SCCS workshop on Industrial CCS, August 28th 2015

CEMCAP – a Horizon 2020 project on CO_2 capture from cement production

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CEMCAP

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The need for CCS in Cement production

- Cement production constitute ~5% of global anthropogenic CO_2 emissions
- In 2013 approximately 20% of global CO_2 emissions from cement production originated from Europe
- About 60% of the CO_2 emissions originate from the conversion of $CaCO_3$ to CaO, the rest is from combustion of fossil fuels and electric power generation
- Cement plants typically have a long lifetime (30-50 years or more) and very few (if any) are likely to be built in Europe

- Consequently:
  - CCS is the only viable measure to significantly reduce CO_2 emissions from the cement industry
  - In Europe, CO_2 capture must be retrofitted to existing cement plants

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The CEMCAP objectives

The **primary objective of CEMCAP** is

To prepare the ground for large-scale implementation of CO_2 capture in the European cement industry

To achieve this objective, **CEMCAP will**

Leverage to TRL6 for cement plants the oxyfuel capture technology and three fundamentally different post combustion capture technologies, all of them with a targeted capture rate of 90%.

Identify the CO_2 capture technologies with the greatest potential to be retrofitted to existing cement plants in a cost- and resource-effective manner, maintaining product quality and environmental compatibility.

Formulate a techno-economic decision-basis for CO_2 capture implementation in the cement industry, where the current uncertainty regarding CO_2 capture cost is reduced by at least 50%.

CEMCAP metrics

- Horizon2020 project coordinated by SINTEF Energy Research
- Duration: May 1st 2015 – October 31st 2018 (42 months)
- Budget: € 10 million
- EC contribution € 8.8 million
- Swiss government contribution: CHF 0.7 million
- Number of partners: 15

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CEMCAP Consortium

Cement Producers

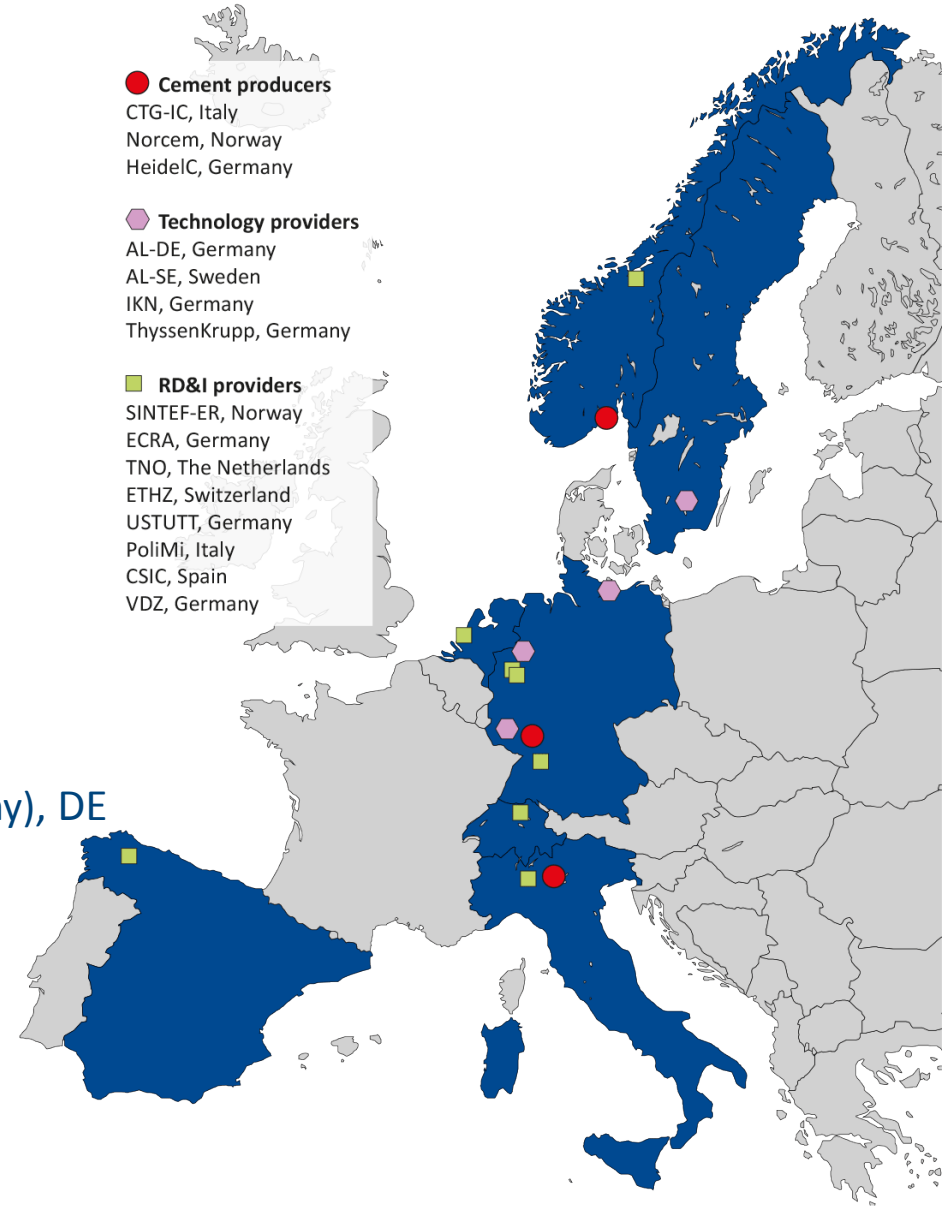
CTG (Group Technical Centre of Italcementi), IT
Norcem, NO
HeidelbergCement, DE

Technology Providers

Alstom Carbon Capture (AL-DE), DE
Alstom Power Sweden (AL-SE), SE
IKN, DE
ThyssenKrupp Industrial Solutions, DE

Research Partners

SINTEF Energy Research, NO
ECRA (European Cement Research Academy), DE
TNO, NL
EHTZ, CH
University of Stuttgart, DE
Politecnico di Milano, IT
CSIC, ES
VDZ, DE



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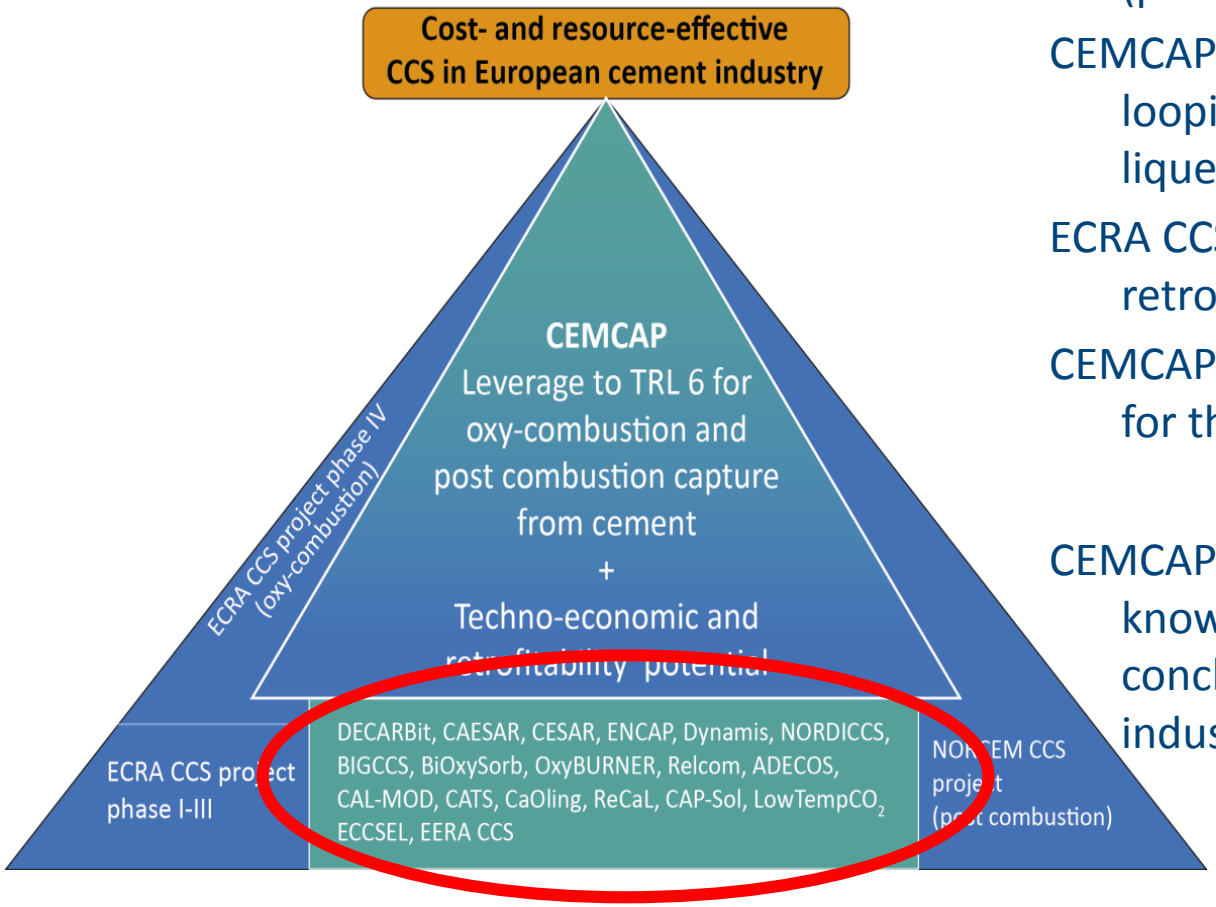
CEMCAP relation to Norcem and ECRA CCS projects



Norcem CCS project: Testing of amine, membrane, solid sorbent, Ca-looping (post-combustion)

CEMCAP: testing of chilled ammonia, Ca-looping, membrane-assisted CO_2 – liquefaction

ECRA CCS project: focusing on oxyfuel retrofit in its current phase IV

CEMCAP: testing of three key components for the oxyfuel plant

CEMCAP base: competence and knowledge from ongoing and concluded CCS projects for power industry

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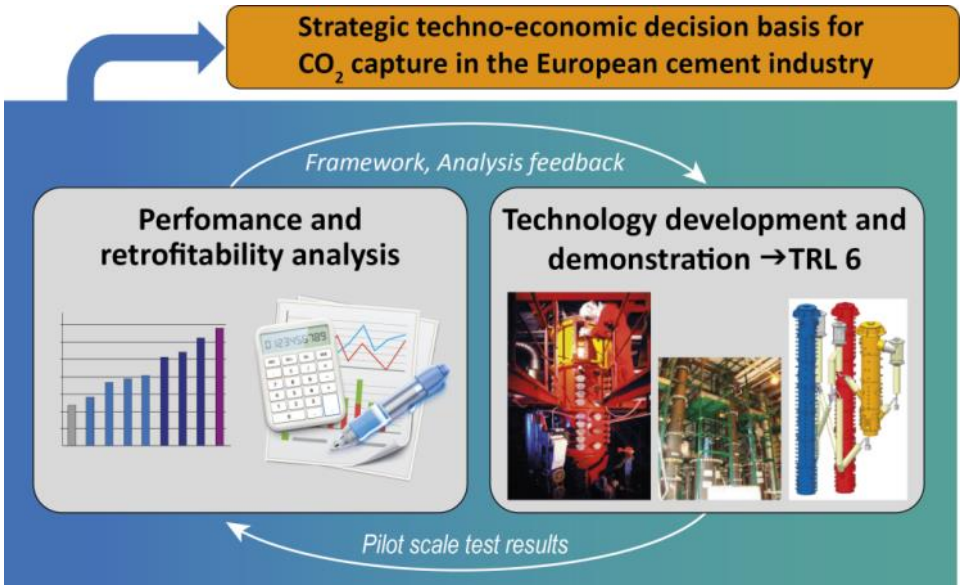
CEMCAP approach: iteration between analytical and experimental research



Analytical work

Capture process simulations

Simulations of full cement plants (kilns) with CO_2 capture

Cost estimations/benchmarking

Retrofitability analysis

Experimental work

Testing of three components for oxyfuel capture

Testing of three different post-combustion capture technologies

~10 different experimental rigs

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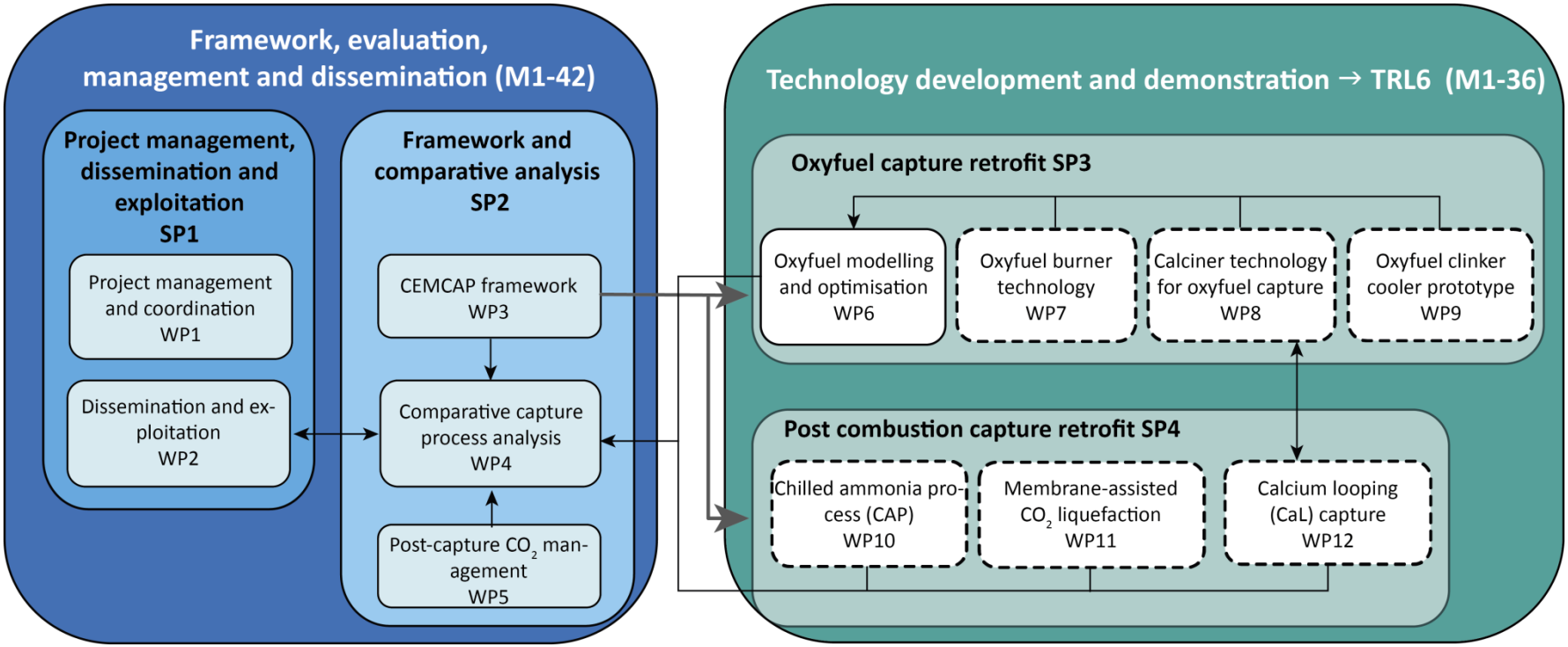
Project structure



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Technologies to be tested - oxyfuel

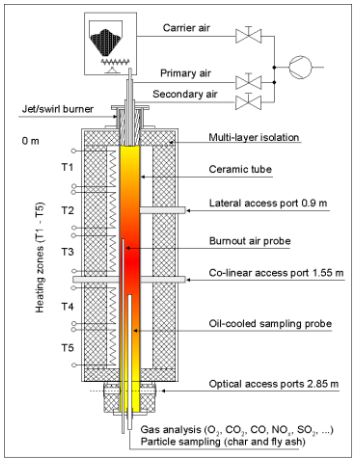
Oxyfuel burner

Existing 500 kWth oxyfuel burner at USTUTT to be modified for CEMCAP

Partners: USTUTT, TKIS, SINTEF-ER

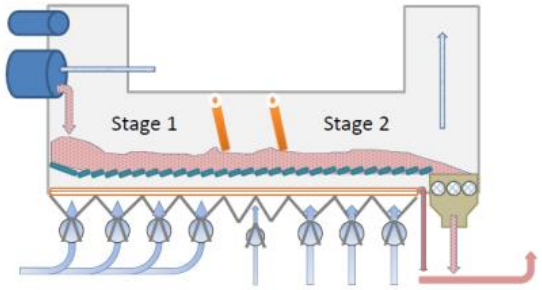
Calciner test rig

Existing <50 kWth entrained flow calciner (USTUTT) to be used for oxyfuel calcination tests



Partners: USTUTT, VDZ, IKN, CTG

Clinker cooler To be designed and built for on-site testing at HeidelbergCement in Hannover



Partners: IKN, HeidelC, VDZ

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Technologies to be tested – post-combustion capture

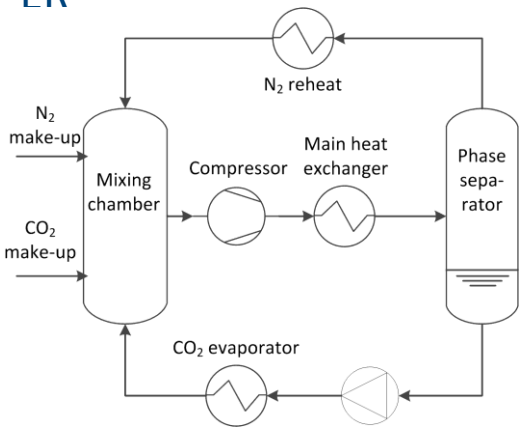
Chilled Ammonia Process (CAP)
Tests at Alstom Power Sweden (never tested for such high CO_2 concentrations before)

Partners: ETHZ, AL-SE, AL-DE

Membrane assisted CO_2 liquefaction

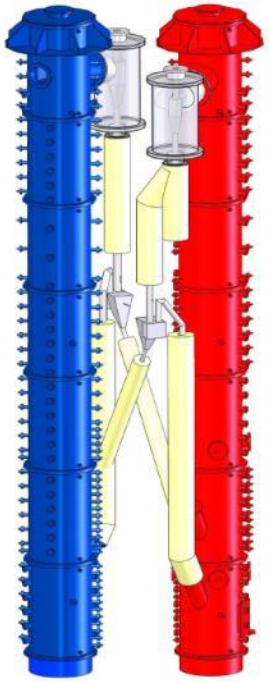
Membrane tests: TNO

Liquefaction tests: SINTEF-ER



Partners: TNO, SINTEF-ER

Ca-looping (USTUTT, CSIC rigs)



Partners: USTUTT, CTG, PoliMi, CSIC, IKN

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Characteristics of technologies included in CEMCAP

	Oxyfuel capture	Post combustion capture technologies		
		Chilled ammonia	Membrane-assisted CO_2 liquefaction	Calcium Looping
CO_2 capture principle	Combustion in oxygen (not air) gives a CO_2-rich exhaust	NH_3/water mixture used as liquid solvent, regenerated through heat addition	Polymeric membrane for exhaust CO_2 enrichment followed by CO_2 liquefaction	CaO reacts with CO_2 to from $CaCO_3$, which is regenerated through heat addition
Cement plant integration	Retrofit possible through modification of burner and clinker cooler	Retrofit appears simple, minor modifications required for heat integration	No cement plant modifications. Upstream SOx, NOx, H_2O removal required	Waste from capture process (CaO) is cement plant raw material
Clinker quality	Maintained quality must be confirmed	Unchanged	Unchanged	Clinker quality is very likely to be maintained
CO_2 purity and capture rate	CO_2 purification unit (CPU) needed. High capture rate and CO_2 purity possible (trade-off against power consumption).	Very high CO_2 purity, can also capture NOx, SOx. High capture rate possible.	High CO_2 purity (minor CO_2 impurities present). Trade-off between power consumption and CO_2 purity and capture rate.	Rather high CO_2 purity (minor/moderate CO_2 impurities present). High capture rate.
Energy integration	Fuel demand unchanged. Waste heat recovery + electric power increase.	Auxiliary boiler required + waste heat recovery. Electricity for chilling.	Increase in electric power consumption, no heat integration.	Additional fuel required, enables low-emission electricity generation.

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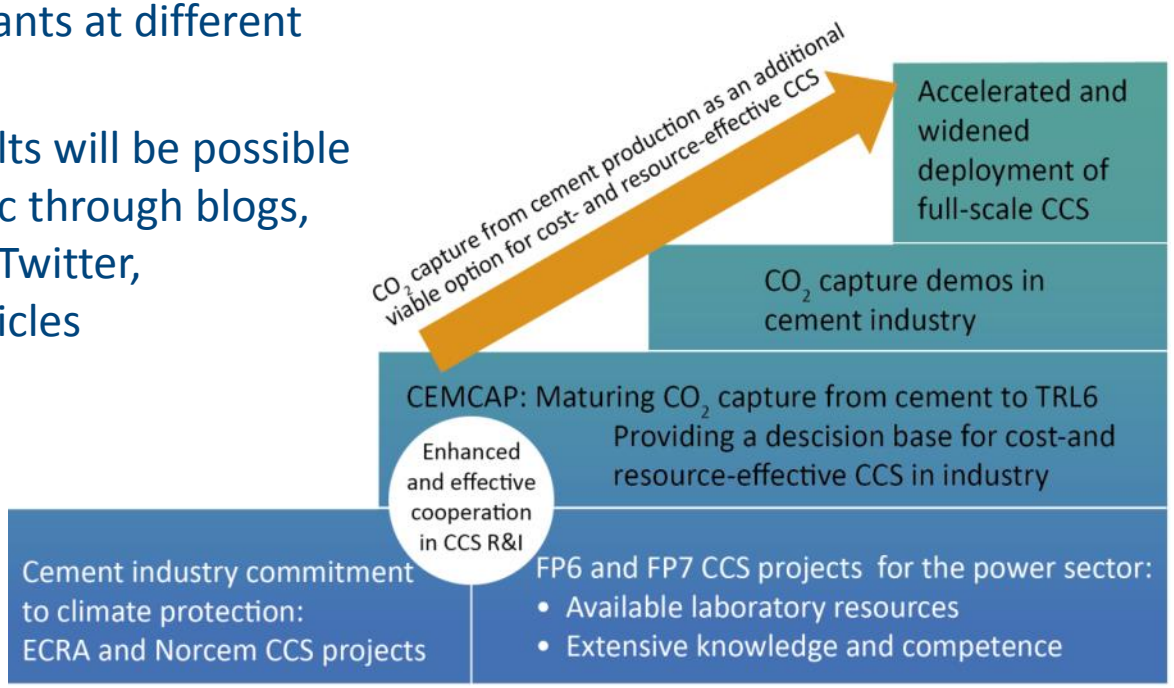
CEMCAP final results

CEMCAP will deliver strategic conclusions for how to progress CO_2 capture from cement plants from pilot-scale testing to demonstration and implementation

Recommendations will be given for different scenarios (i.e. different types of cement plants at different locations in Europe)

CEMCAP progress towards final results will be possible to follow for the interested public through blogs, newsletters, website, Facebook, Twitter, conferences and pop-science articles



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Thank you for your attention!

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