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Low CO2 Stainless Steel; a grade specific definition

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A label could address different purposes:

- Recognising additional effort towards near zero (in particular for primary c-steel production)

- Access to a lead market (Includes financial instruments to incentivise purchase of green steel, government procurement, and voluntary commitments)

- Recognising products with a low CO2 footprint and protection against environmentally unfriendly produced products (compare grade by grade)

Consideration: A Stainless label could help to identify the low-CO2 products but should be grade specific

Definition of Stainless steel; Alloy steels containing, by weight, 1.2% or less of carbon and 10.5% or more of chromium, with or without other elements (Ni, Mo, Mn, V, Ti, Si, Nb etc.

Not in CN code but at least 50% of Fe!

Stainless steel comes in very many grades all having a different specific footprint depending on alloy content and recycled content. Depending on composition and ferro alloy / scrap ratio the footprint varies considerably, in Europe between 1 and 5 ton of CO_2 /ton of stainless steel (scope 1+2+3).

A very important issue is where the alloying elements are being sourced.

CF of 20 common stainless grades
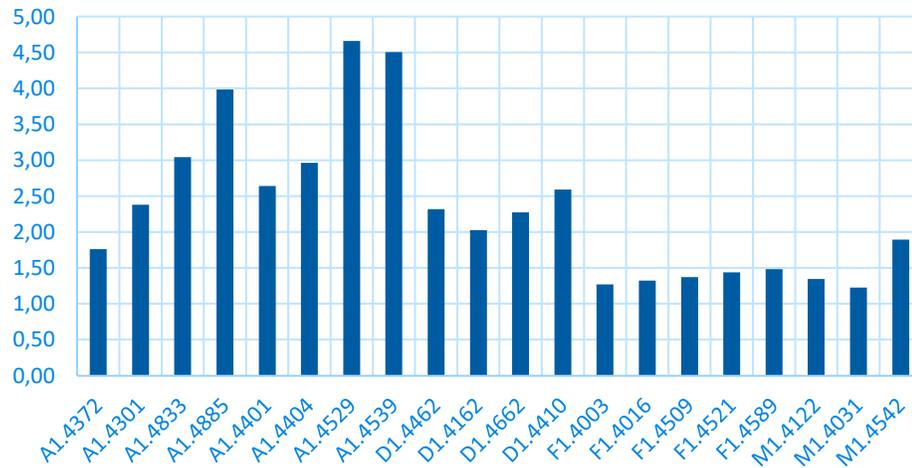
	Cr	Ni	Mo	Mn	C
Min	13,08%	0,00%	0,00%	0,02%	0,01%
Max	25,50%	24,80%	6,50%	5,00%	4,00%

- (stainless) Scrap content varies from 40% (?) – 90%

- Stainless in Europe is produced with EAF + VOD/AOD (Vacuum/Argon oxygen decarburization) furnaces out of scrap and (imported) ferro alloys (FeCr – FeNi – FeMo – MoO3)

- In Europe the average scrap input (stainless scrap + c-steel scrap) is over 80%. The average stainless scrap input is over 60%.

- No distinction between pre- or post consumer scrap.

- In spite of the high scrap input the CO2 footprint of stainless produced in Europe is over 70% caused by the CO2 emissions of the upstream ferro alloy production (upstream scope 3).

- Because of different grades and alloying content no linear relation between scrap input and footprint

- This requires a grade specific approach, dynamic threshold / benchmark.

- MF_n is an alloy content dependent Model Footprint (MF) for grade n based on the average grid mix (376 kg CO2 / MWh) and a fixed scrap input (70% stainless scrap) in Europe.

- Derived by linear regression (Kobolde ©) from the alloy and c-content and known carbon footprints of 20 different stainless grades

$$MF_n =$$

$$((-42{,}57\textbf{C}\ \%n + 27{,}09\textbf{Mn}\%n + 30{,}56\ \textbf{Cr}\%n + 115{,}45\ \textbf{Ni}\%n + 30{,}8\ \textbf{Mo}\%n + 103{,}03\ \textbf{V}\%n + 20{,}78\ \textbf{Ti}\%n + 4{,}63(\textbf{Fe+rest})\%n + EAux)\ /CY + EHR)/\ HRY$$

expressed in (kg CO2 eq per ton of Hot Rolled Coil)

This reflects the average footprint of stainless produced in Europe. In order to get an A-label the performance should be more ambitious than average. This requires a threshold T.

This T is derived from MF using a reduction factor R (in %)

$$T_n = (100\% - R) * MF_n$$

- This actual CF of the different grades will be calculated according to a standard. The standard 'ISO 14067:2018' should be used as a minimum requirement. The GHG impact category of the 'NEN-EN 15804+A2' standard, providing core product category rules (PCR) for Type III environmental declarations may be used as an alternative.

- The calculation up to and including Hot Rolling should be used for the comparison with the threshold to determine the label. The calculation including further downstream processing should be done to provide proper information on the product CF to the client.

The labelling will be done by comparing Tn with <u>the actual CFn of this specific grade</u>, using the real grid mix (market based) and real scrap input calculated via a footprint standard.

The labelling will then be according to this scheme:

Label A: $CFn < Tn$

Label B: $Tn < CFn < 2*Tn$

Label C: $2*Tn < CFn < 3*Tn$

Label D: $3*Tn < CFn < 4*Tn$

Label E: $4*Tn < CFn$ or unknown

In order to make this a transparent and verifiable system, every producer using it should report the following issues for every product:

- The grade name and type

- Composition of the grade for the following alloying elements C, Cr, Ni, Mo, Mn, V, Ti

- The calculated MF of that grade

- The actual CF of that grade scope 1, 2 and 3 using the using the real grid mix (market based), raw material footprints and real scrap input calculated according to a standard for the product including hot rolling; the coil footprint.

- The actual CF of that product including further downstream processing

- The label

Proposal has been discussed with:

- Service centers: Kloeckner

- Automotive industry: ACEA, BMW Group, PSA automobile

- Furniture industry: Miele

- Responsible steel

- ESPR proposal

- ESTEP
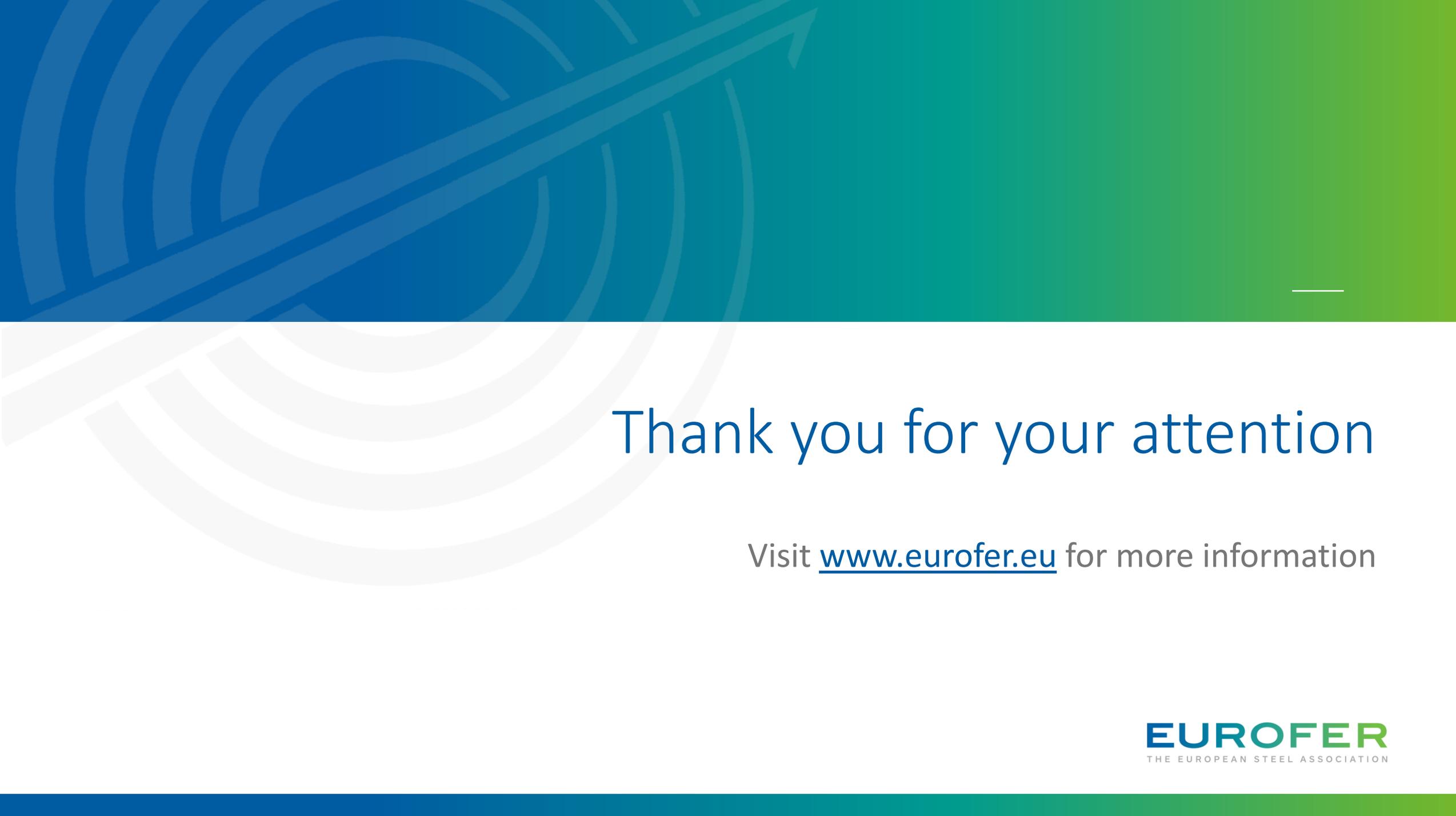
Thank you for your attention

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- The melt shop yield is defined as: the weight of the qualified finished steel products (ex-caster) divided by the weight of the raw materials used to produce them (melt-shop + AOD/VOD). If the melt-shop yield is 96%, it means it will have average 4% metal loss (slags, cut-offs, failed finished products etc.).

- The Hot rolling yield is defined as: the weight of the finished steel products (Hot Rolled Coil) divided by the weight of the initial raw material used in the hot rolling: if the hot rolling yield is 97%, it means 3% waste from hot rolling process.

This equation is:

- good for high recycled content grades (austenitic)

- more challenging for low recycled content grades (no matching scrap available) (ferritic/martensitic/duplex and high alloy austenitic)

- Now a general reduction factor R is proposed; 50%

- Label A: Actual CF < T = (100%-50% *MF)

- Reduction factor for high recycled content grades (austenitic) should be more stringent e.g. 60%

- With these ambition factors most grades produced in Europe score B or C.

- Ambition should be adjusted in time

- Alloys sourced from ferro alloys come with a footprint.

- Alloys sourced from stainless scrap come without (very small) a footprint.

- Based on this input a site / company / batch specific scope 3 footprint for every alloying element can be calculated.

- With this a grade specific scope 3 emission can be calculated.

- Together with the (average) scope 1 and (average) scope 2 emission this would lead to a grade specific footprint.

- This has been done for the year 2019 for the 4 major stainless steel producers in Europe and used to validate the equation. Correlation is very good!