The EU ETS and a low CO2 cement

Anne Dekeukelaere

CEMENTIS

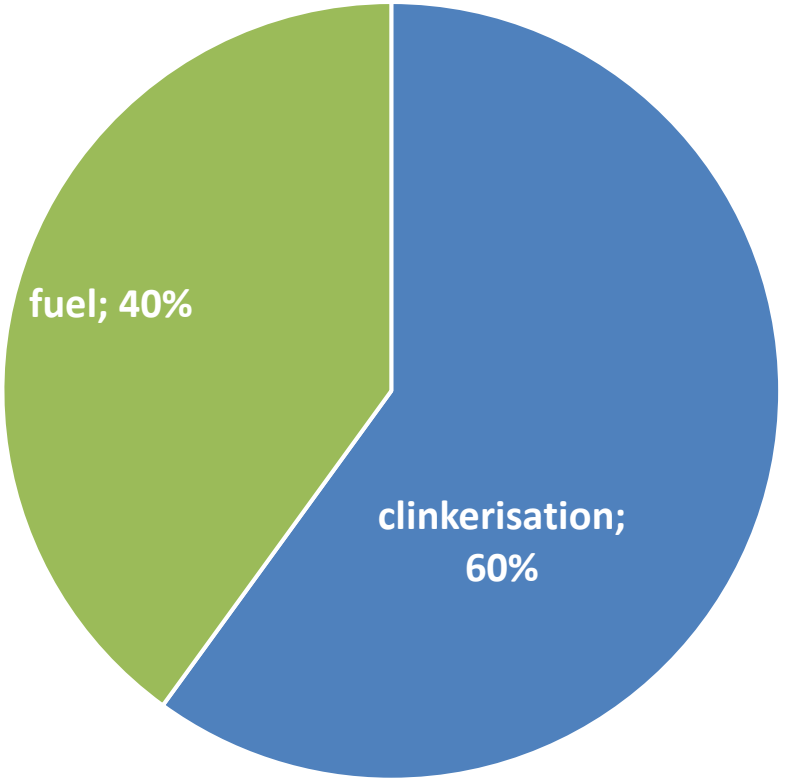
Some basics on cement making process

Cement Manufacturing Process (Fundación Cema)

- Limestone is quarried then crushed into smaller pieces.
- Raw materials are then mixed and grinded with some additives to reach the perfect recipe
- The raw meal then enters a preheater before going into a rotary kiln where the flame reaches 2000° Celsius.
- The chemical reaction of carbonation happens where the limestone ($CaCO_3$) transforms into lime (CaO), emitting carbon dioxide (CO_2). The semi-finished product, called clinker, is then cooled.
- The clinker is then mixed with approximately 5% of gypsum and grounded into a grey powder called Ordinary Portland Cement (OPC).

CEMENTIS

Which CO2 emissions are considered for cement in EU ETS?



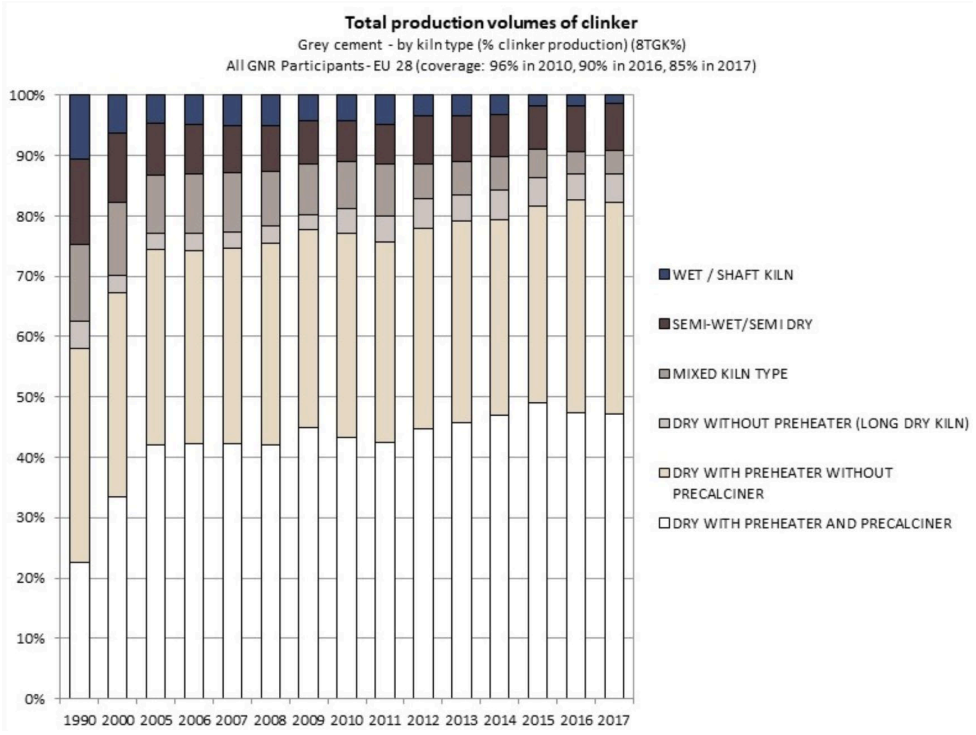
- Approx. 40% of the CO2 considered come from fuel combustion
- Approx. 60% comes from the chemical reaction

  (CaCO3 into CaO + CO2)

CEMENTIS

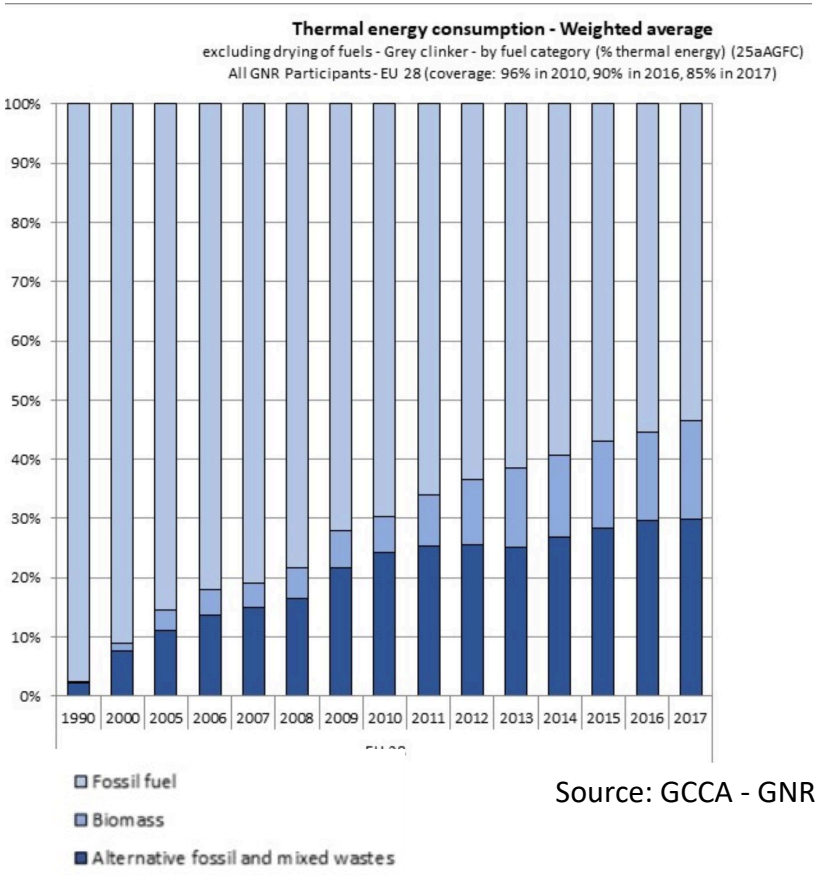
Lowering the fuel combustion part 40% - efficient levers

- Energy Efficiency of the current technology



Source: GCCA - GNR

- Replacing coal by waste

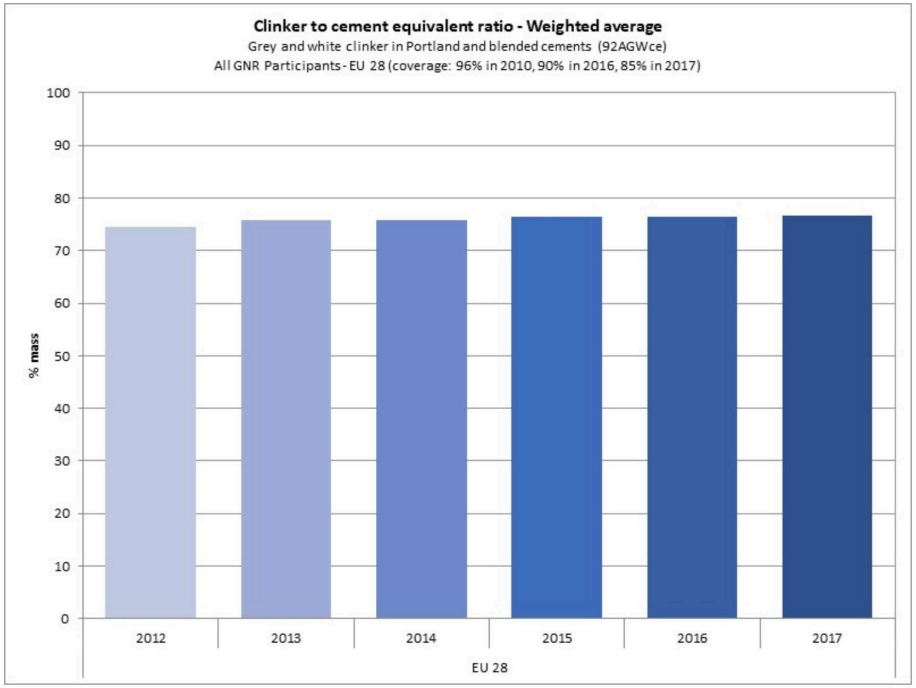


Source: GCCA - GNR

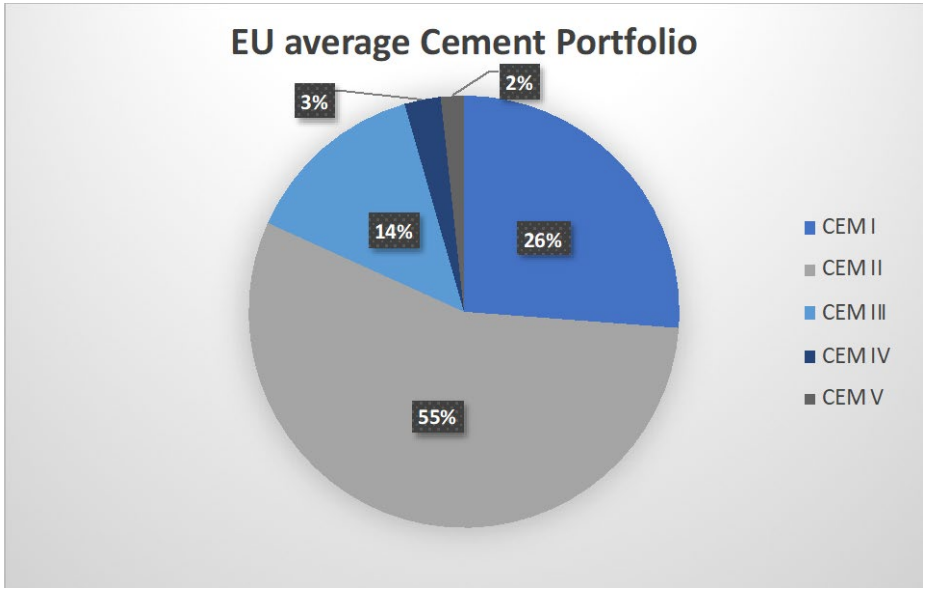
CEMENTIS

Lowering the chemical reaction (60%) part through reducing the clinker content in limestone

Current situation:
The EU clinker to cement ratio is levelling off for the last 5 years.
Standards need to be changed to lower the clinker factor till 50% (ongoing but issues)
Current average clinker factor is 76%



Source: GCCA - GNR

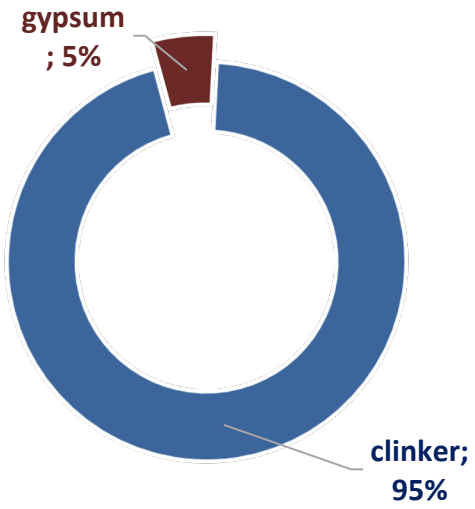


CEM I and CEM II represent together 81% of the market

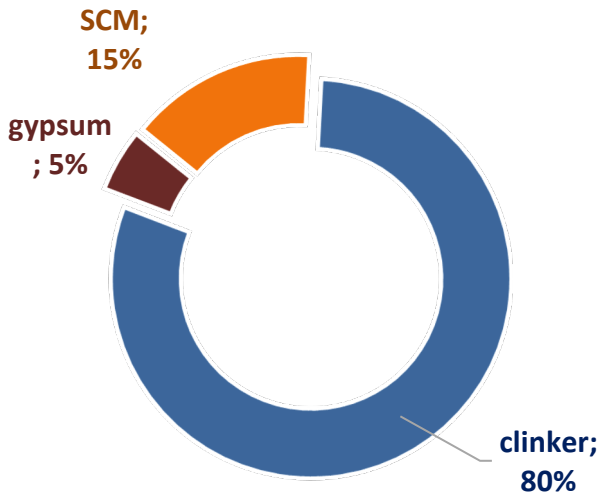
CEMENTIS

Modifying cement types sold in EU

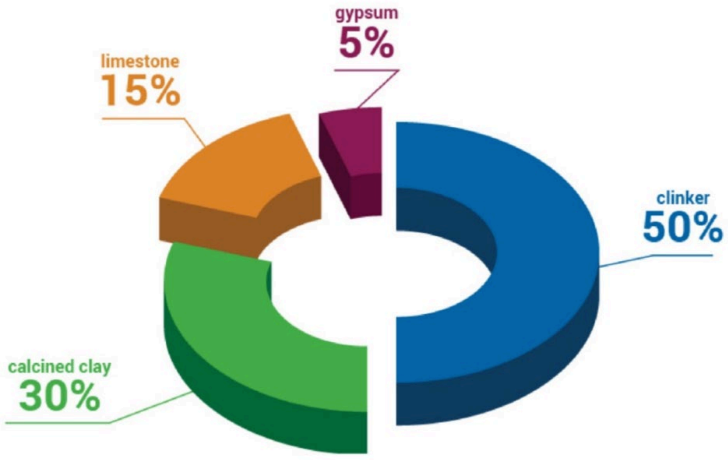
OPC or CEM I composition representing 26% of EU consumption



Avg. CEM II composition representing 55% of EU consumption



LC3, the new low CO2 cement developed by EPFL University Lausanne



Typical composition of an LC³ cement

What would happen to the EU ETS if LC3 is introduced into the EU Cement portfolio replacing 90% of CEM I and 55% of CEM II?

SCM: Supplementary Cementitious Material (fly ash, pozzolana, slag, etc..

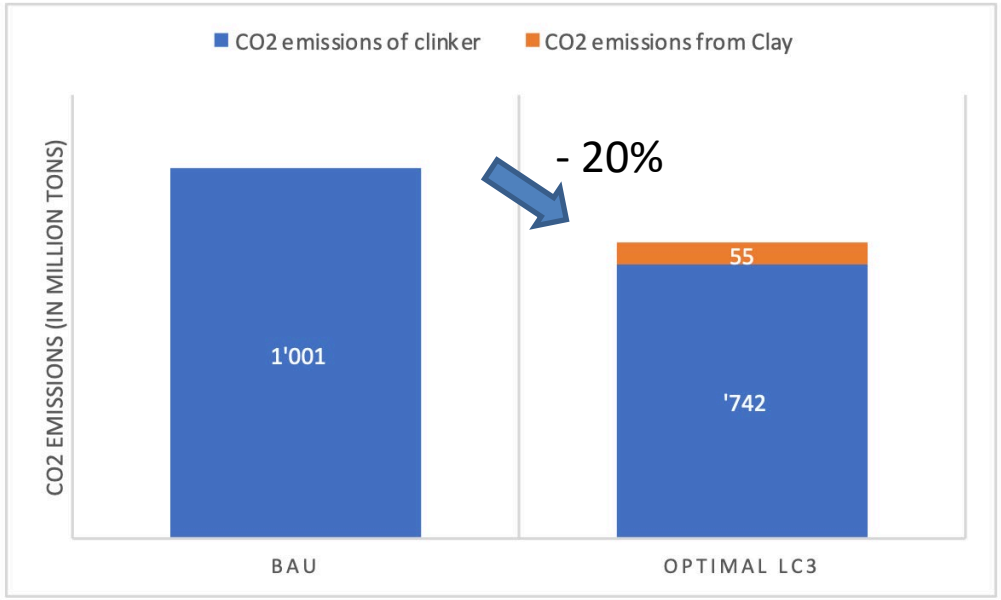
CEMENTIS

Hypothesis of the study

- Real EU Consumption = Production (no export, no import)
- Stable cement consumption 2021-2030
- EU (2018) average gross = 0.813 MT of CO2 per ton of clinker produced taken as BAU for 2021-2030 (no big change, no refurbishment, etc..)
- Use of phase 4 formula =Annual Free Allowances = Benchmark value (BM) x Historical Activity Level (HAL) x Carbon Leakage Exposure Factor (CLEF)
- CLEF= 100%
- Benchmark phase 3= 0.766 ton of CO2 per ton of clinker produced
- Benchmark Phase 4= 0.5% improvement rate per year since 2008
  - period 2021-2025= 0.709 ton CO2/ton clinker
  - Period 2026-2030= 0.689 ton CO2/ton clinker

Comparison between BAU and the LC3 scenario

2021-2030 CO2 emissions comparison

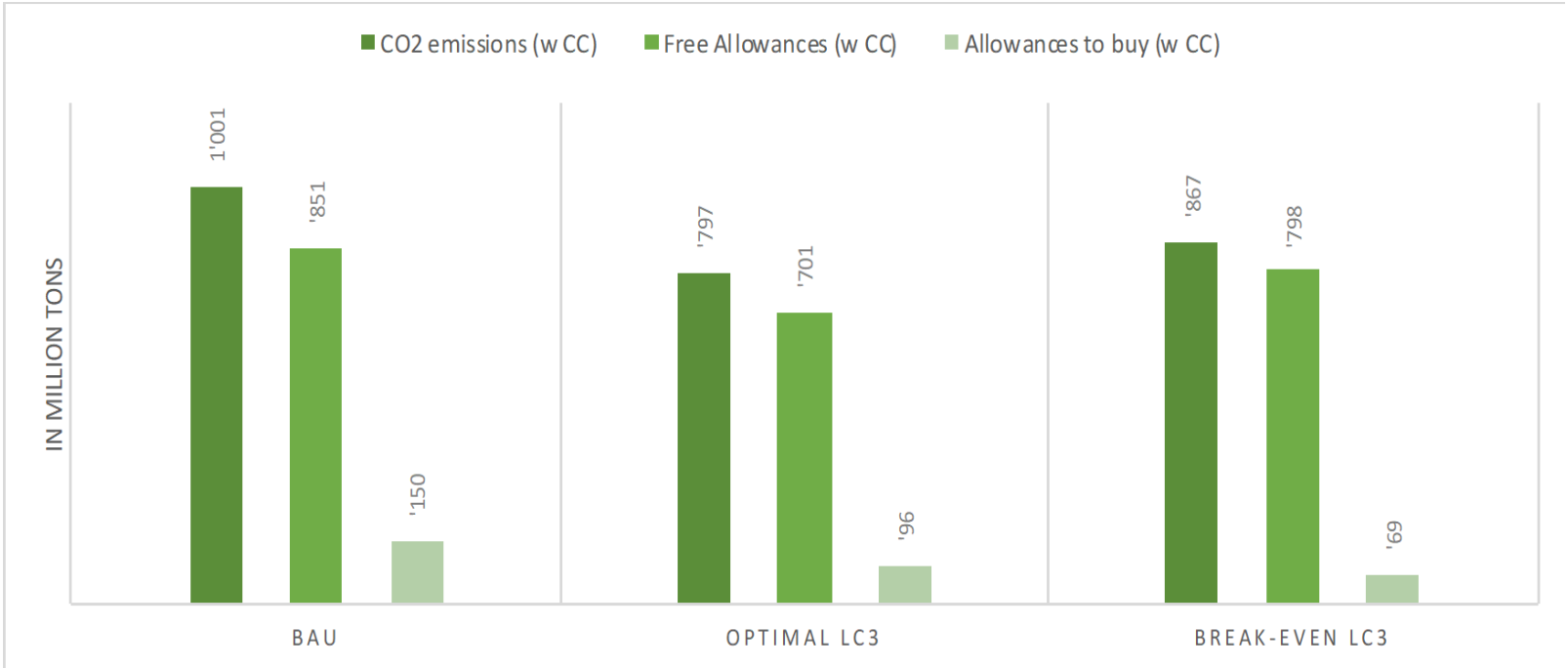


Effects

- The need of clinker to produce the same amount of cement is reduced by 32 million t per year.
- CO2 emissions over the Phase 4 period could be reduced by 20%.
- One ton of calcined clay emits only 0.211 ton of CO2 compared to clinker at 0.813 ton of CO2, a 74% reduction
- The LC3 scenario will provoke a loss of free allowances because the clinker production goes under the -15% level.
- Additional scenario “break-even”: incorporated the LC3 cement in the product portfolio just enough not to cross the -15% clinker production

CEMENTIS

2021-2030 CO2 emissions & allowances comparison



- the Break-even scenario has the following differences over 2021-2030 versus optimal LC3 scenario:
  - It increases free allowances by 97 million t
  - It reduces the allowances to purchase by 27 million MT
  - But it increases CO2 emissions by 70 million MT

CEMENTIS

Conclusions from the thesis

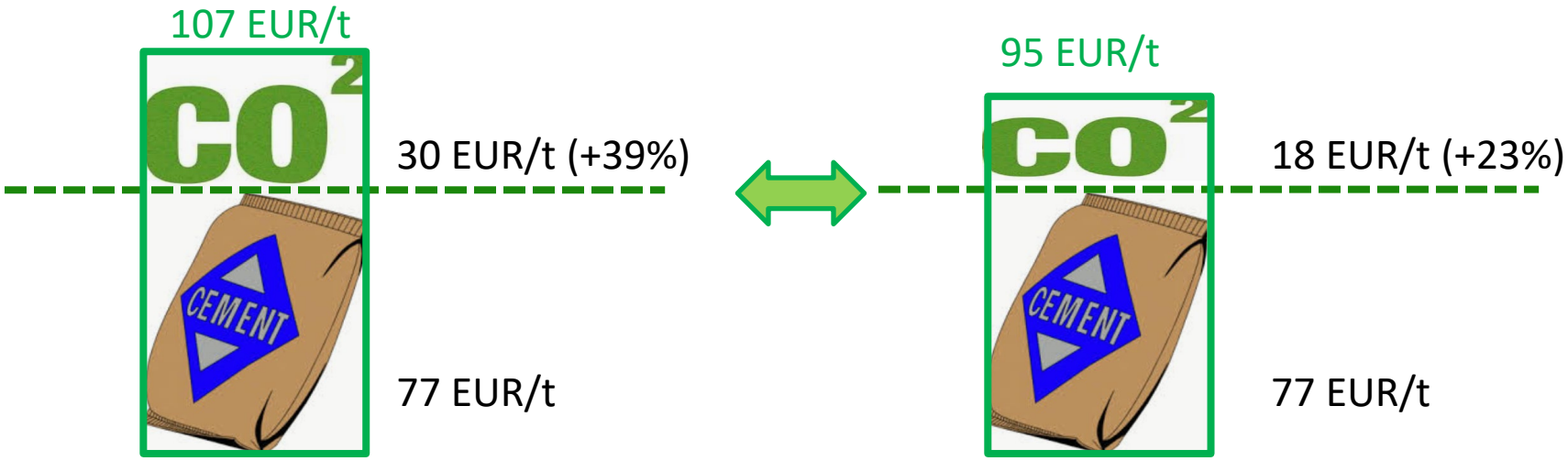
- Trying to benefit from the system is economically profitable but not optimized in terms of CO2 emissions.
- The EU ETS **doesn’t not** incentivize a paradigm shift towards low carbon cement.
- A hybrid formula with an additional benchmark of clinker factor could solve the issue.

- What if there are no free allowances anymore?

What would happen in a full auctioning scenario (CO2 tax)?

If we take the average EU28 ex-factory cement price of 77 EUR per ton as reference & an expected average CO2 price 2021-2030 of 38.6 EUR/t of CO2

- OPC or CEM I
  - 95% clinker
- LC3 cement
  - 50% clinker



CEMENTIS

The possible effect of CO2 tax* on construction housing cost

Residential housing Cost → Concrete cost = 3 – 5% → Cement cost in concrete = 50%

Residential housing Cost → Cement cost = 2%

Average construction cost for house in Berlin of 100 m2 = 262’100 EUR
Cement cost = 5,242 EUR without the CO2 tax
Cement cost with CO2 tax = 7,286 EUR with OPC (2.78%)
6,447 EUR with LC3 (2.46%)

CEMENTIS

*CO2 taxes should also be applied to other construction material like steel.

For a long term sustainable construction sector

- Going down the value chain
  - Concrete producers: reducing the cement content per m^3 of concrete by improving concrete recipes
  - Construction companies: reducing the amount of concrete per m^2 of construction by optimizing the structural elements load requirements
  - Architects: optimized structure design

https://www.research-collection.ethz.ch/handle/20.500.11850/301843

CEMENTIS

New technology

- CCS & CCU is a must to bring down to Zero CO2 but
  - Technology is still under investigation
  - Costs are still high, currently not economic feasible
  - Need of pipelines, storage and financing
  - Not feasible before 2030 according to Cembureau
  - CCS/CCU will represent 40% CO2 reduction to take place between 2030-2050.

Thank you