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REPUBLIC OF TÜRKİYE
MINISTRY OF ENVIRONMENT,
URBANIZATION AND CLIMATE CHANGE

Advancing ETS Readiness in Türkiye – Technical work on ETS benchmarks

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

Fallback BM & curves
Process emissions & waste gases
Biofuels

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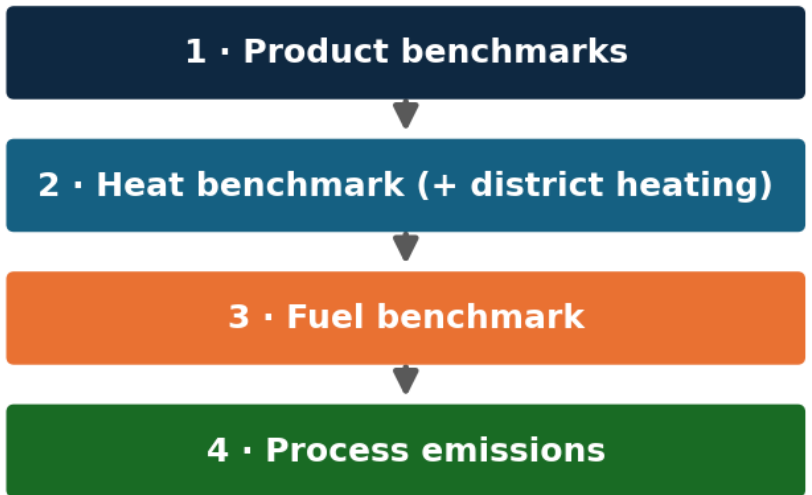
Agenda

- 1 Fallbacks in the allocation logic — the four sub-installation types
- 2 Heat benchmark — measurable heat, boundaries, formula and curve
- 3 Fuel benchmark — non-measurable heat, value and curve
- 4 Process emissions and waste gases
- 5 Heat recovery and complex mixed-energy sites
- 6 Benchmark curves — construction, phase 3→4 update, key parameters
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Where fallbacks sit in the allocation logic

Step 1	Product benchmark sub-installations — first
Step 2	Remaining measurable heat → heat benchmark
Step 3	Remaining non-measurable heat → fuel benchmark
Step 4	Qualifying process emissions → process approach
Rule	Every eligible emission assigned once

Assign each emission once — in order



No overlap · no gaps



The four sub-installation types

Product BM Defined product in FAR Annex I (output-based)

Heat BM Measurable heat not under a product BM

Fuel BM Non-measurable heat not under a product BM

Process Specific process CO₂/non-CO₂ (historical)

District heat Measurable heat to district heating

Product benchmark

defined product (output-based)

Heat benchmark

measurable heat (input-based)

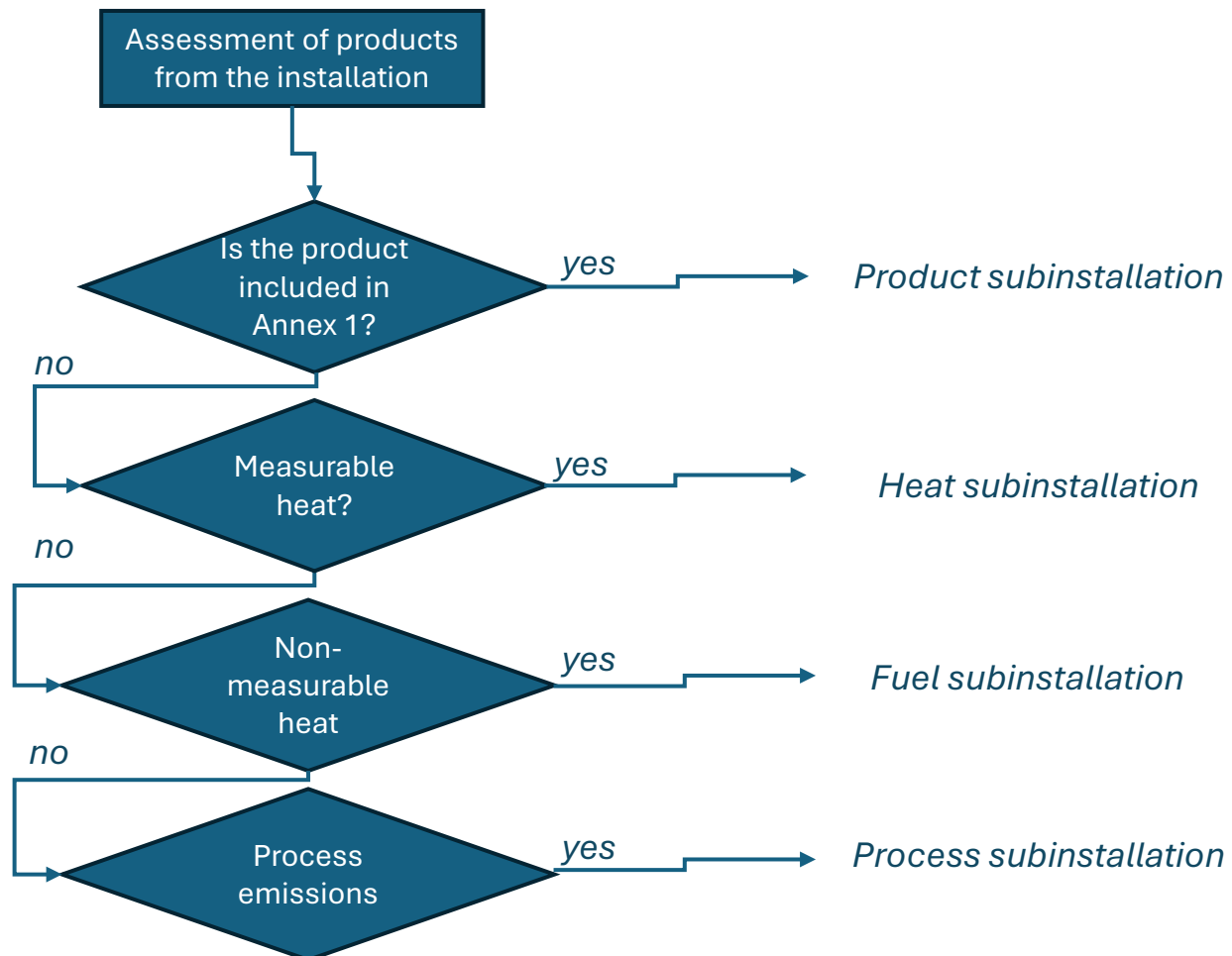
Fuel benchmark

on-measurable heat (input-based)

Process emissions

historical-based

Decision tree



Example from cement sector



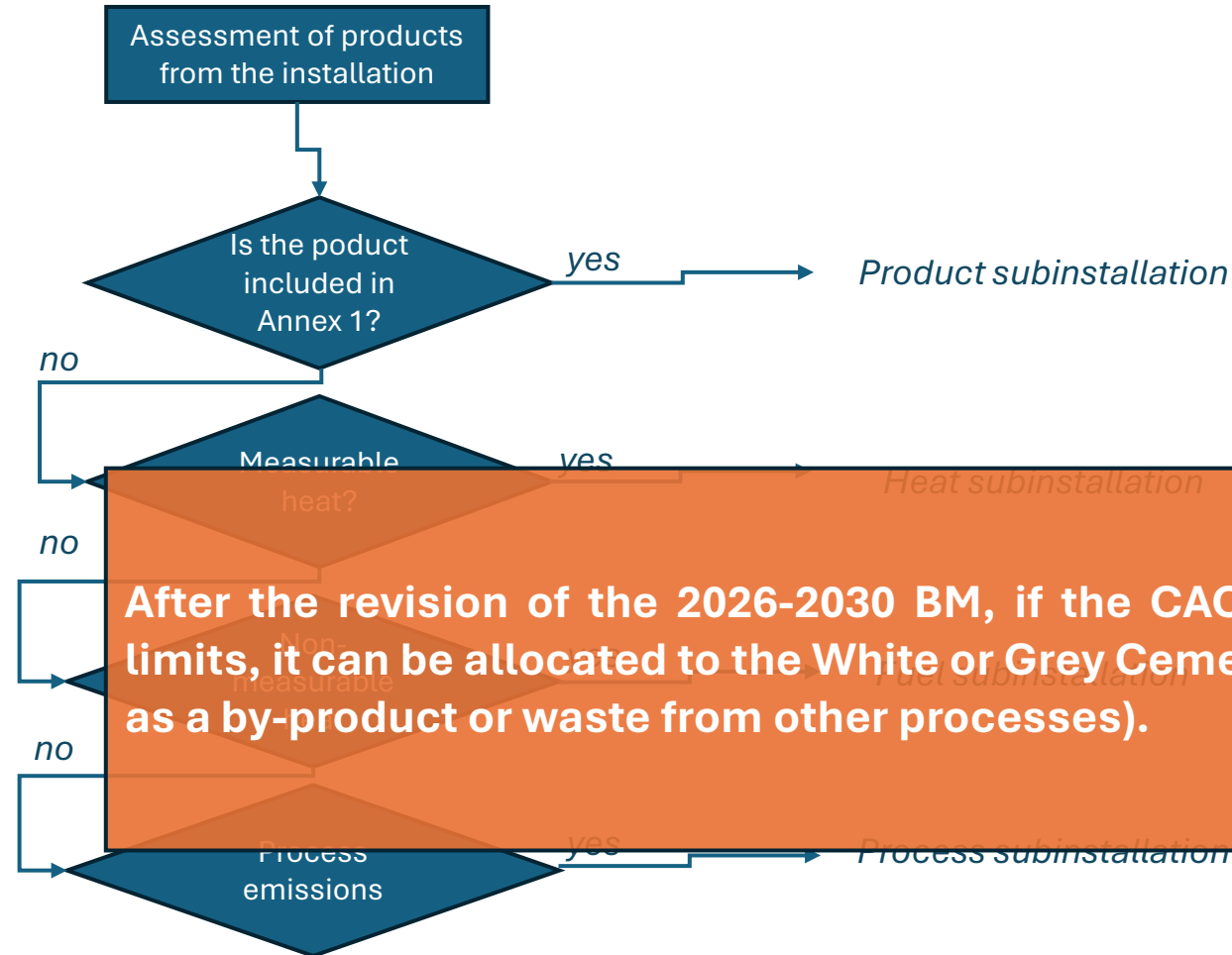
Grey clinker subinstallation
White clinker subinstallation

Fuel subinstallation

Process subinstallation

CAC clinker

Decision tree



Example from cement sector



Grey clinker subinstallation
White clinker subinstallation

After the revision of the 2026-2030 BM, if the CAC clinker produced meets the required chemical limits, it can be allocated to the White or Grey Cement Clinker Product sub-unit (unless it is classified as a by-product or waste from other processes).



Sub-installations vs physical units

Key idea An accounting object, not a physical one

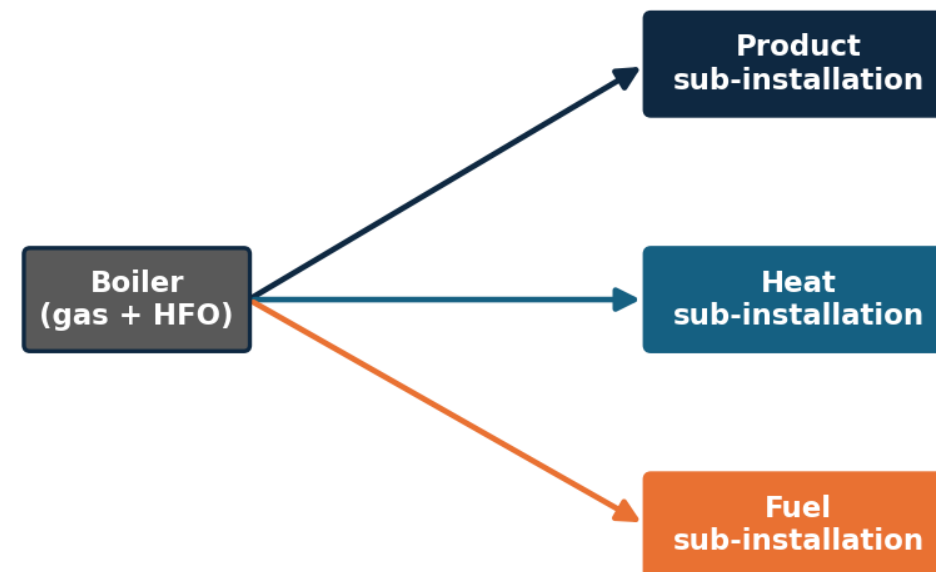
One unit Can belong to several sub-installations

One sub-install. Can contain several units / source streams

Over time Assignment can change across years

Example A boiler fired by gas and heavy fuel oil

One physical unit → several sub-installations





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Heat benchmark and measurable heat

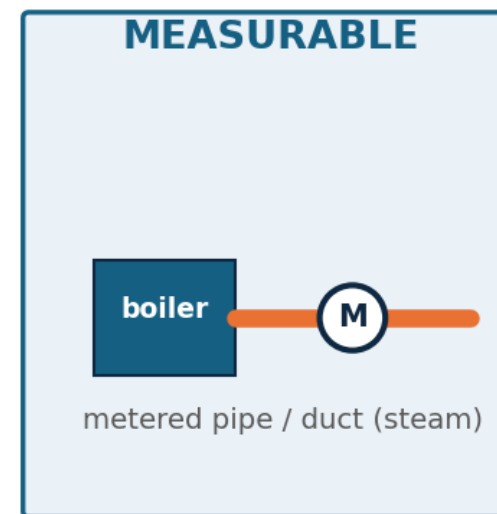
Measurable Net heat flow through identifiable pipes/ducts

Medium Steam, hot air, water, oil, liquid metals, salts

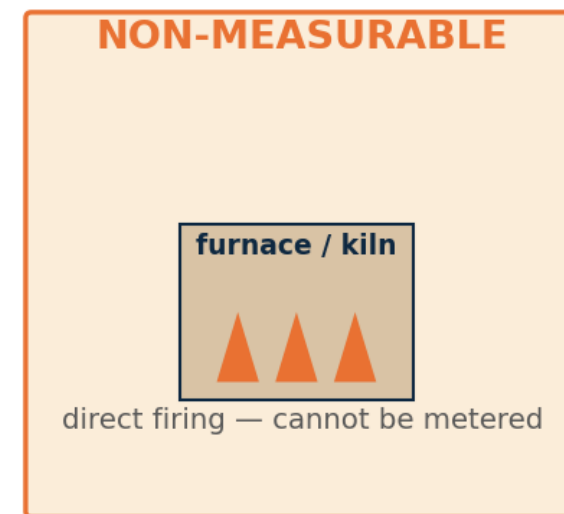
Test A heat meter is — or could be — installed

Non-measurable All other heat (e.g. direct firing in a furnace)

Why Decides heat benchmark vs fuel benchmark



→ **heat benchmark**



→ **fuel benchmark**

Heat benchmark sub-installation — definition & boundaries

Scope Measurable heat not covered by a product benchmark

Sources	Produced on site OR imported from an ETS installation
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Use (a)	Consumed for products, mechanical energy, heating/cooling
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Use (b)	Exported to a non-ETS entity (other than district heating)
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Excluded Heat used to produce electricity

Heat benchmark — the allocation formula

$$F = \text{BMheat} \times \text{HAL} \times \text{CLEF} \times \text{CBAM-factor}$$

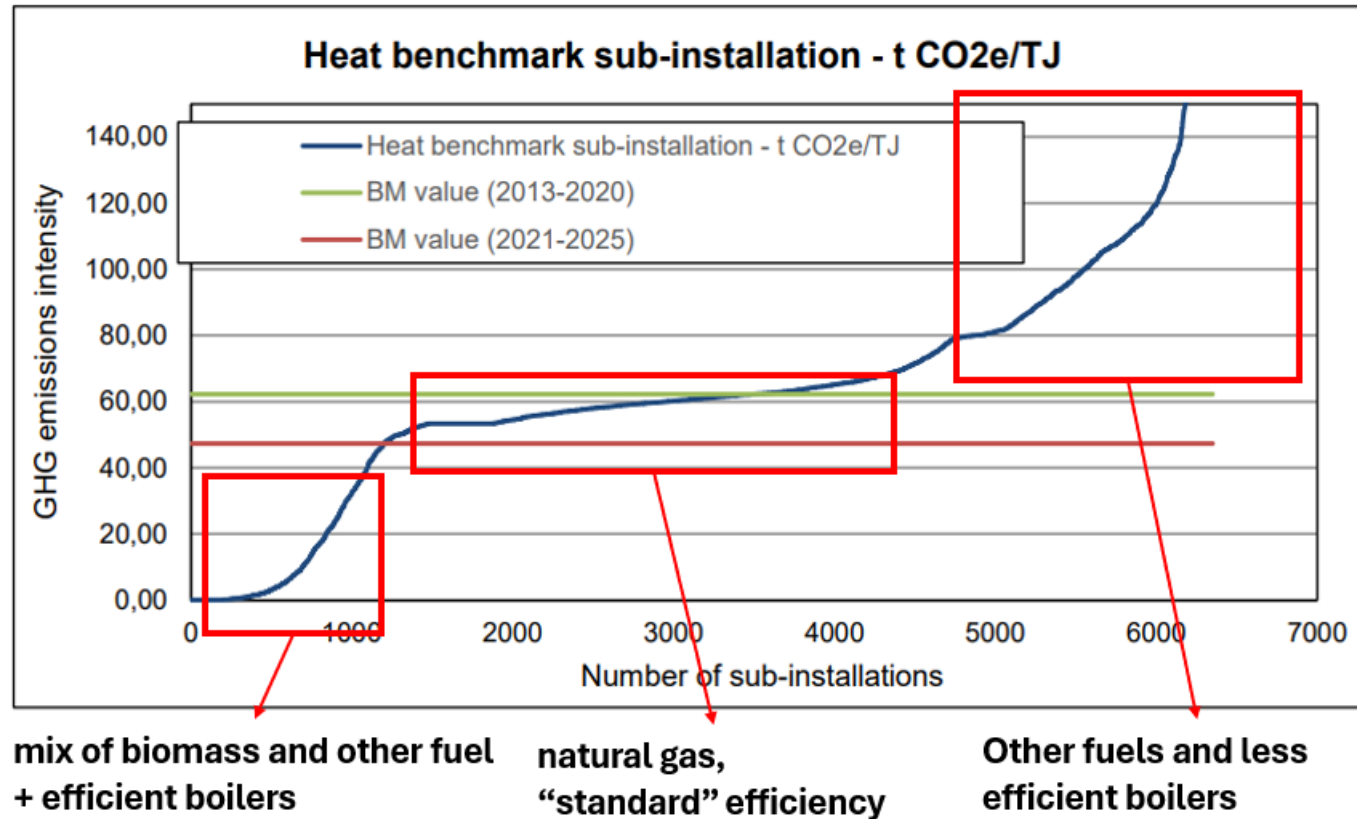
BMheat Heat benchmark value (t CO₂e/TJ → EUAs/TJ)

HAL	Historical activity level = median net eligible heat (TJ/yr)
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CLEF	Carbon-leakage exposure factor for the sub-installation
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CBAM-factor	Applied where the heat serves CBAM goods (from 2026)
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Heat benchmark value and curve



2021–2025	47.3 t CO ₂ e/TJ
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Phase 3	62.3 → –24% (cap)
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10%-best	1.6 t CO ₂ e/TJ
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Reference	gas, 90% boiler eff.
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Coverage	~6,619 sub-install.
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EU heat-benchmark curve (factsheet p.60): phase-3 62.3 → phase-4 47.3 t CO₂e/TJ.

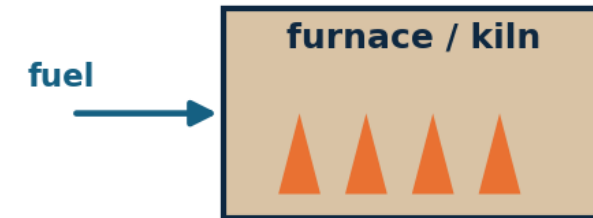


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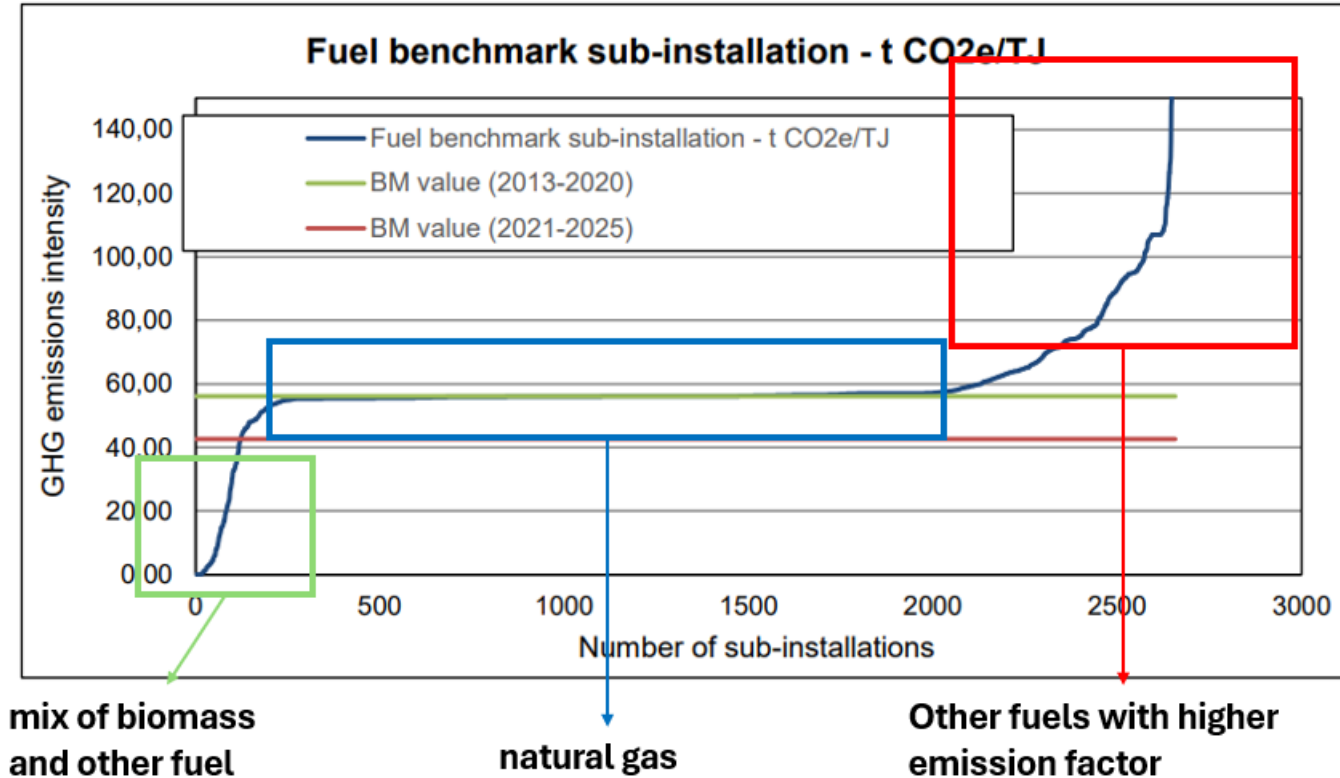
Fuel benchmark sub-installation — non-measurable heat

Scope	Non-measurable heat not under a product benchmark
Source	Fuel combustion (or electricity) to make heat
Use	Consumed for eligible purposes (not electricity)
Includes	Safety flaring
Role	Broadest catch-all for combustion emissions



Non-measurable heat → fuel benchmark (+ safety flaring)

Fuel benchmark value and curve



EU fuel-benchmark curve (factsheet p.61): phase-3 56.1 → phase-4 42.6 t CO₂e/TJ.

2021–2025

42.6 t CO₂e/TJ

Phase 3

56.1 → -24% (cap)

10%-best

34.3 t CO₂e/TJ

Reference

56.1 = natural gas EF

Coverage

~2,789 sub-install.



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Interactive Q&A – Part 1



➡ <https://partici.fi/23503622>

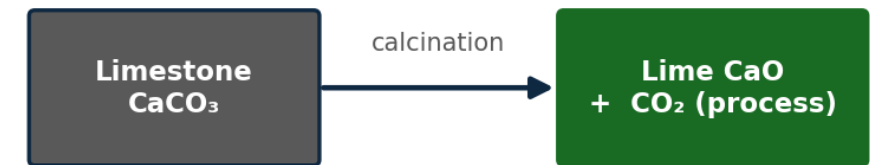


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Process-emissions sub-installation — definition

What	CO ₂ /non-CO ₂ from a reaction, outside a product BM
(a)(b)	Metal-compound reduction; impurity removal
(c)(d)	Carbonate decomposition; carbon-bearing synthesis
(e)(f)	Carbon additives; metalloid/non-metal oxide reduction
Waste gas	Included, minus a natural-gas energy equivalent



Stoichiometric CO₂, not from heat → historical-based allocation (0.97)



Process-emissions allocation and waste gases

Formula $0.97 \times \text{historical process emissions} \times \text{CLEF} \times \text{CBAM-factor}$

Basis	Historical emissions — no benchmark curve
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Weight $\approx 1\%$ of total industrial ETS emissions

Waste-gas split	Energy via fuel/heat BM; only the surplus here
------------------------	--

Coverage ~ 995 process-emissions sub-installations

Process emissions — what they are

Definition GHG emissions OUTSIDE any product-benchmark boundary, as a direct result of a listed reaction (FAR Art. 2(10))

Not from heat	They come from the chemistry of the process, not from burning fuel to make heat
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Type a Non-CO₂ gases (e.g. N₂O) from specific activities

Type b	CO ₂ released directly by the reaction, straight to the atmosphere
---------------	---

Type c CO₂ from later burning a waste gas (only the surplus above natural gas)

From the reaction — not from heat



CO₂ / N₂O released by the chemistry itself,
outside any product-benchmark boundary

Process emissions — the six qualifying processes

(a) Reduction of metal compounds in ores/concentrates - e.g. iron ore to iron

(b) Removal of impurities from metals and metal compounds

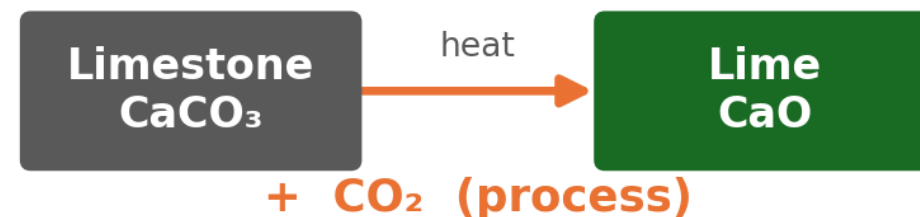
(c) Decomposition of carbonates - e.g. limestone to lime (cement, lime)

(d) Chemical syntheses where carbon-bearing material takes part in the reaction

(e) Use of carbon-containing additives or raw materials

(f) Reduction of metalloid / non-metal oxides - e.g. silica, phosphates

Example: making lime



The CO_2 comes out of the rock, not from the flame

Process emissions — how they are allocated

No benchmark curve

There is no 'efficient performer' to compare against - the CO₂ is fixed by chemistry

Historical-based

Allocation = median historical process emissions x a reduction factor

Reduction factor

0.97 until end-2027, then 0.91 from 2028 (FAR Art. 16(2)(e))

x CLEF

Adjusted by the Carbon Leakage Exposure Factor of the sub-installation

x CBAM factor

Reduced where the goods are within CBAM scope (from 2026)

Order of magnitude

About 1% of total industrial ETS emissions; ~995 sub-installations (EU)

Waste gases — definition and scope

Definition	Gas with incompletely oxidised carbon, gaseous at standard conditions, from a listed process (FAR Art. 2(11))
3 conditions	(1) incompletely oxidised C > 1 wt%; (2) gaseous at standard conditions; (3) from an Art. 2(10) process
Energy test	Burns without auxiliary fuel, or adds significantly to energy when co-fired
Types a / b / c	a: non-CO ₂ (N ₂ O); b: direct process CO ₂ ; c: CO ₂ from burning the waste gas
Not a waste gas	~99% ethylene (no oxidised C) or ~99% pure CO ₂ (fully oxidised)

When is a gas a ‘waste gas’?



completely oxidised — no energy left → NOT a waste gas



incompletely oxidised — still holds energy → WASTE GAS

To qualify, all three must hold:

1. incompletely oxidised carbon > 1 wt %
2. gaseous at standard conditions
3. from a listed process (FAR Art. 2(10))

Waste gases — conditions for free allocation

Efficient use only

Allocation only if the waste gas is used for measurable heat, non-measurable heat or electricity

Flaring / open furnace

Non-safety flaring, or open-furnace burning without energy recovery, is treated as flaring - no free allocation

Safety flaring

Eligible (fuel benchmark) only if the waste gas is produced outside a product benchmark

Open furnace, no recovery

Unknown CO₂ content - 75% of the carbon is assumed converted to CO₂ - process-emissions sub-installation (Art. 10(5)(i))

Flaring of benchmarked WG

From 2026 the product-BM allocation is reduced by the flared waste-gas emissions (Art. 16(5))



Agenda

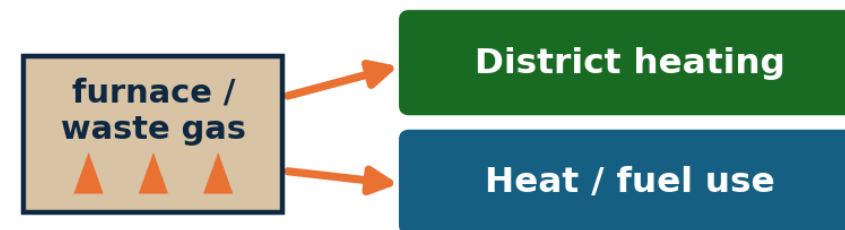
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Heat recovery under the ETS rules

Eligible in principle	Heat recovered from any process/unit (product, heat, fuel or process) is eligible for free allocation
Example	Furnace waste-gas heat feeding a district-heating network is eligible
Second product	Measurable heat recovered & exported from a product-BM sub-installation - deduction from its attributed emissions
Fall-back attribution	Recovered heat can sit in heat-BM / district-heating sub-installations if used for eligible purposes (not electricity)
Avoid double counting	Both activity levels count, but attributed emissions shift between sub-installations to keep the energy balance consistent
Exothermic heat	Recovered heat from exothermic reactions is eligible; emission factor usually 0 (emissions counted elsewhere)

Recovering heat from waste gas

recovered heat

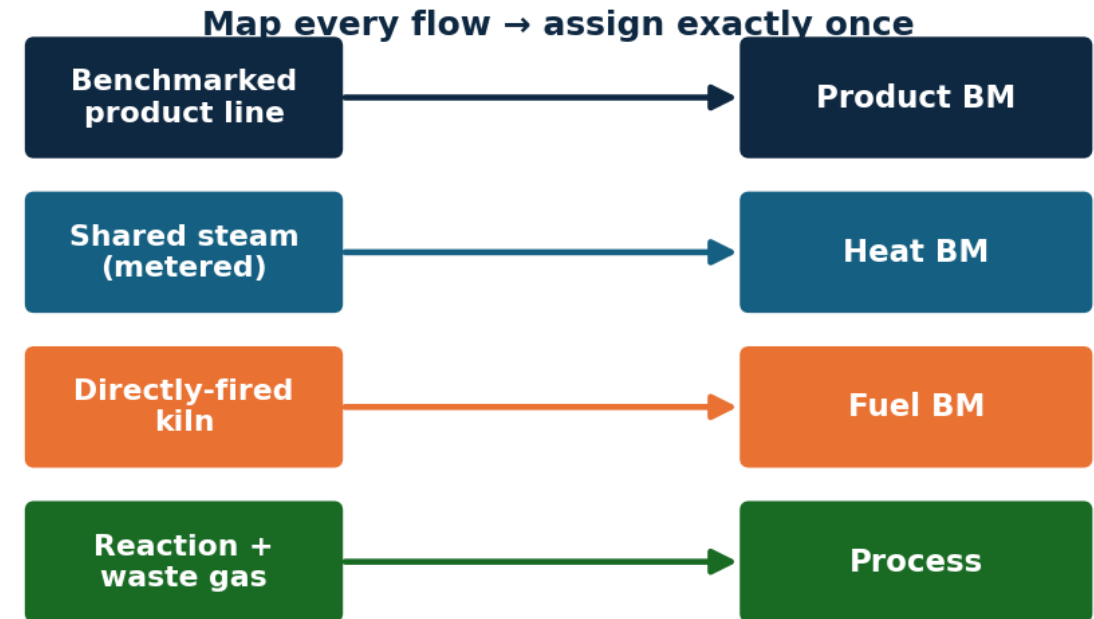


Exported from a product benchmark = ‘second product’

credit given · not for electricity · never counted twice

Complex sites with mixed energy inputs: assigning a mixed-energy site, step by step

- | | |
|---------------|--|
| Step 1 | Map outputs: product-benchmark vs not |
| Step 2 | Metered heat → heat BM; direct-fired → fuel BM |
| Step 3 | Carve out district-heating & electricity heat |
| Step 4 | Identify process emissions & waste-gas flows |
| Check | Every flow assigned exactly once |





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Interactive Q&A – Part 2



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What a benchmark curve is

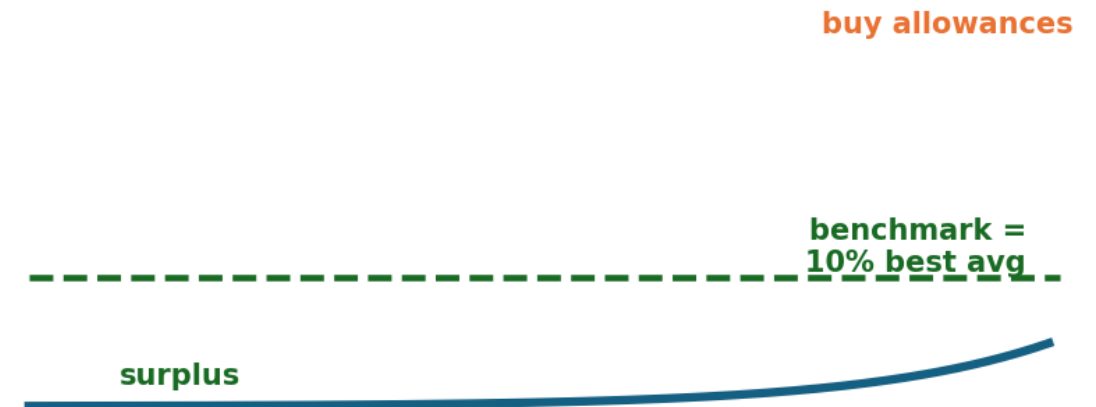
Benchmark GHG intensity (t CO₂e per unit)

Level	Average of the 10% best installations
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Curve All installations ranked best → worst

Effect	Same allowances/tonne → rewards efficiency
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Not a limit Distributes free allocation, not an emission cap



How a curve is built (phase-3 methodology)

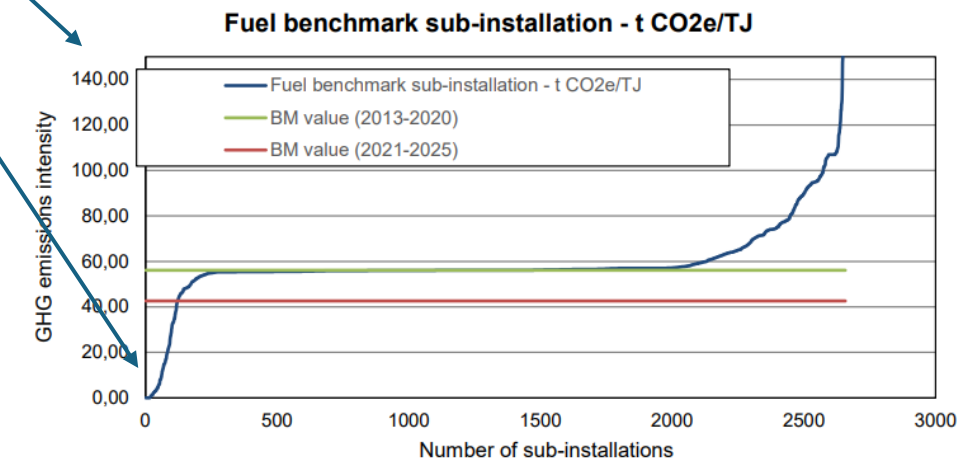
Step 1 Associations collect installation-level data

Step 2 One product, one benchmark (no tech/fuel/geo split)

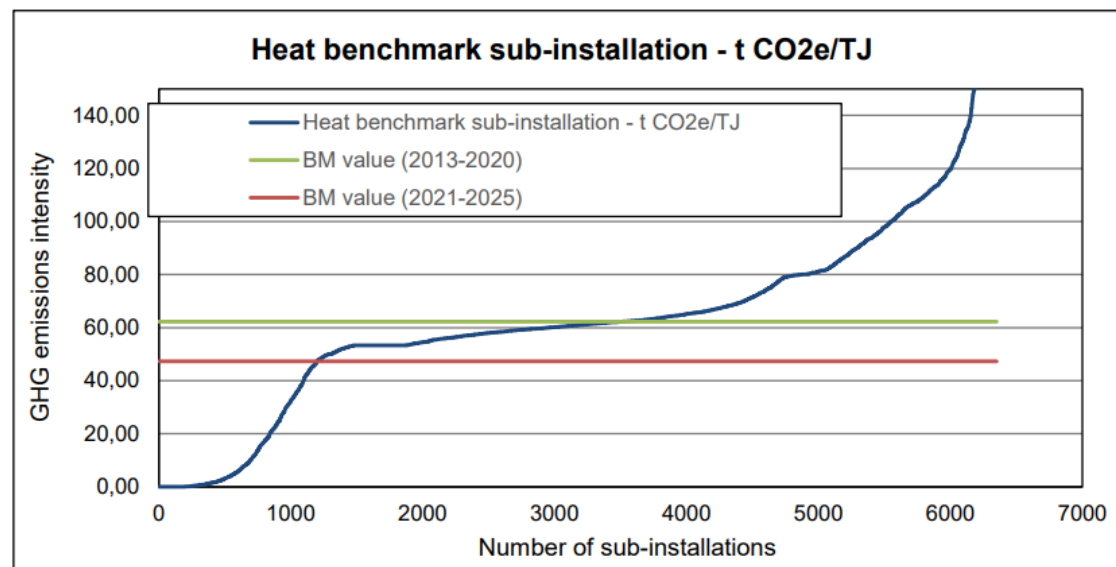
Step 3 Rank installations by GHG intensity

Step 4 Value = average of 10% most efficient

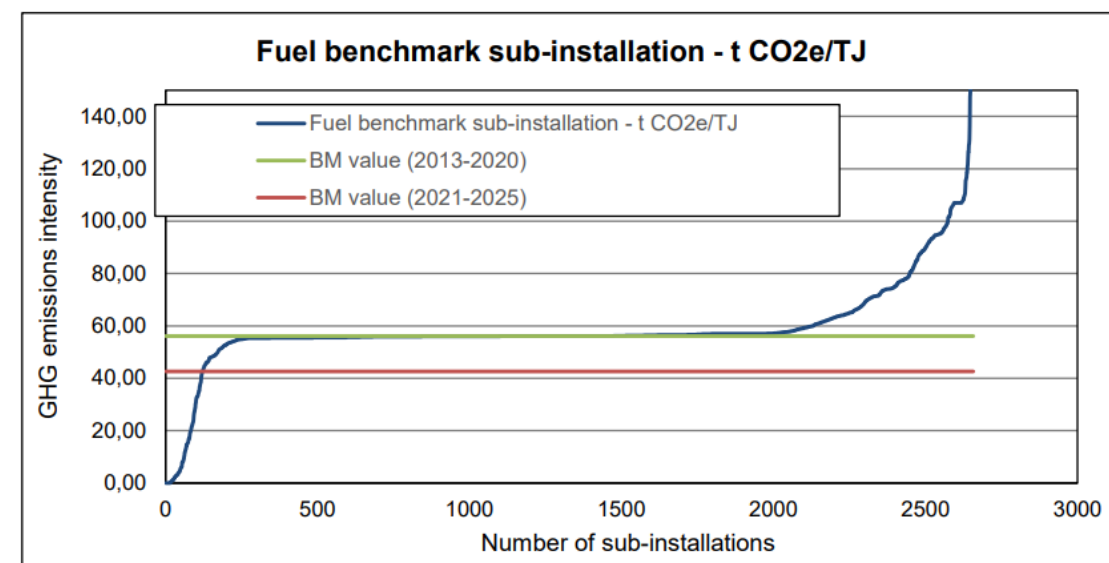
Result 54 benchmarks: 52 product + heat + fuel



Reading a real curve and its key parameters



Heat: 47.3 t CO₂e/TJ (p.60)



Fuel: 42.6 t CO₂e/TJ (p.61)

Axes X = ranked sub-installations · Y = GHG intensity; the steep tail = least-efficient

Heat median 60.9 / weighted avg 76.8 vs benchmark 47.3 t CO₂e/TJ

Fuel median 56.1 / weighted avg 57.9 vs benchmark 42.6 t CO₂e/TJ

Performing beyond the curve: expected technologies

Efficiency First, but not enough below natural gas

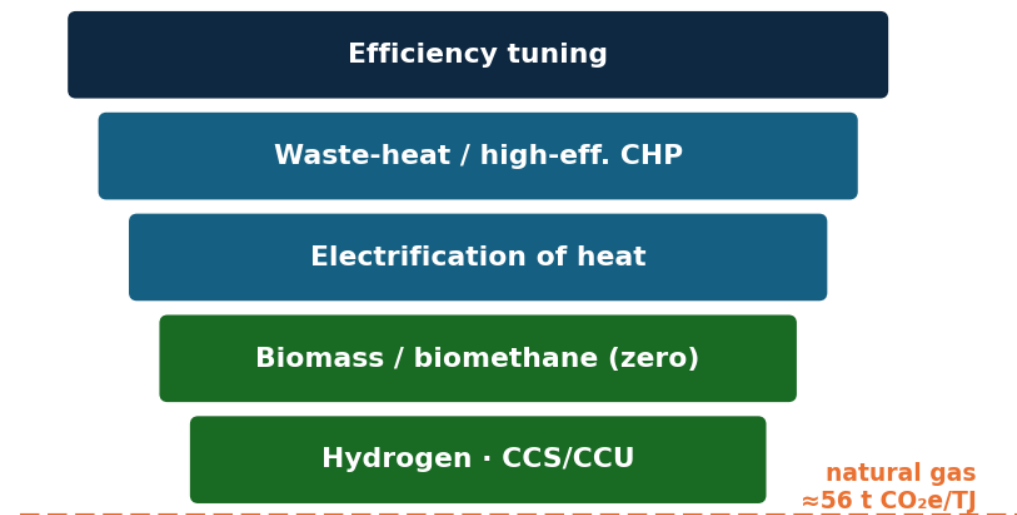
Fuel switch Sustainable biomass / biomethane (zero)

Electrify Metered, eligible electrified heat

Recover Waste-heat & high-efficiency cogeneration

Deep cuts Hydrogen and CCS/CCU for process emissions

Beating the benchmark = changing the energy source





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Biomass and biofuel: impact on fossil emissions

Zero-rated Sustainable biomass/biofuel counted at EF = 0

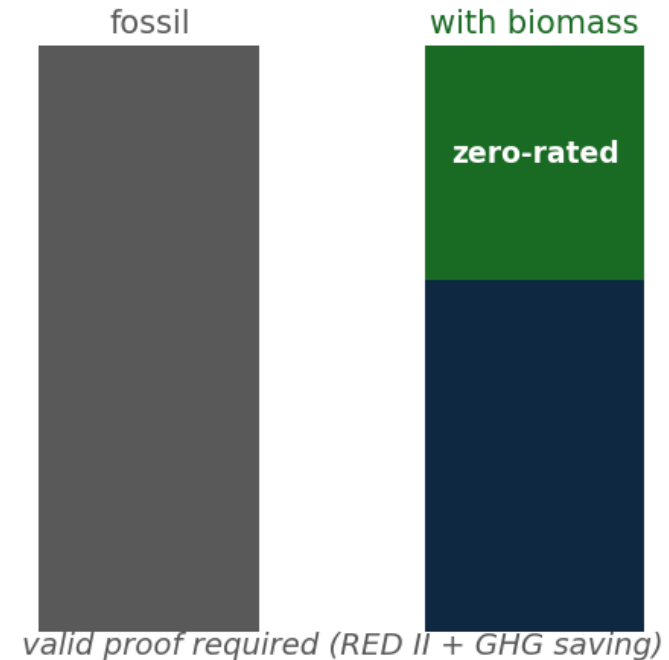
Effect	Lowers fossil CO ₂ — can drop below the benchmark
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Condition	RED II sustainability + GHG-saving criteria
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Legal base	MRR (Reg. 2018/2066) Art. 38–39
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No proof	Stream counted as fossil
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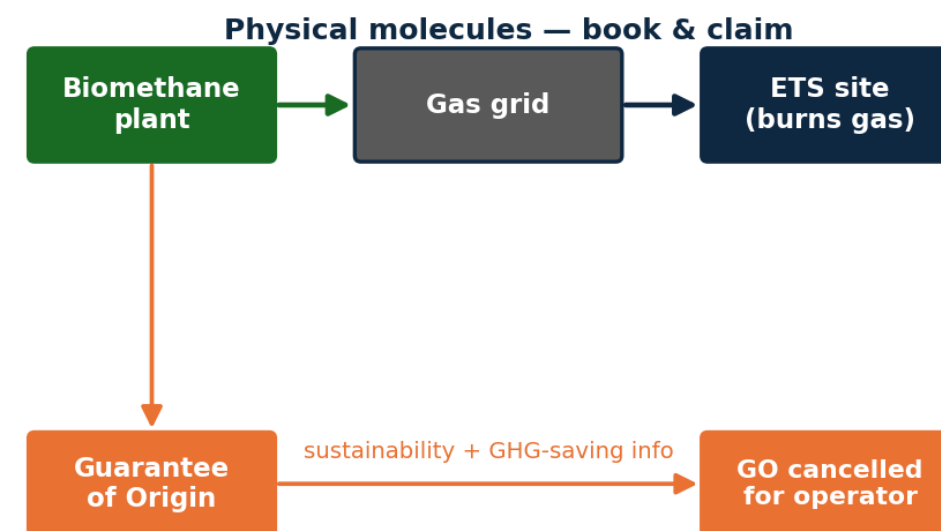
Reported CO₂ intensity



FOCUS — Biomethane and guarantees of origin: the mechanism

Problem	Identification of biogas and no double counting
GO	Electronic certificate of renewable origin (DM 224/2023)
Transfer	GO carries sustainability & GHG-saving info
Claim zero	Cancel the GOs in the operator's favour
Authority	Italian ANC; ITO of 13 Jan 2026

European commission set the rules on directive (UE) 2018/2001
European members set national rules to adopt it



⚠ **For now**, the mechanism works by national registry, after 2027 it will work on European scale with the Union Database (UDB)



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Relevance for the TR ETS pilot — and Q&A

Adopt Heat/fuel/process fallbacks for non-benchmarked outputs

Data	Verified BDRs, monitoring plans, risk-based review
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Decide Update corridor & reference assumptions for Türkiye

Biomass	If allowed: GO registry, cancellation, verification
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Then Questions & discussion



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Interactive Q&A – Part 3



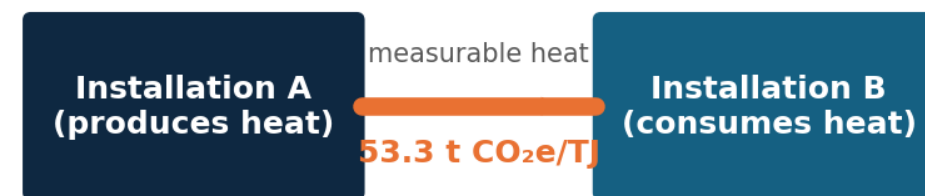
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Back-up slides

Measurable heat flows: import, export, cross-boundary

Net eligible heat	Produced + imported (ETS) – exported to non-ETS DH
Cross-boundary	Consistent emission factors keep the books straight
Import (unknown EF)	53.3 t CO ₂ e/TJ
Export	53.3 t CO ₂ e/TJ
Purpose	Assign the heat emission once, to the right party

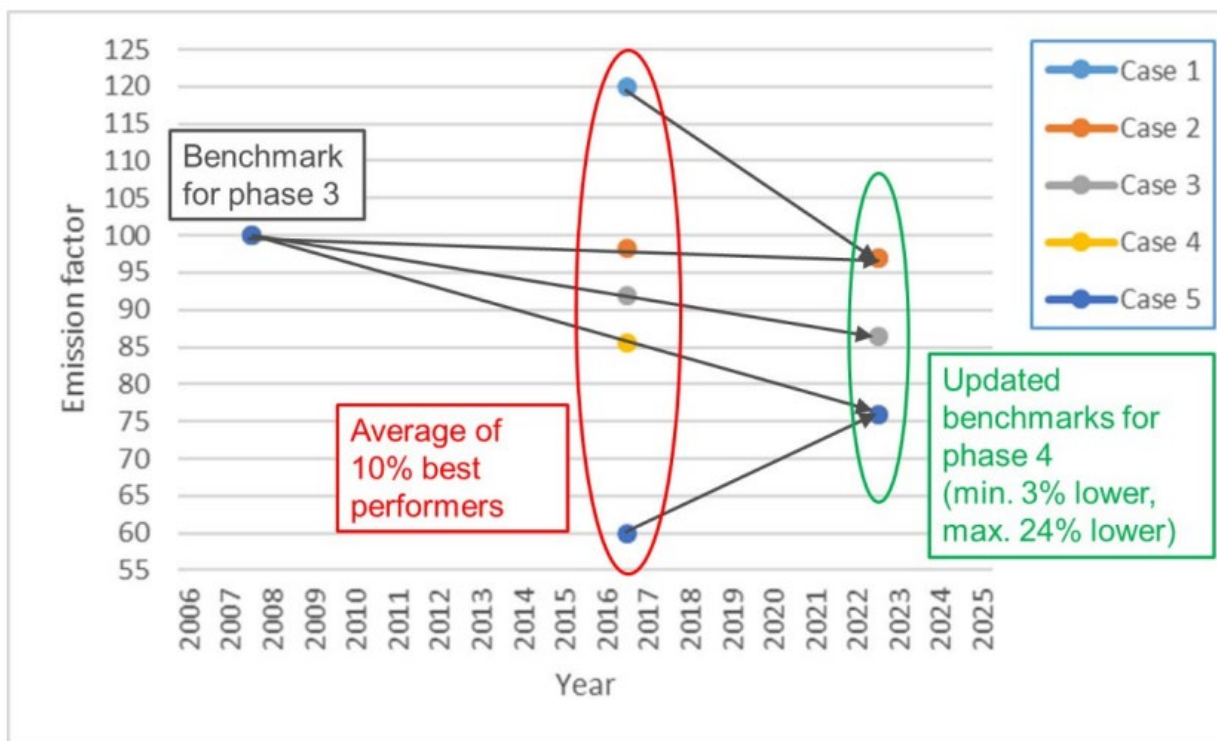


Counted once — never twice, never lost

Continuity with 2024 — what is new in 2026

Covered in 2024 (Day 1)	New in 2026
Heat & fuel benchmark definitions	How the benchmark curves are built & updated
The sub-installation concept	Complex sites with mixed energy inputs
The heat-benchmark allocation formula	Focus: biomass — biomethane guarantees of origin
(taught in 2024 online Day 1)	Technologies to perform beyond the benchmark

Updating the curve: phase 3 → phase 4 (five cases)

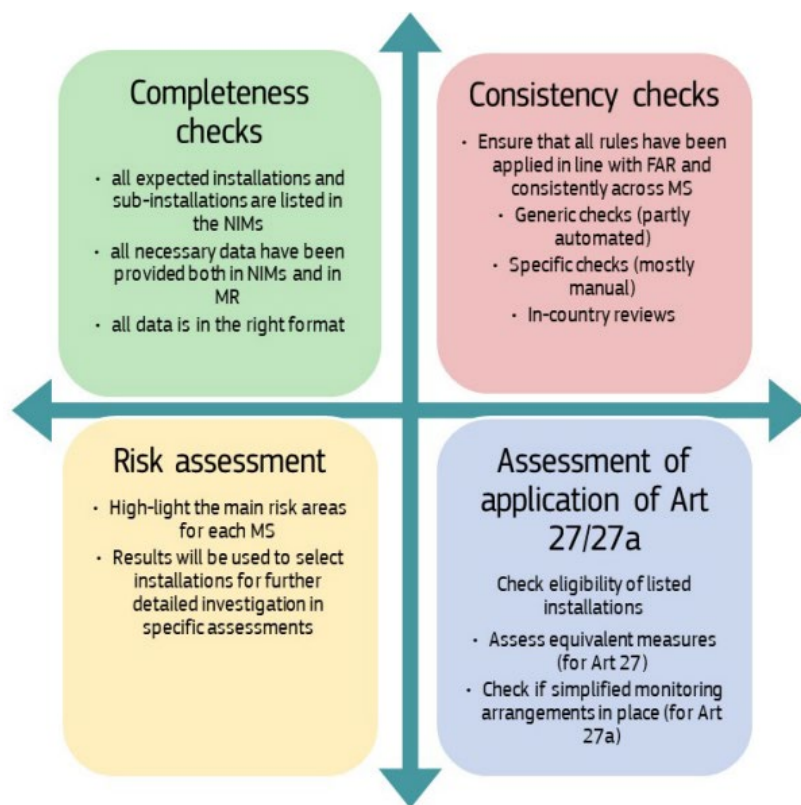


Update mechanism mapped into the 3%–24% corridor (factsheet p.5).

Basis	Verified 2016/17 vs 2007/08
Method	Annual rate over 15 years
Corridor	3% min – 24% max (0.2–1.6%/yr)
5 cases	Map any rate into corridor
Result	The actual technological progress observed over about a decade is applied to reduce the free allocation limits, with the reduction capped within a bandwidth of 3% to 24%

FLAG : Corridor 0.2–1.6%/yr → 3–24% is the 2021–2025 rule. For 2026–2030 the Directive widened it to 0.3–2.5%/yr.

Data quality behind the curve: assessing the NIMs



NIMs assessment (factsheet p.6).

Submit

Member States submit NIMs (Art. 11)

Checks

Completeness + consistency (automated)

Deep dive

~300 high-risk installations (BDRs, MMPs)

Exclusions

Art. 27/27a left out of the update

Result

One consistent dataset, 54 benchmarks



Key takeaways

Fallbacks Cover all non-benchmarked emissions — assigned once, in order

Heat vs fuel	Measurable vs non-measurable; process = historical
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Curves 10%-best average; ranked; updates capped 3–24%

Values	Heat 47.3 & fuel 42.6 t CO ₂ e/TJ — both cut 24%
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Biomass Zero only with proof: sustainability, GHG saving, GOs cancelled

Biomass: concept of GHG SAVINGS

reduction in net emissions produced
throughout the entire life cycle of a
renewable fuel compared to a reference
fossil fuel

Example: the biomass originate from a protected
area located thousands of kilometres away → no
sustainable

$$\text{Savings} = \frac{\sum \text{emission from the fossil fuel comparator} - \sum \text{Total emissions from renewable fuel}}{\sum \text{emission from the fossil fuel comparator}}$$

- **Biofuels and bioliquids:** A 65% saving for plants starting operations from January 1, 2021.
- **Solid and gaseous biomass:** An 80% saving for plants starting operations after November 20, 2023.
- **Waste and Residues:** For fuels produced from waste and residues (excluding agricultural and forestry residues), emissions up to the point of collection are considered zero.

$\sum$ Emissions from transport

$\sum$ Emissions from electricity and gas use



Biomass: GHG savings — the calculation

Formula

$\text{SAVING} = (\text{EF} - \text{E}) / \text{EF}$ — E = renewable-fuel emissions, EF = fossil-fuel comparator

E components

$\text{eec} + \text{el} + \text{ep} + \text{etd} + \text{eu}$ — extraction/cultivation, land-use change, processing, transport & distribution, fuel in use

Fuel in use (eu)

For biomass, combustion CO_2 counts as zero — but CH_4 and N_2O from combustion still count

Deductions

$\text{esca} + \text{eccs} + \text{eccr}$ are subtracted — better farming, CO_2 capture & storage, CO_2 capture & replacement

Why it matters

This calculation sits behind the 65% / 80% thresholds and the zero-rating for waste & residues on the previous slide

Biomethane GO — the operator's workflow

- 1 Update monitoring plan → competent authority
- 2 Annual self-declaration by the biogas producer, verified GHG savings
- 3 Mass balance: produced & injected = bought & consumed
- 4 Cancel GOs (no double counting)
- 5 Same-grid connection + sustainability/GHG saving



Waste gases — splitting allocation: producer vs consumer

Two parts

P = producing the waste gas; C = consuming (burning) it

P inside a product BM	Already in the product benchmark - goes to the producer
P outside a product BM	Process-emissions sub-installation - goes to the consumer
C - always	Like any fuel, to the consumer: heat / fuel / product BM (none if electricity or flaring)
Only the surplus	P counts $EF(WG) - EF(\text{gas } 56.1) \times 0.667$; never negative
Reduction factor	Process-emissions factor 0.97 (to 2027), 0.91 (from 2028)

Splitting the allocation

P = producing it C = burning it

Inside a product BM



Outside a product BM





Reference fuel and special provisions baked into the values

Reference fuel Natural gas underpins heat & fuel benchmarks

Boiler efficiency	90% assumed for the heat benchmark
--------------------------	------------------------------------

Derived factors Heat 53.3; waste gas -37.4 / +48.0 t CO₂e/TJ

Aromatics/H₂/syngas	Adjusted with the refineries benchmark
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Hot metal Fixed -0.2%/yr update