Unlocking Solar Thermochemical Potential: Markets, Opportunities, and Challenges

Workshop – November 12th, 2020

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CEMEX – GLOBAL CONSTRUCTION MATERIALS

Cement

Aggregates

Ready-Mix

● CEMEX OPERATIONS ● A GLOBAL TRADING NETWORK

NET SALES	**13,130**
EBITDA	**2,378**
FREE CASH FLOW	**695**

Millions USD

Urbanization Solutions

Sustainability

Admixtures

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CEMENT

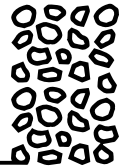
65 CEMENT AND GRINDING PLANTS

93 MILLION TONS PRODUCTION CAPACITY

AGGREGATES

262 QUARRIES

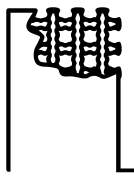
135 MILLION TONS ANNUAL SALES VOLUME



PEOPLE

+40.6 THOUSAND EMPLOYEES

READY-MIX CONCRETE

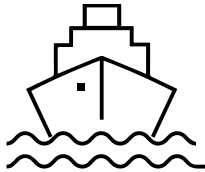


1,427 PLANTS

50 MILLION m^3 ANNUAL SALES VOLUME

TERMINALS

279 LAND DISTRIBUTION CENTERS



56 MARINE TERMINALS

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CEMEX – CLIMATE ACTION

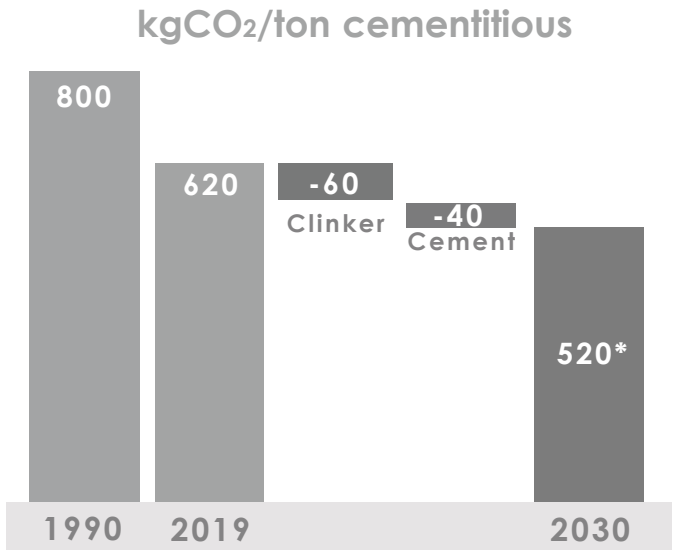
Target 2030:

Cement

35%

Reduction of CO_2 Emissions vs 1990 Baseline

Aligned with the 2 Degree scenario of the IEA



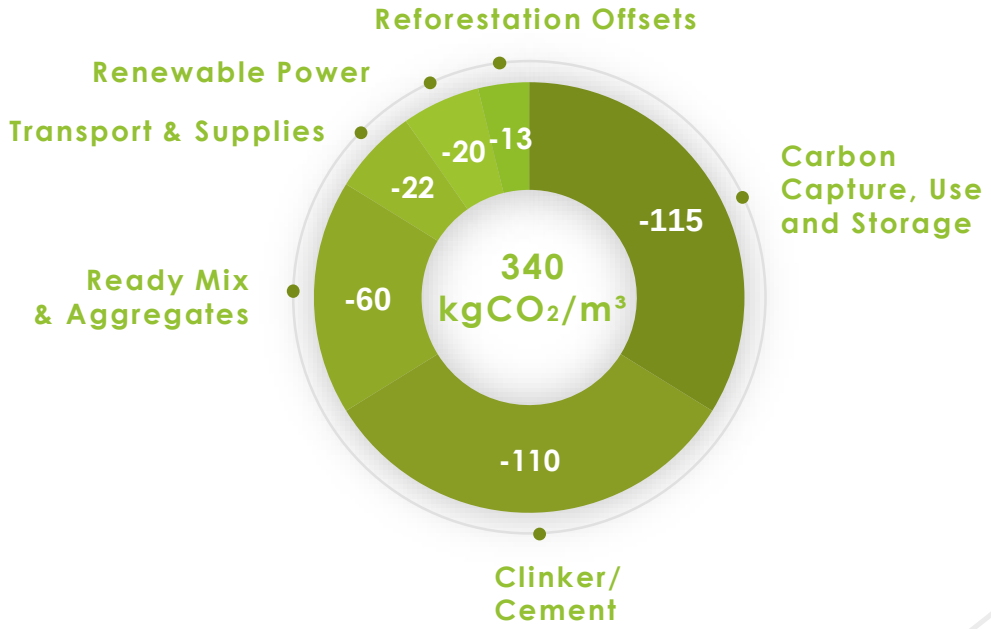
Proven technology, focus on fast deployment and removing barriers

Ambition 2050:

Concrete

Net-zero CO2 Concrete Globally

Estimated CO2 Footprint for a high strength concrete produced with cement Type I



A significant portion of CO_2 mitigation (> 30%) will rely on technologies not yet fully developed – not industrially and commercially viable. Innovation / R&D.

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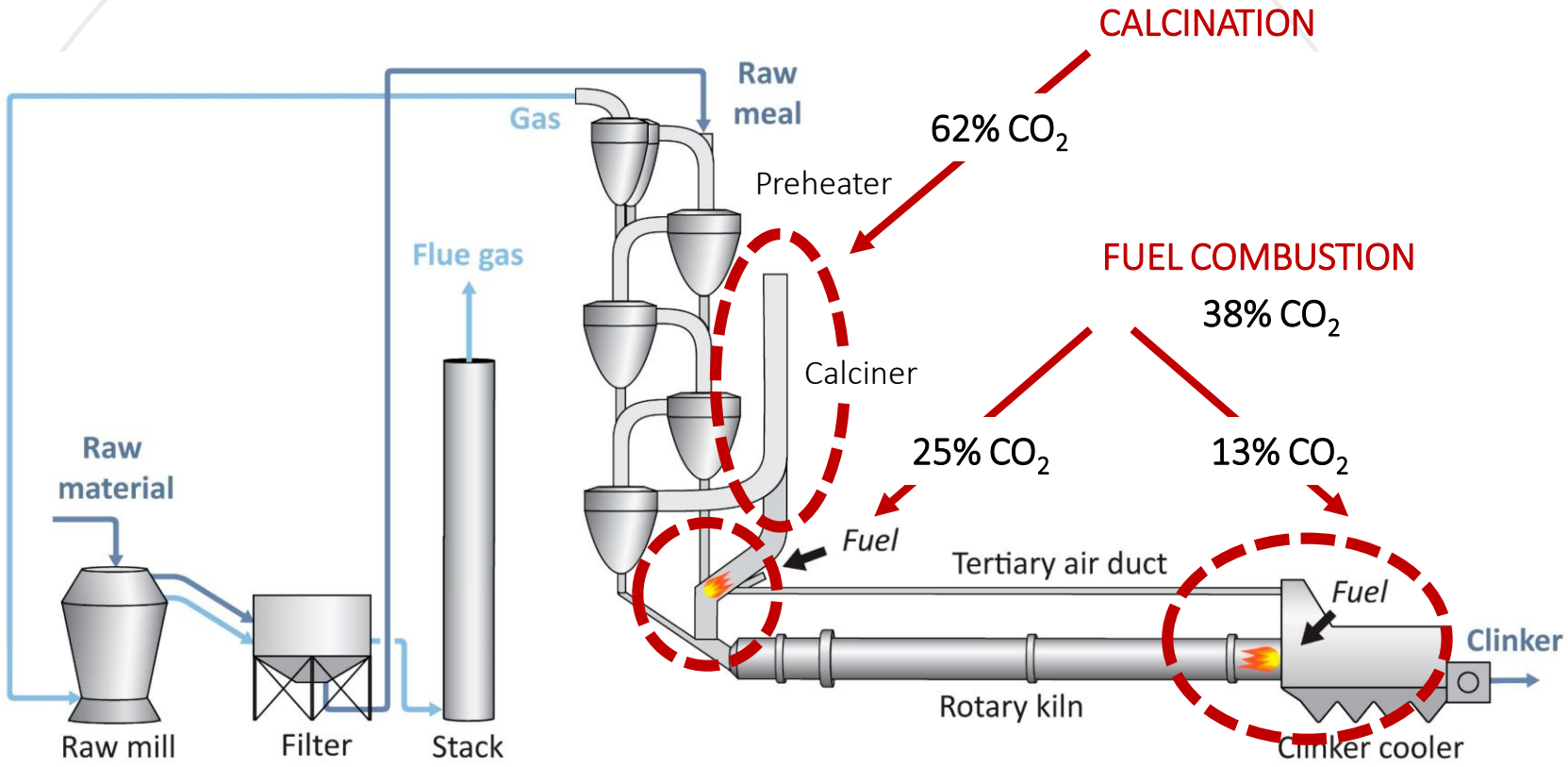
CLINKER MANUFACTURING PROCESS



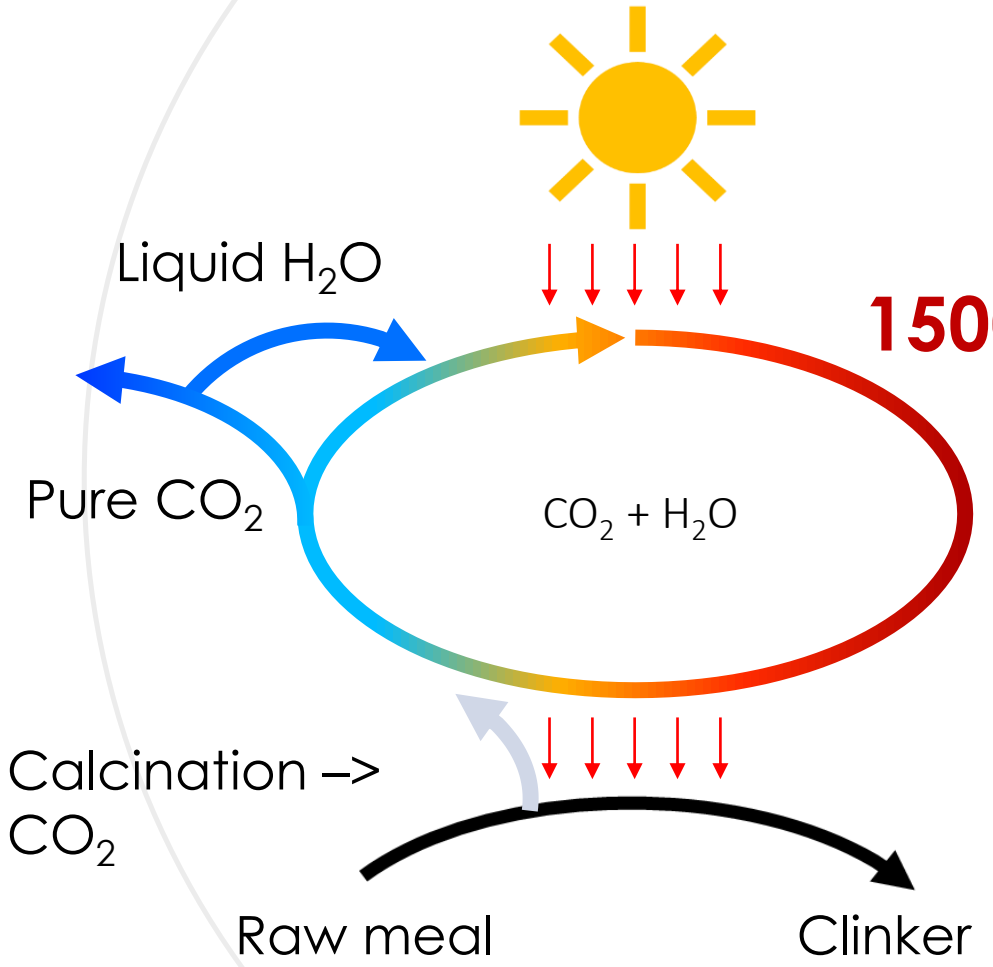
CHALLENGES

- CO_2 Reduction
- CO_2 Concentration & Capture
- CO_2 Reutilization

Cement Manufacture Diagram - Pires, J.. (2019). Carbon Capture and Storage.

SOLAR-DRIVEN PYRO-PROCESSING OF CLINKER

High Performance High Temperature Solar Heat & Thermo-Chemical Processes



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- **DRIVE FULL PROCESS WITH SOLAR ENERGY** in-line with conventional process flow
- **NO** CO_2 emissions
- **NO** fuel costs

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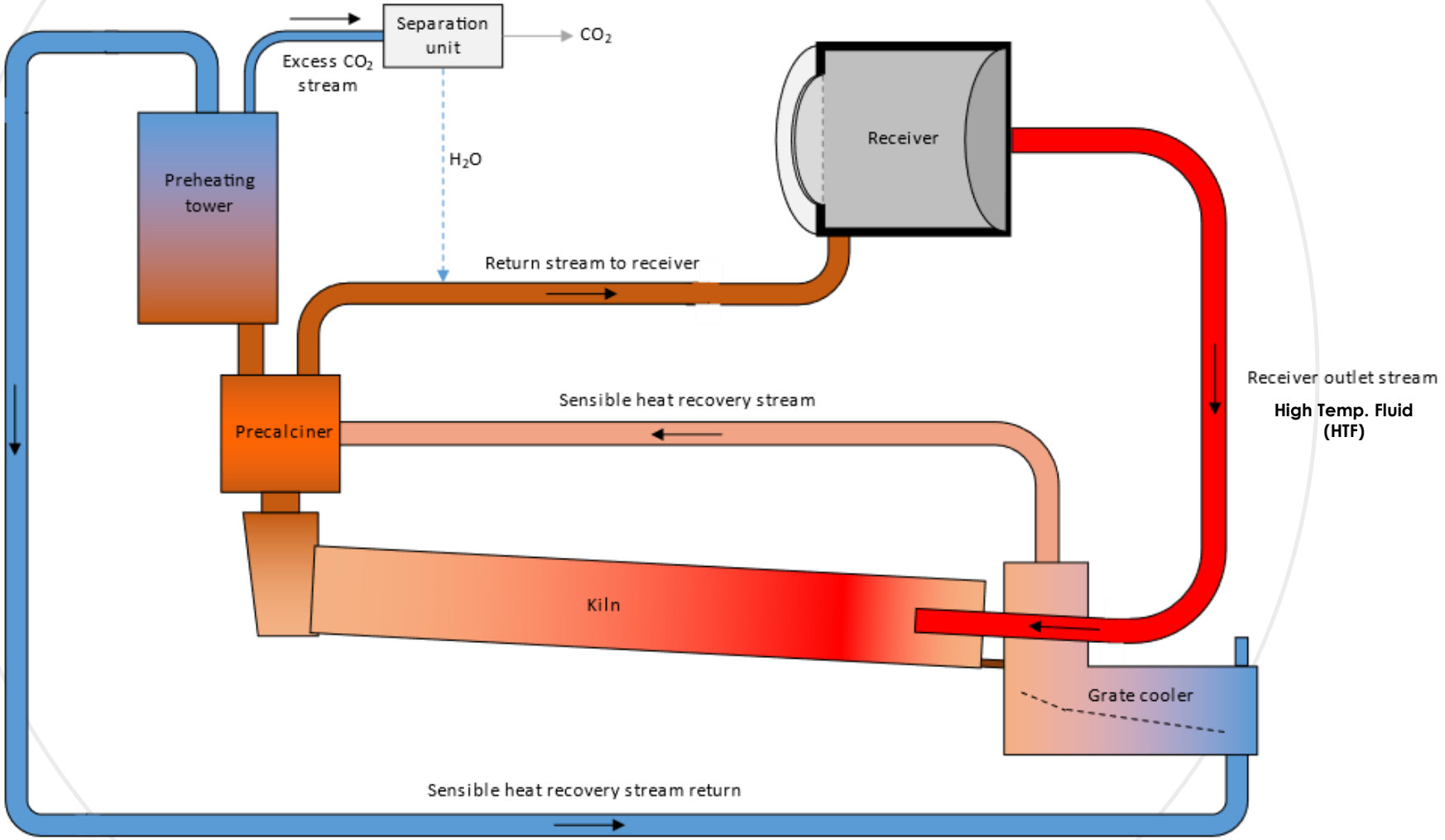
SOLAR-DRIVEN PYRO-PROCESSING OF CLINKER

High Level Conceptualization – Inspiration of the Aspiration



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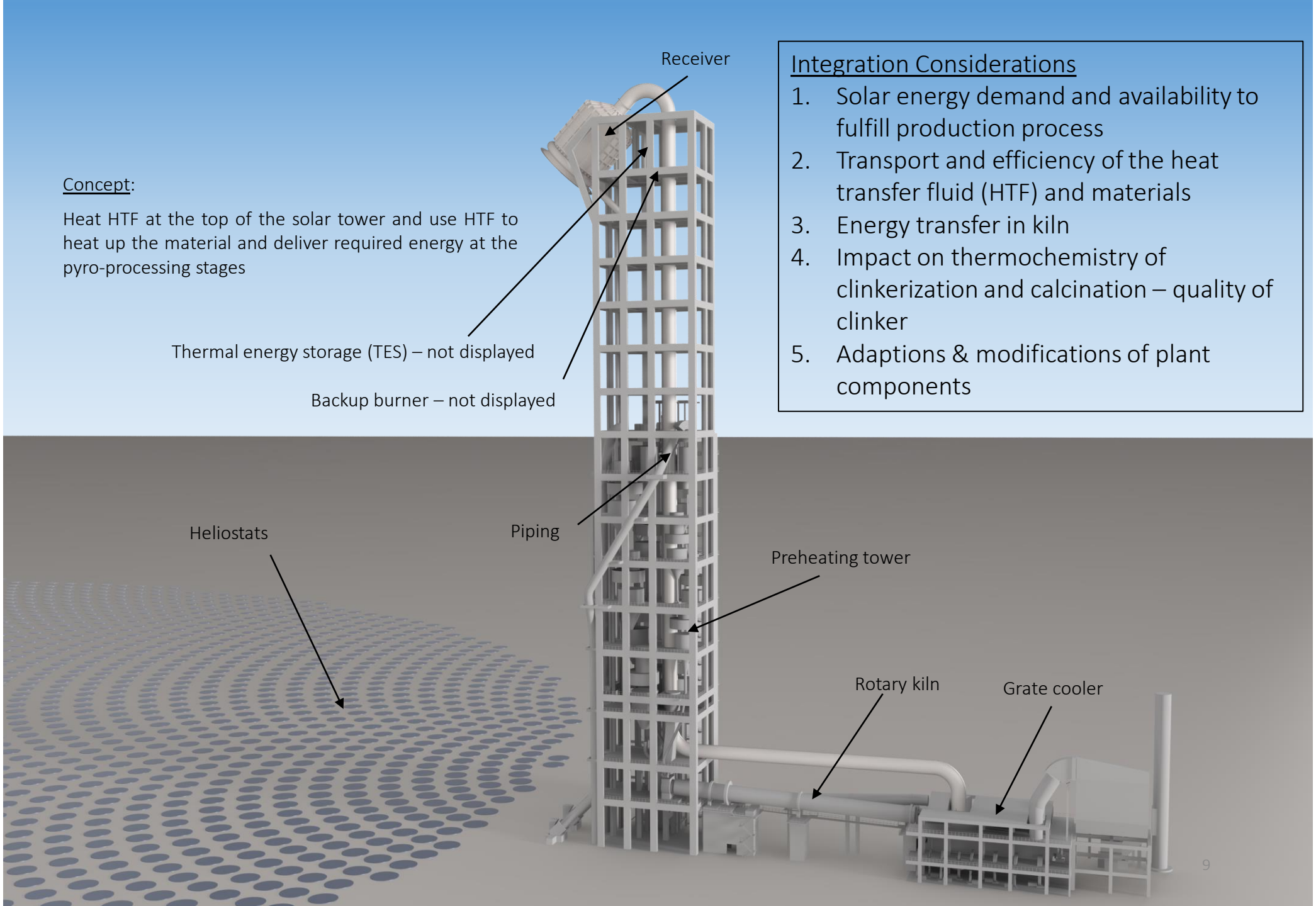
CLOSING THE CARBON CYCLE

INTEGRATION CHALLENGES

Concept:

Heat HTF at the top of the solar tower and use HTF to heat up the material and deliver required energy at the pyro-processing stages



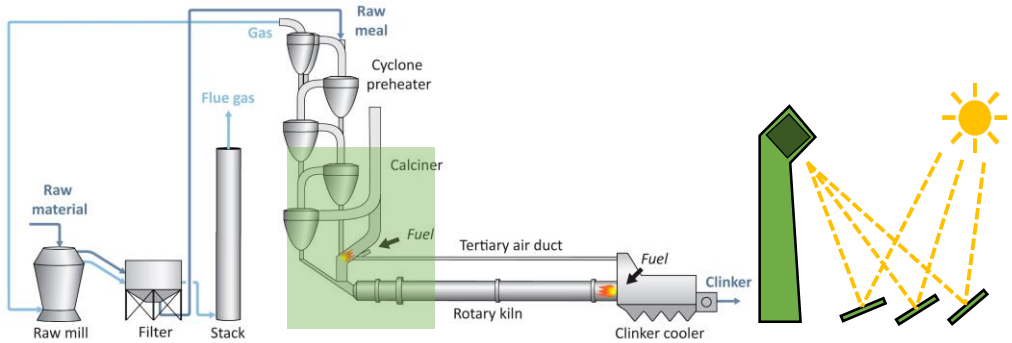
Integration Considerations

1. Solar energy demand and availability to fulfill production process
2. Transport and efficiency of the heat transfer fluid (HTF) and materials
3. Energy transfer in kiln
4. Impact on thermochemistry of clinkerization and calcination – quality of clinker
5. Adaptions & modifications of plant components

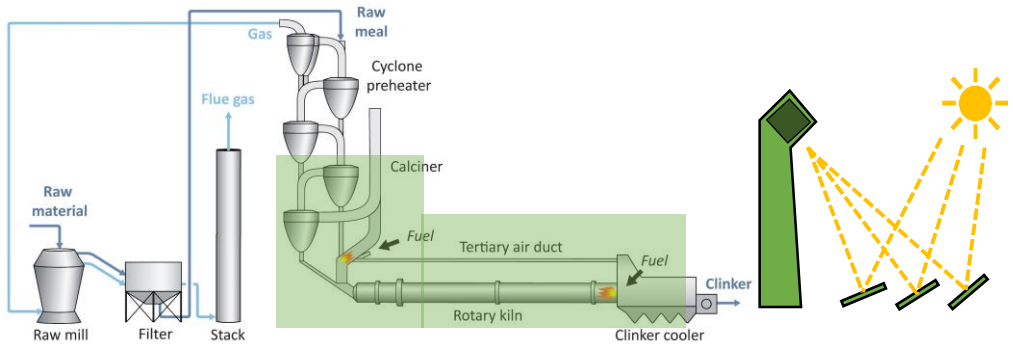
INTEGRATION: STEP-WISE HYBRIDIZATION

CONFIGURATION

Solar Calcination →



Full Solar →



INTERVENTION SCHEME

2021
Calcination "Lab" Pilot
250kW$_{th}$

2023
Calcination Pilot
1 MW$_{th}$

Full Solar
1 MW$_{th}$

2026
Full Integration
10 MW$_{th}$

2028
Industrial Scale
100 MW$_{th}$
600 tpd

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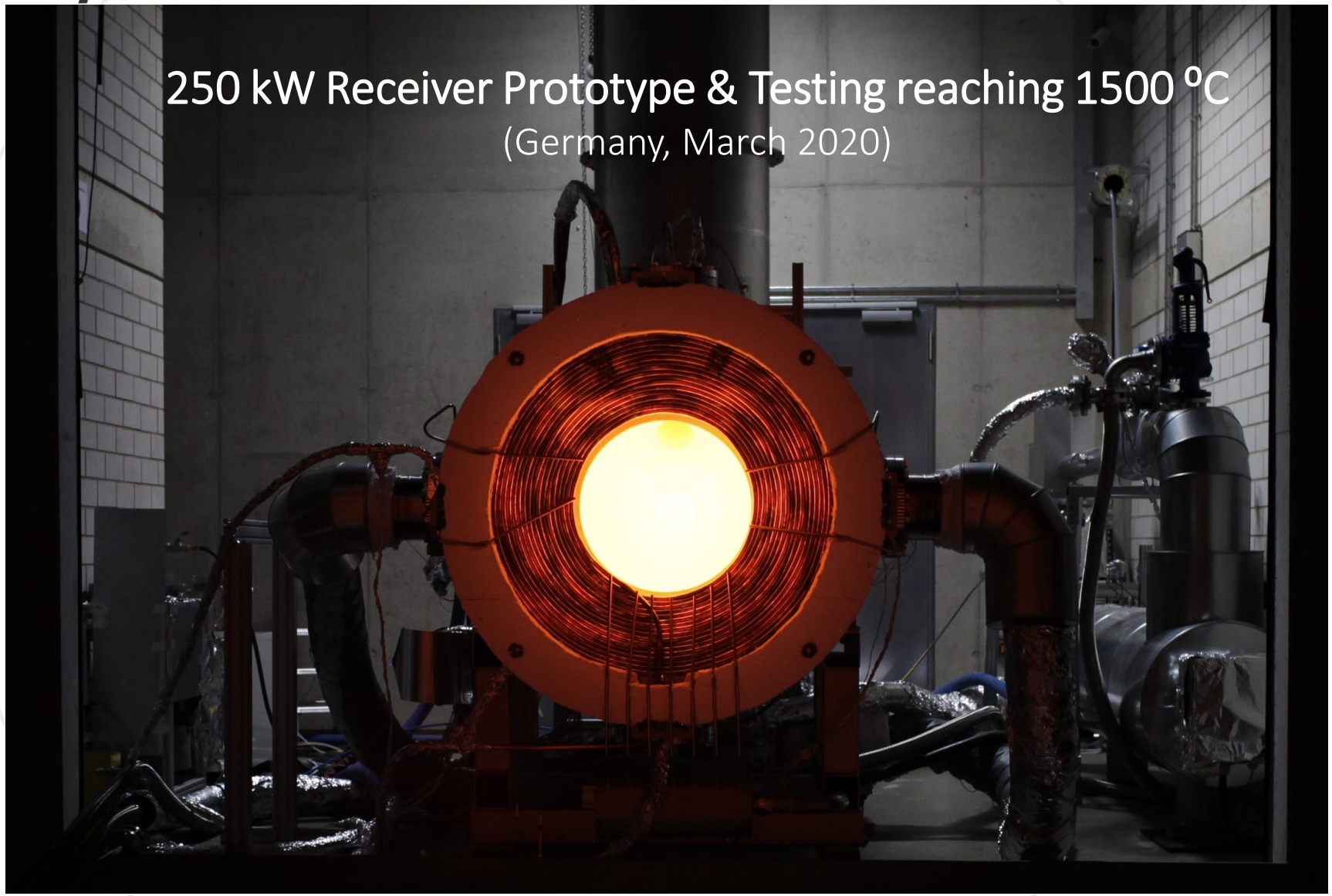
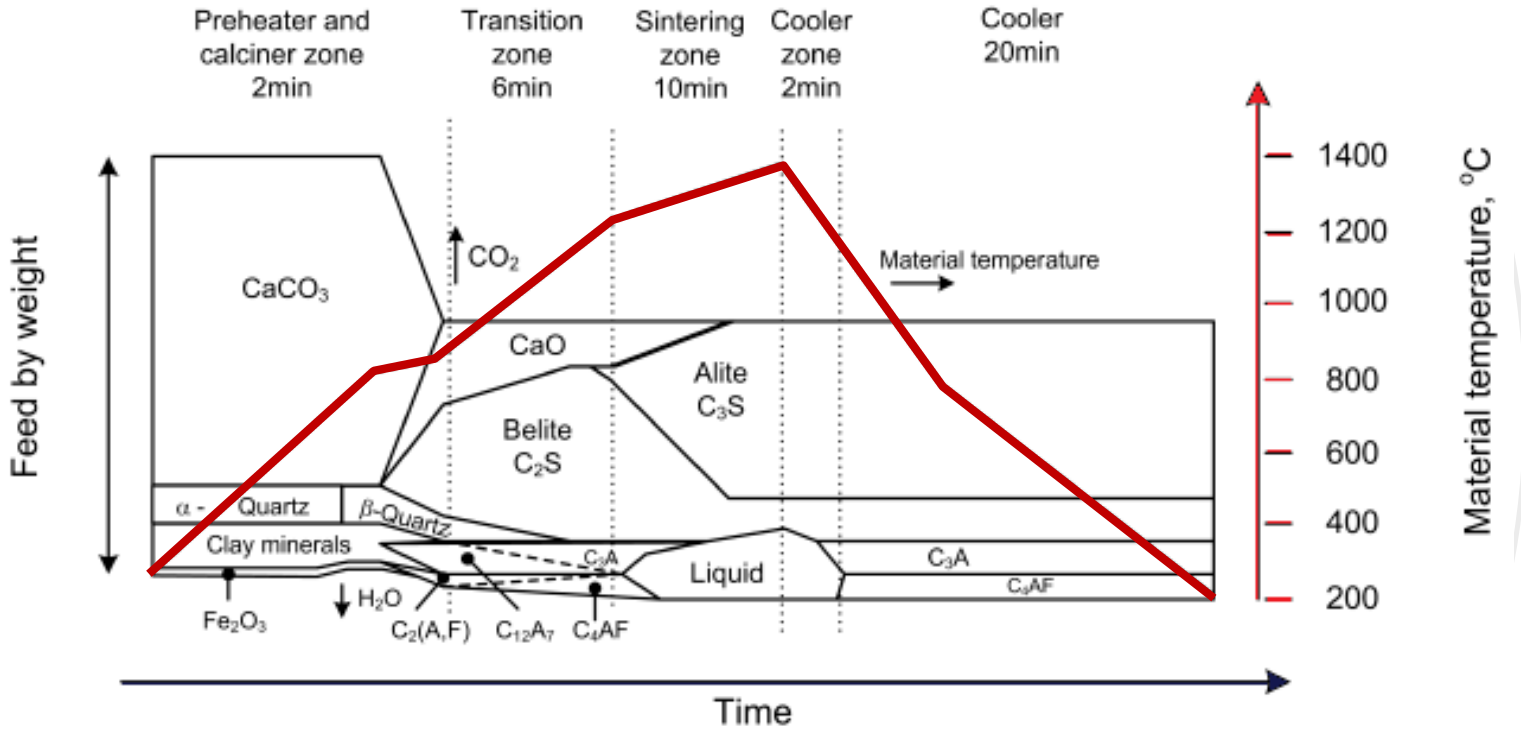

250 kW Receiver Prototype & Testing reaching 1500 °C
(Germany, March 2020)

HTF CLINKERIZATION AND CALCINATION

Material Quality & Performance Unaltered



- Impact of the Heat Transfer Fluid (HTF) on the heating zones including residence time
- Heat exchange efficiency between material as a function of CO_2/ H_2O ratios
- Shifts of heating curves and phases formation

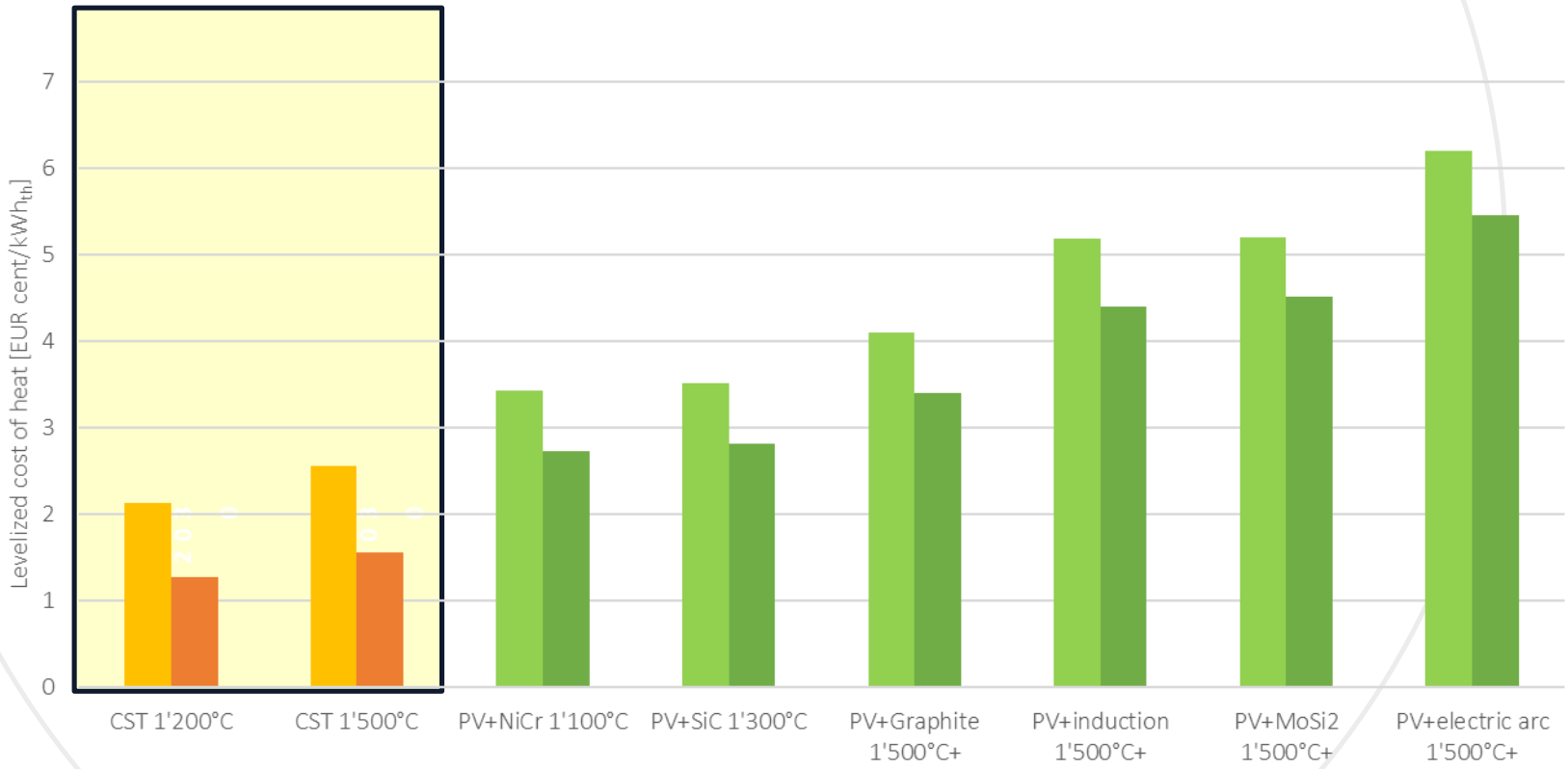
* Nørskov, L. K., Dam-Johansen, K., Glarborg, P., Jensen, P. A., & Larsen, M. B. (2012). Combustion of solid alternative fuels in the cement kiln burner. Kgs. Lyngby: Technical University of Denmark (DTU).

BACK UP

SOLAR HEAT vs OTHER SOURCES

WHY CST (SOLAR THERMAL) - COST OF HEAT

While there is a growing interest in electrically heated systems driven directly by cheap renewable power as alternative to CST systems, even under very aggressive conditions CST has the upper hand.



26th SolarPACES Conferenc – Plenary: Green Hydrogen, "Solar thermal pathways for renewable hydrogen and fuel," Gianluca Ambrosetti, Synhelion

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