Feuille de Route Construction Bas Carbone

Séminaire S1

Paul Baustert

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

Feuille de Route - Séminaires

Juin 2023

Conférence de presse

Septembre 2023

Conférence du CNCD

Novembre 2023

Séminaire S0 MECO

Aujourd'hui

Séminaire S1 GFMC - FEDIL

Suite des séminaires

Séminaire S0 - Résumé

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG

*L'**empreinte carbone** des bâtiments est une méthodologie **standardisée** (EN 15978).*
*Il est cependant important de **rapporter de façon transparente** les choix de modélisation et les résultats.*
Elorri Igos, LIST

*La **qualité** et la **précision** des données d'entrée sont des facteurs fondamentaux déterminant la **confiance** dans les résultats.*
*Évaluer la performance d'un bâtiment implique la définition de **scénarios** de calcul et d'une référence carbone dans un **cadre déterminé**.*
Julien L'Hoest, E&E

*La refonte proposée de la directive sur la performance énergétique des bâtiments (DPEB) crée l'**obligation** d'effectuer des calculs **d'empreinte carbone** pour les nouveaux bâtiments.*
D'autres États membres européens ont déjà créé leurs cadres juridiques.
Paul Baustert, MECO

Séminaire S0 - Résumé

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG

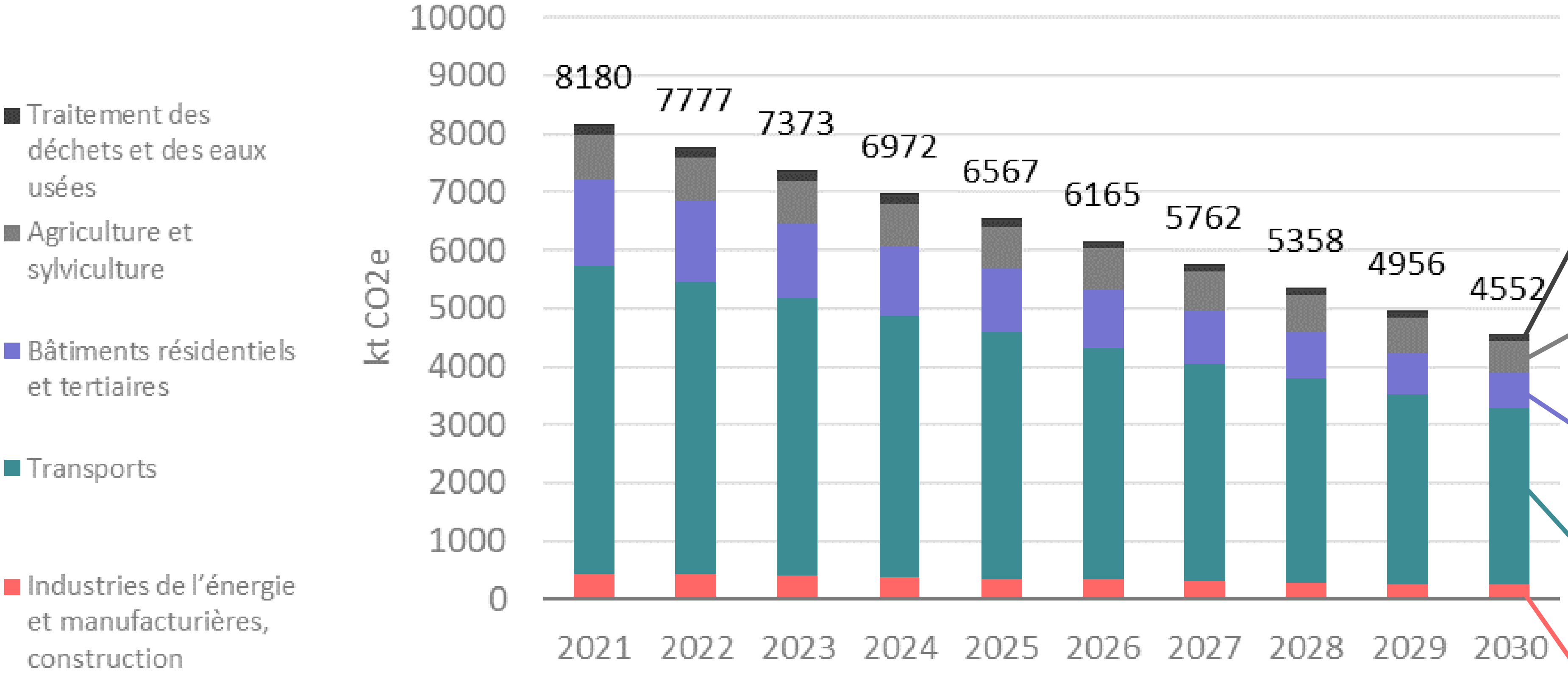
Cycle de vie				Au-delà du cycle de vie
A1-A3 Phase de production	**A4-A5** Phase de construction	**B1-B7** Phase d'utilisation / entretien	**C1-C4** Phase de fin de vie	**D** Avantages et charges au-delà de la frontière du système
50%	5%	B1-B5 20%	2%	Émissions incorporées
		B6 23%		Émissions opérationnelles

Source : reproduit à partir de EN 15978:2011

Source : IStructE Guide, Design for zero pour un immeuble résidentiel de taille moyenne (NZEB)

Séminaire S0 - Résumé

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG



Contributions partielles du secteur de la construction aux émissions territoriales

- p.ex. traitement des déchets de construction
- p.ex. production matériaux biosourcés
- p.ex. phase d'exploitation du bâtiment
- p.ex. transport des matériaux de construction
- p.ex. machines mobiles et stationnaires utilisées sur les chantiers

\+ émissions ETS pour béton, acier, etc.

Source : Règlement grand-ducal du 22 juin 2022 déterminant les allocations d'émissions de gaz à effet de serre annuelles […]

Séminaire S0 - Résumé

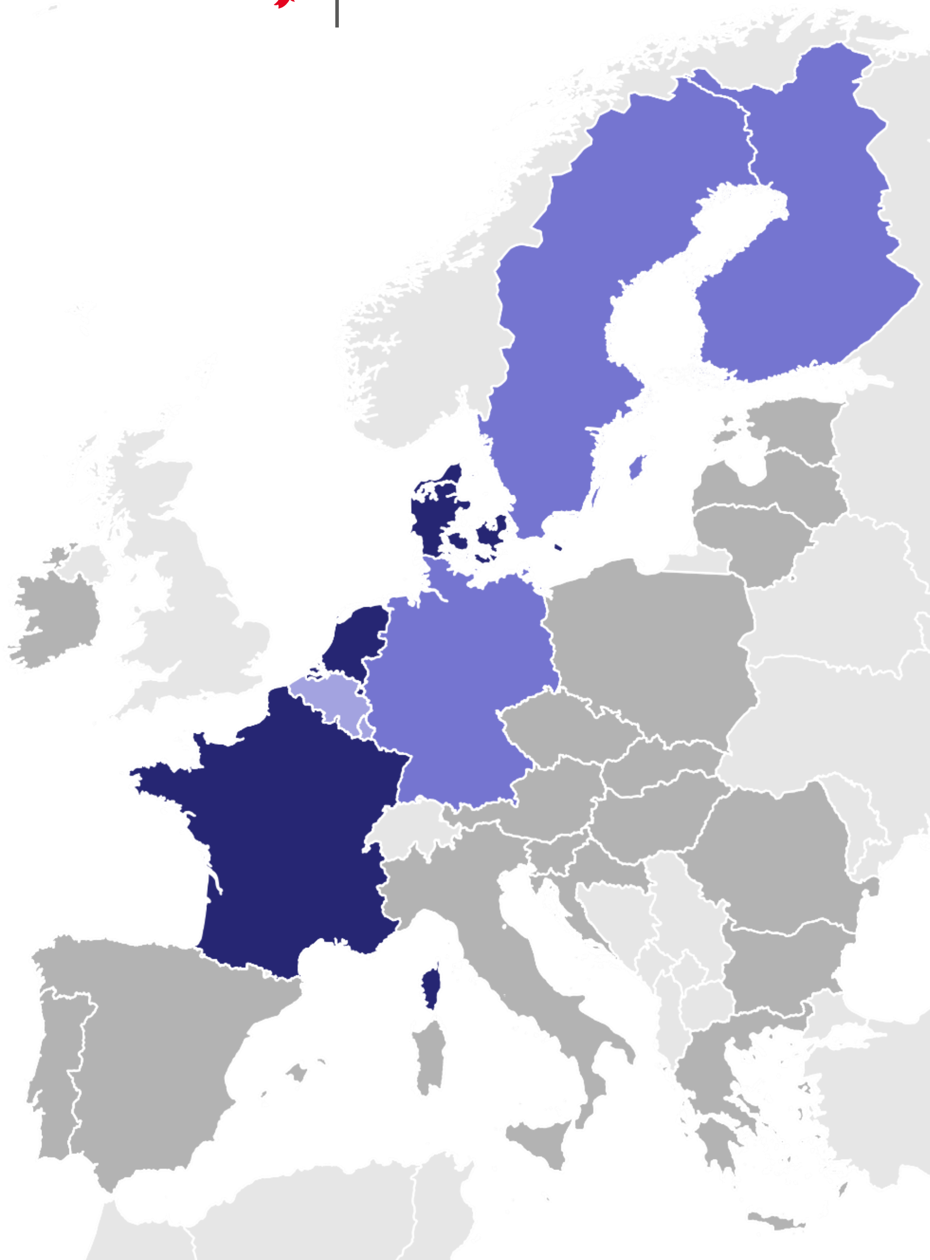
Pays pionniers avec obligation d'évaluer l'empreinte carbone et des valeurs de limite

Pays ayant (prévu) certaines obligations d'évaluer l'empreinte carbone

Pays sans obligations, mais avec programmes de certification volontaires

Pays de l'UE pas analysé

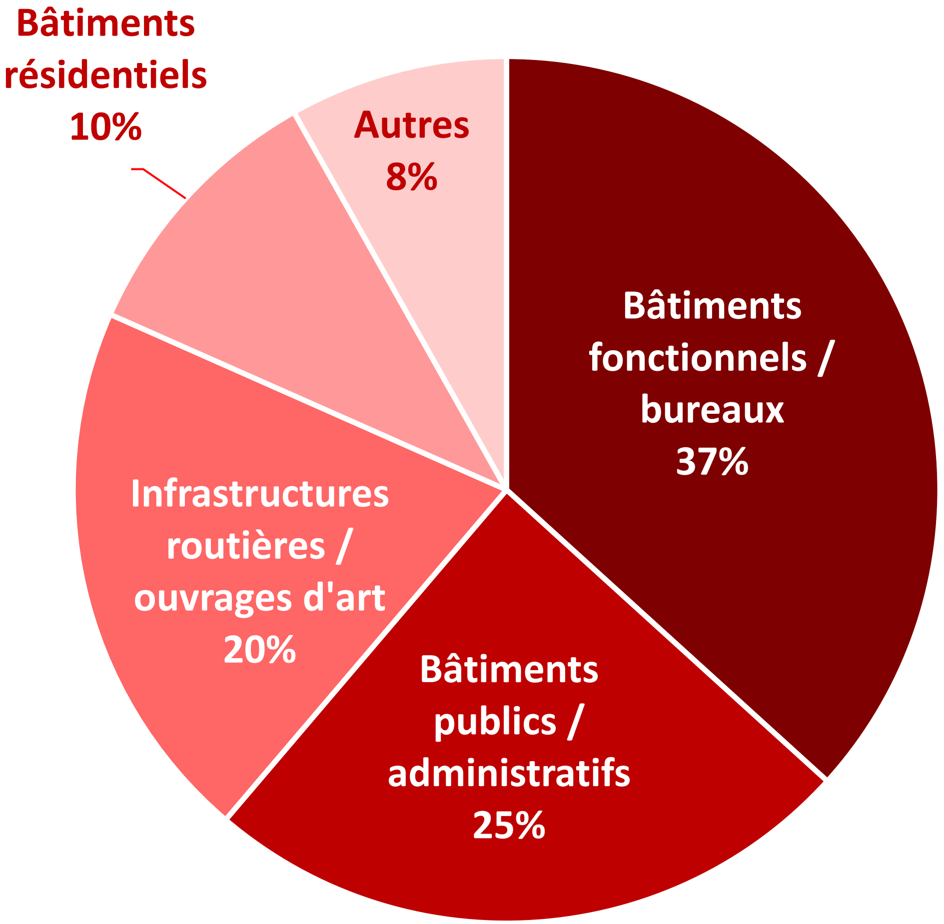
Pays hors UE



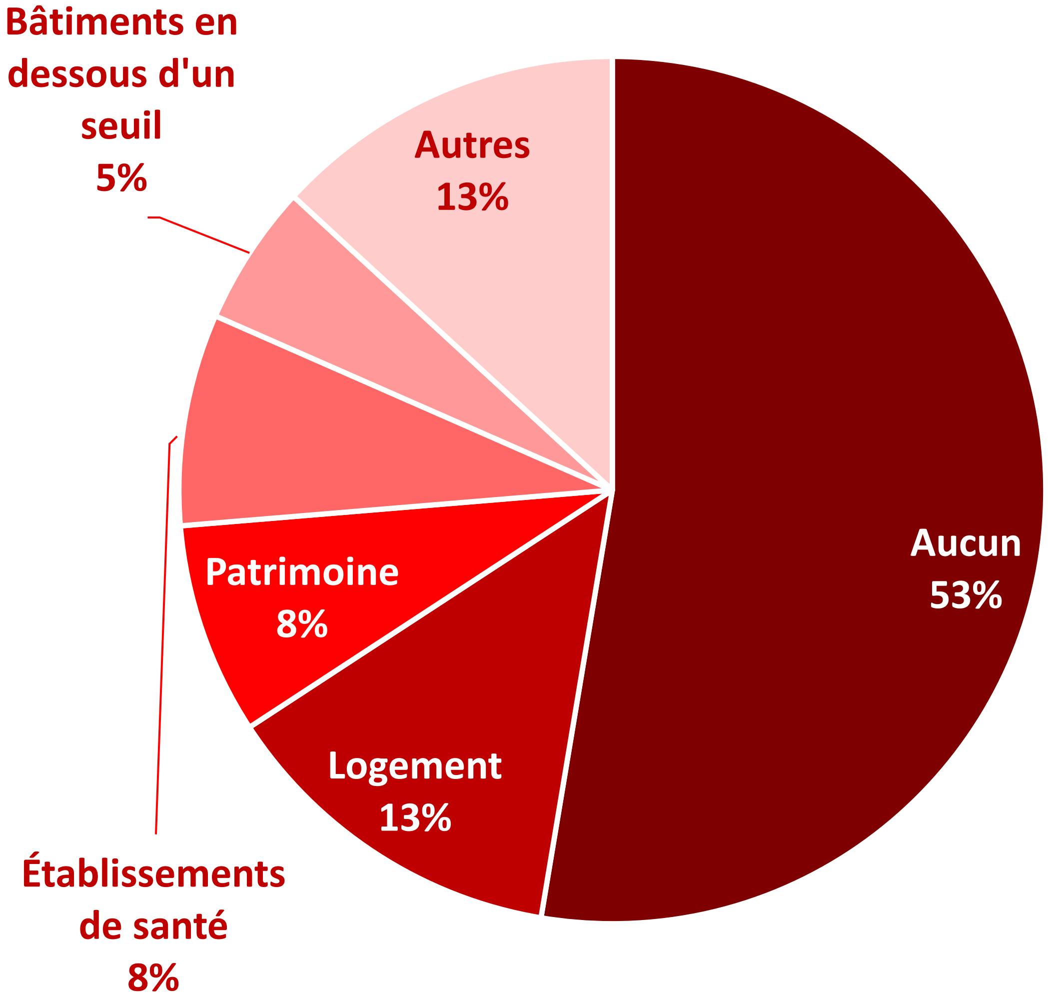
Source : Analyse interne, 2022

Séminaire S0 - Résumé

Q1 : Pour quels bâtiments / infrastructures appliquer en priorité les calculs empreinte carbone ?



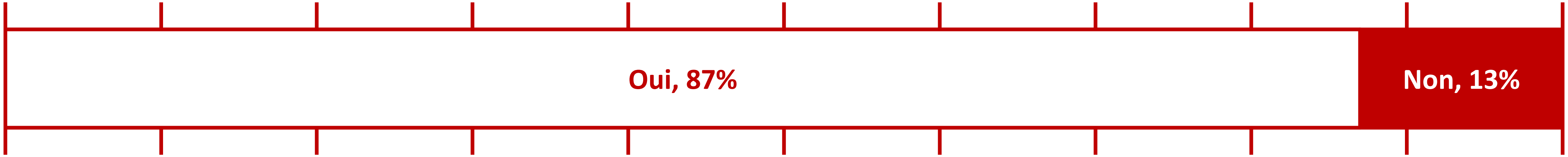
Q2 : Quels bâtiments / infrastructures doivent être exemptés des calculs d'empreinte carbone ?



Séminaire S0 - Résumé

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG

Q3 : Doit-il y avoir des valeurs limites pour l'empreinte carbone des bâtiments ?



Q4 : Pour moi, le principal défi concernant la mise en œuvre de la réglementation de l'empreinte carbone des bâtiments est...

Séminaire S0 - Résumé

Défi #1

Il y a un manque de données DEP luxembourgeoises, d'un programme de DEP luxembourgeois et un manque d'harmonisation entre les programmes DEP des pays voisins.

Il est nécessaire d'avoir des données DEP représentatives du secteur luxembourgeois de la construction et de soutenir les PME dans ce processus.

Défi #2

Défi #3

Défi #4

Défi #5

Décarbonation de l’industrie sidérurgique

Quels sont les solutions disponibles aujourd’hui et les développements en cours?

Feuille de route Décarbonation de la Construction Luxembourg

Séminaire 1 ¦ Matériaux de construction ¦ 21 mars 2024

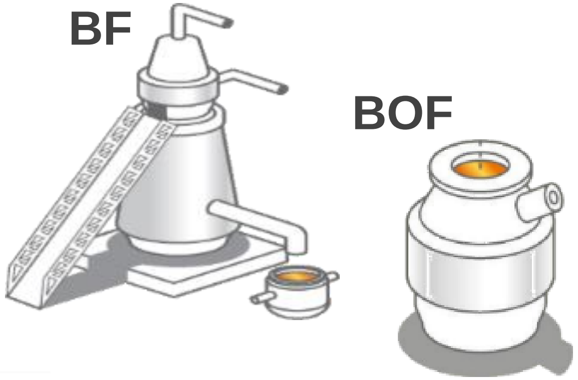
Marion Charlier, PhD
Advanced Building Solutions & Sustainability Lead
ArcelorMittal Steligence® Engineering
marion.charlier@arcelormittal.com

ArcelorMittal

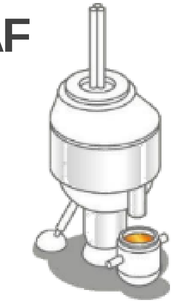
Each steelmaking route has its own carbon footprint – example for sections

BF

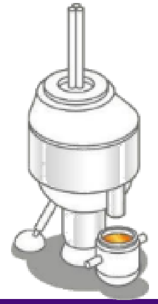
BOF



DRI-EAF



SCRAP-BASED EAF



+ renewably produced electricity

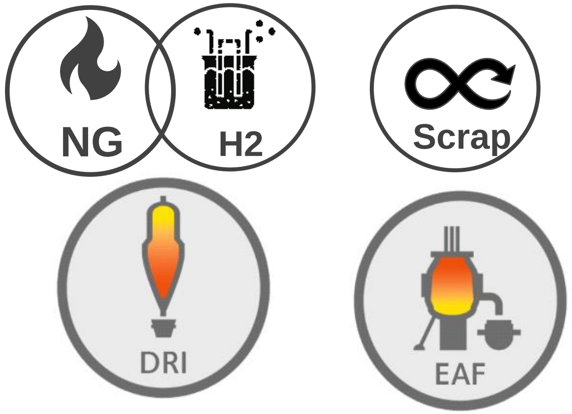
Steelmaking route	Blast furnace-basic oxygen furnace (BF-BOF)	Direct reduced iron (DRI) followed by an EAF	Electric arc furnace (EAF)	EAF with renewably produced electricity
Main input	Coal and iron ore	**direct reduced iron (sponge iron)**	**scrap**	scrap
Main CO_2 source	**Chemical interaction between carbon (coal) and iron ore**: iron reduction produces pig iron which is converted into steel.	Emissions from the use of **natural gas as reductant** Emissions from purchased **electricity**	Emissions from **purchased electricity**	Emissions from **purchased electricity**
Emissions (incl. rolling mill)	Between 2.25 / 2.8 t. CO_2/t	Between 1.12 / 1.35 t. CO_2/t	Between 0.62 / 0.85 t. CO_2/t	Around 0.3 t. CO_2/t

Decarbonizing Steel Production
will require more than one or a combination of different technology route

1 Circular steel

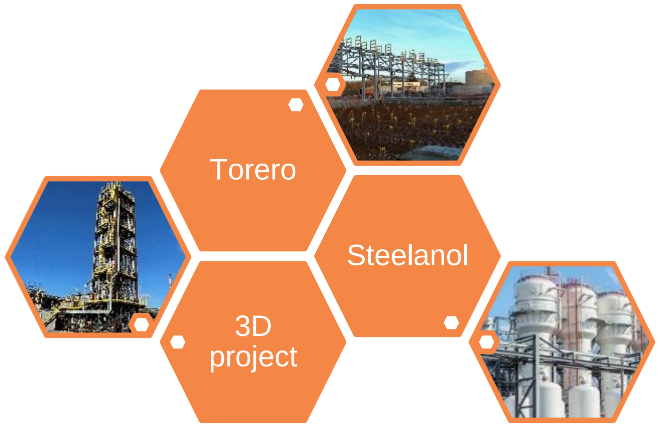
Increasing the use of scrap in our processes

2 Innovative DRI



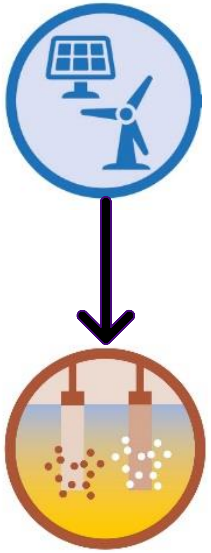
Direct Reduced Iron (DRI) plants coupled with electric arc furnaces (EAF)

3 Smart Carbon steelmaking



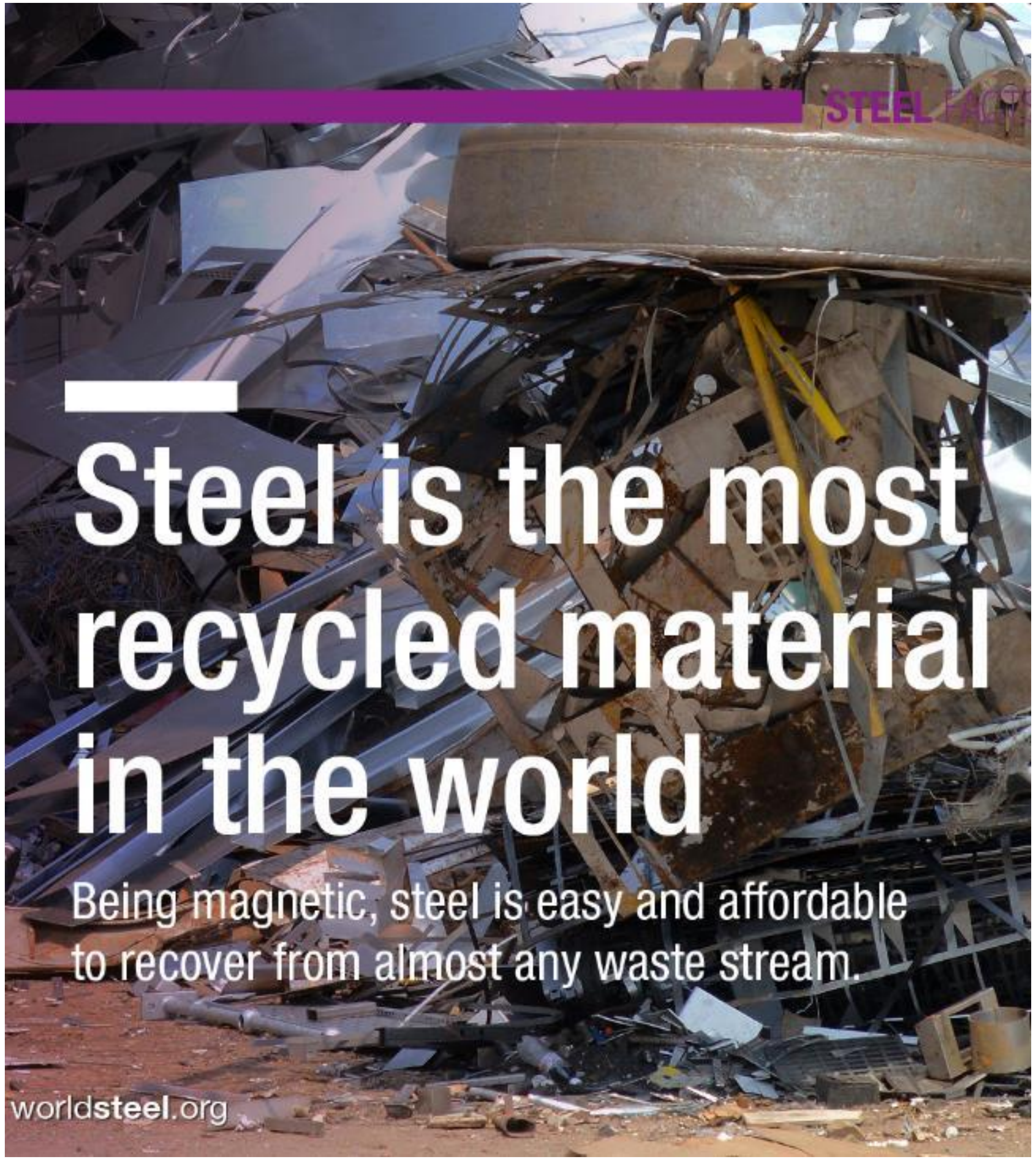
Circular carbon and carbon capture and storage or reuse

4 Direct electrolysis



Clean power to perform direct electrolysis of iron

ArcelorMittal


STEEL
Steel is the most recycled material in the world
Being magnetic, steel is easy and affordable to recover from almost any waste stream.
worldsteel.org


STEEL FACTS
Steel is a permanent material that can be infinitely recycled and is
100%
recyclable without loss of quality.
worldsteel.org

XCarb® Recycled and Renewably Produced – available EPDs

Global warming potential (GWP) in kgCO_2e/tonne (production stage, modules A1-A3)

Sections

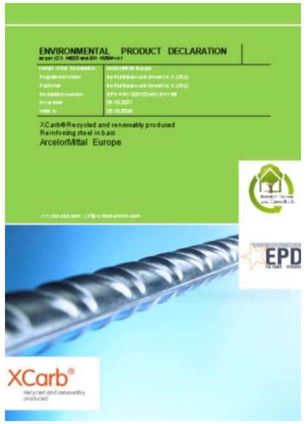
333 kg CO_2e/t

Sheet piles

370 kg CO_2e/t

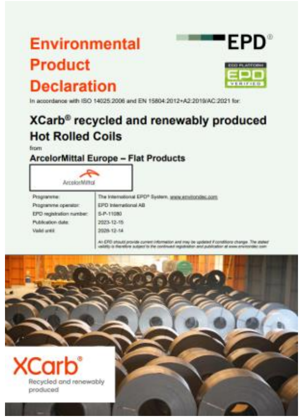
Rebars

300 kg CO_2e/t



Hot rolled coil

600 kg CO_2e/t



Magnelis®

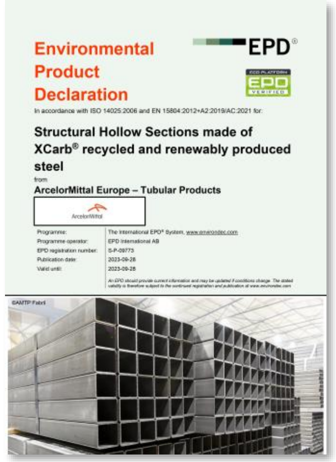
900 kg CO_2e/t

Heavy Plates

914 kg CO_2e/t

Structural hollow sections

640 kg CO_2e/t

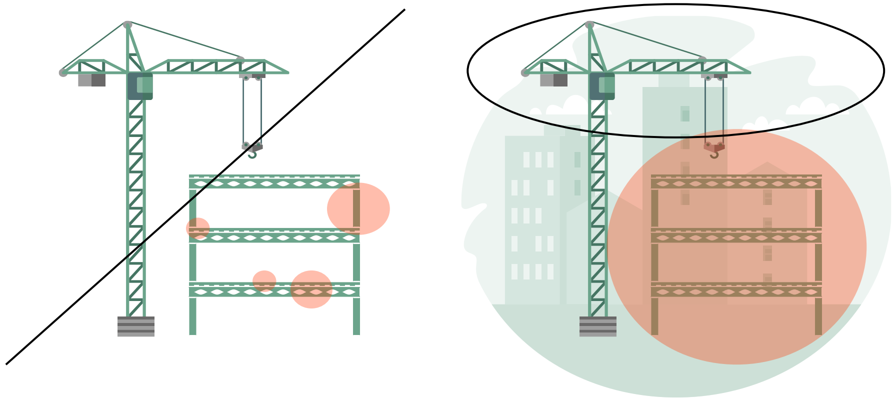


The importance of the design for the Project (Building) LCA

Global Optimization

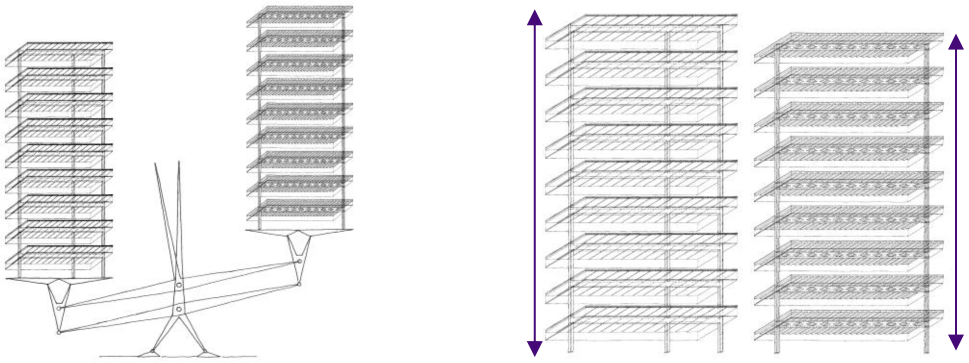
Choosing low carbon materials is important **but not sufficient**

A clever structural design has to be adopted in priority
to efficiently decrease the carbon footprint of the project



Efficient, flexible and lightweight buildings

- Higher steel grades → Superstructure lighter
- Superstructure lighter → less foundations
- Cellular beams → reduced total height



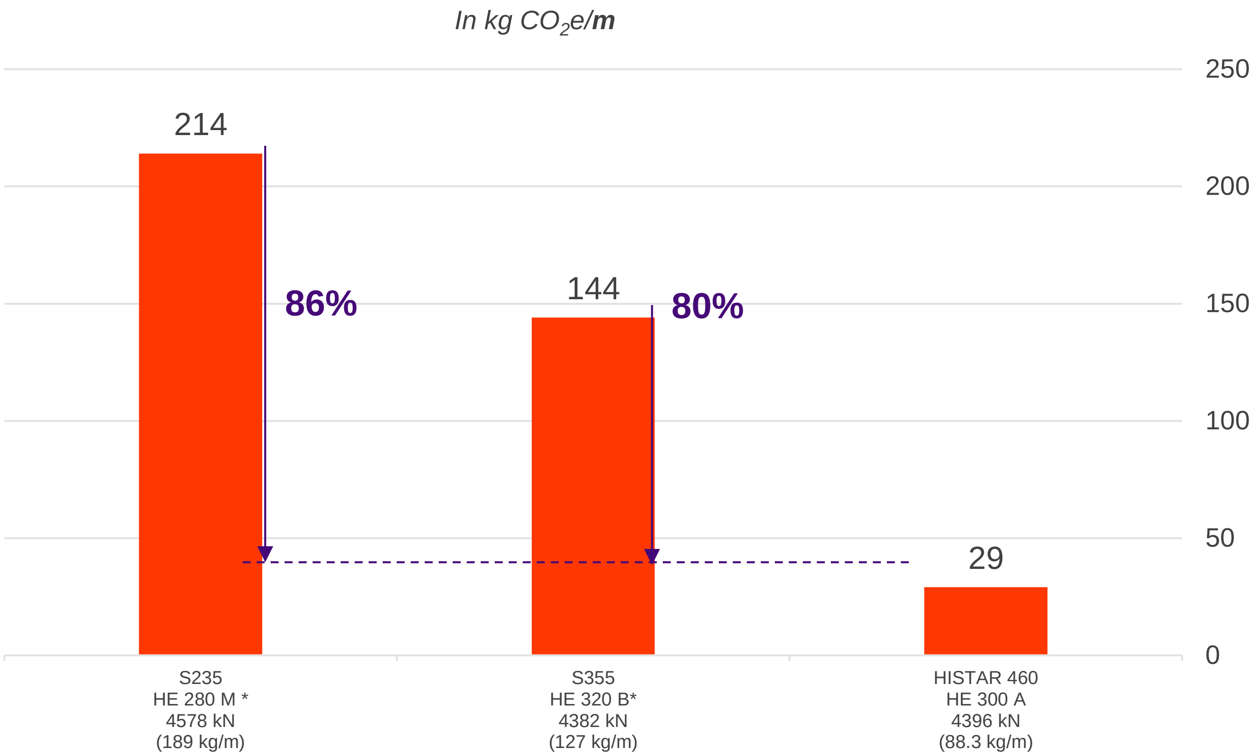
ArcelorMittal

Intelligent material selection makes ALL the difference

Multi-storey column subject to axial load, buckling length 3.5m

CO_2e saving is 647 kg for each 3.5m column

Multi-storey industrial building during construction, in Monaco



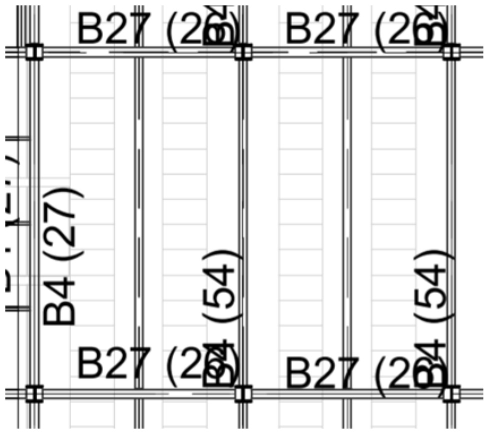
XCarb® Recycled and renewably produced

* Bauforumstahl EPD | A1-A3 | 1130 $kgCO_2e/t$

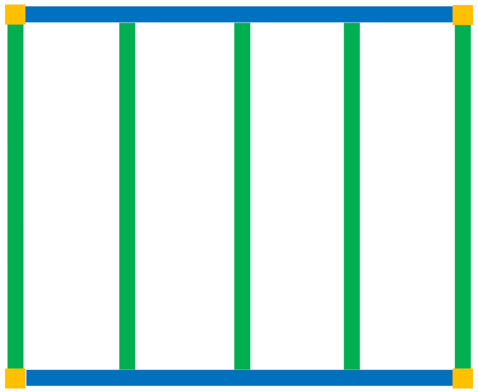
ArcelorMittal

Case study on a DC-type building (modules A-C)

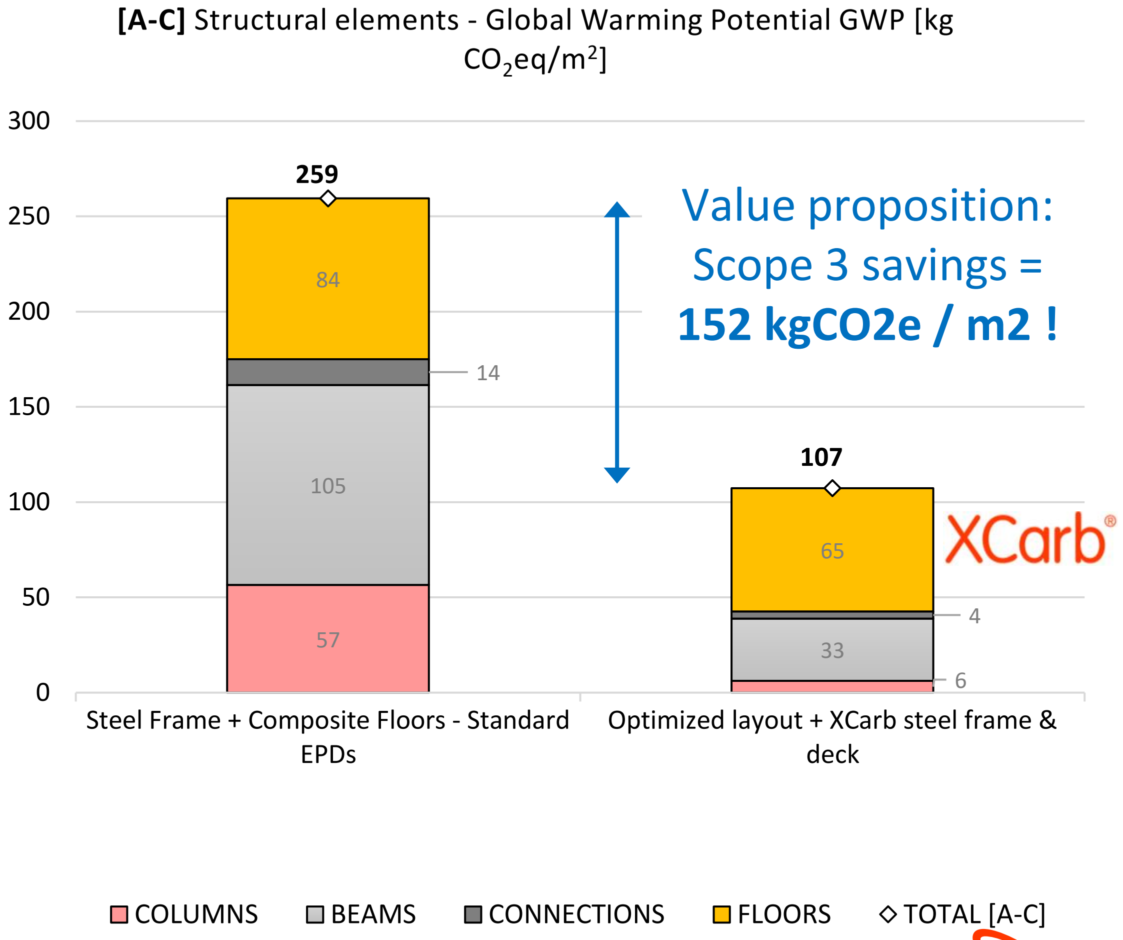
- Including transportation from Europe to APAC and APAC EPD baselines.



Initial solution
(S275 MPa Steel)*



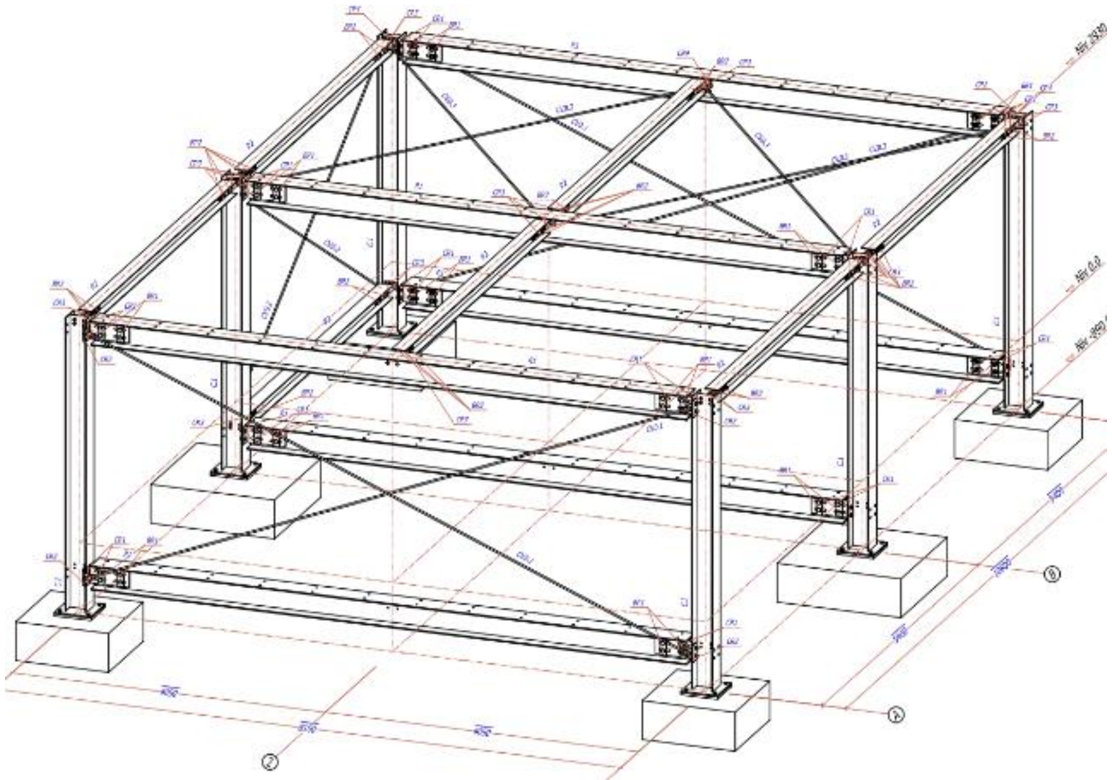
Proposed Layout +
HISTAR + XCarb



* EPD values acc. to world average from World steel Association

ArcelorMittal

Key principles for circularity | Design for disassembly and Reuse



uni.lu
UNIVERSITÉ DU LUXEMBOURG

mundo
Louvain-la-Neuve

ArcelorMittal

A suggested approach to tackle the climate emergency and reduce the embodied carbon of your projects

1. Understand how steel products (and other materials) are made

- Understand where the embodied carbon comes from
- Engage open communication with manufacturers

2. Design & plan

- Challenge the brief & consider several structural variants
- Stay curious & get informed (norms, R&D developments, pilot projects)
- Get all the stakeholders of your construction project involved

3. Rely on what is available today

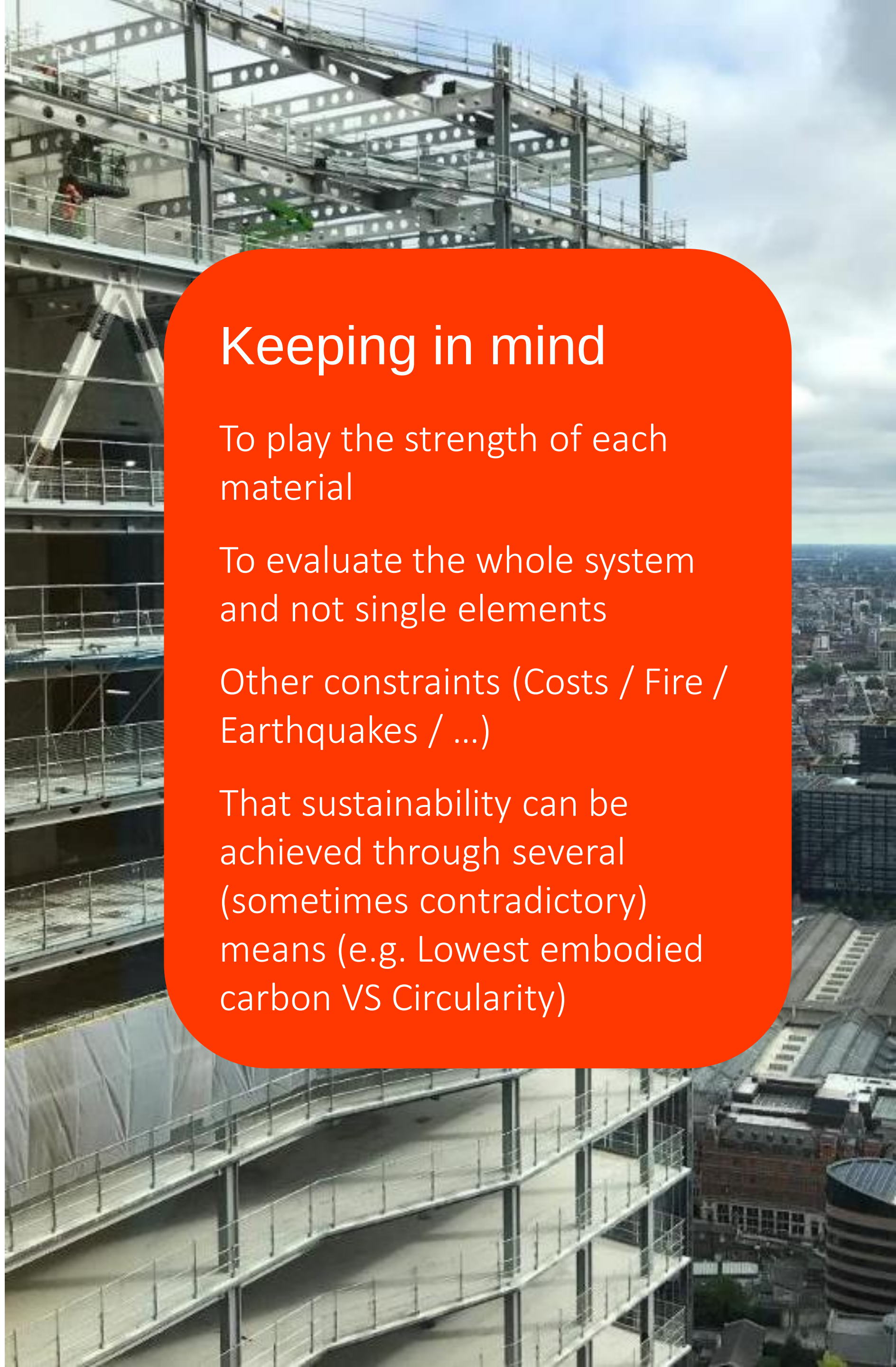
- Understand the supply chain (discuss with suppliers)
- Use XCarb® and rely on high grades to decrease material quantities

4. Request EPD & take time to understand them

- Not all EPD are equally transparent nor comparable

5. Support entities with a robust industrial roadmap, showcasing a real (short term & long term) climate commitment

- Paris Agreement Aligned, clear road map, 2030/2050 targets
- For steel products: Responsible Steel



Keeping in mind

To play the strength of each material

To evaluate the whole system and not single elements

Other constraints (Costs / Fire / Earthquakes / …)

That sustainability can be achieved through several (sometimes contradictory) means (e.g. Lowest embodied carbon VS Circularity)

Thank you

Marion Charlier, PhD
Advanced Building Solutions & Sustainability Lead
ArcelorMittal Steligence® Engineering
marion.charlier@arcelormittal.com

ArcelorMittal

The intelligent construction choice
Steligence®

CEMENT & CONCRETE CO_2 ROADMAP CIMALUX

03/2024

Cimalux

POLICY CONTEXT

THE EUROPEAN GREEN DEAL

Making the EU climate neutral by 2050

Reduce net GHG emissions by 55% by 2030

Delivering the Green Deal: “FIT FOR 55” legislation

CEMENT INDUSTRY & CIMALUX

EU Emissions Trading System (ETS) reform

EU Taxonomy

Carbon Border Adjustment Mechanism (CBAM)

Corporate Sustainability Reporting Directive

Renewable Energy Directive

OUR CUSTOMERS

New EU ETS for building and road transport fuels

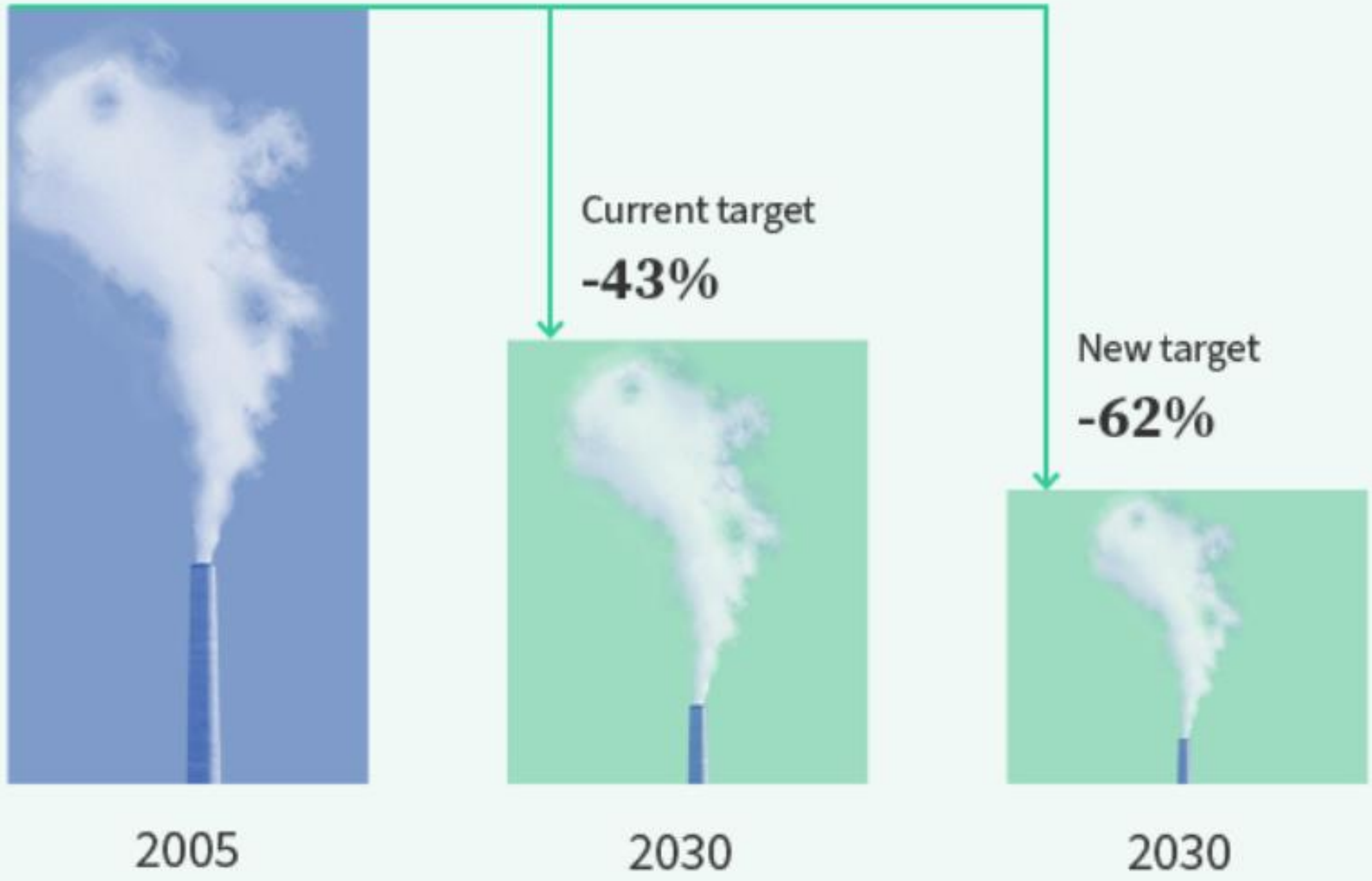
Energy Performance of Buildings Directive

Cimalux

electricity and heat generation

energy-intensive industry sectors (e.g. oil refineries, steel industry, cement, glass and paper production)

commercial aviation (flights within the European Economic Area) more **ambitious** emissions reduction **goals**



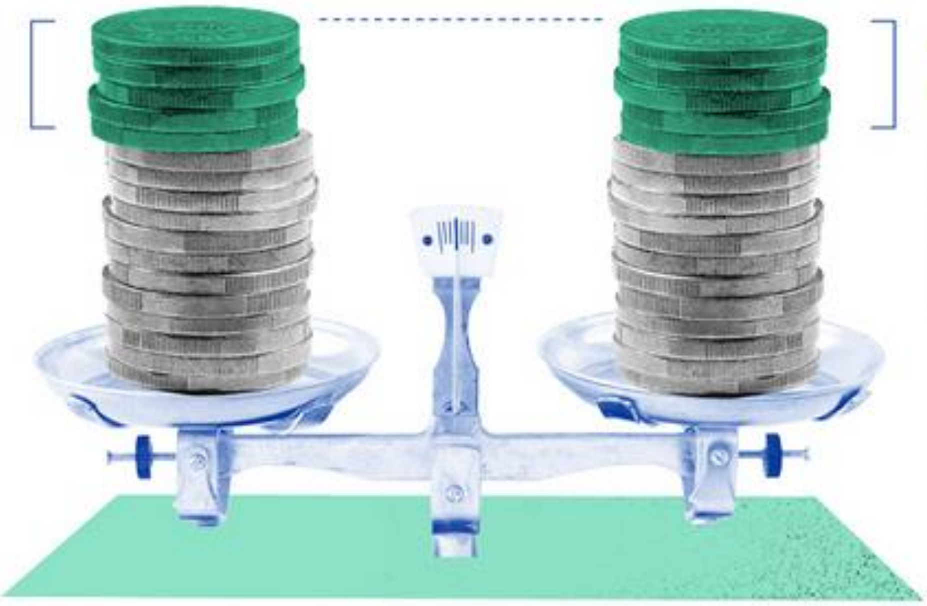
gradual **phasing out of free allowances** for certain sectors (in parallel with the introduction of the **carbon border adjustment mechanism** – a carbon pricing system applicable to energy-intensive products imported into the EU in order to avoid carbon leakage)

How will CBAM work?

Production in the EU | **Production outside the EU**

ETS allowances

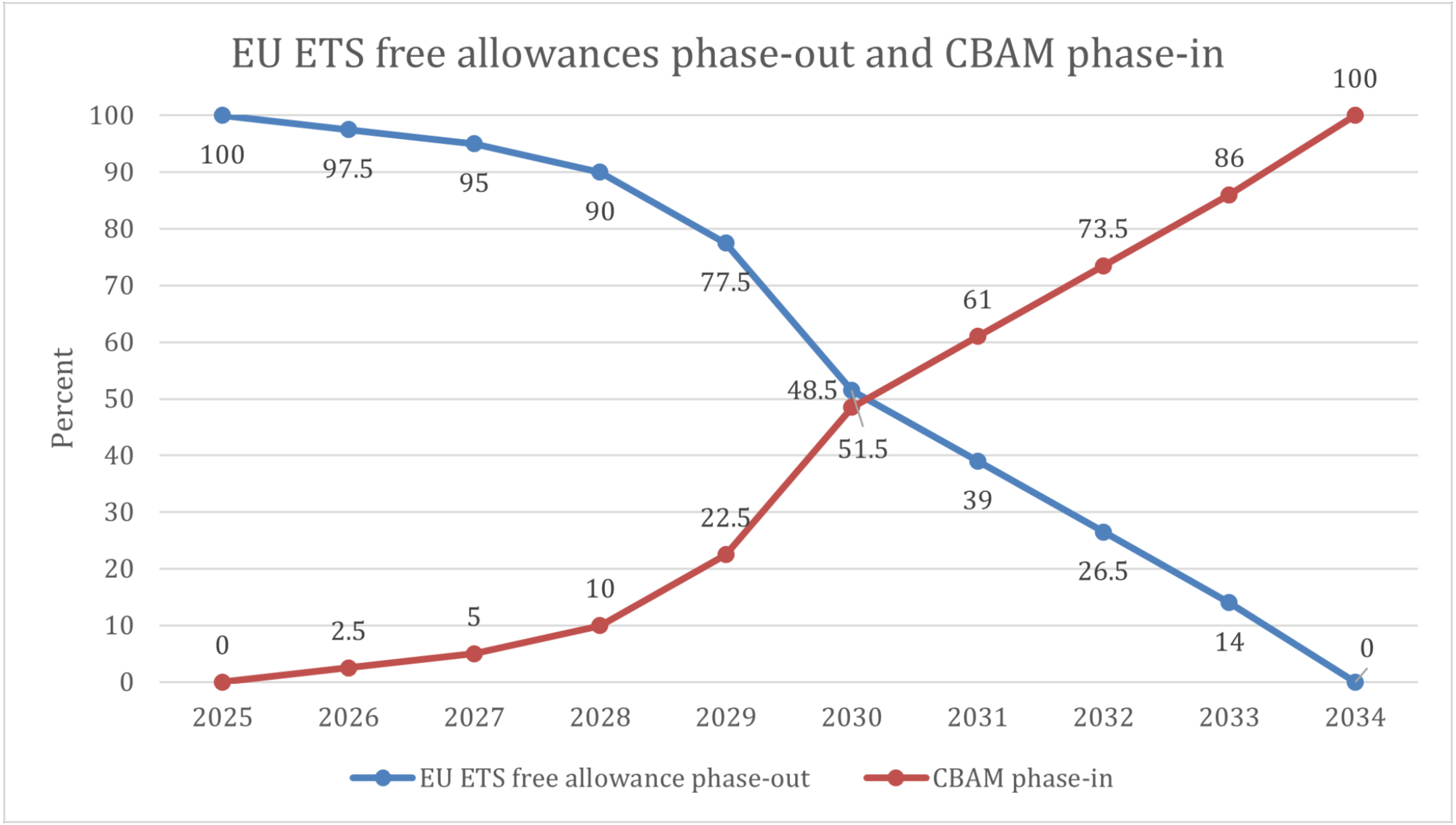
Producers have to cover CO_2 emissions with ETS allowances



CBAM certificates

EU importer has to buy CBAM certificates to cover price difference

Production costs


EU ETS free allowances phase-out and CBAM phase-in
Percent
100
90
80
70
60
50
40
30
20
10
0
2025
2026
2027
2028
2029
2030
2031
2032
2033
2034
100
97.5
95
90
77.5
51.5
39
26.5
14
0
0
2.5
5
10
22.5
48.5
61
73.5
86
100
EU ETS free allowance phase-out
CBAM phase-in

Cimalux

faster reduction of the cap,

fewer allowances on the market:

reduction of

117 million allowances

over two years

the ETS to cover **new sectors:**

→ extension to **maritime transport** (introduced gradually between 2024 and 2026)

→ a separate new ETS for **buildings, road transport and fuels** for additional sectors

LUXEMBOURG

CLIMATE LAW AND REGULATION

PNEC - NATIONAL ENERGY AND CLIMATE PLAN 2021-2030

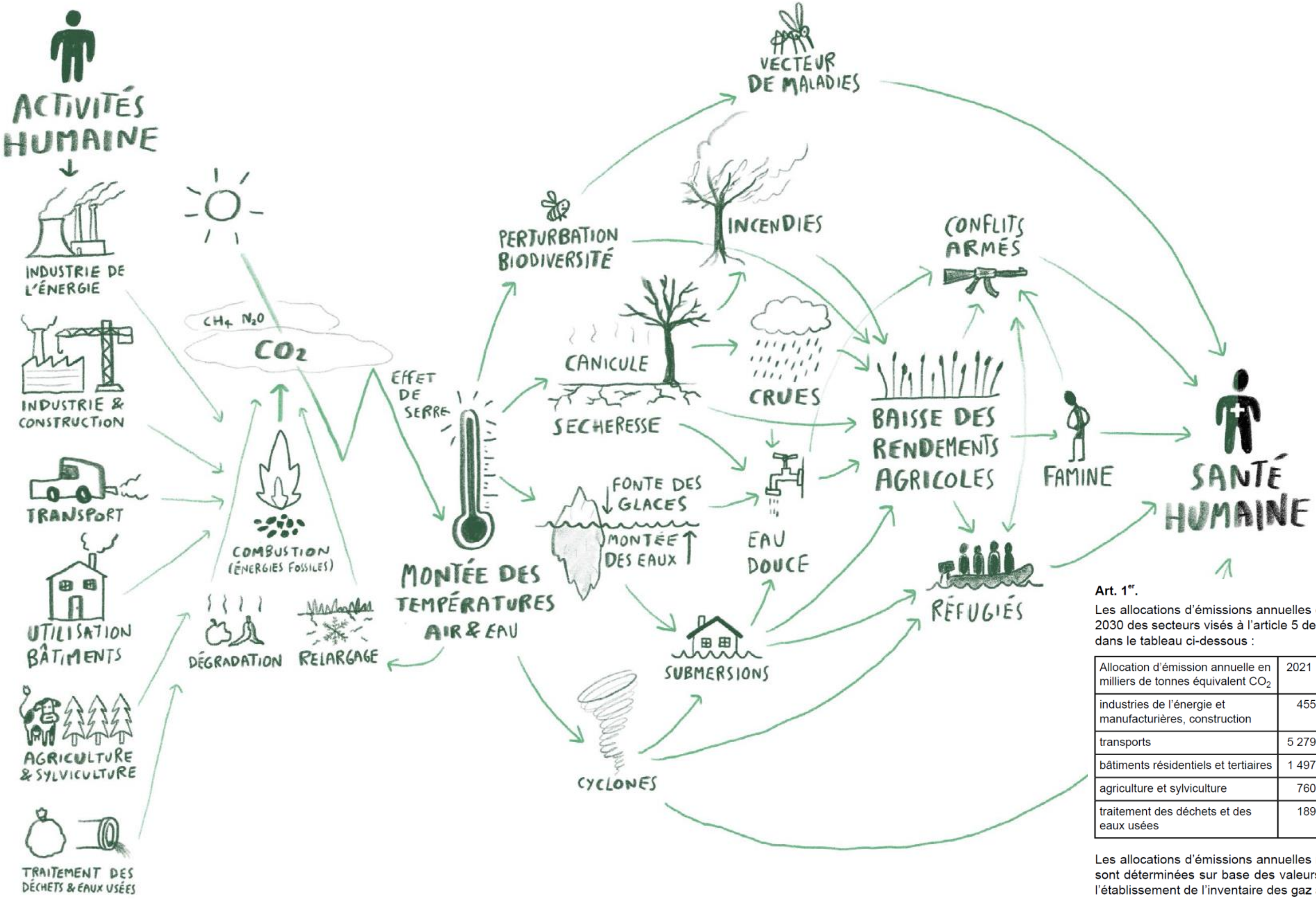
- 6 sectors involved: industry; transport; buildings; agriculture; waste; LULUCF
- Targets:
  - 55% reduction of GHG emissions for non-EU ETS
  - 37% share of renewable energies
  - 44% improvement of energy efficiency
- Research on CCU & DAC
- Decarbonization potentiel assessment can be co-financed

COALITION AGREEMENT 2023-2028

- Commitment to Green Deal, Fit for 55 & Zero Pollution
- Development of energy infrastructures
- Carbon capture storage and use legal framework
- Carbon contracts for difference
- CCUS technologies assessment for the decarbonization of specific sectors like the cement industry
  if needed infrastructures will be developped

FIT4 SUSTAINABILITY

Cimalux



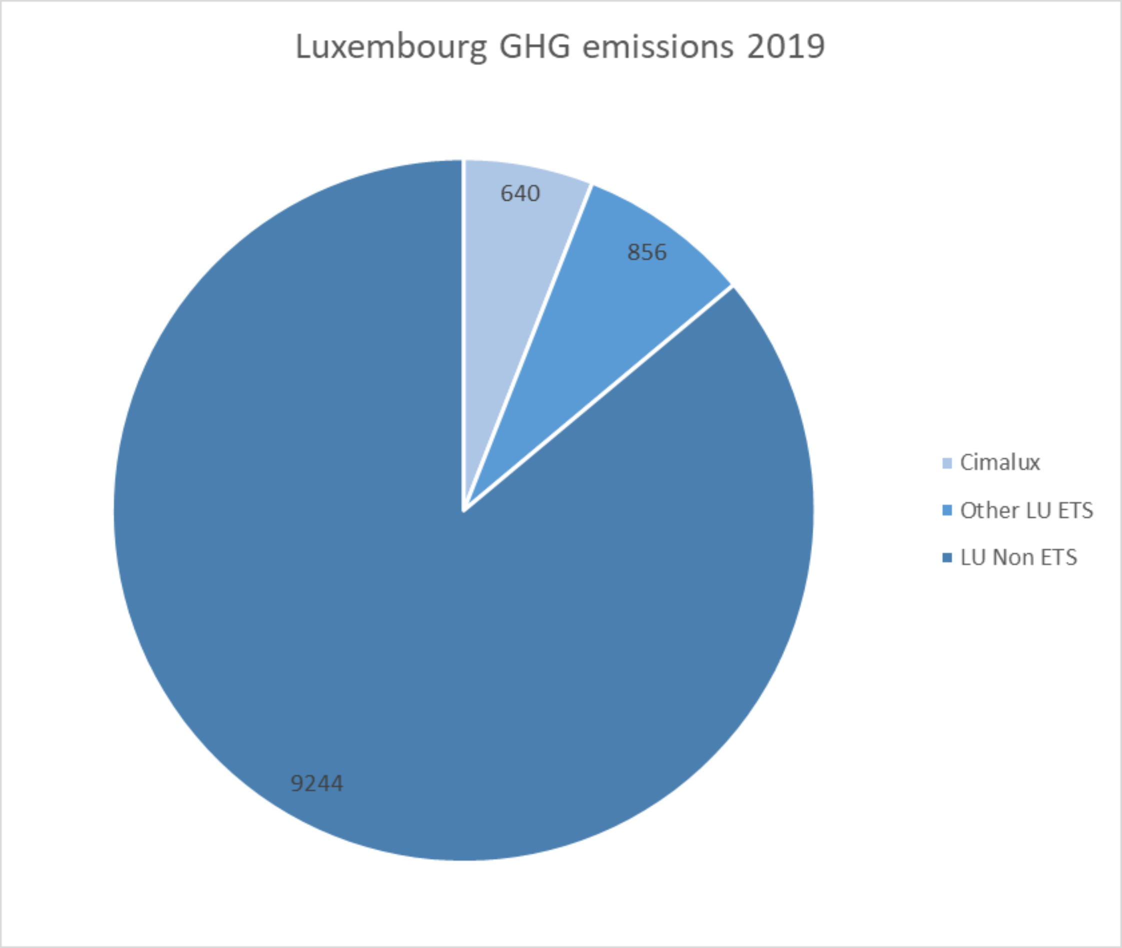
Art. 1er.

Les allocations d'émissions annuelles de gaz à effet de serre pour la période allant jusqu'au 31 décembre 2030 des secteurs visés à l'article 5 de la loi modifiée du 15 décembre 2020 relative au climat sont reprises dans le tableau ci-dessous :

Allocation d'émission annuelle en milliers de tonnes équivalent CO_2	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
industries de l'énergie et manufacturières, construction	455	431	408	384	360	337	313	289	266	242
transports	5 279	5 018	4 757	4 494	4 228	3 986	3 747	3 504	3 271	3 053
bâtiments résidentiels et tertiaires	1 497	1 396	1 295	1 195	1 094	993	893	792	691	590
agriculture et sylviculture	760	752	742	736	731	704	672	645	609	556
traitement des déchets et des eaux usées	189	180	171	163	154	145	137	128	119	111

Les allocations d'émissions annuelles reprises ci-dessus, exprimées en milliers de tonnes équivalent CO_2, sont déterminées sur base des valeurs pour les potentiels de réchauffement planétaire d'application pour l'établissement de l'inventaire des gaz à effet de serre pour l'année 2021.

LUXEMBOURG



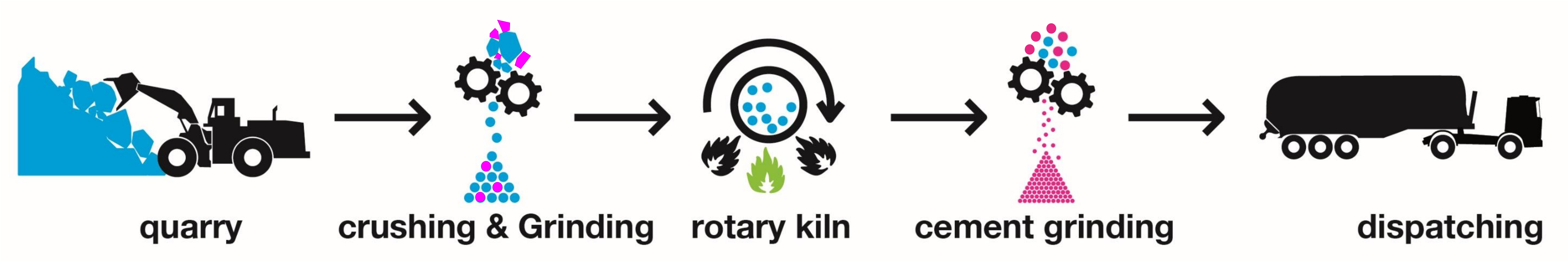
The national cement industry represents:

[Source: NIR 1990 - 2021]

- **43% of all stationary ETS emissions**
- **6% of total national emissions**

Cimalux

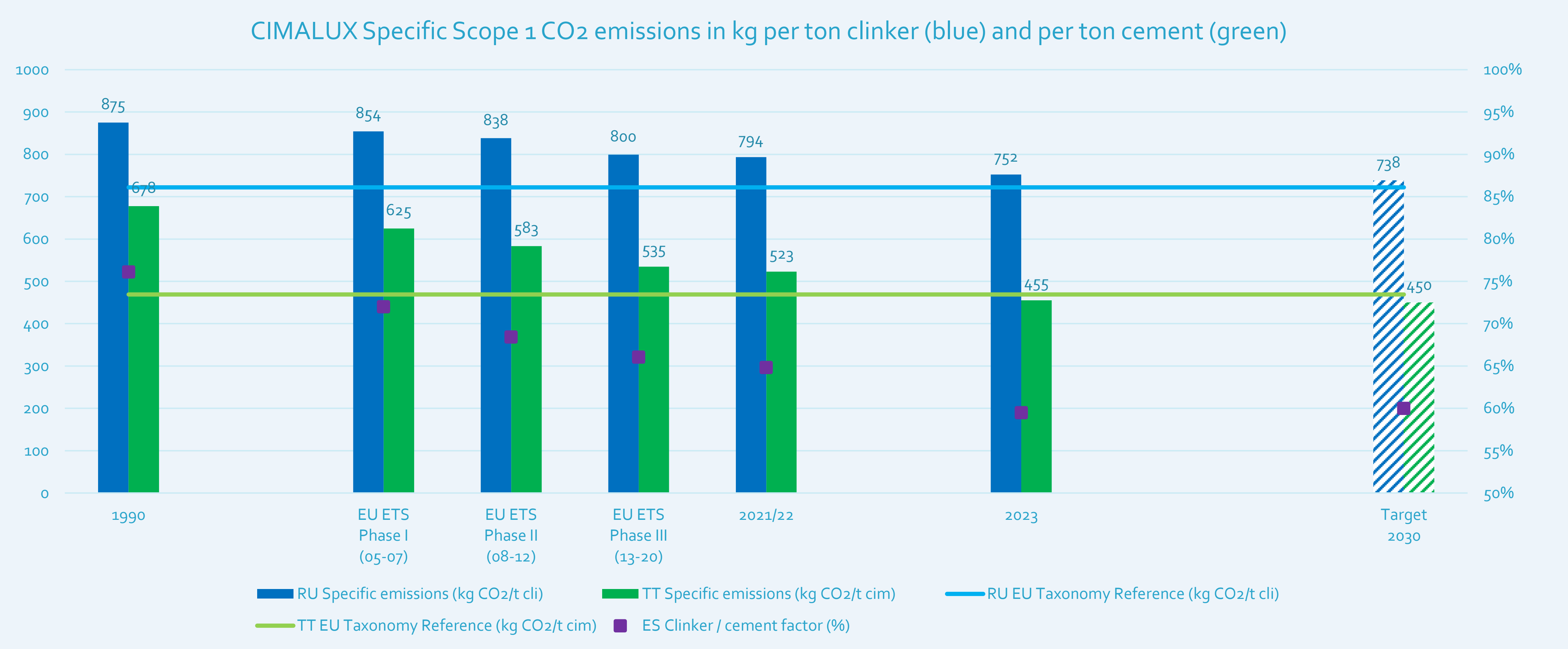
CO_2 origin in cement production (Scope 1, annual, 750 kt clinker, 1.250 kt cement)



Raw materials limestone & marls	Secondary materials	Combustibles	Biomass – Renewable energy RED II	Cement drying & grinding	Clinker / Cement Factor
69%	- 8%	49%	-10%	+ 2%	
560 kt CO_2				10 kt CO_2	0,60

CIMALUX RUMELANGE

SPECIFIC CO2 EMISSIONS



Climate mitigation

Do no significant harm criteria

Greenhouse gas emissions[127] from the cement production processes are:

a. for grey cement clinker, lower than **0,816**[128] tCO2e per tonne of grey cement clinker;

b. for cement from grey clinker or alternative hydraulic binder, lower than **0,530**[129] tCO2e per tonne of cement or alternative binder manufactured.

(128) Reflecting the **median value of the installations in 2016 and 2017** (t CO2 equivalents/t) of the data collected in the context of establishing the Commission Implementing Regulation (EU) 2021/447, determined on the basis of verified information on the greenhouse gas efficiency of installations reported pursuant to Article 11 of Directive 2003/87/EC

(129) Reflecting the median value of the installations in 2016 and 2017 (t CO2 equivalents/t) of the data collected for grey cement clinker in the context of establishing the Commission Implementing Regulation (EU) 2021/447, multiplied by the **clinker to cement ratio (0.65)**, determined on the basis of verified information on the greenhouse gas efficiency of installations reported pursuant to Article 11 of Directive 2003/87/EC

Substantial contribution criteria

The activity manufactures one of the following:

a. grey cement clinker where the **specific GHG emissions**[99] are **lower than 0,722**[100] **tCO_2e per** tonne of grey cement clinker;

b. cement from grey clinker or alternative hydraulic binder, where the specific GHG emissions[101] from the clinker and cement or alternative binder production are **lower than 0,469**[102] **tCO_2e per tonne of cement** or alternative binder manufactured.

(100) Reflecting the **average value of the 10% most efficient installations in 2016 and 2017** (t CO2 equivalents/t) as set out in the Annex to the Commission Implementing Regulation (EU) 2021/447 of 12 March 2021 determining revised benchmark values for free allocation of emission allowances for the period from 2021 to 2025 pursuant to Article 10a(2) of Directive 2003/87/EC of the European Parliament and of the Council, (OJ L 87, 15.3.2021, p. 29)

(102) Reflecting the average value of the 10% most efficient installations in 2016 and 2017 (t CO2 equivalents/t) for grey cement clinker as set out in the Annex to the Implementing Regulation (EU) 2021/447, multiplied by the **clinker to cement ratio of 0,65**.

Where CO_2 that would otherwise be emitted from the manufacturing process is captured for the purpose of underground storage, the CO_2 is transported and stored underground, in accordance with the technical screening criteria set out in Sections 5.11 and 5.12 of this Annex.

→ https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity_en.htm?reference=3.7

i	Technological and organizational levers to reduce CO_2 emissions from the cement and concrete industry by 2050 Process	Description	CO_2 emission reduction potential	Value Chain	Suggested indicators
1	**Efficiency of the clinker manufacturing process**	Technological upgrades to reduce energy consumption in clinker production.	o/+	Clinker	≤ 0.72 to CO_2 / to of clinker
2	**Alternative fuels**	Increasing the substitution rate for primary fuels by massively increasing the use of alternative fuels and co-processing: sewage sludge, end-of-life tires and solvents, solid residues from recycling processes, etc.	++		
3	**Alternative raw materials**	Use of decarbonated raw materials for clinker production: fine fractions from concrete recycling, slag, etc.	+		
4	**CO_2 capture, storage or use**	Implementation of CO_2 capture technologies on clinker production sites and deployment of infrastructures for transport, geological storage or use of CO_2.	(++++)		
5	**Clinker substitution**	Substitution of clinker in cements by other cementitious constituents (SCM: secondary or supplementary cementitious materials) such as limestone, pozzolans or industrial co-products.	(+++)	Cement	≤ 0.469 to CO_2 / to of cement
6	**Use of alternative binders**	Sulfo-aluminous cements type CSA, carbonatable calcium silicate cements type CCSC, alkali-activated binders, etc.	o/+		
7	**Optimization of concrete formulation**	Reduction of clinker content / m^3 of concrete by optimizing aggregate grading curves to improve the compactness of the granular skeleton, improvement of aggregate quality and use of admixtures and additions to lower the Water/Cement ratio.	++	Concrete	≤ 3.5 kg clinker / $m^3 \cdot$ MPa
8	**Optimal specification and strict compliance with exposure classes**	Optimal and differentiated specification of concrete performance for each structural element according to the specific mechanical and environmental stresses to which it is subjected (performance approach).	++		
9	**Structural design optimization**	Optimization of the structural design in order to reduce the contained volume of concrete a/o its clinker content, resources optimization through the use of high and ultra-high-performance concrete, prefabrication and mixed construction systems.	++	Structure	≤ 250 kg CO_2 / m^2 of floor (building structure) ≤ 500 kg CO_2 / m^2 of floor (completed building)
10	**Reuse and recycling**	Dismantling, reconditioning, reuse of building elements, flexible use of buildings, recycling or recovery of materials.	+		

Other points to consider:

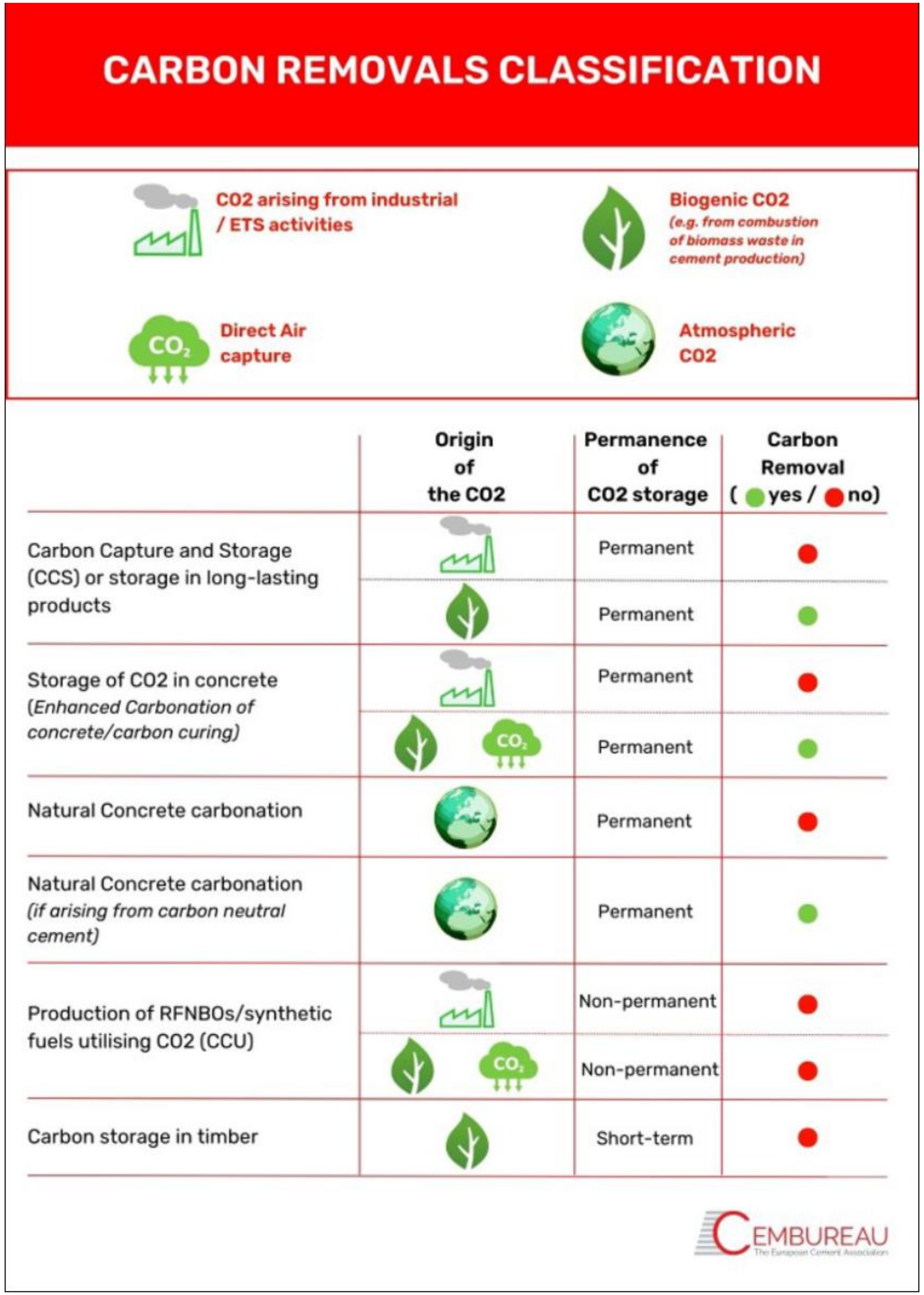
- Carbonation of concrete
- Transport
- H2 – Green Hydrogen
- Electrification
- Reduction of losses and waste during processing
- Respect of execution standards (compaction, protection, curing, …)
- Other:

11) Carbon removal
(CO_2 absorption according to EU regulations)

Working paper based on A. Favier, C. De Wolf, C. Scrivener, G. Habert, A sustainable future for the European Cement and Concrete Industry, ETHZ 2018

Assumptions subject to change

Cimalux



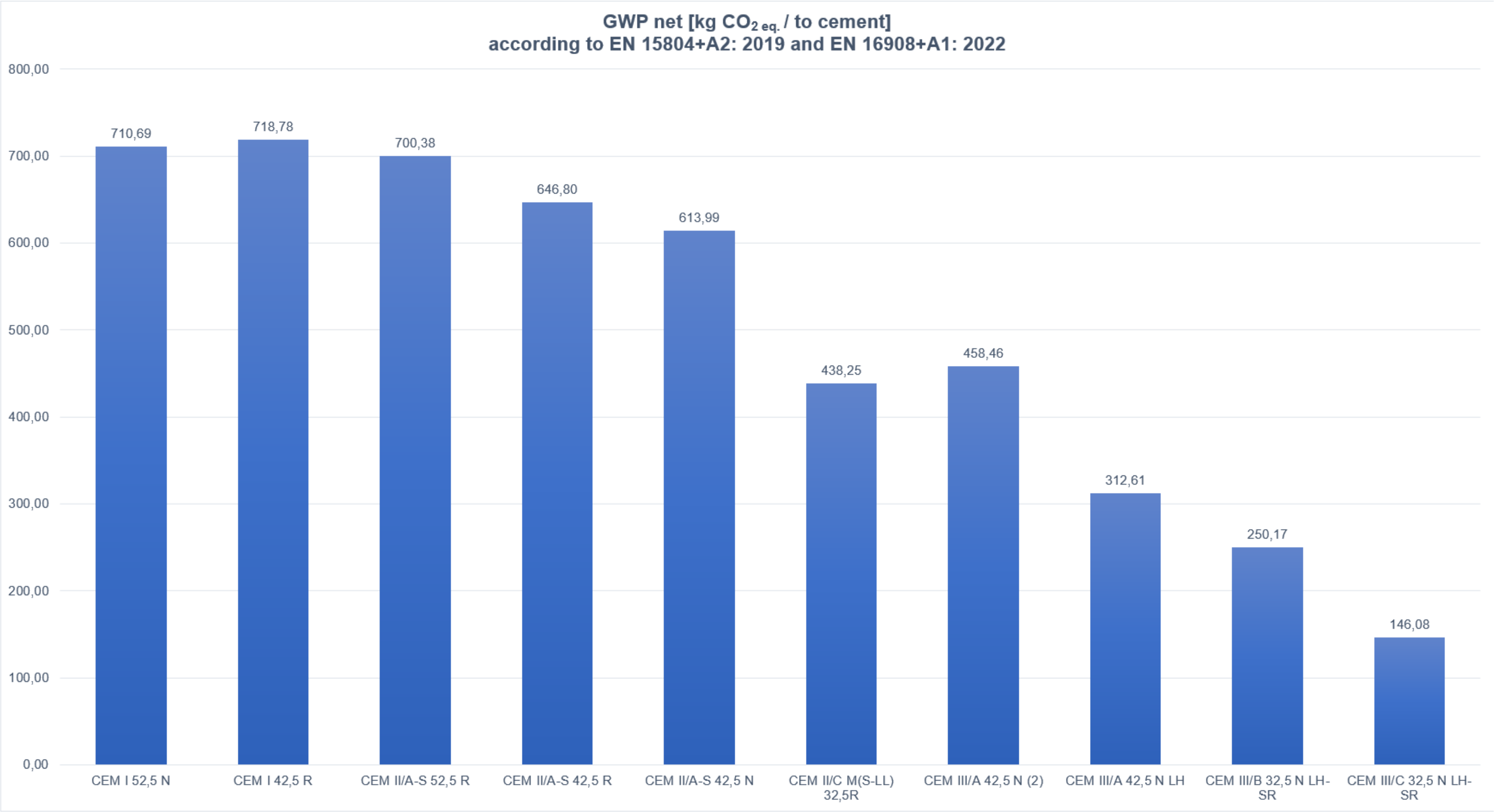
CARBON REMOVALS CLASSIFICATION

- CO_2 arising from industrial / ETS activities
- Biogenic CO_2 *(e.g. from combustion of biomass waste in cement production)*
- Direct Air capture
- Atmospheric CO_2

	Origin of the CO_2	Permanence of CO_2 storage	Carbon Removal (yes / no)
Carbon Capture and Storage (CCS) or storage in long-lasting products		Permanent	
		Permanent	
Storage of CO_2 in concrete (*Enhanced Carbonation of concrete/carbon curing)*		Permanent	
		Permanent	
Natural Concrete carbonation		Permanent	
Natural Concrete carbonation *(if arising from carbon neutral cement)*		Permanent	
Production of RFNBOs/synthetic fuels utilising CO_2 (CCU)		Non-permanent	
		Non-permanent	
Carbon storage in timber		Short-term	

CEMBUREAU The European Cement Association

Cimalux


GWP net [kg $CO_{2\ eq.}$ / to cement]
according to EN 15804+A2: 2019 and EN 16908+A1: 2022
800,00
700,00
600,00
500,00
400,00
300,00
200,00
100,00
0,00
710,69
718,78
700,38
646,80
613,99
438,25
458,46
312,61
250,17
146,08
CEM I 52,5 N
CEM I 42,5 R
CEM II/A-S 52,5 R
CEM II/A-S 42,5 R
CEM II/A-S 42,5 N
CEM II/C M(S-LL) 32,5R
CEM III/A 42,5 N (2)
CEM III/A 42,5 N LH
CEM III/B 32,5 N LH-SR
CEM III/C 32,5 N LH-SR

Cimalux

Dyckerhoff ECODUR-Betone

Zugesichertes Treibhauspotenzial

Branchenreferenzwert Zement = Ø CEM I (Branchen-EPD) GWP_{netto} = 665 kg $CO_{2\text{-eq.}}$ /to

Maximales GWP_{netto} Beton (Lebenszyklusphasen A1-A3) in kg $CO_{2\text{-eq.}}$ /m³			
	ECODUR 30 (GWP Cement < 500 kg $CO_{2\text{-eq.}}$ /to)	ECODUR 40 (GWP Cement < 450 kg $CO_{2\text{-eq.}}$ /to)	ECODUR 50 (GWP Cement < 350 kg $CO_{2\text{-eq.}}$ /to)
C20/25	149	128	107
C25/30	166	142	119
C30/37	183	157	131
C35/45	200	172	143
C45/55	218	187	156
C50/60	228	195	163

Assurer les performances avec une teneur en clinker faible

bétons feidt

Composition du béton E/C = 0,50 avec 340kg ciment/m³			
Temp. ext. ≈ 7°C	**CEM II A-S 42,5N**	**CEM III /A 42,5 N LA**	**CEM III/B 32,5N LH SR**
24 h	3,86 MPa	1,47 MPa	Pas de valeur **
2 jours	12,88 MPa	9,18 MPa	1,87 MPa
7 jours	28,34 MPa	24,91 MPa	12,90 MPa

** le cube n'a pas été endommagé au décoffrage, mais il n'a pas été possible de mesurer sa résistance.

Temp. 25°C	CEM II A-S 42,5N	CEM III /A 42,5 N LA	CEM III/B 32,5N LH SR
24h	13,10 MPa	9,80 MPa	2,21 MPa
2 jours	21,19 MPa	20,90 MPa	8,97 MPa
7 jours	42,68 MPa	34,54 MPa	24,07 MPa

CEM III/B 32,5N LH SR ,
340Kg/m³ , 24 h, ***température extérieur ≈ 7°C***

CEM III/B 32,5N LH SR ,
340Kg/m³ , 24 h, ***température 25 °C***

Données : Bétons Feidt. 2024

Tableau CN F.3.2 – Mélange composé d'un ciment suivant EN 197-1 ou EN 197-5 et d'un ciment de qualité CEM III/C suivant EN 197-1 : pourcentage maximal en masse autorisé de ciment de type CEM III/C dans le mélange en fonction des classes d'exposition à couvrir et du type de ciment choisi lorsque la formulation spécifique des ciments est documentée.

Qualité de ciment suivant EN 197-1 autorisée pour le mélange		Pourcentage P maximal en masse de ciment de type CEM III/C dans le mélange avec la qualité de ciment autorisée à cette fin																	
		X0	XC1	XC2	XC3	XC4	XD1	XD2	XD3	XF1	XF2	XF3	XF4	XA1	XA2 [a]	XA3 [a]	XM1	XM2	XM3
Ciment Portland	CEM I	P											–	P					
Ciment Portland au laitier	CEM II/A-S	P											–	P					
	CEM II/B-S	P											–	P					
Ciment Portland au calcaire	CEM II/A-LL	P					–	–	–	P	–	–	–	P	–	–	P		
Ciment de Haut Fourneau	CEM III/A	P											–	P					
Qualité de ciment suivant EN 197-5 autorisée pour le mélange		X0	XC1	XC2	XC3	XC4	XD1	XD2	XD3	XF1	XF2	XF3	XF4	XA1	XA2 [a]	XA3 [a]	XM1	XM2	XM3
Ciment Portland composé	CEM II/C-M	P			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

P est calculé de la manière suivante :

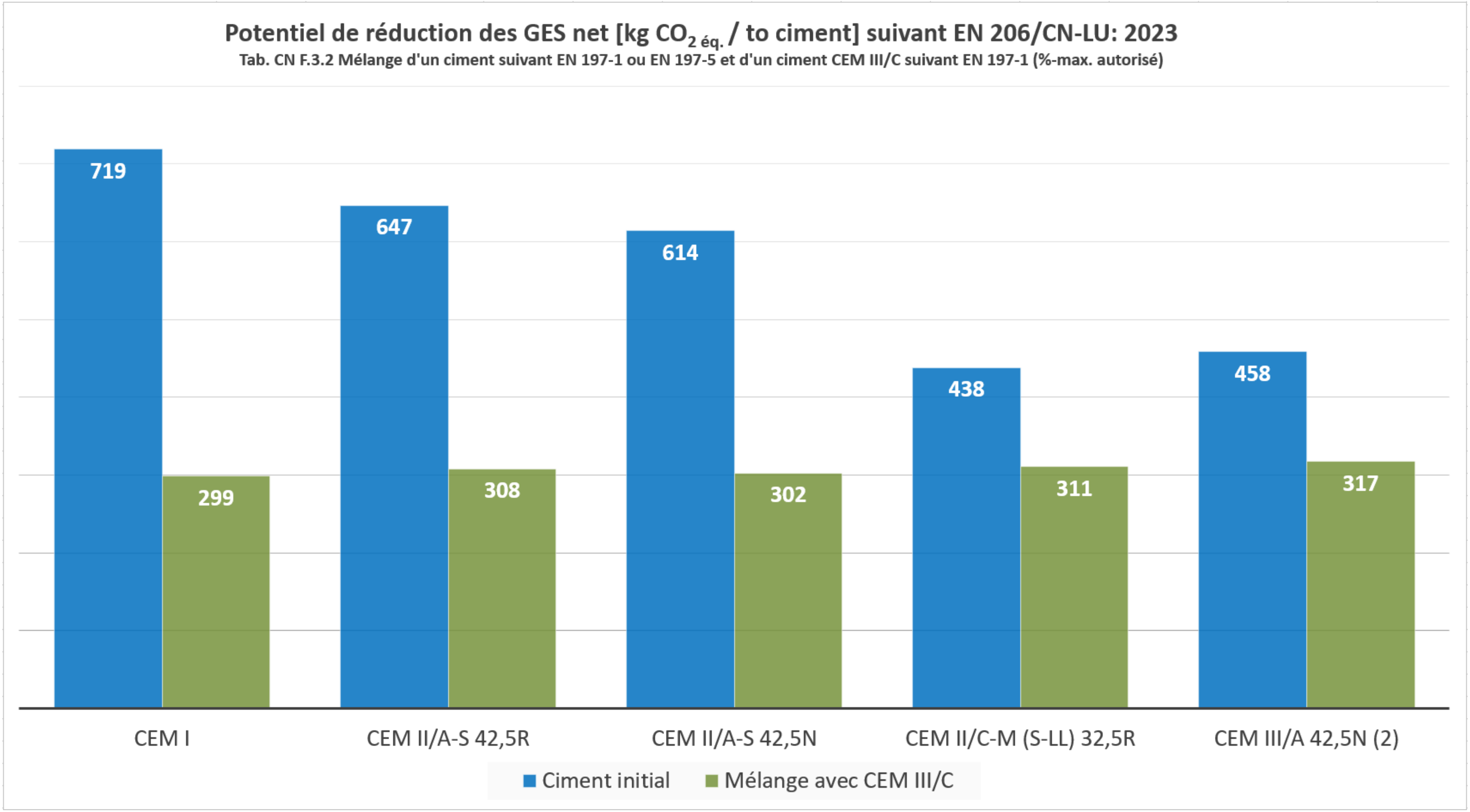
$$P = 100 \cdot \frac{35 - (0{,}98 \cdot t_{CCA})}{0{,}98 \cdot (t_{CC3C} - t_{CCA})} \quad [\%]$$

avec

- P : Pourcentage P maximal en masse de ciment de type CEM III/C dans le mélange, exprimé en pour cent [%]
  Seule une valeur positive de P est applicable. Une valeur négative est considérée comme égale à zéro.
- t_{CCA} : Taux de clinker du ciment autorisé pour le mélange, exprimé en pour cent [%] par rapport à la masse totale des constituants principaux et secondaires de ce ciment tels que déclarés par le producteur de ciment
- t_{CC3C} : Taux de clinker du ciment CEM III/C utilisé pour le mélange, exprimé en pour cent [%] par rapport à la masse totale des constituants principaux et secondaires de ce ciment tels que déclarés par le producteur de ciment

– mélange non utilisable pour cette classe d'exposition

[a] Si l'eau en contact avec la surface du béton accuse une teneur en sulfates SO_4^{2-} > 600 mg/l ou si le sol en contact avec le béton accuse une teneur en sulfates SO_4^{2-} > 3000 mg/kg, chacun des deux ciments constituants du mélange doit être certifié à haute résistance aux sulfates.


Potentiel de réduction des GES net [kg CO2 éq. / to ciment] suivant EN 206/CN-LU: 2023
Tab. CN F.3.2 Mélange d'un ciment suivant EN 197-1 ou EN 197-5 et d'un ciment CEM III/C suivant EN 197-1 (%-max. autorisé)
719
299
647
308
614
302
438
311
458
317
CEM I
CEM II/A-S 42,5R
CEM II/A-S 42,5N
CEM II/C-M (S-LL) 32,5R
CEM III/A 42,5N (2)
Ciment initial
Mélange avec CEM III/C

Cimalux

Fields of analysis for the evaluation of buildings in f(life cycle / cost approach) according to EN ISO 15643-1

Economy total cost approach	Environment	Social cultural and functional qualities	Technical qualities quality and performance	Quality of use process and site quality
• Initial costs	• Grey energy • Embedded carbon [1]		• Mechanical	• Construction
• + Overall elementary cost			• Physic • Thermal • Energy efficiency • Reversibility • Durability	• Operation • Maintenance • Functional modifications • Deconstruction
• + Expanded overall cost	• Exposure limit values • Emissions	• Comfort & Well-being • Health & Safety • Accessibility • Productivity	• Hydric • Thermal • Acoustic • Visual • Sanitary	• Site qualities
• + Shared global cost (monetization of externalities)	• Biodiversity • GWP / global warming potential [2] • EP / eutrophication potential • ODP / ozon depletion potential • POCP / photochem. ozon creation pot. • AP / acidification potential • NEC directive: SO_2 ; NMVOC ; NH_3 ; NO_X ; $PM_{2,5}$	• Local availability • Local know-how • Energy dependence • Resources exploitation • Public health (e.g. asbestos)	• Resilience • Fire resistance • Seismic resistance	• Integration into the urban fabric • Soil artificialisation • Mobility • Avoidance • Reemployment • Reuse • Transformation • Recycling • Valorization • Elimination

Cimalux

grey

decarbonize

Don't talk, just do!

Cimalux

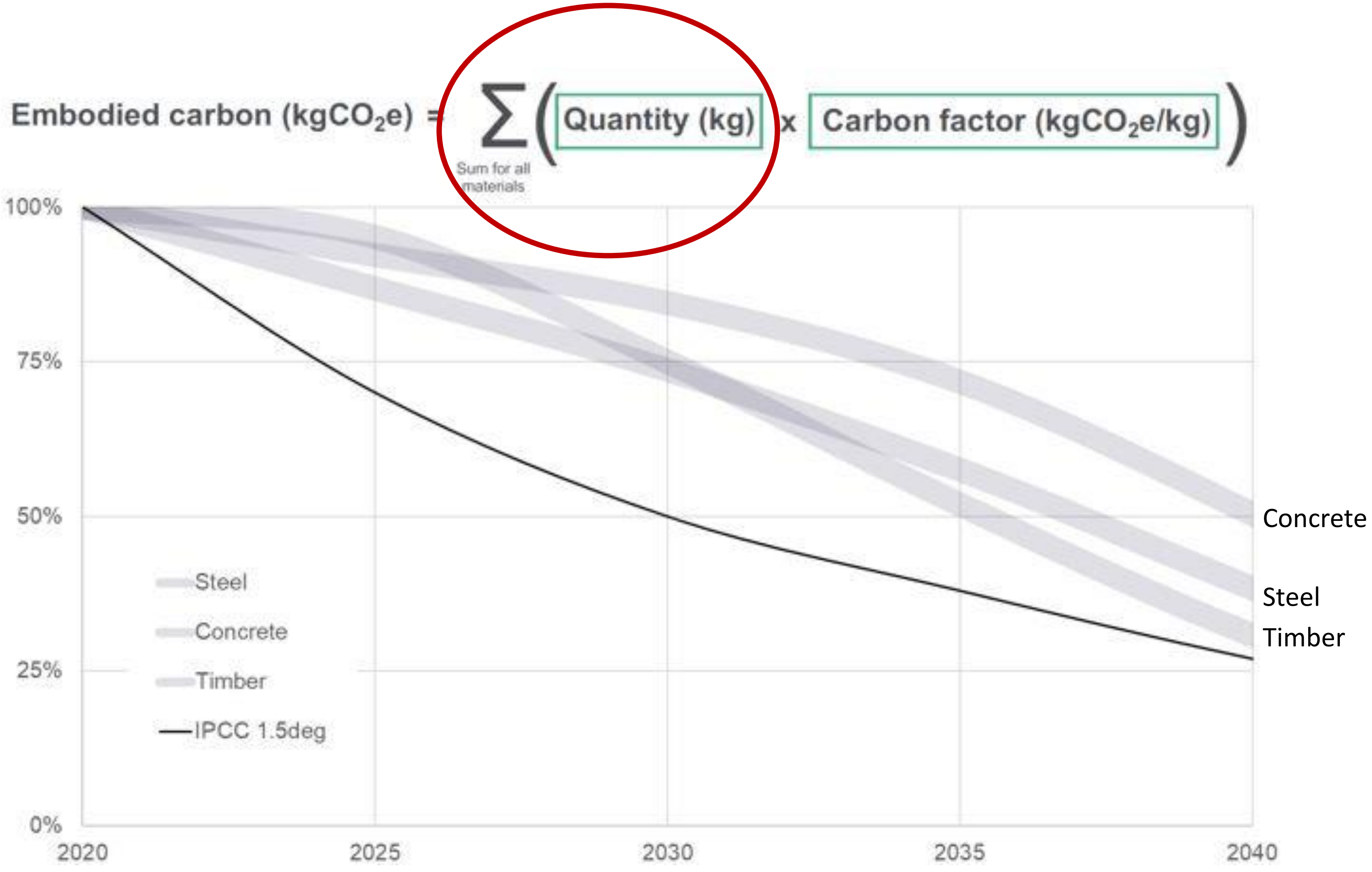
CNCD Séminaire 1 – 21.03.24

Conception et Décarbonation

Lee Franck
LEEN
lee.franck@leenbuild.com

Material Roadmaps

IPCC Alignment



Carbon Reduction

Breaking it down…

$$kgCO_2e = \#People \times m^2/Person \times kg/m^2 \times kgCO_2e/kg$$

Demographics

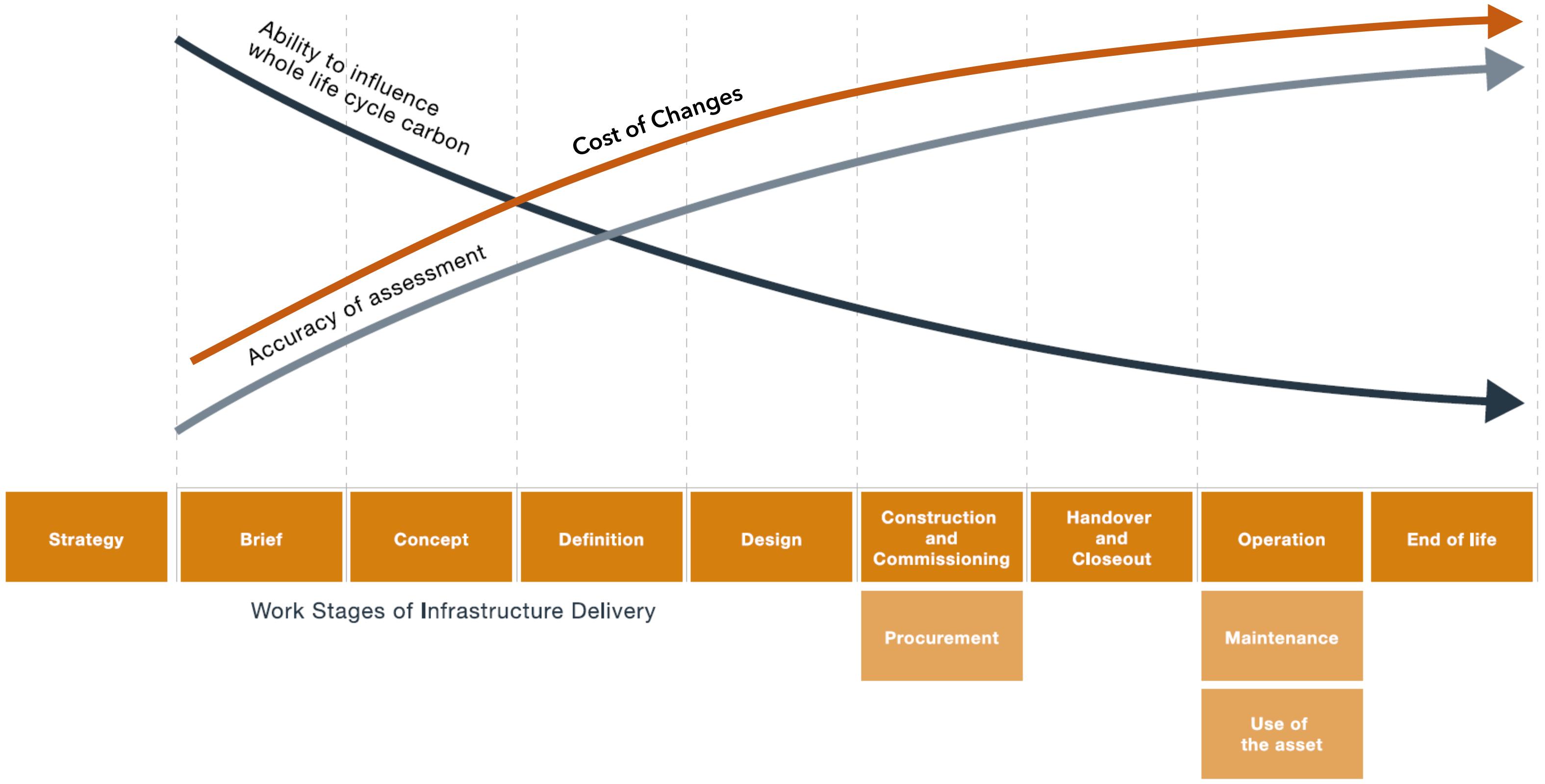
Lower Carbon Materials

Efficiency

Sufficiency

Design Strategy

Value Gain

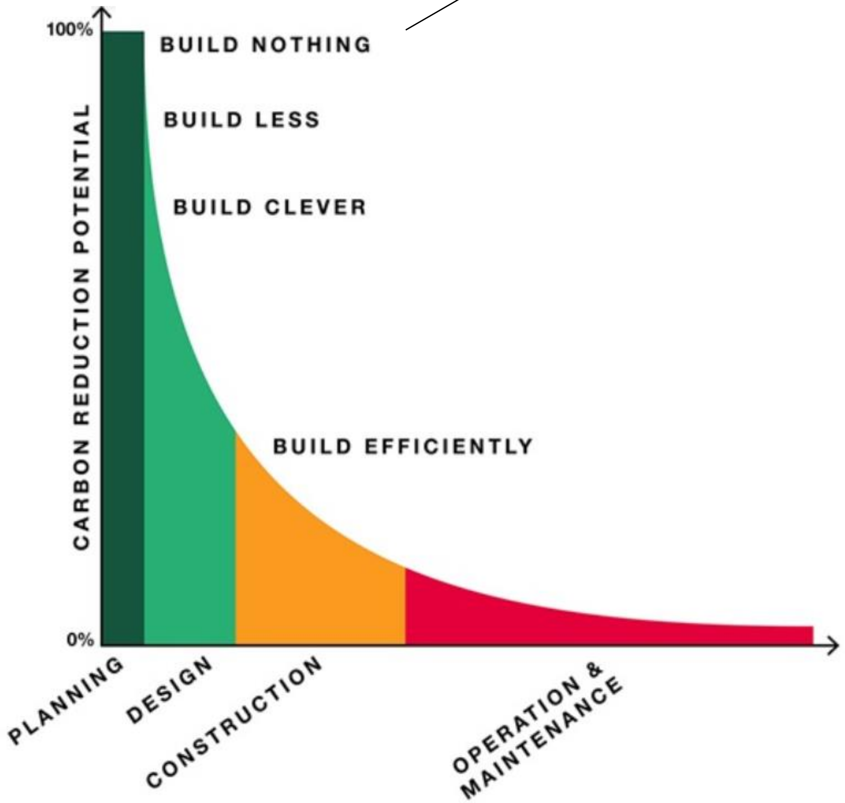


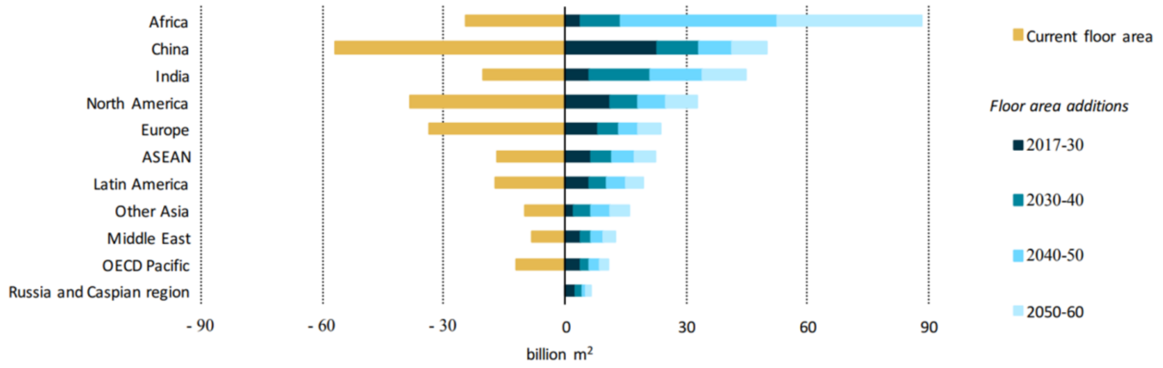
Source:
UKGBC Embodied Carbon – Developing a Client Brief
https://www.ukgbc.org/wp-content/uploads/2017/09/UK-GBC-EC-Developing-Client-Brief.pdf

Design Strategy

1) Build Nothing (100%)

➤ Challenge the brief





Global Building Stock is expected to double in size by 2060

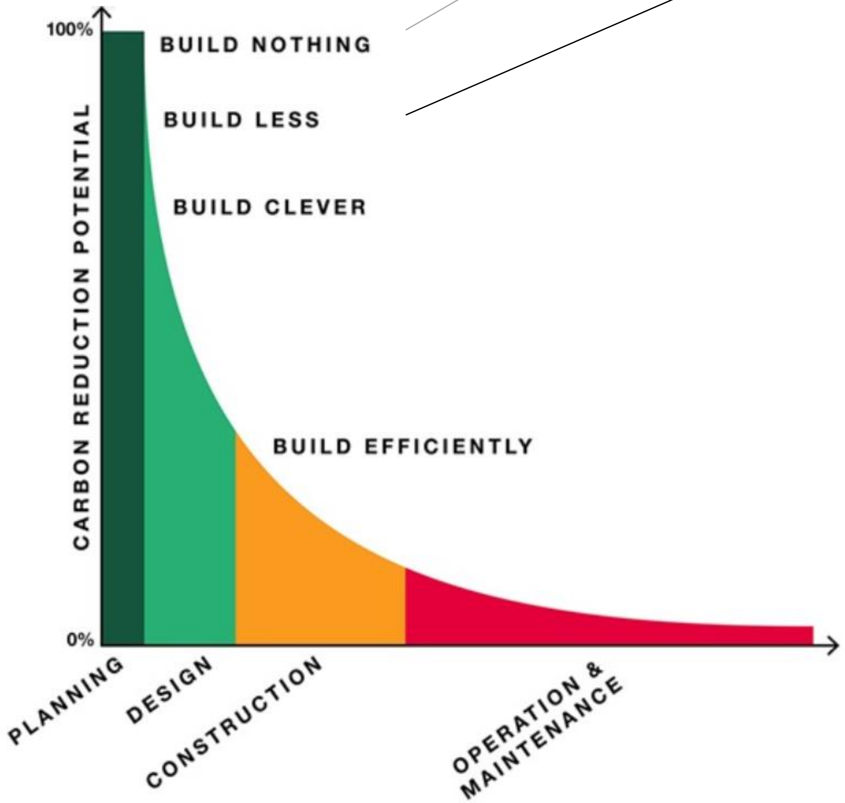
One City of Paris every Week!

Source:
UN Environment and the International Energy Agency Global Status Report 2017
Global Status Report 2017 (worldgbc.org)

Design Strategy

1) Build Nothing (100%)
- ➢ Challenge the brief

2) Build Less (80%)
- ➢ Stop demolishing
- ➢ Retrofit / Repurpose / Reuse
- ➢ Reduce demand
- ➢ Extend life

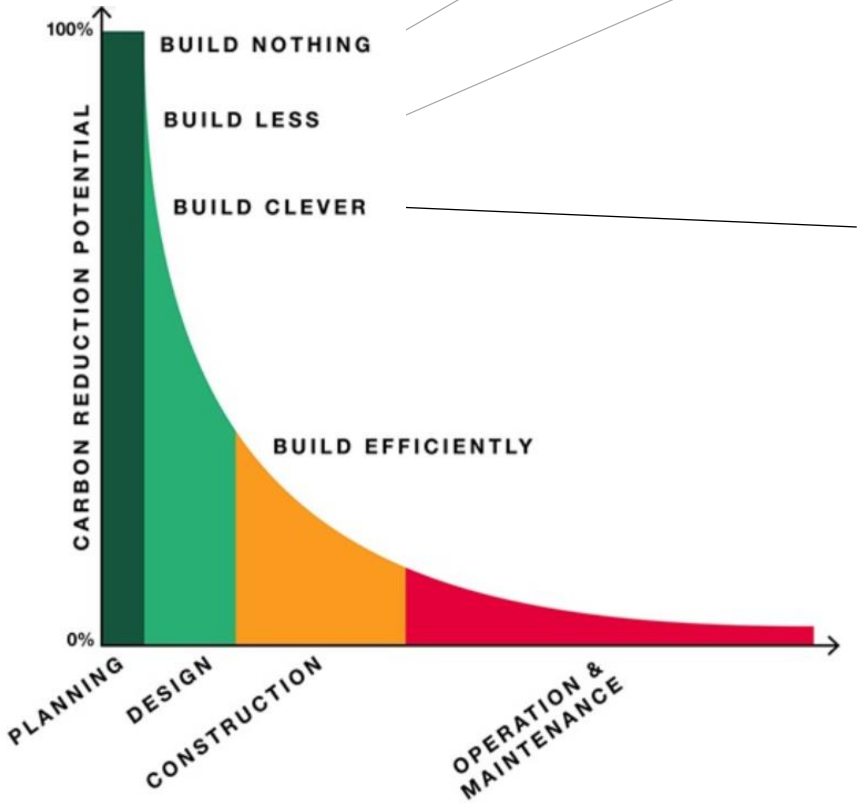


Climate change: Construction companies told to stop knocking down buildings

24 September 2021 · Comments

Climate change

Design Strategy



1) Build Nothing (100%)
- Challenge the brief

2) Build Less (80%)
- Stop demolishing
- Retrofit / Repurpose / Reuse
- Reduce demand
- Extend life

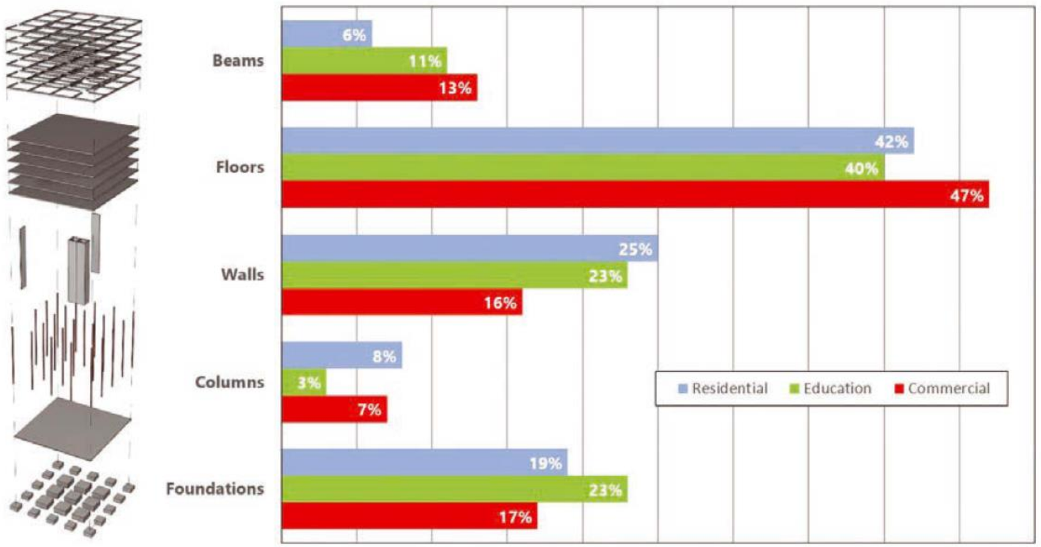
3) **Build Clever (50%)**
- Build compact
- Omit basements
- Appropriate material choices
- Refined design criteria
- Reduce spans
- Use direct load paths
- Use efficient structural forms

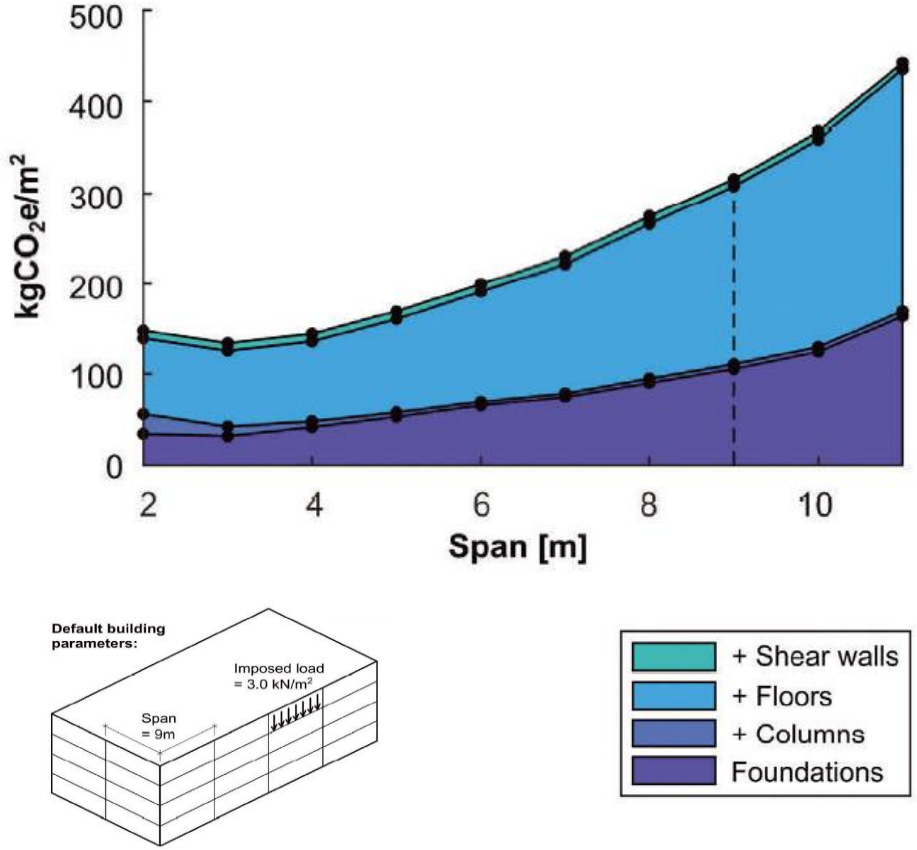
Build Clever

Potential Carbon Saving - **50%**

Reduce spans

FIGURE 5: Distribution of embodied carbon within structure[10]



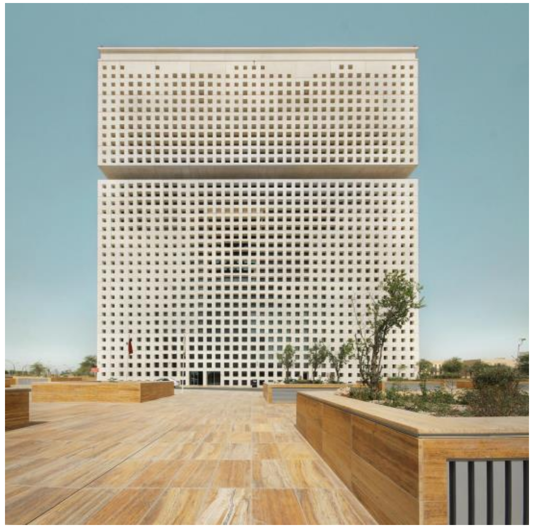


Source:
Lean design: 10 things to do now - The Institution of Structural Engineers (istructe.org)

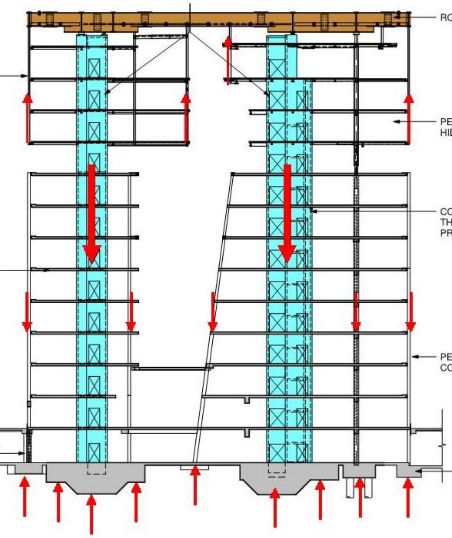
Build Clever

Potential Carbon Saving - **50%**

Use direct load paths



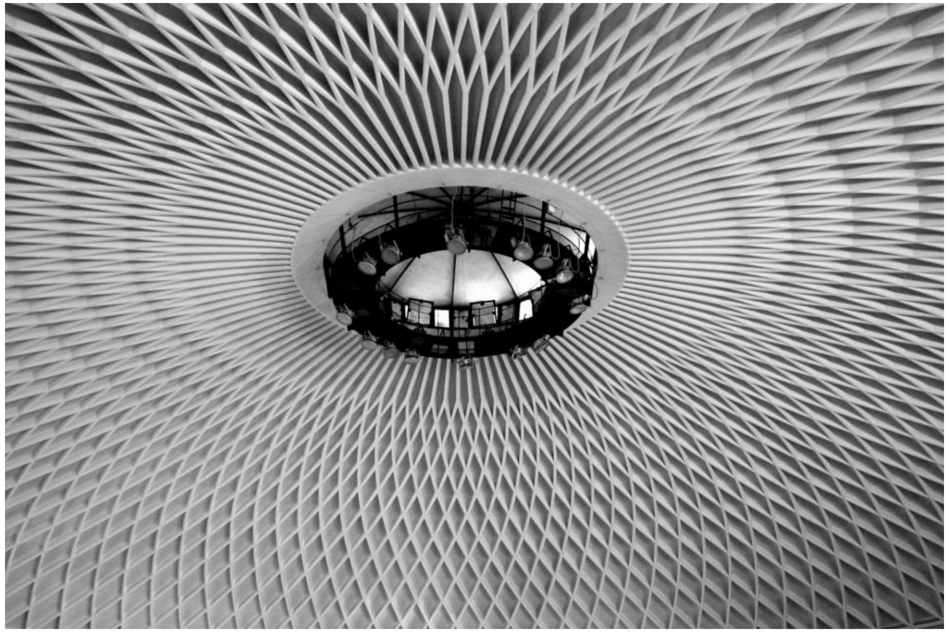
Doha Education City, OMA



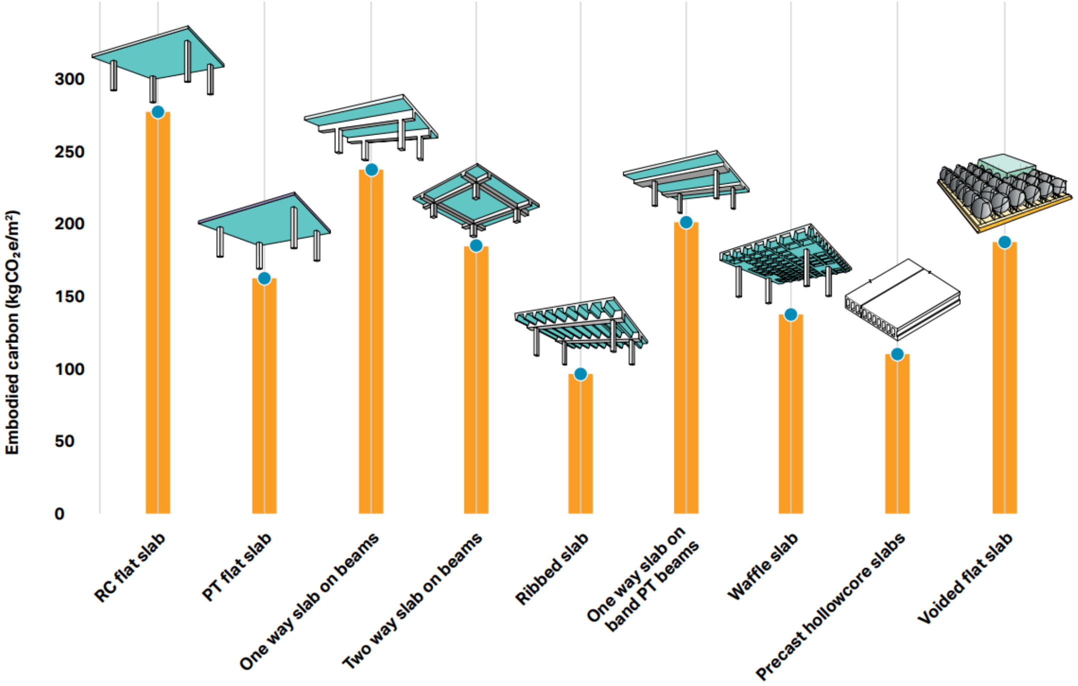
Build Clever

Potential Carbon Saving - **50%**

Use efficient structural forms

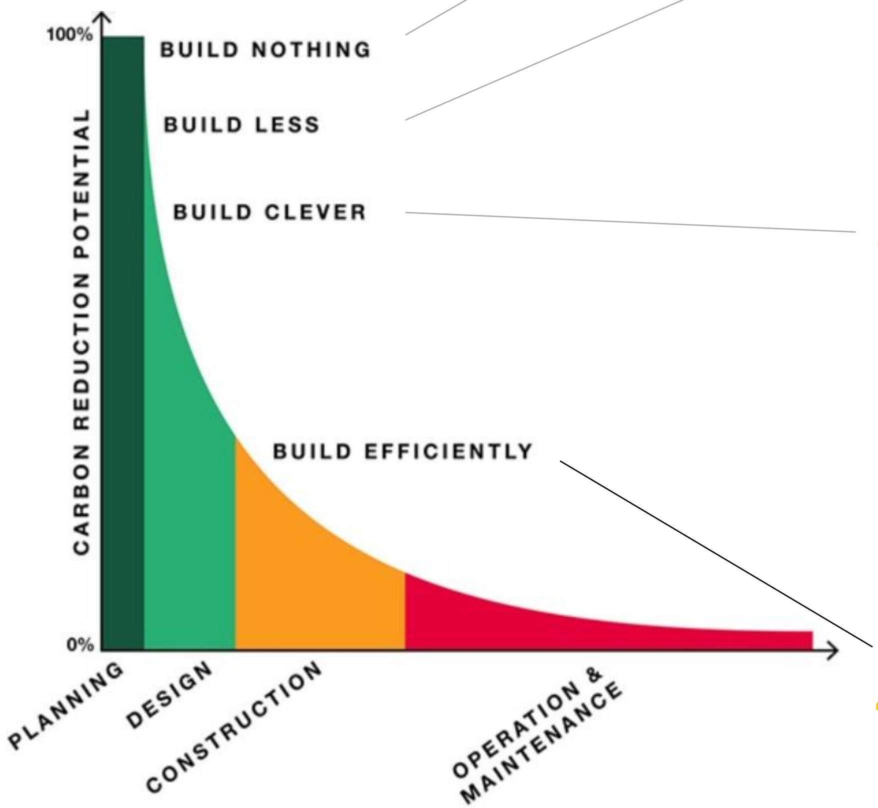


Palazzetto dello sport by Pier Luigi Nervi (1957)



Source:
Arup & wbcsd – Net-zero Buildings

Design Strategy



1) Build Nothing (100%)
- ➢ Challenge the brief

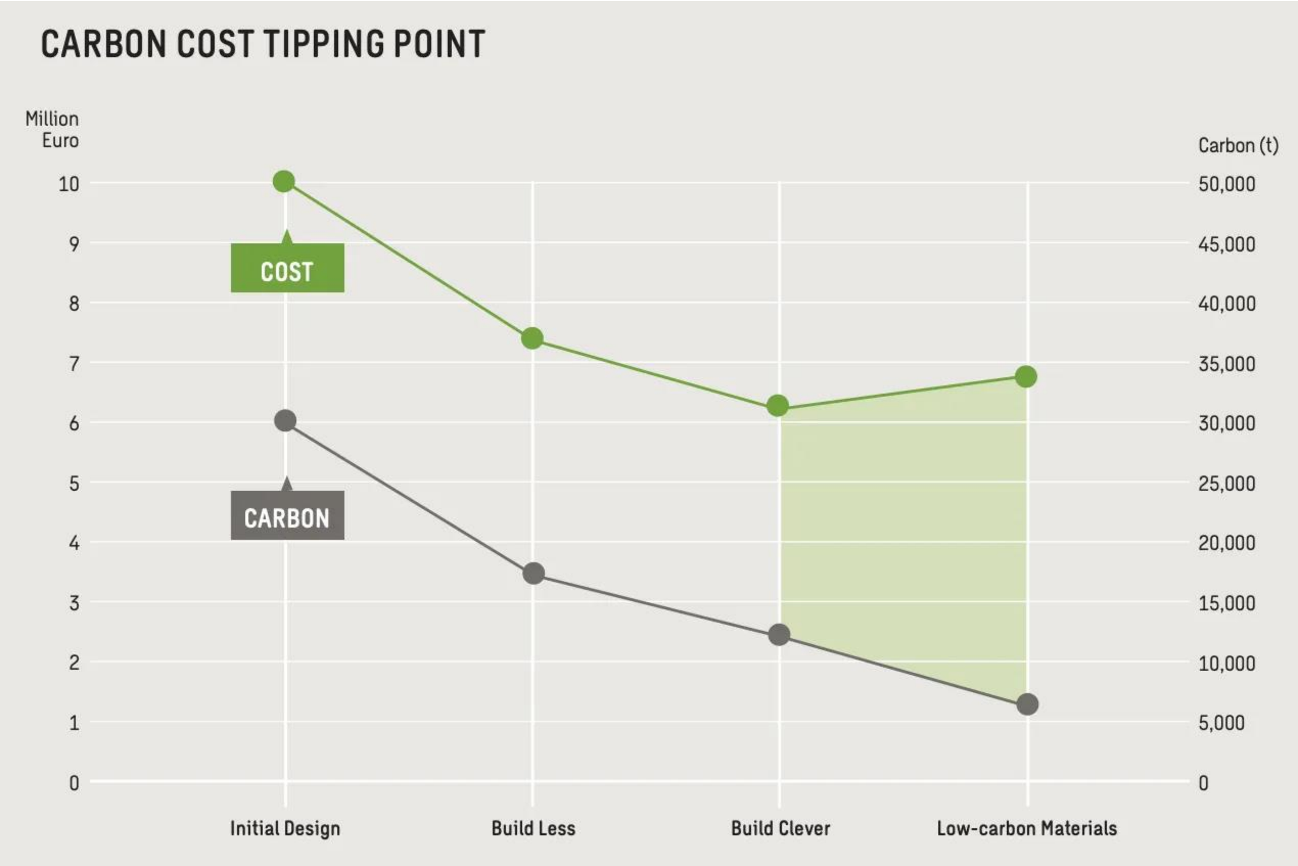
2) Build Less (80%)
- ➢ Stop demolishing
- ➢ Retrofit / Repurpose / Reuse
- ➢ Reduce demand
- ➢ Extend life

3) Build Clever (50%)
- ➢ Build compact
- ➢ Reduce spans
- ➢ Use direct load paths
- ➢ Omit basements
- ➢ Use efficient structural forms
- ➢ Appropriate material choices
- ➢ Refined design criteria

4) Build Efficiently (20%)
- ➢ Review specifications
- ➢ Maximise utilisation ratios
- ➢ Reduce waste / Source locally

Design Strategy

Carbon and Cost



Source:
2050 Materials
https://2050-materials.com/blog/the-interplay-of-carbon-and-cost-in-infrastructure-projects/

Low Carbon Project

- Start early
- Full team
- Educate
- Collaborate
- Iterate
- Compare
- Set targets
- Share

LEEN

Lee Franck
LEEN
lee.franck@leenbuild.com