



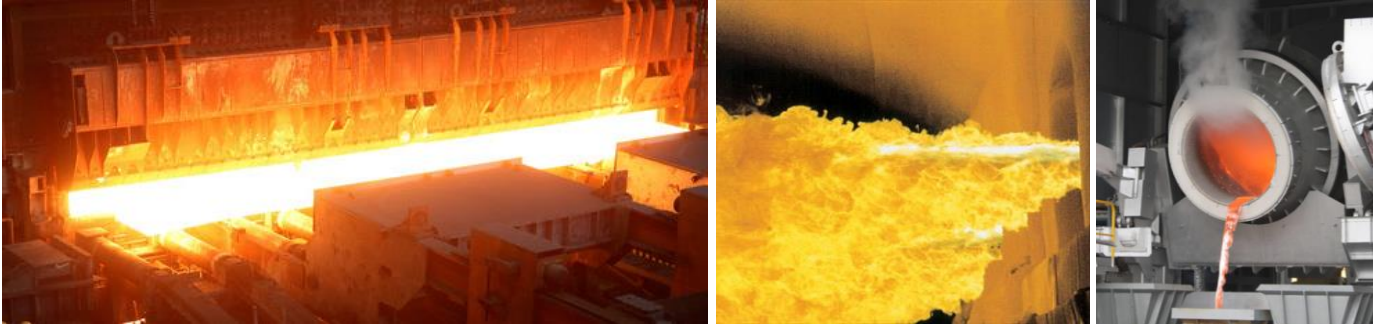
FULL-SCALE DEMONSTRATION OF REPLICABLE TECHNOLOGIES FOR HYDROGEN COMBUSTION IN HARD-TO-ABATE INDUSTRIES: THE ALUMINIUM USE-CASE

November 25th, 2025

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All sectors are equal, but some are more equal than others for net-zero targets



High-temperature heat
Steel, glass, cement and aluminium



Non-energy sources
Ammonia and methanol

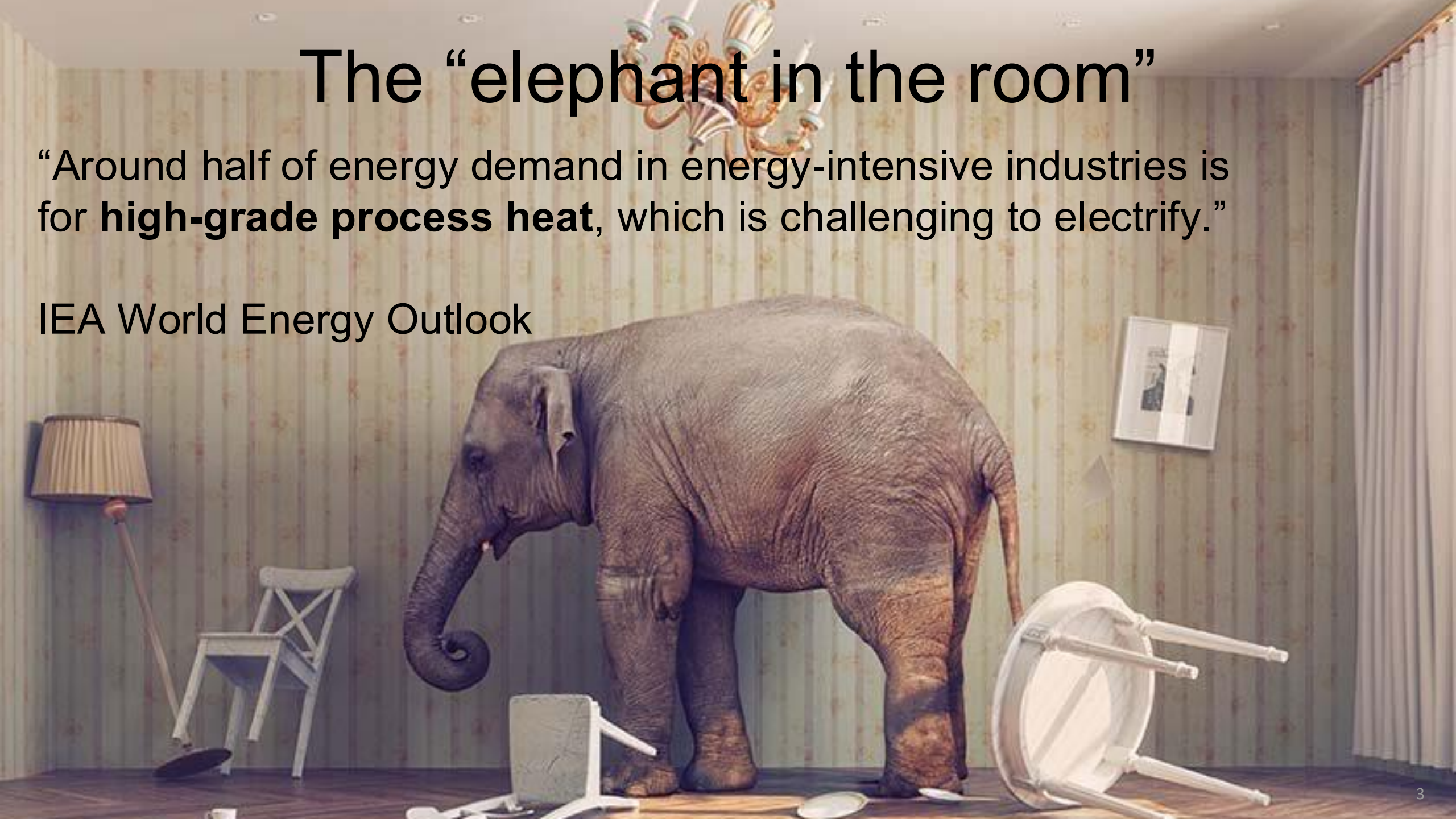


High-density, local energy sources
Shipping, trucking, aviation

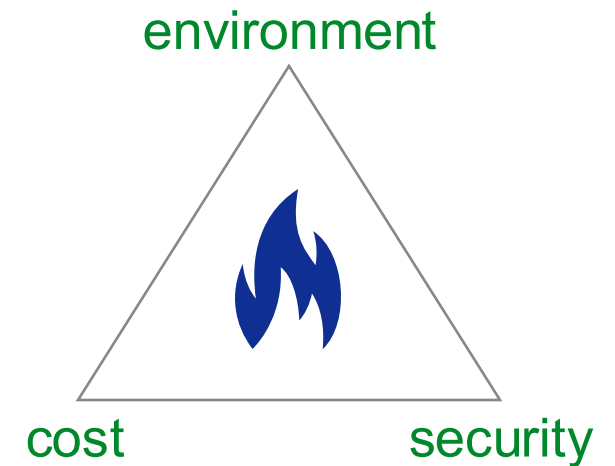
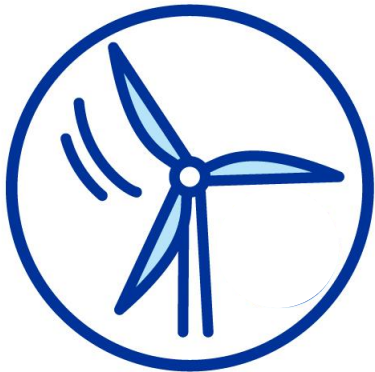
The “elephant in the room”

“Around half of energy demand in energy-intensive industries is for **high-grade process heat**, which is challenging to electrify.”

IEA World Energy Outlook



Renewable excess energy can be converted into renewable synthetic fuels



Relying on RSFs raises unanswered questions and technological challenges



CH6. Lack of training



CH7. Lack of confidence on scalability and business potential

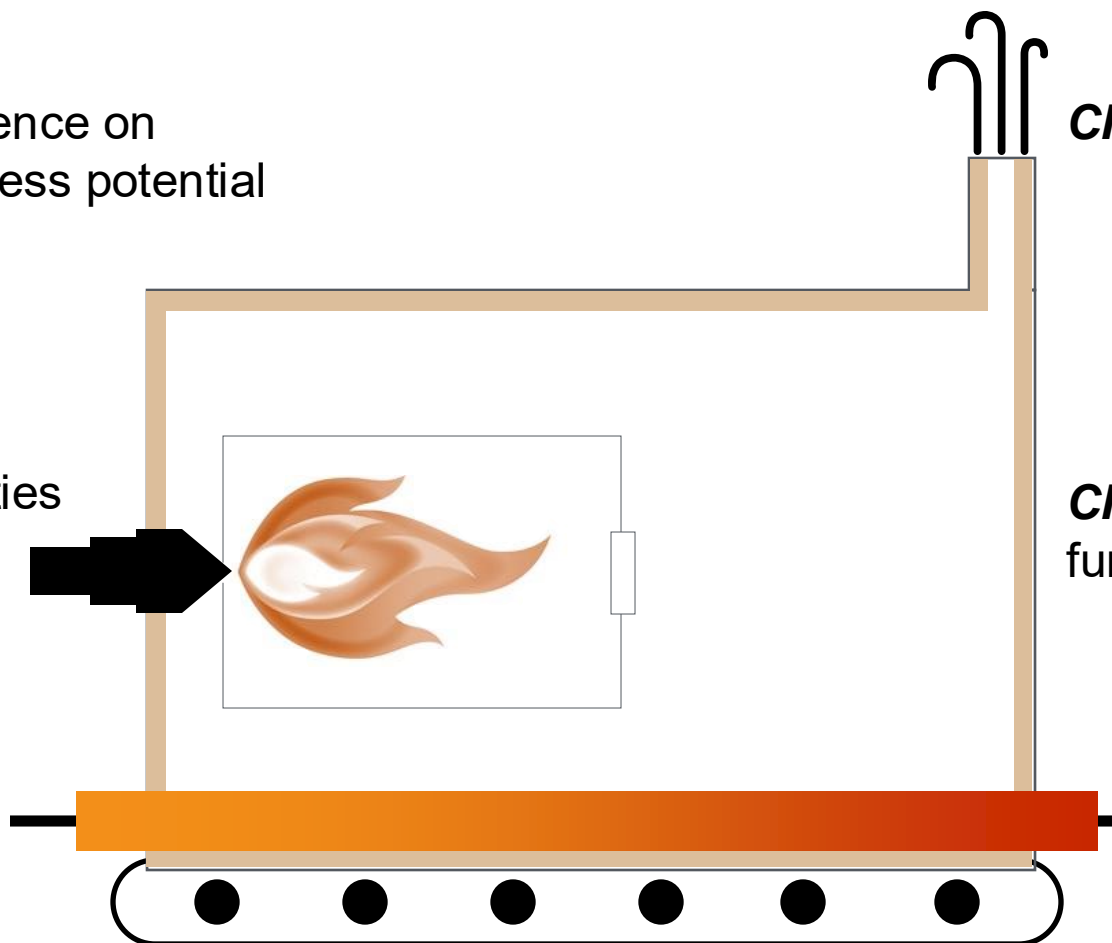
CH1. Different combustion properties

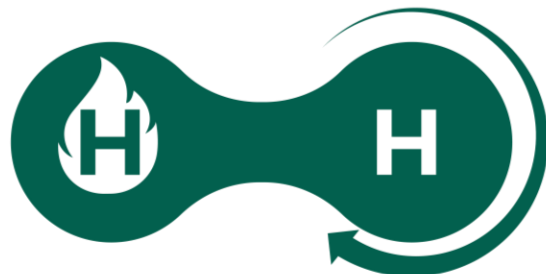
CH5. Safety

CH2. Pollutant emissions

CH4. Accelerated wear of furnaces' components

CH3. Product quality





H 2 A L

DECARBONISING ALUMINIUM RECYCLING WITH HYDROGEN



Fraunhofer



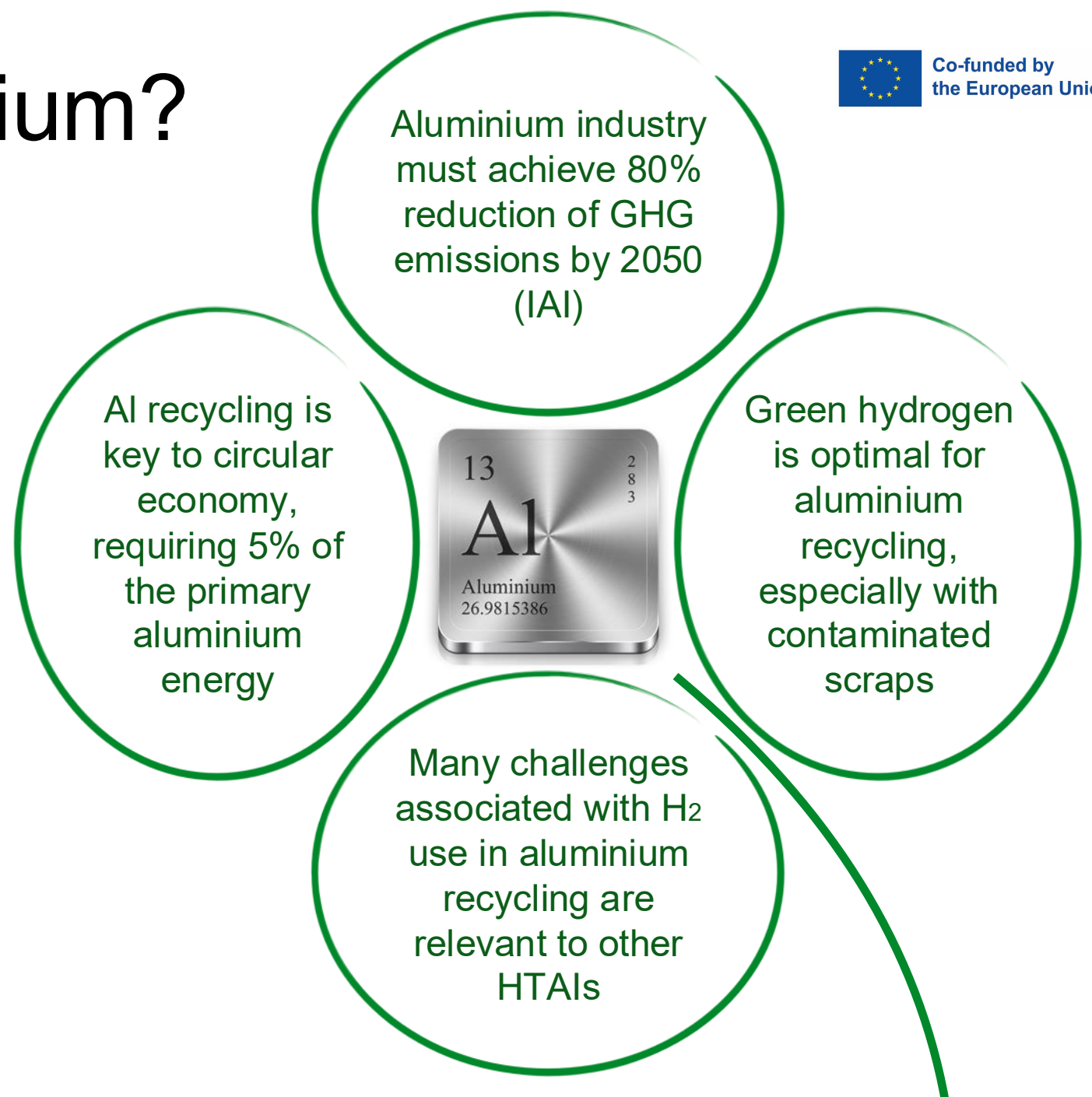
HORIZON-JTI-CLEANH2-2023-1

H2AL objectives

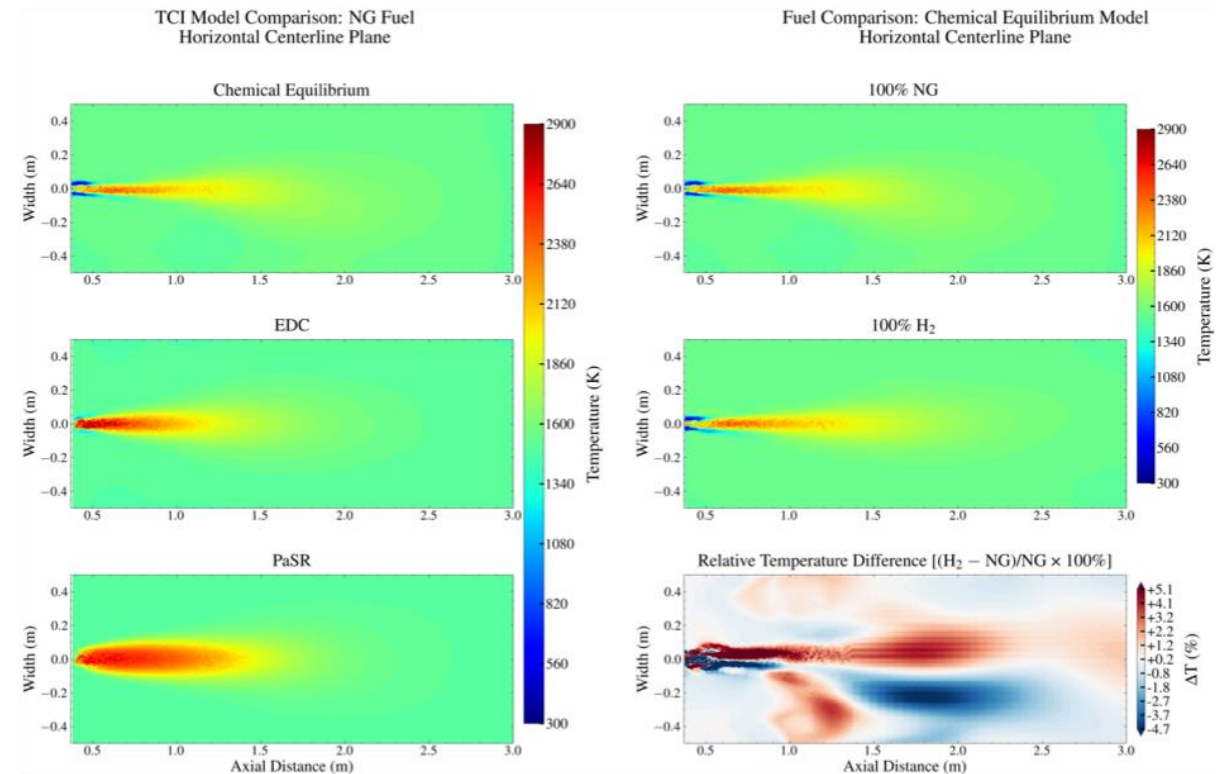
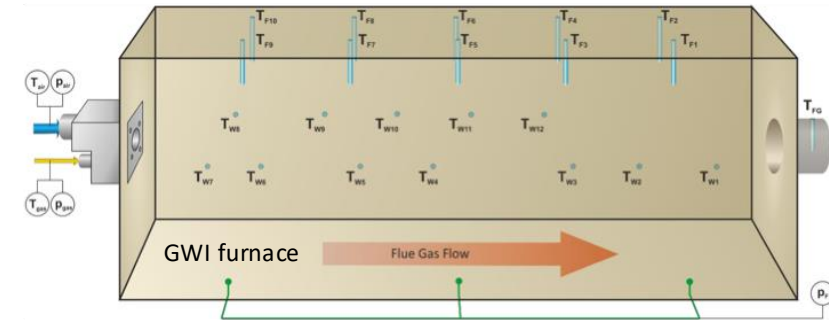
A set of technologies (e.g. burner, refractory material, sensors) to be retrofitted in existing furnaces at 2A facilities for aluminium ingot and internal scrap recycling process running with 100% hydrogen

A set of data/documentation/guidelines ensuring that the project outcomes can be replicated in other HTAIs in a cost-effective, sustainable and safe way

Why aluminium?



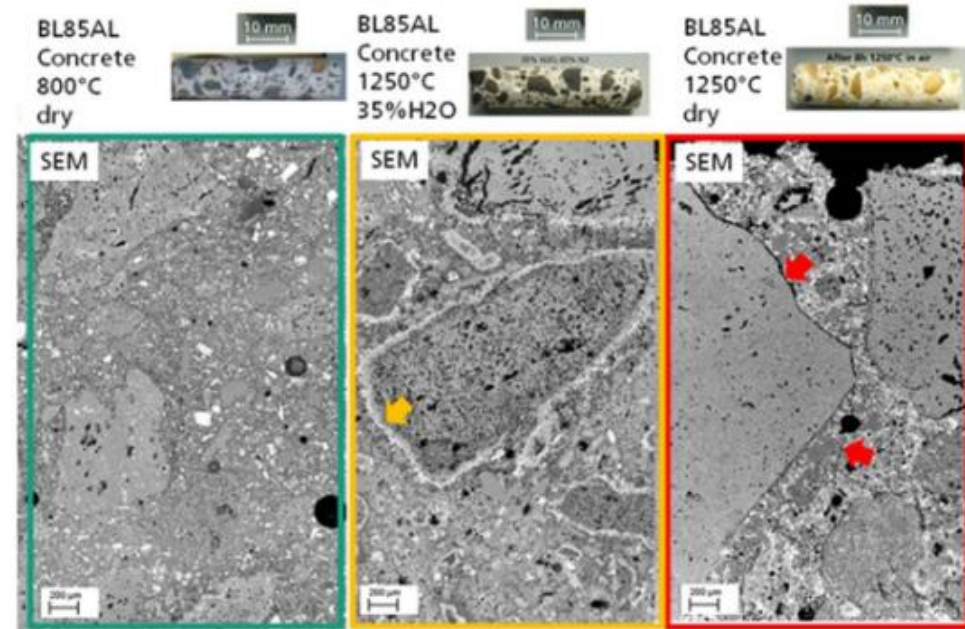
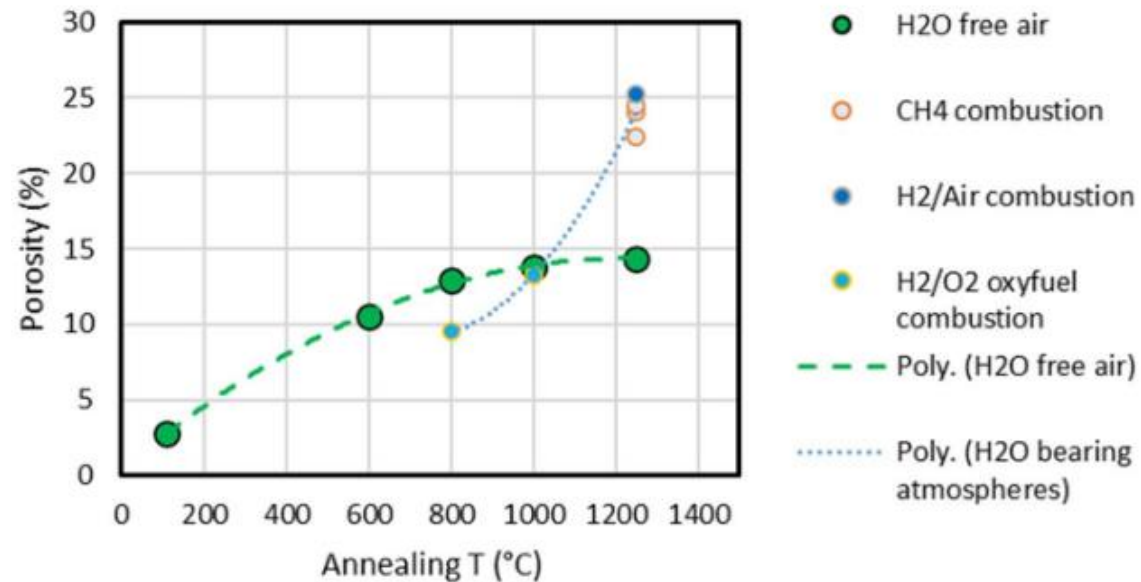
H2AL strategy and results



Combustion experiments and simulations
(ULB, Nippon Gases and GWI)

H2AL strategy and results

BL85AL: Resulting porosity after annealing



Refractory experiments
(Fraunhofer, EKW)

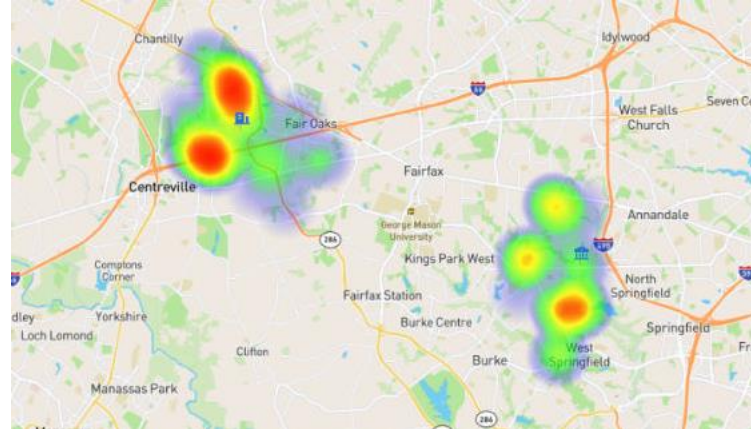
Combustion experiments and simulations
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Simulation-assisted material design, lab testing, and microstructure characterisation to investigate the influence of water and H₂ on the dimensions, weight, and microstructure of the refractories.

H2AL strategy and results



Identification of exploitable results



GIS analysis used to match the locations and demand of aluminium production sites in the EU with hydrogen backbones

Impact and replication (BER, GWI, EA)

Refractory experiments (Fraunhofer, EKW)

Combustion experiments and simulations (ULB, Nippon Gases and GWI)

H2AL strategy and results

Pilot testing
(Tecnalia, Nippon)

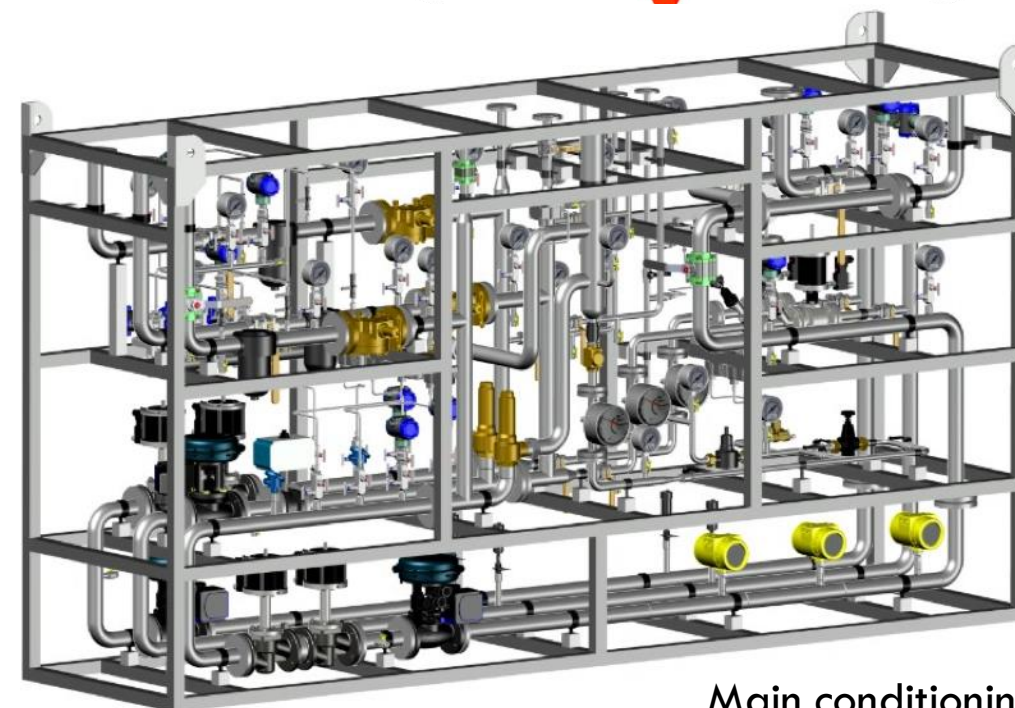
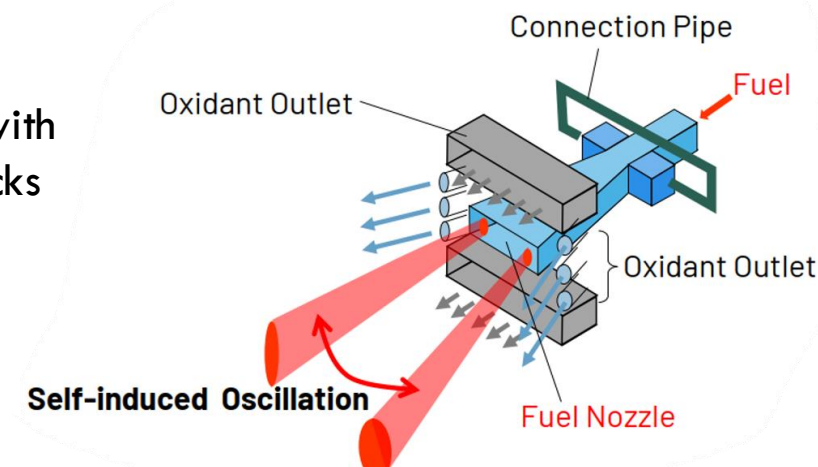
Impact and replication (BER,
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1MW burner with
refractory blocks



Main conditioning skid

H2AL strategy and results

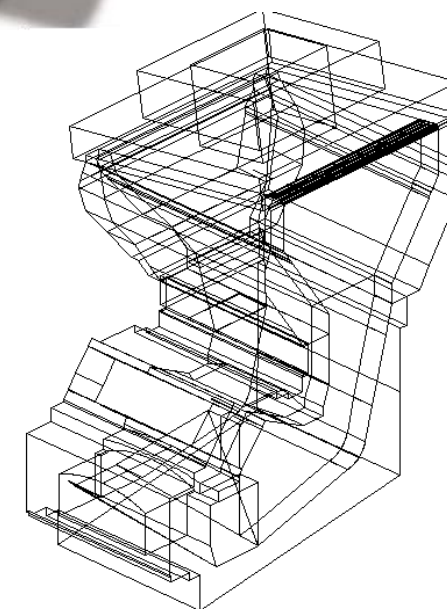
Furnace retrofit
(GHI, EKW, 2A, Nippon)

Pilot testing
(Tecnalia, Nippon)

Impact and replication (BER,
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Refractory and burner replacement,
carpentry adaptation

H2AL strategy and results

Final demonstration
(2A, Nippon)

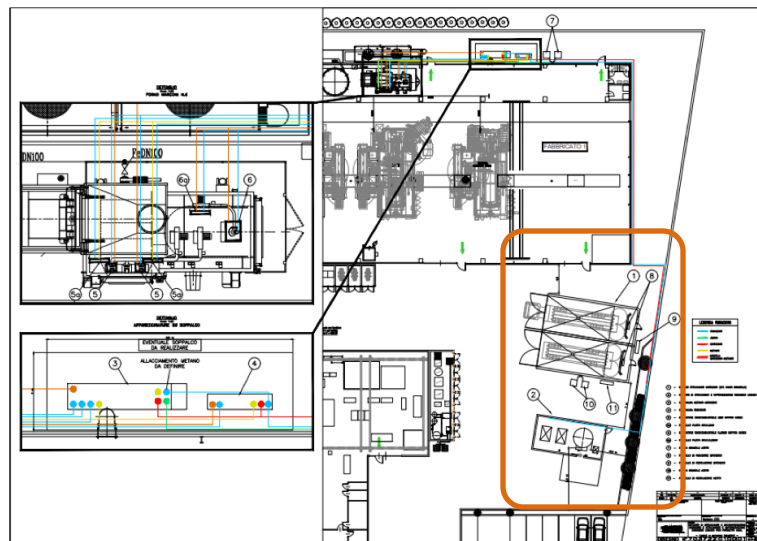
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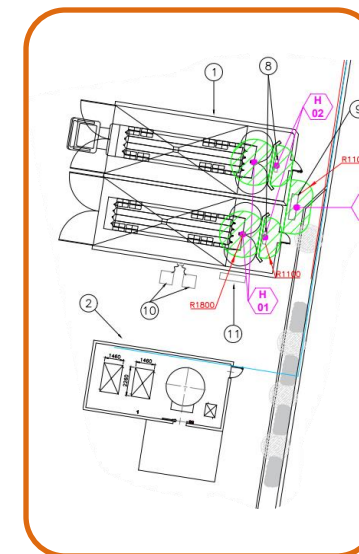
Impact and replication (BER,
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Site layout



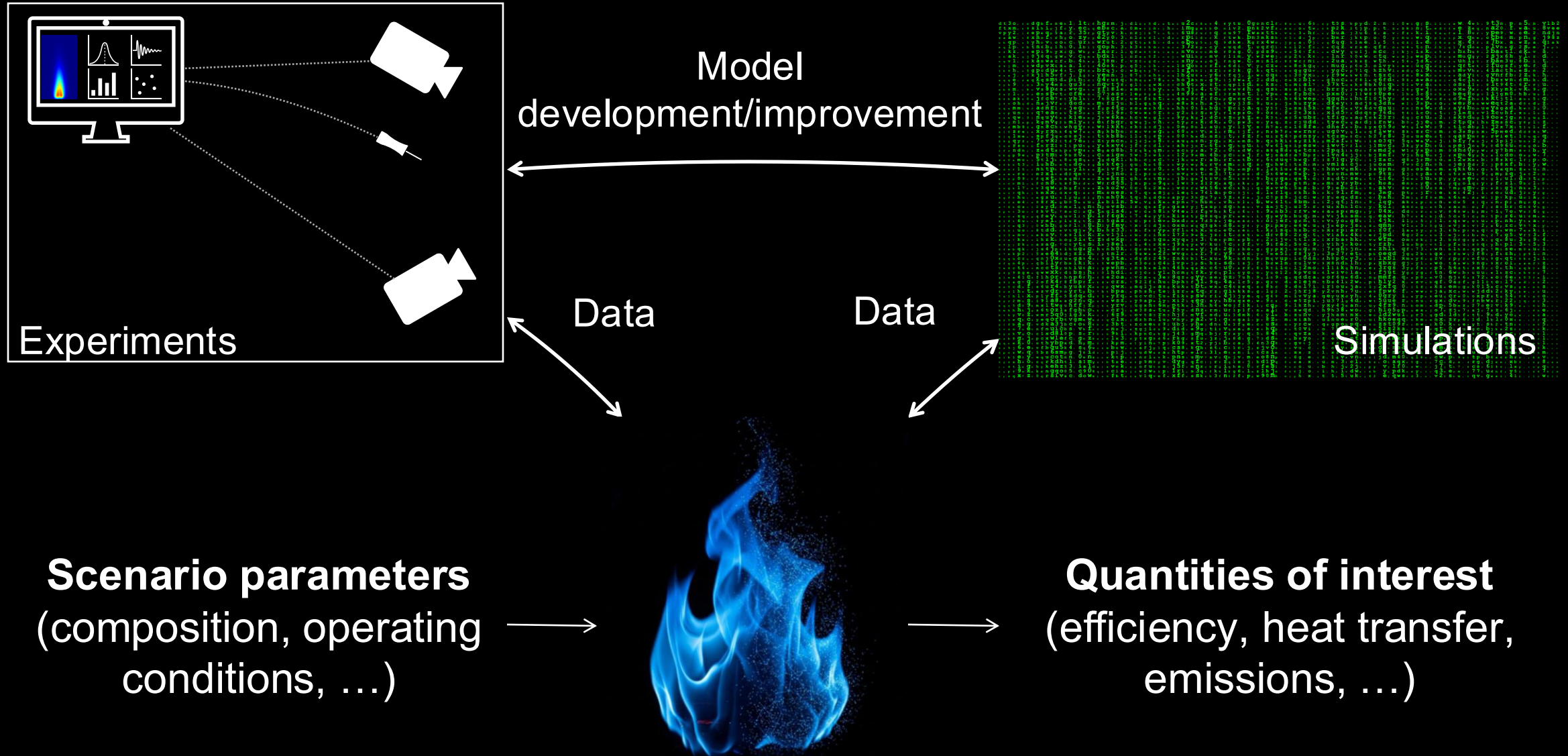
Definition of ATEX
zones and safety
plan

H SOURCE IDENTIFICATION
R ATEX AREA, zone 2 IIC T1



Storage strategies

H2AL digital twin vision



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