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Innovation in waste processing to achieve circularity

Engineering the Circular Economy

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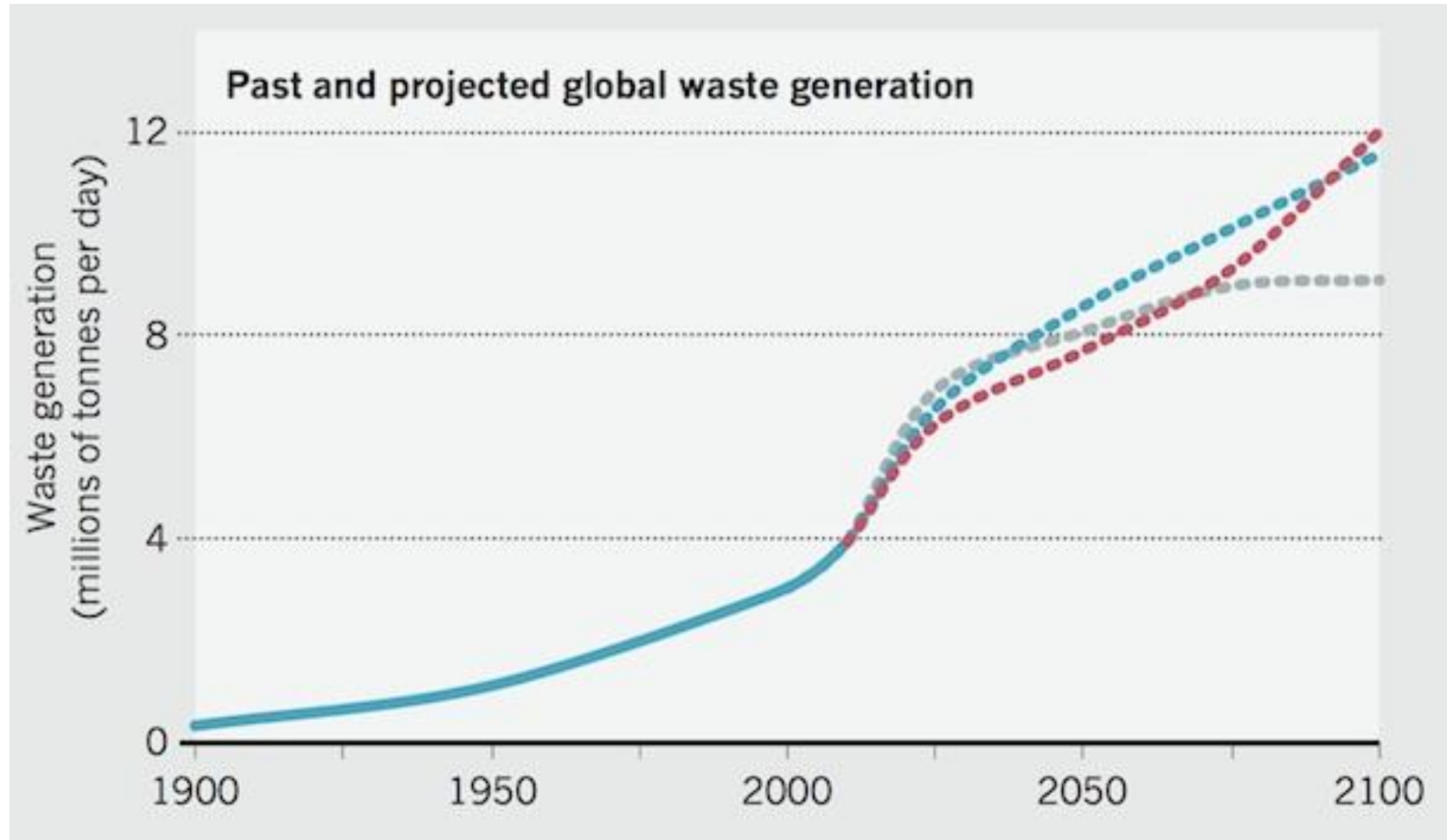
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CYPRUS 2016

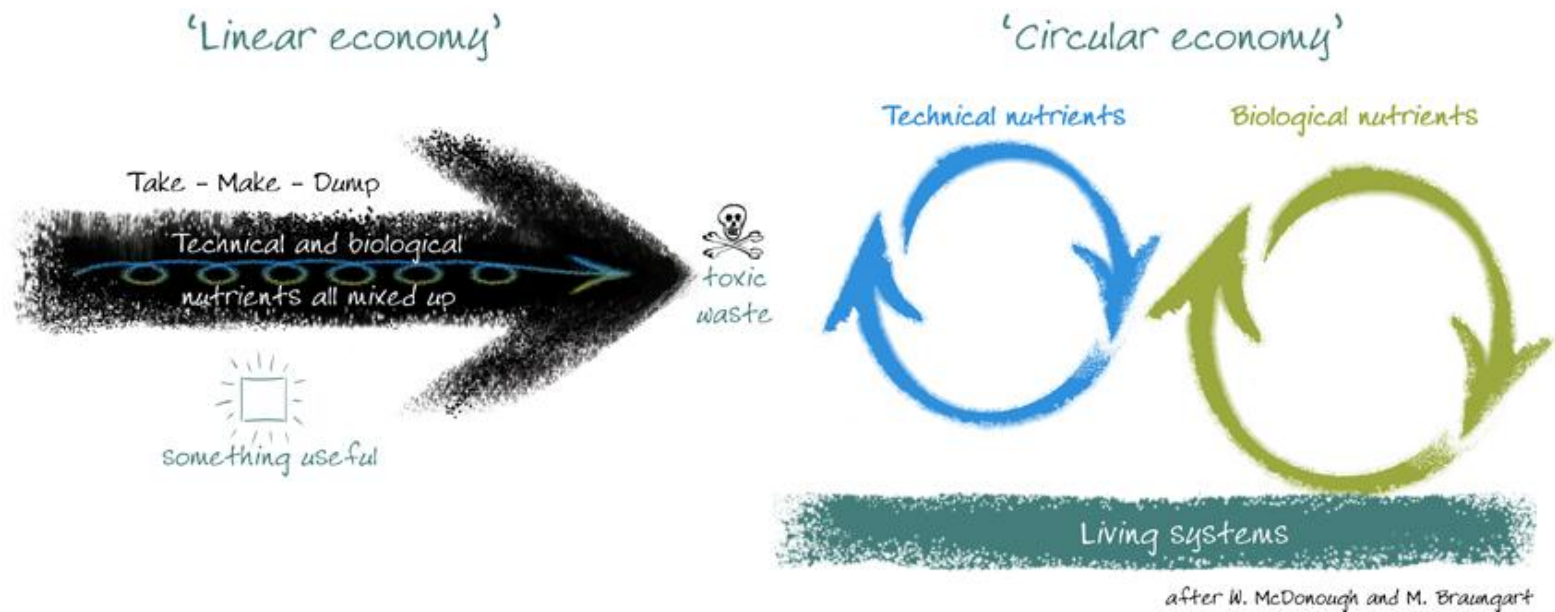
4th International Conference
on Sustainable Solid Waste Management

Global Waste Generation



Global waste generation predictions (Hoornweg, Bhada-Tata and Kennedy, 2013)

Linear vs circular economy



How do we get there?



Research
Materials science and processing

**The best opportunities need research
to make them happen.....**

The circular economy:

an opportunity worth in excess of 1 trillion US\$ for the global economy

McKinsey & Company



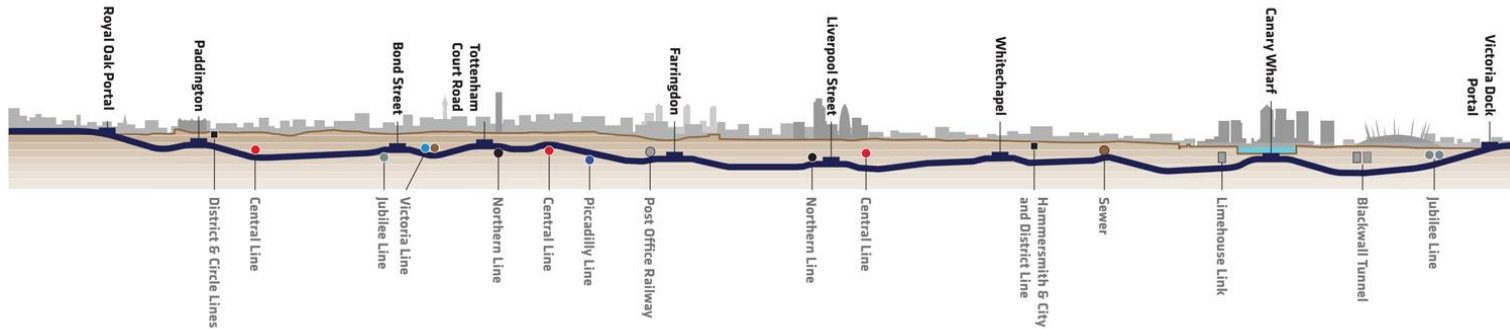
ELLEN MACARTHUR FOUNDATION
Rethink the future

Examples of five wonderful materials that are regarded as problematic wastes and our efforts to make them part of a circular economy.....

Innovation in waste processing to achieve circularity

1. London clay

Tunnelling spoil into cementitious materials

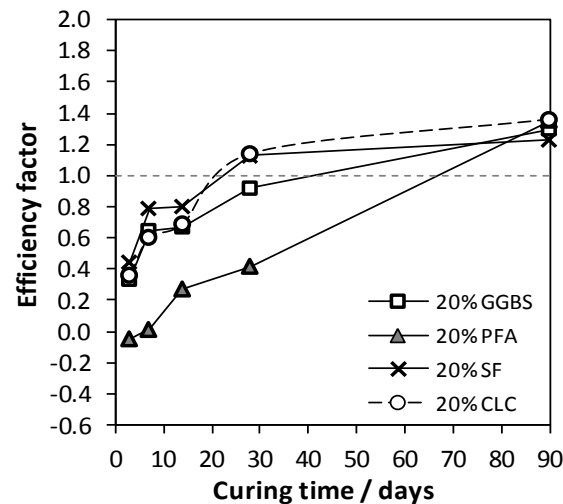


CROSSRAIL 2
SUPPORTING LONDON'S GROWTH



Supplementary cementitious materials

Potential to use London clay as the raw material to produce SCMs
Product to replace with GGBFS and coal fly ash as cement replacement materials
Manufacture an engineered pozzolanic material from wastes

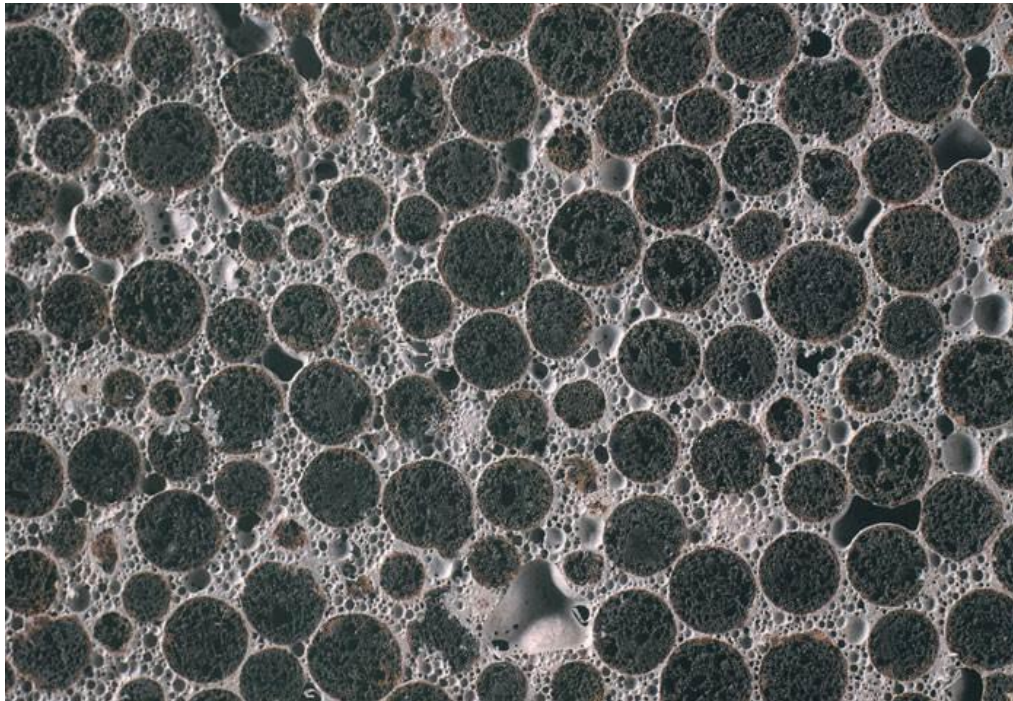


$w/b = 0.4$

Lightweight aggregate applications

Lightweight precast concrete products
Structural lightweight concrete

Lightweight fill material
Medium for water filtration
Landscaping and drainage
Agricultural and horticultural applications





London clay, dried, calcined at 900°C in a rotary kiln, ground to form an engineered SCM

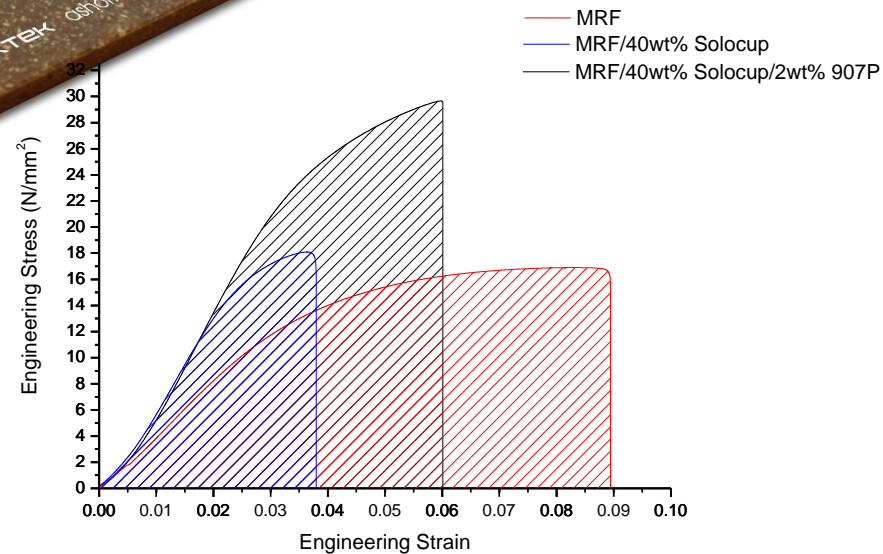
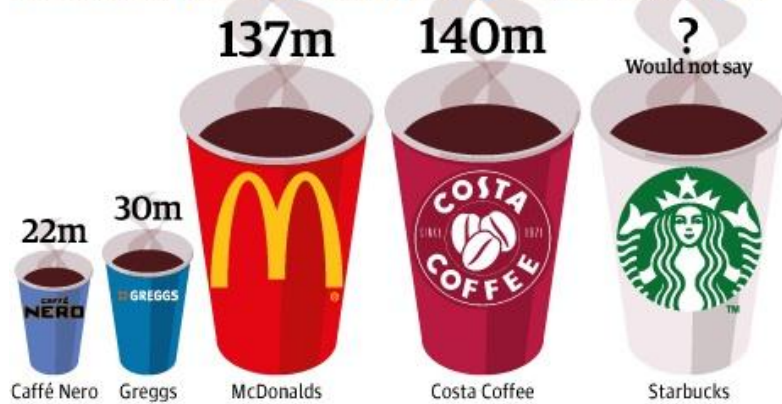
Blended with CEM I to form a pozzolanic cement (EN 197-1, a Type IV cement)

Mixed with glass and other materials to produce lightweight aggregate

2. Disposable cups

Disposable cups into reinforced plastics

Number of disposable cups sold by the big coffee chains each year



3. Waste glass

Paper, plastics, metals, glass



Waste glass into engineered absorbent granules



Raw materials
(glass powder + bloating agent)

Grind + Sieve
(Ball mill)

Mixing + Pelletisation
(Eirich Mixer)

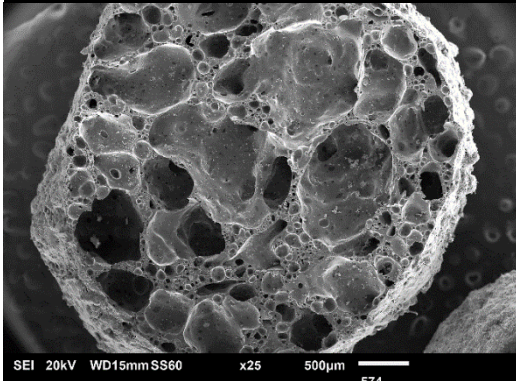
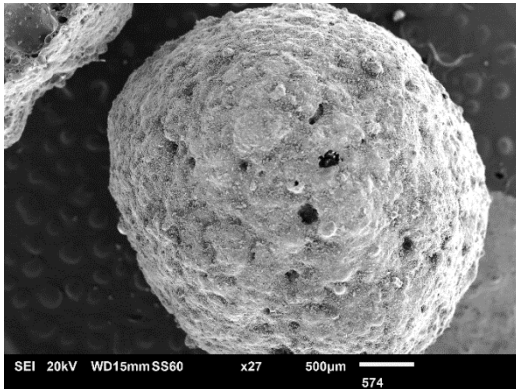
Water

Rapid Firing
(Rotary Furnace)

Foamed Glass Granules
High Water Adsorption



Incorporating phase change materials (PCMs)



4. Incinerator residues

Energy from waste



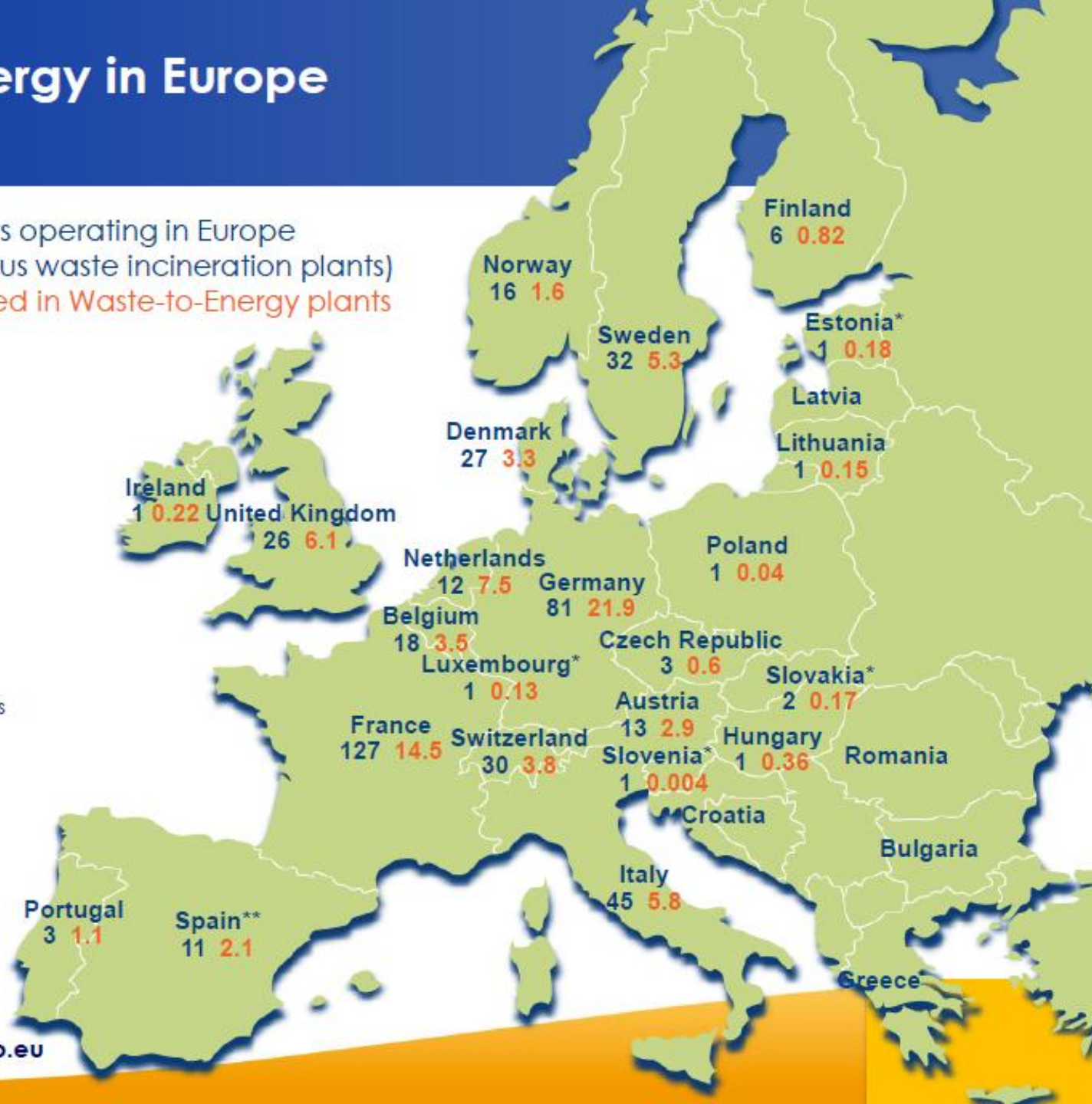
Waste-to-Energy in Europe in 2013

- Waste-to-Energy Plants operating in Europe
(not including hazardous waste incineration plants)
- Waste thermally treated in Waste-to-Energy plants
in million tonnes

Data supplied by CEWEP members
unless specified otherwise

* From EUROSTAT

** Includes plant in Andorra



Incinerator bottom ash as a sustainable source of raw materials

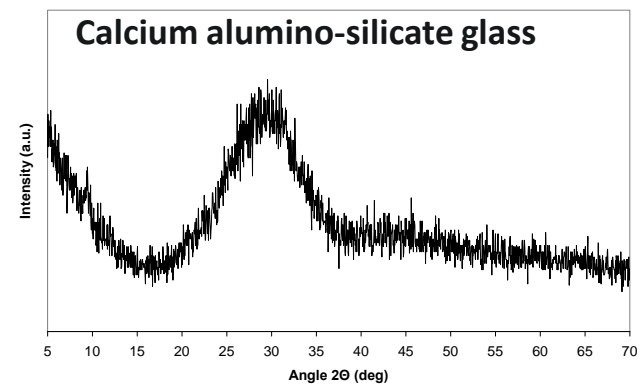


Properties of sintered IBA glass-ceramics

Mechanical property	Sintered ceramics	Clay ceramics
Density (g/cm ³)	2.7	2.3
Young's modulus (GPa)	76.2	71
3-point bending strength (MPa)	80.9	78.2
Vickers microhardness (GPa)	4.4	3.1
Thermal conductivity (W/m*K)	0.6	0.6

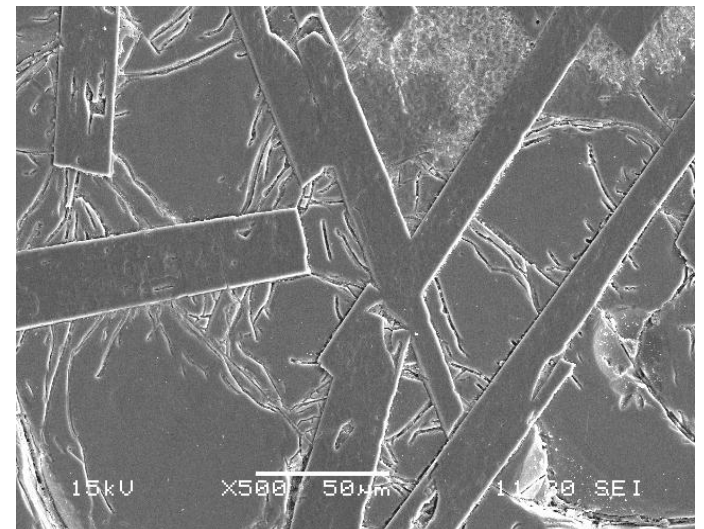
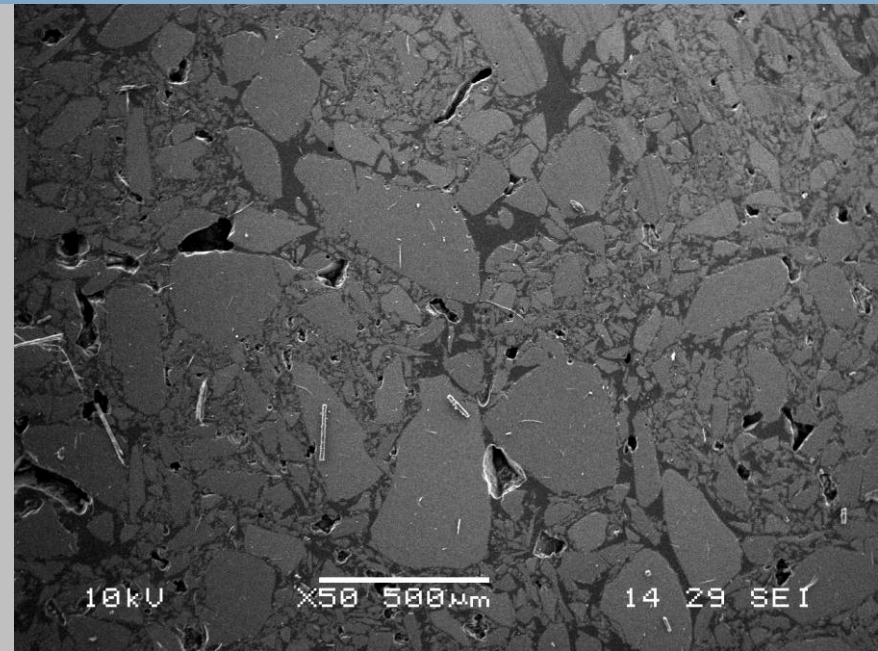
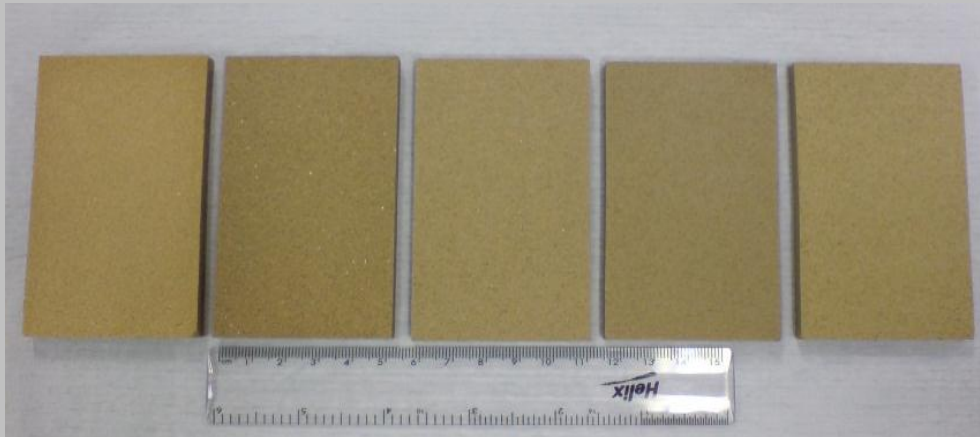


Air Pollution Control residues



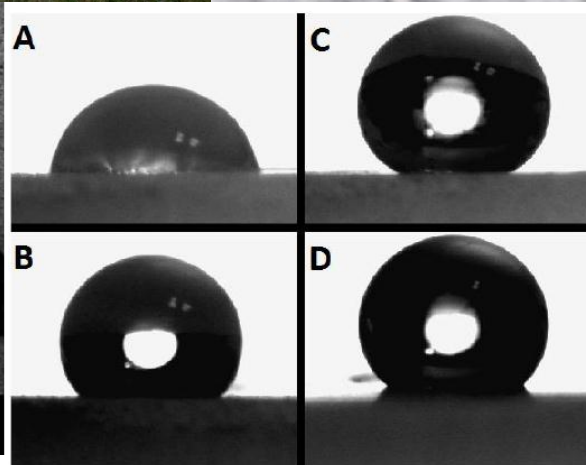
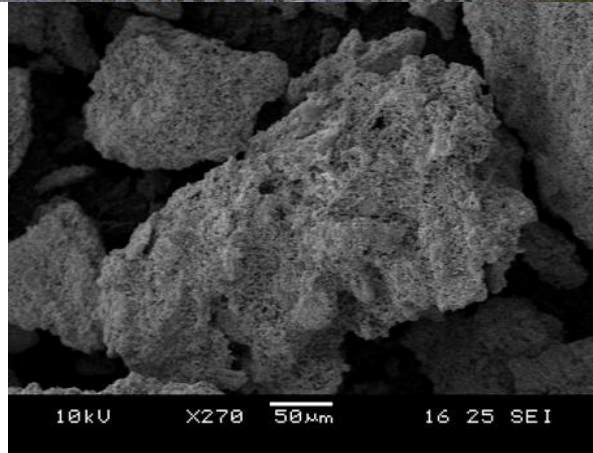
APC residue plasmaroc sintered glass-ceramics

100APC and 50:50 APC:CG



5. Paper sludge ash

Paper sludge ash into hydrophobic powder



Hydrophobic concrete using waste paper sludge ash

Hong S. Wong ^{*}, Robert Barakat, Abdulla Alhilali, Mohamed Saleh, Christopher R. Cheeseman

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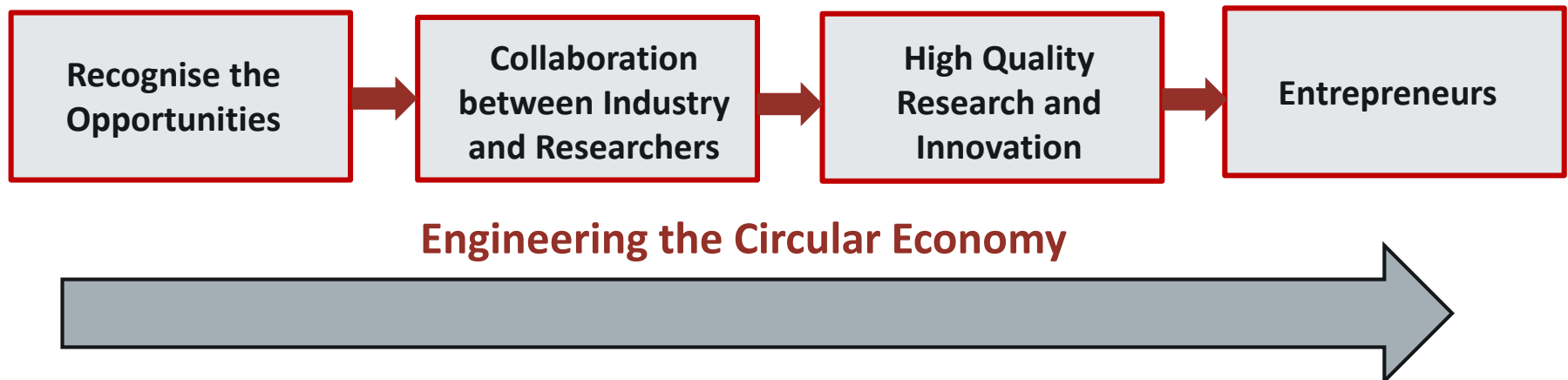
We have to move to a circular economy

Wastes are materials with huge potential for innovation.....

Collaboration between industry and researchers

High quality research and development/innovation

New breed of circular economy entrepreneurs to make it happen.....



One planet.....



Use of science and engineering to deliver *Innovation in Waste Processing* for a circular economy

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