

European Aluminum's Innovation Hub: Enhancing bauxite residue valorization pathways through collaborative EU projects

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Abstract

In 2015, European Aluminum established its Innovation Hub as a collaborative platform to accelerate the transformation to a clean and circular Europe for aluminum producers and cross-sector partners. Since then, the Innovation Hub of European Aluminum plays a crucial role in facilitating the development of European Union (EU) funded collaborative projects across the aluminum value chain by bringing together the necessary participants from the membership, the broader industry, and Research, Development & Innovation organizations. Focusing on the upstream part of the aluminum value chain, one of the most significant challenges is related to the bauxite residue (BR) generation as well as its environmentally and socially acceptable valorization pathways to reduce reliance on landfilling. European alumina refineries are actively seeking innovative solutions to transform this challenge into an opportunity by developing environmentally safe and economically viable solutions which could possibly result in market-accepted BR-based products. Within this context, H2020 projects RemovAL (Grant Agreement no. 776469-completed in April 2023) and ReActiv (Grant Agreement no. 958208-in progress) aim to promote the combination of multiple technologies and establish industrial symbiotic schemes, especially with the construction sector. These cross-sectoral projects seek to overcome environmental issues and technological barriers in a financially efficient manner, ultimately facilitating meaningful BR valorization. As part of both consortia, the Innovation Hub facilitates the cross-sectoral collaboration and advocates for the need to adapt the current EU legislation for enabling the proper valorization of bauxite residue under the overall concept of circular economy.

Keywords: Bauxite residue, Near-zero-waste, Circular economy, Industrial symbiosis, Regulatory framework.

1. Introduction

Alumina refineries play a crucial role in the aluminum value chain, yet they face a significant challenge: the environmentally and socially safe management of bauxite residue (BR), also known as processed bauxite or red mud. The European Union (EU) currently has active alumina plants operating in various countries such as Germany, Greece, Ireland, and Spain, while alumina production has been temporarily suspended in Romania. Neighboring countries such as Bosnia-Herzegovina and Turkey produce alumina, whereas two alumina refineries in Ukraine (Mykolaiv and Zaporozhye) have been shut down.

In 2021, EU-27 produced approximately 6 Mt of alumina, compared to the global production of 138 Mt during the same period. In addition, an estimated 5 Mt of BR were generated in the EU-27, with most being stored in landfills. Notably, significant BR legacy sites exist throughout Europe, including France, Italy, Germany, Hungary, Montenegro, Slovenia, Croatia, Bosnia & Herzegovina, Scotland and elsewhere. The cumulative stockpile of BR in the EU exceeds 250 Mt (dry basis) [1].

Despite the recent decline in BR generation at an EU level, global production reached around 160 Mt in 2021, representing a significant increase from around 60 Mt in 2001. However, this increase occurred without a proportional rise in supply reuse.

Table 1. Production of alumina and bauxite residue in Europe & Turkey [1].

Alumina producer*	Location / Country	Estimated alumina production (ktpa)	Estimated BR production (ktpa)
Aughinish Alumina Ltd (AAL)	Limerick / Ireland	1 900	1 500
Alcoa	San Ciprian / Spain	1 500	1 350
Alum S.A. **	Tulcea / Romania	500	450
Alumina d.o.o	Birac / Bosnia-Herzegovina	600	550
Aluminium Oxid Stade	Stade / Germany	1,050	950
Eti Alüminiyum	Seydişehir / Turkey	490	440
Metlen Energy & Metals	Agios Nikolaos / Greece	860	775
<i>* The Gardanne plant in France has been excluded from consideration.</i>			
<i>** The alumina production is temporarily suspended, thus BR generation has stopped.</i>			

In response, the European alumina refineries are actively seeking innovative and financially viable solutions to transform the challenge of BR into an opportunity by developing environmentally safe and market-accepted BR-based products, following the EU’s circular economy principles.

Within the complex landscape of BR management, cross-sectoral collaboration becomes essential in the quest for comprehensive solutions. European Aluminum’s Innovation Hub stands as a pivotal force in fostering such collaboration and catalyzing innovation within the aluminum industry. Serving as a dynamic platform for industry-wide cooperation and knowledge dissemination, the Innovation Hub brings together diverse stakeholders, enabling them to exchange insights, investigate novel technologies, and explore holistic valorization pathways. In doing so, it not only addresses immediate challenges but also significantly contributes to the long-term competitiveness and sustainability of the European aluminum sector.

2. Current Bauxite Residue Management in Europe: Indicative Case Studies from EU Alumina Refineries

All BR generated in the EU is deposited in Bauxite Residue Storage Facilities (BRSFs). The processes used for handling and storage of BR are determined by factors, such as the age of the refinery, land availability, proximity to the sea, local topography, climate, logistics, nature of the residue and regulations. Over time, major improvements have been made in the design and management of residue facilities to minimize safety risks and environment risks. Table 2 presents indicative BR handling practices from active EU alumina refineries. It is noted that the BR processed using the Best Available Techniques (BAT) has been classified as a non-hazardous waste.

the aluminum industry. By engaging with key stakeholders, organizing policy and cross-fertilization workshops, and contributing to EU policy initiatives with the support of the alumina producers from the Membership, the Innovation Hub unites diverse stakeholders, facilitating the exchange of insights, exploration of novel technologies, and investigation of comprehensive valorization pathways. This collaborative effort not only addresses immediate challenges but also significantly enhances the long-term competitiveness, sustainability, and resource efficiency of the European aluminum sector.

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