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THE LUX DECARBONIZATION RADAR

Mapping a Path to Net-Zero in Hard-to-Abate Industries



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DECARBONIZING ALUMINUM

Inert anodes remove direct emissions

- Rio Tinto and Alcoa formed JV called Elysis
- Elysis advanced inert anodes to TRL 8
- Commercial production this year



USD 1.1 BILLION PLANT UPGRADE IN CANADA

Increased capacity, lower emissions

- Rio Tinto's Complexe Jonquière in Quebec
- CAD 150 million in government support
- Replacing older smelter with new pots
- Carbon footprint is 14% of industry average



"

Our AP60 technology is already proven and producing some of the lowest-carbon aluminum in the world.

Jakob Stausholm, CEO, Rio Tinto



RETOOLING INDUSTRY

01 The challenge of retooling

02 The Lux Decarbonization Radar

03 Retooling strategies and timelines

04 Implications and key takeaways

MY FOCUS: CORE INDUSTRY

How to make materials and products sustainably



Lux Research also helps clients explore new market opportunities

- The new equipment that economies need to implement the energy transition
- Keep an eye out for an Inspire Report forthcoming in July!

RETOOLING CHALLENGES IN EUROPE

Leilac-2 project to relocate as Heidelberg Materials end clinker production in Hanover

Devastating irony: Europe's "most sustainable" ethane cracker project suspended due to environmental pollution Britain's Largest Steel Mill to Become Greener, at a Cost of Jobs

Evonik to cut 1,500 jobs in Germany

The German chemicals company does not expect an economic recovery in 2024

Italy readies special administration plans for ArcelorMittal steelworks

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ECONOMIC INFRASTRUCTURE

- Existing assets: retrofit or greenfield
- Electric grid: low-carbon power sources
- CO_2 and H_2 infrastructure: pipelines, ports
- Workforce: High-skill workers
 - Demand: buyers that pay green premium

POLICY DRIVES DECARBONIZATION

Divergence between regions with and without effective carbon price



REGULATION CAN SUPPORT DEMAND

Incentives for low-carbon materials

Cove	red Construction Material	Minimum quantity for disclosure (subject to change) ⁴
Concrete mixes		50 cubic yards or more
Asphalt mixes		16,854 pounds (or 10 cubic yards) or more
Steel		
i.	Rebar	
ii.	Hollow Structural Sections	20,000 pounds or more for rebar
iii.	Fabricated Steel Plate	· ·
iv.	Hot-Rolled Sections	5,000 pounds or more, for all others (categories
v.	Cold-Formed & Galvanized	ii – vi)
Glass		OF NEW
i.	Flat Glass	2,000 square feet or more
ii.	Processed Glass	2 A A A
iii	Insulated Glazing Units	* (1) × 1

Procurement is a useful policy tool

- Historical success in biobased fuels
- Emerging attention on construction materials

THE ALTERNATIVE IS "HOLLOWING OUT"





If you get retooling right, your company should be a leader for the next 25 years.

THE LUX DECARBONIZATION RADAR



LUX DECARBONIZATION FRAMEWORK



THE LUX DECARBONIZATION RADAR



MAKESHIFT: BIOCOAL



Torero officially commisioned

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RETROFIT: GASIFICATION



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TRANSFORMATION: BIOBASED CONCRETE



WHEN DO YOU APPLY THESE STRATEGIES TO RETOOL YOUR MANUFACTURING FACILITIES?

10 YEARS OF SERVICE LIFE: MAKESHIFT



Prioritize cost-saving, circular approaches

- Low-hanging fruit more prominent in chemicals and cement
- Not a core solution for net-zero

IN 10–15 YEARS: TRANSFORMATION



Near-zero-carbon manufacturing needs 10 years to scale up

- Governments will support deployment
- Not all tech on same timeline
- Don't create stranded assets

20-PLUS YEARS OF SERVICE LIFE: RETROFIT



Early action amplifies impact

- Policy context is crucial
- Hydrogen vs. CCUS will plug into different value chains

HOW CAN INNOVATION GROUPS PUT THIS GUIDANCE INTO PRACTICE?

INVEST IN CUTTING-EDGE STARTUPS

Knowledge > money

Bets on transformational startups help:

- Gain insights into obstacles and enablers
- Hedge against failures
- Facilitate acquisition



ADJUST THE WORKFORCE

Build new competencies

- Corner office and factory floor
- Leverage academic partnerships



FOSTER YOUR ECOSYSTEM

Energy transition needs collaboration

- Hydrogen and carbon consortia
- Supply and demand match better at scale
- Ancillary innovations support your projects



Hydrogen projects at Port of Rotterdam; source: Port of Rotterdam



ENERGY SUPPLY RESILIENCE

LOW-CARBON SUPPLY CHAIN

EXPORTABLE TECHNOLOGY







KEY TAKEAWAYS

Regulation creates the incentives for low-carbon manufacturing.

Tailor your retooling strategy to the policy environments where you operate and sell, especially demand-side incentives.

2

Prepare today for stepchange transformation in 10 years.

R&D and innovation activities lay the groundwork for the big strategic bets in the 2030s.

3

Compete on the product; cooperate on infrastructure.

Leverage public support and diverse consortia to build out the necessary pipelines and terminals.



THANK YOU

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