



Dossier

INDUSTRIAL DECARBONISATION: A BEST PRACTICES DOSSIER FROM ACROSS EUROPE

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Introduction

These dossiers highlight best practices from across the EU in industrial decarbonisation, featuring projects ranging from primary extraction to recycling of structural metals and CRMs. Three out of the five cases presented have been designated by the European Commission as 'strategic projects' under the EU CRM Act.

The document highlights the key actions each project is taking to achieve its production and decarbonisation targets, as well as the challenges they face. The analysis emphasises the business model and financial instruments that play a major role in bridging decarbonisation targets with maintaining economic competitiveness in heavy industry.

The cases also serve as a benchmark for assessing where the Czech Republic stands compared to the rest of Europe in terms of how well these projects are progressing and what lessons can be adapted towards the Czech case.

1. VOESTALPINE AG GREENTEC STEEL

The Voestalpine Greentec Steel project aims to replace existing BF-BOFs with two new EAFs, with a view to expanding production of scrap-based steel to 2.5 Mt. The expected costs of the investment are €1.5bn, which is predominantly financed by the EIB, Austrian Government, and Voestalpine's Green Financing Framework.¹ The first phase of EAF replacement is expected to be operational at both Linz and Donawitz by early 2027 and will reduce the steel plant's carbon footprint by 4 MT of CO₂ annually. The main challenges currently are sustaining electricity costs, scaling up hydrogen power, and maintaining long-term market demand for green steel.



Linz

voestalpine AG, "Rendering Linz 2027,"
https://cdnstorevoestalpine.blob.core.windows.net/image-container/956482/Open_CMS_Print/greentec-steel-linz-rendering.jpg.



Donawitz

voestalpine AG, "Rendering Donawitz 2027,"
https://cdnstorevoestalpine.blob.core.windows.net/image-container/956473/Open_CMS_Print/Donawitz_Still_Shot01_DE.jpg

¹ voestalpine AG, "voestalpine Supervisory Board Approves EUR 1.5 Billion for Further Decarbonization," press release, 22. March 2023, <https://www.voestalpine.com/group/en/media/press-releases/2023-03-22-voestalpine-supervisory-board-approves-eur-1-5-billion-for-further-decarbonization/>. ; European Investment Bank, "Austria: voestalpine to Receive €300 Million EIB Loan for Research and Development of Green Steel Production," press release, 1. July 2024, <https://www.eib.org/en/press/all/2024-230-austria-voestalpine-to-receive-eur300-million-eib-loan-for-research-and-development-of-green-steel-production>

Project Overview

Organization	Voestalpine AG
Sector	Steel
Technology	Electric Arc Furnace (EAF)
Investment	€1.5 billion
Project Status	Full-scale, construction underway

What problems does the project address?

Following decarbonization policies (NZIA, CRMA, CBAM, ETS) introduced by the EU targeting intensive industries such as steel-making, Voestalpine's greentec steel project aims to address reducing emissions produced in its activities and production, targeting a sum of 30% reduction under Scope 1 and 2, and 25% under Scope 3 by 2029 to reach net-zero emissions by 2050.² This project also works to reinforce circular models by reintegrating high-quality scrap as the primary raw material for EAFs to eliminate dependence on imported coking coal.

What does the project do?

- Replacement of traditional and carbon-intensive steel-making technology (BF-BOFs), with limited capacity to use scrap as a primary input, with EAFs powered by green electricity to produce green steel marketed as 'greentec steel edition' premium line.
- Reduction of Scope 1, 2, and 3 emissions: reduction of carbon footprint is targeted not only in the production, but also in the operational activities of

² voestalpine AG, "Climate Action," in *Corporate Responsibility Report 2024*, voestalpine AG, 2024, <https://reports.voestalpine.com/2024/cr-report/assets/downloads/klimaschutz-va-crr24.pdf>, 50.

the Linz and Donawitz sites. This is approached through securing renewable electricity to power the EAFs and the scaling of green hydrogen power, drawing from Voestalpine's pilot project H2FUTURE, which relies on PEM electrolysis mechanisms.

Main Challenges

- **Scale of Investment:** The replacement of BF-BOFs with EAFs at both Linz and Donawitz requires a considerable amount of investment, which Voestalpine AG secured through multilayer investments, the majority of which is sourced from the EIB, Austrian state subsidies, and Voestalpine's own Green Financing Framework.³ The Greentec steel project was also rejected for funding from the EU ETS Innovation Fund for the construction of the EAFs.
- **Electricity Costs:** This project is also highly dependent on securing green electricity at viable prices. In May 2025, Voestalpine issued a press release demanding energy price compensation from the federal government to maintain competitiveness, investments, and the security of jobs.⁴ Moreover, to reach the net-zero target by 2050, this project relies on the potential for hydrogen-based steel making to be scaled beyond its pilot projects and for green hydrogen to be available at affordable prices.
- **Market Demand/Risk:** Greentec steel remains a premium product, which depends on the willingness of customers to absorb higher costs for carbon-reduced steel. This demand can also be steered by EU regulations on imports of cheaper, yet more carbon-intensive produced steel.

³ voestalpine AG, *Introducing voestalpine's Green Financing Framework*, non-deal related roadshow presentation, June 2024, <https://www.voestalpine.com/group/static/sites/group/downloads/de/aktie/anleihen/greenfinance/greenfinancing-presentation.pdf>.

⁴ voestalpine AG, "voestalpine Group Successfully on Course with 'Strategy 2020' – Profitability Targets Remain Unchanged," press release, 17. December 2015, <https://www.voestalpine.com/group/en/media/press-releases/2015-12-17-voestalpine-group-successfully-on-course-with-strategy-2020-profitability-targets-remain-unchanged/>.

Key Takeaways

- **Early downstream customer engagement:** Voestalpine's carbon-reduced premium steel marketed as 'greentec steel edition' was introduced to customers five years before the expected commissioning of the EAFs.⁵ By employing its hydrogen-based reducing agents, Voestalpine is able to make early marketisation of its green steel possible and allows for minimal disruption in its revenue patterns.
- **Phased/hybrid approach:** to reduce risking the project's success, Voestalpine approaches its ambitious goals through a phased timeline with careful consideration of the marketability of CO₂-reduced steel and re-skilling of its workforce with a commitment to no net-job losses for Phase 1 of the EAF transition.⁶ Gradually phasing in new Carbon Direct Avoidance technology and phasing in EAFs offer greater confidence not only in the project's success, but also in investors seeking to purchase 'green bonds' through Voestalpine's Green Financing Framework.
- **Technological readiness:** Voestalpine AG has undertaken various pilot projects at an early stage that are focused on R&D of Carbon Direct Avoidance technology (Hy4Smelt, H2FUTURE, SuSteel) on a smaller scale before applying it to the Linz and Donawitz sites.
- **Securing Scrap Supply:** In parallel to the development of EAFs, this project also emphasises the importance of attaining high-quality scrap material supply. Purchasing pre-consumer scrap can be costly due to lower supply, which is why Voestalpine has pursued a flagship project with Mercedes-Benz and TSR Recycling to process post-consumer scrap into high-quality scrap.⁷

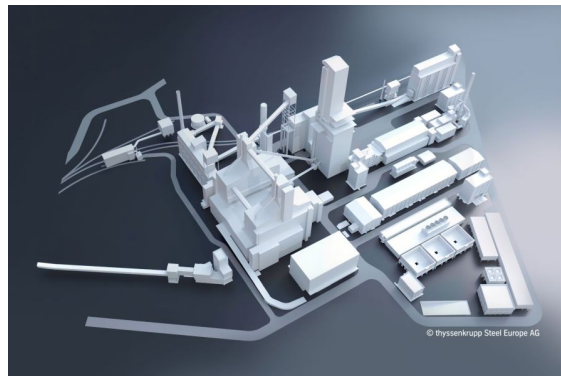
⁵ voestalpine AG, "voestalpine Delivers First CO₂-Reduced Premium Steel to Customers," press release, 13. June 2022, <https://www.voestalpine.com/group/en/media/press-releases/2022-06-13-voestalpine-delivers-first-co2-reduced-premium-steel-to-customers/>.

⁶ voestalpine Corporate Blog, "We Are Creating Tomorrow's 'Green Jobs,'" 25. October 2023, <https://www.voestalpine.com/blog/en/career/working-environments/we-are-creating-tomorrows-green-jobs/>.

⁷ voestalpine AG, "voestalpine, Mercedes-Benz, and TSR Launch Showcase Project in Circular Economy," press release, 14. May 2024, <https://www.voestalpine.com/group/en/media/press-releases/2024-05-14-voestalpine-mercedes-benz-and-tsr-launch-showcase-project-in-circular-economy/>.

2. THYSSENKRUPP AG - tkH2Steel/bluemint® Steel

tkH2Steel is Thyssenkrupp's approach to decarbonising the steel industry by replacing coal-based blast furnaces with a DR plant in Duisburg that will eventually be powered by green hydrogen to produce an output of 2.5 Mt of direct-reduced iron while offsetting 3.5 Mt of CO₂.⁸ The cost of this project is roughly €3 billion, drawing the majority of investments from public grants amounting to approximately €2 billion and €1 billion from Thyssenkrupp's corporate equity.⁹ Currently, this project faces challenges of securing a hydrogen tender at commercially competitive prices and internal restructuring of Thyssenkrupp's steel division.



thyssenkrupp Steel Europe, "3D Model of the Plant Complex Planned at the Duisburg Location," https://www.thyssenkrupp-steel.com/media/content_1/presse/bilder/2023_1/maerz_5/motiv_dr-anlage_pm_image_w1300.jpg.

⁸ thyssenkrupp Steel Europe, "bluemint® Steel: CO₂-Reduced Steel," thyssenkrupp Steel, <https://www.thyssenkrupp-steel.com/en/products/bluemint/bluemint.html>.

⁹ GMK Center, "Thyssenkrupp: Looking for Ways to Save the Steel Business," *GMK Center*, 26. December 2024, <https://gmcenter/en/posts/thyssenkrupp-looking-for-ways-to-save-the-steel-business/>.

Project Overview

Organization	Thyssenkrupp AG
Sector	Steel
Technology	Direct Reduction (DR) Plant
Investment	~€3.3 billion
Project Status	Full-scale, construction underway

What problems does the project address?

The replacement of blast furnaces with DR plants seeks to address CO₂ emissions from steel production, specifically targeting the iron-making step. Furthermore, the old model offered no circular recovery from the ore-to-iron process, which iron ore is currently imported. Pressure to seek sustainable solutions is also compounded by rising ETS compliance costs.

What does the project do?

- Addresses reducing Scope 1 & 2 emissions in producing bluemint® green steel by constructing a DR plant that will eventually run fully on hydrogen power. Before fully employing hydrogen power, the DR plant is able to operate on natural gas to allow a phased approach to reaching its decarbonisation targets.
- The EPC contract for this project was awarded to SMS Group, which plans on constructing the DR plant based on MIDREX® Flex technology and will also incorporate infrastructure to support water recycling on site.¹⁰

¹⁰ HTW Editorial Team, "thyssenkrupp Steel Awards €1.8 Billion Contract to SMS Group for H₂-Powered DRI Plant," *Hydrogen Tech World*, 1. March 2023, <https://hydrogentechworld.com/thyssenkrupp-steel-awards-e1-8-billion-contract-to-sms-group-for-h2-powered-dri-plant>.

- Construction of a 40km pipeline between Duisburg and Dorsten (DoHa project) in order to complete the uptake of hydrogen power in Duisburg, the tkH2Steel project requires the construction of a hydrogen pipeline between Duisburg and Dorsten to secure connection to the supraregional H₂ network.¹¹

Main Challenges

- **Hydrogen Supply & Pricing:** While the construction of this pipeline remains in progress, Thyssenkrupp confirmed with S&P Global Platts that it has paused negotiations on their tender for hydrogen procurement citing prices being higher than previously assumed.¹² This also signals a broader issue of underdevelopment of the European green hydrogen market, which is infrastructurally delayed and current pricing setting back green steel to be competitive enough against carbon-intensive produced steel.
- **Conditional Payment Mechanism:** The European Commission granted state aid approval for German federal and state funding totalling to roughly €2 billion. This funding package consists of a Direct Grant (€550 million) for the development of this project and a Conditional Payment (€1.45 billion) for the DR plant to transition from natural gas to uptake hydrogen.¹³ However, the obstacle of securing long-term hydrogen supply puts not only the project timeline at risk, but the security of finances from the Conditional Payment Mechanism.

¹¹ thyssenkrupp Steel Europe, "Climate-Neutral Steel – Our Strategy," thyssenkrupp Steel, last modified 20. February 2026, <https://www.thyssenkrupp-steel.com/en/company/sustainability/climate-strategy/climate-strategy.html>.

¹² Eurometal, "thyssenkrupp Steel Pauses German Green Hydrogen Tender on High Prices," *Eurometal*, 26. March 2025, <https://eurometal.net/thyssenkrupp-steel-pauses-german-green-hydrogen-tender-on-high-prices/>.

¹³ European Commission, "State Aid: Commission Approves German €550 Million Direct Grant and Conditional Payment Mechanism of up to €1.45 Billion to Support ThyssenKrupp Steel Europe in Decarbonising Its Steel Production and Accelerating Renewable Hydrogen Uptake," press release, 20. July 2023, https://ec.europa.eu/commission/presscorner/api/files/document/print/es/ip_23_3928/IP_23_3928_EN.pdf.

- **Financial Distress of the Steel Division:** Thyssenkrupp had reported a significant group net loss of €1.4 billion in FY2023/2024, €1 billion of which was lost in the steel division (Steel Europe).¹⁴ For this period, these losses were due to weak demand from key customer industries, competition with manufacturers in Asia, and high energy costs associated with decarbonisation efforts.¹⁵ Recently, financial reporting on Q1 2025/2026 states that the group has experienced a further net loss of €334 million, which was largely driven by the restructuring of the 'Steel Realignment' collective agreement.¹⁶ These financial pressures may affect the capacity for Thyssenkrupp to secure enough capital for completion and commissioning of the tkH2steel project.

Key Takeaways

- **Public Co-Funding:** This project relies on a generous amount of federal and state funding approved by the European Commission. The European Commission press release notes that Thyssenkrupp would not have proceeded in investments towards green steel production without public support.¹⁷
- **Economic Viability of the Hydrogen Market:** Currently, the European supply chain for green hydrogen lags behind in infrastructure development and price competitiveness. These delays in commercializing green hydrogen puts at risk the bridging between decarbonisation efforts through

¹⁴ thyssenkrupp AG, "thyssenkrupp Held Its Ground in a Difficult Market Environment – Positive Free Cash Flow before M&A and Progress with the Transformation in Fiscal Year 2023/2024," press release, 11. December 2024, <https://www.thyssenkrupp.com/en/newsroom/press-releases/pressdetailpage/thyssenkrupp-held-its-ground-in-a-difficult-market-environment-positive-free-cash-flow-before-manda-and-progress-with-the-transformation-in-fiscal-year-20232024-289822>.

¹⁵ Ibid.

¹⁶ thyssenkrupp AG, "thyssenkrupp in the 1st Quarter of 2025/2026: Despite Market-Related Declines in Sales, EBIT up on Prior Year – Group Forecast Confirmed for All Key Performance Indicators," press release, 12. February 2026, <https://www.thyssenkrupp.com/en/newsroom/press-releases/pressdetailpage/thyssenkrupp-in-the-1st-quarter-of-20252026-despite-market-related-declines-in-sales-ebit-up-on-prior-year-group-forecast-confirmed-for-all-key-performance-indicators-311682> ; thyssenkrupp AG, "Consensus Reached on Collective Restructuring Agreement 'Steel Realignment': thyssenkrupp Steel and IG Metall Lay Foundation for Sustainable Future," press release, 12. July 2025, <https://www.thyssenkrupp.com/en/newsroom/press-releases/pressdetailpage/consensus-reached-on-collective-restructuring-agreement-'steel-realignment':-thyssenkrupp-steel-and-ig-metall-lay-foundation-for-sustainable-future-299681>.

¹⁷ European commission, "State Aid: Commission Approves German €550 Million Direct Grant," 20. July 2023, p. 2

green hydrogen uptake and the economic rationale underpinning this transition.

- **Technological Adaptability:** The DR plant is compatible with natural gas and hydrogen power, which relieves immediate pressure to secure a long-term hydrogen supply contract in advance while still reducing carbon footprint. This offsets some of the risk behind the delays in securing a hydrogen tender as natural gas will reduce CO₂ emissions by roughly 50% compared to coal-powered blast furnaces.¹⁸ As such, the hydrogen question does not need to be immediately resolved for the DR plant to make meaningful progress in reaching its decarbonisation targets.

3. ELEMENTAL BATTERY METALS - POLVOLT

The POLVOLT is one of the EU's CRMA strategic projects that aims to establish a site for smelting and refining of strategic metals and e-scrap to produce battery-grade metals and other refined metals necessary for industries in electromobility, renewable energy, telecommunications, and defence. POLVOLT consists of two platforms, the first of which focuses on processing copper and e-scrap metals. Platform 2 focuses on refining battery black mass into lithium compounds, nickel and cobalt intermediates, and selected battery-grade materials.¹⁹ The expected cost of this project is ~€688.6 million for Platform 1, however the total expenditure for Platform 2 has not yet been disclosed pending evaluation for the technology required and the market conditions for refining battery metals in Europe. This project is financed predominantly through the EU Innovation Fund (€150.5 million), the Polish government's TCTF grant (~€240 million), and a pending EIB loan that is currently under appraisal, covering only Platform 1 of the project (€87

¹⁸ thyssenkrupp Steel Europe, "Transformation of the Steel Industry Can Become a Model for the Transition to Climate Neutrality," press release, 28. June 2021, <https://www.thyssenkrupp-steel.com/en/newsroom/press-releases/transformation-of-the-steel-industry-can-become-a-model-for-the-transition-to-climate-neutrality.html>.

¹⁹ Elemental Group, "Polvolt Project," Elemental Group, <https://www.elemental.biz/polvolt/>.

million). The main challenges to the project currently include confirming a key technological partner with copper smelting competence, assessing market conditions for the viability of Platform 2, and Poland’s coal-intensive energy grid.



Elemental, "Siedziba Elemental Zawiercie - zakład," 2026,
<https://elementalbatteries.com/media/system/podstrony/ELEMENTAL-V5-AERIAL-2.jpg>.

Project Overview

Organization	Elemental Group - Elemental Battery Metals
Sector	CRMs & SRMs: Copper, Nickel, Cobalt, Manganese, Lithium (battery-grade), PGMs
Technology	Pyrometallurgy (Platform 1) & Hydrometallurgy (Platform 2)
Investment	~€715 million (Platform 1)
Project Status	Pre-construction/financing

What problems does the project address?

Currently, Europe is heavily dependent on China for processing and refining critical materials to be imported back into the EU. As of 2024, China refines ~74% of lithium carbonate globally, ~90% of REE capacity, and ~74% of cobalt refining.²⁰ In an effort to reduce this dependency and close the circularity loop in Europe, POLVOLT targets building domestic capabilities for refining copper, precious metals, and battery black mass. This project aligns with the EU's CRMA targets, which emphasise the goal of sourcing 25% of the EU's consumption from recycled materials.²¹ This not only contributes to achieving a circular economy but also encourages greater resilience of European industry towards global price volatility, supply chain disruptions, and geopolitical crises. Lastly, Elemental Group cites that the POLVOLT project will address the rising demand for copper and other structural metals in areas such as e-mobility, renewable energy infrastructure, and AI data centres.²²

What does the project do?

- This project is approached in phases, divided into two platforms. Platform 1 accounts for the first phase and the dominant aspect of this project, which seeks to process copper-bearing materials and e-scrap to recover high-purity copper, precious metals, and other selected rare and speciality

²⁰ Green Li-ion, "Poland Battery Recycling: Central Europe Capacity Build," Green Li-ion, <https://www.greenli-ion.com/post/poland-battery-recycling-infrastructure-investment>.

²¹ European Commission, "Critical Raw Materials Act," Internal Market, Industry, Entrepreneurship and SMEs, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials/critical-raw-materials-act_en.

²² Elemental Group, "Polvolt Project."

metals recovered from circuit boards and electronics.²³ Platform 2 focuses on refining black mass recovered from spent lithium-ion batteries to produce lithium compounds, nickel and cobalt intermediates, and selected battery-grade materials.²⁴ Furthermore, Platform 2 will integrate black mass into its primary feedstock produced by an adjacent mechanical pre-treatment facility, the Elemental Strategic Materials (ESM) plant.

- POLVOLT's approach to creating domestic capabilities for CRM refining is very contingent on market-driven conditions and demand for CRMs and structural metals. Especially in planning Platform 2, POLVOLT is not looking to immediately secure large-scale investments ahead of future market conditions, nor does it aim to directly compete with large-scale refining firms in Asia. Instead, the project will cautiously approach its business strategy by targeting niche parts of the refining process where there is potential for profitability and plans to commence operations of Platform 2 once end-of-life electric vehicle batteries have reached the European recycling market.²⁵

Main Challenges

- **Securing Investment/Financing:** Securing adequate funding, especially for Platform 1, is crucial in advancing the timeline towards beginning the construction of the copper platform. Elemental Group is currently seeking a technological and industrial partner to acquire a 33%-49% equity stake in Platform 1 of the project to further develop the design, construction, and operation of the copper smelting and refining facilities.²⁶
- **Market Viability for Platform 2:** While the copper platform (Platform 1) of the overall project serves a mature and undersupplied market, Platform 2 is dependent on the growth and competitiveness of the European battery manufacturing market. Specifically, this is dependent on a sufficient supply of black mass extracted from end-of-life EV batteries and the domestic

²³ Ibid.

²⁴ Ibid.

²⁵ Ibid.

²⁶ Ibid.

availability of recycled inputs. If the European market does not meet these conditions by the time Elemental Group makes its assessment for Platform 2, large-scale investments towards developing these capabilities would likely be economically unviable.

- **Scope 2 Emissions:** While there are no announced plans for how POLVOLT will power its operations, technologies in Platforms 1 & 2 are typically powered by natural gas, fuel oil, and electricity. Considering that Poland's electricity generation is ~56% dependent on the usage of coal, there is concern for how this project plans on decarbonising its technology and Scope 2 emissions.²⁷ As a result, the potential rise in Scope 2 emissions signals potential vulnerability towards electricity price volatility and setbacks in progress towards decarbonisation.

Key Takeaways

- **Cautious Industrial Strategy:** The POLVOLT project approaches its business model and timeline in a cautious and disciplined manner. Platform 1 has identified a growing demand for copper and e-scrap while supply remains short. Moreover, Platform 1 is currently identifying which final form of copper best matches the streams of demand that would generate the highest margins. Before Platform 2 commits to large capital expenditures, it will assess the market conditions once the first wave of end-of-life EVs has reached the European market and avoid direct competition with firms in Asia that outsize the capacity of refinement in Europe.
- **Closing the Circularity Loop & Strategic Autonomy:** Currently, the circularity of the battery recycling chain falls short in the refinement step, which is being outsourced to China. Developing domestic capabilities for refinement of CRMs and SRMs not only encourages circularity of industrial value chains but also reinforces the strategic autonomy of European industry. This is a crucial sticking point for developing a rationale behind supporting sustainable practices and strengthening geopolitical resilience and economic competitiveness.
- **Strategic Partnerships:** A crucial step to materialising the POLVOLT project requires strategic partnerships with firms that have expertise in designing,

²⁷ International Energy Agency, "Poland Energy Mix," IEA, <https://www.iea.org/countries/poland/energy-mix>.

engineering, and constructing the technology required for refining facilities. The selection of a strategic industrial partner will not only determine the timeline and viability of this project but also shape the long-term operational competitiveness of POLVOLT in the CRM refining market.

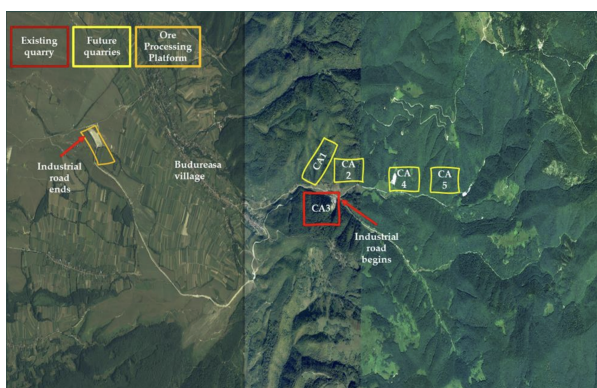
4. VERDE MAGNESIUM

The Verde Magnesium (VerdeMg) project is working to revive Europe's industry in magnesium extraction through sustainable practices by relying on renewable energy sources in Budureasa, Romania. This project has the potential to expand production of magnesium metal from 5,000 t (first commercial phase) to 90,000 t annually.²⁸ The expected costs of the investment are ~\$1 billion (USD), 10% of which will be dedicated to the redevelopment of mining and 41% of which will be used for developing the magnesium smelter.²⁹ This is largely financed by VerdeMg's equity sponsor, Amerocap, the Romanian government, and further financing is being accessed through the project's CRMA strategic designation. The project should be operational by early 2027 (pilot scale) and commercial operations commencing by late 2028.³⁰ The main challenges this project currently faces are regulatory/permitting obstacles, securing EU public financing, and foreseeable cost competitiveness against Chinese imports.

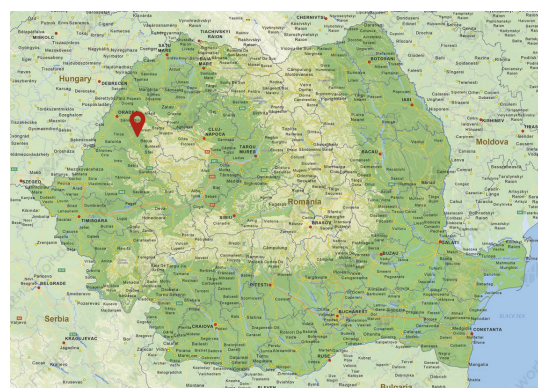
²⁸ Alexandru Rosu, "Verde Magnesium: A Strategic Project in the European Union" (presentation, 81st IMA World Magnesium Conference, Fukuoka, Japan, May 19–21, 2024), <https://cdn.ymaws.com/www.intlmag.org/resource/collection/1B278489-BEAC-4779-8813-E1E6F7D06DEA/IMA-Verde-Magnesium-Alex-Rosu-Tues-11-20-11-40.pdf>, p. 8

²⁹ Rosu, "Verde Magnesium: A Strategic Project in the European Union," p. 5

³⁰ Rosu, "Verde Magnesium: A Strategic Project in the European Union," p. 8



Rosu, "Verde Magnesium: A Strategic Project in the European Union," slide 12.



Rosu, "Verde Magnesium: A Strategic Project in the European Union," slide 11.

Project Overview

Organization(s)	Verde Magnesium & Amerocap
Sector	Magnesium metal
Technology	Aluminothermic Reduction Technology (ATR)
Investment	~\$1 billion (USD)
Project Status	Under Development

What problems does the project address?

While the EU has an abundant supply of magnesium-bearing metal, it currently imports 100% of magnesium metal primarily from China.³¹ This project seeks to revive Europe's domestic capabilities for extracting and processing magnesium-bearing metals, which VerdeMg is approaching through redeveloping a large

³¹ European Commission, *Strategic Projects under the Critical Raw Materials Act: Strategic Raw Materials — Magnesium Metal*, Publications Office of the European Union, 2025, <https://webgate.ec.europa.eu/circabc-ewpp/d/d/workspace/SpacesStore/0cff8447-1caf-4385-a31a-d57624722d3a/download>.

brucite deposit in Romania. Furthermore, this project reinforces circularity by incorporating aluminium scrap alongside the mined and calcined brucite.

What does the project do?

- **MineCo:** The first aspect of VerdeMg is situated as a brownfield project. VerdeMg secured mining rights to a previously abandoned brucite deposit in Budureasa. This deposit was evaluated to have >50 Mt of resources and reserves with a high MgO content (>22%).³² Brucite ore and other deposits in this quarry are highly versatile, offering various materials relevant for mining products and construction materials. Moreover, brucite ore offers a competitive advantage in producing magnesium metal: the calcined material has a much lower weight and requires a lower calcination temperature, significantly lowering the carbon footprint compared to other feedstocks.
- **SmelterCo:** The second component of this project is developing domestic and sustainable capabilities for magnesium processing. Rather than relying on the carbon-intensive Pidgeon process, this project will implement aluminothermic reduction technology, which emits far fewer emissions. Alongside the mined brucite, this process will incorporate post-consumer and industrial aluminium scrap as a reducing agent.
- **Renewable Energy Sources:** SmelterCo will rely on renewable energy sources to power its operations. VerdeMg plans to build solar panels to source the majority of the required energy, and any remaining energy required will be sourced by RES producers.³³ Budureasa (Bihor County) offers great potential as a geothermal hub, thus making solar and geothermal energy a viable source in the region.

³² Rosu, "Verde Magnesium: A Strategic Project in the European Union," p. 10

³³ Verde Magnesium, "Who Is Verde Magnesium?," YouTube video, 3. March 2023, <https://youtu.be/ihlHUiFYEnA>.

Main Challenges

- **Permitting/Regulation:** The project initially faced major issues in regulatory bottlenecks and delays in obtaining a mining license from the National Agency for Mineral Resources of Romania. The public tender process was blocked in 2019 with little explanation, which created considerable delays in achieving production by 2025. The mining license was not secured until December 2024. VerdeMg has also been vocal about EU-wide issues in developing CRM projects in Europe, citing regulatory obstacles in permitting and considerable cost structure gaps compared to imports.³⁴
- **Cost Competitiveness:** Considering the EU imports 100% of its magnesium metal from abroad, VerdeMg faces fierce competition from abroad (predominantly China) against cheaper imports and the sheer capacity of mining and processing capabilities. This highlights the importance of industrial economic policies such as the CBAM in supporting domestic capabilities and competitiveness for sustainable industry.
- **Project Financing:** The project investment (~\$1 billion USD) relies on financing from its equity sponsor, Amerocap, the Romanian government, and EU public financing. While financing from Amerocap has been secured, funding from the Romanian government and the EU has not yet been contracted. The EU's CRMA designation towards this project opens opportunities for VerdeMg to secure public financing, but this action has yet to be completed.
- **Scaling ATR Technology:** Employing ATR technology has not yet been proven feasible at an industrial scale, which is why VerdeMg plans to undertake a pilot industrial test before scaling output production. This goes hand in hand with the need for greater capital intensity in scaling ATR technology rather than relying on the Pidgeon process, which currently dominates global production.

³⁴ Argus Media, "Q&A: EU Strives for Local Magnesium Production," *Argus Media*, 3. April 2023, <https://www.argusmedia.com/en/news-and-insights/latest-market-news/2435793-q-a-eu-strives-for-local-magnesium-production>.

Key Takeaways

- **Strategic Location:** Budureasa (Bihor County) offers a significant geothermal advantage, which links the rationale behind reviving Europe's magnesium mining industry with adopting sustainable practices. VerdeMg is not only purchasing renewable energy, but also plans on expanding renewable infrastructure in the region by constructing more solar panels to support ATR technology.
- **Major Equity Sponsor:** Verde Magnesium has the financial support from Amerocap, a private equity firm that owns 70% of this project.³⁵ Having a long-term industrial sponsor like Amerocap enables de-risking of what can be seen as a high-stakes project utilising first-of-a-kind technology at an industrial scale. Moreover, Amerocap's majority stake and long-term commitment to VerdeMg reflect greater credibility for potential institutional lenders to commit towards financing the project.
- **Combining Extraction with Circularity:** In producing magnesium metal, VerdeMg incorporates both primary extraction of brucite ore and aluminium scrap as primary feedstock in the smelters. The output of magnesium metal and green byproducts (relevant for cement, metallurgical, and chemical industries) will also have the potential to be reincorporated back into the smelters.
- **Automotive Industry:** Magnesium is the lightest structural metal and is 35% lighter than aluminium and 78% lighter than steel.³⁶ Especially in EV production, reliance on the lightweight nature of magnesium allows for greater battery efficiency and increased range.³⁷ VerdeMg also identifies the expanding application of magnesium into parts such as transmission casings and structural assembly parts.³⁸

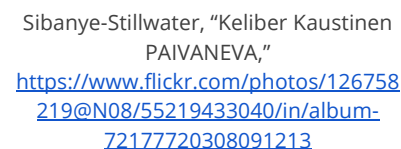
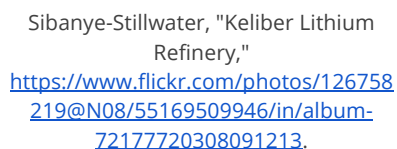
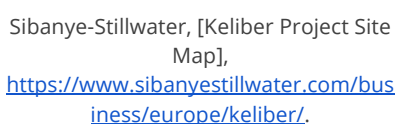
³⁵ S.C. Verde Magnesium S.R.L., "Organisation Detail," EU Transparency Register, https://transparency-register.europa.eu/search-register-or-update/organisation-detail_en?id=924610441093-11.

³⁶ Arnold and Sawyer, "Verde Magnesium: Europe's Critical Minerals Comeback."

³⁷ Ibid.

³⁸ Ibid.

Sibanye-Stillwater's Keliber Lithium is an integrated lithium extraction and processing project in Finland. The project owns several lithium-rich deposits, where it aims to extract lithium-bearing spodumene and employ innovative soda pressure leaching as a less carbon-intensive refining route. Moreover, the use of soda pressure leaching is done in partnership with Metso Outotec, a sustainable technology firm. The total CAPEX towards this project is €783 million, which is largely supported through a green loan that is sourced from EIB financing, commercial banks guaranteed by Finnvera, and a syndicated group of commercial banks. Construction for this project has been completed and mining commenced in Q2 2026. The project is estimated to be operating at full capacity by 2028 and expects to yield 15,000 tonnes of lithium hydroxide monohydrate. The main challenges to this project are high capital expenditures, volatile global prices for lithium hydroxide, and permitting issues.



Project Overview

Organization(s)	Sinbaye-Stillwater (79.82%), Finnish Minerals Group (20%), Finnish Shareholders (0.18%)
Technology	Soda Pressure Leaching (SPL)
Sector	Lithium Hydroxide
Investment	€783 million (CAPEX)
Project Status	Construction Completed (Q1 2026), Mining Commenced, Production Ramp-Up Underway

What problems does the project address?

The Keliber integrated lithium extraction, concentration, and processing project is the EU's first mine-to-market endeavour in creating a domestic lithium supply chain. Currently, the EU is 81% dependent on foreign extraction and 100% dependent on processing of battery-grade lithium.³⁹ With these dependencies, European battery manufacturers are at high risk of disruptions in the global lithium supply chain due to geopolitical disruptions and price volatility. This project also addresses the carbon-intensive process of conventional lithium processing, which Keliber intends to employ an alternate soda pressure leaching process that yields less carbon emissions.

³⁹ European Commission, *Strategic Projects under the Critical Raw Materials Act: Strategic Raw Materials — Lithium (Battery Grade)*, Publications Office of the European Union, 2025, <https://webgate.ec.europa.eu/circabc-ewpp/d/d/workspace/SpacesStore/760da134-e3de-4421-a3d4-751cbea62e9a/download>.

What does the project do?

- **Integrated Extraction and Processing:** Keliber mines spodumene ore, which is converted into spodumene concentrate and finally refined into battery-grade lithium hydroxide. This supply chain is all done within a 43km radius in Central Ostrobothnia.⁴⁰
- **Soda Pressure Leaching (SPL):** As opposed to the conventional spodumene sulphate process, Keliber has partnered with Metso Outotec to implement technology for soda pressure leaching. This alternate refining process eliminates hazardous inputs (sulphuric acid), significantly reduces energy demand, and renders it less carbon-intensive.
- **Water Recycling:** The refinery's water consumption is roughly 80% circulated water with further plans of implementing water recycling technologies in the mining sites.⁴¹
- **Renewable Energy:** Renewable energy supplier Adven has built a concentrator that is dependent on heating through biofuels and electricity. This technology offers cost advantages over the volatile energy market while maintaining a lower carbon footprint.⁴² Moreover, the Keliber project is one of the least carbon-intensive lithium projects largely due to the Finnish electricity grid being largely sourced from low-carbon energy.⁴³
- **Circularity in By-Product Valorisation:** Analcime sand, a by-product of the chemical refining process can be used in the expansion of the Port of Kokkola harbour, thereby removing the solid waste stream from the refinery.

⁴⁰ Ibid.

⁴¹ Sibanye-Stillwater, "Construction of Keliber's Lithium Project to Start – Investment of 588 M€," press release, 28. November 2022, <https://www.sibanyestillwater.com/business/europe/keliber-en/keliber-news/2022/construction-of-kelibers-lithium-project-to-start-investment-of-588-me/>.

⁴² Adven, "The Energy Production Investment Project of the Sibanye-Stillwater's Keliber Lithium Project Is Progressing towards Commissioning," Adven, 5. June 2025, <https://adven.com/articles/the-energy-production-investment-project-of-the-sibanye-stillwaters-keliber-lithium-project-is-progressing-towards-commissioning/>.

⁴³ Sibanye-Stillwater, "Keliber Performs Well in Emissions Comparison," Sibanye-Stillwater, 9. March 2022, <https://www.sibanyestillwater.com/business/europe/keliber-en/keliber-news/2022/keliber-performs-well-in-emissions-comparison/>.

Main Challenges

- **High CAPEX:** Throughout the timeline of the project, Sibanye-Stillwater announced in its Q1 2025 Operating Update increasing capital expenditures than previously estimated in 2022 due to additional regulatory requirements, changes to the scope of the project, and a decline in lithium prices.⁴⁴ Furthermore, the integrated approach and new technologies implemented in this project generates much more capital intensity in executing the mine-to-market approach.
- **Permitting & Regulation:** This project faced several regulatory bottlenecks against the Rapasaari Mine and Päiväneva Concentrator, mainly due to appeals launched by environmental NGOs, local landowners, and fishing cooperatives. These regulatory pushbacks ultimately increased the project cost and delayed the commissioning of the Rapassari mine. Sibanye-Stillwater was able to mitigate this obstacle by relying on the now commissioning Syväjärvi mine as primary feedstock to the concentrator for five years while the Rapassari mine awaits approval.
- **Lithium Price Volatility:** Throughout 2023 to mid-2025, global lithium prices dropped by roughly 75% due to an oversaturation in global supply primarily from Chinese and Australian production.⁴⁵ Not only did this prompt an increase in the project's CAPEX, lithium price volatility steered the Keliber project into mitigating this market risk through a staged start-up approach in commissioning the refinery. Currently, the mining and concentrating component in the project is in commission, which will allow Sibanye-Stillwater to amass a stockpile of lithium concentrate that is readily available for when the refinery is commissioned. Commissioning of the refinery will be dependent on lithium prices meeting market conditions and securing offtake agreements.

⁴⁴ Sibanye-Stillwater, *Q1 2025 Operating Update*, 9. May 2025, https://thevault.exchange/?get_group_doc=245/1746764866-ssw-booklet-Q12025-operating-update.pdf.

⁴⁵ International Energy Agency, "Market Review," in *Global Critical Minerals Outlook 2024*, IEA, 21. May 2024, <https://www.iea.org/reports/global-critical-minerals-outlook-2024/market-review>.

Key Takeaways

- **Strategic Location for an Integrated Supply Chain:** The entirety of the lithium production supply chain is contained within a single country, which defies the conventional global nature of the lithium supply chain. This model undercuts many of the risks and obstacles associated with the global supply chain including geopolitical disruptions, export restrictions, and potential delays in long-haul transport.
- **Timeline Success:** The Keliber Lithium project stands out in its ability to maintain its construction timeline. Contributing factors to on-time delivery includes prioritizing construction of the refinery before the brownfield development of the mines and building the concentrator, which took the longest to complete.⁴⁶ This specific sequencing of construction prevented a situation where upstream capabilities are set while downstream construction continues to prolong the timeline.
- **Staged Start-Up:** While hot-commissioning of the refinery has not yet started, the Keliber project seeks to de-risk ramping up capacity and offer greater flexibility towards the volatile nature of the global lithium project by relying on a phased rollout of the mining and concentrating phase before commissioning the refinery. Working in phases also allows for the project to ensure operational and technical readiness of the mines and concentrator before production ramps up in the refining step. This approach is able to mitigate risks, but does not eliminate pressure from external market forces before the project is able to secure the majority of its revenue.

⁴⁶ Mika Seitovirta, "Sibanye-Stillwater's Keliber Lithium Project: Expected to Be the First Mine-to-Market Producer in the European Market" (presentation, Sibanye-Stillwater, May 2024), https://thevault.exchange/?get_group_doc=245%2F1715255750-2024-05Sibanye-StillwatersKeliberlithiumprojectupdate.pdf.