CLEAN clinKER by calcium looping for low-CO_2 cement

CLEANKER

17th October 2018, Brussel - Belgium
ECRA/CEMCAP/CLEANKER Workshop
"Carbon Capture Technologies in the Cement Industry"

EU research project CLEANKER Technology, progress and project perspectives

Martina Fantini

Summary

- Project objectives
- The demo plant
- The consortium
- Work packages and main activities
- CLEANKER project timeline

Primary project objectives

The ultimate objective of CLEANKER is advancing the integrated Calcium-looping process for CO_2 capture in cement plants.

This fundamental objective will be achieved by pursuing the following primary targets:

- **Demonstrate the integrated CaL process at TRL 7, in a new demo system connected to the operating cement burning line of the Vernasca 900.000 ton/y cement plant, operated by BUZZI in Italy.**
- **Demonstrate the technical-economic feasibility of the integrated CaL process in retrofitted large scale cement plants through process modelling and scale-up study.**
- **Demonstrate the storage of the CO_2 captured from the CaL demo system, through mineralization of inorganic material in a pilot reactor of 100 litres to be built in Vernasca, next to the CaL demo system.**

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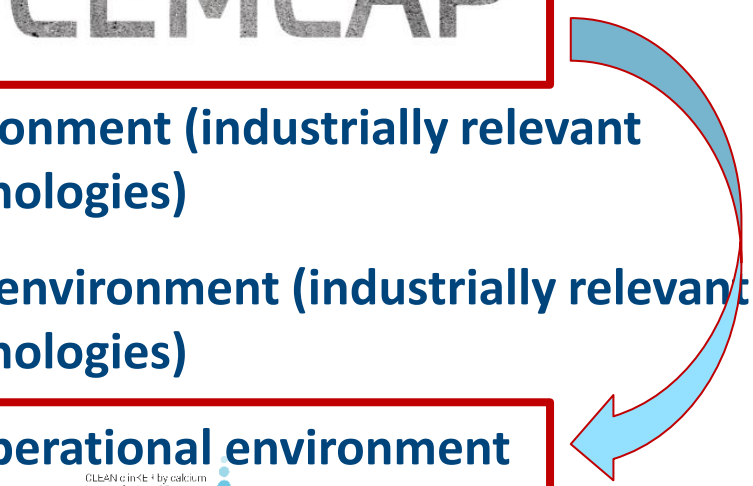
Vernasca plant location

Primary project objectives

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)



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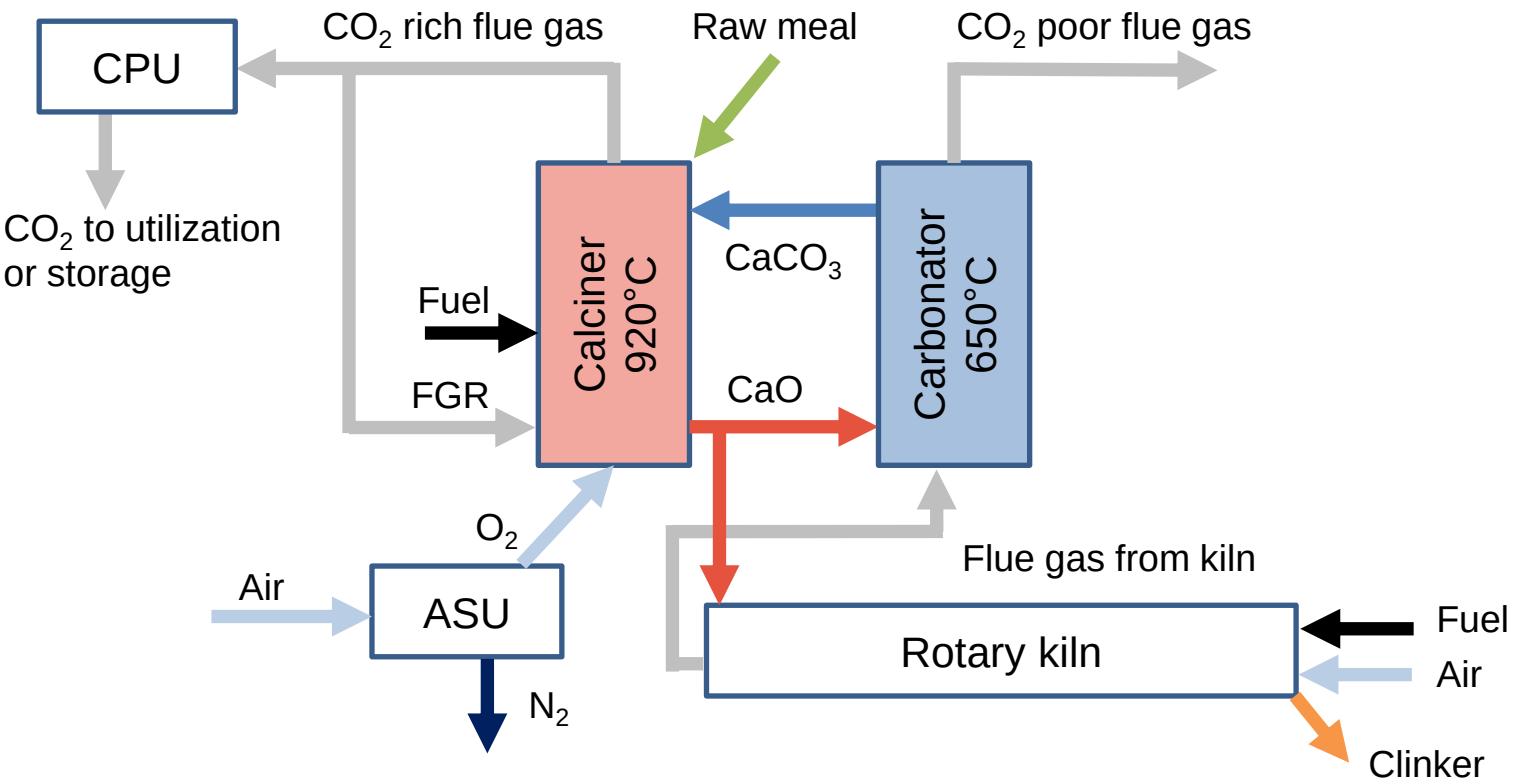
Schematic of the integrated CaL concept

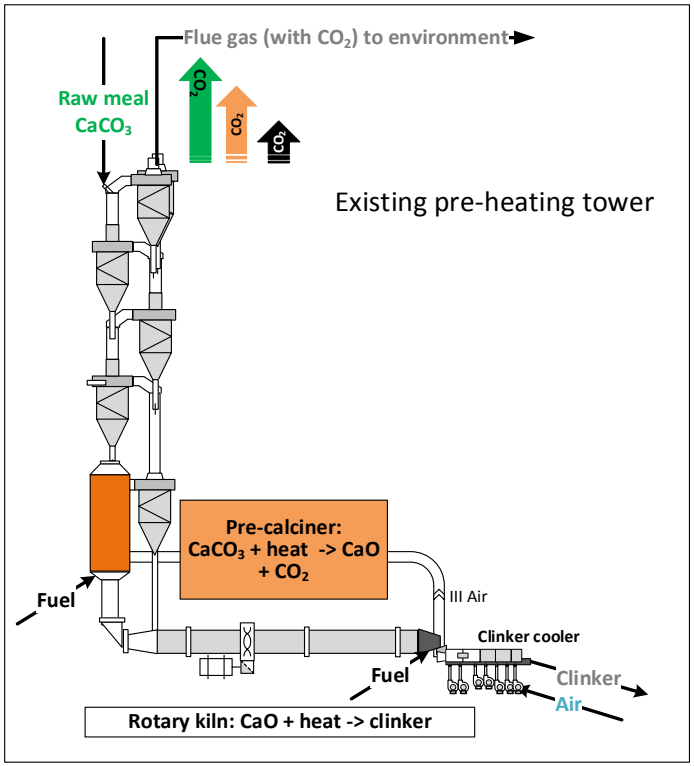


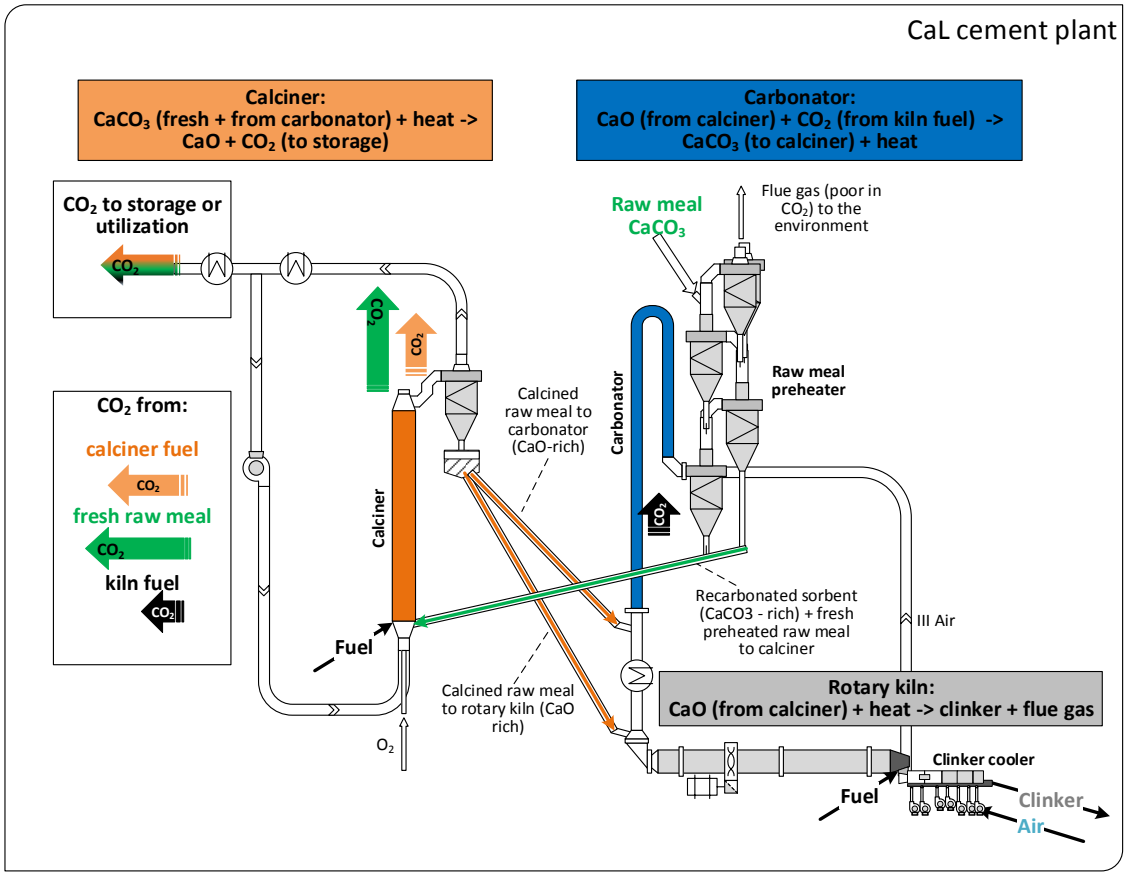
Calcination:

$$CaCO_3 + O_2 + \text{fuel (CH)} \rightarrow CaO + CO_2 + CO_2 + H_2O \text{ (920°C)}$$

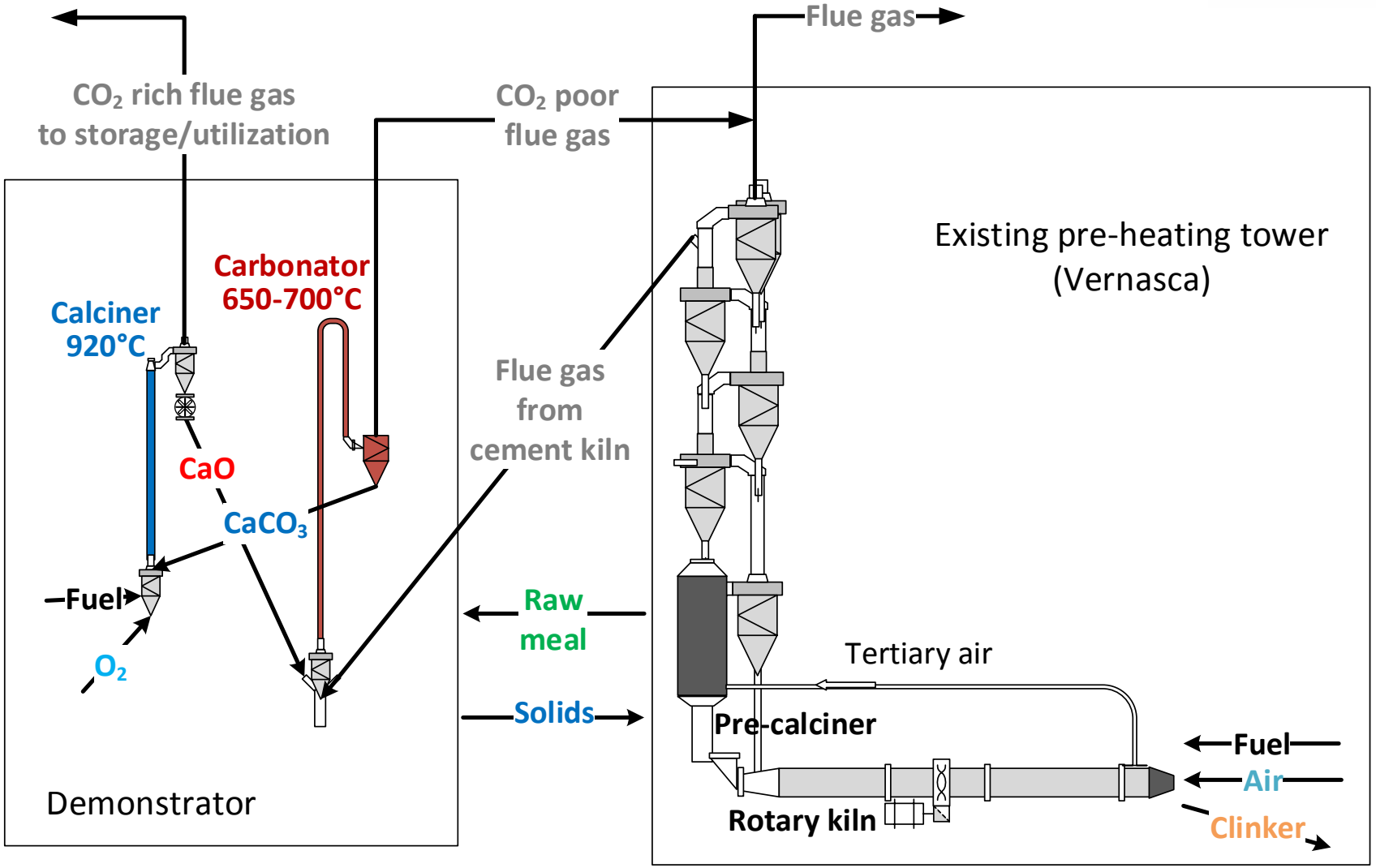
$$+ CO_2 \text{ (650°C)}$$

Integrated CaL concept

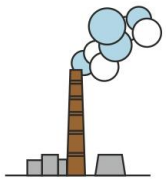




Indicative configuration of the CLEANKER pilot

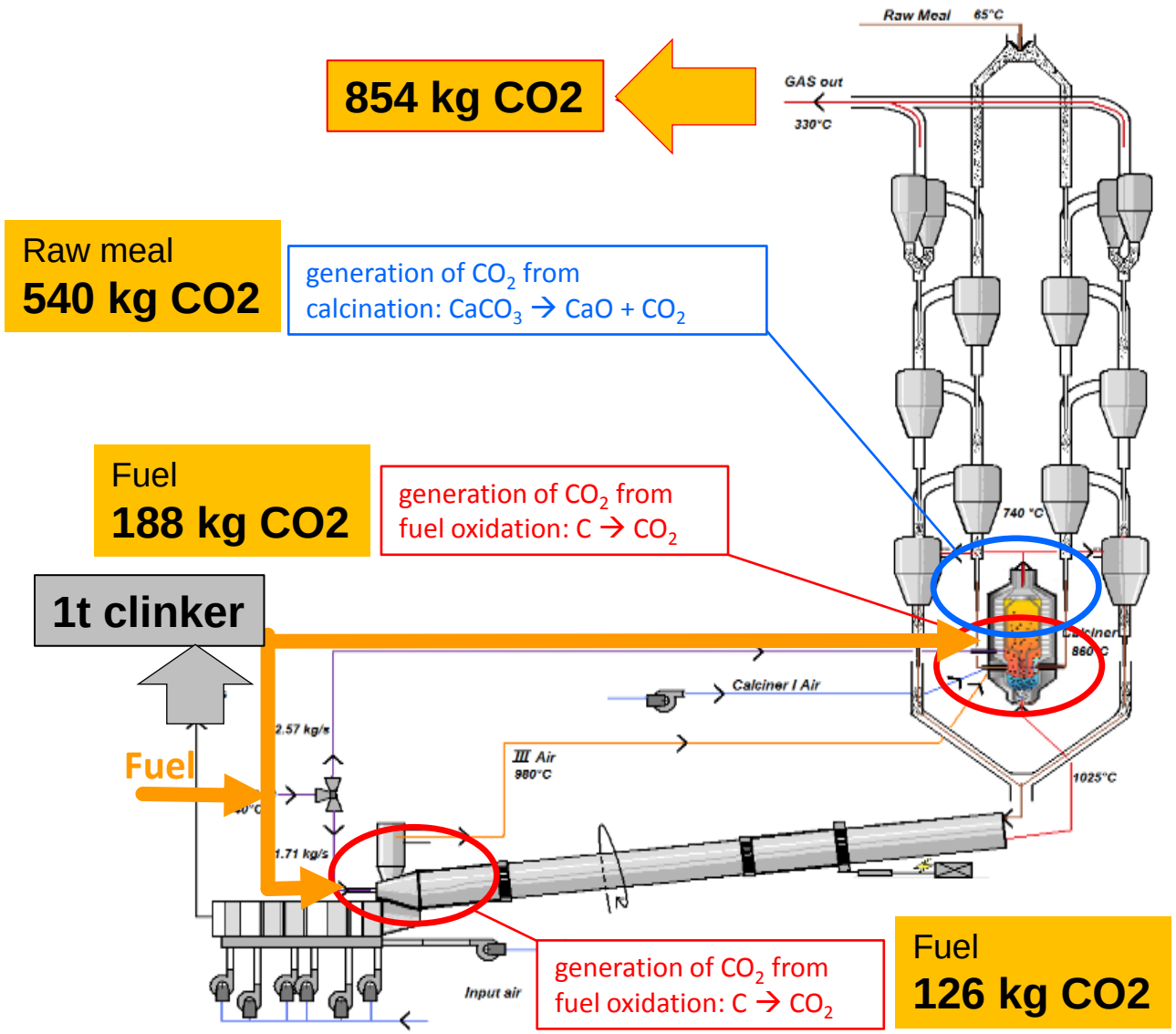


Project targets

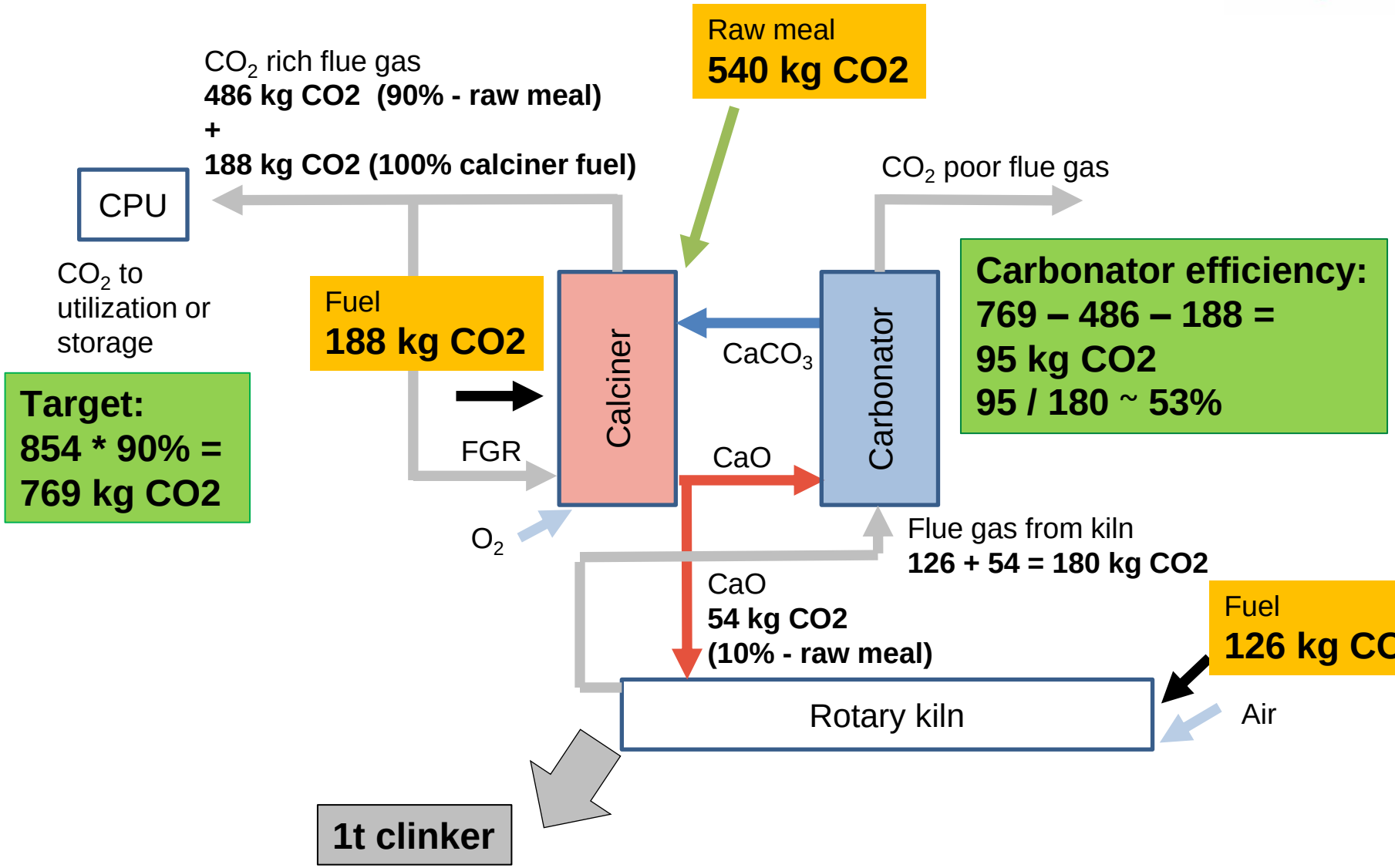
Objective	Key indexes	Target
CO_2 emissions 	• CO_2 capture efficiency • CO_2 specific emissions	• Cement plant CO_2 capture efficiency >90% • Negative direct CO_2 emissions by biomass co-firing (Bio-CCS) • Reduction of total CO_2 specific emissions (kg_{CO2} per ton of cement) >85%*
Energy efficiency 	• Fuel consumption • Electricity consumption • Specific primary energy consumption for CO_2 avoided (SPECCA*)	• increase of total fuel consumption with respect to state of the art plants <40%* • increase of electric consumption with respect to state of the art plants <20%* • SPECCA* < 2 MJ_{LHV} per kg of CO_2 avoided • SPECCA* at least 10% lower than that of benchmark full oxyfuel cement plants
Economics 	• Cost of cement • Cost of CO_2 avoided	• Increase of cement cost < 25 €/$_{tcement}$ • Cost of CO_2 avoided <30 €/t_{CO2}

**SPECCA = Specific primary energy consumption for CO_2 avoided*

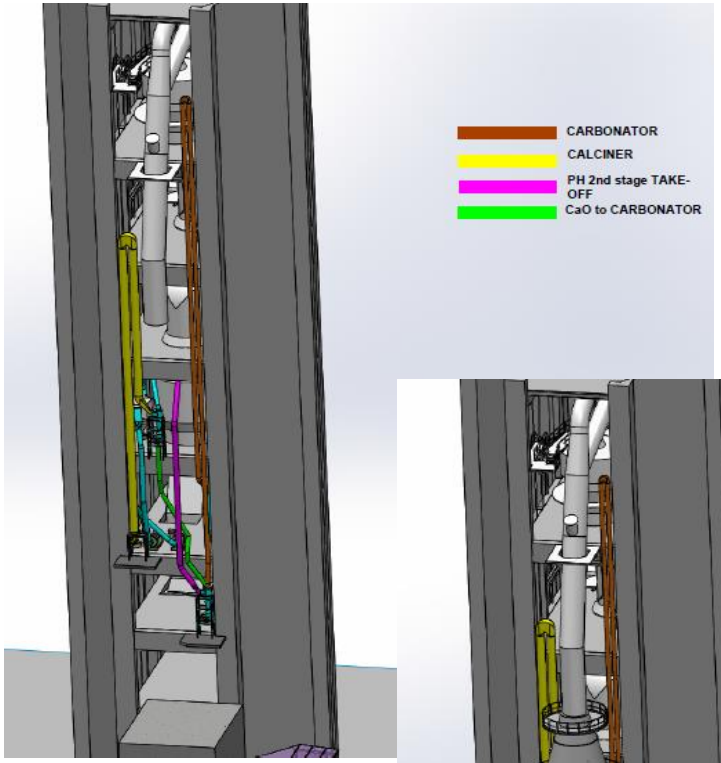
Minimum carbonator efficiency required?

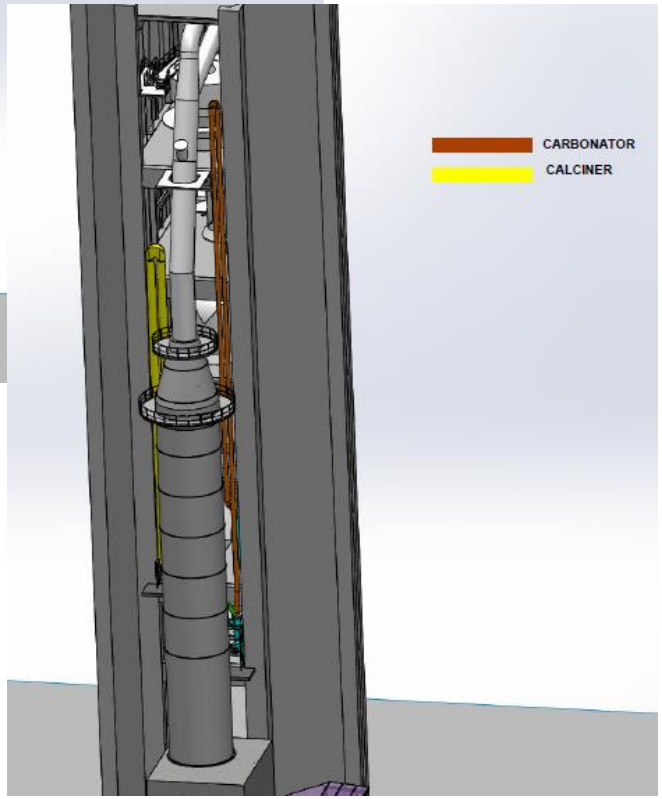


Minimum carbonator efficiency required?



Vernasca kiln preheater and rendering of CaL pilot





The consortium

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CLEANKER

Starting date: October 1st 2017

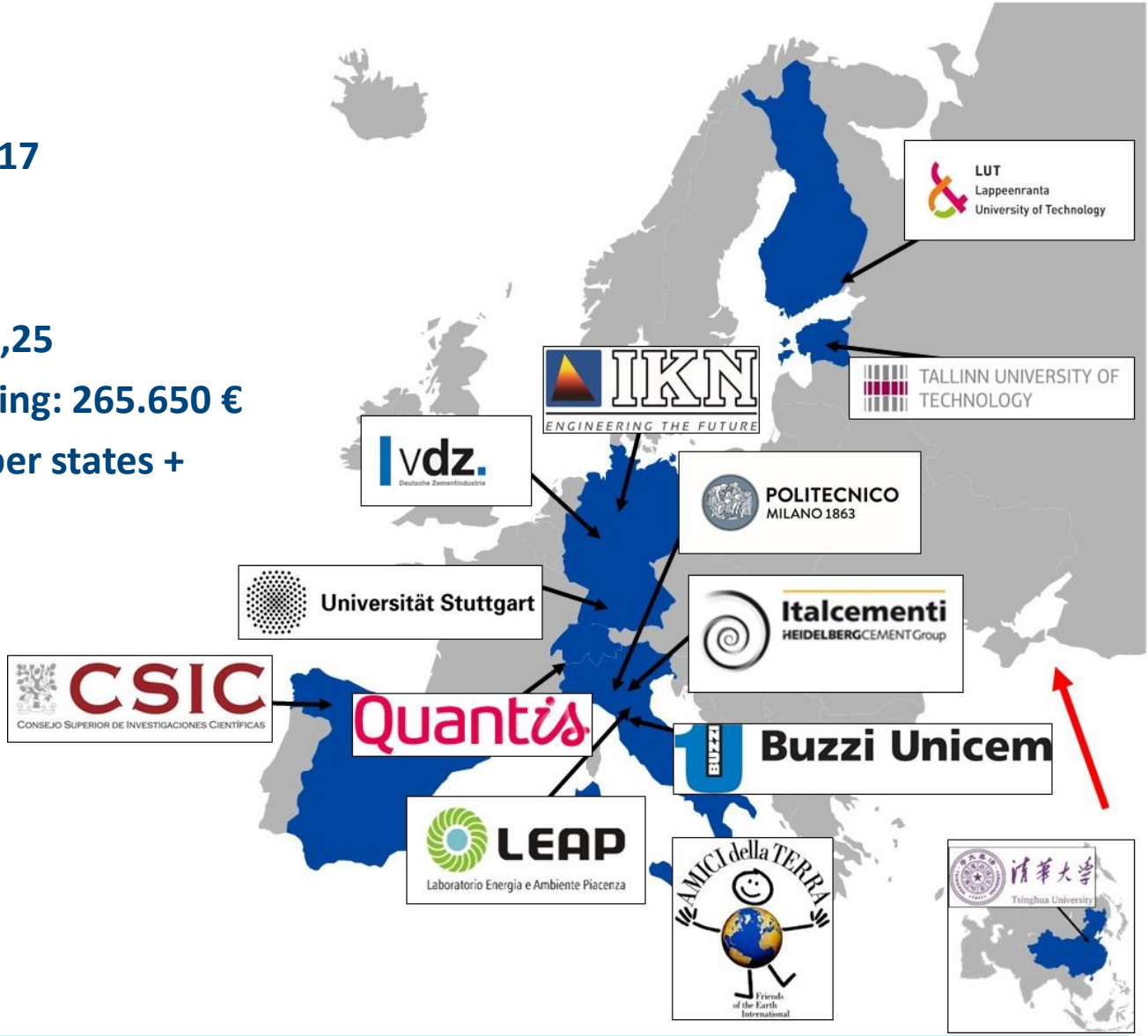
Duration: 4 years

Total budget: € 9.237.851,25

UE co-financing: € 8.972.201,25

Chinese governement founding: 265.650 €

Partner: 13 from 5 EU member states + Switzerland and China



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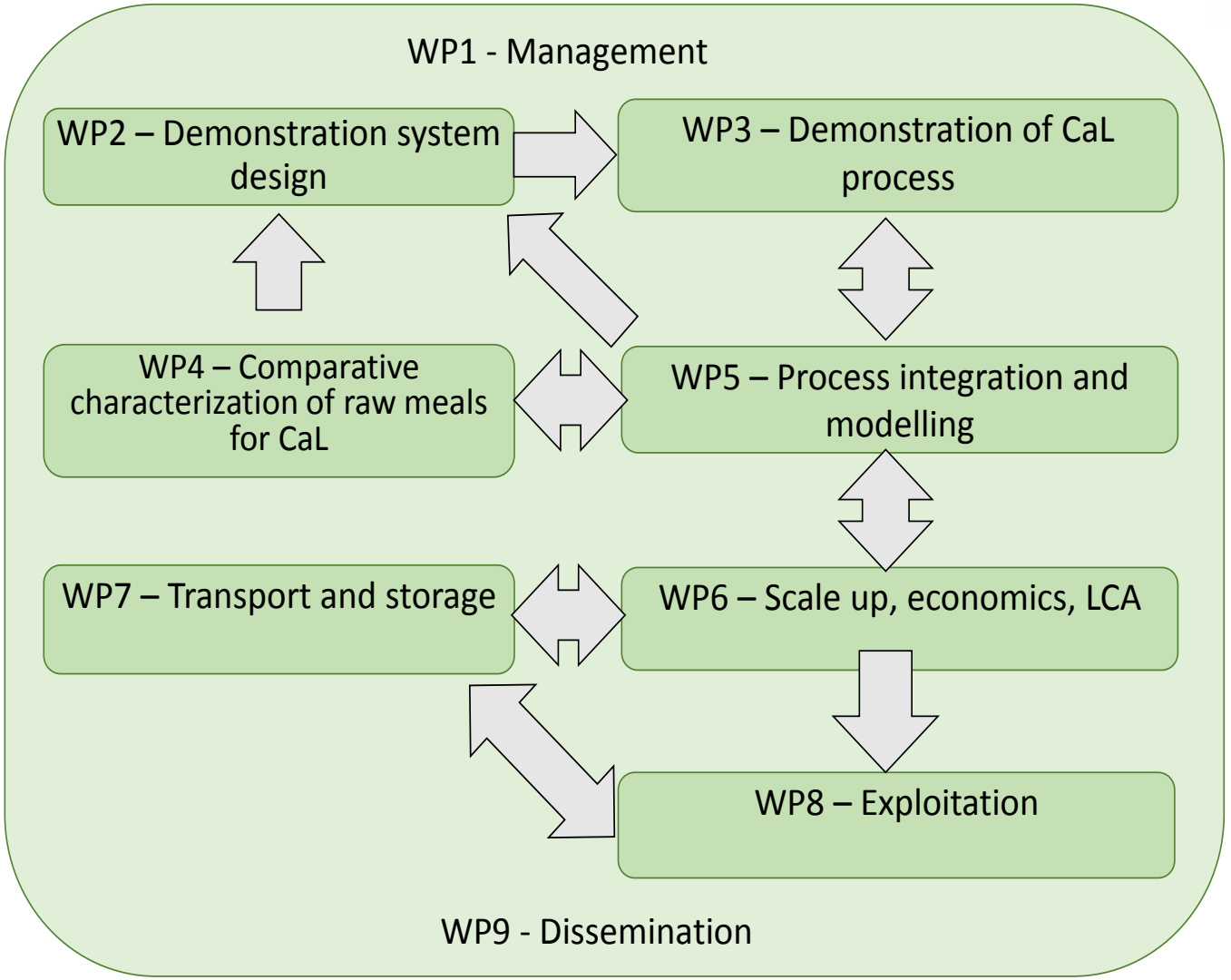
The WPs structure

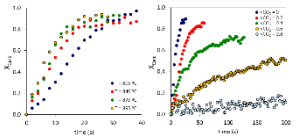


CLEANKER timeline

1st October 2017

17-18 October 2017
Kick-off meeting
(Piacenza)

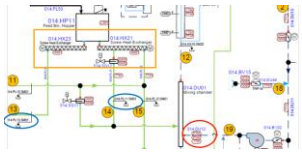
July 2018
Raw meal
characterization



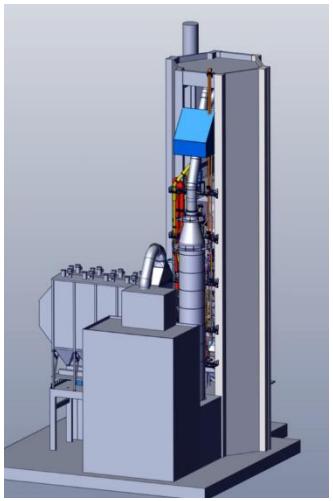
2017 | 2018 | 2019 | 2020 | 2021

30th September 2021

June 2018
Measuring points
and
instrumentation



July 2018
Final Plant layout

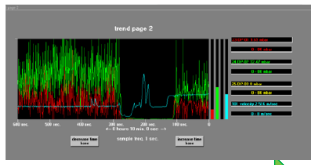


December 2019
Erection

March 2019
Main items fabrication

January 2020
Inspection

March 2020
Running tests and
data analysis



April 2021
Casting concrete results
and full economic analysis
of cement plant with CaL

September 2021
Strategic conclusions

Acknowledgments

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