An innovative value chain for sustainable products

Christian Leroy, Innovation & LCA, European Aluminium

AMAP colloquium, 16 Nov 2017, 4pm
/ Presentation outlines

1/ Who we are
2/ The Aluminium sector in Europe and the main applications
3/ Our vision, the sustainability roadmap and the Innovation Hub
4/ The main R&D challenges along the value chain
5/ Some examples of collaborative EU projects
6/ Conclusions
Who we are

80+ members

approx. 600 plants in 30 European countries (EU 28, EFTA and Turkey)

1 million + Direct and indirect jobs across Europe’s value chain

Founded in 1981

European Aluminium represents the entire value chain of the aluminium industry in Europe

An innovative value chain serving EU key markets

€39.5 Billion annual turnover [2015]

90% of aluminium is recycled in construction and automotive in Europe

Europe produces 16% of worldwide aluminium, half of which from recycled sources
1/ The aluminium value chain
Aluminium Markets & production in Europe

MAIN END-USES FOR ALUMINIUM PRODUCTS IN EUROPE IN 2015

CONSTRUCTION 24%
CONSUMER DURABLES 7%
MOBILITY 39%
HIGH TECH ENGINEERING 17%
PACKAGING

ANNUAL PRODUCTION

Metal production (primary and recycled)
Around 50% comes from recycled sources

9.0 Mt +9% since 2012

Semi-production (rolling* and extrusion)
*including Turkey

7.7 Mt +6% since 2012
Aluminium Sector in Europe*, 2015

TOTAL =

- Bauxite ~16 Mt
- Alumina 10 Mt
- Metal 13 Mt

PRODUCTION

- ~6 Mt
- ±4.2 Mt PRIMARY
- ±4.5 Mt RECYCLED

Net IMPORTS

- ~13 Mt
- 4.3 Mt

SEMİ’S

- ±4.9 Mt ROLLED (39%)
- ±2.9 Mt EXTRUDED (24%)
- ±3.3 Mt CASTINGS (27%)
- ±1.2 Mt Wire, powder, slugs…(10%)

- ±1 Mt Foil (22%)

* Europe= Former CIS excluded, except Baltic states, Turkey included
1 Based on statistics (includes recycling from tolled and purchased scrap)
2 Integrated automotive producers incl.
3 Inventories not taken in account
Key-attributes:
• Lightweight
• High mechanical resistance to weight ratio
• Corrosion-resistance
• Crashworthiness
• Dimensional stability
• No ageing
• Formability
• Barrier property
• Aesthetics
Aluminium’s low density, high strength-to-weight ratio, dimensional stability, corrosion-resistance, formability, recyclability and crash resistance is a key driver of lightweight, safe vehicles that contribute significantly to fuel savings and safety in transport.
Average component content per vehicle 2016

- Total European car production -

Average aluminum content: 150.6 kg / vehicle

Source: Ducker study 2016 for European Aluminium
2. Aluminium makes Electric vehicles lighter and safer

- Many electric vehicles are aluminium intensive
- Tesla Model S has the highest safety rating
2 / Aluminium is also used in battery systems

- Aluminium extrusions in battery frames
- Aluminium cables
- Aluminium for battery cooling
Aluminium offers dimensional stability, high strength-to-weight ratio, corrosion resistance, durability and recyclability. These key assets stimulate the development of products that directly contribute to sustainable buildings, through natural lighting, energy savings, air tightness and energy production through solar heating and photovoltaics.
The unique intrinsic properties of aluminium – high formability, lightweight yet strong, attractive metallic appearance, providing a total barrier to light, gases and moisture and recyclability - make it a preferred packaging material for food and drink.
Aluminium’s dimensional stability, light weight, durability, conductivity and recyclability are key assets in making aluminium an ideal material in electronics and consumer durables, particularly in premium products.
« Aluminium is a key enabler of Europe’s transition to sustainability and responds to today & tomorrow’s societal needs »

Our Vision

Endlessly recyclable

Strong yet light

Incredibly versatile

Corrosion free and durable

Energy Saver

Total barrier
The European aluminium industry’s Sustainability Roadmap 2025

“The Roadmap is born from our belief in the fundamental need to reconcile sustainability and growth objectives in Europe” Pierre Vareille, European Aluminium Chairman, April 2015
The European aluminium industry is committed to sustainability

The 2025 Sustainability Roadmap
- Covering the entire value chain
- Setting voluntary targets in three areas
- Engaging members in exchanging best practices, sharing expertise and developing joint projects
- Monitoring progress regularly through the Sustainable Development Indicators
- Integrating input from external experts

https://www.european-aluminium.eu/policy-areas/sustainability/
3 / Innovation Hub as key enabler

INNOVATION HUB:
ALUMINIUM AT THE CENTRE OF A SUSTAINABLE EUROPE

OUR GOALS

- Building a proactive community of innovative companies across the value chain
- Triggering research projects that advance a sustainable future and tackle technological challenges
- Connecting with the EU innovation agenda and relevant funding opportunities
- Engaging with the Public Private Partnerships that define the EU’s research agenda and priorities

INNOVATION OBJECTIVES

1. Higher energy efficiency and reduced CO₂ emissions
2. Greater resource efficiency
3. Lower environmental impact
4. Optimal process technologies
5. New materials
6. Better enabling technologies
7. Improved skills and education
Based on a long history of European Aluminium’s involvement in education and technology

Based on some excellent past projects, e.g. VIR* projects, SuperLightCar project, and current projects, e.g. E2Vent

Officially initiated in 2015 following a strong recommendations of top executives

It is a coordinated industrial platform where European aluminium companies are committed on a voluntary basis

- To collaborate together on key RTD topics and innovations
- To collaborate with other key stakeholders in Europe, e.g. RTOs, other industrial sectors, policy makers, etc.
3 / Innovation Hub: main Objectives

➢ Framework objectives
   1. Providing a European-wide view on the technology and R&D needs for developing a coherent approach to R&D along the aluminium value chain.
   2. Acting as a key stakeholder in the most relevant European Private Public Partnerships (PPPs), including Sustainable Process Industry through Resource and Energy Efficiency (SPIRE), Factory of the Future (FoF) and Energy Efficient Buildings (EeB).
   3. Developing a Innovation Hub Community by stimulating networking and cooperation between the Aluminium industry and the R&D community, e.g. by organising innovation workshop targeting calls and topics of key EU funding programs, e.g. the Horizon 2020 program

➢ Project objectives
   1. Initiating and facilitating the development of EU funded R&D projects directly addressing the aluminium value chain
   2. Facilitating the members participation in those projects
   3. Joining EU project when relevant.

➢ Communication objectives
   Positioning Aluminium sector as a key player in the EU Innovation landscape
The «Innovation Hub» concept

- PPP (SPIRE, FoF, EeB) and other relevant platforms (Eumat)
- Key innovation players
- EU officials (e.g. DG Research)
- H2020 Brokerage events
- Consortium under development
- Relevant EU projects, etc.

European Aluminium

Innovation Hub

Innovation Board
Chair: Philippe Meyer, Management: Christian Leroy

Primary WG
Manufacturing WG
Recycling WG

External Stakeholders:
3  /  14 Companies and 2 MG engaged in 2017

[Logos of various companies]
Engagement in key innovation platforms & markets

- SPIRE, sustainable process industry
  - Raw material Processes
  - Energy efficiency
  - Metallurgy
  - Recycling

- Automotive & Transport
  - Lightweight cars
  - Lightweight trucks
  - Passive Safety
  - New innovative vehicles

- Energy Efficient Buildings
  - Smart envelop systems
  - Windows
  - Facade

- Factories of the Future
  - Recycling
  - Sorting
  - Forming
  - Joining

EUROPEAN ALUMINIUM
KULeuven workshop on 31 May 2016

- First major event
- > 50 experts and innovation leaders from company members, Academia & Research & technology organisations (RTO)
- Successful for better connecting aluminium industry with RTO and potential partners.
- Publication of the mapping report.
3 / Developing the community: Leaflet
3 / Highlighting Innovation stories


- Leading the way in energy efficient buildings
- A new skin material to reduce weight of complex automotive parts
- NASA’s choice for stronger and lighter spacecrafts
- High-strength technology for safer vehicles
- Driving energy efficiency in aluminium recycling
- Industrialising energy-efficient electrolysis production technology
60 participants
More than 20 presentations
Good networking, some project ideas initiated, one EU project idea on bottom ash
## Aachen WS – 21 June 2017 – Topics of the parallel sessions

<table>
<thead>
<tr>
<th>Room 1 - Recycling</th>
<th>Room 2 - Primary production</th>
<th>Room 3 - Manufacturing &amp; Materials</th>
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</thead>
<tbody>
<tr>
<td><strong>Session I</strong></td>
<td><strong>Session II</strong></td>
<td><strong>12:40 - 13:40 - Lunch break</strong></td>
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<tr>
<td>11:15 – 12:40</td>
<td>13:40 – 15:10</td>
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<tr>
<td>Session Introduction and guidelines - H2020 opportunities for recycling - Magdalena Garczynska (20')</td>
<td>Session Introduction and guidelines – Thymis Balomenos (15')</td>
<td>Rolling and further processing of flat products at the IBF Author: Stephan Højda - IBF (25')</td>
</tr>
<tr>
<td>Impact of organics in Al-scrap on process and efficiency Pr. Bernd Friedrich- IME -RWTH (35')</td>
<td>H2020 opportunities for the primary production and Rethink-Al project proposal - Arne Petter Ratvik -SINTEF (40')</td>
<td>Texture-based metal plasticity modelling– Philip Eyckens - KULeuven (25')</td>
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<tr>
<td>Removing of Fe from the melt through high sheer processing technologies – Geoff Scamans – Brunel University (30')</td>
<td>Pragmatic Modelling in Aluminium Electrolysis Stein T. Johansen - SINTEF (30')</td>
<td>Innovating methods for industrial issues: examples in joining, shape forming, and characterisation for Al alloys- Laurent BEDEL &amp; Etienne BOUYER – CEA-tech (25')</td>
</tr>
</tbody>
</table>

**12:40 - 13:40 - Lunch break**
Main objective: enable the integration of at least 20% of post-consumer scrap as sourcing of the value chain of wrought products
- 3 automotive components (e.g. door, B-pillar and battery box) will be produced for demonstration purposes

### Partners of the project

<table>
<thead>
<tr>
<th>No.</th>
<th>Partners of the project</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ciaotech-PNO</td>
<td>IT</td>
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<tr>
<td>2</td>
<td>Aleris</td>
<td>DE</td>
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<tr>
<td>3</td>
<td>Assan</td>
<td>TR</td>
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<tr>
<td>4</td>
<td>Constellium</td>
<td>FR</td>
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<tr>
<td>5</td>
<td>Elval</td>
<td>GR</td>
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<td>6</td>
<td>European Aluminium</td>
<td>BE</td>
</tr>
<tr>
<td>7</td>
<td>Hydro</td>
<td>NO</td>
</tr>
<tr>
<td>8</td>
<td>Novelis</td>
<td>UK</td>
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<tr>
<td>9</td>
<td>Sapa</td>
<td>SE</td>
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<tr>
<td>10</td>
<td>Manchester University</td>
<td>UK</td>
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<tr>
<td>11</td>
<td>VUB-Brussel</td>
<td>BE</td>
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<tr>
<td>12</td>
<td>Brunel University</td>
<td>UK</td>
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<td>13</td>
<td>IKA-RWTH</td>
<td>DE</td>
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<td>14</td>
<td>IRT-M2P</td>
<td>FR</td>
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<td>15</td>
<td>SWERA-KIMAB</td>
<td>SE</td>
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<tr>
<td>16</td>
<td>NTNU-SIM Lab</td>
<td>NO</td>
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<tr>
<td>17</td>
<td>KULEuven</td>
<td>BE</td>
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<tr>
<td>18</td>
<td>International Al Institute</td>
<td>UK</td>
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Making wrought alloys more recycling friendly

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**Project Duration**: 48 months
**Estimated EU contr.**: 12,500,000 €
RemovAL: Removing the waste streams from the primary Aluminium and other metallurgical sectors (SC5-14-2017)

- Objective: Deliver and validate a complete feasibility study for valorising Bauxite Residue (BR) along with other industrial by-products, taking into consideration waste characteristics, logistics and potential for symbiosis with other plants in the geographical vicinity.
- 13 M€ EU funding requested, 4 years project
- 27 partners including: Mytilineos S.A.(formerly Aluminium of Greece), Rio Tinto, Alcoa, Alum, European Aluminium and IAI
Define the innovation needs and priorities of the European Aluminium Industry along the value chain

First consolidated report published in May 2016
Seven generic objectives

1. Improve energy efficiency and reduce CO2 emissions
2. Improve resource efficiency
3. Reduce environmental impact
4. Optimise process technologies
5. Develop new materials
6. Develop and optimise enabling technologies
7. Develop the industrial competence, skills and aluminium knowledge

have been identified for supporting the sustainability of Aluminium industry & delivering innovative solutions
The aluminium value chain & key process steps and product stages
<table>
<thead>
<tr>
<th>Generic objectives</th>
<th>Specific objectives</th>
<th>R&amp;D challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve energy efficiency and reduce CO₂ emissions</td>
<td>Reduce by 20% the energy use or/and the CO₂ emission of the alumina process</td>
<td>Further optimise leaching and calcination process</td>
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<tr>
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<td>Develop low-temperature heat recovery technologies</td>
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<tr>
<td>Improve resource efficiency</td>
<td>Use of lower-grade bauxite</td>
<td>Develop bauxite pre-treatment process to reduce transformation costs and residue storage</td>
</tr>
<tr>
<td>Optimise process technologies</td>
<td>Increase the life time of the plant</td>
<td>Improve maintenance techniques and durability of materials (e.g. reduce caustic embrittlement).</td>
</tr>
<tr>
<td>Reduce environmental impact (air)</td>
<td>Reduce NOₓ and particles air emissions</td>
<td>Develop and implement more advanced burner and abatement technologies</td>
</tr>
<tr>
<td>Reduce environmental impact (solid waste)</td>
<td>Develop sustainable bauxite residue storage or use of residue</td>
<td>Develop maintenance-free storage solutions</td>
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<td>Use bauxite residue as ingredient of products, e.g. construction products</td>
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<tr>
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<td>Develop technologies to convert bauxite residue into valuable resources, e.g. extracting vital raw materials.</td>
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## 4 / Primary production (Precompetitive R&D)

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<tr>
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<th>Specific Objectives</th>
<th>R&amp;D challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve energy efficiency and reduce CO$_2$ emissions</td>
<td>Reduce direct CO$_2$ equivalent emission</td>
<td>Use of biomass as raw material in anode production – bio-anodes</td>
</tr>
<tr>
<td>Optimise process technologies</td>
<td>Develop extended-life pot lining (&gt;5,000-day life)</td>
<td>Eliminate or improve control of cathode erosion</td>
</tr>
<tr>
<td></td>
<td>Improve alumina dissolution behaviour in the pots</td>
<td>Dissolution mechanisms understanding (behaviour in bath, and alumina characteristics)</td>
</tr>
<tr>
<td>Reduce environmental impact (solid waste)</td>
<td>Discover alternative techniques to turn aluminium process waste into usable feedstock/products</td>
<td>Qualify recycled refractory materials obtained from spent pot lining and bake furnaces</td>
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<tr>
<td></td>
<td>Address industry excess salt bath short to mid-term trend</td>
<td>Shared project/evaluation with the bauxite &amp; alumina stream on alumina soda content</td>
</tr>
<tr>
<td>Improving overall performance on HSE aspects</td>
<td>Improving the overall performance on Health and Safety</td>
<td>Decrease human exposure to health and safety hazards by improving plant automation and process control</td>
</tr>
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</table>
## Semi-fabrication

<table>
<thead>
<tr>
<th>Generic objectives</th>
<th>Specific objectives</th>
<th>R&amp;D challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve energy efficiency and reduce CO₂ emissions</td>
<td>Reduce thermal energy and electric consumption of furnaces</td>
<td>Optimise further processing route to reduce cycle time and energy consumption e.g. at pre-heating and homogenisation</td>
</tr>
<tr>
<td><strong>Optimise processing technologies</strong></td>
<td>Increase fabrication efficiency through better control of the aluminium deformation process and improved tool performances</td>
<td>Maximise tooling life through new surface treatment or new materials for extrusion dies or rolling rolls</td>
</tr>
<tr>
<td></td>
<td>Improve knowledge for more cost effective and robust processing routes</td>
<td>Better understanding of microstructure evolution along the process chain</td>
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<td></td>
<td>Develop modelling capabilities for more cost effective and robust processing routes</td>
<td>Develop real-time predictive modelling tools</td>
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<tr>
<td></td>
<td>Increase manufacturing efficiency through better monitoring via sensors and measurements</td>
<td>Develop new or improved non-contact sensors and surface inspection devices</td>
</tr>
<tr>
<td>New processing routes for more performing products</td>
<td>Use of continuous casting technologies and associated alloys</td>
<td>Develop continuous casting technologies and associated alloys</td>
</tr>
<tr>
<td></td>
<td>Develop further alloy capabilities and performances through non-conventional processes</td>
<td>Develop a cost efficient process routing to make powder-metallurgical products, routed via rolling feedstock, via extrusion feedstock, via net shape manufacturing technologies</td>
</tr>
</tbody>
</table>
## Product Manufacturing

<table>
<thead>
<tr>
<th>Area</th>
<th>Generic objectives</th>
<th>Specific objectives</th>
</tr>
</thead>
</table>
| Forming                    | Optimise process technologies       | Better control and predict forming behaviour  
Develop further forming technologies                                                                 |
| Joining                     | Optimise process technologies       | Develop advanced joining techniques that reduce impact on material properties  
Develop low cost joining techniques for dissimilar materials and hybrid solutions |
| Machining                   | Optimise process technologies       | Optimise machining processes for more eco-efficiency                                                                                             |
| Surface & coatings          | Reduce environmental impact         | Develop alternatives to chromate coatings                                                                                                        |
|                             | Optimise process technologies       | Develop aluminium product with tailor-made and functionalised surface properties                                                                 |
| Additive manufacturing      | New disruptive technologies         | Additive manufacturing for tailor-made aluminium products (bulk) or surface properties                                                            |
| Product Design              | Optimise design technologies        | Use of numerical methods for analysing and guiding robust and eco-efficient design of products  
Optimise design for light weighting & crash management                                           |
| All                         | Skills and knowledge                | Secure proper expertise along the product value chain.                                                                                              |
|                             | Education                           | Improve the level of knowledge and expertise in downstream industry and in engineering education                                                  |
### Recycling

<table>
<thead>
<tr>
<th>Area</th>
<th>Generic objectives</th>
<th>Specific objectives</th>
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</thead>
<tbody>
<tr>
<td>Scrap &amp; raw materials</td>
<td>Improve resource efficiency</td>
<td>Generate high quality aluminium scrap flow from contaminated or mixed scrap flows</td>
</tr>
<tr>
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<td></td>
<td>Facilitate closed loop recycling within alloy groups</td>
</tr>
<tr>
<td></td>
<td>Improve process efficiency</td>
<td>Increase performance of raw materials, master alloys, grain refining agents</td>
</tr>
<tr>
<td>Melting &amp; solidification</td>
<td>Improve energy efficiency and reduce CO₂ emissions</td>
<td>Reduce the energy consumption of the melting furnace and associates CO₂ emission by 20%</td>
</tr>
<tr>
<td></td>
<td>Improve resource efficiency</td>
<td>Reduce the oxidation rate in refining furnaces by 50%</td>
</tr>
<tr>
<td></td>
<td>Improve resource efficiency</td>
<td>Increase service life of furnaces by 50%</td>
</tr>
<tr>
<td></td>
<td>Optimise process technologies</td>
<td>Increase quality and composition of the melt before casting (analysis)</td>
</tr>
<tr>
<td>Products &amp; alloys</td>
<td>Material development</td>
<td>Expand the applications of recycled aluminium by better management of impurities</td>
</tr>
<tr>
<td></td>
<td>Material development</td>
<td>Develop new high performance alloys based mostly on recycled aluminium</td>
</tr>
<tr>
<td>Horiz.</td>
<td>Improve safety</td>
<td>Significantly reduce the risk of fire and explosion</td>
</tr>
<tr>
<td></td>
<td>Optimise process technologies</td>
<td>Better control recycled aluminium quality</td>
</tr>
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SCALE project (2017-2020)

SCALE:
Production of Sc compounds & Sc-Al alloys from European metallurgical by-products
The **ENSUREAL project** aims to demonstrate a modified version of the Pedersen process for the production of alumina. The main advantages of the process are:

1) Zero waste: No red mud, only useable by-products like pig-iron and limestone.

2) A wider range of bauxite qualities can be used (more efficient mining, less tailings, better profitability for the mine, and security of supply for Europe since European bauxite qualities generally have a lower quality.
Objectives: Developing the manufacturing technologies of a specific anodic material that has shown at lab scale outstanding properties in high temperature and corrosive media of the aluminium electrolysis. 

Benefits: The use of inert anode in the aluminium production would decrease by a minimum of 50% the CO2 emissions as compared to the current process with carbon anode.
MOdel based coNtrol framework for Site-wide Optimization of data-intensive processes

The MONSOON project - MOdel-based coNtrol framework for Site-wide Optimization of data-intensive processes - aims to establish a data-driven methodology to support identification and exploitation of optimization potentials by applying model-based predictive controls so as to perform plant and site-wide optimization of production process. The ambition of MONSOON project is shared by 2 significant process industries from the sectors of aluminium and plastic.
Full name: Low Cost Materials Processing Technologies for Mass Production of Lightweight Vehicles
Objective: to enable the novel HFQ® process, (solution Heat treatment, cold die Forming and Quenching) patented by ICL, (TRL4), to be used for the manufacture of lightweight, high strength body and chassis structures and components for low-cost vehicles, by establishing a prototype, full scale pilot production line (TRL6)
Affordable Lightweight Automobiles ALLIANCe

- Effective and affordable lightweighting requires a holistic approach;
- High complexity of this optimisation makes lightweighting one of the most challenging tasks of modern automotive designers and engineers.

An International Hub For Lightweight Innovation

ALLIANCe has the ambition to become a central hub for innovation in lightweight design in Europe. To do so, it will establish an open inclusive framework towards external centres and clusters in this field, involving them in the project through an Open Lightweight Design Contest and dedicated workshops.
• **Objective**: development of an Energy Efficient Ventilated Facades for Optimal Adaptability and Heat Exchange enabling low energy architectural concepts for the refurbishment of existing buildings

• **Principle**: external thermal building refurbishment solution with an external cladding and an air cavity that embeds different breakthrough technologies

• European Aluminium is partner in this project
Conclusions

• Aluminium has several unique properties to support smart sustainable solutions.
• The European Aluminium industry is committed to its sustainability roadmap 2025 and to make aluminium a key-enabler to the low carbon society and circular economy.
• The Innovation Hub is the collaborative platform to coordinate pre-competitive research efforts supporting the sustainability roadmap.
• Any interested stakeholders is invited to join the community (innovation@european-aluminium.eu)

• Thank you for your attention
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