Carbon Dioxide Capture and Utilisation: Mineralisation

November 2018

Mineralisation/Carbonation is a circular economy solution to industrial waste and CO_2 emissions

The Global CO_2 Initiative – 5GT per year CO_2 Emission reduction through mineralisation

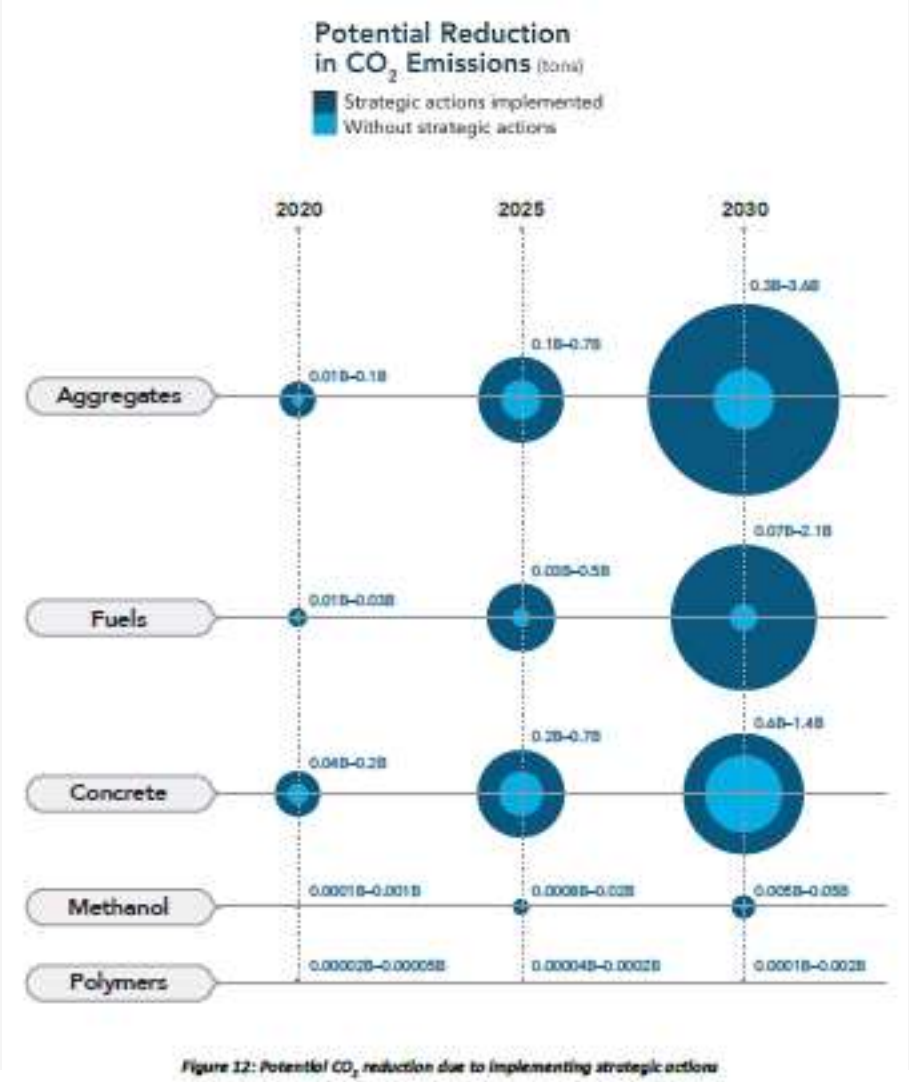


Figure 12: Potential CO_2 reduction due to implementing strategic actions

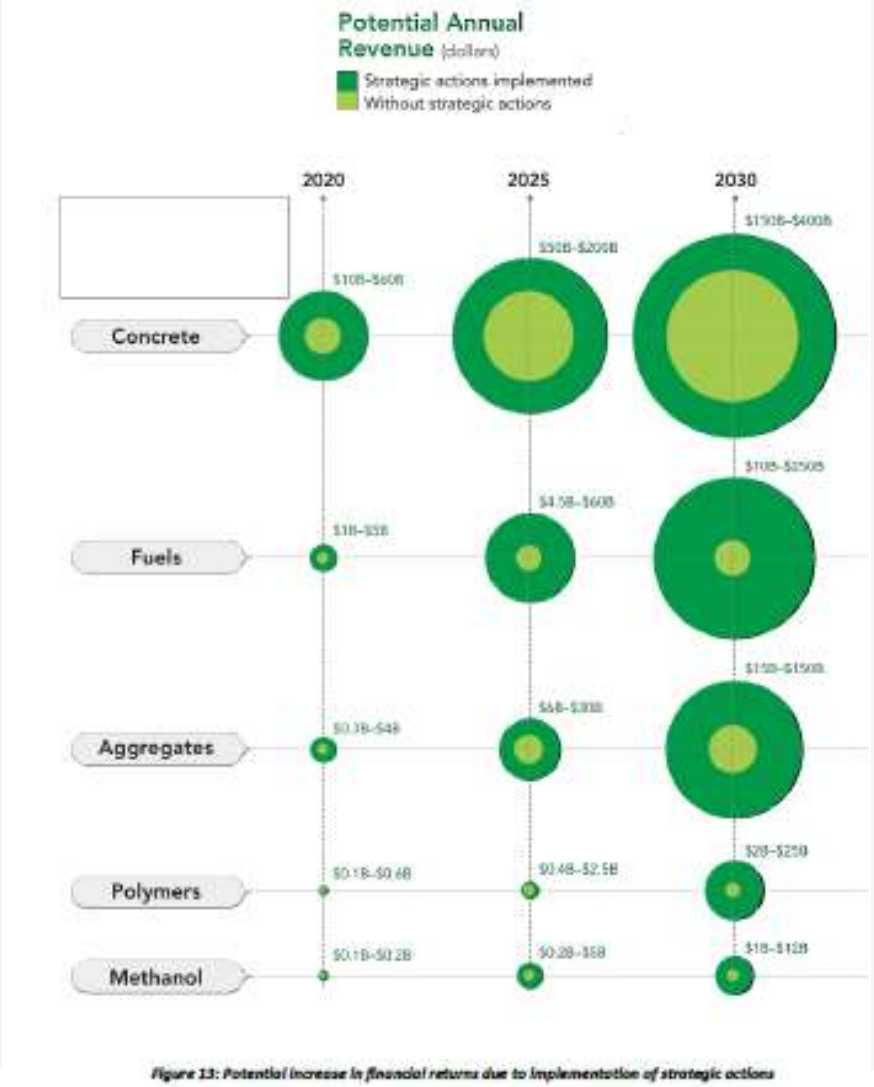


Figure 13: Potential increase in financial returns due to implementation of strategic actions

Concrete Curing:

CarbonCure: using CO_2 to accelerate the hydration of cement

Solidia: developing a special cement that when treated CO_2 will carbonate rather than hydrate to go hard.

Carbonates:

Carbon8 Systems: treating industrial wastes with CO_2 to manufacture products for the construction industry

Orbix/Carbstone: Using CO_2 in an autoclave to manufacture concrete blocks from steel slags.

Calera: Calcium carbonate cement from variety of wastes and production of boards

Cambridge Carbonates: carbonated products from MgO derived from ultrabasic rocks

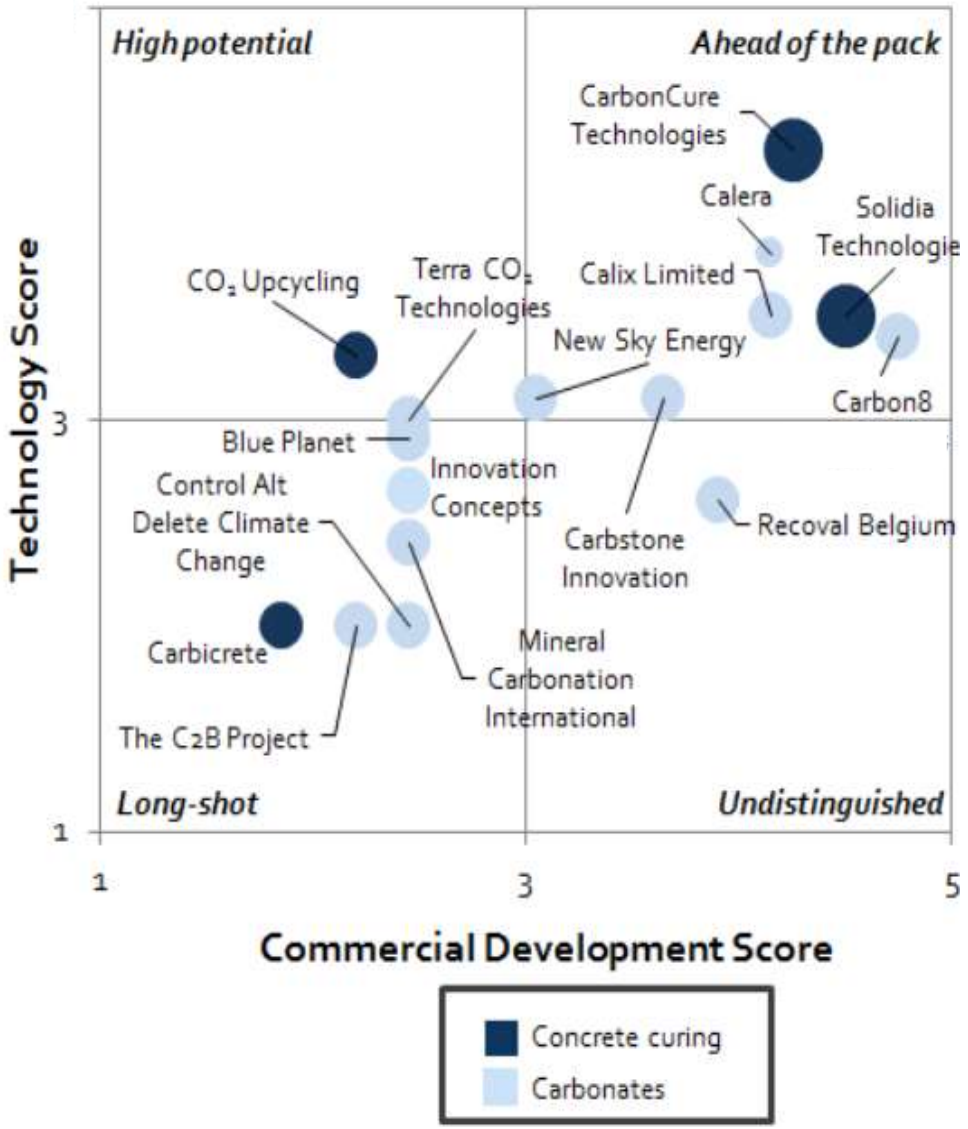
Carbon Xprize Finalists (4 from 10):

CarbonCure

Carbicrete: precast concrete from steel slags

Carbon Capture Machine: precipitated Mg and Ca carbonates from alkaline brines

Carbon upcycling UCLA: carbonate based concrete from coal flyash



Global CO_2 Initiative: CO_2 Utilization ICEF Roadmap 2016

Carbon8 Systems – example of commercial CO_2 Utilization

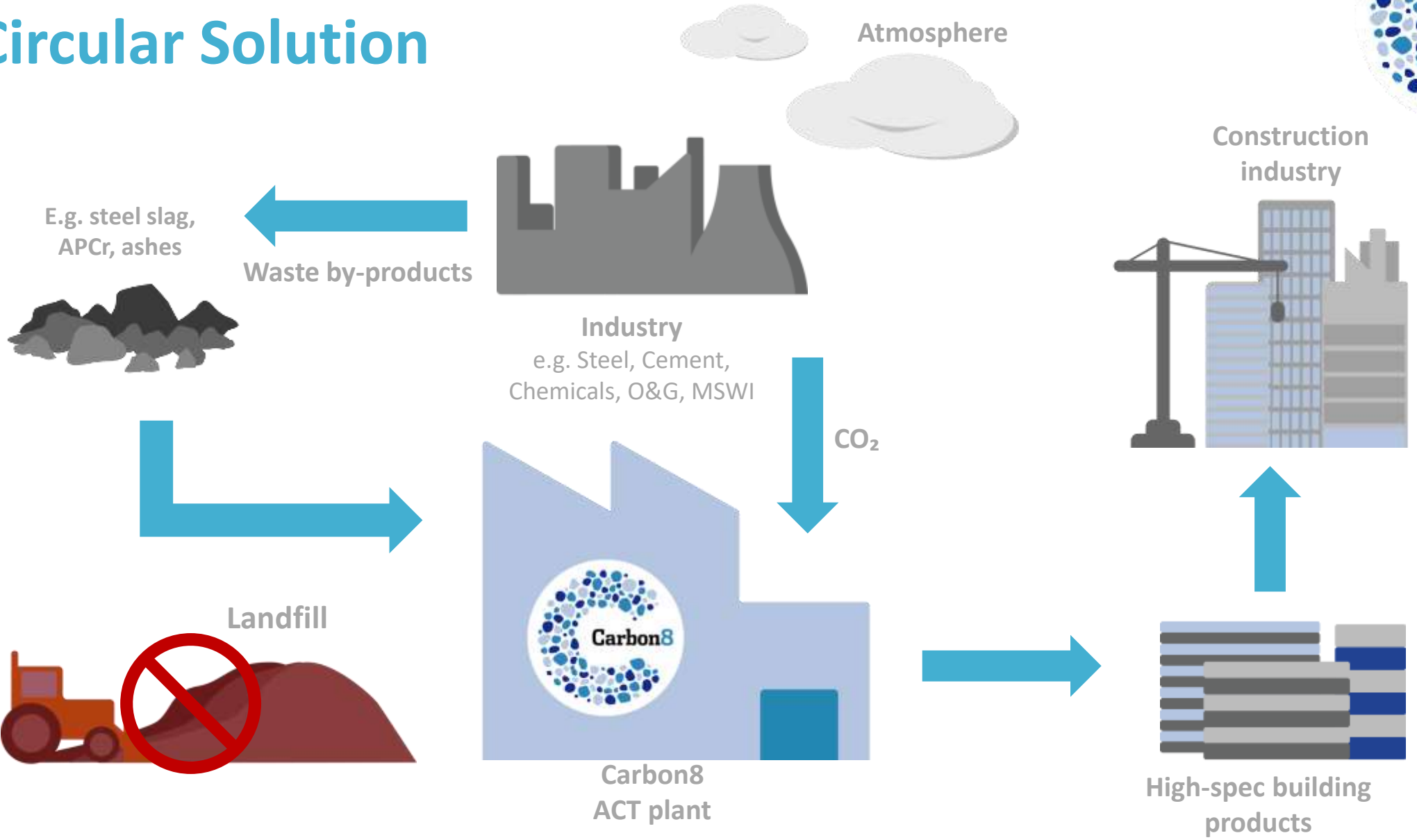
1. Full-scale commercial plant

- TRL 9
- 3 plants each processing up to 40,000 tonnes of residue a year
- £1m+ annual profit per plant
- Potential to capture 3,000 t of CO_2 at each site

2. Carbonation-in-a-box

- Funded demonstrator in Ontario
- Direct CO_2 capture
- Removes waste management and transportation costs
- Modular and plug and play
- TRL 7-8

Circular Solution



Markets

28.2 million tonnes of CO_2

177. 4 million tonnes of carbonatable residues across first 5 industries in Europe

Cement

EfW/ WtE

Biomass

Paper

Steel

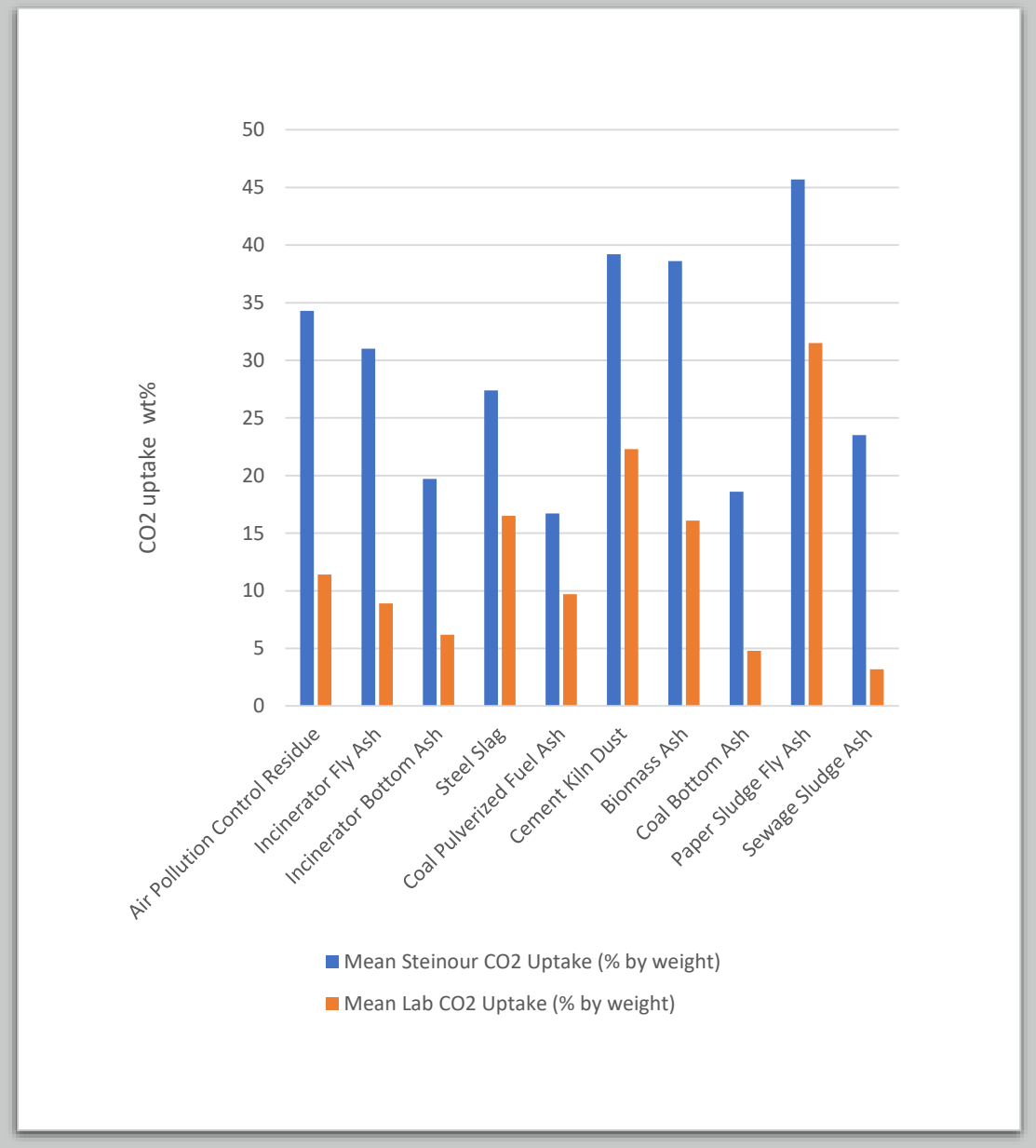
Market size

Key industry	Waste streams	Global volume (million tonnes)	European volume (million tonnes)	Current average cost of disposal (£/tonne)	Total European market size (£million)	Tonnes of CO_2 captured in Europe (million tonnes)
EfW	APCr, fly ash, bottom ash	75	45	120	5,400	4.41
Cement	Cement Bypass Dust (CBPD), Cement Kiln Dust (CKD)	410	21.73	50	1,086	4.78
Steel	Steel slag, stainless steel slag, EAF dust	507.36	63.42	50	3,171	11.42
Biomass	APCr, fly ash, bottom ash	70.2	35.1	60	2,106	5.63
Paper & Pulp	APCr, fly ash, bottom ash	45	12.15	60	729	1.94
TOTAL		**1,105.4**	**177.4**		**12,492**	**28.18**

Research and Development Needs

Three linked areas of research:

1. Understanding of the mechanics/kinetics of the carbonation reaction
   - Fundamental understanding of the Solid/liquid/gas interface
2. Methods to increase the uptake of CO_2 closer to the theoretical maximum
   - Modifying the starting materials
   - Enhancing the reaction with catalysts or ultrasound
3. Ways to process the products of the reaction to produce more valuable products
   - Speciality aggregates – lighter or unique properties cf natural aggregates
   - Precipitated carbonates – fillers in wide range of products



Mineralisation/Carbonation

- TRL 9 : Fully Commercial – Here Now
- Energy efficient – carbonation is an exothermic reaction
- Can use CO_2 from flue gas directly without the need for expensive purification and transport
- Solves other environmental problems – removing the need for:
  - Waste to landfill
  - Extraction of natural aggregates
- Permanent capture of CO_2
- Very large, growing market for products
- Profitable use of CO_2 - £200/t CO_2 profit