Brussels, 23-34 October 2017

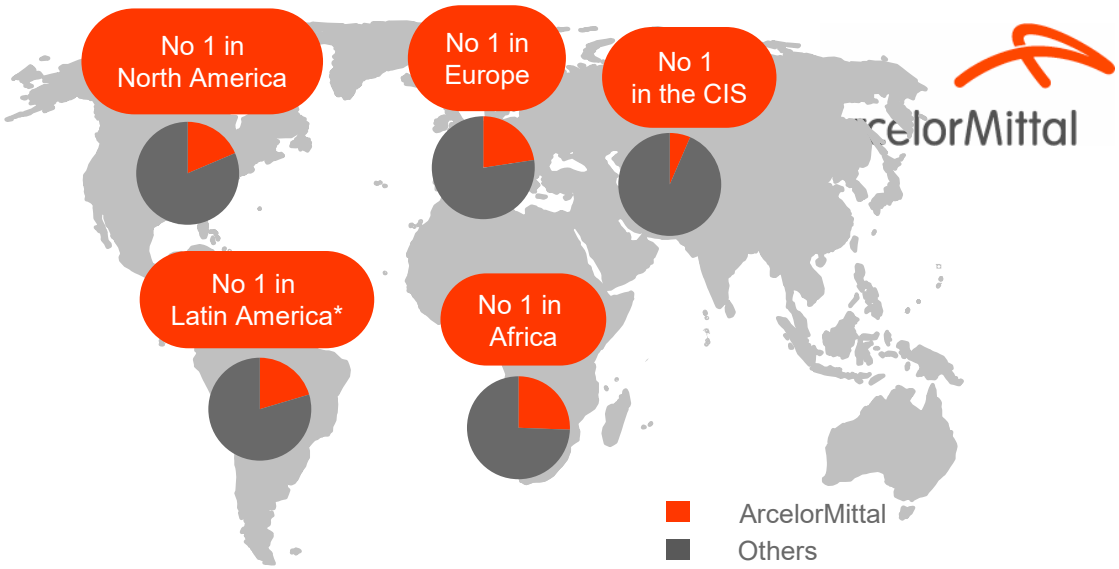
ArcelorMittal

The Innovative Role of Steel in the 21th Century

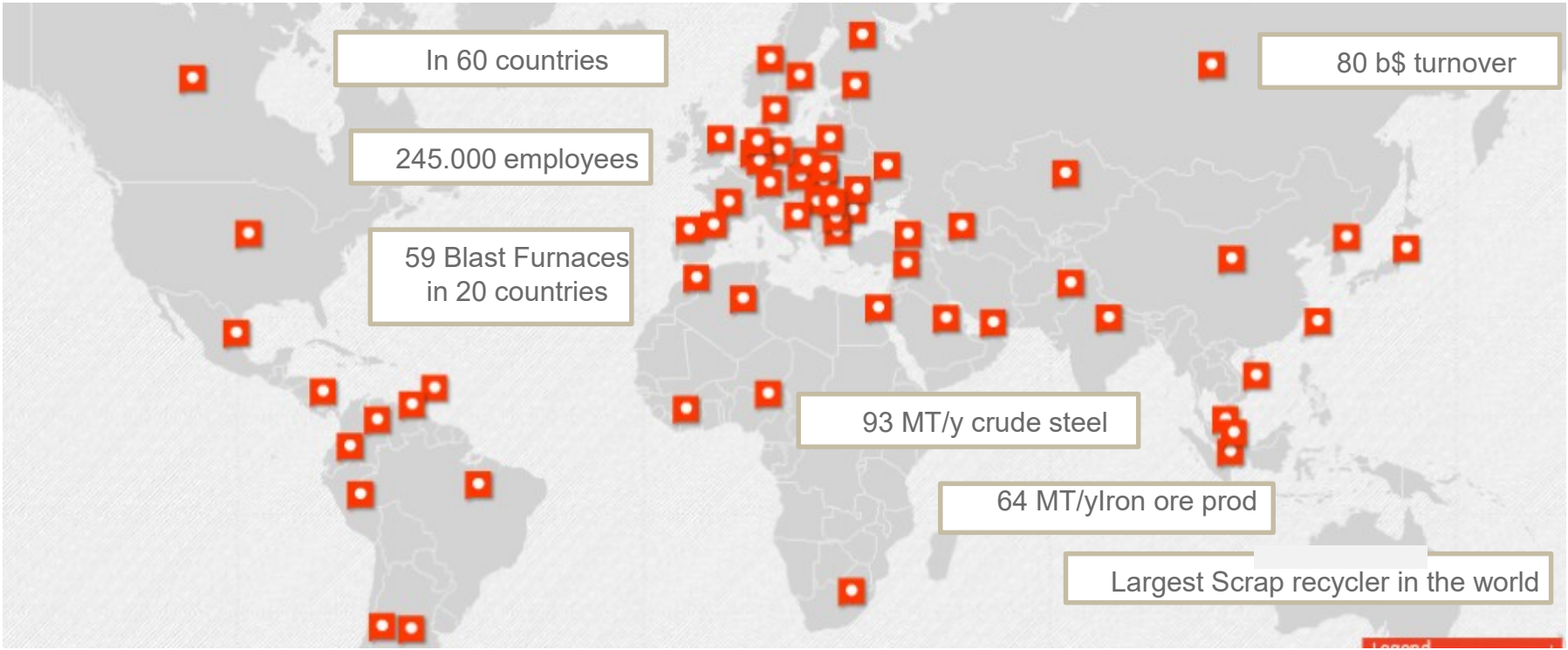
Inspiration through Collaboration

Carl De Maré, Vice-President Technology Strategy


93mt in 2016
5% Market Share


No 1 in North America
No 1 in Europe
No 1 in the CIS
No 1 in Latin America*
No 1 in Africa
ArcelorMittal
Others

ArcelorMittal worldwide



Steel – The Fabric of Life

Steel is essential in modern society

Steel is crucial to
the white goods industry

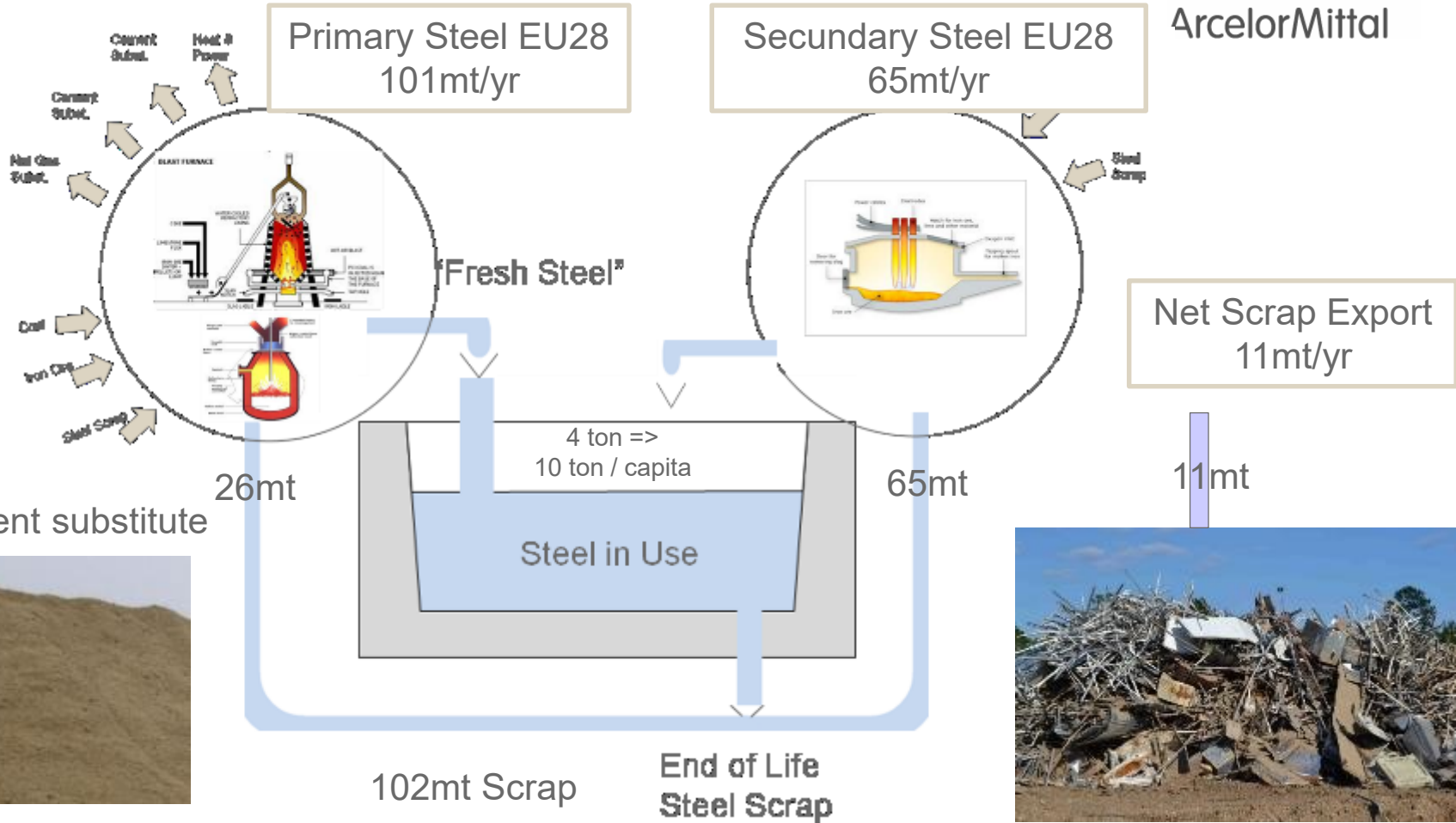
Steel is irreplaceable for the
car industry

Steel is used to produce
sustainable energy

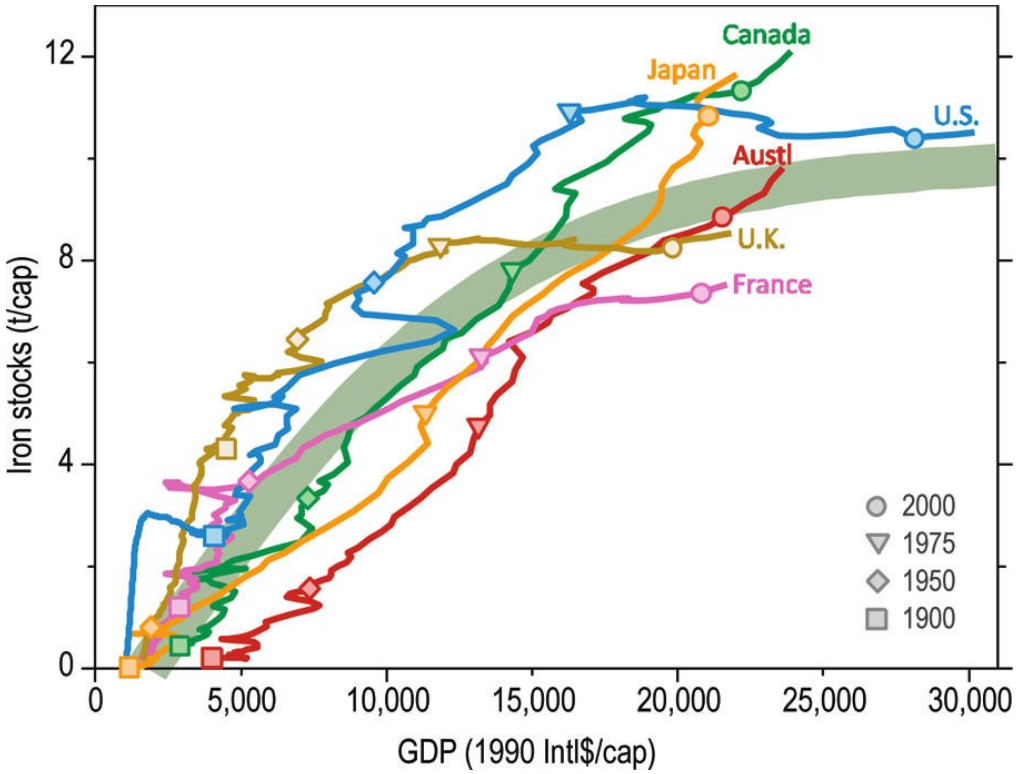
Steel for
sustainable housing

Steel is the example of a global circular economy

Figure for EU28



Expected Evolution of Steel use in 21th Century



GROWTH PHASE :

- Steel is needed to develop a sustainable society
- Correlated with population and with GDP upto ca 10 ton per capita

SUSTAINABLE PHASE:

- Steel need correlated to replace end of life products

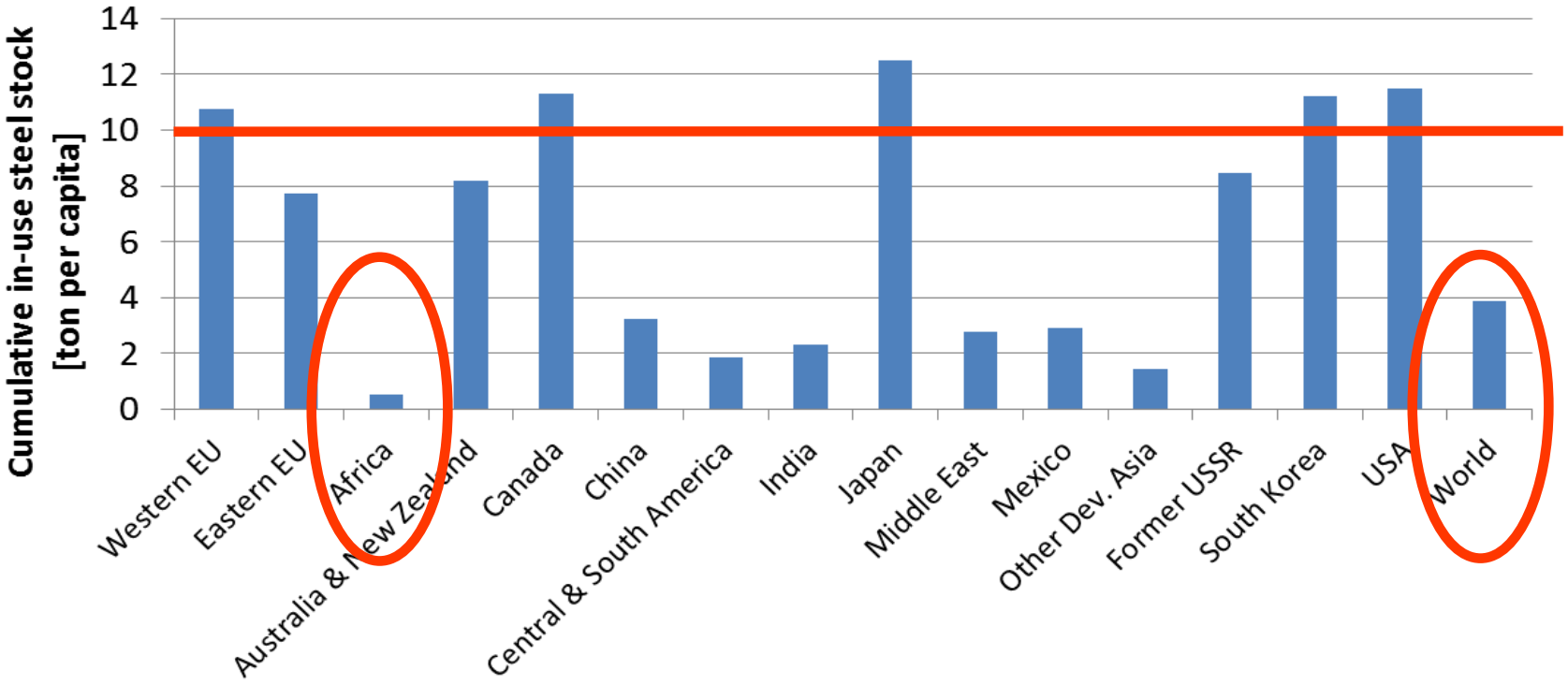
Daniel MULLER, Tao WANG and Benjamin DUVAL, Patterns of iron use in societal evolution , Environ. Sci. Technol. 2011, 45

10.000 kg/person steel in use

1 kg/person/day steel consumption

30 billion ton is currently “in use” in the global economy

Steel stock per region per capita



20 x

12>10 > 8 ton/p steel stock
1000 g/day/p steel consumption

= **400kg/p** steel stock +
50 g/day/p steel consumption

Evoluation of PPP and Population per Region

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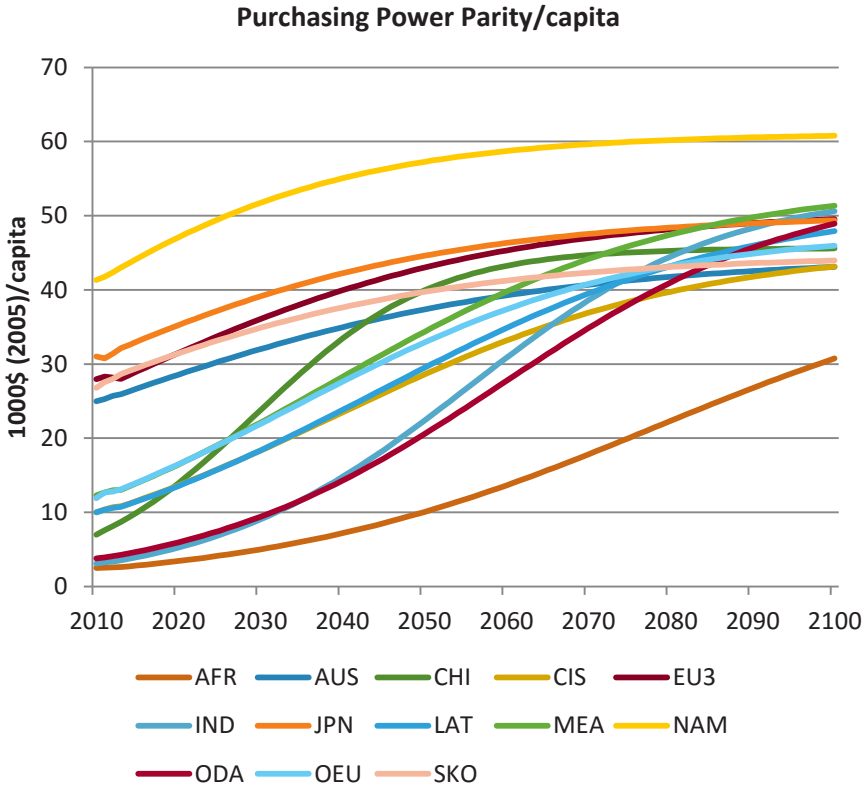
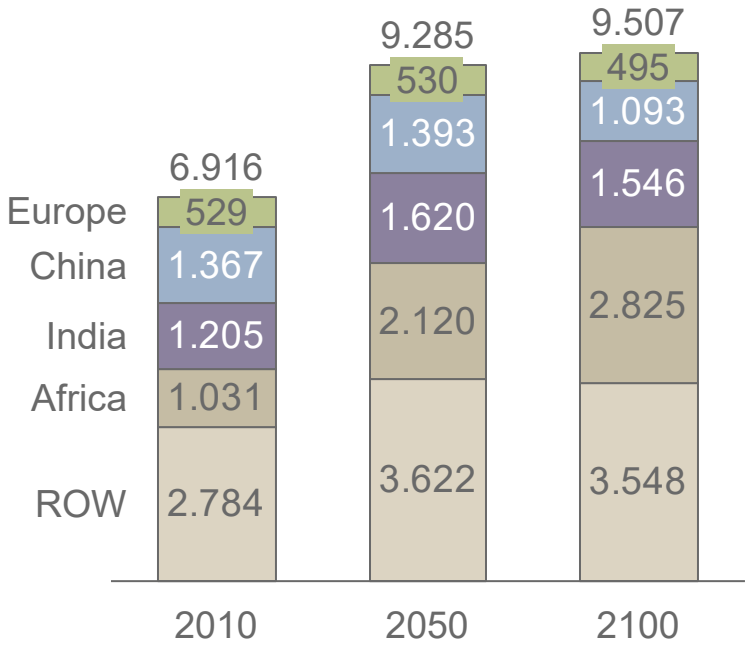
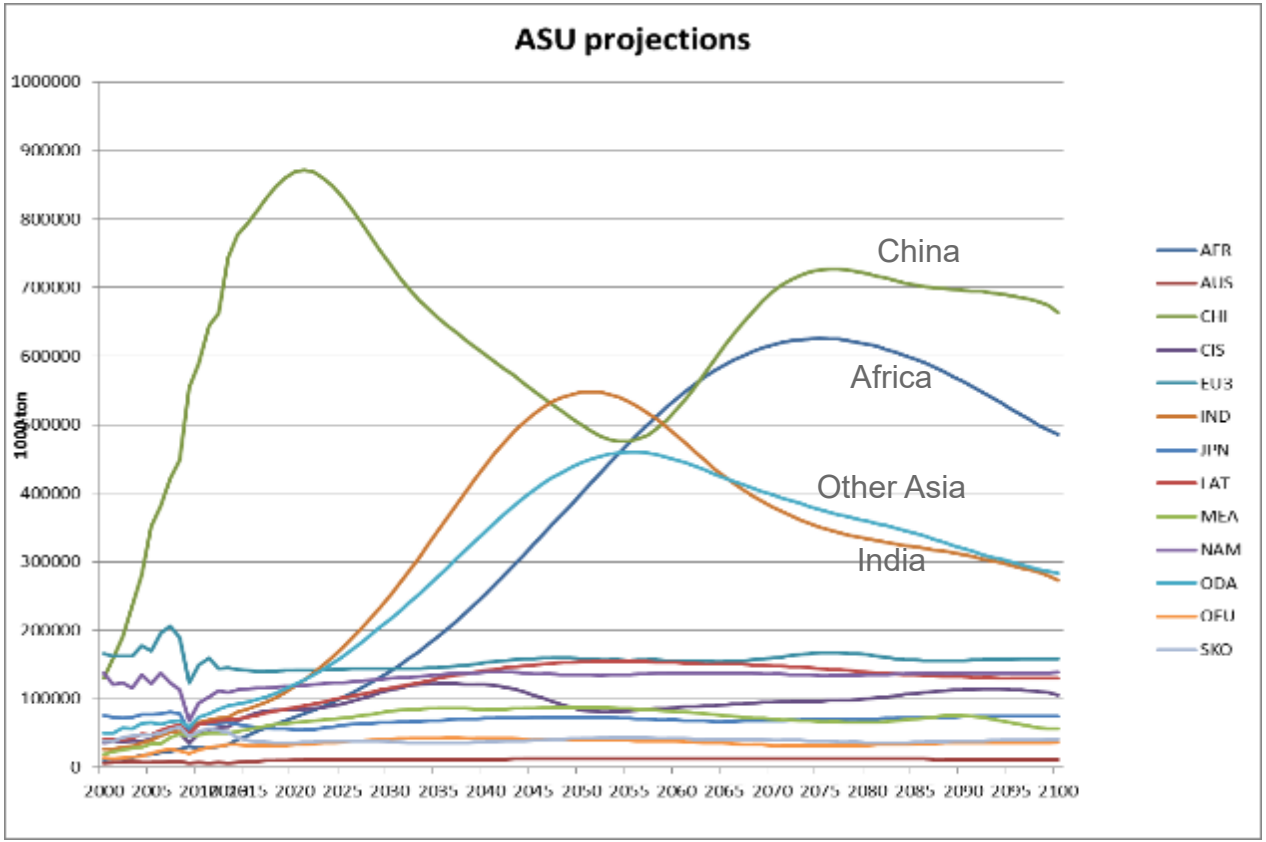


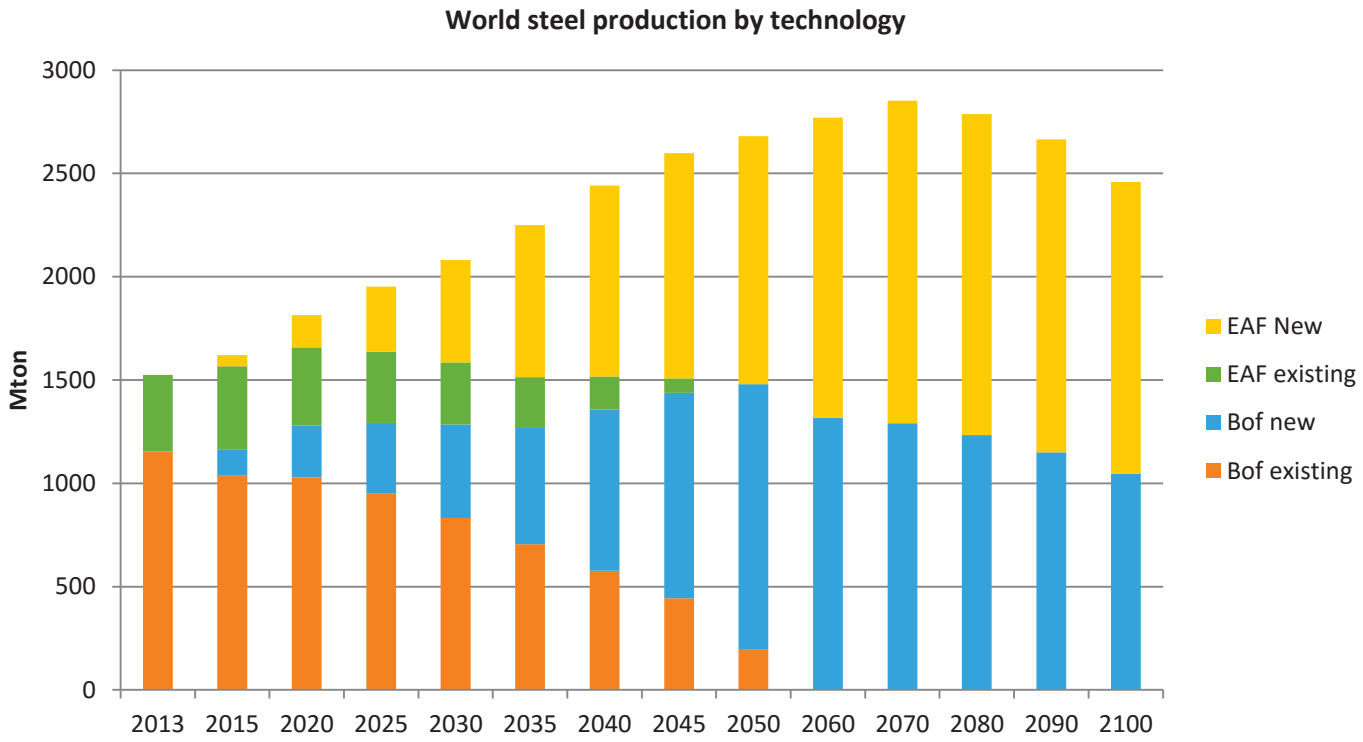


Apparant Steel Consumption per Region



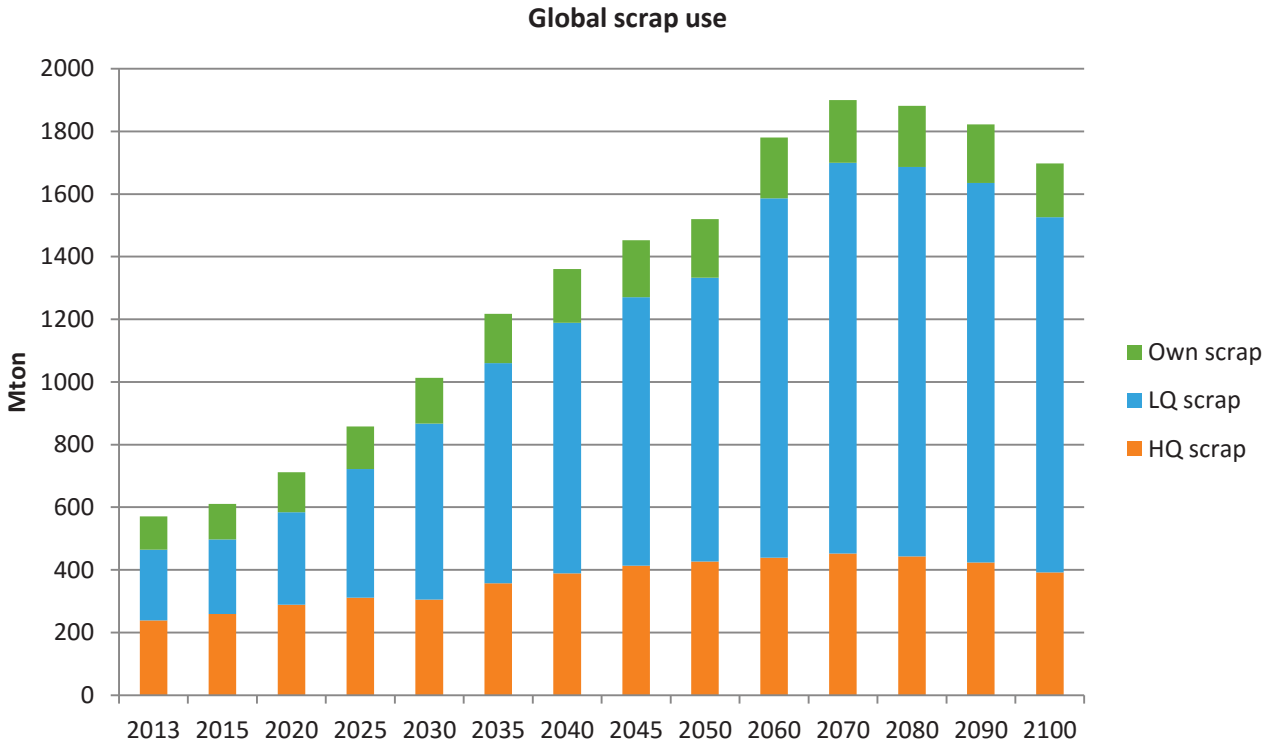
Source: Study KTH, Vito, ArcelorMittal

Evolution of Primary and Secundary steelmaking in the 21th Century



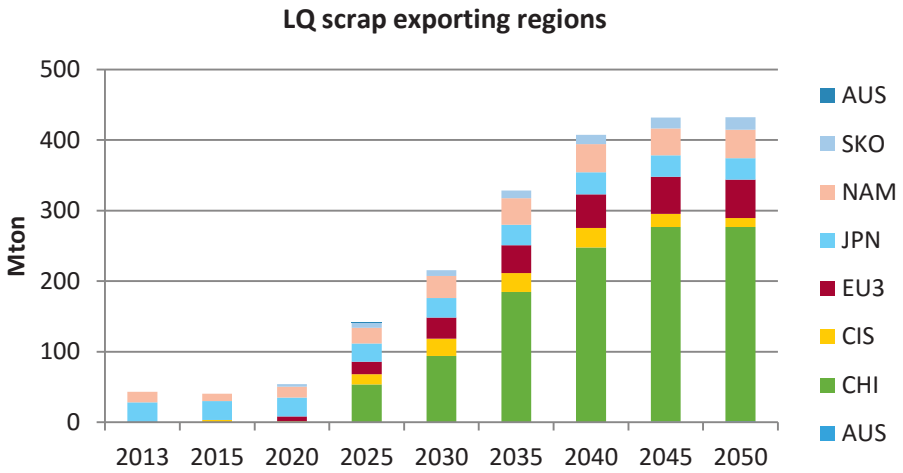
Source: Study KTH, Vito, ArcelorMittal

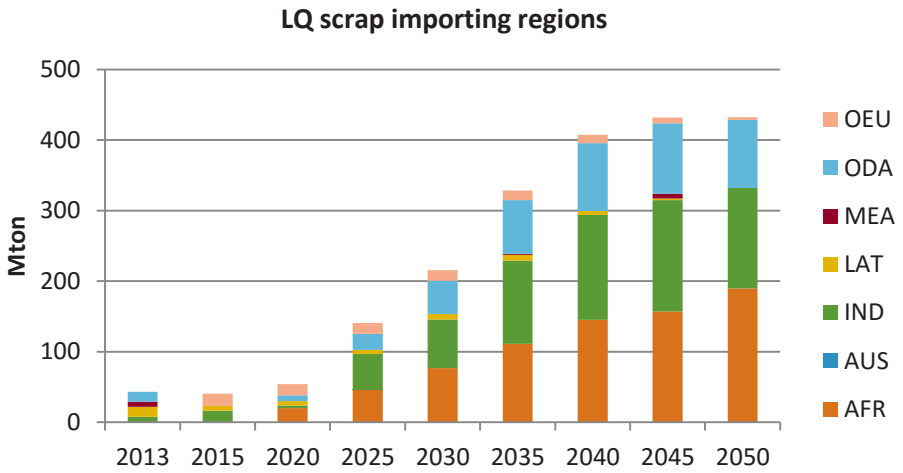
Evolution of Scrap Arising in the 21th Century



Source: Study KTH, Vito, ArcelorMittal

Impact on the Scrap Flows





Source: Study KTH, Vito, ArcelorMittal

Steel & Climate

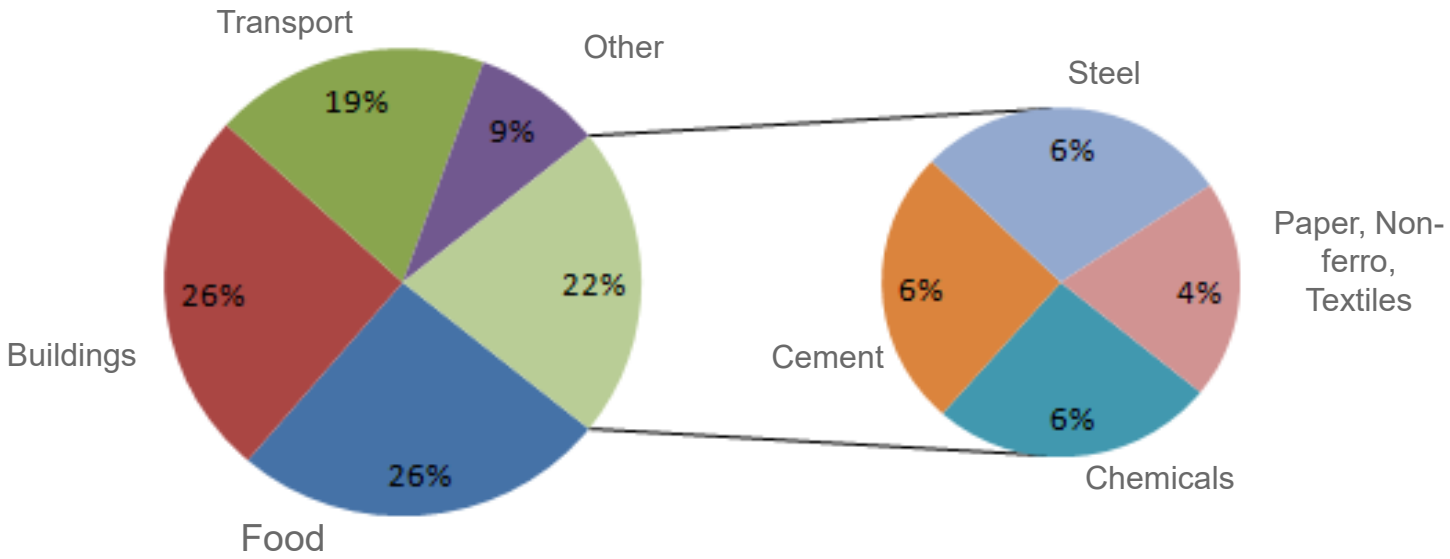
Steel is responsible for 6% of global emissions

- Climate Impact ArcelorMittal

59 blast furnaces in 20 countries

1/3 of production based on scrap recycling

207mt CO2 Emissions =ca 80% of CO2 (NL+B)



Source: Designing Climate change mitigation plans that add up – B. Bajzelj, J. Allwood, J. M. Cullen

Steel is a low emission material
Accounting for recycling and LCA sets the record straight

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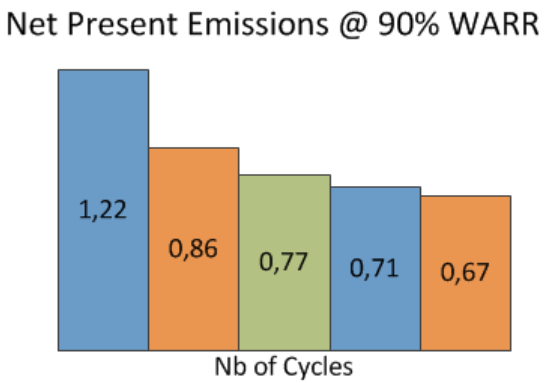
Material*	Primary CO2 tCO2/t	Life Cycle CO2 tCO2/t
Natural Stone	0.2	0.2
Pine	0.45	0.45
Steel	2.5	0.86
Clincker	0.9	0.9
Carbon fibre	17	17
Ti	40	17

*Elaboration on M. Ashby Materials and the Environment

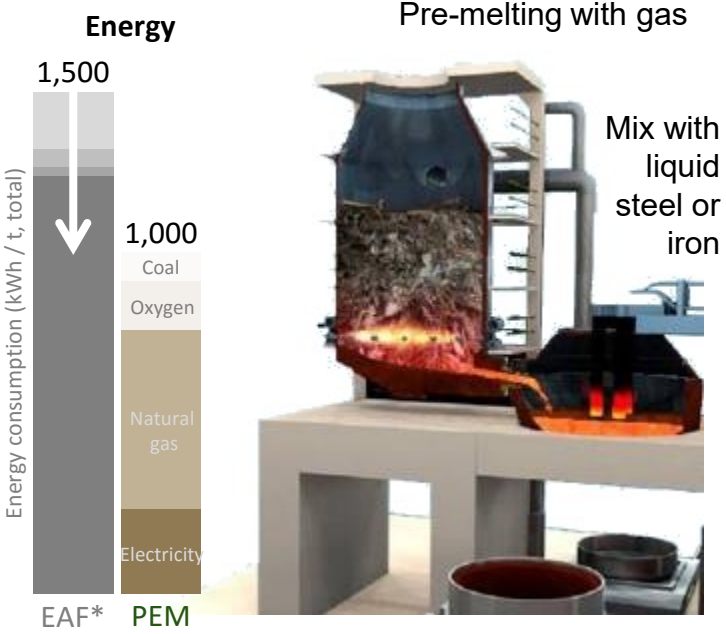


Based on D/C system and WARR, after one cycle emissions are < 50% of what conventionally is believed

Low Capex Secundary Steelmaking with primary energy melter

Pilot Project ArcelorMittal and SMS for 200.000 ton per year melting

SMS group ArcelorMittal



* Average according to a study by World Steel Association

Primary steelmaking is build on the efficient use of carbon

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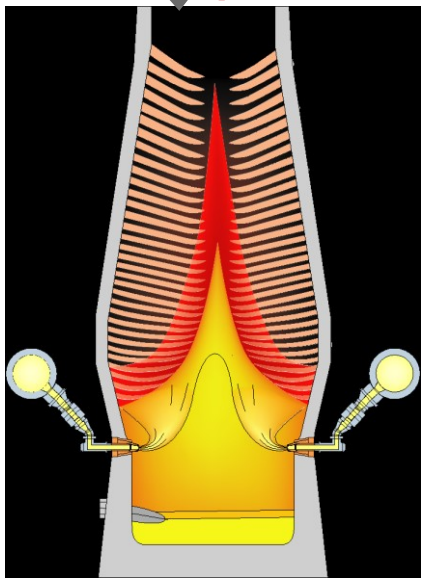
$$FeO + C + O2 \rightarrow Fe + CO + CO2$$

Iron Ore
Cokes

Cleaned SynGas
CO/CO2/H2



CO_2

% Powder Coal
Oxygen

Power Plant

Not the use of Carbon, but the emission of CO2 is the problem

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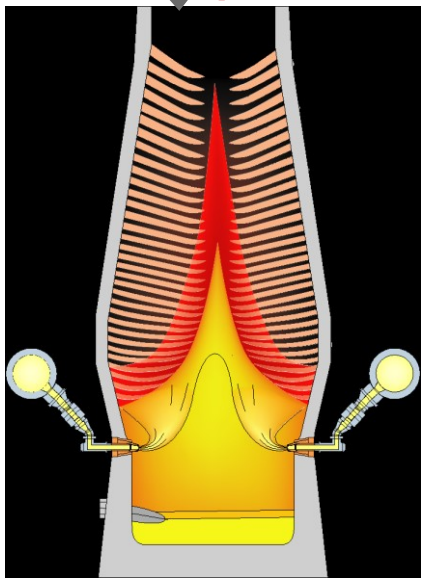
$$FeO + C + O2 \rightarrow Fe + CO + CO2$$

Iron Ore
Cokes

% Powder Coal
Oxygen



Cleaned SynGas
CO/CO2/H2

Recycle the Carbon

Power Plant

Chemicals & Fuels

Nature is already recycling Carbon billions of years

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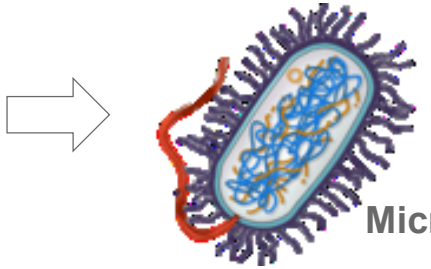
Carbon Waste Gas (CO) from
Iron-Ore Reduction
In **Blast Furnace**



Microbe

Water
H2O

Ethanol
C2H5OH

Ethanol is used for transport (fuel), chemicals (plastics), food and pharmaceutics

AM Gent Commercial Demonstration Project to produce Ethanol from waste gas with our partner Lanzatech

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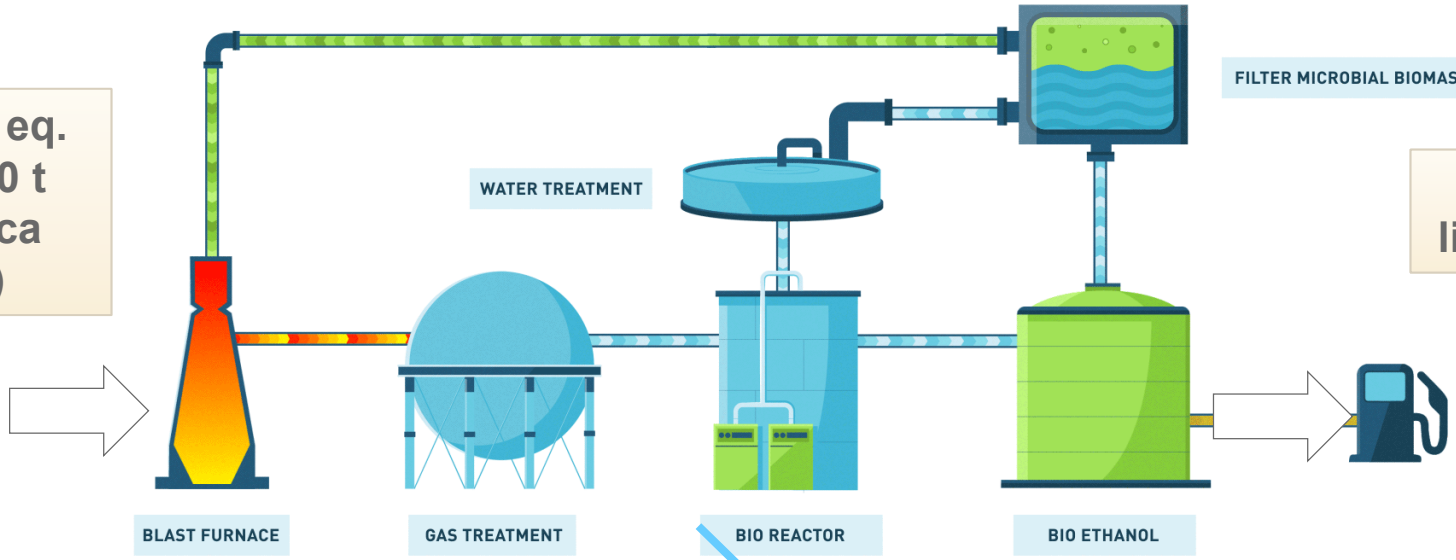
BF Gas eq. 600.000 t steel (ca 15%)



80 million liter per year

Steelanol
Fueling a sustainable future

LanzaTech

Sponsored by Horizon2020 LCE-12

AM Gent Commercial Demonstration Project 2015-2019

ArcelorMittal









Sustainability impact of Steelanol Demo

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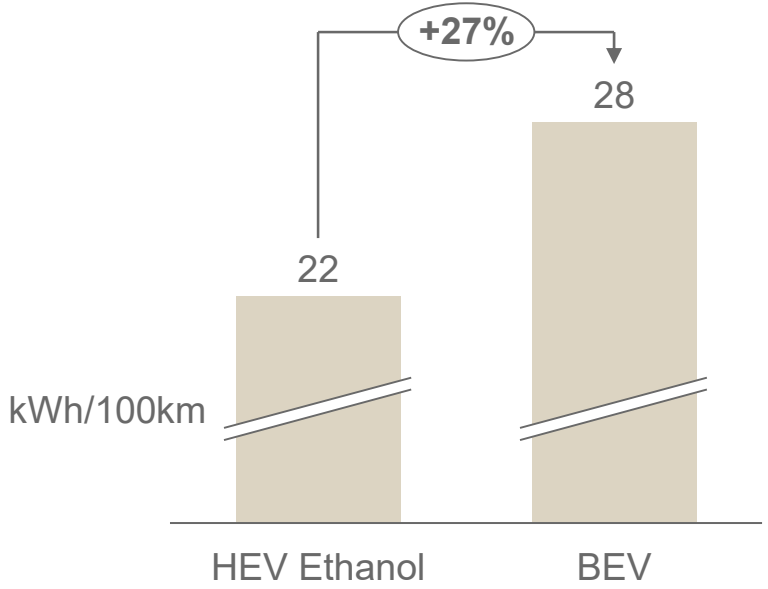
Scale up to global steel industry : 1000x



80million liter of Demo Project =
100.000 electrical cars

27% less kWh consumed per 100km
(w/o energy impact of battery disposal end of life)

Potential for next step 10x larger units
Potential impact if implemented world wide: 1000x

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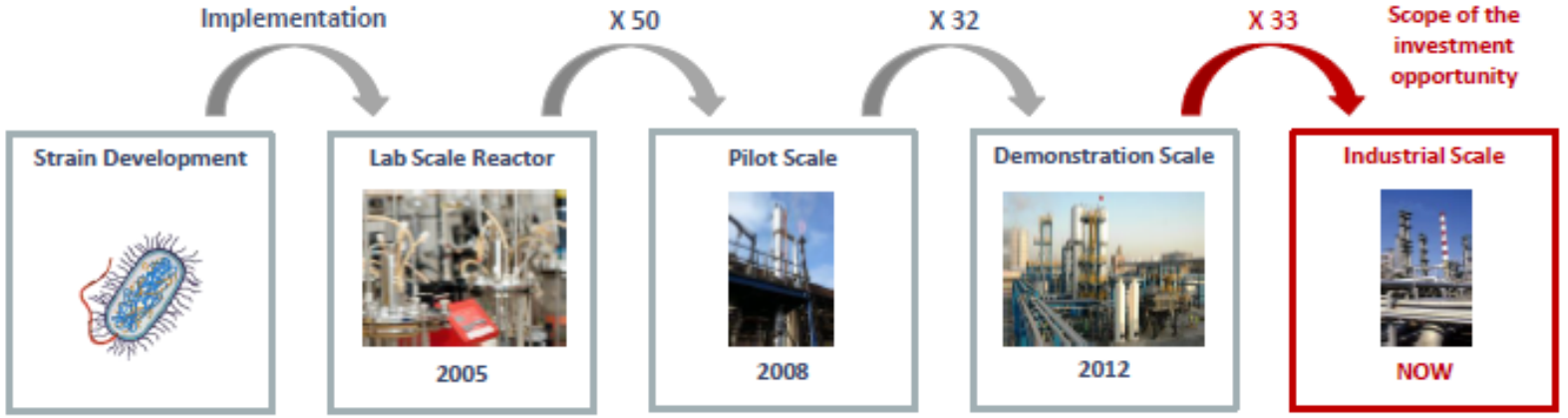


Production Rate	0.5 – 1 kg EtOH/day	50 – 100 kg EtOH/day	± 1,500 kg EtOH/day	± 72,000 kg EtOH/day
Reactor Size	1 – 10 l	2 x 500 l	16,000 l	533,000 l
Location	LT lab	Blue Scope Steel Mill Glenbrook, New Zealand	Baosteel (Shanghai, China) + Shougang (Bejing, China)	Steelanol

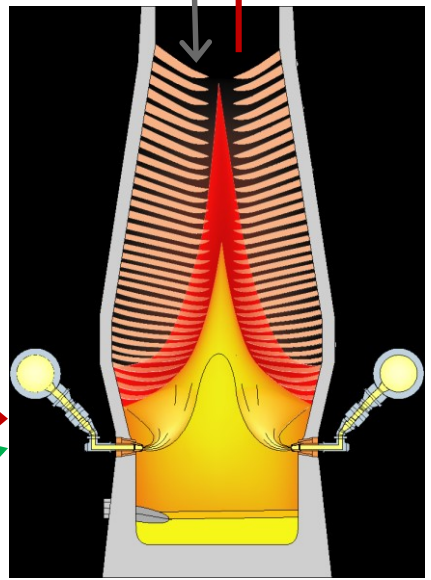
LanzaTech

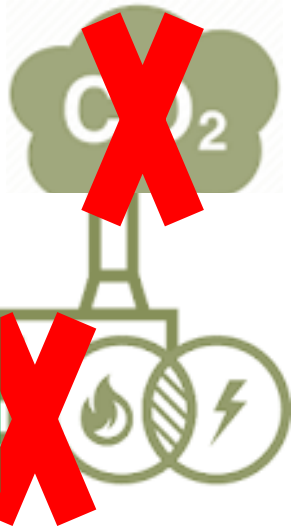
Cradle to Cradle: closing the carbon loop

$$FeO + C + O2 \rightarrow Fe + CO + CO2$$

Iron Ore
Cokes

Cleaned SynGas
CO/CO2/H2





Recycle the Carbon

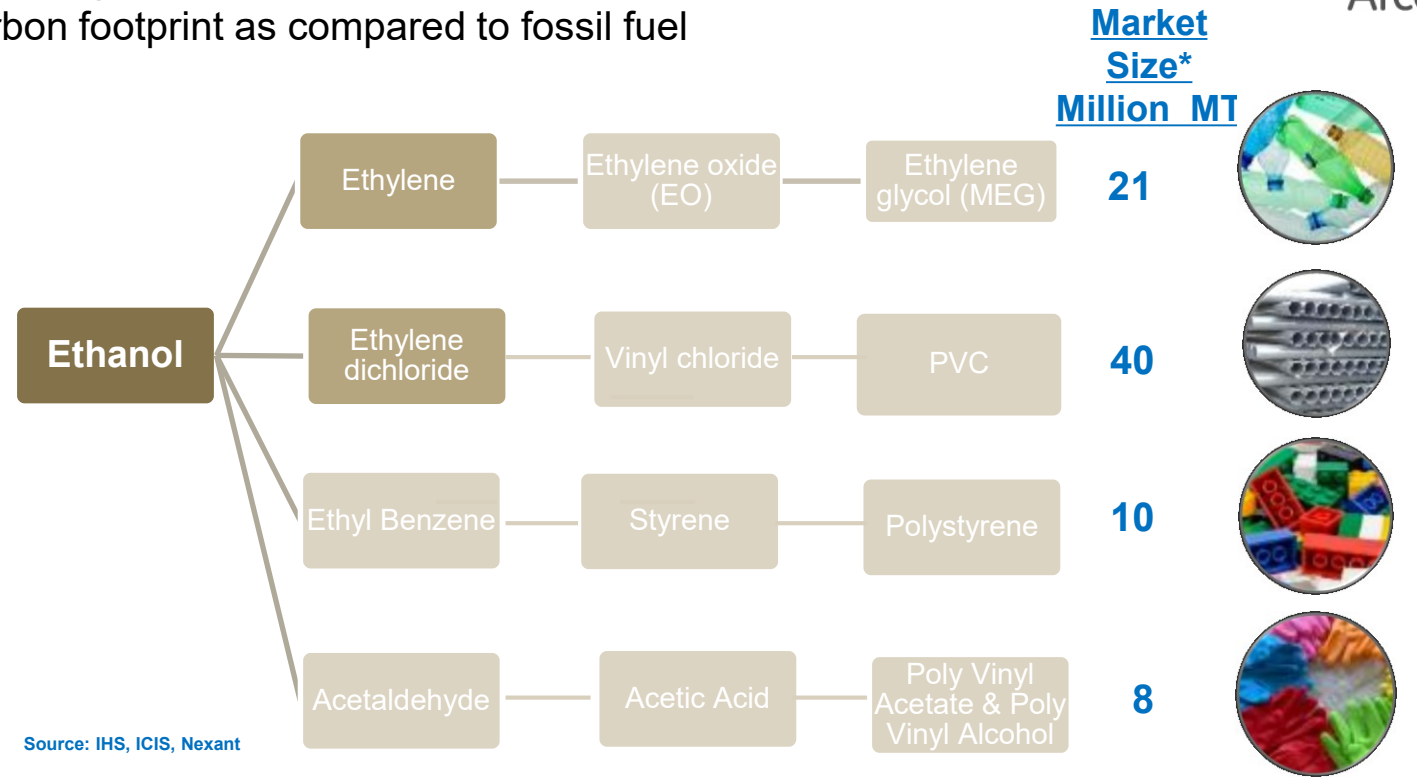
% Powder Coal
Oxygen

Biomass & Waste

Chemicals

Ethanol Derivatives – Value Chain

Ethanol based petrochemicals have been shown to have 30-40% lower carbon footprint as compared to fossil fuel



Low carbon ethanol leads to sustainable products

Forrest Plantation in Brasil
A Clean and Renewable Energy

See Poster of Forestry Energineer Roosebelt de Paula Amado of AM BioFlorestas in Brasil

Steel is a key enabler for circular economy and cross sectorial collaboration

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CO and Hydrogen Reuse

Steelanol

Renewable Fuels

Bio-Chemical & Electrical Conversion

Renewable Plastics

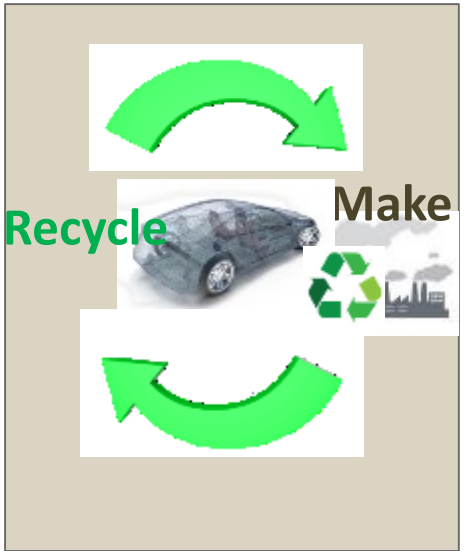
Polyurethane seating foams

Exterior paints and coatings

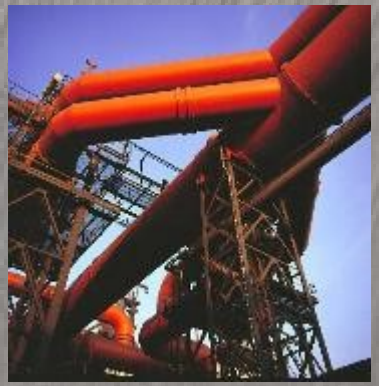
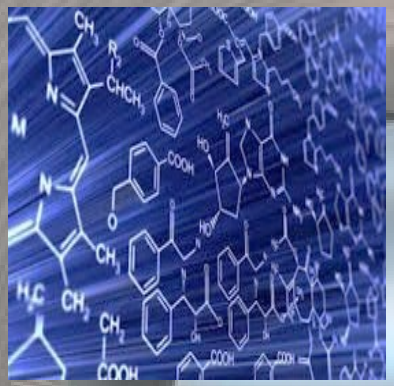
Synthetic rubbers

Proteins

Interior plastic mouldings






Inspiration through Collaboration

Thanks for your attention
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