

H2AL

FULL-SCALE DEMONSTRATION OF REPLICABLE TECHNOLOGIES FOR HYDROGEN COMBUSTION IN HARD TO ABATE INDUSTRIES: THE ALUMINIUM USE-CASE



Project ID	101137610
PRR 2024	Pillar 4 – H ₂ end uses: stationary application
Call topic	HORIZON-JTI-CLEANH2-2023-04-04: Hydrogen for heat production for hard-to-abate industries (e.g. retrofitted burners, furnaces)
Project total cost	EUR 7 005 639.25
Clean H₂ JU max. contribution	EUR 5 993 812.38
Project period	1.1.2024–31.12.2026
Coordinator	Université libre de Bruxelles, Belgium
Beneficiaries	2A SpA, Bluenergy Revolution SCARL, EKW GmbH, European Aluminium, Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung EV, Fundacion Tecnalia Research & Innovation, Gas- und Wärme-Institut Essen EV, GHI Hornos Industriales SL, Nippon Gases Industrial SRL

<https://cordis.europa.eu/project/id/101137610>

PROJECT AND GENERAL OBJECTIVES

The overall objective of the H2AL project is to develop, validate, implement and demonstrate at full scale in real operational conditions a set of technologies, such as an integrated hydrogen burner and support systems, refractory materials and sensors, within heating furnaces in hard-to-abate industries – aluminium ingot and internal scrap recycling – by retrofitting an existing furnace at the demonstration site (2A facilities). The demonstration will run for more than 6 months – with at least one trial of 100 hours at 100 % H₂ and with a thermal output of at least 2 MWth – ensuring that technology readiness level 7 is achieved at the end of the project. The impact of H₂ combustion on the refractory materials, overall furnace structure and product quality (aluminium) will also be investigated, and measures to minimise its effects will be implemented. H2AL will also develop and implement a set of data, documentation and guidelines ensuring that the project outcomes can be replicated in other industrial sites (in other hard-to-abate industries) in a cost-effective, sustainable and safe way.


NON-QUANTITATIVE OBJECTIVES

- Understanding hydrogen combustion and its effects.
- Developing safe and efficient H₂ combustion systems for industrial plants.
- Providing insights into the physics of H₂ combustion and its impact on process parameters, using laboratory-scale experiments and simulations.
- Developing a burner for 100 % H₂ and H₂ / natural gas mixtures.
- Redesigning two state-of-the-art oxy-fuel burner technologies to use 100 % H₂ and H₂ / natural gas blends without compromising on aluminium quality, process efficiency or NOx emissions.
- Operating under non-conventional conditions to deliver high efficiency, excellent heat transfer characteristics and low NOx emissions.
- Retrofitting a furnace with the developed burner, optimal refractory materials and sensing solutions.
- Retrofitting 2A's furnace with newly developed oxy-fuel burners, optimised refractory materials and

sensors for monitoring the H₂ combustion process.

- Carrying out a full-scale demonstration of H2AL technologies in the aluminium industry.
- Demonstrating the effectiveness and feasibility of H2AL's technologies in the aluminium industry at full scale in 2A facilities.
- Running the demonstration for at least 6 months, operating for at least 100 hours at 100 % H₂.
- Implementing standard operating procedures for safety and plant integration.
- Developing and implementing standard operating procedures to safely integrate H₂ combustion systems in industries that are difficult to decarbonise.
- Shifting conventional industrial processes to hydrogen-based systems.
- Comprehensively evaluating H₂ substitution for fossil fuels in furnaces and other hard-to-abate sectors.
- Investigating potential impacts on process performance, product quality, equipment operation and maintenance.
- Conducting techno-economic analyses to replicate the solution in other industrial sites and industries.
- Studying the impact of H₂ on final product costs and CO₂ emission reduction in final product price under the emissions trading scheme programme.
- Developing and promoting new business models for the widespread exploitation of H₂-based solutions in heat generation in high-tech areas (hard-to-abate industries).
- Developing new business models inspired by traditional industrial energy efficiency energy service company models and energy/gas utility ones.
- Developing a techno-economic tool to assess the economic viability of the proposed solution with different types of H₂ supply.
- Paving the way for the large-scale demonstration of H₂ technologies in burners and furnaces.
- Collaborating with industry stakeholders and regulatory bodies to identify the best approach to adopting these technologies financially sustainably.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives, SRIA (2021–2027) and AWP 2023	Application of H ₂ burners with low NOx emissions	mg/Kg	< 100 mg/kg, for example as low as 20 mg/kg for SNCR-enhanced flameless regenerative burners)	
	Enabling the utilisation of H ₂ -based heat production	-	Enabling the utilisation of H ₂ -based heat production at the 2A foundry and in other aluminium and hard-to-abate industries	
	Insights into process	-	Insights into the effect of, for example, H ₂ /O ₂ ratio, flame temperature and emissions on process	
	Safety protocol and risk assessment	-	Systematic analysis and application of safety protocol and risk assessment for the use of H ₂ at the testing and demonstration site	
SRIA (2021–2027) and AWP 2023	TRL 9 roadmap	-	TRL 9 roadmap for further industry integration, including business model opportunities for replication in other scenarios, including GIS data	
	Comprehensive evaluation of the KPI H ₂ combustion	-	Comprehensive evaluation of H ₂ combustion	
	Technology roadmap for the effective integration of 100 % H ₂ combustion	-	Technology roadmap for the effective integration of 100 % H ₂ combustion for heat production in the aluminium industry	
Project's own objectives and SRIA (2021–2027)	Roadmap for 100 % elimination of fossil fuel combustion in the aluminium industry	-	Roadmap for 100 % elimination of fossil fuel combustion in the aluminium industry	
	Technology roadmap and industry best practices	-	Technology roadmap and industry best practices to (at least) maintain the quality of the final product (aluminium) in terms of melt quality, porosity, dimensional accuracy and mechanical properties	
	Full-scale operational demonstration	hours	Full-scale operational demonstration at the 2A foundry, running for at least 100 hours at 100 % H ₂	
	Understanding of H ₂ utilisation	-	Better understanding of H ₂ utilisation	
	Optimised combustion models	-	Optimised combustion models to further improve the consortium's simulation tools for H ₂ combustion mechanisms	
	Plant integration processes and procedures	-	Documented demonstrator at 2A facilities, including plant integration processes and procedures	
	New burners	% H ₂	New burners capable of using 0–100 % of H ₂ / natural gas mixtures	