Introduction

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Session 5 :

Decarbonization of Bulk Materials

WORLD MATERIALS FORUM

Steel, aluminum and cement direct emissions account for 15-20% of world CO_2 emissions

2020	Material production (Mio Tons)	Average direct emissions intensity (CO_2eq/ton)	CO_2 direct emissions (Mio Tons CO_2eq)	% of World CO_2 emissions	World CO_2 emissions Mio Tons CO_2eq (*not including other GHG : methane, PFC, …*)
Steel (1)	1 864	1,4	2 600	7%	37 000
Cement (2)	4 281	0,59	2 500	7%	
Aluminum	65	(4 to 20) (3)	1 000	3%	
Total			6 100	17%	

Note: emisions intensity varies by country and production conditions

(1) Iron & steel analysis - International Energy Agency, November 2021
(2) Cement analysis - International Energy Agency, November 2021
(3) Aluminum Production in the Times of Climate Change, the journal of the Minerals, Metals & Materials Society November 2019

Decarbonization of bulk materials production is facing major challenges

1. **Long-lived capital assets**: Industrial plants tend to have long lifetimes: typically, 30-40 years for plants in heavy industries. Retiring them early to switch to alternative technologies would incur very large costs. (…)

2. **High-temperature heat requirements**: Heavy industry requires high temperature heat for many of its processes, which today is almost exclusively provided by burning fossil fuels. (…)

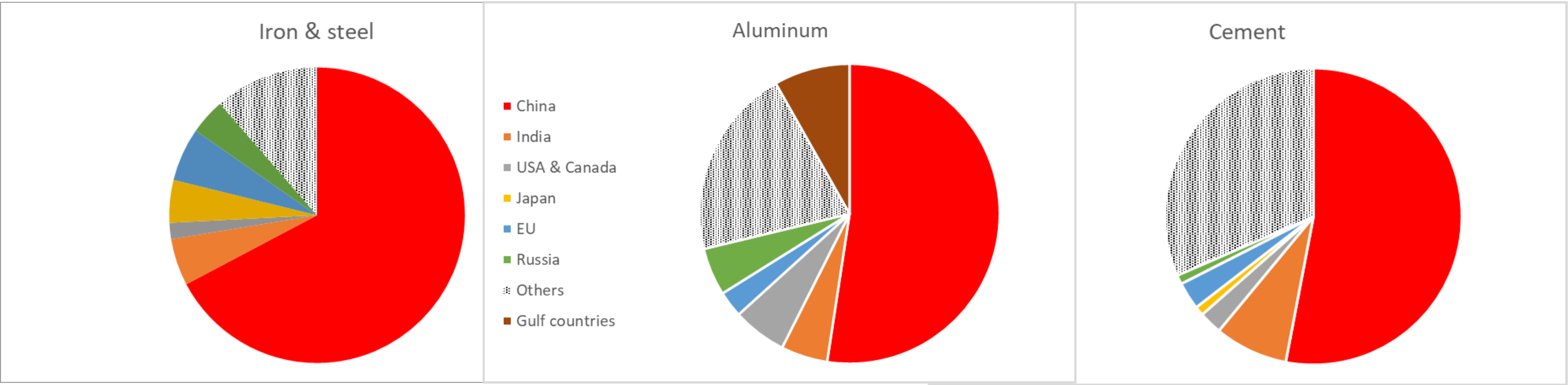
3. **Process emissions:** (…) A key example is the CO_2 that results from the calcination reaction that is necessary to produce clinker, the active ingredient in cement, and that constitutes around two-thirds of the direct emissions in the sector.. (…).

4. **Trade considerations:** Many industrial products are traded in highly competitive global markets (e.g. steel, aluminium, primary chemicals). This makes it challenging for an individual producer or country to turn to the currently more expensive low-carbon production pathways in order to reduce emissions without being undercut on price.

Source: "The challenge of reaching zero emissions in heavy industry" - International Energy Agency, 2020

Need of a level playing field in international competition

A majority of the production is located in China and India where the carbon content of the energy used in steel, aluminum and cement production is on average significantly higher

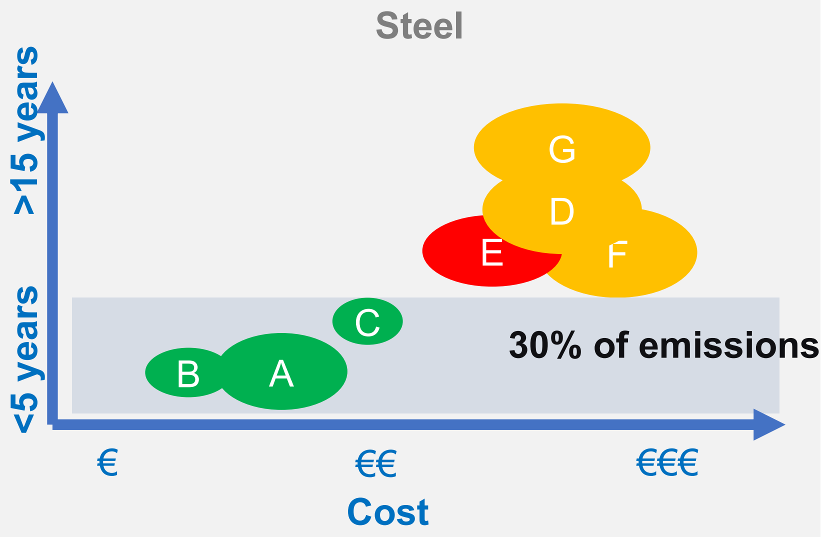


Which technologies to decouple materials production and CO_2 emission ?

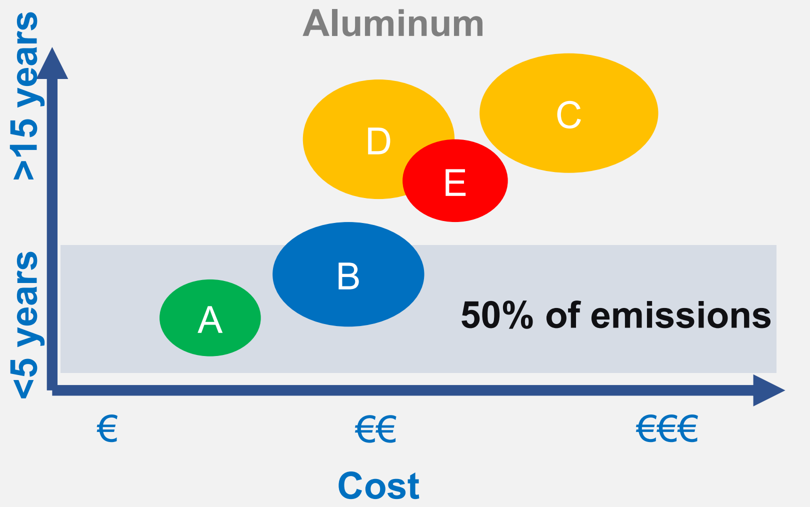
	Iron & steel	Aluminum	Cement
Material demand evolution by 2050	+35% (1)	+40% / +50% (2)	+12% / + 23% (3)
Main CO2 reduction technologies	❖ Scrap recycling in electric furnace ❖ Scrap recycling in O2 converter ❖ Hydrogen ❖ CO gas recirculating ❖ DRI (reduction of iron ore) ❖ Electrolysis ❖ CCS & CCUS	❖ Scrap recycling ❖ Heat produced from renewables ❖ Green electricity ❖ Inert anode ❖ Carbon anode from biomass ❖ CCS & CCUS	❖ Reduce clinker rate ❖ Recycling of concrete ❖ Replace fossile fuels ❖ Up grading cement kilns ❖ Low carbon clinkers ❖ CCS & CCUS

(1) & (3) : source IEA *(2) : source International Aluminum*

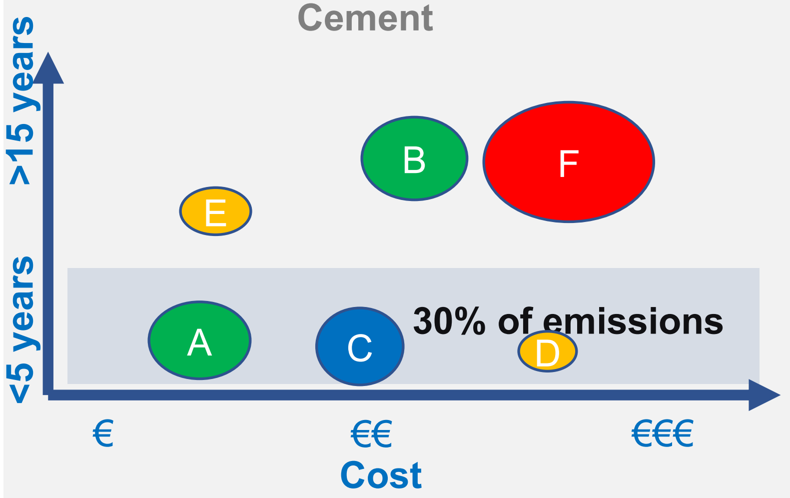
Assessment of solutions in terms of technological maturity and cost (example, French study)



A. Scrap recycling in electric furnace
B. Scrap recycling in O2 converter
C. CO gas recirculating
D. Hydrogen
E. CCS and CCUS
F. DRI (reduction of iron ore)
G. Electrolisis



A. Scrap recycling
B. Heat produced from renewables
C. Inert anode
D. Carbon anode from biomass
E. CCS and CCUS



A. Reduce clinker rate
B. Recycling of concrete
C. Replace fossile fuels
D. Up grading cement kilns - BAT
E. Low carbon clinkers
F. CCS and CCUS

From: Sectoral Transition Plans, LIFE Climact' program, ADEME (French Agency for Ecological Transition) - 2021

"Net-zero CO2 emissions from the industrial sector are challenging but possible" (IPCC, April 2022)

- "Reducing industry emissions will entail **coordinated action throughout value chains** to promote all mitigation options, including demand management, energy and materials efficiency, circular material flows, as well as abatement technologies and transformational changes in production processes."

- "Progressing towards net zero GHG emissions from industry will be enabled by the adoption of **new production processes using low and zero GHG electricity, hydrogen**, fuels, and carbon management."

- "For almost all basic materials – primary metals, building materials and chemicals – many low- to zero- GHG intensity **production processes are at the pilot to near-commercial** and in some cases commercial stage but not yet established industrial practice."

Source: IPCC – Mitigation of climate change, summary for policymakers WG III - 2022

Speakers

	**Shunichi Miyanaga,** Chairman MHI (Japan), Co-chair .
	**Guy Sidos,** CEO Vicat (France), Co-chair .
	**Eric Niedziela,** chairman ArcelorMittal France

	**Vincent Christ,** CEO Elysis (Canada)
	**Cody Finke,** CEO Brimstone Energy (USA)