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Advanced Indirectly Heated Carbonate Looping Process

ANICA

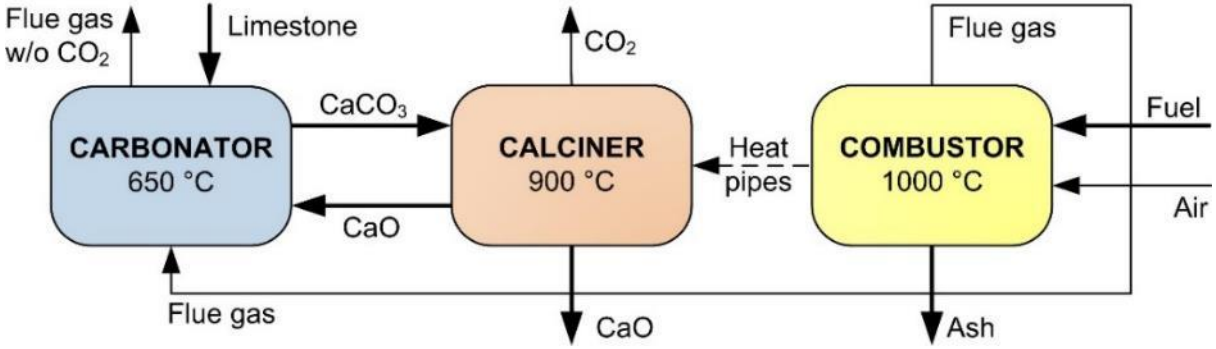
CO_2 capture at lime and cement plants

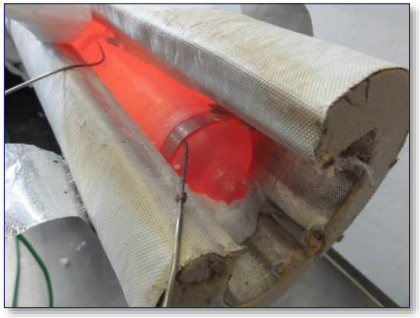
ACT Workshop
17 Nov 2020

Jochen Ströhle
Technical University of Darmstadt

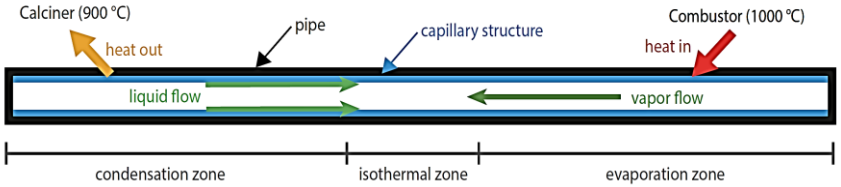
Accelerating CCS Technologies

Indirectly Heated Carbonate Looping (IHCaL) Process





Source: FAU



- Sorbent used as product
- Efficient heat utilization (→ power)

Indirect heating:

- No oxygen for calciner → high efficiency
- No fuel in calciner → pure sorbent
- Almost pure CO_2 stream at calciner exit

Key Performance Indicator	Target
CO_2 capture efficiency	> 90 %
CO_2 purity	> 95 %
Net efficiency for power generation	> 45 %
Sorbent utilization	> 90 %
CO_2 avoidance costs	< 25 €/t
Net CO_2 emissions	< 0

ANICA Objectives

Overall aim:

Develop concepts of indirectly heated carbonate looping (IHCaL) process for ***CO_2 capture*** *from* ***lime*** *and* ***cement*** *plants*.

Specific Project Objectives

- Test at 300 kW_{th} **pilot plant**
- Prove feasibility of **utilizing of spent sorbent**
- Develop **novel concepts** of IHCaL reactors
- Assess **risks**, **economics**, **environmental** impact
- Design a 20 MW_{th} **demonstration** plant


Source: Lhoist

Consortium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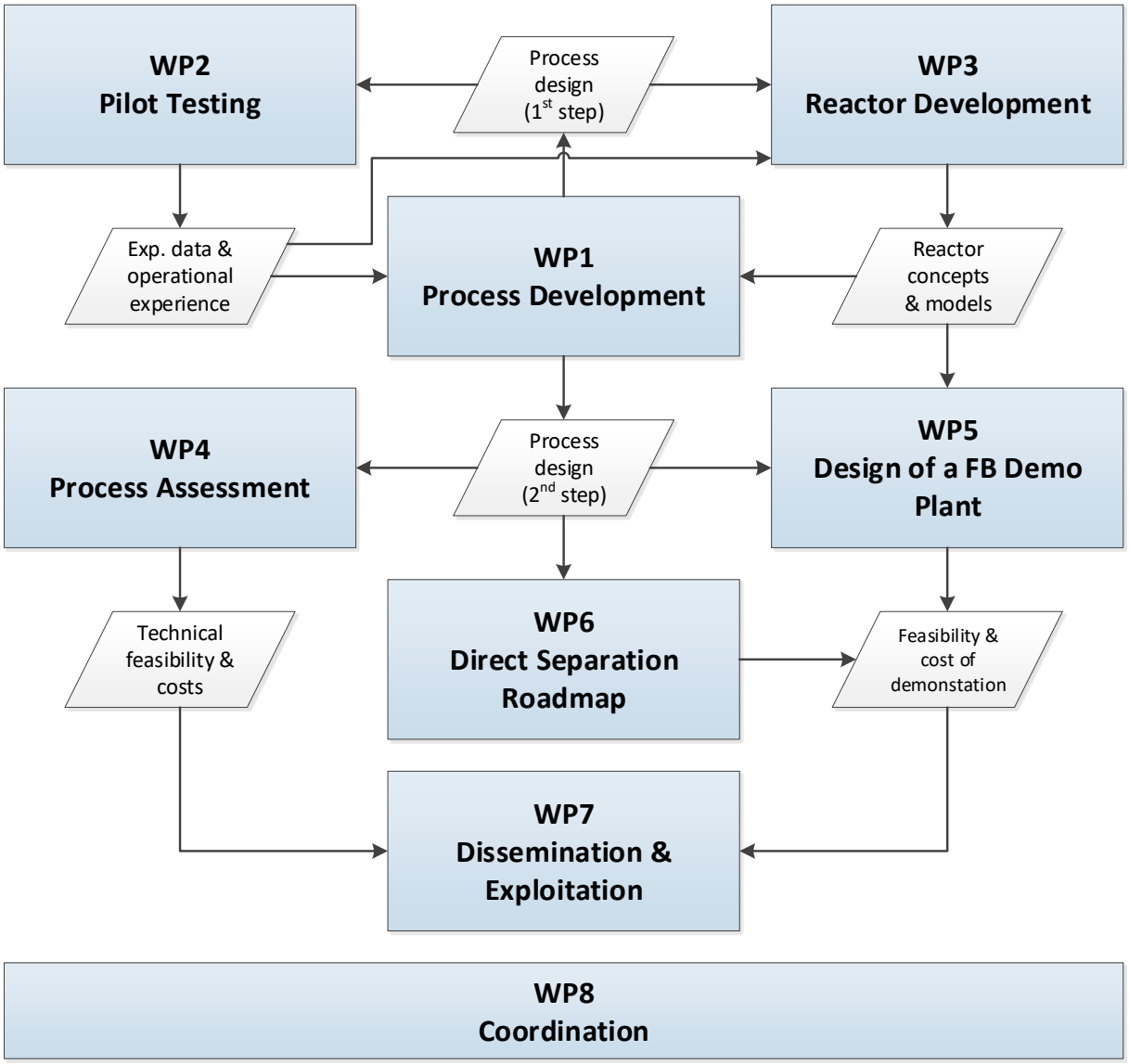
Project Structure

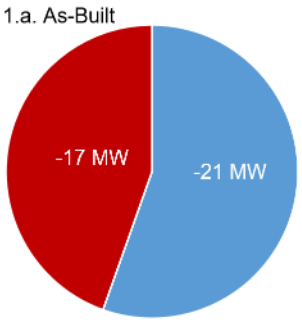


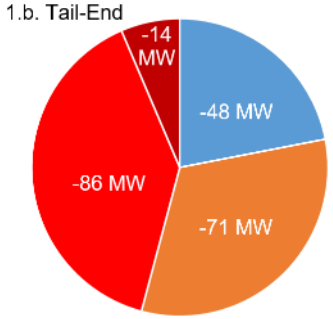
WP 1 – Process development
Integration into the lime process

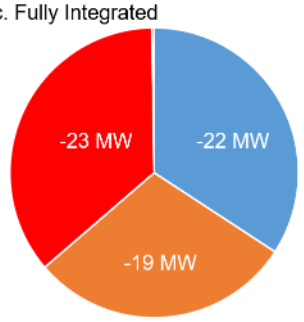
- 2 reference plants:
  - Hönnetal Lime Plant (Germany)
  - Thessaloniki Lime Plant (Greece)

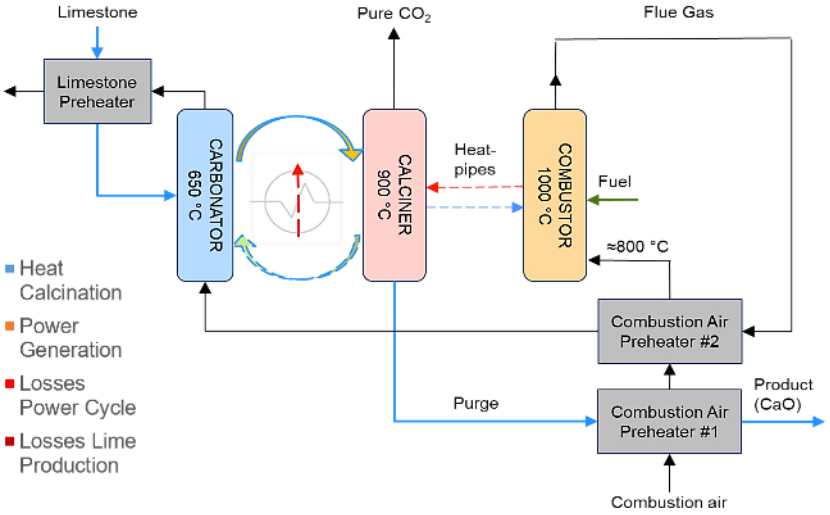
- Different IHCaL concepts developed
  - Tail-end solution
  - Fully integrated concepts

- Results
  - Critical points for integration identified
  - High overall efficiency achieved with heat recovery steam cycles



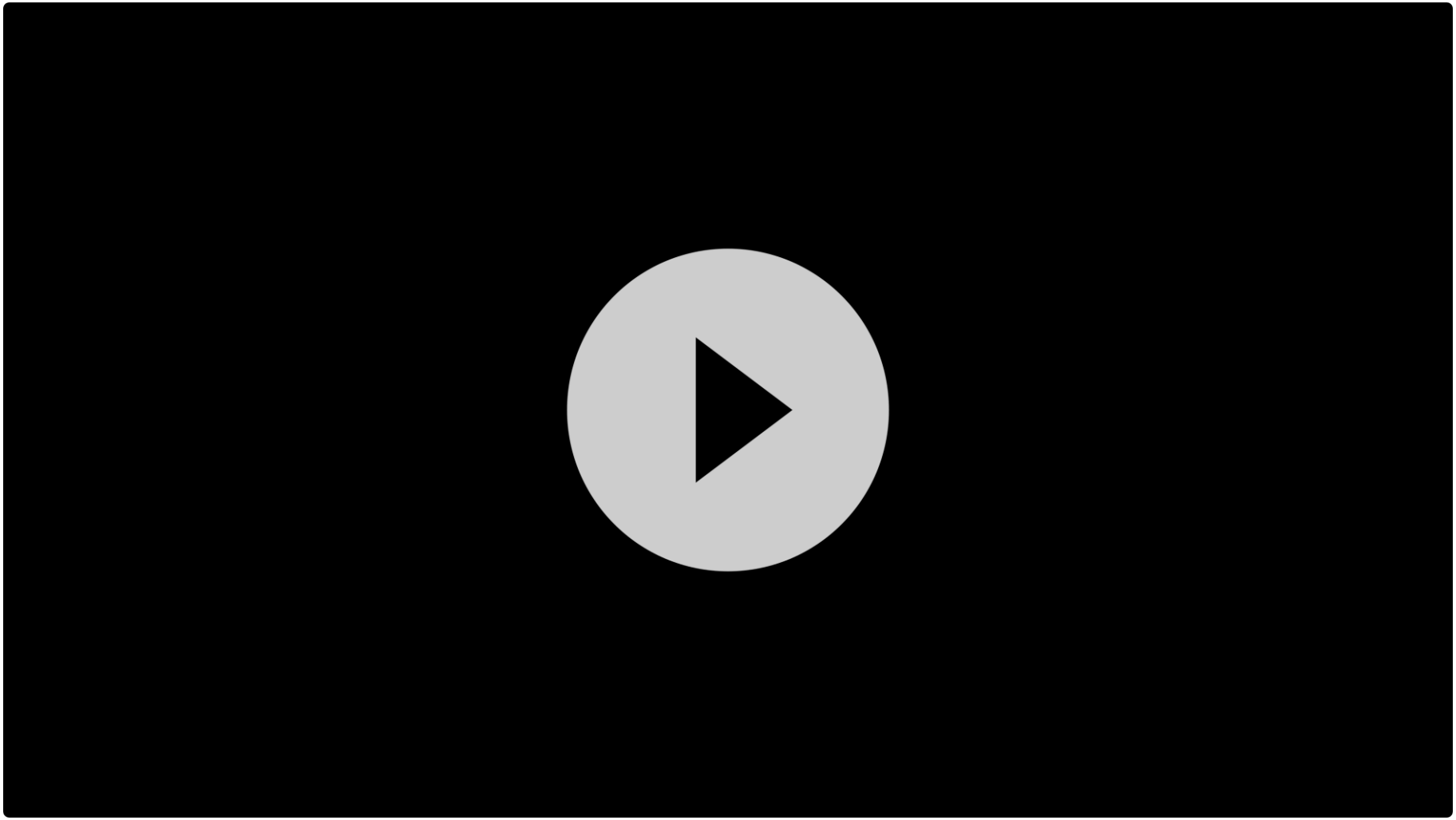






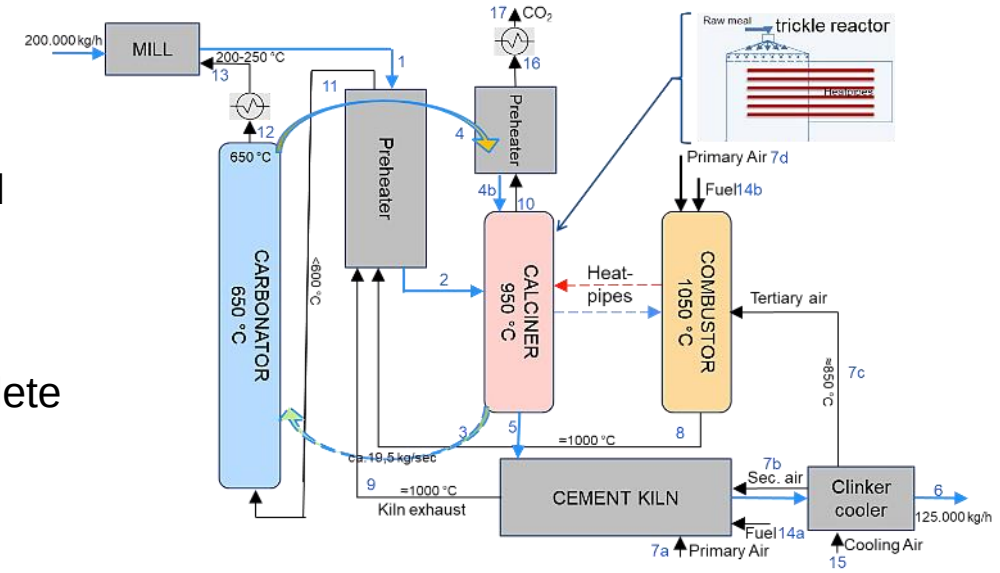
Video Presentation

EST Institute, TU Darmstadt



WP 1 – Process development
Integration into the cement process

- 2 reference plants selected:
  - BAT (Best Available Technology) plant for comparison with former projects
  - Real cement plant Dyckerhoff
- 12 concepts developed with different reactor types
  - Trickle bed reactor
  - Fluidized bed reactor
- Modelling and boundary conditions
  - Energy & mass balances prepared and boundary conditions defined
  - Plant layout, operational data, chemical composition
- IHCaL Concept simulation
  - Programming of the BAT plant is complete



WP 2 – Pilot Testing

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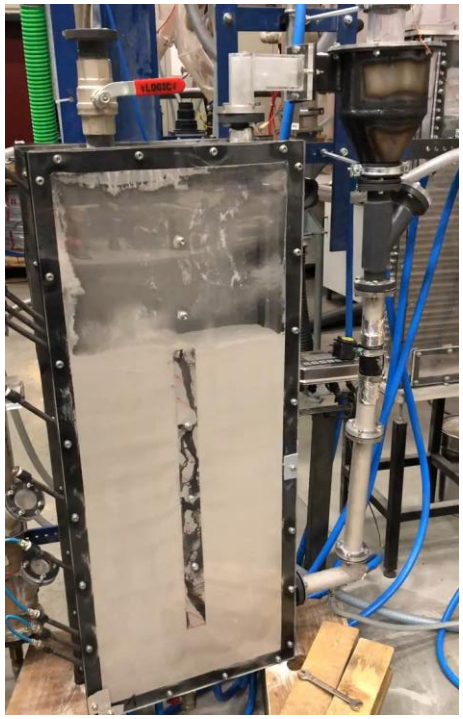
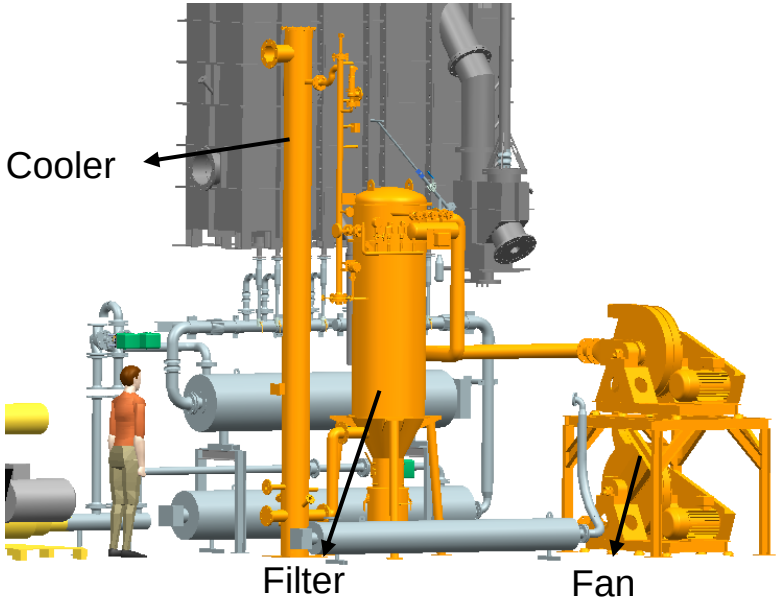
Upgrades at the 300 kW_{th} Pilot Plant

- Design of flue gas path to carbonator (installation starts in Jan 2021)
- Solid fuel feeding system for coal and RDF (design is being validated in cold model)
- External cyclone to minimize loss of material (being tested in cold model)





Cold Commissioning 05/2021 → Hot Commissioning 06/21 → First Campaign 06/21

Video Presentation

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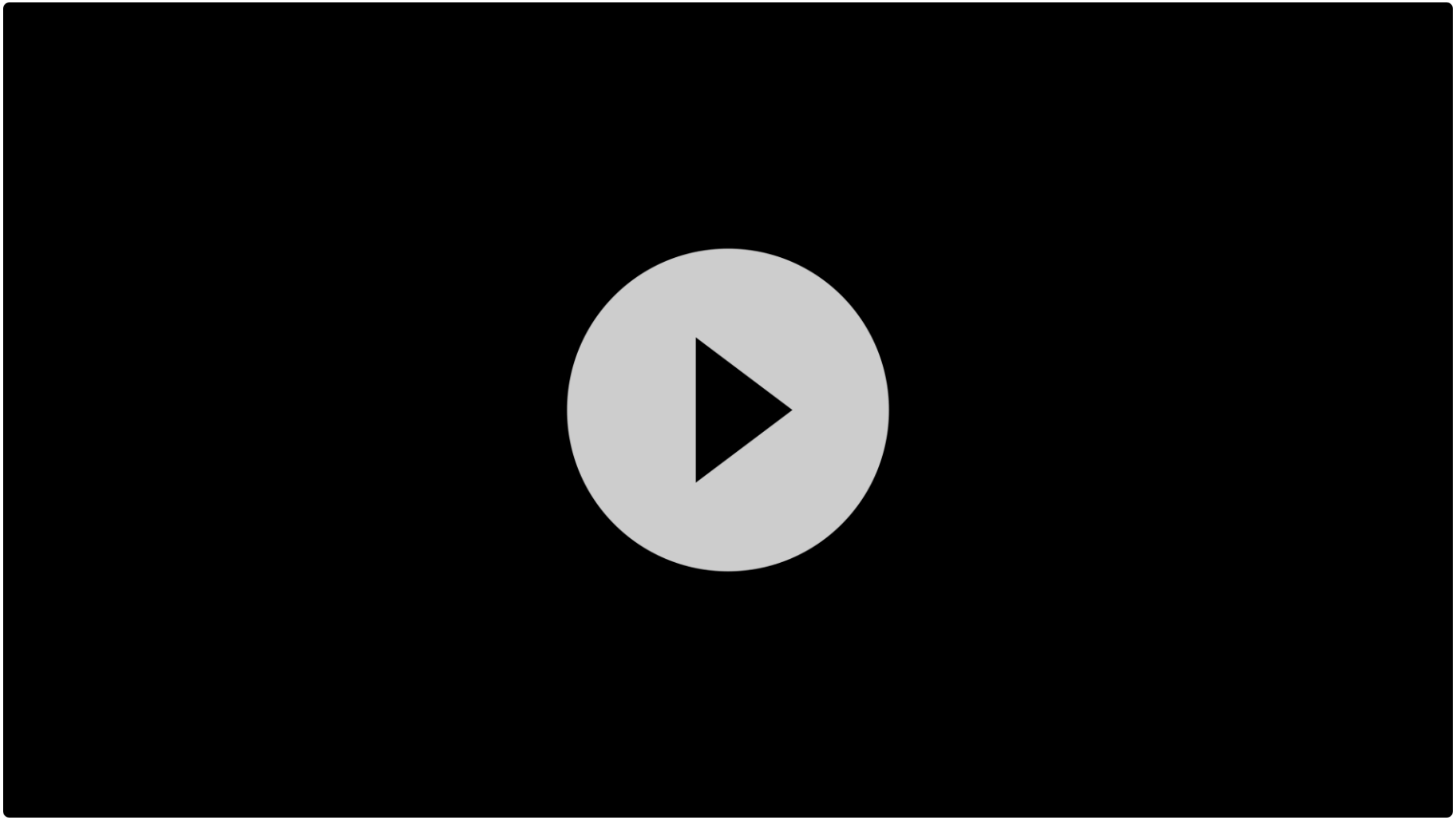
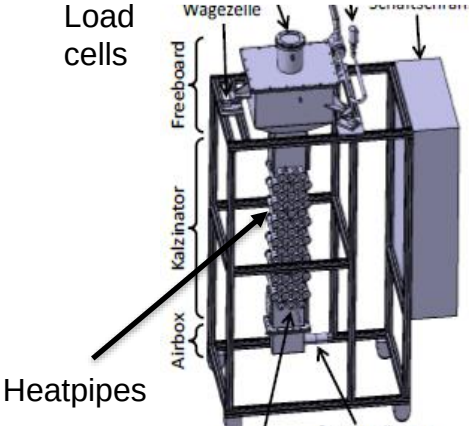
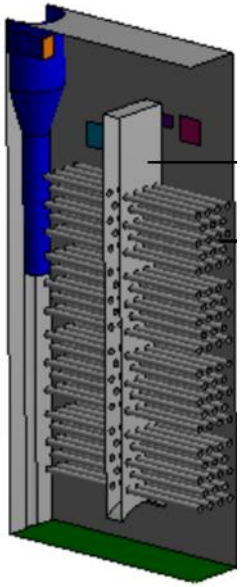


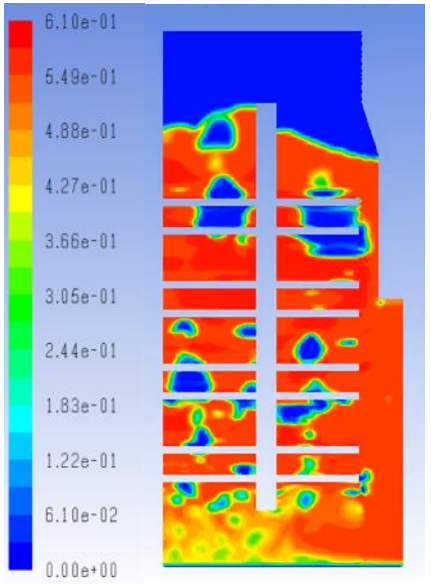
WP 3 – Reactor development

- Experiments at Batch-Calciner
  - Commissioning successful
  - Calcination of cement raw meal successful, but still low reactivity
  - Further studies necessary



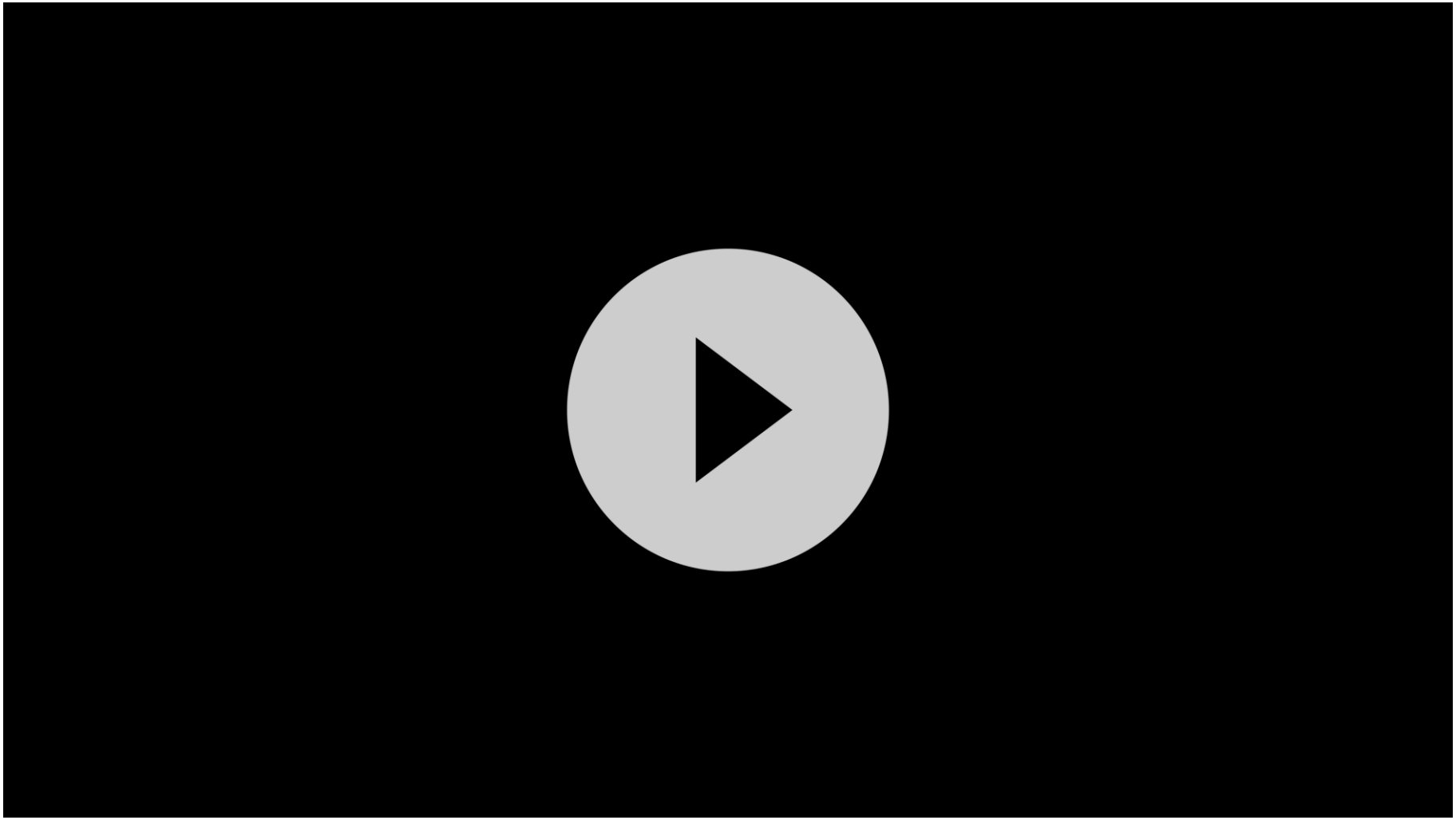
- Calciner CFD simulations
  - Target: optimize design & operating parameters
  - **Cold model:**
    - Hydrodynamics captured well with EMMS drag model
    - Pressure profile shows good agreement with experimental data
  - **Hot model:**
    - Preliminary results show good agreement with experimental data.





Video Presentation

Centre for Research & Technology Hellas



WP 4 – Process Assessment

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Ulster University

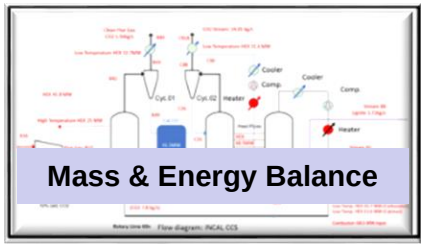
ESTRA

Initial design

Process modelling

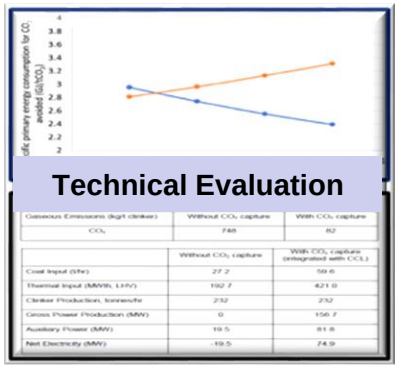
Experiments

Redesign



Mass & Energy Balance

Capital Cost Estimation

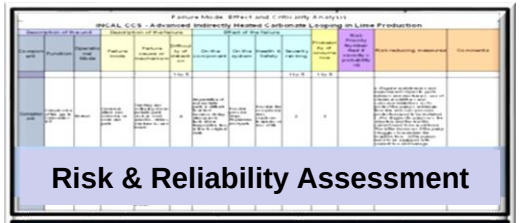


Technical Evaluation

Techno-economic Performance Evaluation

Risk & Reliability Assessment

Life Cycle Assessment (LCA)



Risk & Reliability Assessment

Environmental Assessment (LCA)

WP 7 – Dissemination & Exploitation

- Logo
- Website
- Conferences
- Newsletters

8th High Temperature Solid Looping Cycles Network Meeting Workshop

20-21 January 2020, Geleen, The Netherlands
Chemelot Industrial Park, room Pellinore

www.act-anica.eu

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ADVANCED INDIRECTLY HEATED CARBONATE LOOPING PROCESS

Integrating the indirectly heated carbonate looping process in cement and lime industry for a sustainable CO_2-free production through CO_2 capture.

NEWSLETTER II - OCTOBER, 2020

WHAT WILL YOU FIND HERE?

Acknowledgement

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Thank you for your attention!