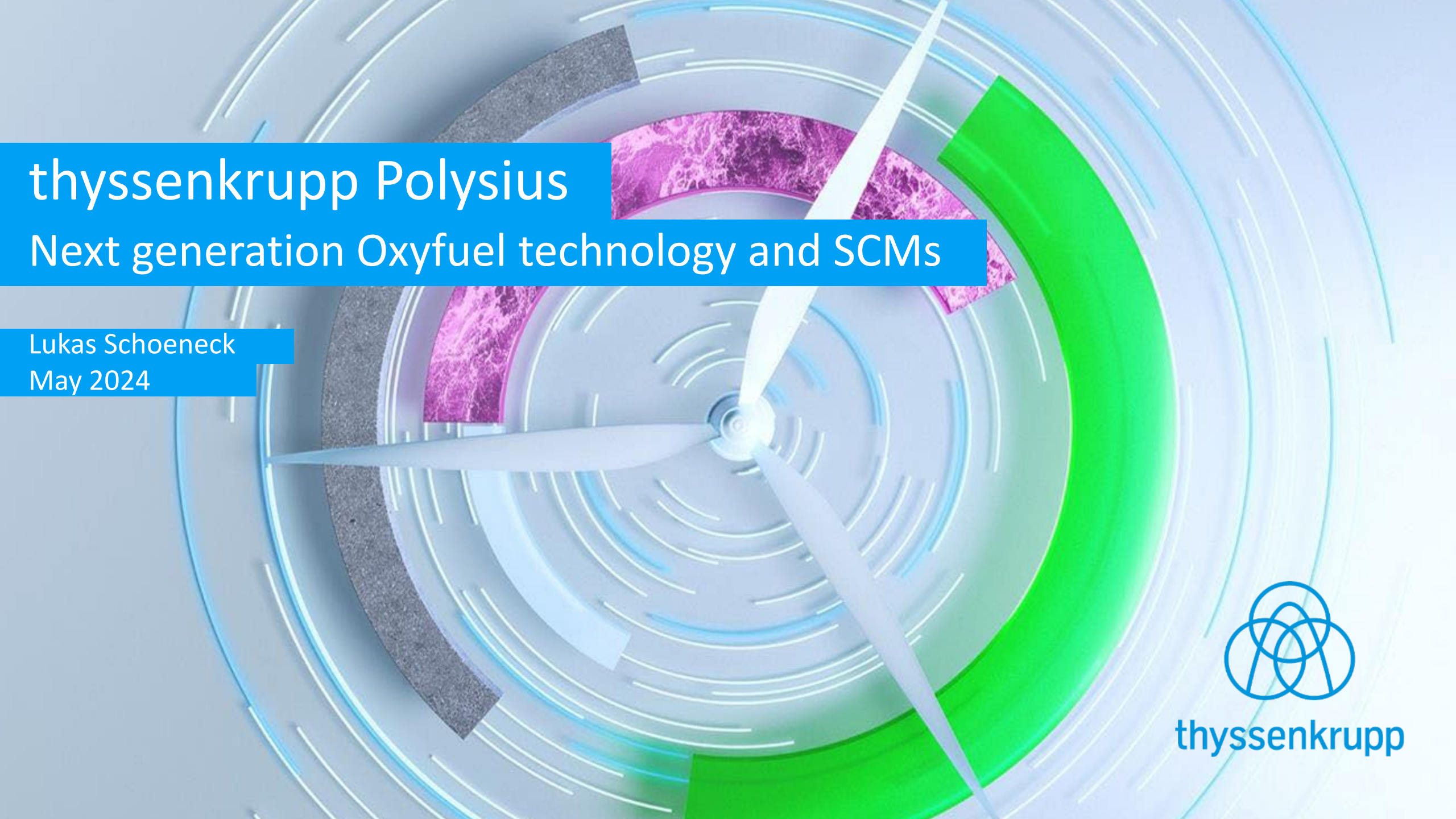
thyssenkrupp Polysius

Next generation Oxyfuel technology and SCMs

Lukas Schoeneck
May 2024



thyssenkrupp

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California Companies Secure $700 Million for Cement Decarbonization

The Department of Energy recently announced that 33 industrial projects, including two California-based companies, will receive federal funding to decarbonize.

April 11, 2024

Cement Australia backs carbon capture tech

December 5, 2022 | iQ Industry News | By Industry Queensland

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European Commission > ... > News > 37 large-scale clean tech projects sign grant agreements worth €3.45 billion supporting the EU's clean energy trans

NEWS ARTICLE | 15 December 2023 | European Climate, Infrastructure and Environment Executive Agency | 2 min read

37 large-scale clean tech projects sign grant agreements worth €3.45 billion supporting the EU's clean energy transition

The newest batch of highly innovative clean technology projects will receive funding from the Innovation Fund, one of the world's largest funding programmes for the demonstration of innovative low-carbon technologies.

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CEMNET.COM » CEMENT NEWS » HERACLES GROUP'S OLYMPUS CO2 PROJECT RECEIVES EU FUNDING

Heracles Group's Olympus CO2 project receives EU funding

06 December 2023

The EU Innovation Fund has chosen to co-finance Heracles Group's (Holcim) Olympus CO_2 capture project. The Olympus project aims to transform Heracles Group's plant in Milaki, Greece, into a zero carbon cement plant through the use of innovative carbon capture and storage (CCS) technologies. The project marks an investment of over EUR300m, of which the EU Innovation Fund will grant EUR124.5m.

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News Taiwan Cement Corporation to roll out carbon capture projects with ThyssenKrupp Polysius

Taiwan Cement Corporation to roll out carbon capture projects with ThyssenKrupp Polysius

Written by Global Cement staff
05 February 2024

Print

Taiwan: Taiwan Cement Corporation has signed a memorandum of understanding (MoU) with ThyssenKrupp Polysius. Under the MoU, the partners will implement carbon capture projects

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News Heidelberg Materials France to trial carbon capture installation at Airvault cement plant

Heidelberg Materials France to trial carbon capture installation at Airvault cement plant

Written by Global Cement staff
13 March 2024

Print

France: Heidelberg Materials France plans to install a 1Mt/yr carbon capture system at its Airvault cement plant in the New Aquitaine. The Airvault cement plant is undergoing an upgrade, including the replacement of two pre-existing semi-dry lines with a new dry line and pre-calciner. This will reduce the plant's CO_2 emissions by 30% per tonne, reduce its energy consumption by 10% per tonne, reduce its clinker factor and raise its alternative fuel substitution rate to 90%. CO_2 capture is set to commence in 2030. The project is one of several, under the GOCO₂ carbon capture, storage and utilisation (CCUS) cluster, which also includes installations at Holcim France's Saint-Pierre-La-Cour plant and Lhoist France's Réty lime plant.

Chair Dominik von Achten said "We started an ambitious modernisation programme for our sites in France several years ago, with a planned investment of more than €400m. With the integration of AirvaultGOCO₂, we are now adding a cutting-edge project in the field of carbon capture to our previous efforts, which will enable a further, massive reduction of Heidelberg Materials' carbon footprint in France."

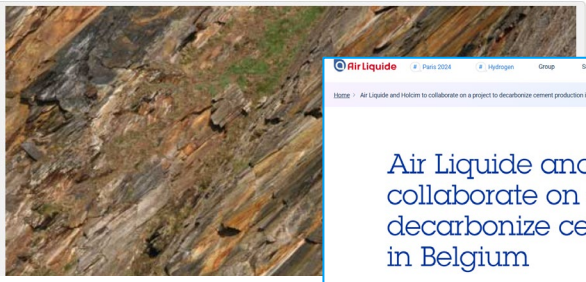
Chief sustainability officer Nicola Kimm added "Our approach in Airvault is a perfect example of Heidelberg Materials' strategy to implement dedicated carbon reduction roadmaps. We are taking every possible step to reduce CO_2 emissions: Phasing out fossil fuels, reducing the clinker content of our cements, and improving energy efficiency. To mitigate the remaining residual emissions, we rely on CCUS – as part of an integrated scheme and with our strong partners in GOCO₂."

New supplementary cementitious materials

By Arthur Harrisson
Published 19 August 2019

Tagged Under: slate Quarry SCM supplementary cementitious materials pozzolana reactivity cement chemistry

The search for new supplementary cementitious materials (SCMs) is ongoing. A recent review of existing SCMs and the potential for new ones caught the eye of Arthur Harrisson and provided further potential for investigation.



ement and concrete

CAPTURE | PRESS RELEASE

EU Innovation Fund Backs GeZero Carbon Capture Project With €191M

by Petya Trendafilova · December 20, 2023 · 3 minute read

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Materials

Air Liquide

Home > Air Liquide and Holcim to collaborate on a project to decarbonize cement production in Belgium

Air Liquide and Holcim to collaborate on a project to decarbonize cement production in Belgium

Paris, France, May 02, 2023 | Press Releases | Industry

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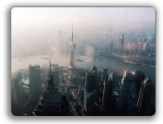
China starts CCUS focus

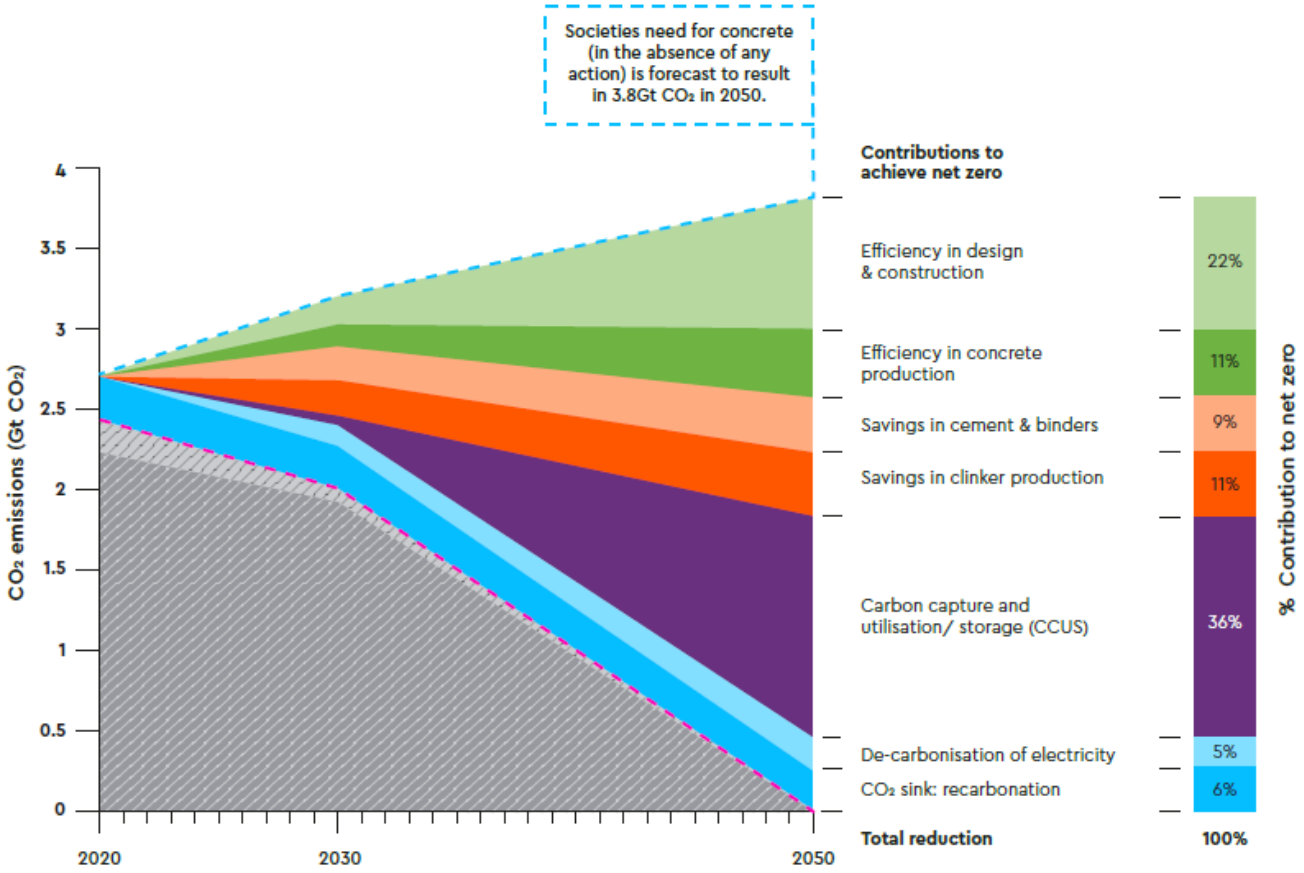


14 July 2023

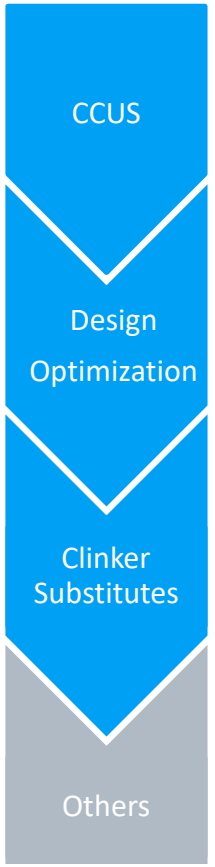
Confidential

There are multiple levers that will be implemented to reduce CO2 emissions at different stages of the whole life of cement and concrete

The CO_2 reduction levers



Levers with a big CO2 reduction contribution

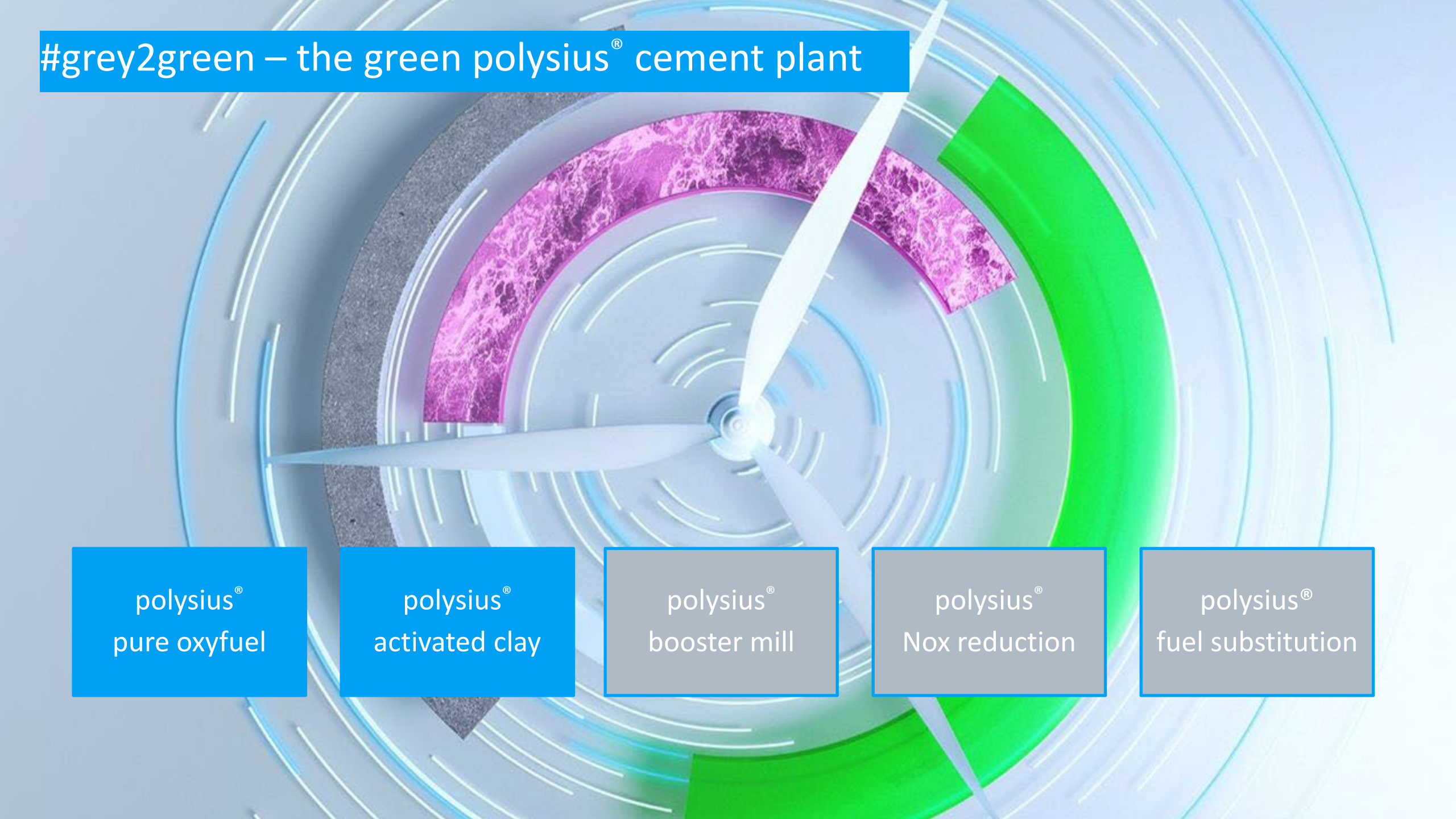


#1 Carbon capture and utilization/ storage CCUS

#2 Efficiency in design & construction

#3 Savings in cement and binders & Savings in clinker production

#grey2green – the green polysius® cement plant



polysius®
pure oxyfuel

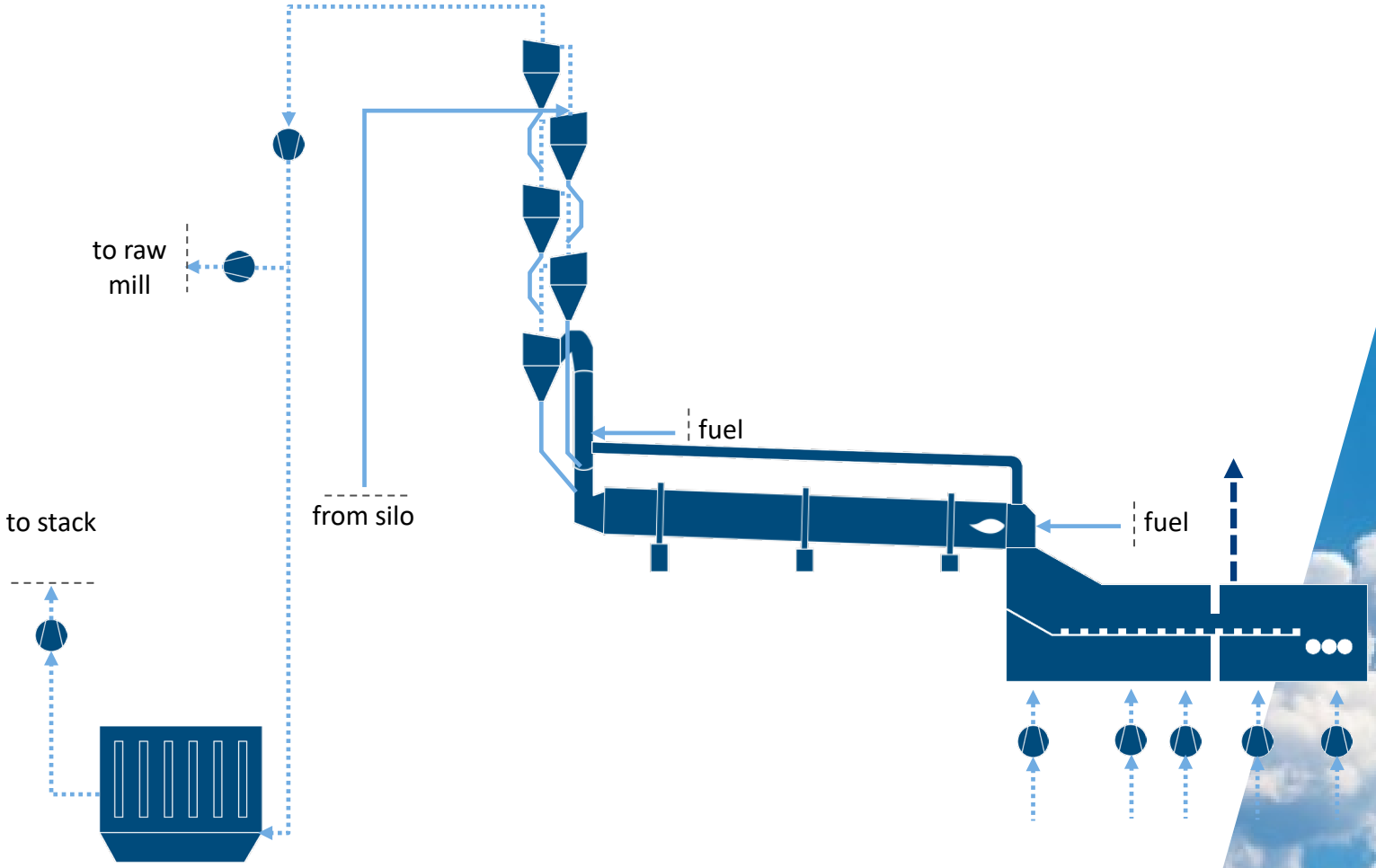
polysius®
activated clay

polysius®
booster mill

polysius®
Nox reduction

polysius®
fuel substitution

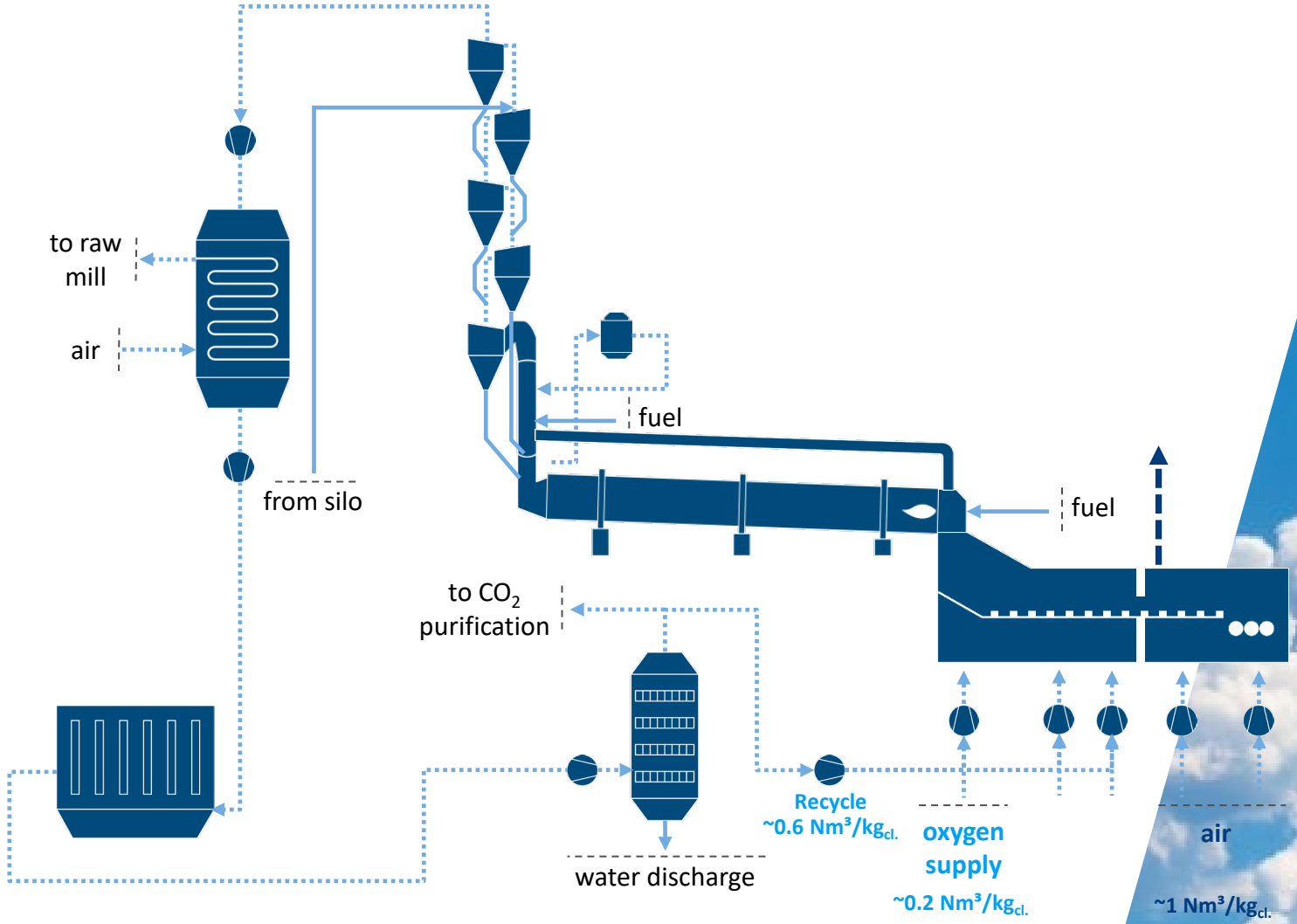
Standard clinker burning process



- ✓ Clinkerization process used since >150 years
- ✓ Pyroprocess with cyclones and precalciner used since 50 years

polysius® pure oxyfuel / **Oxyfuel 1st Gen**

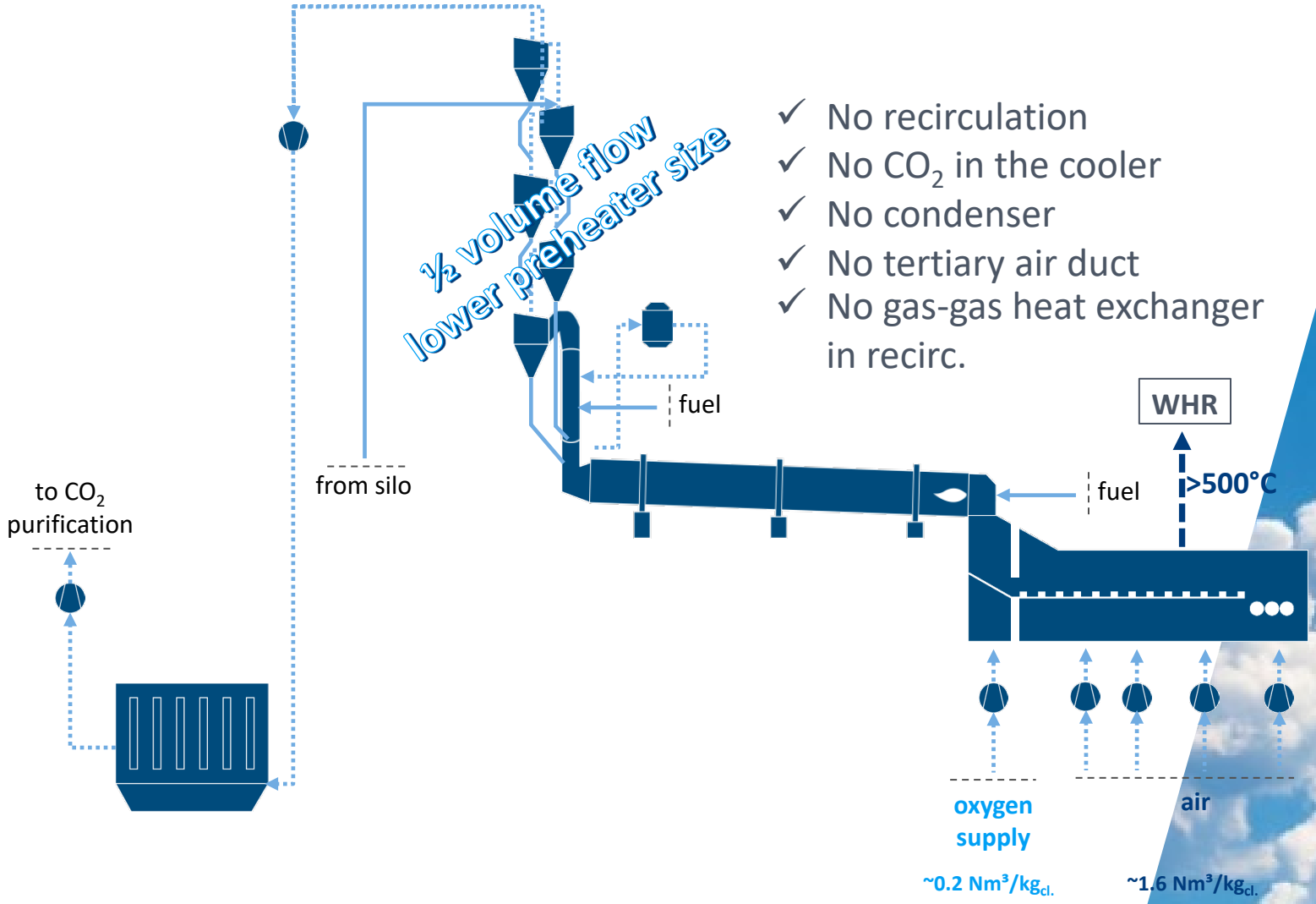
The best of oxyfuel



- ✓ Adaptation of well-known oxyfuel principle
- ✓ Revamp solution for existing lines
- ✓ Free use? Patent situation to be watched

polysius® pure oxyfuel / **Oxyfuel 2nd Gen**

The best of oxyfuel



- ✓ No recirculation
- ✓ No CO_2 in the cooler
- ✓ No condenser
- ✓ No tertiary air duct
- ✓ No gas-gas heat exchanger in recirc.

- ✓ Cost effective
- ✓ Simple process and layout
- ✓ Unique process improvements

- ➢ Higher clinker quality possible
- ➢ Less fuel preparation likely
- ➢ Strong potential for Waste Heat Recovery
- ➢ No bypass exhaust gas
- ➢ Calcination in lower CO_2 partial pressure
- ➢ Higher CO_2 concentration and lower exhaust gas flow

Evolution of Oxyfuel / basic process patented

Comparison between Polysius Pure Oxyfuel (2nd generation) and Oxyfuel 1 technology

Dimension	Oxyfuel 1st gen	Main difference relating to…	Polysius Pure Oxyfuel
Characteristic approach	Flue gas recycle to comply with solid to gas ratio of ~1 kg Gas/ kg Solids in the calciner		No or minimum flue gas recycle to comply with solid to gas ratio of ~2 kg Gas/ kg Solids in the calciner
Amount of equipment	More	Heat exchanger, fan, PH, condenser, tertiary air duct, recirculation sys.	Less
CAPEX	Higher	15-20%	Lower
OPEX Clinker	Higher	2-4 USD/t_{ck}*	Low
OPEX Cement	Higher	5-10 USD/t_{CEM}**	Low
Electr. pwr consumption	Higher	~+6...20 kWh/tCO2 ***	Lower
Electr. pwr consumption CPU	Higher	+2...4% ****	Lower
Volume of PH and calciner	100%	Factor 2	50%

*All figures are estimated, *Model / Assumption: Maintenance costs are partially CAPEX related, i.e. the bigger the machines / plant complexity, the higher the OPEX , **Estimating that clinker substitution is based on increase Alite content only, *** Assumption for the additional equipment, **** Assumption due to lower CO2 concentration

We started to transform the industry – with five pure oxyfuel projects.

Pilot plant
CI4C Mergelstetten

- 450 t / day semi-industrial scale
- >>€100 million investment by customer consortium
- Start: May 2022
- Operation from 2025

Pure oxyfuel kiln line
C2B Holcim Lägerdorf

- Capture of1 million tons of CO2 p.a.
- Construction phase start: 2025
- Operation and optimization: 2027

Pure oxyfuel kiln line
Contessa Nexe Croatia

- Capture of 0.7 million tons of CO2 p.a.
- Construction phase start: 2026
- Operation + optimization: 2028

We started to transform the industry – with five pure oxyfuel projects.

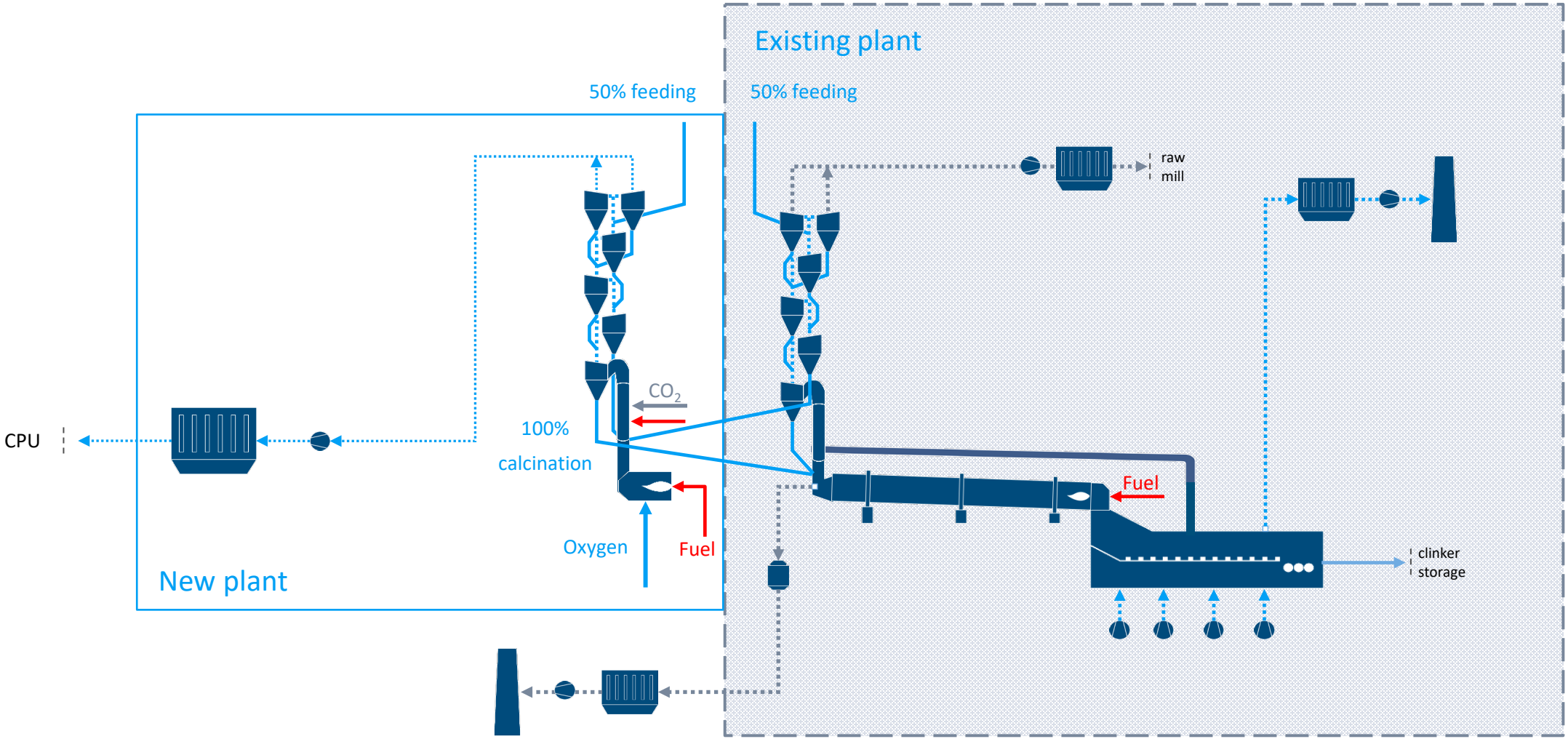
Pure oxyfuel kiln line
Heidelberg Geseke - GeZero

- 2800 t / day semi-industrial scale
- >0,7 million tons of CO2 p.a.
- Start: May 2022
- Planned operation from 2029

Pure oxyfuel & Oxyfuel kiln line
Titan Cement IFESTOS Project

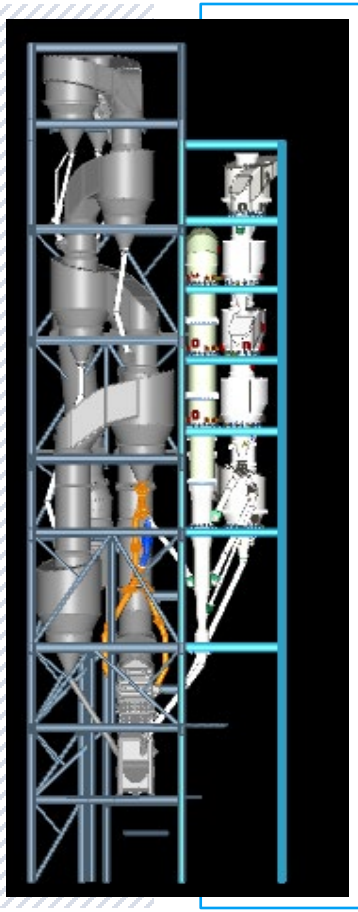
- 1,9 million tons of CO2 per year (biggest carbon capture project in the EU)
- Start: May 2022
- Planned operation from 2029

Polysius Separate Oxyfuel Calciner – A perfect revamp solution for existing plants



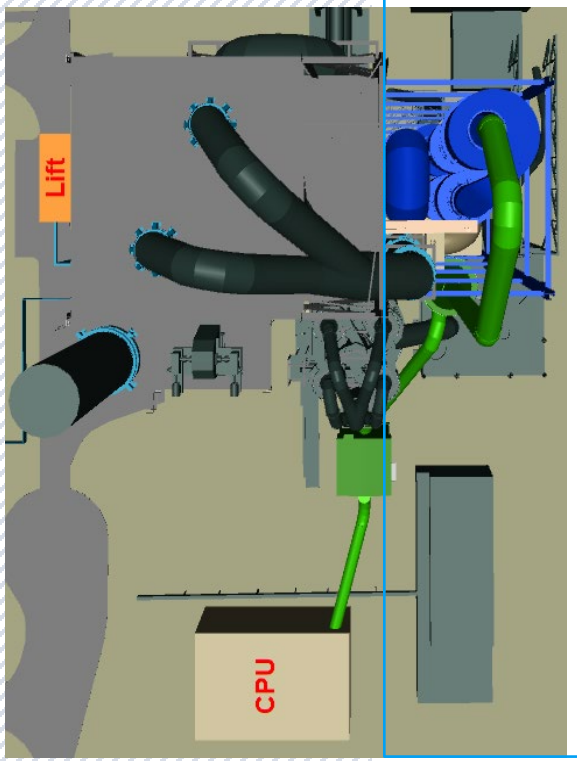
SOC can be built during operation, target is to capture 75 percent of CO_2 with a concentration of >90 percent

Polysius Separate Oxyfuel Calciner – A different approach



Existing calciner & preheater

New oxyfuel preheater



- 75% capturing ration
- “Revamp” approach for existing lines
- Lower CAPEX against full carbon capture approach
- Pilot plant planned with Taiwan Cement in Taiwan

Comparison between Polysius SOC and standard SOC

Dimension	Standard SOC solution	Main difference relating to…	Polysius SOC
Characteristic approach	Flue gas recycle to comply with solid to gas ratio of ~1 kg Gas/ kg Solids in the calciner		No or minimum flue gas recycle to comply with solid to gas ratio of ~2 kg Gas/ kg Solids in the calciner
Heat consumption	Higher	Less heat radiation, only half of the recycle gas needs to be reheated	Lower
Heat exchanger	High dust, cleaning required		Low dust, no cleaning required
False air intake until CPU	High	+2...5%	Low
CO2 concentration @CPU	Lower (<90%)	+2...5%	Higher (>90%)
Electr. pwr consumption (PH+Calc.)	Higher		Lower
Electr. pwr consumption CPU	Higher	~+6...20 kWh/tCO2	Lower
Volume of PH and calciner	100%	Factor 2	50%
CAPEX	Higher	relating to Heat exchanger, fan, preheater and calciner	Lower

*All figures are estimated

Activated Clays

Which are the market drivers for the cement industry applying an activated clay plant?

Drivers for activated clay…

An activated clay plant by thyssenkrupp …

… high clinker costs ✓

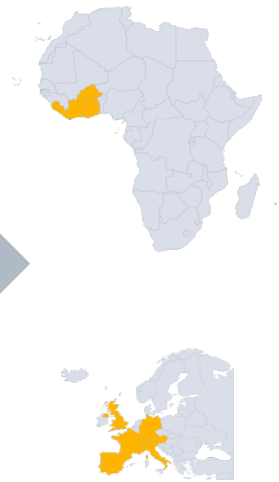
… sold out cement market ✓

… CO_2 reduction ✓

… circular economy ✓

…are applicable in different regions

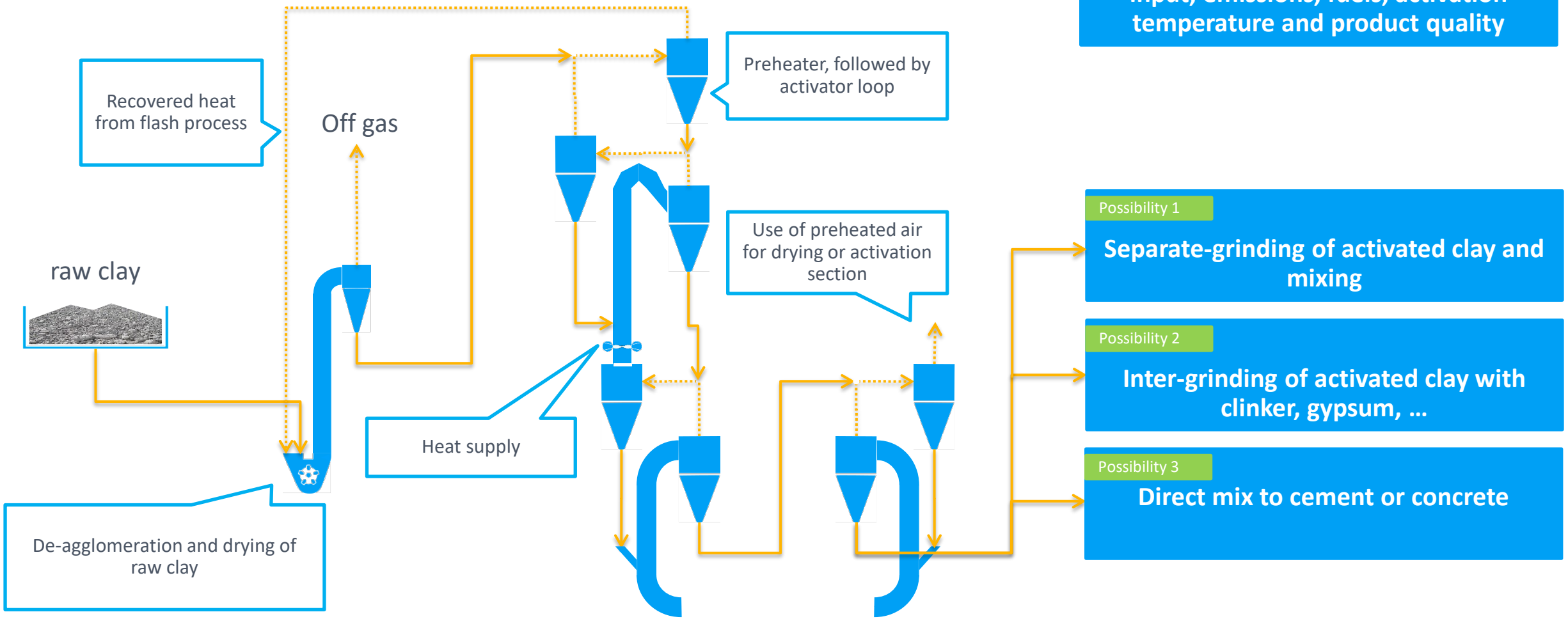
reduce the clinker factor



Less coal fired power plants and the transformation of green steel will boost the SCM market significantly!

General flow sheet of a flash activation process

Detailed process design based on individual boundaries like raw clay input, emissions, fuels, activation temperature and product quality



Grey2Green Projects – First Activated Clay Flash Calciner in the world with Cimpor

First activated clay plant on an industrial scale

Location: Kribi, Cameroon

- Customer: Cimpor Global Holdings
- Capacity: 720 t/day of activated clay per day
- Activated clay can play a crucial role to reduce the clinker factor for Cement producers. Reduces CO_2 during production process by ~30

First quality results are very positive convincing

meca-clay

grinding
minimum energy consumption for maximum surface area

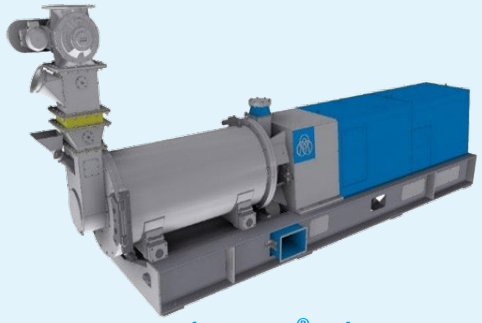
mechano-Chemical activation
maximum energy to create defects for further chemical process

Dry agitated bead mill technology

→ High-energy density

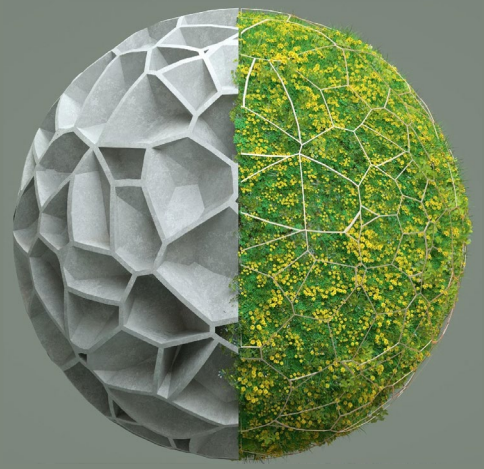
250-300 kW/m3 vs ~20 kW/m³ in a ball mill)

→ Scalability



polysius® charger

- ✓ Mechanochemistry does not change the laws of thermodynamics!
- ✓ Mechanochemistry is „green chemistry“ and replaces thermal energy by mechanical (electric) energy.
- ✓ Mechanochemical clay activation can avoid up to 70 % of the thermal CO_2 emissions from calcining clay (depending on the desired SCM performance and the source of electrical power used)



First Reference Plant –for MeCAClay – An industrial break-through in the SCM market

Comparison between different ways of activating clays

Dimension	Calcined Clay	MeCA Clay
Method	Thermal activation	Mechano-Chemical activation
Raw material	Feed stock limitation (min. kaolinite share)	Any type of clay
Energy source	Fossil fuels predominantly required	(green) electrical energy
Emissions	Gas cleaning required	Minimal emissions
Process and plant layout	Separate calcining and grinding	All in one, compact and simple
Product quality	Non adjustable	Adjustable, less water demand, high early strength
Heat consumption in [kcal/kg]	525 (= 609 kWh/t)	150 (= 174 kWh/t for drying)
Electrical consumption in [kWh/t]	66 (20 for grinding)	~450* (for activation & grinding)
Overall energy consumption in [kWh/t]	675 (**90% th** + **10% el**)	624 (**28% th** + **72% el**)

Mechanochemical clay activation can avoid up to 70 % of the thermal CO_2 emissions from calcining clay

Summary

- Polysius Pure Oxyfuel (2nd generation) is has significant CAPEX and OPEX advantages for Carbon Capture against the 1st generation of Oxyfuel
- A Polysius Separate Oxyfuel Calciner is the perfect revamp solution for existing production lines capturing 75 percent of the CO_2
- The demand for more SCMs will strongly grow on a global scale
- meca clay is a technical revolution to further reduce the carbon footprint of activated clays

Thank you very much for your attention!