Frugal Innovation...

Six Principles:

1. Engage and iterate
2. Flex your assets
3. Create sustainable solutions
4. Shape customer behaviour
5. Co-create value with prosumers
6. Make innovative friends

- Decline of size and efficacy of big corporation in-house R&D
- Proliferation of agile SME innovators
- Increasingly, partnerships of (large corporate / government) resources and (SME) innovations is leading to effective, frugal innovation
Industrial CO₂ emissions from the cement and lime industries... ...a challenge requiring innovative solutions

- Around 60% of total CO₂ emissions from the cement and lime industries are released directly, and unavoidably, from the processing of limestone:

\[ \text{Ca CO}_3 \xrightarrow{\text{Heat}} \text{CaO} + \text{CO}_2 \]

- 1 Tonne Limestone \rightarrow ~0.5 Tonne Lime + ~0.5 Tonne CO₂

- CCS will need to be applied to 59% of European cement plants to meet the EU’s emission reduction target

- The cement and lime industries are under intense competitive and cost pressures
Calix’s LEILAC concept...

Calix since 2013, has been operating a 25kTpa, indirect heated / direct CO₂ separation kiln for magnesite (Mg CO₃)

The LEILAC concept is to extend the technology into lime and cement via a pilot plant

Key Challenges:
• Scale-up of temperature
• Impact of corrosion and scale formation
• Calcination level and throughput
• Capital cost of the pilot
• Future scale-up and integration
Innovation takes collaboration, persistence and courage…

• Calix is an Australian SME. When we started engaging potential collaborative partners for LEILAC, we had 22 FTEs.

• Australia is isolated geographically, corporately and politically (wrt CO₂ capture) from the rest of the world.

• Development of the technology had to take place outside of Australia.

• Our first LEILAC bid failed to achieve funding, but the second succeeded. It is an unusual “R&D Project” – involving construction of a 60m tall tower!

• The project required convincing high profile organisations to commit to a very public grant bid process and R&D project – the partners within the LEILAC consortium are to be commended on their courage wrt their support of an R&D project very much in the public eye.
Pilot plant in Lixhe, Belgium
  • Lime application 8tph
  • Cement application 10tph
Indirect heating raw cement meal and limestone:
  • Target 95% capture rate of process-related CO₂
€12m H2020 grant plus €9m in-kind
  • 5-year project, started in early 2016
High Impact
  • Energy source flexibility – alternative fuels or electricity
  • Compliments other developing CO2 technologies such as oxy-fuel

The LEILAC (Low Emissions Intensity Lime And Cement) Project Vision is to future-proof the cement and lime industries without significant impact on operability, capital intensity or efficiency...
Progress to date…

Successfully reduced all the major risks:
• A good understanding and characterisation of the feeds
• Informed choices of materials and equipment for the reactor
• Understanding of the corrosion and scale risk and development of mitigation strategies
• Confidence in the design and outputs, based on significant process, kinetics and CFD modelling

Dissemination
• Visitor Centre at Lixhe completed ahead of schedule
• Press coverage, articles in Global Cement Magazine, BusinessGreen etc.
• Website in English, French and Dutch
Scale-up will require on-going innovation and collaboration...

- **2018-2020**
  - LEILAC pilot plant test campaigns

- **2021-2025?**
  - Cement - large scale demonstration
  - Lime - first commercial plants

- **2030?+**
  - First commercial plants - cement
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654465