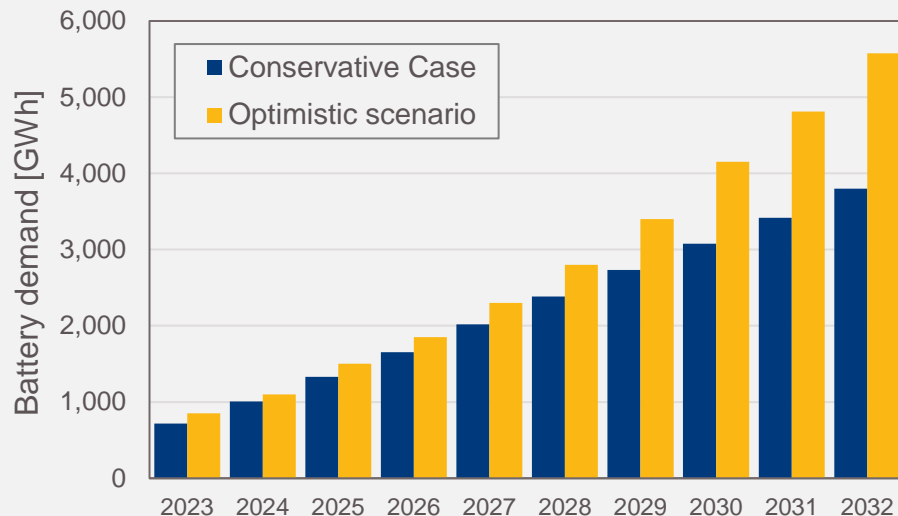
## Technology:

- Solid electrolytes are critical performance components to reach energy density and safety targets.
- Solid electrolytes and precursors (lithium sulfide) are key compounds regarding quality and product availability of ASSBs.

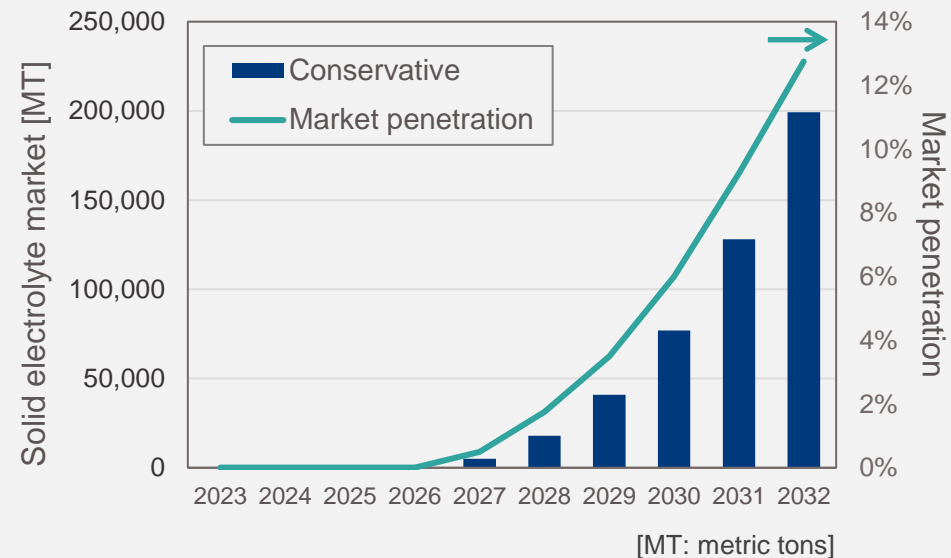
# NEXT GENERATION AUTOMOTIVE BATTERY TECHNOLOGY: ALL-SOLID-STATE BATTERIES (ASSB)

Sources: SolidPower (2023); Avicenne (2021); Roland Berger (2022); HSBC (2021)

## Automotive battery demand



## Solid electrolyte market



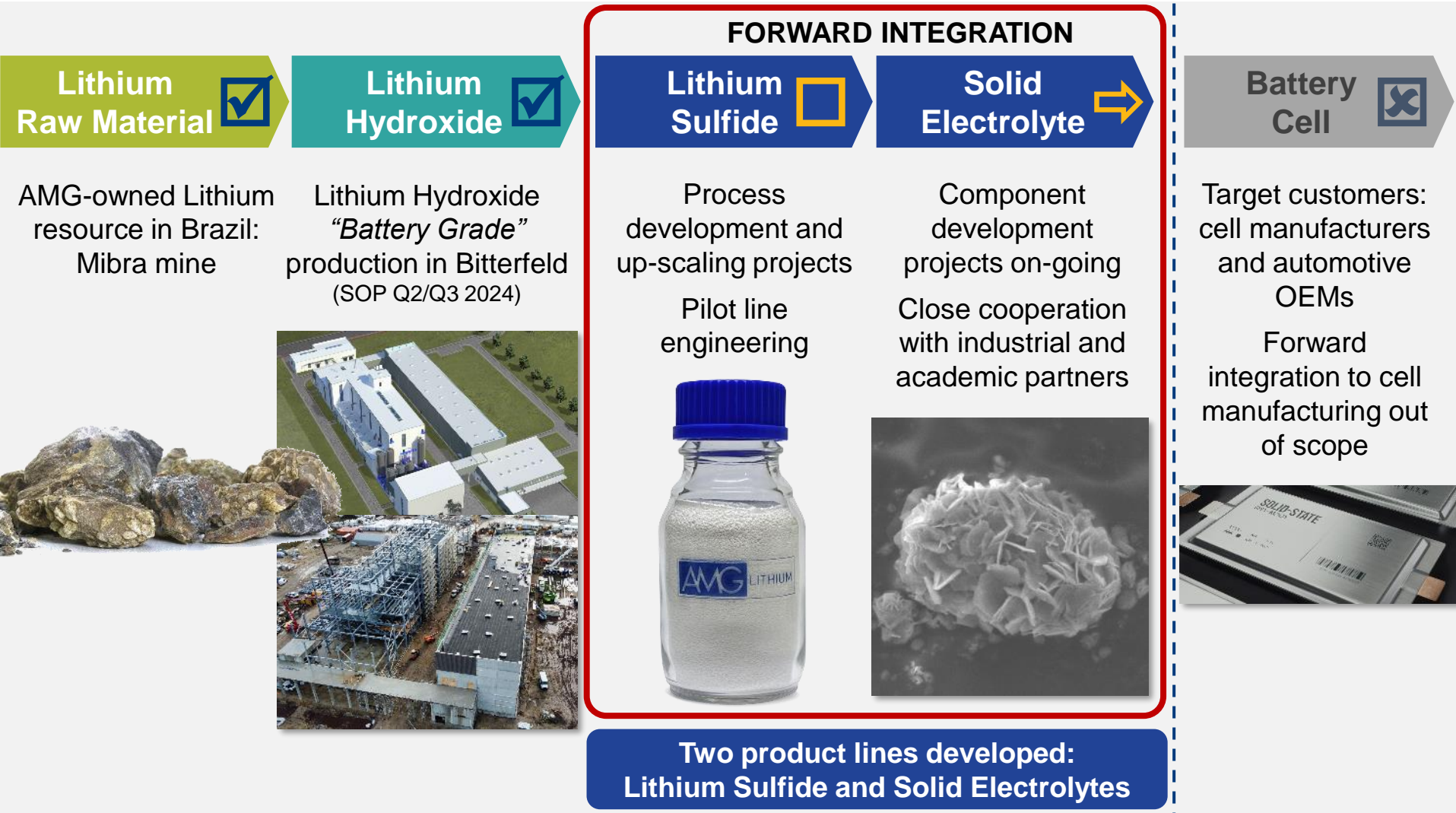
### Application & Market:

- Forecasts estimate 5-7% market penetration in 2030 (total market of ~5.000 GWh)
- EV market forecast indicates large growth potential on long-term view 2030+

### Current activities:

- **Samsung** is currently commissioning a 1 GWh pilot production line
- **Toyota** and Idemitsu entered cooperation; **CATL** to supply Chinese automotive OEMs from 2028 onwards
- **BMW** placed investment in **Solid Power** (20 mio €), **VW** in **Quantumscape** (100 mio €)

# VALUE CREATION: FROM MINE TO BATTERY COMPONENTS



# GLOBAL CUSTOMER ACTIVITIES

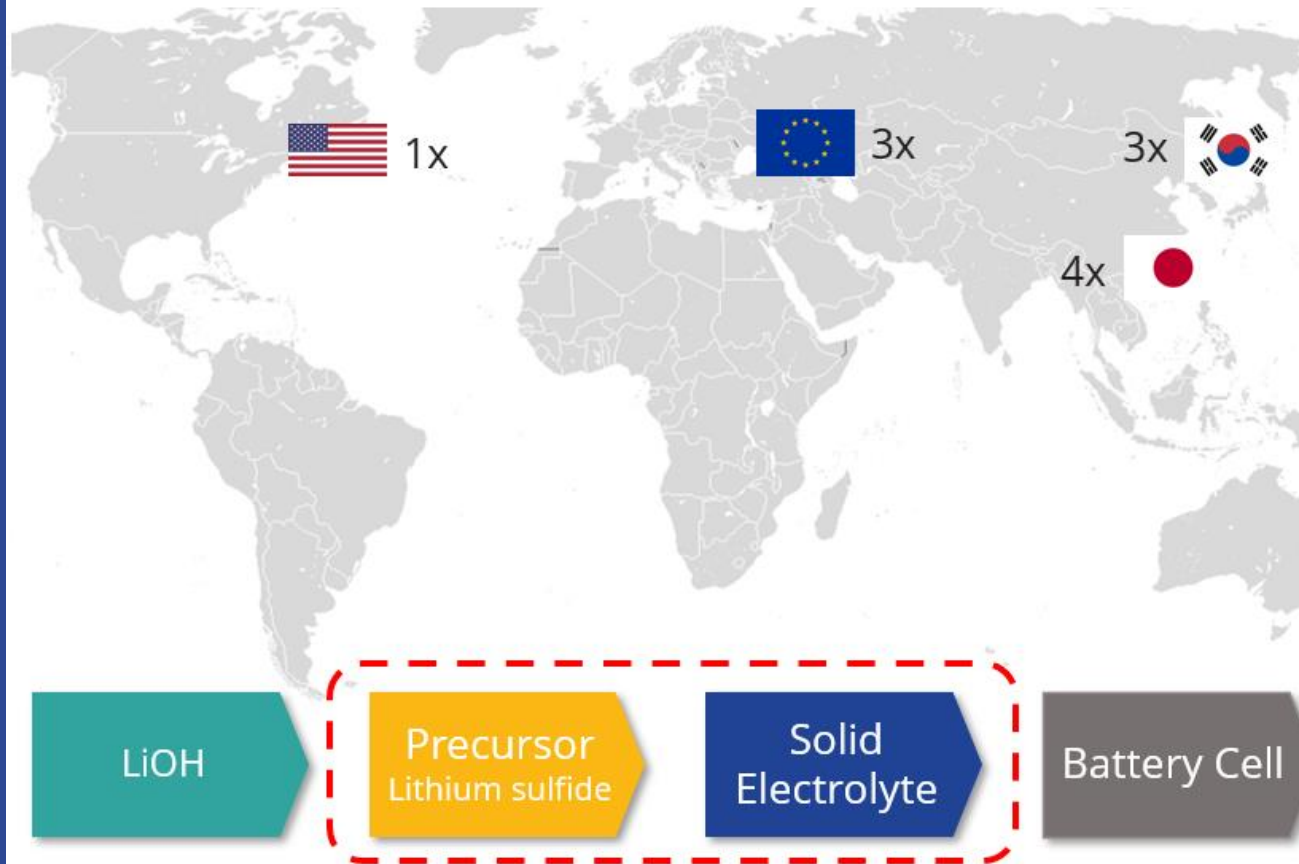
## Current Status:

Projects with customers in:

- Europe (3x): development projects & evaluation
- USA (1x): qualification
- Japan (4x): qualification & evaluation projects
- Korea (3x): sampling / evaluation

## Our position:

- AMG Lithium is technology enabler
- Position as development partner and prospective material supplier; ramp-up schedule aligned to accommodate evaluation and qualification projects at customers' site.
- Backward integrated technology leader to Lithium source and precursors for solid electrolyte production





# ALL-SOLID-STATE BATTERY ACTIVITIES – A GLOBAL LEADER

## **Advanced Technology & Processing:**

- High performance materials with a broad variety of modifications
- Flexible process technology to accommodate customized solutions

## **Decades of experience of the technical and commercial teams:**

- Team members with more than 10 years expertise in the field of solid electrolyte and battery materials
- Pioneers in Argyrodite and Lithium Sulfide development
- Strong technical background based on early decision for sulfidic materials

## **Excellent position in customer network:**

- Global network with automotive OEMs
- Close cooperation with leading players

## **Secured material streams:**

- Backward integrated to Lithium mine, control of precursor materials
- Close cooperation with base material suppliers
- Fully qualified sourcing with secured, long-term supply streams

# APPENDIX



# AMG SPODUMENE CONTRACT PRICE IS DIRECTLY TIED TO SPOT PRICE FOR LITHIUM CARBONATE AND HYDROXIDE

## AMG Spodumene Contract Components

**Component  
I**

Average Index Spot Price<sup>1</sup>:  
*(Lithium Carbonate + Lithium Hydroxide) / 2*

**Component  
II**

Total Cost =  
*Minimum Spodumene Price + Conversion Cost*

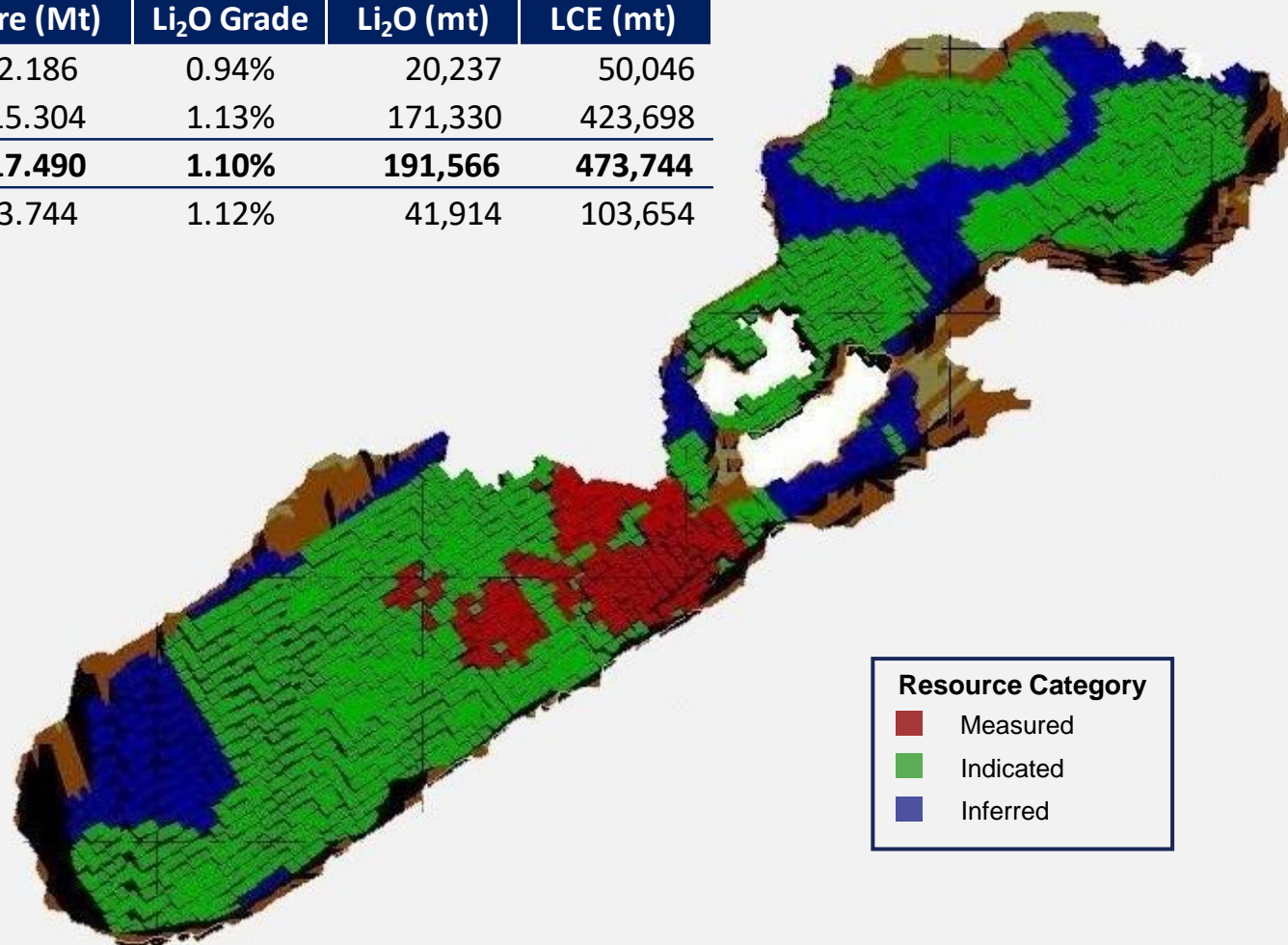
**AMG  
Spodumene Price**

*(I – II) % + Minimum Price*

<sup>1</sup> Asian Metal Market spot price

# MIBRA RESOURCE – 2021

Category	Ore (Mt)	Li <sub>2</sub> O Grade	Li <sub>2</sub> O (mt)	LCE (mt)
Measured	2.186	0.94%	20,237	50,046
Indicated	15.304	1.13%	171,330	423,698
<b>Measured &amp; Indicated</b>	<b>17.490</b>	<b>1.10%</b>	<b>191,566</b>	<b>473,744</b>
Inferred	3.744	1.12%	41,914	103,654







LITHIUM LAB



LITHIUM HYDROXIDE - BITTERFELD, GERMANY



LIVA BATTERY



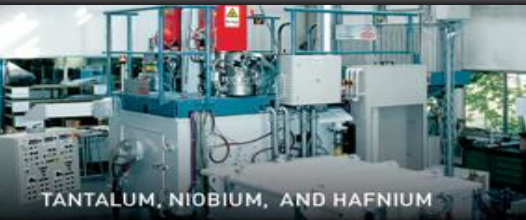
LI PROCESSING, AMG BRAZIL



TITANIUM



PLUTONIUM



TANTALUM, NIOBIUM, AND HAFNIUM

This announcement appears as a matter of record.



AMG's LAW:

"Everything that  
can be recycled  
will be recycled."

AMG Critical Materials N.V.

[amg-nv.com](http://amg-nv.com)



LITHIUM TAILINGS



ENGINEERING - HANAU, GERMANY



MELTSHOP - ZANESVILLE, OHIO



V<sub>2</sub>O<sub>5</sub>



VANADIUM, MOLYBDENUM AND NICKEL - CAMBRIDGE, OHIO



VANADIUM, MOLYBDENUM AND NICKEL - ZANESVILLE, OHIO