



DE|CARBONATE

VTT

Cement precalcination with electricity and carbon dioxide sequestration

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25/05/2022 VTT – beyond the obvious

Content

- Rationale and the concept
- Industrial applications
- Decarbonate project
- Experimental kiln
- Results from pilot scale experiments

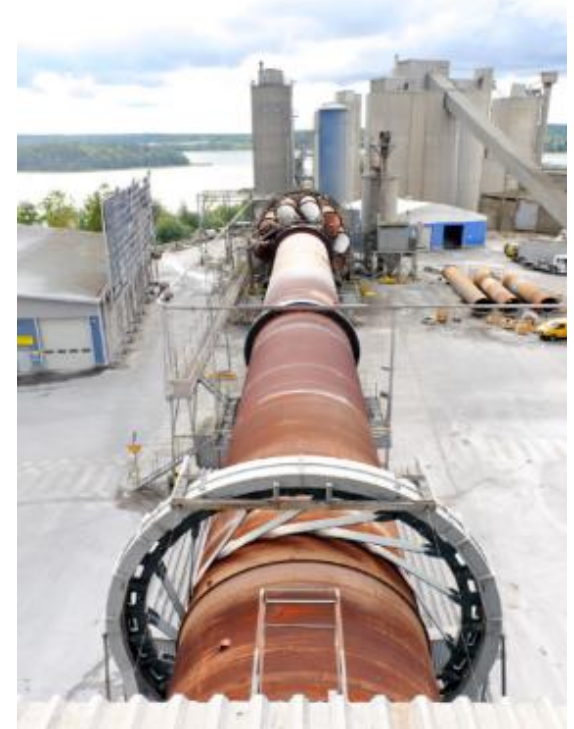
Rationale and present situation

- Limestone is one of the most used materials
 - 2,5 Gt of CO₂ from cement production
→ 8 % of global emissions
- Pressure and demand from market
- Increasing emission allowance price in the EU ETS
- Unstable fuel prices



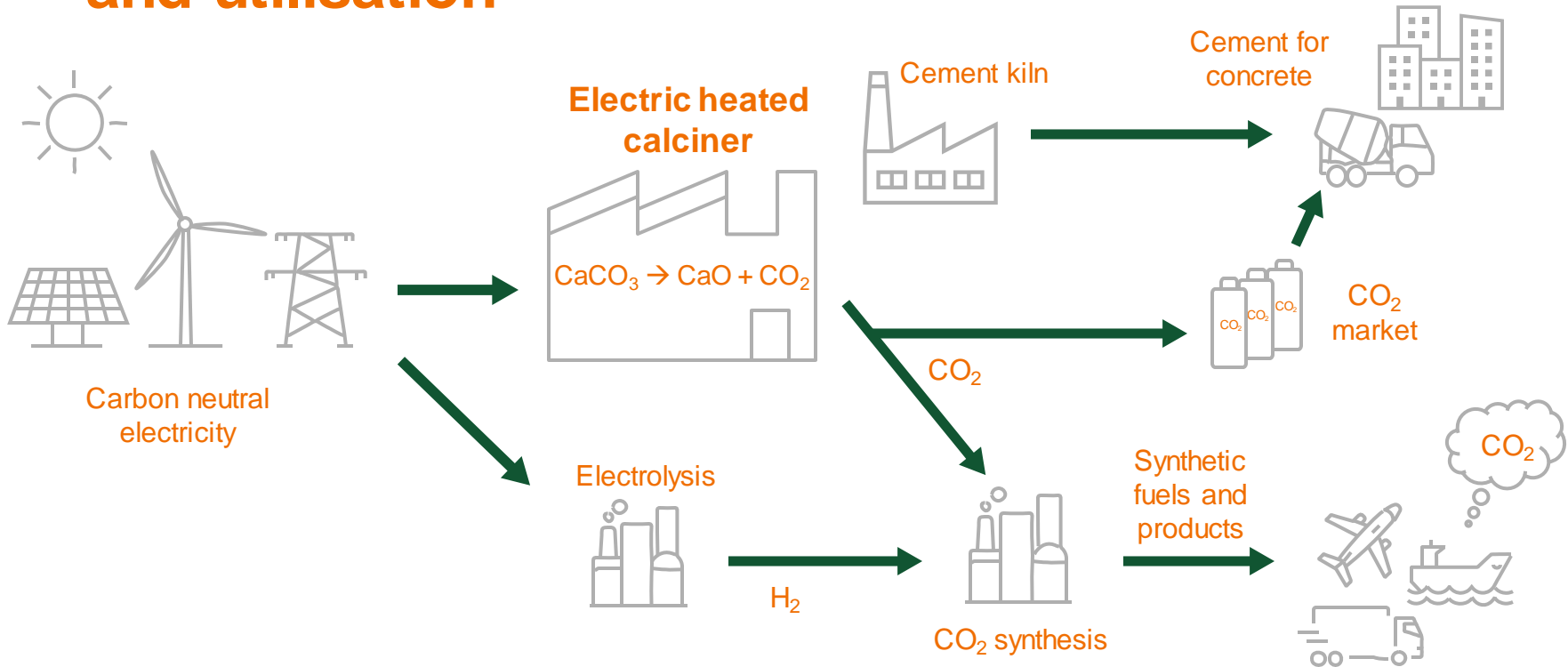
Shifting from fossil fuels to electricity decreases the amount of CO₂ by roughly 50%

Almost 100% concentration!



Picture: Finnsementti

Electrically-heated calciner with CO₂ capture and utilisation



Rapid changes in operational environment

Emission allowance daily future price in the EU ETS [€/t CO₂]



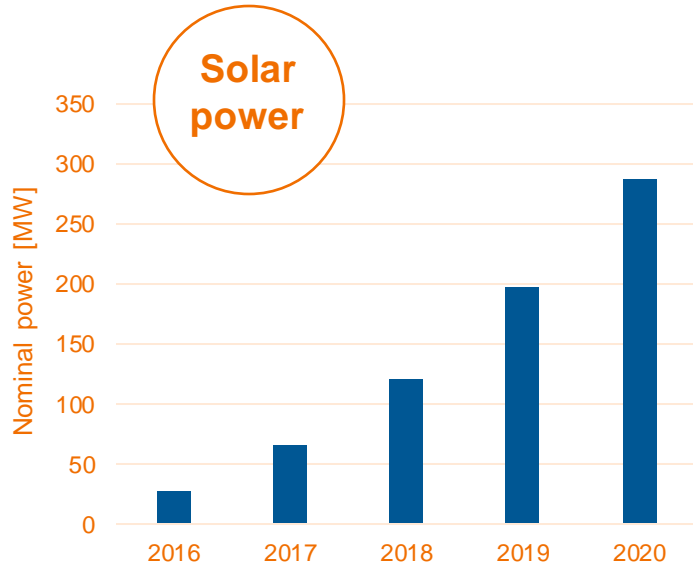
Picture and data: <https://www.theice.com/products/18709519/EUA-Daily-Future/data?marketId=400431&span=3>

Natural gas price, Dutch TTF benchmark [€/MWh]



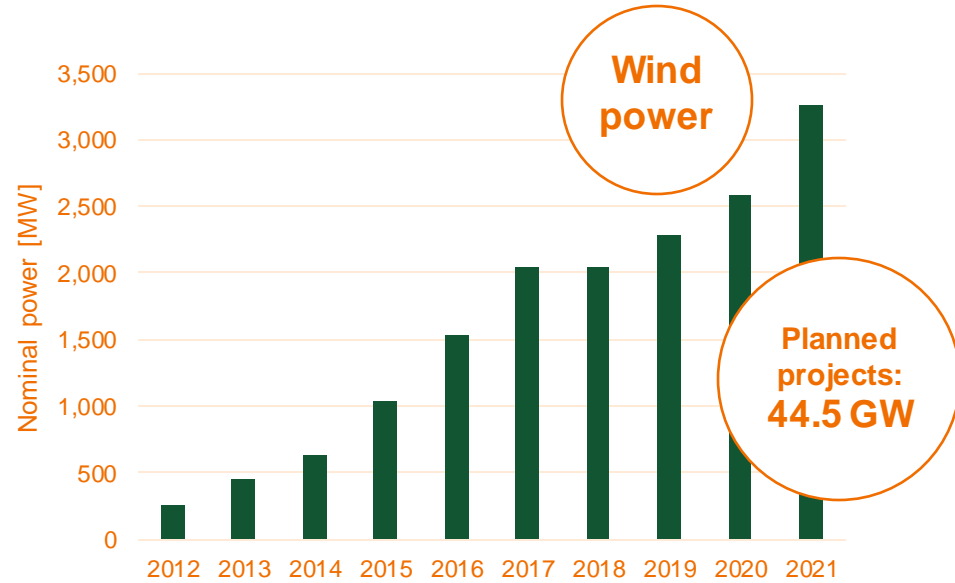
Picture and data: <https://tradingeconomics.com/commodity/eu-natural-gas>

Installed intermittent RES capacity in Finland



Network-connected small-scale production capacity of solar electricity

Data: <https://energiavirasto.fi/en/-/solar-electricity-production-capacity-grew-by-45-in-2020-nearly-300-megawatts-in-small-scale-production>

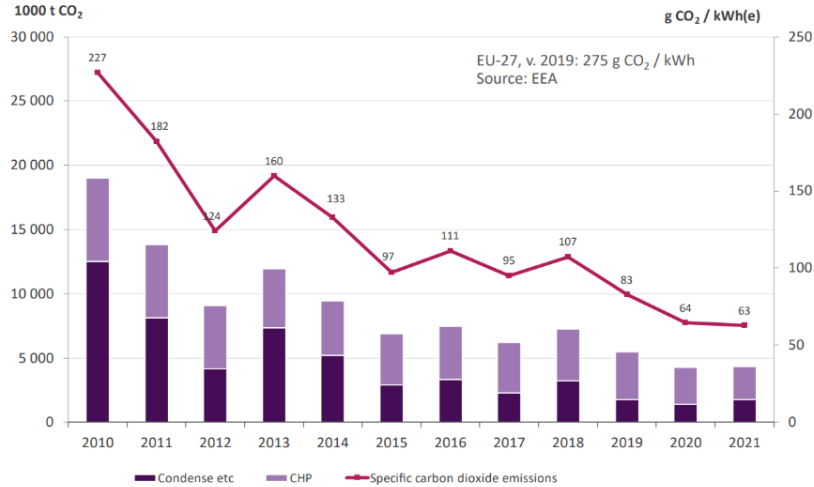


Installed wind power capacity

Data: <https://tuulivoimayhdistys.fi/kategoria/tilastot-2> and <https://tuulivoimayhdistys.fi/tuulivoima-suomessa/sunnittelussa-olevat-hankkeet>

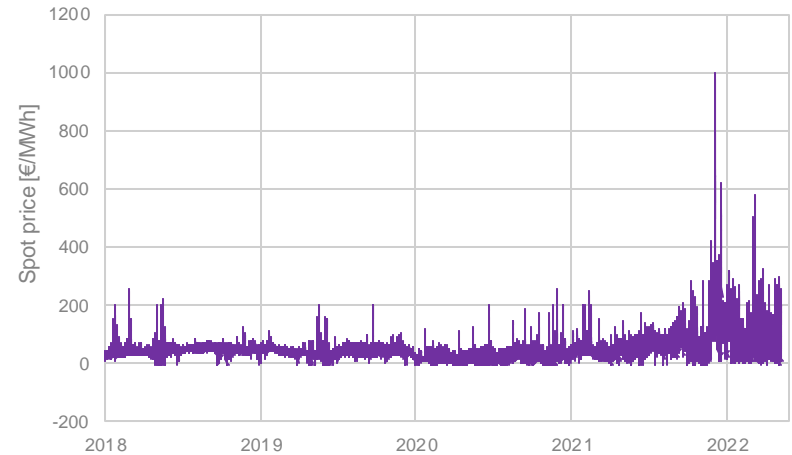
Power generation in Finland

CO₂ emissions of power generation



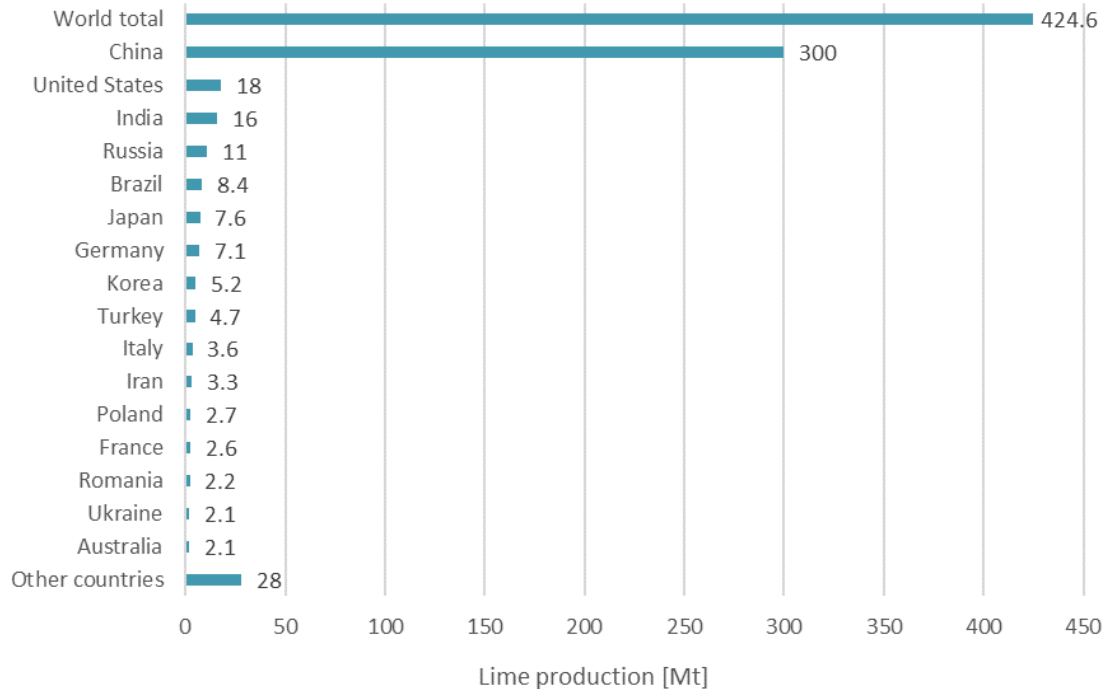
Picture: https://energia.fi/en/newsroom/publications/energy_year_2021_-_electricity.html#material-view

Electricity price, Nordpool spot



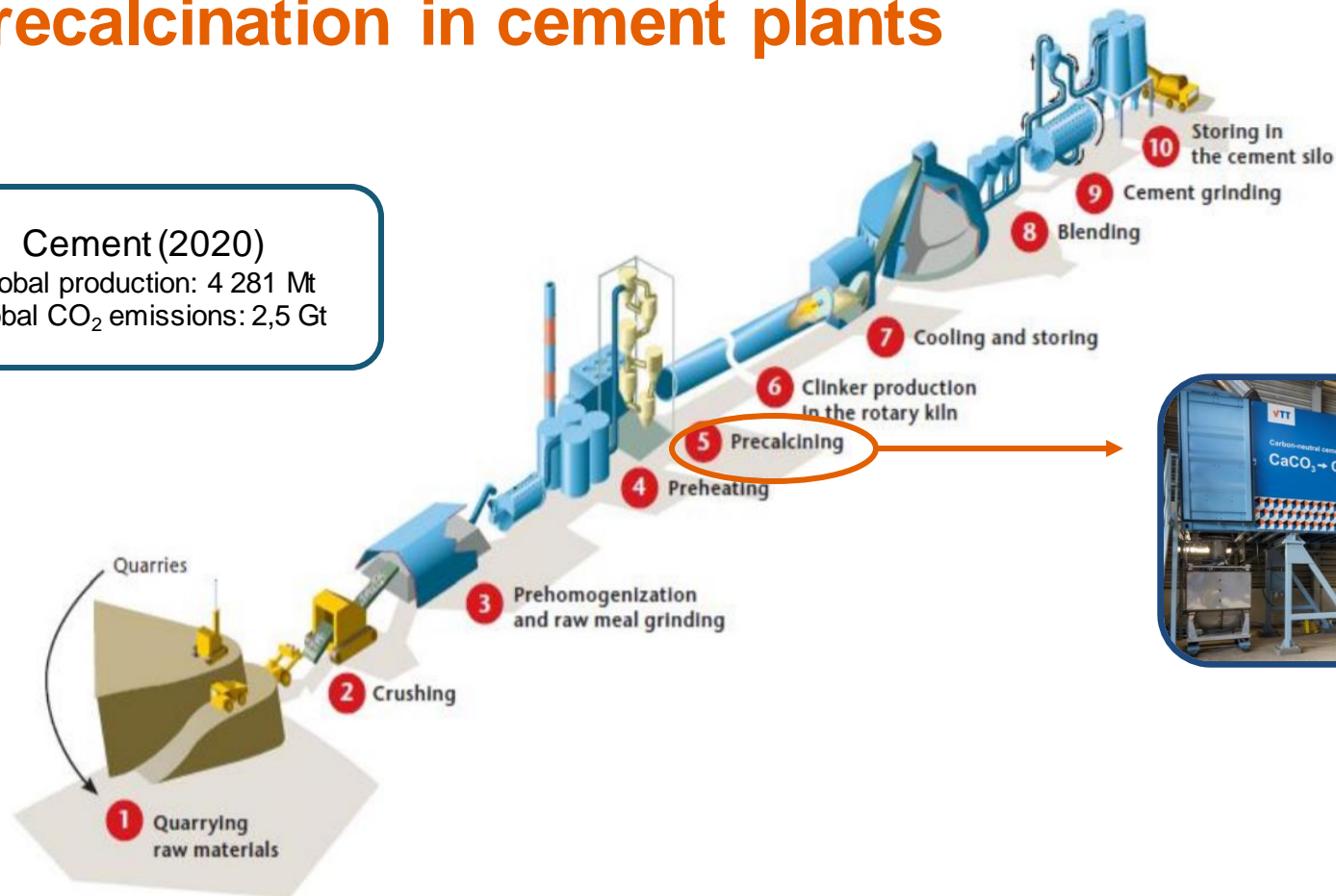
Data: <https://www.nordpoolgroup.com/en/historical-market-data/>

Electric heated kiln directly suitable for burnt lime production

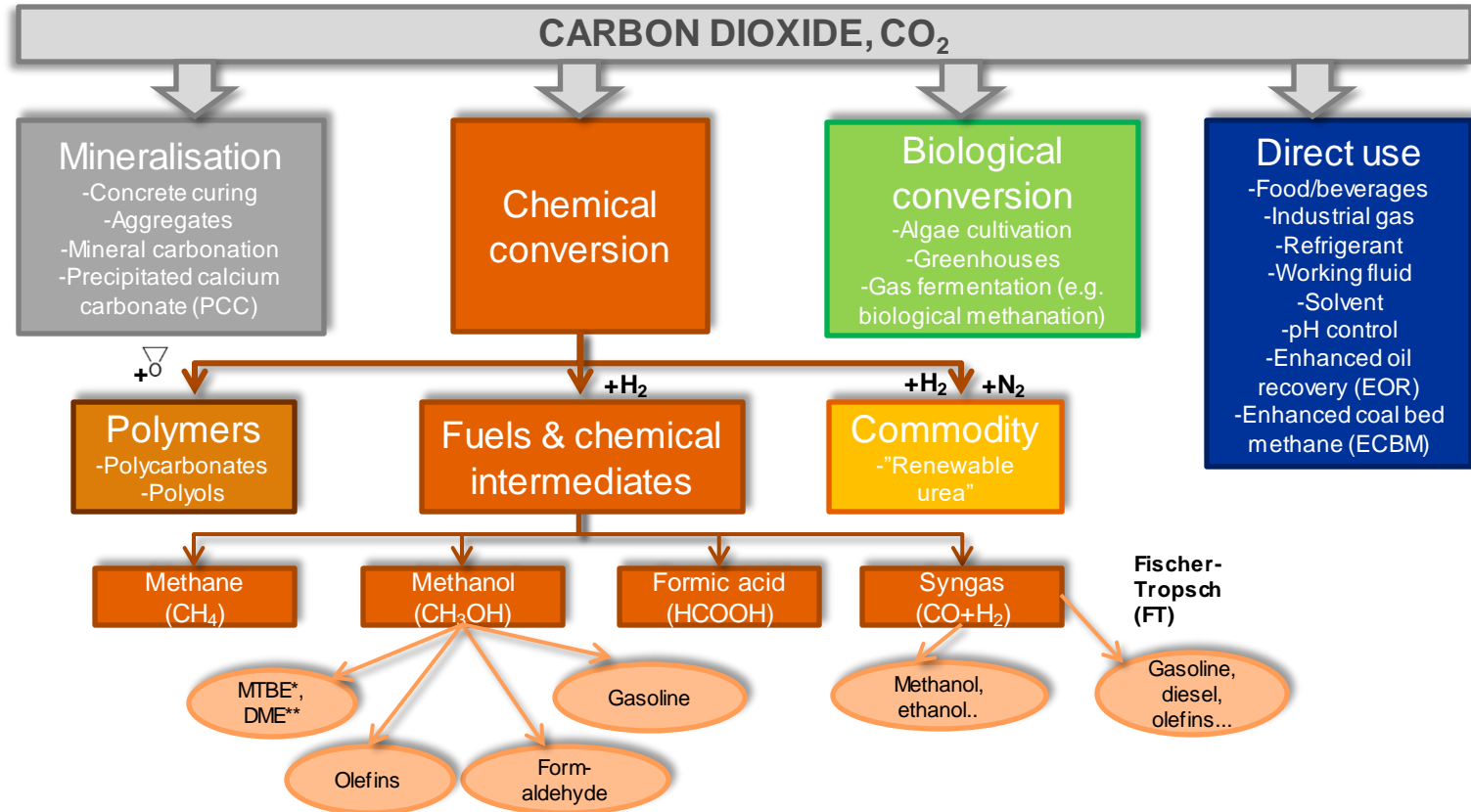


Precalcination in cement plants

Cement (2020)
Global production: 4 281 Mt
Global CO₂ emissions: 2,5 Gt



CO₂ utilisation



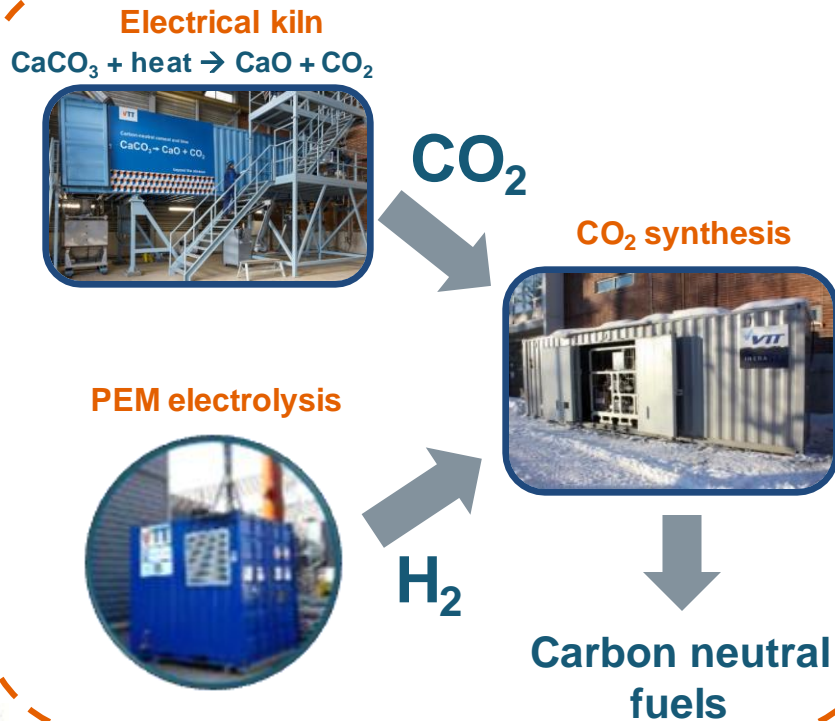
NOTE: The diagram presents only the most important options for the near-term . There are other routes such as electrochemical and photochemical routes and hundreds of other possible products.

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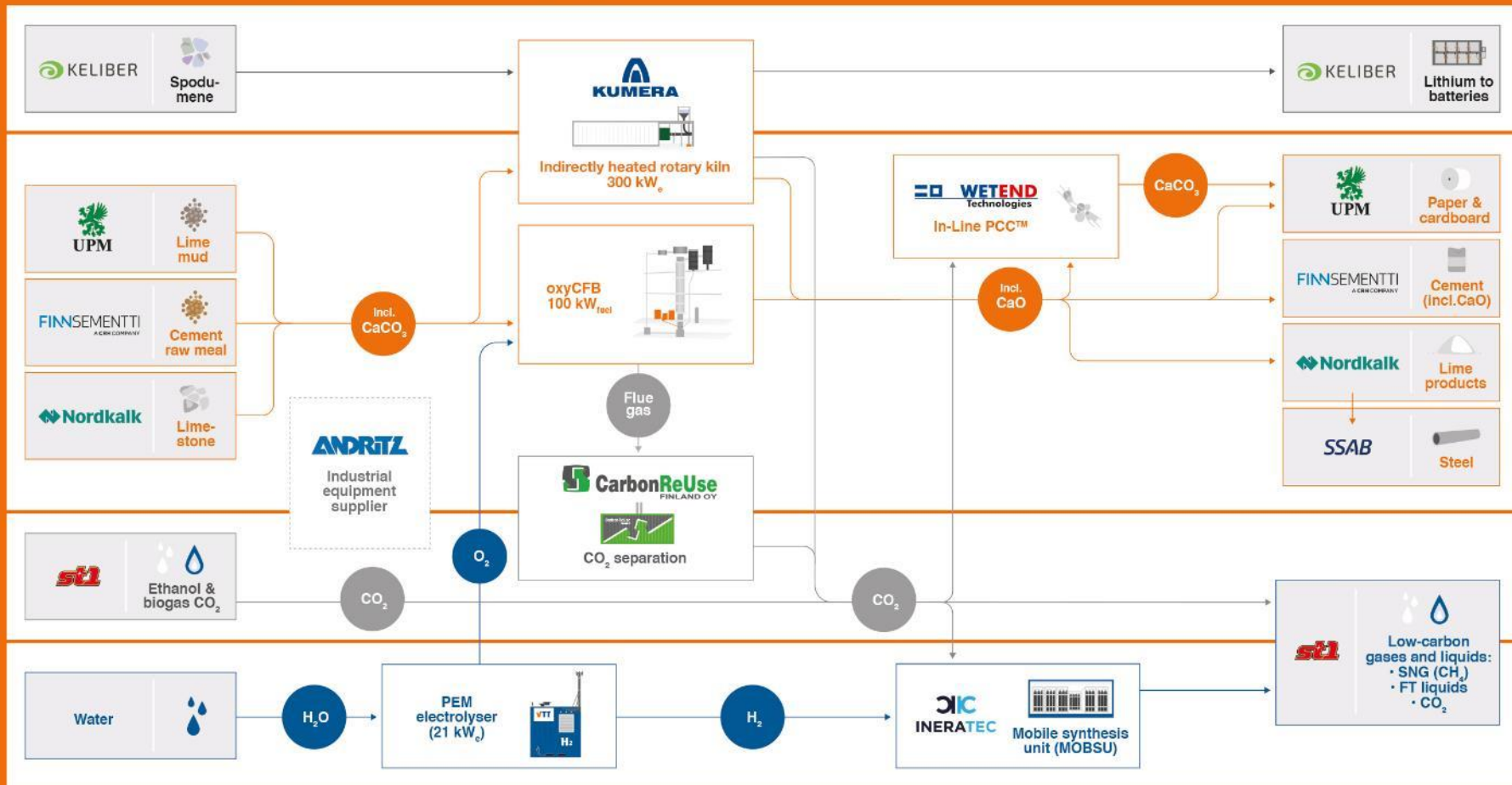
- Using indirect heating by electricity roughly 50 % of CO₂ emissions can be directly avoided (by substituting fossil fuels)
- Pure CO₂ stream can be used for utilization (CCU) or permanently stored (CCS)
- The **Decarbonate** project will prove the concept using electrically heated rotary kiln integrated by CO₂ capture and upgrading

VTT's budget: 1.2 MEUR
Schedule: Oct/2019 – Mar/2022

VTT's pilot infra for complete CCU chain



DE CARBONATE partners and value chains



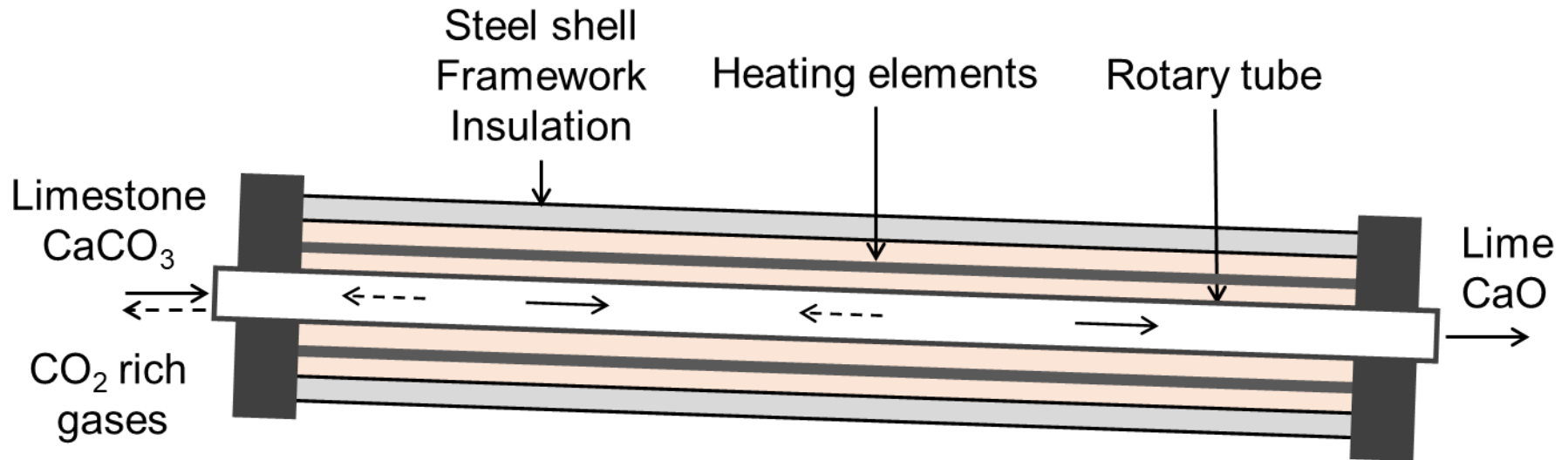
Carbon-neutral cement and lime



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Drum length: 9 m
Drum diameter: 0.6 m
System height: 8 m
Power: > 300 kW
Capacity: > 100 kg/h
Mobile, built inside a 40 ft sea container

Schematic illustration



Observations from the pilot scale rotary kiln first trials

CO₂ content in kiln off gases up to 98 vol-% (dry)

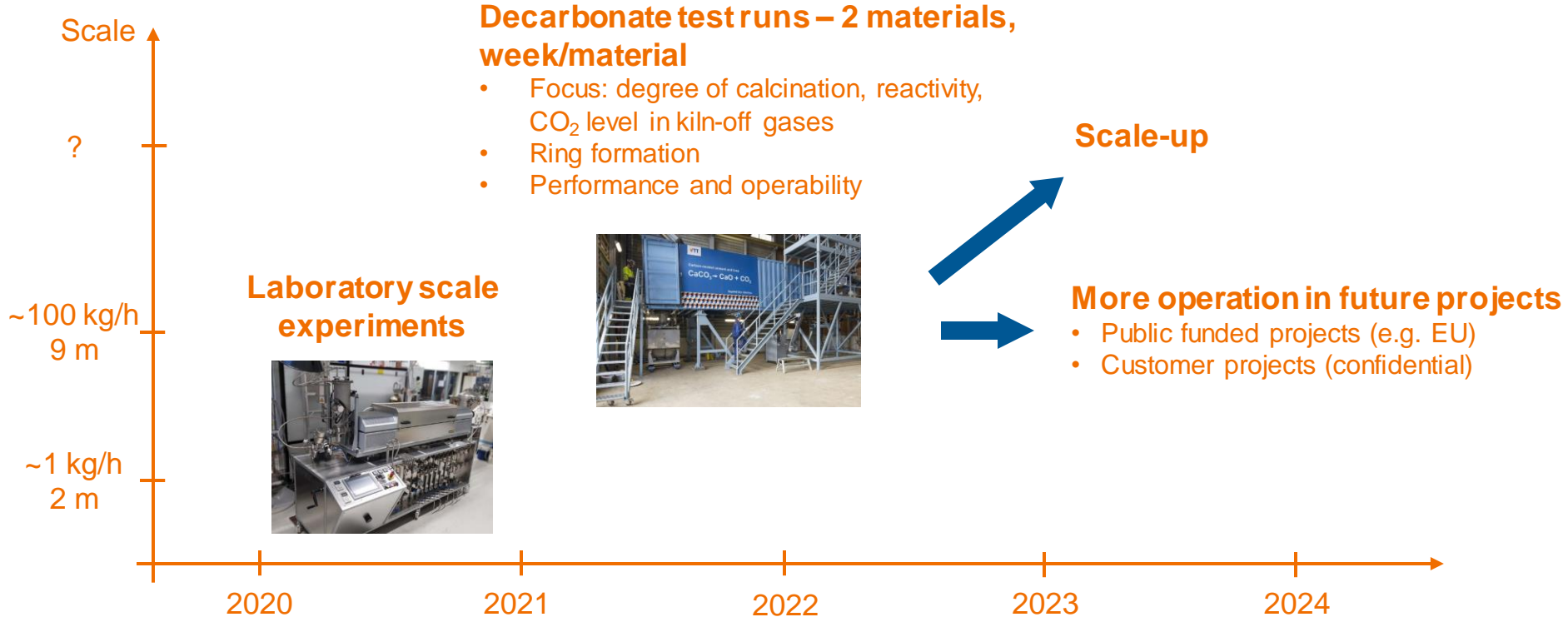
Degree of calcination 88-98%

Continuous 3 x 4 day operation at ~1000 °C

No shutdowns or major availability issues



Next steps



Thank you for your attention!

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