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REPUBLIC OF TÜRKİYE
MINISTRY OF ENVIRONMENT,
URBANIZATION AND CLIMATE CHANGE

Promoting Enhanced EU ETS Alignment in Türkiye's Emerging ETS

This activity is part of the European Union Climate Dialogues Project (EUCDs)

Cement sector

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MODULE 2 — CBAM-RELEVANT PRODUCT BENCHMARKS BY SECTOR

Online Day 3 — Cement: Clinker & Lime

Grey clinker · white clinker · lime — benchmarks, system boundaries, BDR & a worked calculation

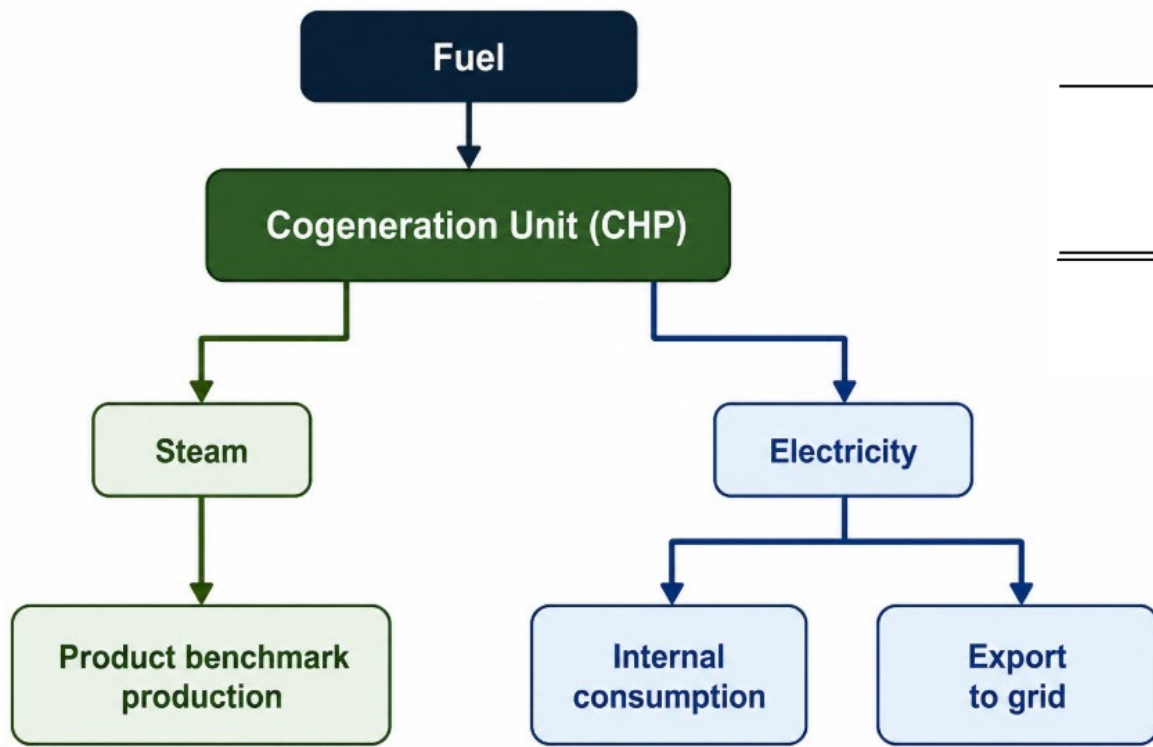
Grey clinker 0.693 t CO₂e/t

White clinker 0.957 t CO₂e/t

Lime 0.725 t CO₂e/t (not CBAM)

Experts: F. Romani / M. Franke · DRAFT — pending GIZ approval

How should fuel consumption and emissions from a cogeneration unit (CHP) be allocated between product, heat and electricity sub-installations under the Turkish ETS?



	Category	Energy source	Year of construction		
			Before 2016	2016–2023	From 2024
	G10	Natural gas, LPG, LNG and biomethane	52,5	53,0	53,0



I have one follow-up question regarding the evidence required for CBAM.

- For electricity imported from Turkey into Bulgaria, what documents would the European Commission or the customs authority actually accept as proof of the hourly import and the associated embedded emissions?
- Would market operator data (e.g. EPIAŞ in Turkey and IBEX/ADEX in Bulgaria) be sufficient, or would the evidence have to come from the Transmission System Operators (TEİAŞ and ESO), such as hourly nominations and capacity allocations?
- In other words, which data source is considered the official evidence for CBAM compliance?

Regulation 2025/2547



For electricity imports, the European Commission requires proof of physical hourly flow, not just commercial trading. The officially accepted evidence comes from the Transmission System Operators (TSOs)—TEİAŞ for Turkey and ESO for Bulgaria—not from market operators like EPIAŞ or IBEX, which only confirm financial transactions but not physical delivery. Specifically, to use actual emissions, you must provide written TSO documentation demonstrating that there was no physical congestion on the interconnector at the time of export, and formal confirmation that the corresponding capacity was explicitly designated for that specific hour. These TSO-issued documents, combined with the generator's verified emission report (proving below 550 g CO₂/kWh) and smart meter data from both production and consumption sites, form the complete and auditable evidence chain. Without these official TSO records, customs authorities will not accept actual emission values and will default to the higher predefined emission factors, significantly increasing your carbon costs.



DAY 3

Agenda for the day

1 Introduction: cement & lime in the EU ETS and CBAM

2 The process & how emissions are counted (MRV)

3 EU ETS benchmarks & the benchmark curve (clinker · white clinker · lime)

4 System boundaries, emission calculation and monitoring plan - Clinker plant example

5 Lime plant example: Monitoring emissions and free allocation

6 Conclusions and last considerations

Case study



CONTINUITY WITH DAY 2

From iron & steel to cement — what carries over, what changes

Same framework as Day 2

- Product benchmarks = average of the 10% best EU installations
- Free allocation = $BM \times HAL \times CLEF \times CBAM \text{ factor}$
- Carbon-leakage list $\rightarrow$ $CLEF = 1$ (100%)
- Sub-installations, BDR data, verified MRV

What is different for cement

- ~2/3 of the CO_2 is process (calcination), not fuel
- CBAM default $\approx$ EU ETS benchmark (little spread)
- Lime is on the leakage list but NOT a CBAM good
- Cement is far more CBAM-exposed than steel



CONTEXT — RESEARCH MATERIAL (OECD study, continued from Day 2)

Cement is the CBAM sector the border levy protects least

–1.44%

EU value added — the worst-hit CBAM sector

The steepest value-added fall of any CBAM good, even with the border levy in place (Full Policy Mix).

up to –2.8%

when free allowances are removed

Loss for sectors whose free allocation covered >85% of emissions — cement and basic metals — before any CBAM cushion.

–3% → –1%

steel is rescued, cement is not

CBAM lifts basic metals back to about –1%; cement stays near its full loss because fewer of its products are covered.

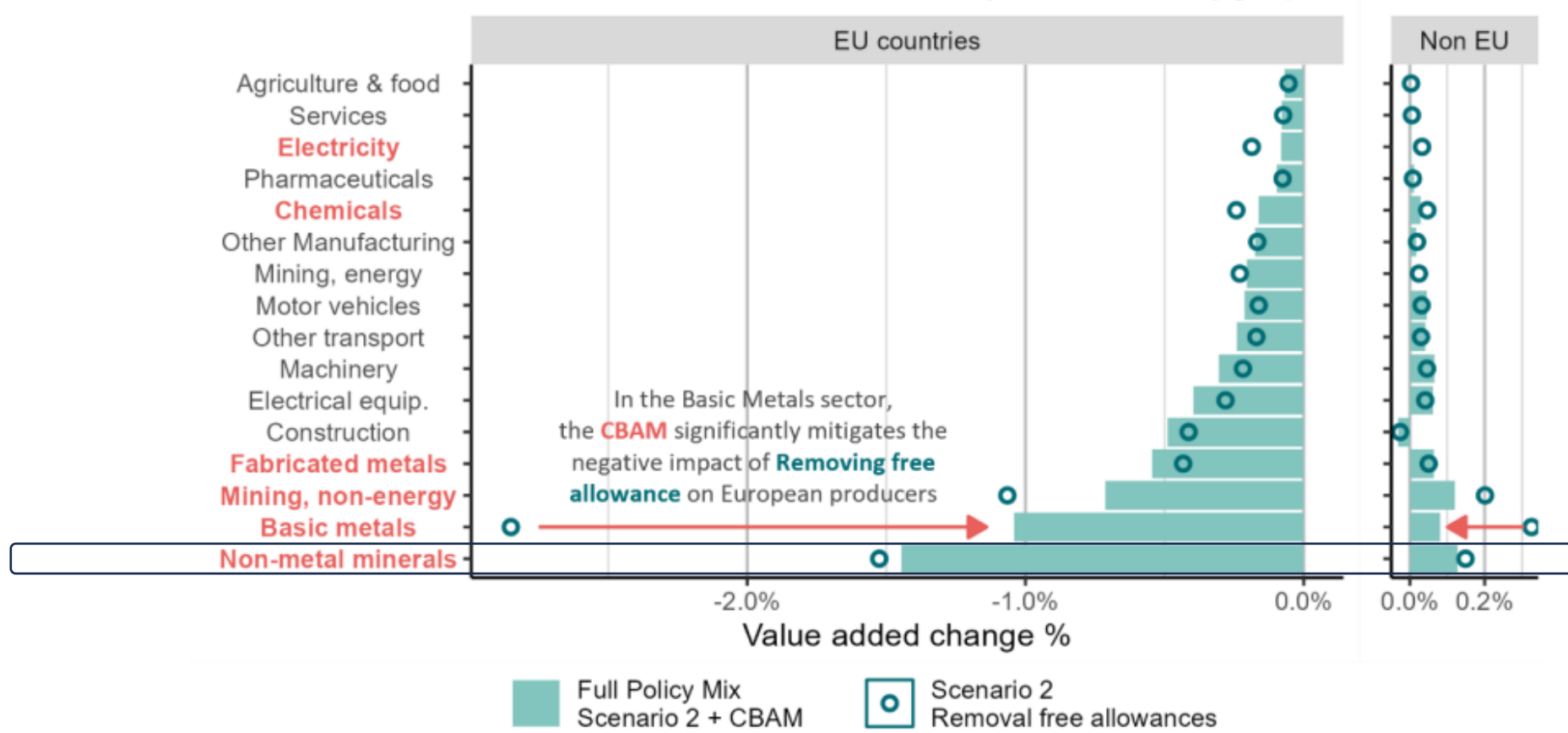
Why cement fares worst: its downstream products (concrete, mortar, articles) sit outside CBAM, so the border levy covers only part of the value chain — and cement carried the second-largest free allocation. Less cover plus more to lose gives the deepest value-added hit.

Source: OECD (2025) — The potential effects of the EU CBAM along the supply chain, Figs. 11–12 & Executive summary. [research material/]



CONTEXT — RESEARCH MATERIAL (OECD study, continued from Day 2)

Effect on value added of the removal of free allowance and CBAM by sector and country group





CONTEXT — RESEARCH MATERIAL (OECD study, continued from Day 2)

What the CBAM means for cement specifically

Why the border levy under-protects cement

- Limited product coverage: only clinker and cements are CBAM goods; concrete, mortar and cement articles stay outside
- Scope 2 counts: cement is one of only two sectors (with fertilisers) where electricity emissions are included
- Imported cement also carries its clinker emissions — clinker is itself a CBAM precursor (Scope 3)
- Cost pass-through is wide and uncertain — 20–100% for cement (vs 60–100% for steel)

What it means for Türkiye

- The study's small positive result for Türkiye comes from low-carbon recycled steel (EAF) — not from cement
- Read it as a caveat, not relief: cement stays Türkiye's most CBAM-exposed product
- No measurable EU ETS leakage in cement or steel so far (Branger, Quirion & Chevallier, 2016)...
- ...but removing free allowances and adding CBAM shifts that balance for the 2026 pilot

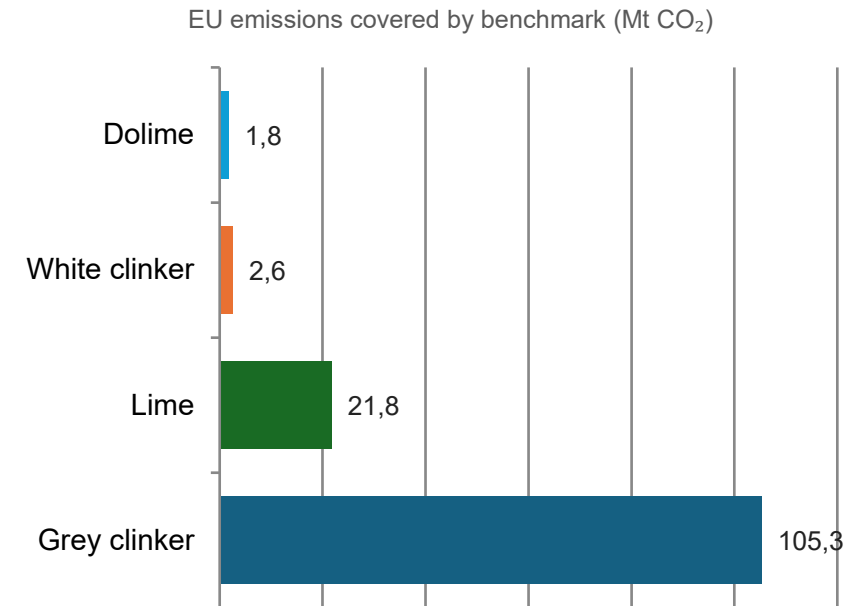
Source: OECD (2025) — *The potential effects of the EU CBAM along the supply chain*, §2 & Box 3; Branger, Quirion & Chevallier (2016). [research material/]



EU ETS — THE EUROPEAN PICTURE

Why cement matters: a top emitter with the most installations

- Grey clinker ≈ 105 Mt CO₂ (2016/17) — among the EU ETS's largest single sources
- 191 installations for grey clinker — the most of any benchmark
- Lime adds ≈ 22 Mt CO₂ across 171 installations
- Emissions are structural: $\sim 2/3$ come from calcining limestone
- All on the carbon-leakage list (CLEF = 1); clinker also within CBAM scope



Source: EU benchmark-curve factsheet (12 Oct 2021), attributed 2016/17 emissions. [research material/]



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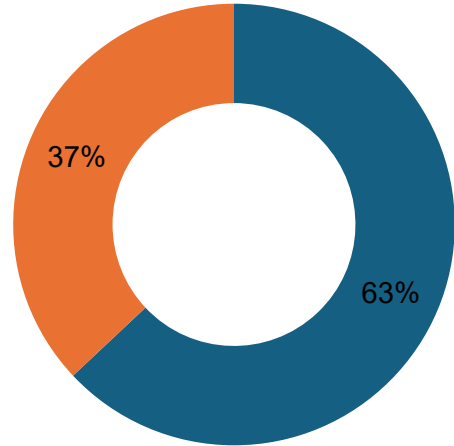
Case study



THE CEMENT PROCESS

Where the CO₂ comes from — and the levers

Typical clinker CO₂ split

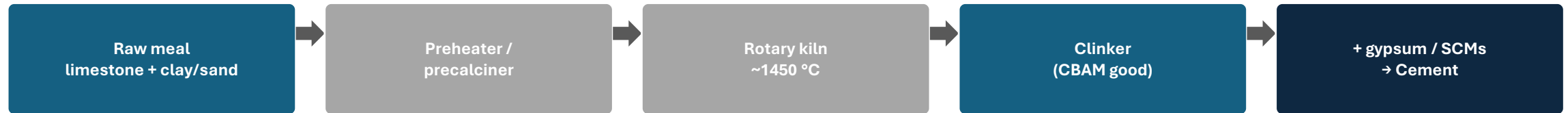


■ Process (calcination) ■ Fuel combustion

- Process emissions (~2/3): unavoidable by fuel switching — they come from the limestone itself
- Fuel emissions (~1/3): lever via alternative fuels (waste, tyre-derived) and biomass (zero-rated)
- White clinker is higher (0.957): low-iron raw meal needs a hotter kiln → more fuel CO₂
- Biggest product-level lever — clinker substitution — sits outside the clinker benchmark

THE CEMENT PROCESS

How clinker and cement are made



Calcination (in the kiln): $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ — limestone releases CO_2 as it turns into lime; this is the bulk of cement's emissions.

- Clinker is the CO_2 -intensive intermediate; cement = clinker + gypsum + supplementary cementitious materials (SCMs)
- The EU ETS benchmark is set per tonne of CLINKER, not per tonne of cement
- Lowering the clinker content of cement (clinker substitution) cuts emissions at the cement-product level

Sources: FAR 2019/331 Annex I; GD9 §10. Process per standard cement chemistry.



EMISSIONS ACCOUNTING (MRV)

How cement emissions are counted

Process emissions (calcination)

- Method A — carbonate input: $t \text{ carbonate} \times \text{emission factor}$
- Method B — oxide output: $t \text{ CaO/MgO in clinker} \times \text{EF}$
- Correct for cement kiln dust (CKD) & bypass dust

Fuel & other

- Combustion: $\text{fuel} \times \text{NCV} \times \text{EF} \times \text{OF}$ (incl. alternative fuels)
- Biomass fraction is zero-rated for CO_2
- Or measurement-based (CEMS) in the stack

- All emissions of the clinker process — calcination, fuel, CKD/bypass dust — are attributed to the clinker sub-installation
- Electricity emissions are outside the benchmark boundary (handled via indirect-cost support, not free allocation)
- For a national ETS, the carbonate data and the biomass/alternative-fuel split are the parameters needing most care

Sources: MRR (EU) 2018/2066 (Arts. 24–25); GD9 §10. [ETS/ · ETS/training material/]



EMISSIONS ACCOUNTING (MRV)

Two methods to calculate process emissions: Lime (EU Regulation 2018/2066)

Method A: Input-based approach

Starting point:

- Raw material consumption
- CaCO_3 and MgCO_3 content
- Moisture and gangue correction

Raw materials



Carbonate content



Stoichiometric conversion



Process CO_2 emissions

Best suited when

- Raw material composition is well characterised

Method B: Output-based approach

Starting point

- Lime production
- CaO , MgO and residual CO_2 analyses
- Residual carbonates correction

Lime production



Chemical composition



Actual calcined oxides



Process CO_2 emissions

Best suited when

- Product quality is continuously monitored

Both methods are based on the same stoichiometric principles and should lead to equivalent annual process emissions when properly applied.



EMISSIONS ACCOUNTING (MRV)

Two methods to calculate process emissions: Cement clinker (EU Regulation 2018/2066)

Method A: Input-based approach

Starting point:

- Raw meal consumption
- CaCO_3 and MgCO_3 content
- Moisture and non-carbonate correction

Raw meal



Carbonate content



Stoichiometric conversion



Process CO_2 emissions

Best suited when

- Raw meal composition is well characterised

Method B: Output-based approach

Starting point

- Clinker production
- Clinker chemical composition (CaO , MgO)
- CKD and bypass dust (where applicable)

Clinker production



Chemical composition



Actual calcined oxides



Process CO_2 emissions

Best suited when

Clinker production and quality are continuously monitored

Both methods are based on the same stoichiometric principles and should lead to equivalent annual process emissions when properly applied.



RECAP

What we covered — the cement process & emissions accounting

Make clinker, then cement

Raw meal → kiln (~1450 °C) → clinker → + gypsum/SCMs → cement;
benchmark is per tonne clinker

Calcination dominates

$\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$; ~2/3 of clinker CO_2 is process, ~1/3 fuel

Levers

Alternative fuels & biomass (fuel side); clinker substitution at product level

How it's counted

Process via carbonate input (A) or oxide output (B); fuel by combustion;
CKD corrected

Next: the EU ETS cement benchmarks and the benchmark curve.



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EU ETS

Cement & lime product benchmarks

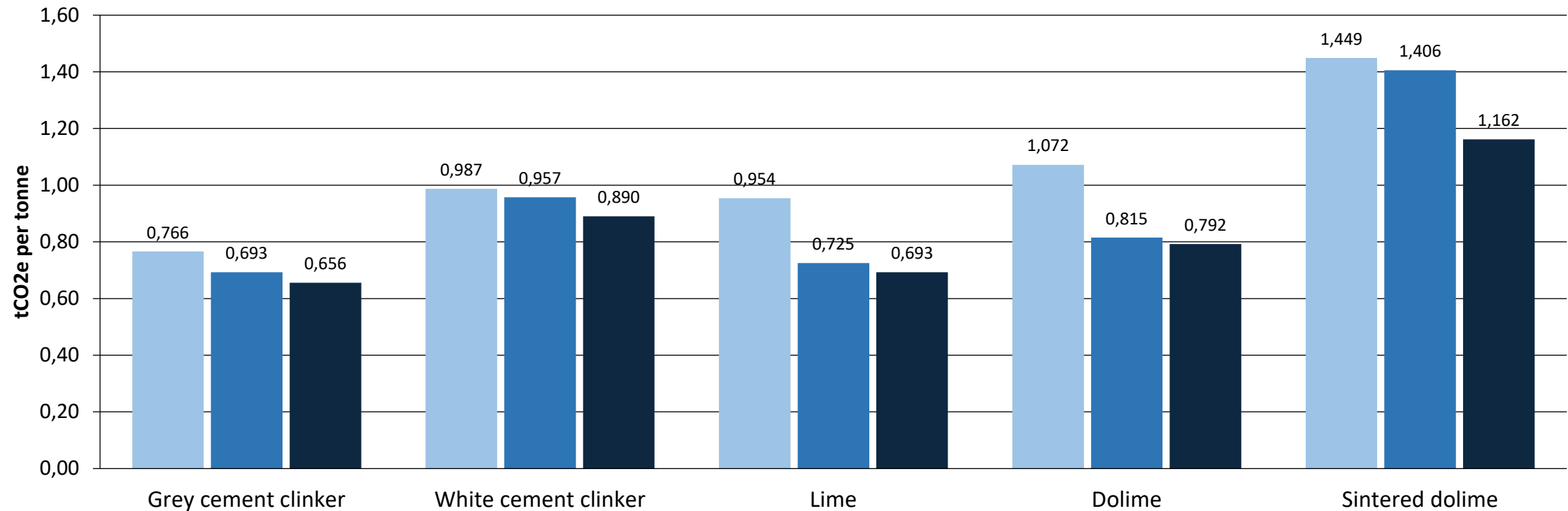
Product benchmark	Unit	2026 - 2030	2021 - 2025	Ph-3 ref.	# EU inst.	CBAM?
Grey cement clinker	t clinker	0,656	0.693	0.766	191	Yes (0.666)
White cement clinker	t clinker	0,890	0.957	0.987	12	Yes (0.859)
Lime	t standard lime	0,693	0.725	0.954	171	No
Dolime	t standard dolime	0,792	0.815	1.072	36	No
Sintered dolime	t sintered dolime	1,162	1.406	1.449	6	No

EU ETS

Benchmark tightening over time

Product benchmark values by period (tCO₂e / t)

■ Ph-3 ref. ■ 2021 - 2025 ■ 2026 - 2030



INTERFACE — KEY SLIDE

Crosswalk: EU ETS cement benchmarks ↔ CBAM

EU ETS benchmark	CBAM good?	CBAM benchmark (Reg 2025/2620)	Free allocation phase-out?
Grey cement clinker	Yes — clinker (CN 2523 10 00)	0.666 (grey, col A & B equal)	Yes — CBAM factor to 0% by 2034
White cement clinker	Yes — clinker (CN 2523 10 00)	0.859 (white)	Yes — CBAM factor
Lime	No — not a CBAM good	—	No — CBAM factor = 1 (keeps free allocation)

Key: clinker (and cement, via its clinker content) is in CBAM scope and loses free allocation from 2026; lime stays outside CBAM and keeps full free allocation. For clinker the CBAM default $\approx$ the EU ETS benchmark.



CBAM - Default Values

Regulation (EU) 2025/2621

Türkiye

Other Countries and Territories

Product CN Code	Description	Default Value (direct emissions)	Default Value (indirect emissions)	Default Value (total emissions)	2026 Default Value (including mark-up)
Cement					10% mark-up
2507 00 80	Calcined clay	–	–	–	–
2523 10 00	White clinker	–	–	–	–
2523 10 00	Grey clinker	–	–	–	–
2523 21 00	White Portland cement	–	–	–	–
2523 29 00	Grey Portland cement	–	–	–	–
2523 90 00	White hydraulic cements	–	–	–	–
2523 90 00	Grey hydraulic cements	–	–	–	–
2523 30 00	Aluminous cement	1,820	0,140	1,950	2,145

Product CN Code	Description	Default Value (direct emissions)	Default Value (indirect emissions)	Default Value (total emissions)	2026 Default Value (including mark-up)
Cement					10% mark-up
2507 00 80	Calcined clay	0,210	0,070	0,280	0,308
2523 10 00	White clinker	1,320	0,060	1,370	1,507
2523 10 00	Grey clinker	1,370	0,050	1,410	1,551
2523 21 00	White Portland cement	1,300	0,140	1,450	1,595
2523 29 00	Grey Portland cement	1,360	0,080	1,440	1,584
2523 90 00	White hydraulic cements	1,310	0,180	1,490	1,639
2523 90 00	Grey hydraulic cements	1,280	0,090	1,370	1,507



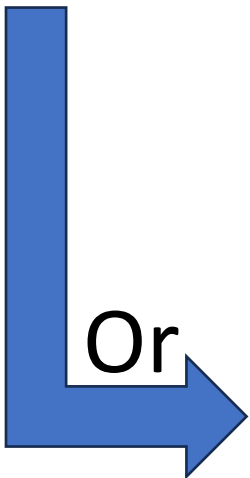
CBAM - Default Values

How to face high carbon price

Installation emission verification



[Regulation \(EU\) 2025/2547](#) on
methods for the calculation of
emissions embedded in goods



National ETS



BENCHMARK 1 OF 4

Grey cement clinker

What it is

- Grey cement clinker (or alternative hydraulic binders) for cement
- Unit: tonnes of grey clinker (as total hydraulic binder produced)
- Boundary: all processes linked to clinker — calcination + fuel
- By-pass / kiln dust attributed to the clinker sub-installation

Benchmark facts

Unit t grey clinker

CLEF 1 (100%)

CBAM scope yes

CN code 2523 10 00

ETS weighted average emission value

0.810 t CO₂e/t

EU ETS benchmark (2021–25)

0.693 t CO₂e/t · 191 EU installations

CBAM default emission value

1,551 t CO₂e/t · CN 2523 10 00

CBAM Benchmark

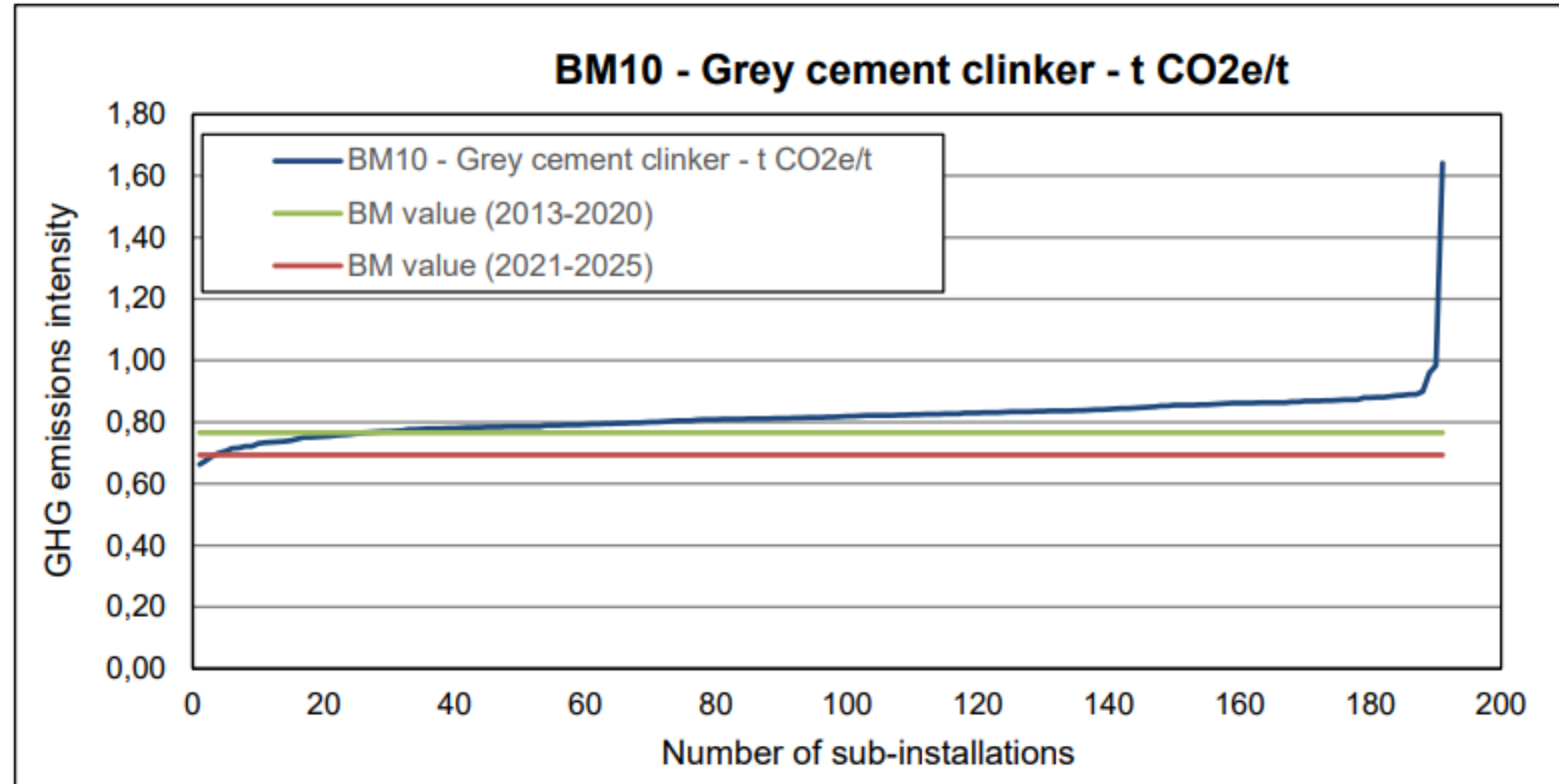
0,66 t CO₂e/t · CN 2523 10 00

Sources: FAR 2019/331 Annex I; GD9 §10; benchmark-curve factsheet; CBAM Reg 2025/2620. [ETS/ · CBAM/]



BENCHMARK 1 OF 4

Grey cement clinker



Weighted average GHG emissions intensity of all installations in 2016/2017

0,810

t CO₂e/t



BENCHMARK 2 OF 4

White cement clinker

What it is — and why it's higher

- White clinker for white cement (decorative, architectural use)
- Made from low-iron / low-manganese raw materials
- Needs a hotter kiln + sometimes bleaching → more fuel CO₂
- Same calcination chemistry, but higher fuel intensity

Benchmark facts

Unit t white clinker

CLEF 1 (100%)

CBAM scope yes

EU inst. 12 (rare)

ETS weighted average emission value

1.114 t CO₂e/t

EU ETS benchmark (2021–25)

0.957 t CO₂e/t · ≈ 38% above grey clinker

CBAM default emission value

1,507 t CO₂e/t · CN 2523 10 00

CBAM benchmark (default)

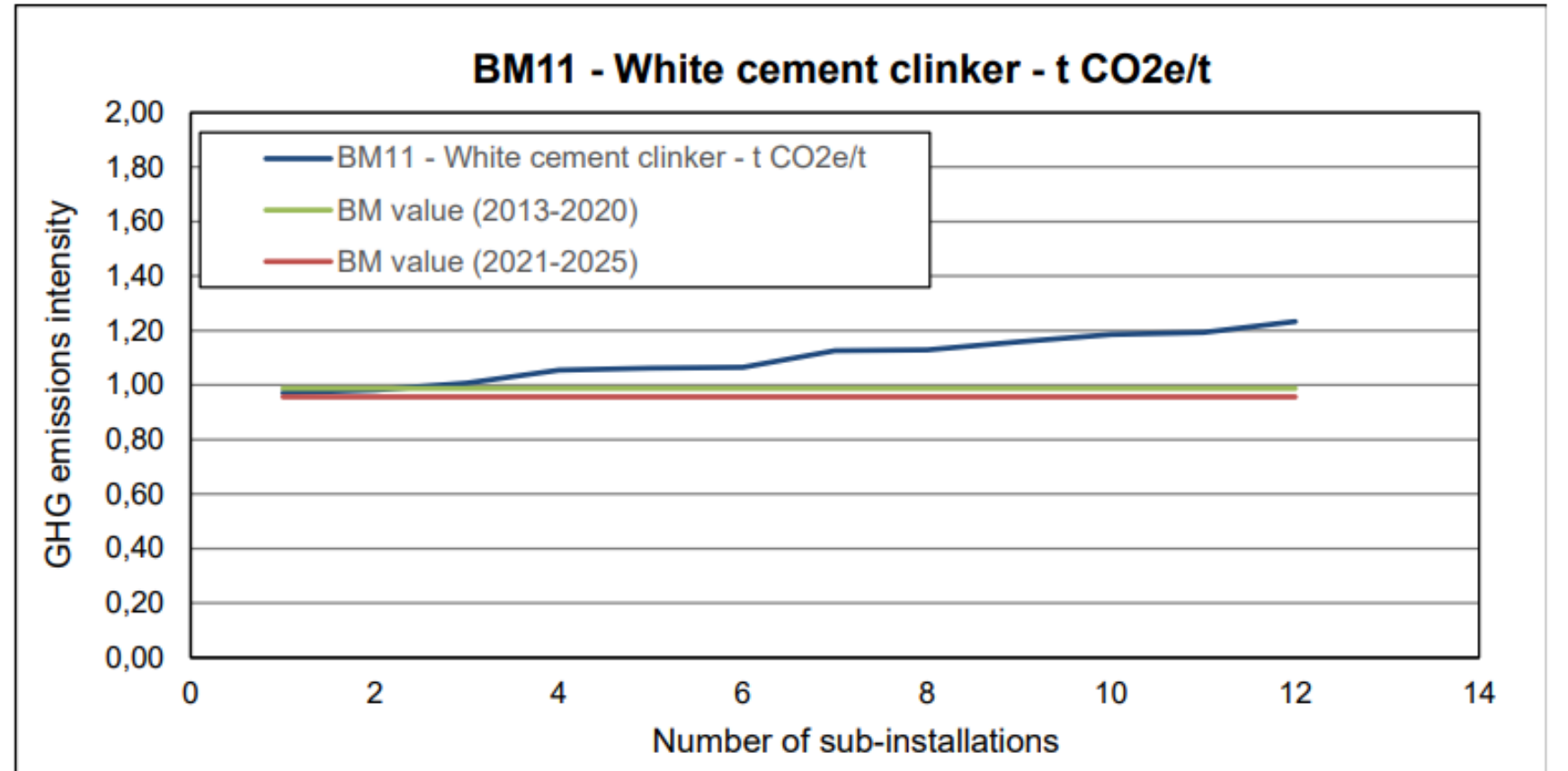
0.859 t CO₂e/t · CN 2523 10 00 (white)

Sources: FAR 2019/331 Annex I; GD9 §11; benchmark-curve factsheet; CBAM Reg 2025/2620. [ETS/ · CBAM/]



BENCHMARK 2 OF 4

White cement clinker



Weighted average GHG emissions intensity of all installations in 2016/2017

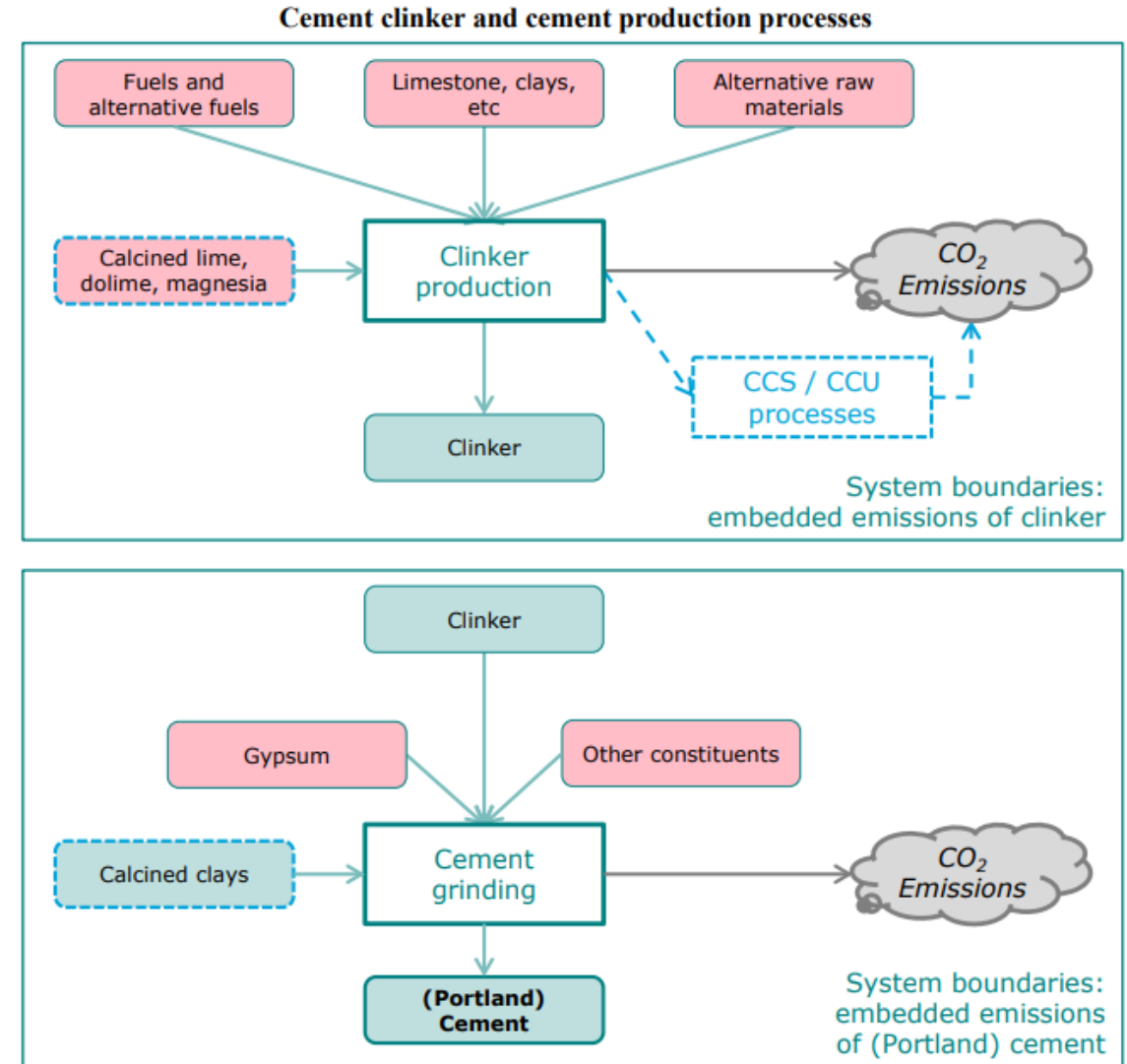
1,114

t CO₂e/t



Emission calculations

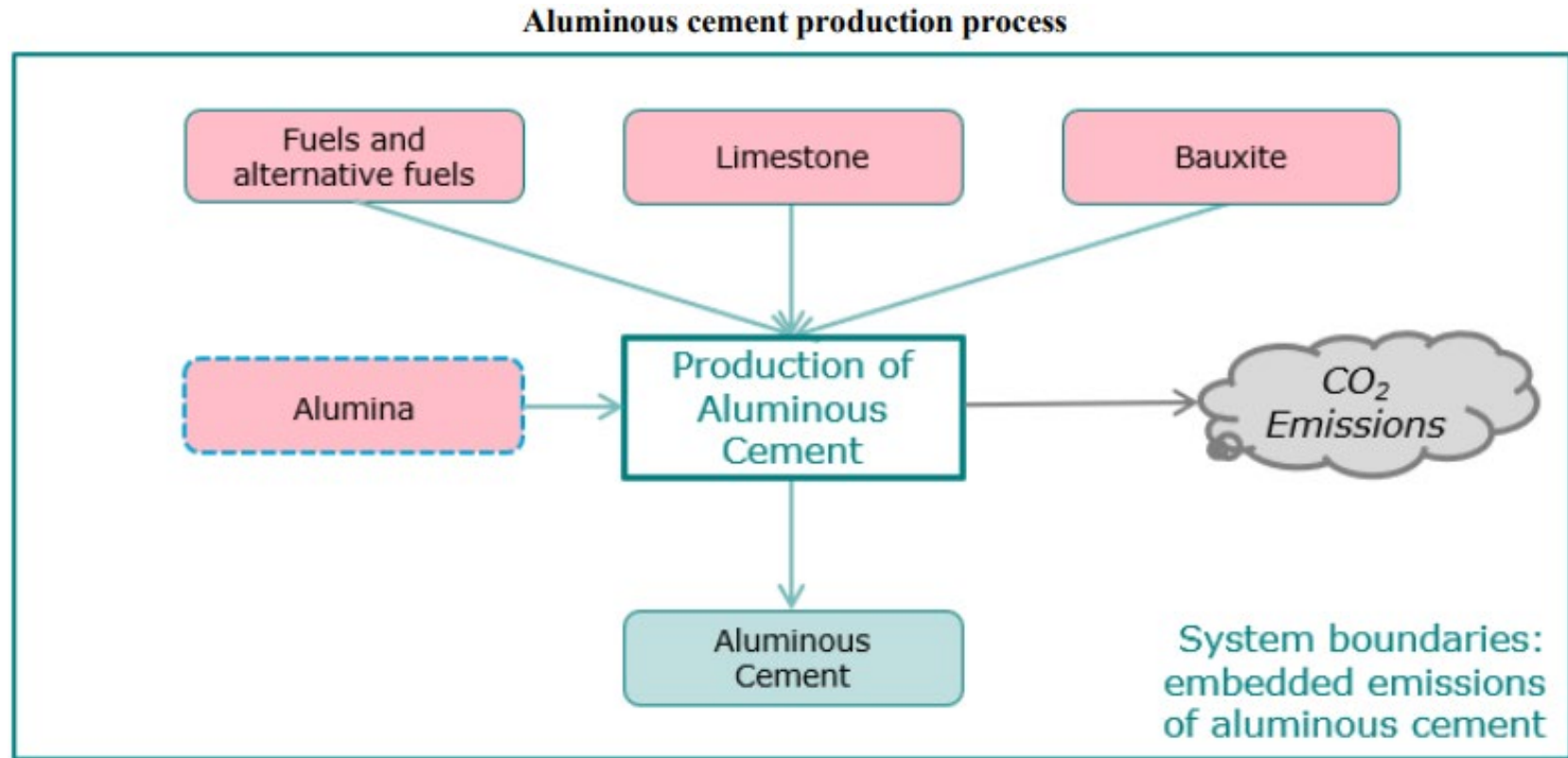
Cement clinker and cement production processes





Emission calculations

CAC: Aluminous cement production processes





BENCHMARK 3 OF 4

Lime — on the leakage list, but NOT a CBAM good

What it is

- Quicklime: CaO from decarbonation of limestone (CaCO_3)
- Unit: tonnes of 'standard pure' lime (94.5% free CaO)
- Boundary: all processes linked to lime production
- Mostly process emissions — same calcination as clinker

Benchmark facts

Unit t standard pure lime

CLEF 1 (100%)

CBAM scope NO

EU inst. 171

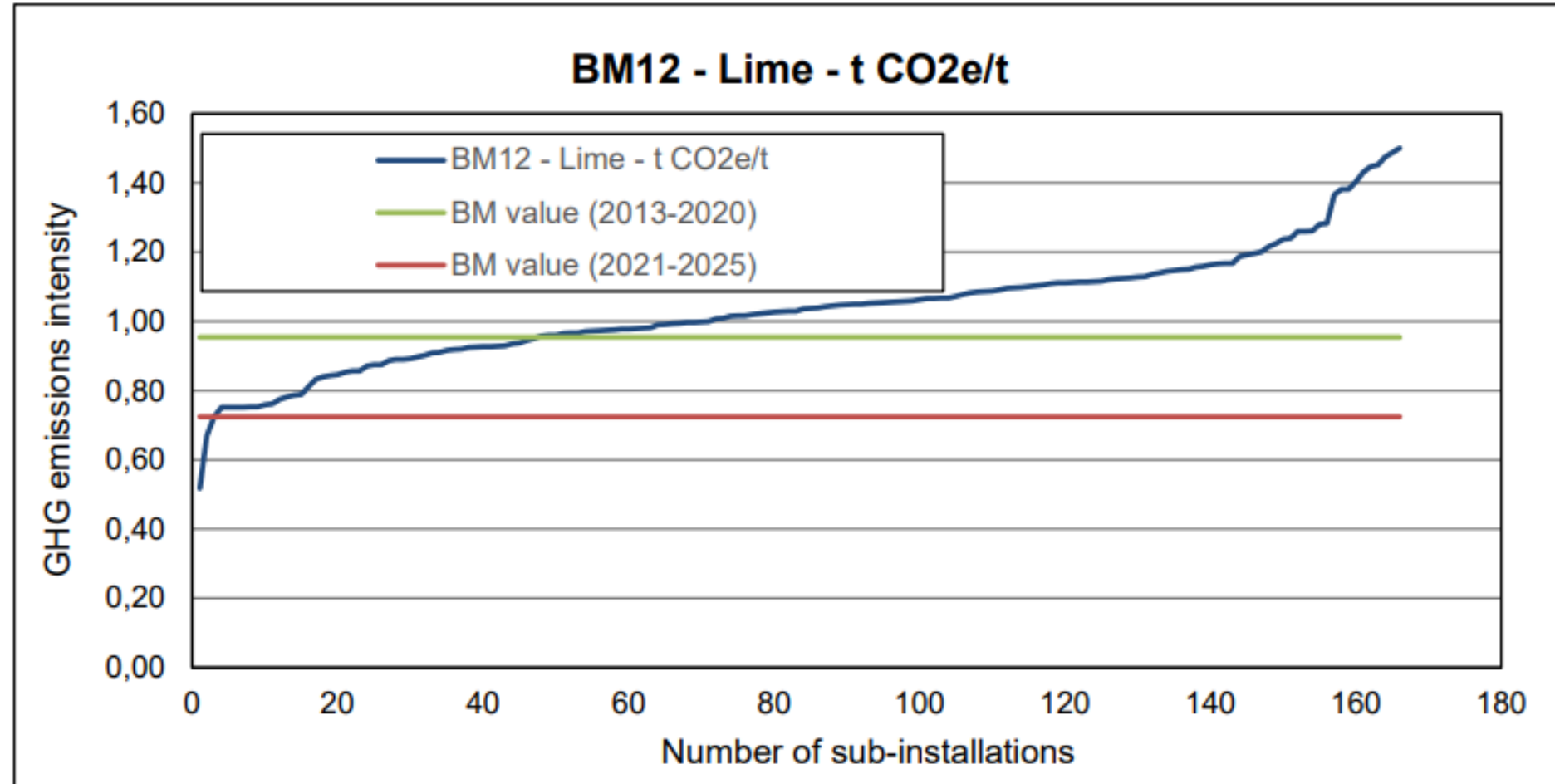
Consequence: lime is on the carbon-leakage list (CLEF = 1) but is not a CBAM good — its CBAM factor stays at 1, so it keeps full free allocation (no phase-out). EU ETS benchmark 0.725 t CO₂e/t across 171 installations.

Sources: FAR 2019/331 Annex I; GD9 §12 ('Under the CBAM scope: No'). [ETS/]



BENCHMARK 3 OF 4

Lime



Weighted average GHG emissions intensity of all installations in 2016/2017

1,059

t CO₂e/t



BENCHMARK 4 OF 4

Dolime — on the leakage list, but NOT a CBAM good

What it is

- Dolime: $\text{CaO} + \text{MgO}$ from decarbonating dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$)
- Unit: t 'standard pure' dolime (57.4% CaO ; 38.0% MgO)
- Boundary: fuel prep, calcination/sintering & flue-gas treatment
- Definition: residual $\text{CO}_2 > 0.25\%$; free MgO 25–40%; density $< 3.05 \text{ g/cm}^3$

Benchmark facts

Unit t standard pure dolime

CLEF 1 (100%)

CBAM scope NO

EU inst. 36

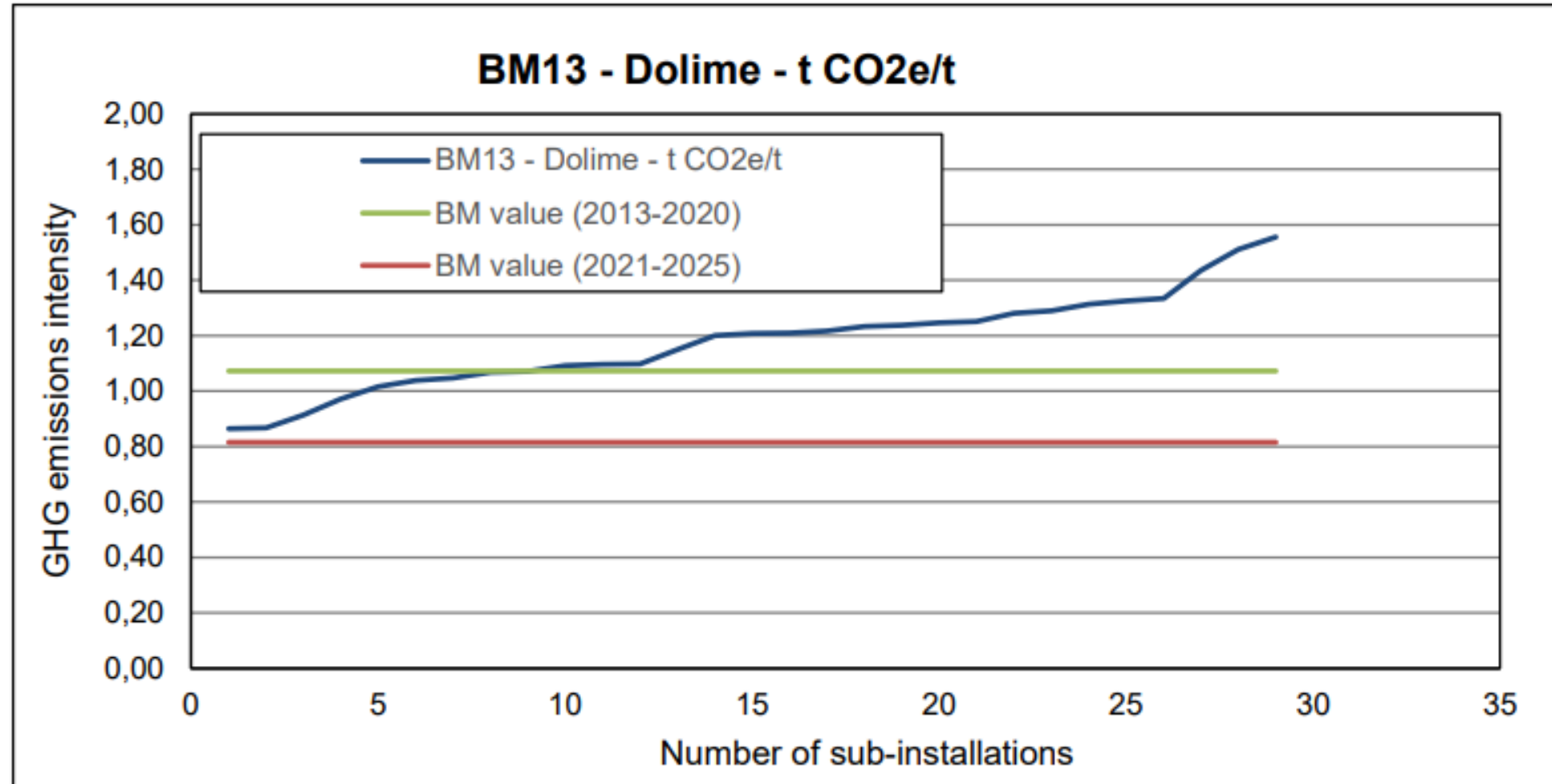
Consequence: dolime is on the carbon-leakage list (CLEF = 1) but is not a CBAM good — CBAM factor = 1, so free allocation does not phase out. EU ETS benchmark $0.815 \text{ t CO}_2\text{e/t}$ across 36 installations; HAL is corrected using free CaO/MgO content.

Sources: FAR 2019/331 Annex I/III; GD9 §13 (Dolime; CBAM scope: No). [ETS/]



BENCHMARK 4 OF 4

Dolime



Weighted average GHG emissions intensity of all installations in 2016/2017

1,214

t CO₂e/t



RECAP

What we covered — EU ETS cement benchmarks & the benchmark curve

Three benchmarks

Grey clinker 0.693, white clinker 0.957, lime 0.725 (t CO₂e/t)

The curve

Benchmark = 10% best; clinker intensities cluster tightly (process-driven)

CBAM ≈ EU ETS

For clinker the CBAM default (0.666) ≈ the EU ETS benchmark — little spread

Lime is special

On the leakage list but not a CBAM good → keeps full free allocation

Next: system boundaries, sub-installations & BDR data.



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SYSTEM BOUNDARIES

Sub-installations for a cement / lime plant

- Clinker sub-installation = one product-benchmark sub-installation (grey or white)
- Calcination, fuel, and CKD/bypass-dust emissions all attributed here
- Lime is its own product-benchmark sub-installation
- Residual scope → fallback sub-installations: heat, fuel, process emissions
- No emission counted under two sub-installations (no double counting)

Attribution hierarchy

1 Product benchmarks

2 Heat benchmark

3 Fuel benchmark

4 Process emissions

Sources: FAR 2019/331 (sub-installation attribution); GD9 §10–12.

SYSTEM BOUNDARIES

Summary — what is inside each benchmark

Benchmark	Unit	Key processes inside the boundary
Grey cement clinker	t clinker	Raw-meal prep, calcination, kiln fuel, clinker cooling; CKD/bypass dust included
White cement clinker	t clinker	As grey clinker; higher kiln temperature / fuel for low-iron raw materials
Lime	t standard lime	Calcination of limestone in lime kilns; fuel; mostly process emissions
(Dolime / sintered dolime)	t product	Calcination of dolomite/magnesite — specialised lime products

Across all: electricity emissions are excluded from the boundary; biomass CO₂ is zero-rated; measurable heat handled separately.

Sources: FAR 2019/331 Annex I; GD9 §10–14.



EU ETS · MONITORING, REPORTING & VERIFICATION

Accounting the CO₂ emissions of a cement plant

Source streams, methodologies, tiers and reporting — a complete walkthrough of one real installation.

Cement Plant

Integrated dry-process plant · anonymized

≈ 543,000 t CO₂

Fossil emissions, reporting year 2024

7 sources · 8 streams

Emission sources F1–F7 · source streams
CM1–CM8



The accounting framework

1

Define the boundary

List every emission source (F) and every source stream (CM) inside the permit — down to the fire-pump diesel.

2

Choose the methodology

Calculation-based standard methodology: combustion formula for fuels, process formula for carbonates.

3

Apply tiers

The bigger the stream, the stricter the accuracy requirements on activity data and calculation factors.

4

Report and verify

Annual emissions report, independently verified, based on an approved monitoring plan.

COMBUSTION EMISSIONS

$$E = AD \times NCV \times EF \times OF$$

PROCESS EMISSIONS

$$E = AD \times EF \times CF$$



02 • THE INSTALLATION

Cement Plant X at a glance

1

rotary kiln

dry process, with preheater

661 kt

clinker produced

from $\approx 1,023$ kt of raw meal

4

fuel families co-fired

pet coke, tyres, plastics, natural
gas

543 kt

CO₂ per year

fossil, rounded + 11 kt biomass
CO₂ rated zero

A fully integrated plant: raw materials are ground into **raw meal**, burned into **clinker** in kiln F1, then ground with additives into **cement** for bagging and dispatch. Auxiliary boilers heat offices and buildings; emergency devices stand by on diesel.

Every unit emits CO₂ — and **every single one is inside the accounting boundary**, from the kiln's 540,000 tonnes to the fire pump's 9.

NOTE ON THE DATA

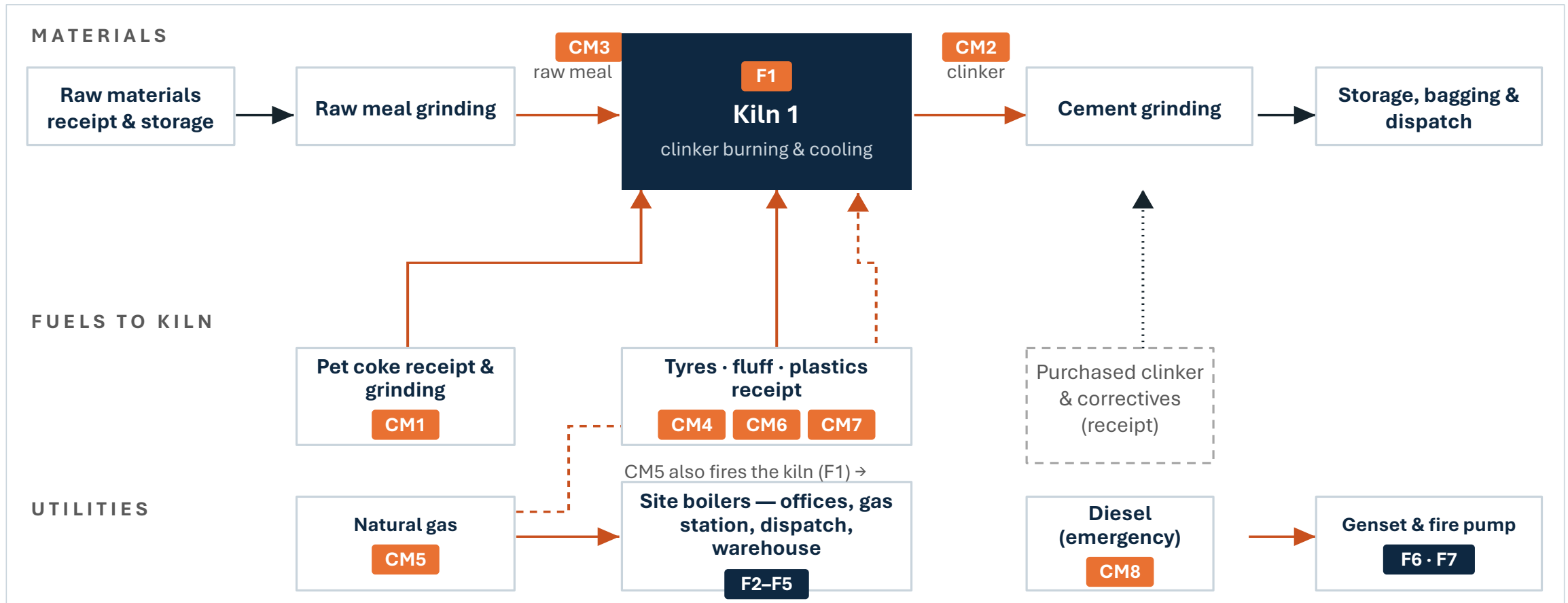
Installation anonymized. All quantities rounded. Reporting year: 2024.



03 • SOURCE-STREAM DIAGRAM

Process flow and source streams

CM source stream (measured) **F** emission source (emits)





04 • WHERE CO₂ LEAVES THE PLANT

Emission sources F1–F7

F1

The clinker kiln

Decarbonation of raw meal + combustion of fossil and alternative fuels, including biomass fractions.

99.8% of the plant's CO₂

F2

Office boiler

natural gas

F3

Gas-decompression boiler

natural gas

F4

Dispatch boiler

natural gas

F5

Warehouse boiler

natural gas

F6

Emergency genset

diesel

F7

Fire-fighting pump

diesel

Completeness rule

Every combustion or process unit inside the permit boundary is a source — even the fire pump that emitted 9 tonnes. Nothing is left out; small sources just get lighter requirements.



05 • WHAT GETS MEASURED

Source streams CM1–CM8

Stream	Description	Method	CO ₂ 2024 (t, rounded)	Class
CM1	Petroleum coke (main kiln fuel)	Combustion	174,000	Major
CM2	Clinker — carbonate decarbonation	Process	340,000	Major
CM3	Raw meal — non-carbonate carbon (TOC)	Process	4,300	Minor
CM4	Used tyres (31% biomass)	Combustion	23,500 + 10,800 bio	Major
CM5	Natural gas (kiln + boilers)	Combustion	700	De-minimis
CM6	Fluff (not used this year)	Combustion	0	De-minimis
CM7	Plastics & rubber (31% biomass)	Combustion	260 + 120 bio	De-minimis
CM8	Diesel — emergency devices	Combustion	9	De-minimis

Major: everything not minor or de-minimis

Minor: < 5,000 t CO₂/yr or < 10% of total

De-minimis: < 1,000 t CO₂/yr or < 2% of total



06 • FORMULA I

Combustion emissions

$$E = AD \times NCV \times EF \times OF$$

Activity data

Tonnes of fuel consumed in the year.

From calibrated weighbridges and belt scales, reconciled with stock changes.

Pet coke: **58,800 t**

Net calorific value

Energy content per tonne (GJ/t).

Laboratory analysis of representative samples, per an approved sampling plan.

Pet coke: **31.5 GJ/t**

Emission factor

t CO₂ per TJ of energy.

Lab-derived for major streams; standard national factors allowed for small ones.

Pet coke: **93.9 t CO₂/TJ**

Oxidation factor

Share of carbon actually oxidised.

Conservatively set to 100% — unburned carbon is not deducted.

All fuels: **100%**

Applies to CM1, CM4, CM5, CM6, CM7, CM8 — expressing consumption on an energy basis (AD × NCV) is the preferred MRR approach.



07 • FORMULA II

Process emissions

$$E = \text{Clinker output} \times EF_{cli} \times CF$$

CM2 Clinker decarbonation — Method B (output)

CaCO_3 and MgCO_3 in the raw meal release CO_2 when burned. Instead of weighing every carbonate input, measure the **clinker produced** and apply an emission factor derived from its CaO / MgO content.

661,000 t
clinker (weighed)

0.545
t CO_2 / t clinker (lab)

≈ 340,000 t
 CO_2 after conversion factor

CM3 Non-carbonate carbon in raw meal

Organic carbon (TOC) in the raw meal also burns: 1,023,000 t of meal $\times$ 0.0042 t CO_2 /t $\approx$ **4,300 t CO_2** .

≈ 63%

of the plant's CO_2 is process emissions — released by chemistry, not by fuel choice.



08 • ZERO-RATED CARBON

Biomass in alternative fuels

Used tyres (CM4) — 11,800 t burned, 34,300 t CO₂ released at the stack

biomass fraction: 31% (natural rubber, by analysis)

23,500 t CO₂ — fossil

counted in full, allowances surrendered

10,800 t CO₂ — biomass

reported, rated zero

Prove the fraction

The biomass share must come from laboratory analysis. EN 15440 offers three methods for determining the biomass fraction of a mixed material: 1. The selective dissolution method; 2. The manual sorting method; 3. The 14C method.
Or approved standard values — never assumed.

Report both fractions

Biomass CO₂ appears in the annual report as a memo item with emission factor zero — transparency without cost.

Why it matters

≈ 11,000 t of zero-rated CO₂ per year is a direct financial incentive to substitute fossil fuels with waste-derived ones.



08 · ZERO-RATED CARBON

Biomass in alternative fuels — the rules behind the zero rating

ZERO-RATING IS CONDITIONAL — MRR ART. 38(5)

Biomass counts at emission factor zero only if it meets the RED II sustainability and GHG-saving criteria.

Evidence: a Proof of Sustainability from a RED II certification scheme, or the purchase and cancellation recorded in the Union Database.

Criteria not met → the preliminary emission factor becomes final: the CO₂ counts as fossil, in full.

Waste-derived fuels — tyres, fluff, plastics mixes

Not agricultural or forestry biomass → only the GHG-saving criterion applies, and only where biomass use started after 1 Jan 2021.

Prove the biomass fraction — Art. 39

Laboratory analysis (e.g. EN 15440). An estimation method needs CA approval, plus proof that analysis is technically infeasible or unreasonably costly.

No reliable data? Use conservative values

High preliminary EF, low biomass fraction. Tyres: typically 20–30% biogenic; Annex VI default EF 85.0 t CO₂/TJ, with a consistent NCV.

Why it matters

Zero-rated CO₂ means no allowances to surrender — and because free allocation follows the product benchmark, not the fuel, a substitution to compliant biomass cuts the carbon bill while the allocation stays. The evidence trail (analyses, PoS, UDB records) is exactly what the verifier re-checks.

Source: GD3 — Biomass and other zero-rating under the EU ETS MRR (26 Sep 2025); MRR Arts. 38–39 & Annex VI.



09 • ACCURACY REQUIREMENTS

Tiers and uncertainty

MAJOR STREAMS

CM1 • CM2 • CM4

- Highest tiers required
- Activity data: $\pm 1.5\text{--}2.5\%$ max uncertainty
- NCV, EF, biomass fraction: plant-specific, from accredited lab analyses
- Formal sampling plan per material

MINOR STREAMS

CM3

- Lower tiers acceptable
- Activity data: $\pm 5\text{--}7.5\%$
- Standard or literature factors allowed
- Less frequent analyses

DE-MINIMIS STREAMS

CM5 • CM6 • CM7 • CM8

- No minimum tier
- Conservative estimates permitted
- Supplier invoices as activity data
- National standard factors

The principle

Measurement effort is proportional to the tonnes at stake: 94% of this plant's CO₂ sits in two streams, and that is where the strictest accuracy applies. Dropping a tier requires proof of unreasonable cost or technical unfeasibility.



09 · ACCURACY REQUIREMENTS

Uncertainty assessment in practice — four routes to prove a tier

A tier is a maximum permissible uncertainty for the year's activity data (95% confidence). The monitoring plan must show, with evidence, how each tier is met — GD4 allows four routes.

ROUTE CO-1

Instrument under national legal metrological control (NLMC): the maximum permissible error in service counts as the uncertainty — no further evidence.

ROUTE CO-2a

No NLMC, but the instrument is installed and checked to comparable requirements: the MPES for that instrument class may still be used.

ROUTE CO-2b

Use the expanded uncertainty from calibration, multiplied by a conservative adjustment factor for in-service conditions.

ROUTE CO-3

Full instrument-specific uncertainty assessment — always allowed; required when the simplified routes cannot show compliance.

THE OPERATOR

Keeps instruments calibrated and maintained exactly as the monitoring plan says, and includes stock changes in the assessment.

If a tier still cannot be met: corrective action — or evidence of technical infeasibility or unreasonable costs, and the next lower tier.

THE VERIFIER

Confirms the validity of the uncertainty information (AVR): calibration certificates, NLMC evidence, the calculation itself.

Expert judgement can be acceptable for minor and de-minimis streams and low-emitting installations.

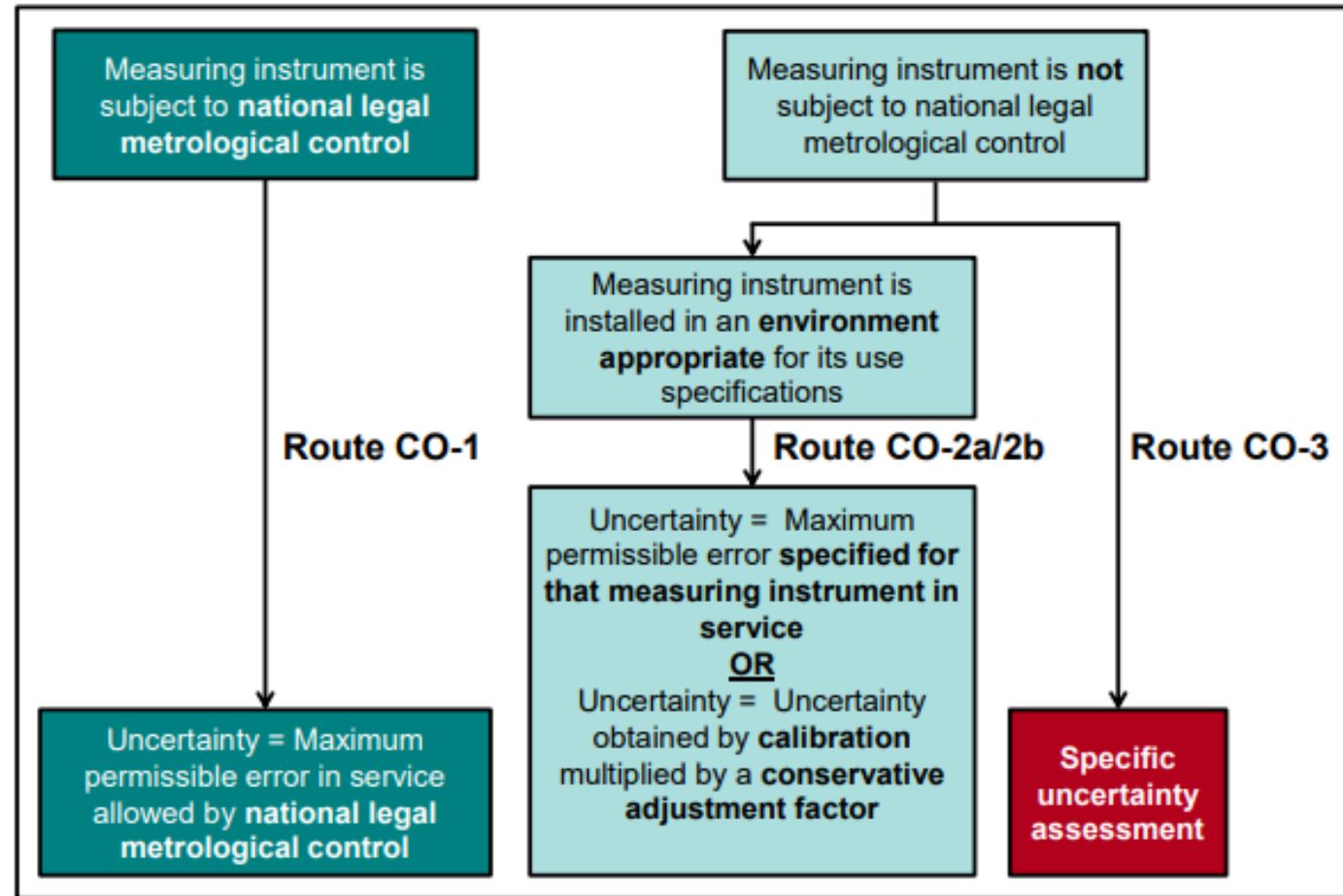
Cement Plant X: the pet-coke dosing scales ($\pm 1.5\%$ tier) are verified under national metrological control — Route CO-1, no extra uncertainty study needed.

Source: GD4 — Guidance on uncertainty assessment (2021); Commission training material on uncertainty (2019); MRR Art. 12 & Annex II.



09 · ACCURACY REQUIREMENTS

Uncertainty assessment in practice — four routes to prove a tier





09 • ACCURACY REQUIREMENTS

What the monitoring plan defines

A tier is a predefined level of data quality and accuracy for monitoring parameters under the MRR (Regulation 2018/2066). Higher tiers require greater accuracy but are generally more demanding and costly to achieve.

Per source stream, the MP fixes:

- Monitoring approach — calculation-based
- Activity data: weighbridge / metering (tonnes, TJ)
- Emission factor, NCV, biomass fraction — and the TIER for each
- Clinker process emissions: Method B (output-based)
- Process/combustion split and the biomass treatment

Why it matters

- The MP is approved by the competent authority
- It is the contract: the AER must follow it, and the verifier checks against it
- A national ETS needs the same: an approved plan per installation

Source: plant monitoring plan (anonymised real example); MRR (EU) 2018/2066; GD9 §10. [uploaded example]



09 · ACCURACY REQUIREMENTS

Unreasonable costs — when may an operator settle for less accuracy?

THE TEST — MRR ART. 18

Costs are unreasonable where they exceed the benefit of the improvement.

An objective calculation, not a negotiation: the operator shows the numbers, the competent authority evaluates them.

WHAT COUNTS ON EACH SIDE

Costs: the annuity of the investment (economic lifetime, interest), O&M and external analyses — only additional costs, clearly attributable to the improvement.

Benefit = 20 €/t CO₂ × emissions of the stream × improvement factor.

Improvement factor: for activity data, the gap between achieved and required uncertainty; 1% for all other improvements.

WORKED CHECK — MAJOR FUEL STREAM

Current uncertainty 2.8% · tier requires 1.5% · stream emits 760,000 t CO₂/yr

Benefit = 20 × 760,000 × 1.3% ≈ €197,600 / yr

Any upgrade costing less than that is reasonable — the operator must carry it out.

WHAT IT DOES — AND DOES NOT — DO

Justifies the next lower tier or an approved estimation method — never a gap in monitoring.

Improvements up to €2,000/yr (€500 for low emitters) are never unreasonable.

The claim is re-examined through the regular improvement reports — it is a postponement, not an exemption.

Where even tier 1 is out of reach, a fall-back approach (Art. 22) with an overall uncertainty threshold remains the last resort.

Source: Commission training material on unreasonable costs (2019); MRR Arts. 18 & 22; GD4.

09 • ACCURACY REQUIREMENTS and primary data

Laboratory analyses behind the numbers



Stream (sample)	Key laboratory values	Feeds in the AER
Petroleum coke (CM1)	EF 93.5 tCO ₂ /TJ · NCV ≈ 30.8 GJ/t	fossil combustion CO ₂
Used tyres / PFU (CM4)	EF 89 tCO ₂ /TJ · NCV ≈ 32 GJ/t · biogenic fraction zero-rated	alternative-fuel CO ₂ + biomass
Raw meal / farina (CM3)	CO ₂ 33.7% · TOC (organic C) 0.13% · CaO 43%	process check + non-carbonate carbon
Clinker (CM2)	CaO 65.5% · MgO 1.27% → calcination ≈ 0.53 t CO ₂ /t	process emissions (Method B)

Return to primary source: every emission factor in the AER traces to a dated, signed lab certificate — exactly what the verifier re-checks. Tyres carry a biogenic fraction, so part of their CO₂ is zero-rated.

Combustibile come Ricevuto (ar)

Biomassa (Bar)

%

28,68

EN 15440:2011 (Annex A) / AC:2011 + EN ISO 16993:2015



10 • INSTRUMENTATION

Metering points S1–S35

S1 · S2

Weighbridges

All incoming solids: pet coke, tyres, plastics, raw materials, diesel deliveries.

S3 – S26

Cement & dispatch scales

Finished-product weighing at bagging and shipping — closes the mass balance.

S27 – S30

Fuel dosing scales

Belt scales at solid-fuel grinding — the direct measurement behind CM1's 58,800 t.

S31 – S35

Gas meters

Fiscal-grade natural gas metering for kiln, boilers, offices and laboratory.

Traceability rule

Every tonne in the report traces back to a named instrument in the monitoring plan — calibrated, maintained, with a documented fallback if it fails.



11 • FROM SCALE TO TONNES OF CO₂

Worked example — petroleum coke (CM1)

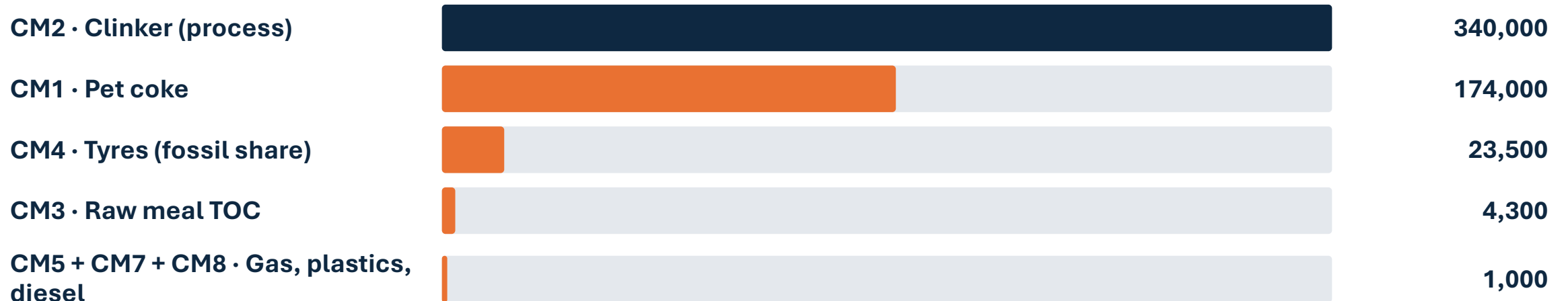
1	Fuel weighed on dosing scales S27–S30 over the year	58,800 t
2	× net calorific value from laboratory analysis (31.5 GJ/t)	= 1,853 TJ
3	× emission factor from laboratory analysis (93.9 t CO ₂ /TJ)	= 174,000 t CO ₂
4	× oxidation factor 100% · biomass fraction 0% → reported emissions	≈ 174,000 t CO ₂

Every combustion stream — tyres, plastics, gas, diesel — follows exactly these four steps, with its own measured values.



12 • REPORTING YEAR 2024

Annual emissions summary



≈ 543,000 t CO₂

total fossil — allowances to
surrender

≈ 10,900 t CO₂

biomass — reported, rated
zero



13 • CLOSING THE LOOP

Reporting and verification

BEFORE THE YEAR

Monitoring plan

Sources, streams, formulas, tiers, instruments and procedures — approved by the competent authority. The diagram on slide 4 is part of it.

ALL YEAR

Data collection

Weighing, sampling, lab analyses, meter readings — with data-flow and control procedures, and records kept for 10 years.

BY 31 MARCH

Verified report

The annual emissions report is checked by an accredited independent verifier before submission.

BY 30 SEPTEMBER

Surrender

One allowance per verified tonne —
≈ 543,000 for Cement Plant X —
surrendered in the Union Registry.

Beyond the EU

The same building blocks — boundary, streams, tiers, verification — are the template for any emissions trading system, from monitoring plan to surrendered allowance.



DAY 3

Agenda for the day

1

Introduction: cement & lime in the EU ETS and CBAM

2

The process & how emissions are counted (MRV)

3

EU ETS benchmarks & the benchmark curve (clinker · white clinker · lime)

4

System boundaries, emission calculation and monitoring plan - Clinker plant example

5

Lime plant example: Monitoring emissions and free allocation

6

Conclusions and last considerations

Case study



Monitoring emissions and free allocation in lime production

How a real EU lime installation accounts for its CO₂ under the Monitoring & Reporting Regulation — and how its free allocation is calculated under the Free Allocation Rules.

“LimeCo” — anonymised installation

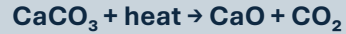
All values rounded

MRR 2018/2066 · FAR 2019/331



CASE STUDY (LIME) · THE INSTALLATION

A lime plant at a glance



≈ 0.79 t CO₂ per t CaO from the stone alone

EU ETS INSTALLATION BOUNDARY — “PRODUCTION OF LIME” · CAPACITY ≈ 1,100 T/DAY

Limestone & dolomite
from quarry · weighbridge S1

Biomass wood dust · CM3
main kiln fuel · weighbridge S1

Natural gas · CM2
pre-heat burners · gas meter S2

CO₂ ↑ stacks EP1–EP3 (process + combustion)



3 vertical shaft kilns

emission sources F1 · F2 · F3 — ≈ 56 MWth
calcination at ≈ 900–1,100 °C



Quicklime (CaO) · CM1
silos S5 · weighbridges S7/S8

Dolime (CaO·MgO) · CM5
same instruments

Dispatch to customers
steel · construction · chemicals

Minor on-site sources: emergency diesel genset F5 (CM4) ·
office boiler F7

OUTSIDE the boundary — 2 gas CHP engines (F4/F6)

operated by another company — their fuel and CO₂ are monitored by that operator, never by LimeCo

OUTSIDE the EU ETS — premixed-mortar plant on the same site

consumes lime and CHP heat, but is not an Annex I activity



Monitoring & reporting emissions

Regulation (EU) 2018/2066 — the Monitoring & Reporting Regulation (MRR): the compliance cycle seen from the operator's side.





CASE STUDY (LIME) · PART 1 — MRR

System boundaries and emission sources

The installation

Annex I activity “production of lime, or calcination of dolomite/magnesite” (> 50 t/day), plus all directly associated on-site activities — monitored under an approved monitoring plan.

Category B installation — Art. 19(2)

Average verified emissions 50,000–500,000 t CO₂e/yr (LimeCo ≈ 199,000 t). The category drives the minimum tiers required.

One source, one operator

Each emission source is monitored inside exactly one installation boundary. That rule — not any later correction — is what prevents double counting.

SOURCE	EMISSION POINT	STATUS
F1–F3 Calcination kilns	EP1–EP3 kiln stacks	Included — the plant’s emissions
F5 Emergency diesel genset	EP4 genset stack	Included — de minimis
F7 Office-heating boiler	shared gas metering	Included — de minimis
Premixed-mortar plant	—	Excluded — not an Annex I activity

Source: anonymised real EU lime plant; MRR (EU) 2018/2066 Arts. 19–20; GD1 §4.

CASE STUDY (LIME) · PART 1 — MRR

Source streams and monitoring approaches

Calculation-based methodology throughout (Art. 21) — no continuous measurement. Every fuel and material that causes emissions is a source stream with its own tiers.

STREAM	METHOD (ART. 24)	CATEGORY (ART. 19(3))	ACTIVITY DATA	CALCULATION FACTORS
CM1 Quicklime	Process — Method B (oxide output)	Major	Tier 2 $\pm 2.5\%$ required · $\pm 0.1\%$ achieved (weighbridges)	EF: monthly lab analyses of free CaO/MgO · CF = 1
CM5 Dolime	Process — Method B (oxide output)	Major	Tier 2 $\pm 2.5\%$ required · same instruments	EF: monthly lab analyses · CF = 1
CM3 Biomass wood dust	Combustion — standard method	Zero-rated (100% biomass)	Weighbridge, no tier obligation	Type I standard values · RED II sustainability evidence
CM2 Natural gas	Combustion — standard method	De minimis	Turbine meter + volume converter · conservative estimate allowed	NCV/EF Type II values from national GHG inventory
CM4 Diesel (genset)	Combustion — standard method	De minimis	Invoices / delivery records	Commercial standard-fuel values

Categories scale the effort: minor streams < 5,000 t CO₂/yr (or < 10% up to 100,000 t) · de minimis < 1,000 t CO₂/yr (or < 2% up to 20,000 t) — both may use lower tiers and estimation methods outside the tier system.

Source: monitoring plan (anonymised real EU lime plant); MRR Arts. 19, 21, 24.



CASE STUDY (LIME) · DOC 2 — MONITORING PLAN

What the monitoring plan fixes for each source stream

Per source stream, the MP fixes:

- Monitoring approach — calculation-based
- Activity data: bridge weigher (S1/S7/S8), gas meter (S2/S6), silo level (S5)
- Emission factor, NCV, biomass fraction — and the TIER for each
- Lime process: Method B (oxide output), EF from lab analysis
- Wood biomass: biomass fraction 99% → CO₂ zero-rated

Why it matters

- The MP is approved by the competent authority
- It is the contract: the AER must follow it, and the verifier checks against it
- A national ETS needs the same: an approved plan per installation

Source: monitoring plan (anonymised real EU lime plant); MRR (EU) 2018/2066; GD9 §12.



CASE STUDY (LIME) · PART 1 — MRR

Process emissions from calcination

METHOD B — ART. 24(2), ANNEX IV §9

$$E_m = AD \times EF \times CF$$

AD — tonnes of oxide produced (quicklime or dolime)

EF — stoichiometric factor from the product's composition

CF — conversion factor = 1 (all oxide assumed from carbonate)

EMISSION FACTOR — ANNEX II §4

$$EF = 0.785 \times m(\text{CaO}) + 1.092 \times m(\text{MgO}) \quad [\text{t CO}_2/\text{t}]$$

The ratios 44/56.1 and 44/40.3 are the molar masses of CO₂ over CaO and MgO.

Free CaO and MgO contents come from monthly laboratory analyses — Arts. 32–35: EN standards, accredited laboratory, approved sampling plan.

EXAMPLE — ONE MONTH OF QUICKLIME

$$m \text{ CaO} = 84.0\% \quad \cdot \quad m \text{ MgO} = 0.8\%$$

$$EF = 0.785 \times 0.840 + 1.092 \times 0.008$$

$$EF \approx 0.67 \text{ t CO}_2 / \text{t lime}$$

WHY METHOD B, NOT METHOD A?

Method A weighs the carbonate input; Method B weighs the oxide output.

LimeCo already weighs every tonne of product for sale — the ±2.5% tier is met with ±0.1%.

Variable stone quality makes input-side carbonate analysis harder, and kiln dust would need a separate correction under Method A.

Source: MRR Art. 24(2), Annex II §4 & Annex IV §9; monthly laboratory certificates (anonymised).



CASE STUDY (LIME) · PART 1 — MRR

Combustion emissions from kiln fuels

STANDARD METHOD — ART. 24(1)

$$Em = FQ \times NCV \times EF \times OF$$

fuel quantity × net calorific value × emission factor × oxidation factor

NATURAL GAS CM2 — PRE-HEAT BURNERS

FQ (turbine meter)	200 × 1000 Nm ³
NCV (Type II, national inventory)	36.6 GJ / 1000 Nm ³
EF (Type II)	56.8 t CO ₂ / TJ
OF	100%
Emissions	≈ 420 t CO₂

BIOMASS WOOD DUST CM3 — MAIN KILN FUEL

FQ (weighbridge)	62,000 t
NCV	15.6 GJ/t → ≈ 970 TJ
Biomass fraction (Arts. 38–39)	99%
Biogenic CO ₂ (memo item)	≈ 108,000 t
Emissions counted	1,080 t CO₂

Zero-rating is conditional: the biomass must meet the RED II sustainability and GHG-saving criteria, with evidence kept for verification — otherwise the preliminary EF (≈ 112 t CO₂/TJ for wood) applies in full.



CASE STUDY (LIME) · PART 1 — MRR

Worked example — annual emissions

SOURCE STREAM	ACTIVITY DATA	CALCULATION	FOSSIL CO ₂ [t]
CM1 Quicklime (process)	230,000 t	$\times 0.67 \text{ t CO}_2/\text{t} \times 1$	154,100
CM5 Dolime (process)	55,000 t	$\times 0.81 \text{ t CO}_2/\text{t} \times 1$	44,550
CM2 Natural gas (combustion)	200 kNm ³	$\times 36.6 \text{ GJ/kNm}^3 \times 56.8 \text{ t/TJ}$	420
CM4 Diesel (combustion)	< 1 t	standard values	≈ 0
CM3 Biomass wood dust	62,000 t	99% biomass → zero-rated	1,080 (106,920 is biogenic)
Total reportable emissions			≈ 200,080

99.8% of fossil CO₂ is process CO₂

Because the kilns burn biomass, virtually all counted emissions come from the stone — a lime-sector signature.

Verified report by 31 March

Annual emissions report checked by an accredited verifier; allowances surrendered by 30 September.

Source: annual emissions report (anonymised real EU lime plant), values rounded; MRR 2018/2066; AVR 2018/2067.



Free allocation

Delegated Regulation (EU) 2019/331 (FAR) · benchmark values Reg. 2021/447 · activity-level changes Reg. 2019/1842.





WORKED CALCULATION

Free-allocation formula and the CBAM factor

$$F_{p,k} = BM_p \times HAL_p \times CLEF_{p,k} \times CBAM_{p,k}$$

- BM = benchmark value · HAL = median historical activity level (t clinker or t lime)
- CLEF = 1 (100%) for cement & lime — both on the carbon-leakage list
- CBAM factor: clinker phases out (97.5% in 2026 ... 0% in 2034)
- CBAM factor for LIME = 1 (not a CBAM good) → lime free allocation does NOT phase out

Sources: GD9 free-allocation section; Directive 2003/87/EC Art. 10a; GD9 §10–12 (CBAM scope).



CASE STUDY (LIME) · PART 2 — FAR

Sub-installations and the lime product benchmark

Sub-installation 1 — product benchmark “lime”

Kilns’ share for quicklime: process CO₂, all kiln fuels, ancillaries. Carbon-leakage exposed.

Sub-installation 2 — product benchmark “dolime”

Kilns’ share for dolime, split by campaign production records. Carbon-leakage exposed.

No fallback sub-installations

A product benchmark covers all direct emissions inside its boundary (“all processes directly or indirectly linked”) — so no heat or fuel benchmark may overlap it. FAR Art. 10: the sub-installations’ sum must never exceed the installation’s totals.

BENCHMARK VALUES — EUA / T STANDARD PURE

	Lime	Dolime
2013 starting point (Annex I)	0.954	1.072
2021–2025 (Reg. 2021/447, max –24%)	0.725	0.815
2026–2030 (proposed May 2026)	0.693	0.792

“STANDARD PURE” PRODUCT — FAR ANNEX I

Lime: tonnes with free CaO content of 94.5%.

Dolime: tonnes with 57.4% CaO + 38.0% MgO.

Real production is converted to this quality — plants making lower-purity lime are not over-allocated per raw tonne.

Source: FAR (EU) 2019/331 Arts. 10–11 & Annex I; Reg. (EU) 2021/447; GD9 §12.



CASE STUDY (LIME) · PART 2 — FAR

Historical activity level and standard purity

HAL — FAR ART. 15(3)

The median annual activity level over the baseline period — 2014–2018 for the 2021–2025 allocation, 2019–2023 for 2026–2030 — reported in the verified baseline data report (NIMs).

CONVERSION TO STANDARD PURE — ANNEX III §2

$$\text{HAL std} = \text{HAL uncorr} \times (0.7848 \cdot m \text{ CaO} + 1.0920 \cdot m \text{ MgO}) / 75.28$$

$m \text{ CaO}$, $m \text{ MgO}$ in mass-% per baseline year · dolime uses the same form with denominator 86.55. The plant's tonnes are re-expressed at the CO_2 intensity of the standard product.

No composition data? Conservative defaults apply — lime $\leq 85\% \text{ CaO} / 0.5\% \text{ MgO}$; dolime $\leq 52\% \text{ CaO} / 33\% \text{ MgO}$ — always to the operator's disadvantage.

EXAMPLE — LIMECO QUICKLIME

HAL uncorr = 225,000 t

$m \text{ CaO} = 84\%$ · $m \text{ MgO} = 1\%$

factor = $(0.7848 \times 84 + 1.092 \times 1) / 75.28 = 0.890$

HAL std $\approx$ 200,000 t standard pure lime

225,000 physical tonnes count as 200,000 benchmark tonnes — the plant's lime is less pure than the 94.5% reference.

One measurement system, two regimes

Composition comes from the same monthly lab analyses already used for the MRR emission factor.

Source: FAR (EU) 2019/331 Art. 15(3), Annex III §2; GD2 §6; GD9 §12.



CASE STUDY (LIME) · PART 2 — FAR

Preliminary allocation

$$F_{\text{prelim}} = BM \times HAL \times CLEF$$

per sub-installation, per year (FAR Art. 16) · CLEF = carbon-leakage exposure factor: 1.00 for CL-exposed products like lime and dolime; 30% → 0% during 2026–2030 for others

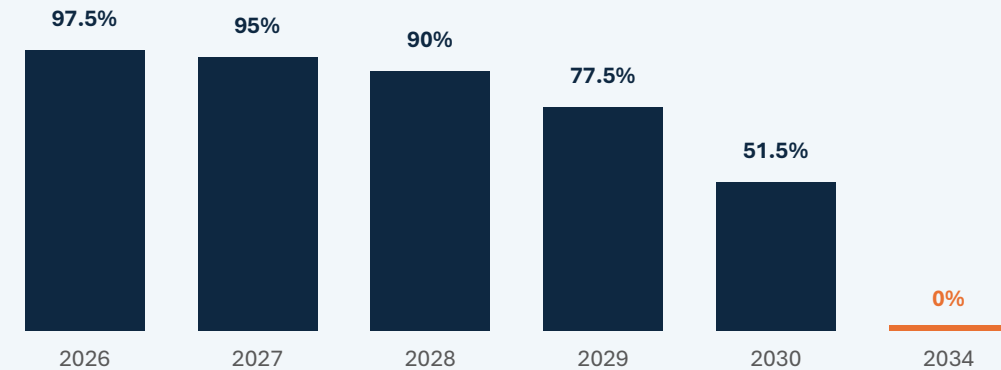
FROM PRELIMINARY TO FINAL

All EU sub-installations are summed; if the total exceeds the free-allocation cap, a cross-sectoral correction factor scales everything down (not triggered in 2021–2025).

Deductions apply for measurable heat imported from non-ETS suppliers (FAR Art. 21).

Full conditionality: energy-audit recommendations must be implemented, or allocation is cut by 20% (from 2024).

CBAM GOODS PHASE OUT — LIME DOES NOT



The CBAM factor multiplies the allocation of CBAM goods (clinker, cement). Lime is not in CBAM Annex I — its factor stays 1, so lime allocation does not phase out.

Source: FAR Art. 16; Directive 2003/87/EC Art. 10a(1a); CBAM Reg. (EU) 2023/956 Annex I; GD9 §12.



CASE STUDY (LIME) · PART 2 — ALC, REG. 2019/1842

Annual activity levels and adjustments

1 · Report every year

Verified activity-level report (ALC) for each sub-installation, submitted with the annual cycle (typically by 31 March).

2 · Compare the 2-year average with HAL

Average activity of the two preceding years vs. the sub-installation's HAL. Within $\pm 15\%$: allocation unchanged.

3 · Beyond $\pm 15\%$: recalculate

Allocation is recalculated with the average activity level in place of HAL — upwards or downwards, symmetrically. Each further move of 5% triggers a new adjustment.

Why it matters

No windfall profits when production falls, no penalty for growth — allocation tracks reality with a stability band.

Source: Implementing Reg. (EU) 2019/1842 Arts. 3–5; FAR Art. 16; GD2 §7.

LIMECO LIME SUB-INSTALLATION — HAL STD = 200,000 T

+15% — 230,000 t

HAL = 200,000 t

–15% — 170,000 t

avg 177,500 t (–11%) → allocation kept

avg 160,000 t (–20%) → recalculated:
 $160,000 \times 0.725 = 116,000$ EUA



CASE STUDY (LIME) · PART 2 — FAR

Worked example — free allocation

SUB-INSTALLATION	HAL UNCORRECTED	AVG. COMPOSITION	HAL STANDARD PURE	BM 2021–25	PRELIMINARY EUA / YR
Lime (CL-exposed)	225,000 t	84% CaO · 1% MgO	200,000 t	0.725	145,000
Dolime (CL-exposed)	55,000 t	55% CaO · 36% MgO	52,400 t	0.815	42,700
Total preliminary allocation (CLEF = 1.00)					≈ 187,700

Coverage ≈ 94%

187,700 EUA against ≈ 199,000 t of verified fossil CO₂.
The gap (≈ 11,000 EUA/yr) must be bought — the price signal survives even with full carbon-leakage protection.

Outlook 2026–2030

New baseline (2019–2023) and the proposed lime BM 0.693: $200,000 \times 0.693 \approx 138,600$ EUA/yr. No CBAM factor applies — lime is not a CBAM good.

Biomass is not rewarded twice

Allocation follows the product, not the fuel. LimeCo's biomass switch lowers its emissions, so more of its allocation is surplus — that is the incentive working.

Source: anonymised real EU lime plant; FAR 2019/331; Reg. 2021/447; GD9 §12.



CASE STUDY (LIME) — WHAT THE EXAMPLE SHOWS

Five takeaways from the lime worked example

- One verified chain: Schema → Monitoring Plan → AER → ALC — primary data to allocation
- Lime is $\approx 99.6\%$ process (calcination) — because of biomass used on the plant
- Kilns fired mostly on wood biomass → only ≈ 650 t fossil combustion
- Lime EF ≈ 0.72 t CO₂/t — essentially at the 0.725 (2019 – 2005) benchmark (near the 10% best)
- Lime keeps full free allocation (not a CBAM good) — unlike clinker's phase-out

For a national / Türkiye ETS: lime needs the same product-benchmark and verified-data approach, but sits outside CBAM — design its allocation separately from CBAM goods.

Source: anonymised real EU lime plant; FAR 2019/331; GD9 §12; MRR 2018/2066; AVR 2018/2067.



DAY 3

Agenda for the day

1

Introduction: cement & lime in the EU ETS and CBAM

2

The process & how emissions are counted (MRV)

3

EU ETS benchmarks & the benchmark curve (clinker · white clinker · lime)

4

System boundaries, emission calculation and monitoring plan - Clinker plant example

5

Lime plant example: Monitoring emissions and free allocation

6

Conclusions and last considerations

Case study



CASE STUDY (LIME) · SUMMARY

Key points for ETS design

1

Capture process CO₂

Lime CO₂ is mostly process CO₂ from the stone — monitoring rules must cover carbonates and oxides (Methods A/B), not only fuels.

2

Scale the effort with tiers

Tight uncertainty and lab analyses for major streams; simplifications for minor and de-minimis ones.

3

Draw boundaries once, cleanly

One source, one operator; sub-metering settles shared sites; product benchmarks cover all direct emissions, so fallbacks cannot overlap.

4

Benchmark the product, corrected for quality

The “standard pure” conversion makes one EUA/t value fair across plants of different purity.

5

Keep allocation dynamic

Annual activity-level reports with a ±15% band and 5% steps track reality without constant recalculation — and one measurement system (weighbridges + monthly analyses) feeds both emissions monitoring and allocation.

Source: anonymised real EU lime plant; MRR 2018/2066; FAR 2019/331; AVR 2018/2067; GD9 §12.



WORKED CALCULATION

Allocation and the CBAM factor — clinker vs lime

Sub-installation	2025 (CBAM 100%)	2026 (×97.5%)	2030 (×51.5%)
Grey clinker (×0.693)	485,100	472,973	249,827
Lime (×0.725) — not CBAM	217,500	217,500	217,500
Total	702,600	690,473	467,327

Read it: clinker free allocation roughly halves by 2030 and ends in 2034; lime stays flat at 217,500 EUA because its CBAM factor is 1. The plant's CBAM exposure is entirely on the clinker.

CBAM factor: Directive 2003/87/EC Art. 10a. Lime out of CBAM scope: GD9 S12. Arithmetic by the trainer.

WORKED CALCULATION**The CBAM side — clinker default values**

CBAM good	CN code	CBAM benchmark (col A & B)
Grey cement clinker	2523 10 00 (grey)	0.666 t CO ₂ e/t
White cement clinker	2523 10 00 (white)	0.859 t CO ₂ e/t
Cement (grey)	2523 29 00	via clinker content (precursor)
Lime	—	not a CBAM good

Note: for clinker the CBAM column A (free-allocation) and column B (default) values are equal — intensities are uniform. Finished cement carries the embedded emissions of its clinker content. The importer's CBAM bill $\approx$ embedded intensity $\times$ EU ETS price, net of the (declining) free-allocation factor.

Source: CBAM Reg 2025/2620 Annex (cement: 2507 00 80, 2523 ...). [CBAM/]



WORKED CALCULATION

Results & the read-across to Türkiye

On the EU side

- Clinker free allocation could halve by 2030
- Lime keeps full free allocation (not a CBAM good)
- CBAM default $\approx$ EU ETS benchmark for clinker

For Türkiye (imports)

- Cement is the most CBAM-exposed sector ($\approx$ 4.1% of export value)
- Little room to beat the benchmark — process emissions are structural
- A domestic carbon price would keep revenue at home

Because clinker intensities are uniform and mostly process-based, importers have limited ability to undercut the benchmark — so CBAM cost is hard to avoid without a domestic carbon price or clinker substitution.



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CLOSE

Cement and lime – Day 3

Questions and discussion · Next: Day 4 — aluminium

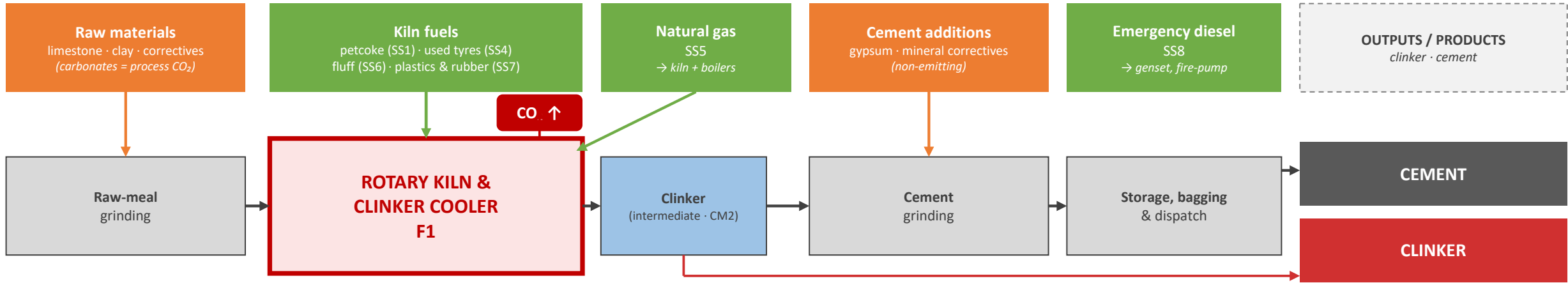
Primary sources cited in this storyboard

- EU ETS Directive 2003/87/EC (consolidated 01.03.2024) — Art. 10a [ETS/]
- Free Allocation Regulation (EU) 2019/331 (cons. 01.01.2024) — Annex I, Annex IV [ETS/]
- Free Allocation Guidance GD9 — sector-specific guidance, iron & steel §2-7 [ETS/]
- Supporting guidance: GD3, GD4, GD5, GD6, GD8 [ETS/]
- CBAM Implementing Reg (EU) 2025/2620 — benchmark Annex (codes C-J; DRI; pig iron; iron ore) [CBAM/]
- CBAM Reg (EU) 2023/956 and 2025/2621 (default values) [CBAM/]
- Accreditation & Verification Reg (EU) 2018/2067 (AVR) [MRV/]
- Continuity reference: Presentations 2024 / Day 3



INPUTS

CASE STUDY — A REAL GREY-CLINKER PLANT



Auxiliary combustion units — minor CO₂ (fuel combustion only) · boilers F2–F5 fed by natural gas (SS5) · emergency units F6–F7 fed by diesel (SS8)



Where is CO₂ released?

Rotary kiln (F1) — the main source:

- Process CO₂ — decarbonation of raw meal ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$)
- Combustion of fossil & alternative fuels (petcoke, tyres, fluff, plastics, gas)
- Biomass fraction of alternative fuels — monitored, zero-rated under ETS

Boilers F2–F5 & emergency units F6–F7 — minor CO₂ from fuel combustion only.

Legend

Source streams (SSx): CM1 petcoke · SS2 clinker/cement · SS3 raw meal (non-carbonate C) · SS4 tyres
SS5 natural gas · SS6 fluff · SS7 plastics & rubber · SS8 emergency diesel

■ red box = ETS emission source (CO₂ released here)

■ green = fuel / combustion stream ■ orange = raw material

■ grey = process step ■ blue = intermediate → flow