



LafargeHolcim's activities: CCS/U and low CO₂ cements, focus on Solidia

Second ECRA Chair Scientific Event ,

Mons, 09th November 2016

Vincent Meyer, Michel Gimenez



LafargeHolcim

The Global Picture

CO₂ emissions

- Worldwide anthropic CO₂ emissions: 37 Gt/y (2013)
- Cement industry: 4 – 4.5 Gt/y (2013)
-  ~ 190 Mt/y i.e. ~ 4 % of cement and ~ 0.5 % of WW emissions
LafargeHolcim
- We are the 2nd private company bigger emitter in the world

Levers for cement industry to mitigate CO₂ emissions are:

- Performance levers (i.e., SHC, waste fuels (biomass), clinker ratio),
- CO₂ capture & storage or uses/applications,
- New CO₂ products (AETHER, SOLIDIA...),

CO₂ Capture into the Cement Plant

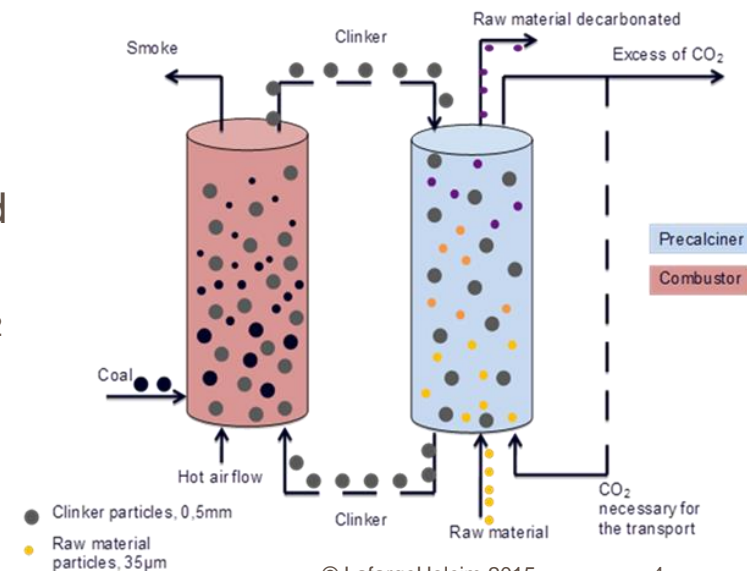
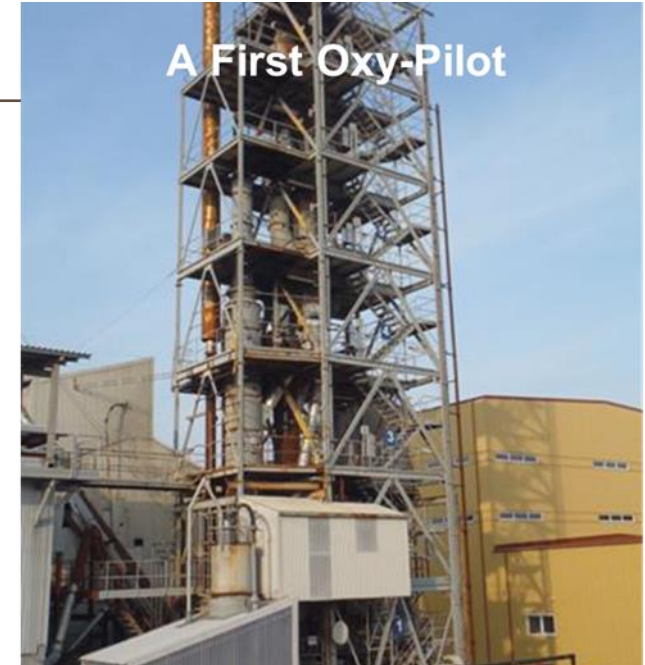
- CO₂ capture is tricky
 - e.g., post-combustion amine scrubbing (MEA), is not integrated to the cement plant and is very energy intensive (in terms of both kWh & GJ)
- CO₂ capture appears to be technically feasible into the cement plant but there is no viable business model identified today; the more integrated to the cement process, the cheaper the capture
- Once captured, CO₂ needs to be used or geologically stored



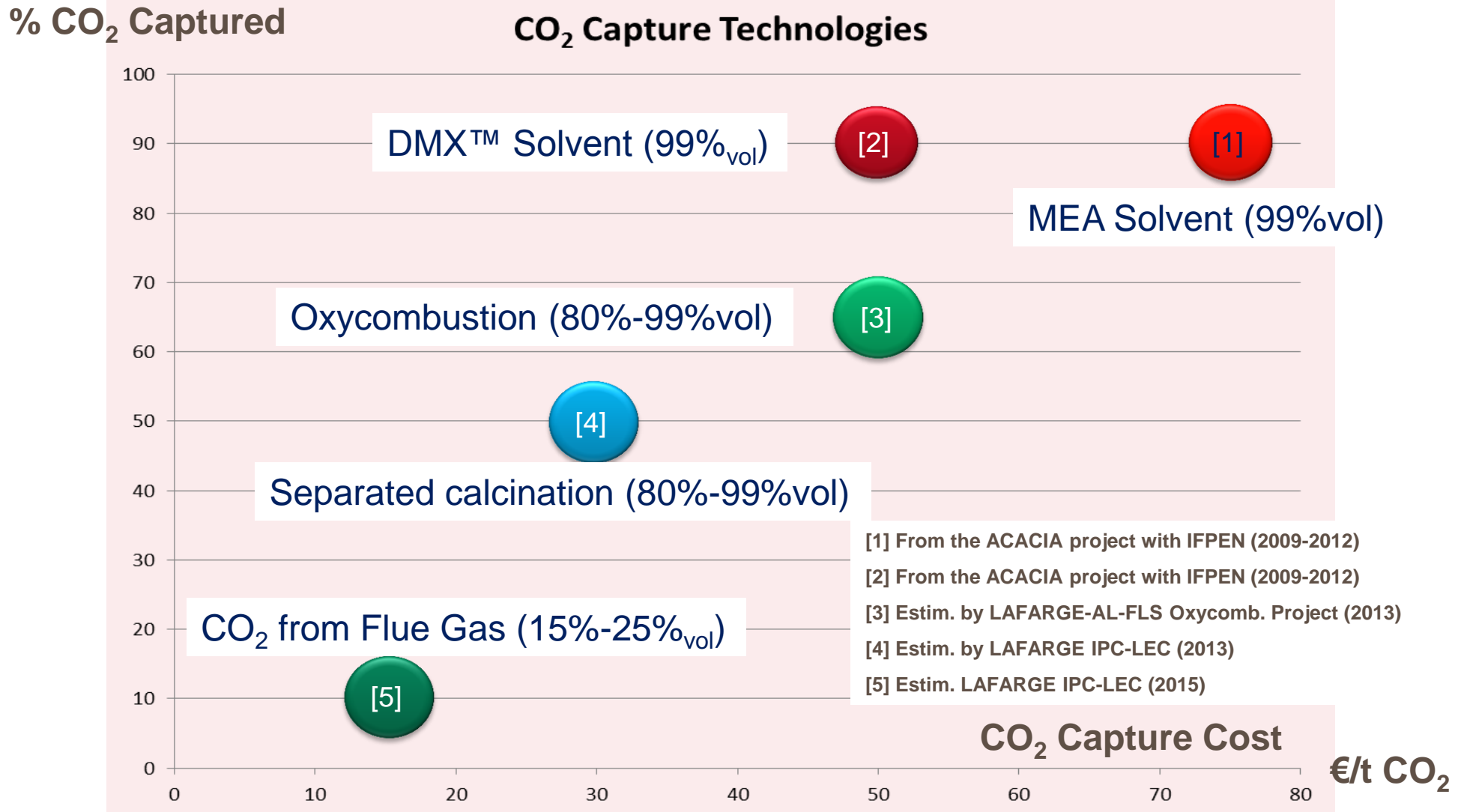
The CCSU Projects at LafargeHolcim (1)

CO₂ capture projects

- [CapCO₂ Project](#), studying the post-combustion MEA scrubbing of CO₂ from cement plant stack (2005-2008),
- [ACACIA Project](#), studying post-combustion breakthrough technologies like Enzymes, Ionic Liquids, Clathrates, Demixing Amines to capture CO₂ (2008-2012) with Solvay, Rhodia, IFPEN, GDF-Suez, ARKEMA, AXELERA, Veolia Environment
- [Oxy-Combustion Project](#) with Air Liquide and FLSmidth (2009-2014); oxycombustion at calciner only at FLSmidth pilot plant Dania/Denmark
- [SCALP](#) Separated Calcination Project (since 2010, stopped 2014) with ENSIACET Chemical Engineering Department, aiming at separating calcination CO₂ from Combustion CO₂ for more integrated CO₂ capture process into the cement plant



Summary Learning on Capture Technologies



The CCSU Projects at LafargeHolcim (2)

CO₂ storage project

- **France Nord Project** to find a CO₂ storage in a deep saline aquifer North of France (2009-2014) with TOTAL, EDF, GDF-Suez, Air Liquide, Vallourec, IFPEN, BRGM

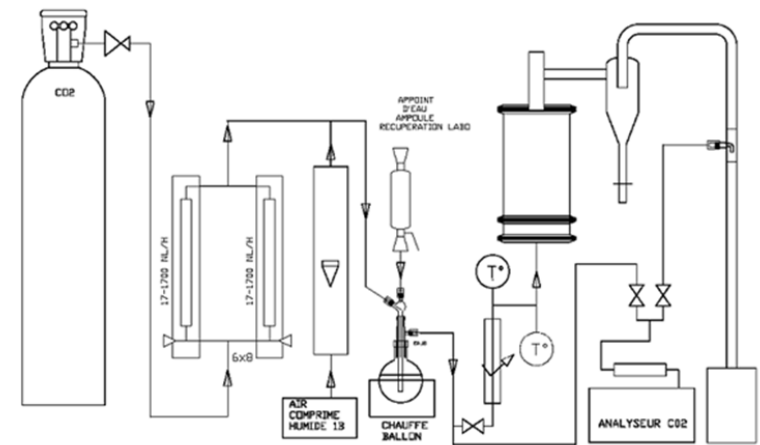
Outputs:

- Loggings & data were assessed by TOTAL & IFPEN
- No big enough storage was identified → Decision to stop the project year 2014 prior to any CO₂ was injected
- Learning on CO₂ geological storage issues

The CCSU Projects at LafargeHolcim (3)

CO₂ reuse projects

- **Algae Pilot experimentation** into a cement plant (France) with Salata GmbH (2009)
- **IPMC** (In Plant Mineral Carbonation), LAFARGE (2010), aiming at carbonating W Fly Ash to capture CO₂



- **SOLIDIA** low-CO₂ cement and concrete (2013-on going)

Solidia presentation

Who is Solidia?

- Solidia technologies
 - US Start-up found in 2009
 - Funding : \$80 Millions from investors
 - Kleiner Perkins Caufield & Byers, Bright Capital, BASF Venture Capital, BP Ventures, LafargeHolcim, Total...

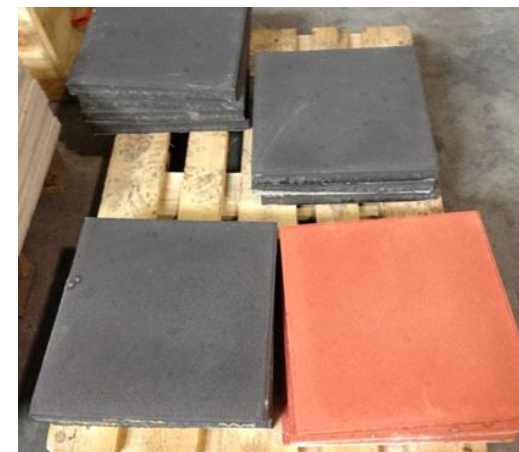
▪ Development of a non hydraulic binder for concrete precast



Solidia solution

Technical solution: clients advantages

- Solidia binder = **Carbonatable binder**
 - Strength development when concrete is in presence of CO_2 in temperature (40 to 70°C)
 - Compressive strength after **1 curing day : ~40- 60 MPa on mortar**
 - Adapted curing chambers for precast concrete
 - 1st step : blocks, pavers, terrace plates...



Solidia solution

Technical solution: cement & concrete



- Same Raw Materials



- Same Kiln



- Same Mix Components
- Same Mixer
- Same Cycle Time



- Same Forming Casting
- Same Cycle Time



- CO₂-Curing
- Reduced Curing Times
- 28 Day < 1 Day

Solidia Cement™

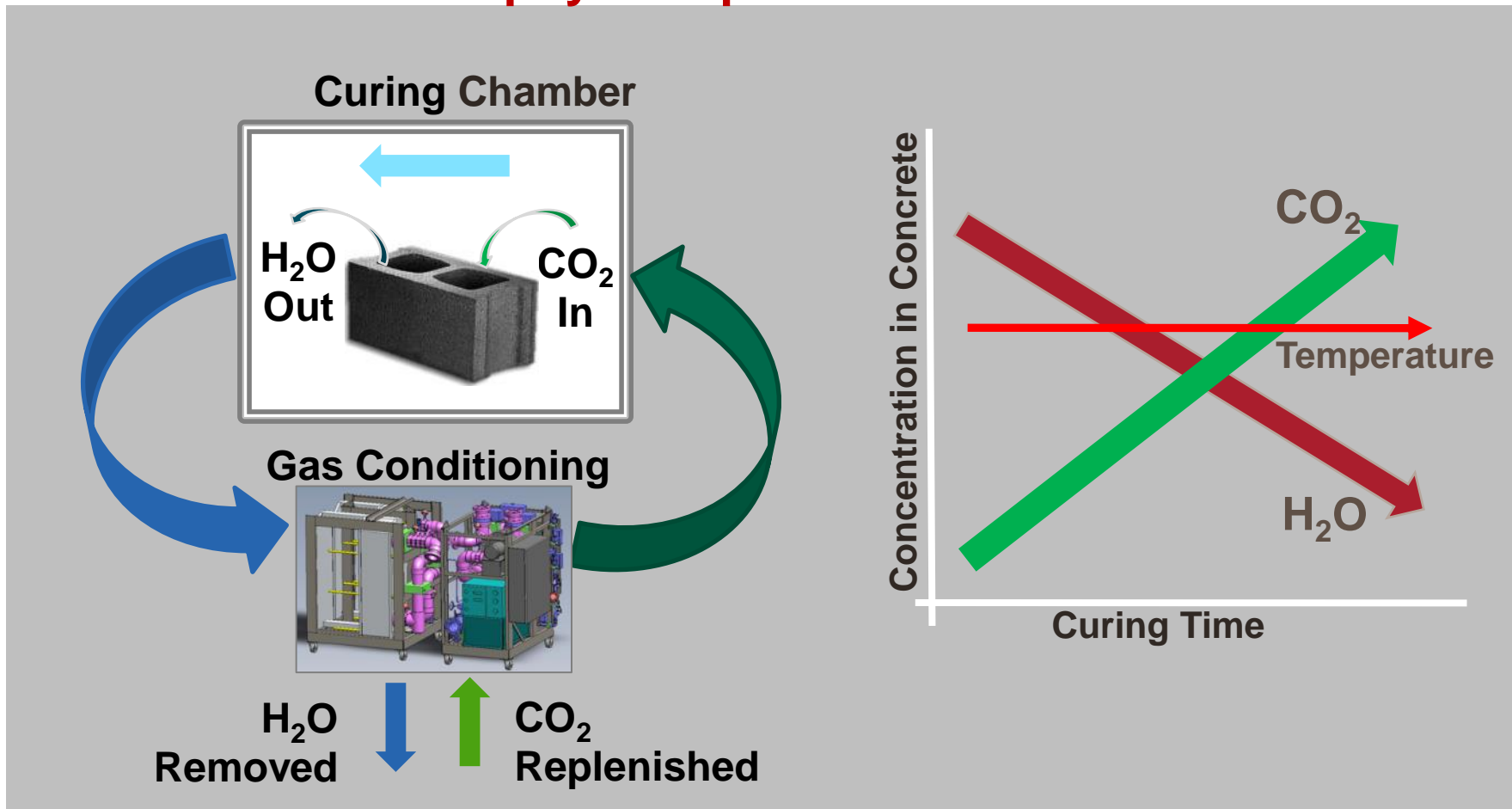
CO₂ emissions at cement plant
reduced
by 250 kg (per ton of clinker)

Solidia Concrete™

Up to 300 kg of CO₂ permanently
stored in concrete (per tonne of
cement used)

Solidia solution

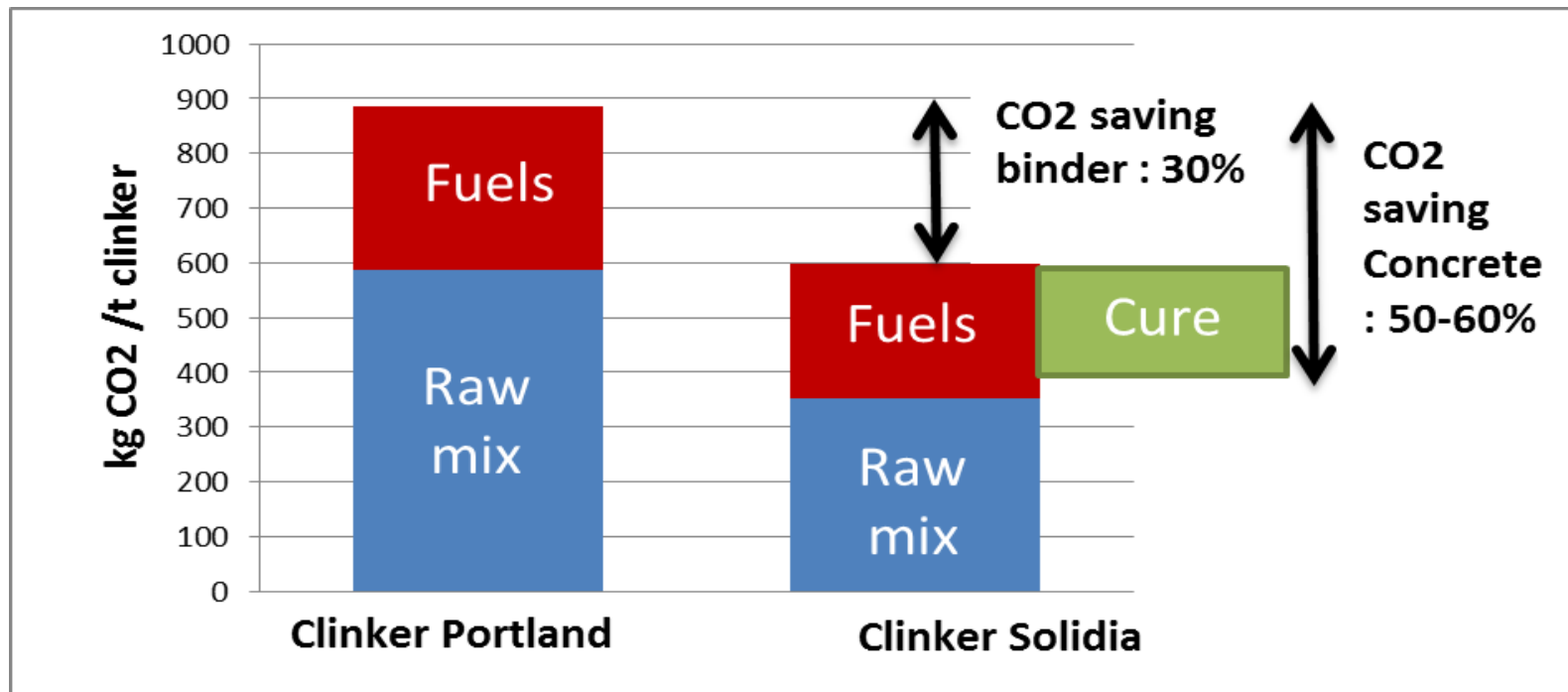
Technical solution: physical phenomena



Solidia solution

Technical solution: CO2 emissions reduction

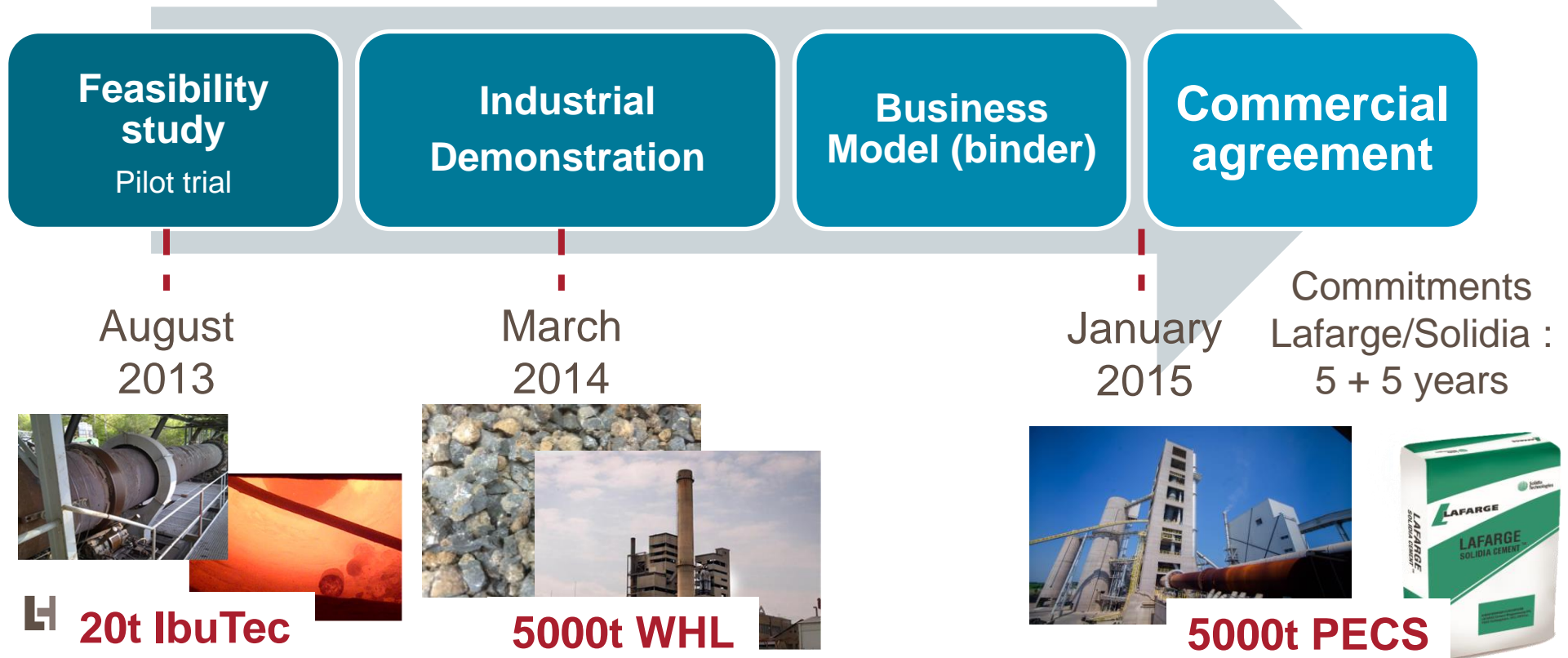
- Clinker composition : Wollastonite CS, Rankinite C3S2 & Belite C2S
 - Different raw mix and lower clinkering T°C than for OPC
- CO₂ balance of Solidia binder produced at WHL



From partnership to commercial agreement

Partnership LafargeHolcim/Solidia

- Step 1, August 2013 : JDA between Lafarge and Solidia
- Step 2, January 2015: Commercial agreement

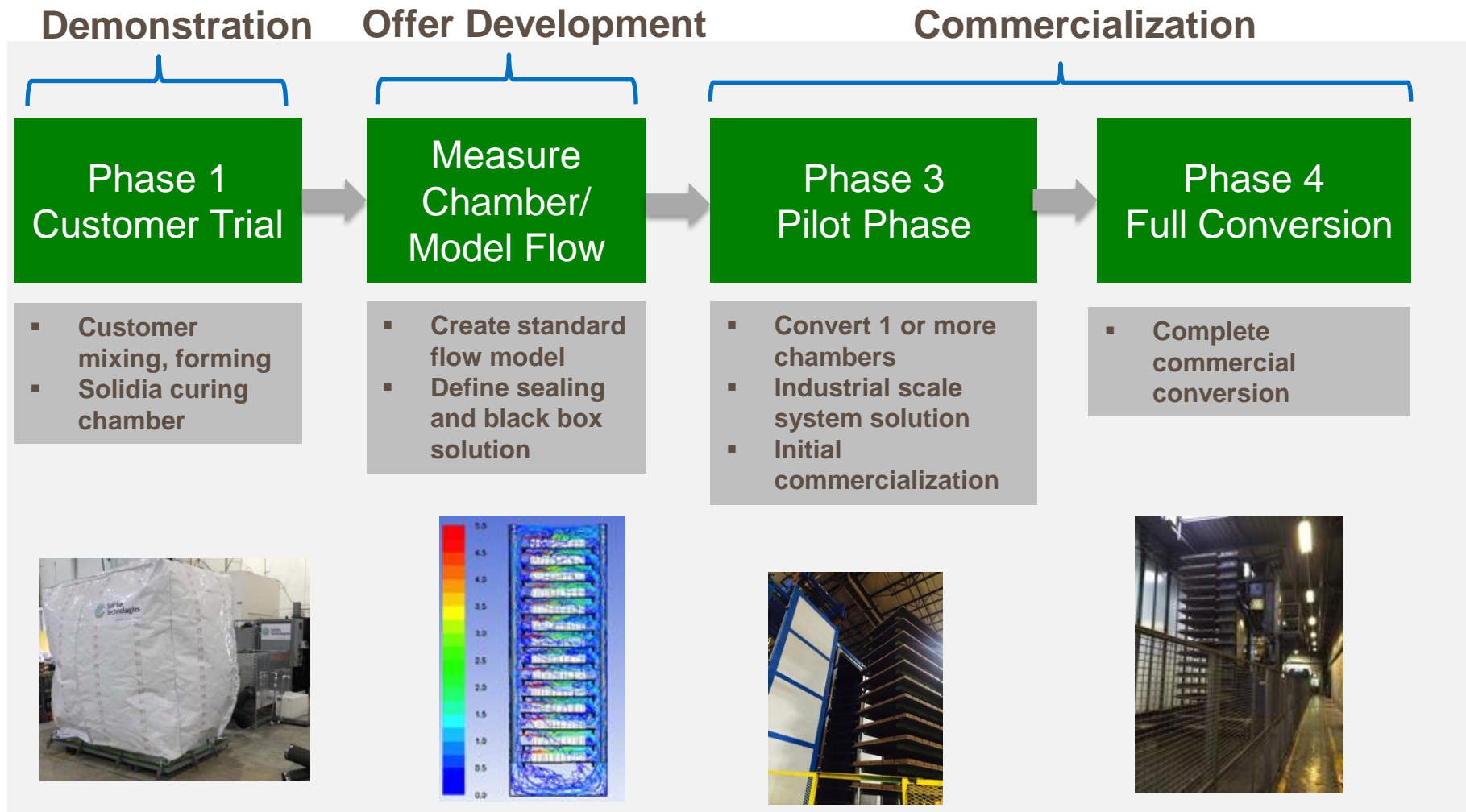


Solidia Concrete™

Benefit Summary

Product	<ul style="list-style-type: none">▪ Same Mix Designs▪ 28-day Strength in < 1 Day▪ Low Shrinkage▪ Light Cement Colour▪ Better Pigmentation▪ No $\text{Ca}(\text{OH})_2$:<ul style="list-style-type: none">▪ Low Efflorescence▪ ...
Process	<ul style="list-style-type: none">▪ Same Mixing / Forming▪ Rapid Cure▪ Fast Clean-up▪ Reduced Concrete Waste▪ Streamline Post-Cure Processes▪ Reduced Inventory▪ Extended Production Season
Sustainability	<ul style="list-style-type: none">▪ Up to 70% Reduction in CO_2▪ Consumes Waste CO_2▪ Stores as Stable Calcium Carbonate▪ 80% of Process Water Can be Recycled▪ Local Raw Materials▪ Potential Carbon Credits▪ Sustainable Construction Credits

Solidia Technologies®: Commercialization Process



Trial Process

Phase 1 Portable Curing System

What Does a P1 Look Like?



More than 30 pilot trials performed worldwide till end of 2013

A first precast production line converted in US (P3)



Solidia first Customer Phase 3 Trial- North America

EP Henry: Conversion of precast curing chamber

Solidia Cement Silo



Cement Pavers



CO₂ Tank



Gas Conditioning System



*Typical Run ~8,000 pavers
(40 t concrete, 5 t cement)*

Solidia first Customer Phase 3 Trial- North America

EP Henry: commissioning & commercialization process

EP Henry: 2016

- Equipment Commissioning (Run 1-3)
- Mix design optimization (Run 4-7)
- Forming optimization (Run 8-11)
- Curing optimization (Run 12-14)
- Repeatability and fine-tuning (Run 15-17)

Latest run results (10/2016):

Mean CS = 9000psi, no paver < 7200psi, better aesthetic (comparable to OPC performances)

Next steps

- New clinkering campaign in US



Typical Run
~8,000 pavers
(40 t concrete,
5 t cement)

Thank you for your attention

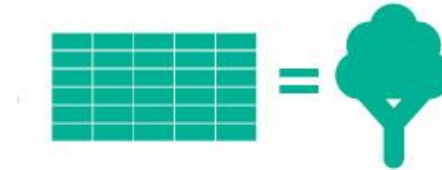
Solidia's CO₂-curing technology reduces water consumption in the production of concrete up to 80%.



If global concrete production converted to Solidia's systems, the world could realize an annual water savings of 2 trillion liters.



30 Solidia Concrete™ blocks will absorb 22kg of CO₂ at production.



In one year, a tree will do the same.

Questions?

LafargeHolcim and Solidia acknowledge the European Union for its funding in the framework of LIFE Program under grant agreement N° LIFE15 CCM/FR/000116.

