Aalto University
School of Engineering

CO_2 utilization by production of PCC from CO_2 and steelmikg slags

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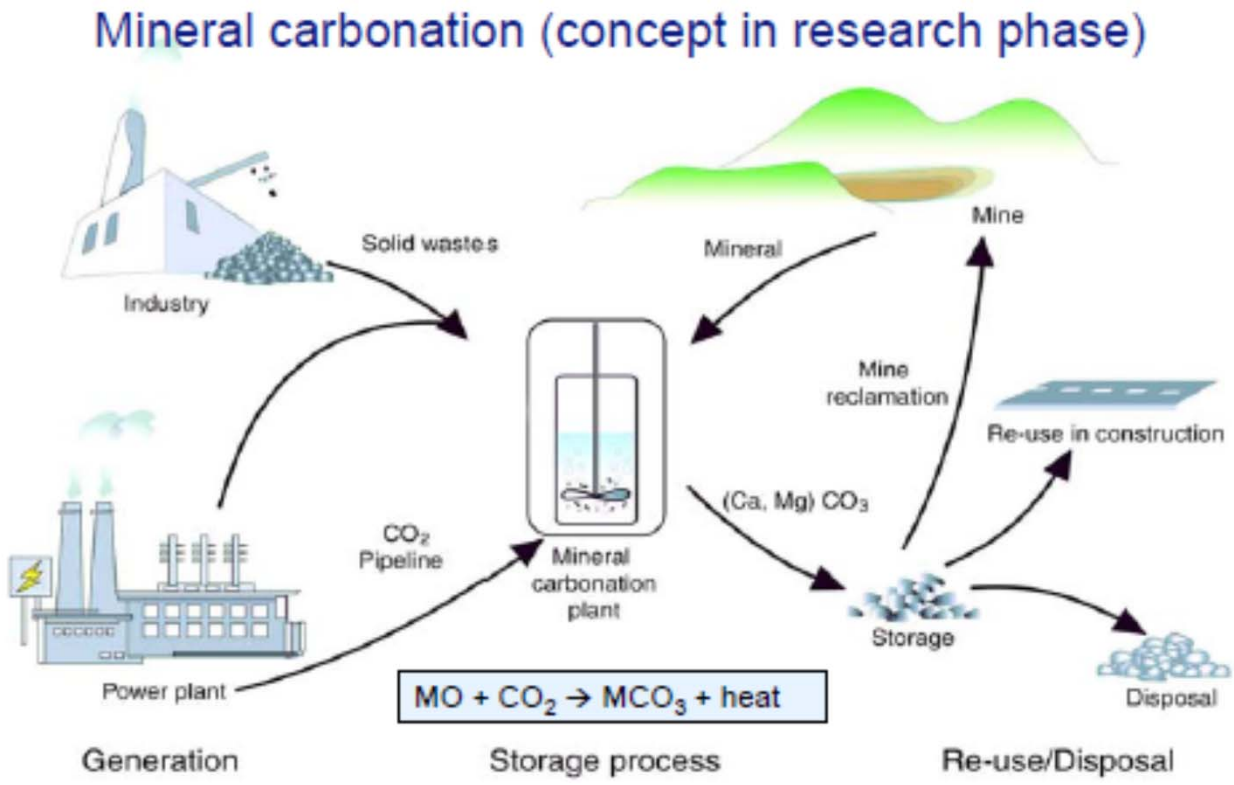
Background

- **CCSP, work package 5: Storage of CO_2**
  - **CO_2 fixation by minerals**

- **MgO / $CaO_{(s)}$ + $CO_{2(g)}$ → $MgCO_3$ / $CaCO_3$**

Background

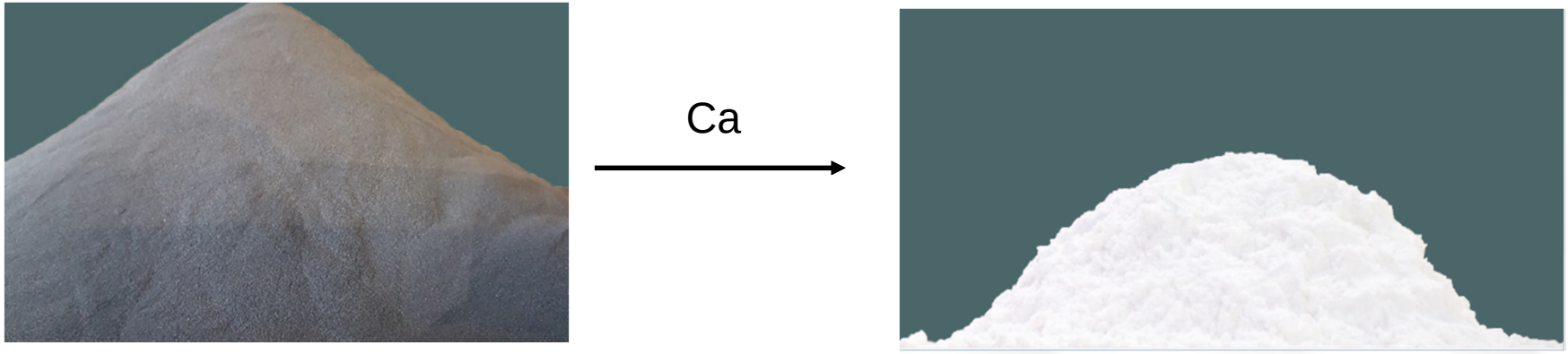

Mineral carbonation (concept in research phase)
Industry
Solid wastes
Mineral
Mine
Mine reclamation
Re-use in construction
CO_2 Pipeline
Mineral carbonation plant
(Ca, Mg) CO_3
Storage
Power plant
Disposal
$MO + CO_2 \rightarrow MCO_3 + heat$
Generation
Storage process
Re-use/Disposal

Advantages vs disadvantages

(+)
+ Capture + Storage are in ONE
+ No leakage
+ No monitoring
+ Final product is marketable
(-)
- Limited storage capacity
- Energy and material intensive (some processes)

Slag2PCC concept

- **Steelmaking slags + CO2 → PCC**



40% -50 %CaO

Motivation

- **According to the IEA Iron and steel industry is accounts about 7% of global CO_2 emissions,**
- **The steel industry produces, besides steel, also slags, a by-product , while it emits large quantities of CO_2**
- **1t steel → 2t CO_2**

Lab- scale experimental set-up

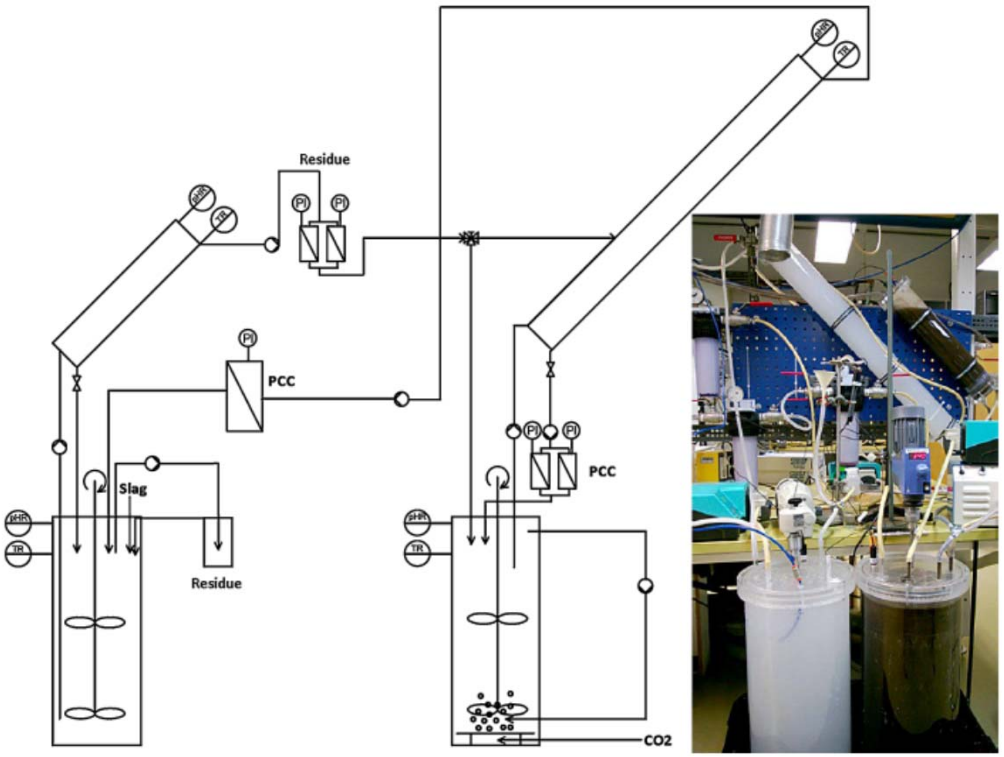
- **500ml reactor**
- **1 -10 g of slag**

Lab- scale experimental set-up

- **Results:**
- **Extraction stage:**
  - **Ammonium salt (NH_4Cl, NH_4NO_3 and CH_3COONH_4)**
  - **can selectively dissolve calcium from the slag**
- **Carbonation stage:**
  - **After filtration, the calcium rich solution reacts with CO_2 to produce precipitated calcium carbonate (PCC)**

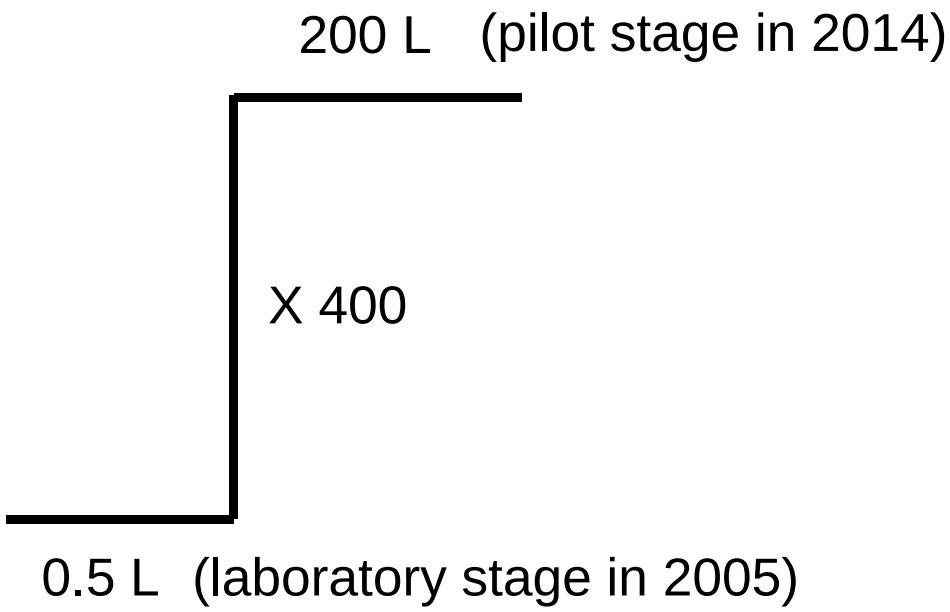
Scale-up of the Slag2PCC

Scale-up @ ÅA

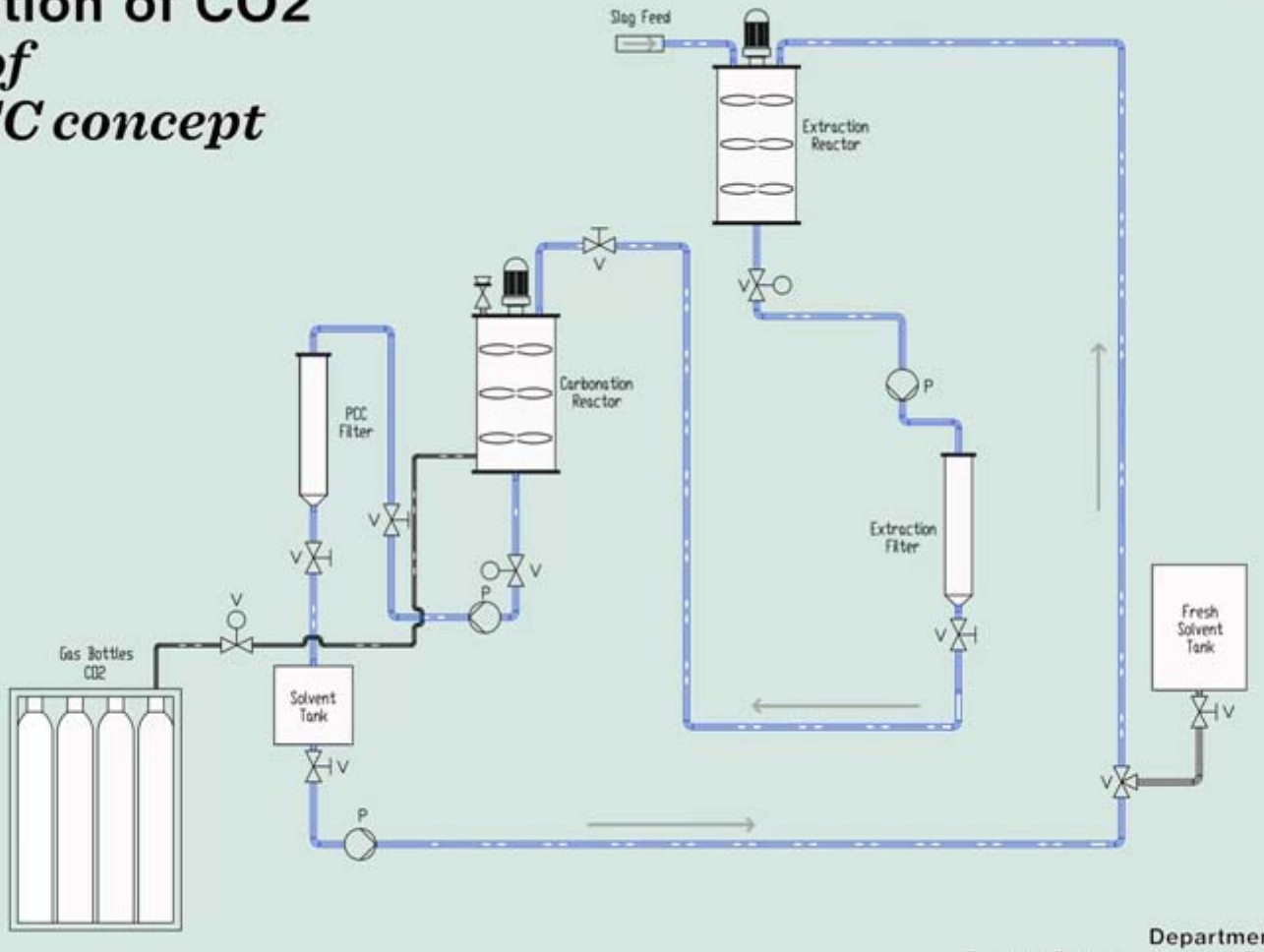


Slag2PCC test facility
@
Åbo Akademi, Turku

Scale-up @ Aalto



Mineralization of CO2
Scale-up of Slag to PCC concept



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Department of Energy Technology
Energy Engineering and Environmental Production

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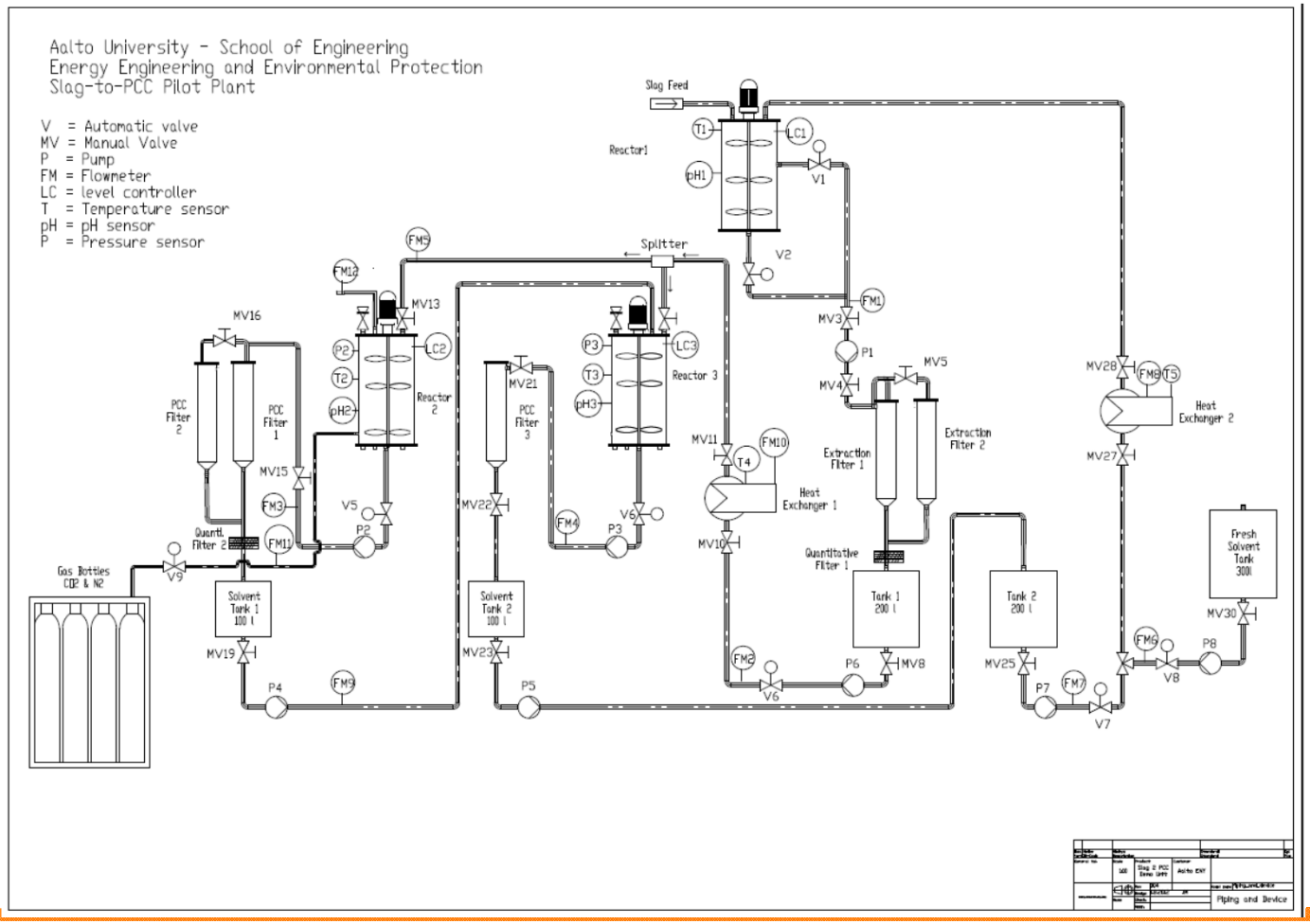
Scale-up @ Aalto

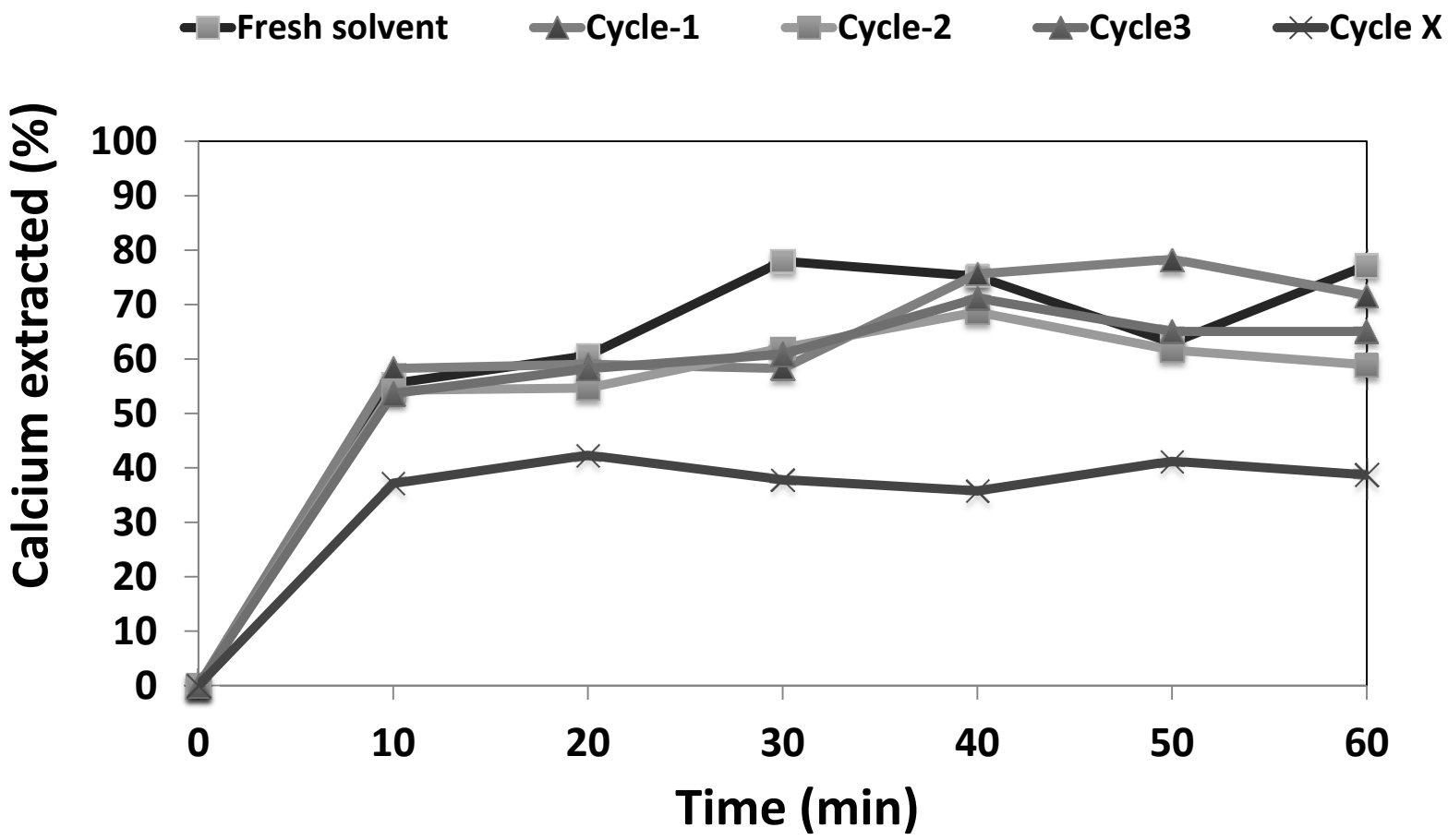


Slag2PCC pilot plant
@
Aalto university

Results from the pilot scale

- **Extraction:**
  - **80% calicium extraction efficiency**
  - **Solvent recovered and recycled**
    - **– to minimize the chemical consumption**

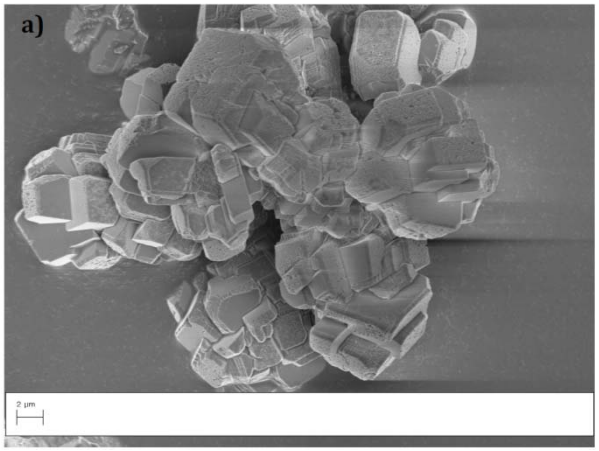
Results from the pilot scale

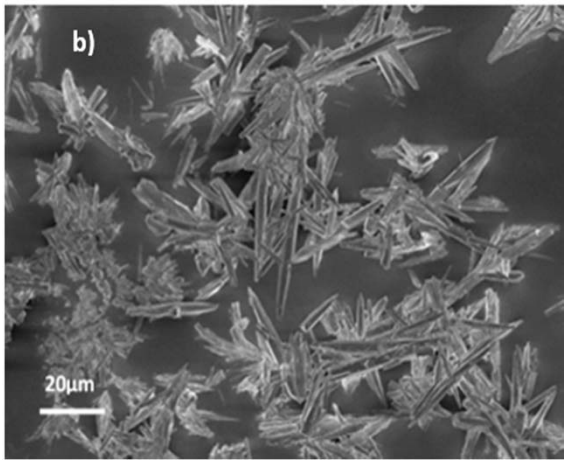


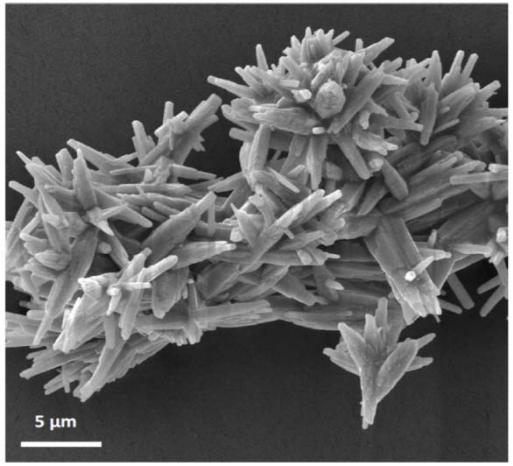
Results from the pilot scale

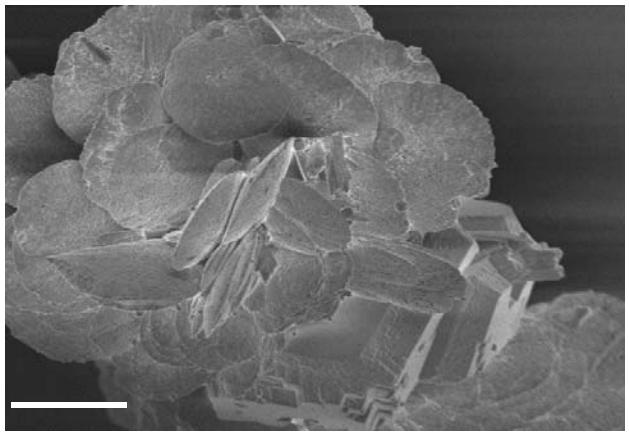
- **Carbonation:**
  - **We successfully produced different PCC merphologies e.g. calicite and aragonite**

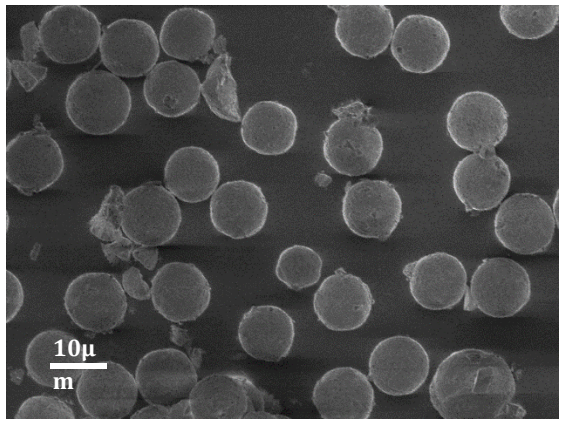
Results from the pilot scale

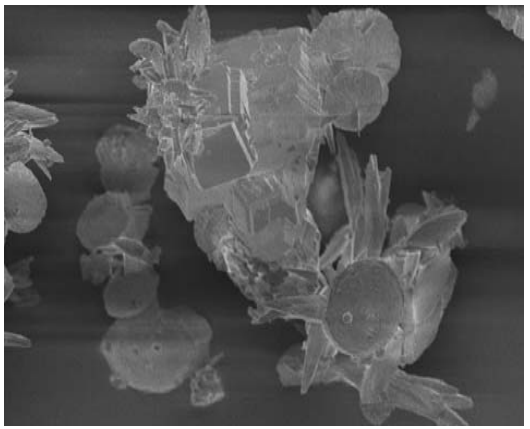








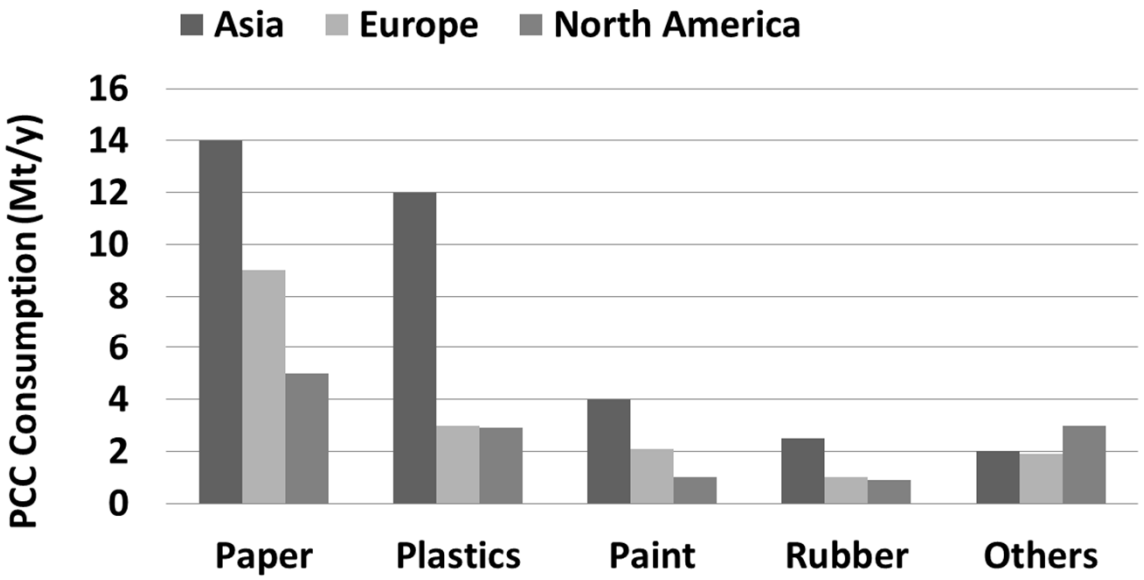




The final product: PCC

- **PCC is used as a raw material in a wide variety of industries:**
  - **paper, plastic, pharmaceutical, etc.**
- **Pulp and paper industry is the largest consumer of PCC**

PCC global market



- **The global consumption of PCC increased from 10 Mt in 2004 to 14 Mt in 2011**

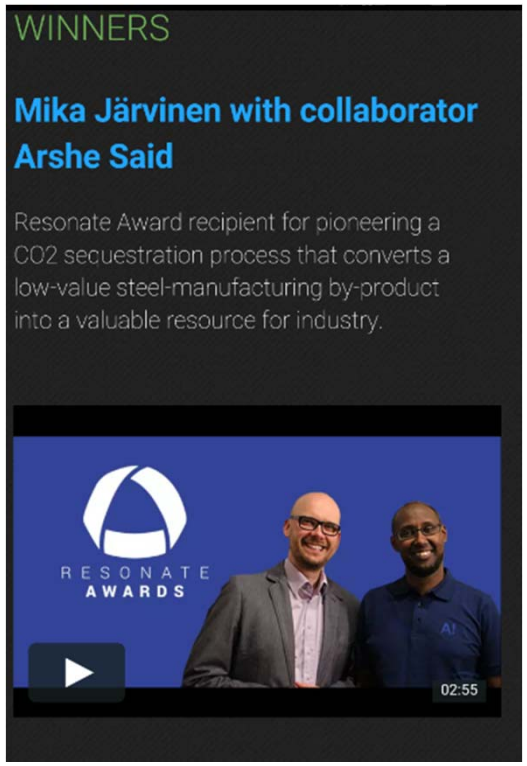
Slag2PCC market

- **Slag2PCC technology is technically and economically feasible**
- **PCC produced via Slag2PCC process can replace the conventional PCC and GCC**
- **Creating our global market niche**

Public relationship (PR)

- **Local media attention**
- **International media attention**

Public relationship (PR)



Public relationship (PR)

- **International recognition**

Public relationship (PR)

- **The Caltech Resonate Award 2015**
  - **Slag2PCC research team at Aalto University has received the Resonate Award 2015 from Caltech's Resnick Sustainability Institute**

Public relationship (PR)

- **Local recognition**

<u>Success case</u> – Steelmaking slag together with CO2 turns into calcium carbonate

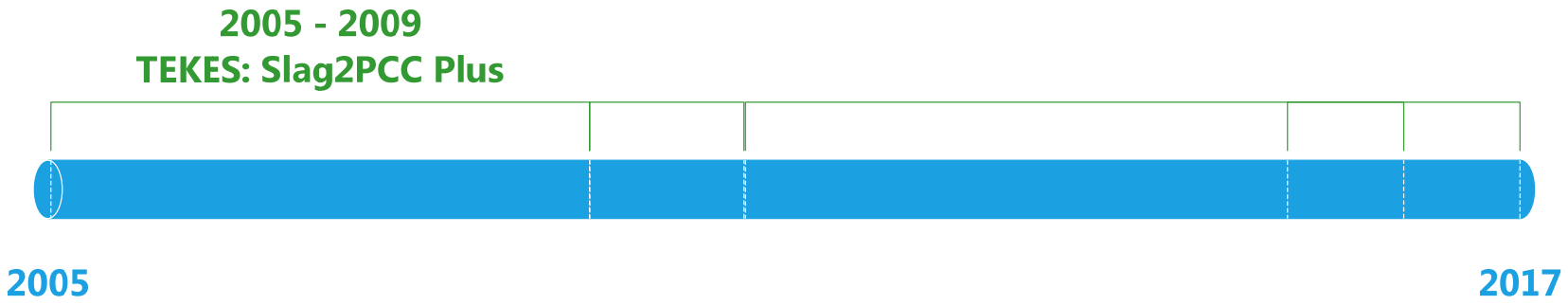
Public relationship (PR)

- **International collaborations**
  - **Japan is a good example**

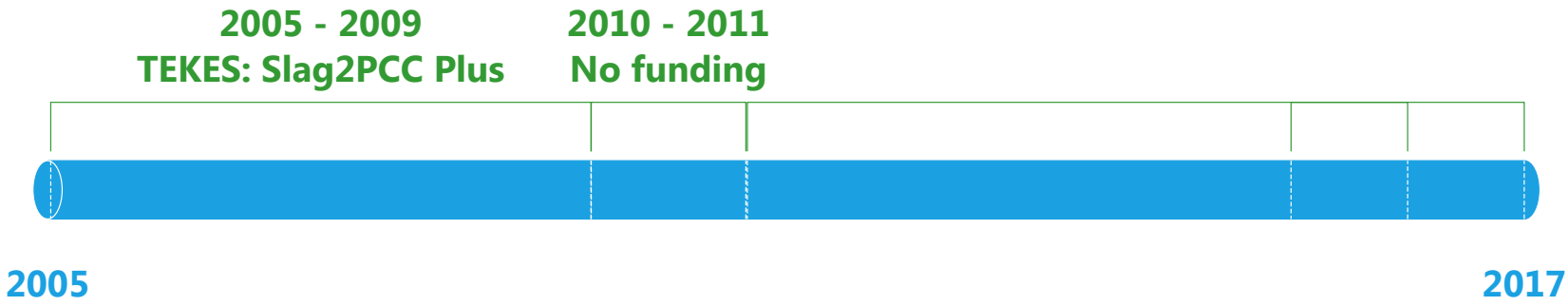
History

- **Past, present & Future**

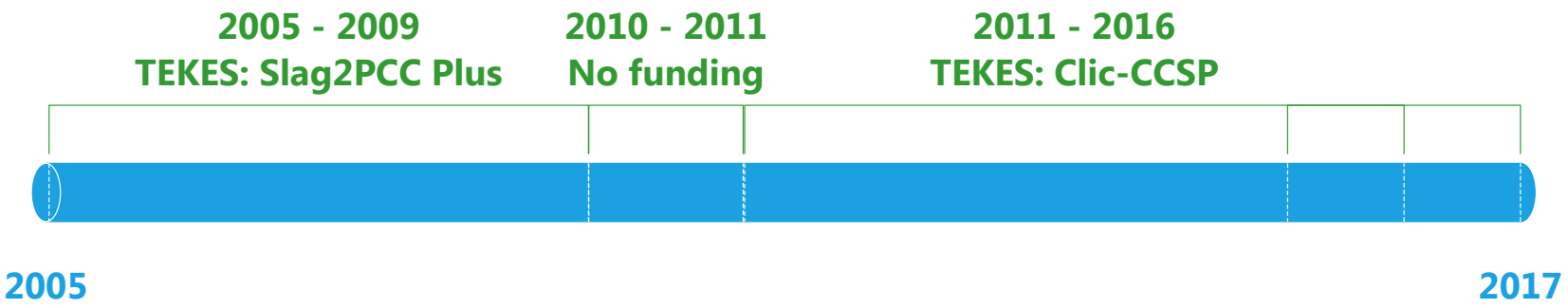
Past, present & future



Past, present & future



Past, present & future



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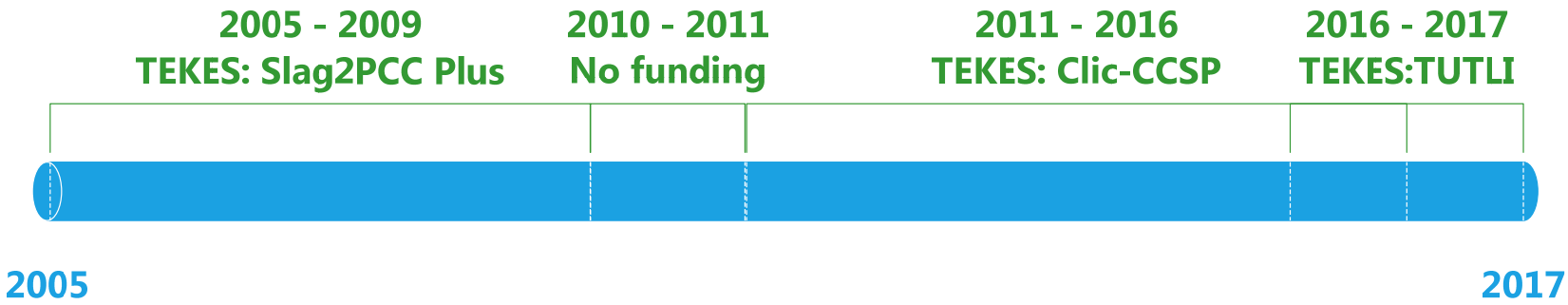
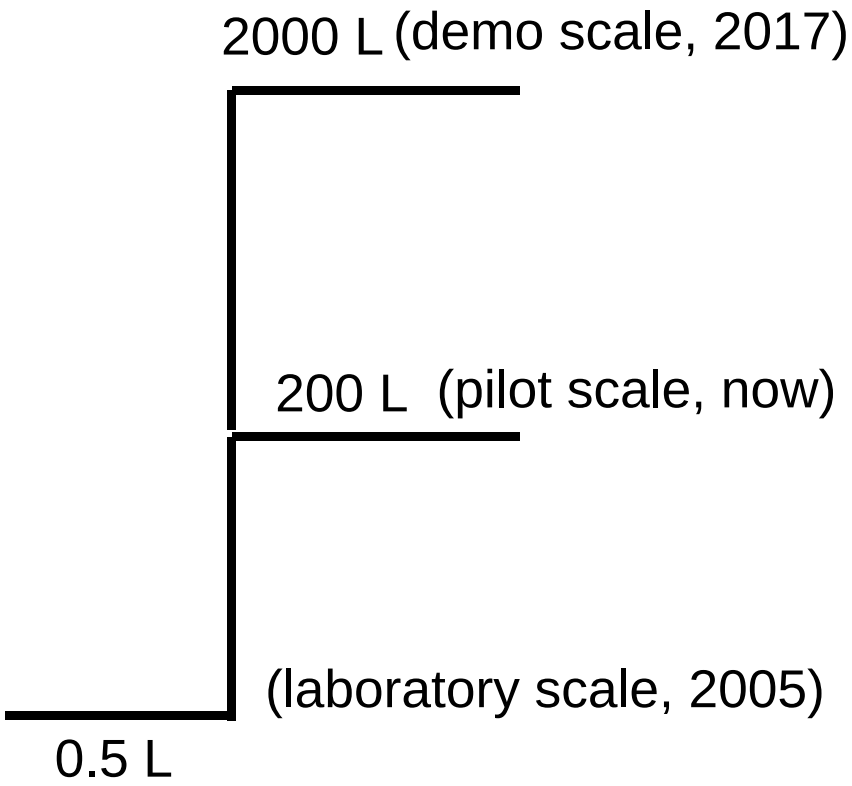


Post CCSP

- **Commercializing the technology**

Post CCSP


2000 L (demo scale, 2017)
200 L (pilot scale, now)
(laboratory scale, 2005)
0.5 L

Conclusions

- **The collaboration between industry and research organization was very fruitful**

  →<u>The CCSP program was very successful</u>

Acknowledgement

CLIC Innovation Oy

Tekes

All CCSP Partners

Thanks!