SAPICO2 Project Update
Amiens, 2015

CD Hills

University of Greenwich, Chatham Maritime, UK

c.d.hills@gre.ac.uk

UNIVERSITY of GREENWICH

Carbon8

UNIVERSITÉ de Picardie Jules Verne

france (manche channel) england interreg

European Regional Development Fund
The European Union, investing in your future

Fonds européen de développement régional
L'union Européenne investit dans votre avenir

Sustainable Aggregate Production with Imbibed Carbon diOxide

UNIVERSITY of GREENWICH

Background

- Research on using CO_2 as a resource dating back to ca. 1993
- Initially focused on contaminated soil (1999)
- Later developed using MSW APCr in the UK
- Trials 2010-2012, leading to first commercial facility
- Realizsation that many wastes can be carbonated
- SAPICO2 conceived in early 2011 to explore boundaries and validate approach

Broad objectives of SAPICO2

- Developing the next generation of carbonated sustainable substrates made from solid waste and CO_2 gas
- These are carbon -ve and fit for purpose
- Joint research and evaluation of suitable waste streams in the UK and France
- Produce and performance test the carbonated products for use as building materials
- Engage with UK and French stakeholders and assess marketing potential
- A platform for SAPICO3 – A Cross Border Centre for Carbonation Technology

UNIVERSITY of GREENWICH

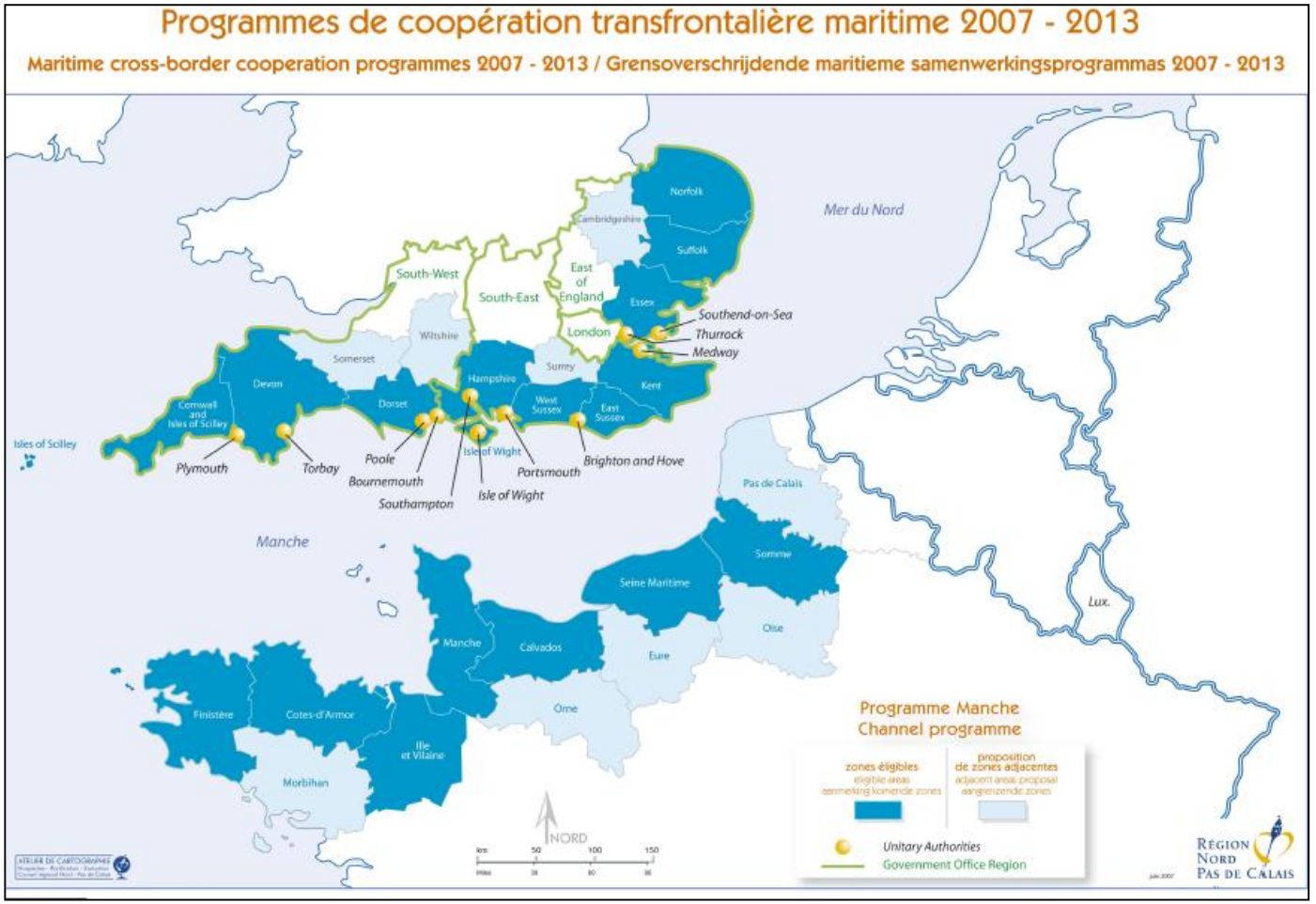


Figure 1: Co-operating regions of INTERREG's Manche (Channel) programme

Developments and Achievements

- Characterised and examined 100+ French and UK wastes so far (chem, phys and CO_2 uptake)
- Made bulk samples for performance testing (strength, durability, thermal properties, C-footprint) Engaged with waste producers (e.g. incinerator owners in France)
- Organising x2 workshops
- Developing partnerships for future collaboration
- New materials made from biomass

UNIVERSITY of GREENWICH

Treatment of diverse waste streams (and soil)

Steel Wastewater Sludge

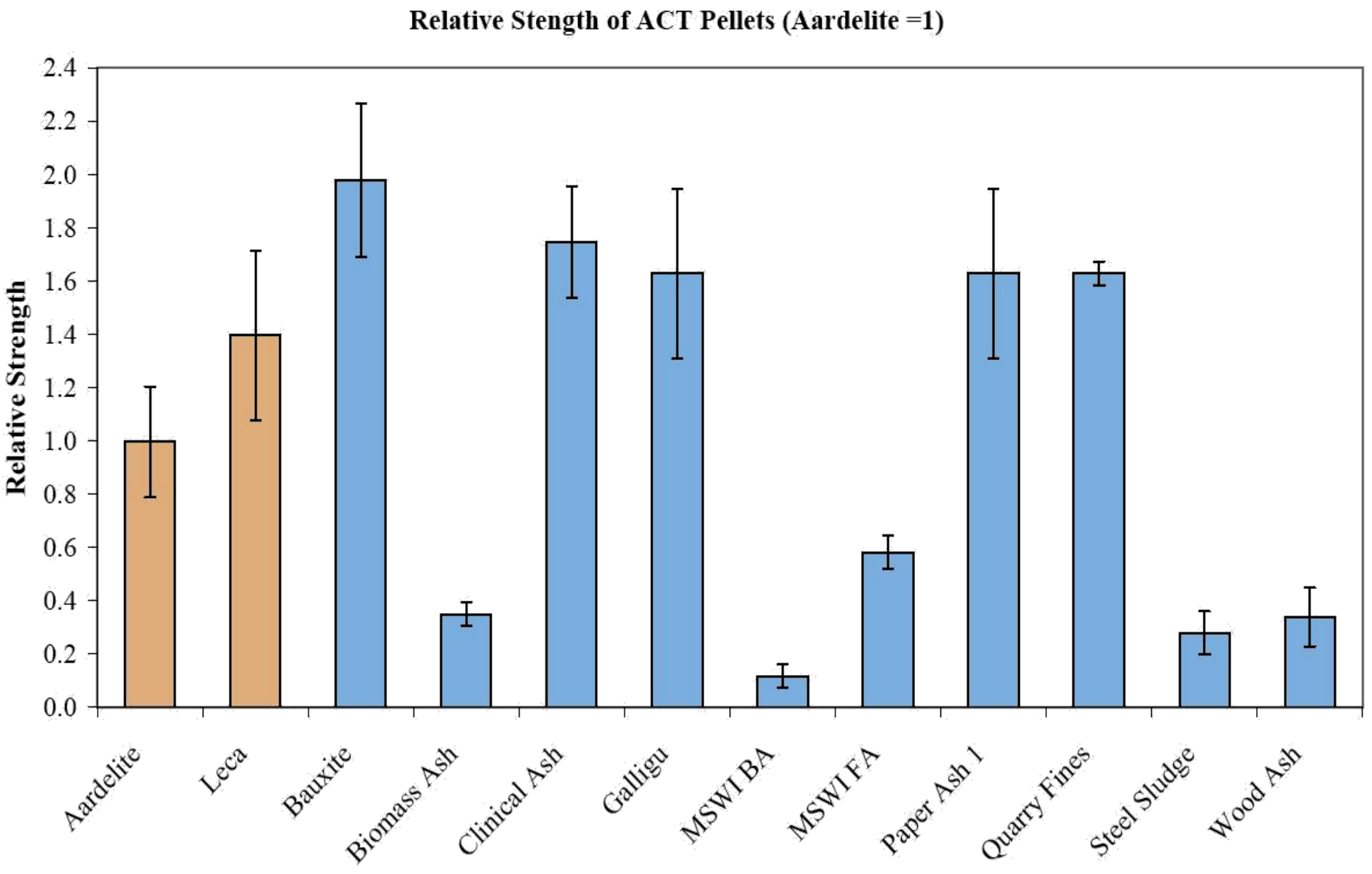
Quarry Fines

Bauxite

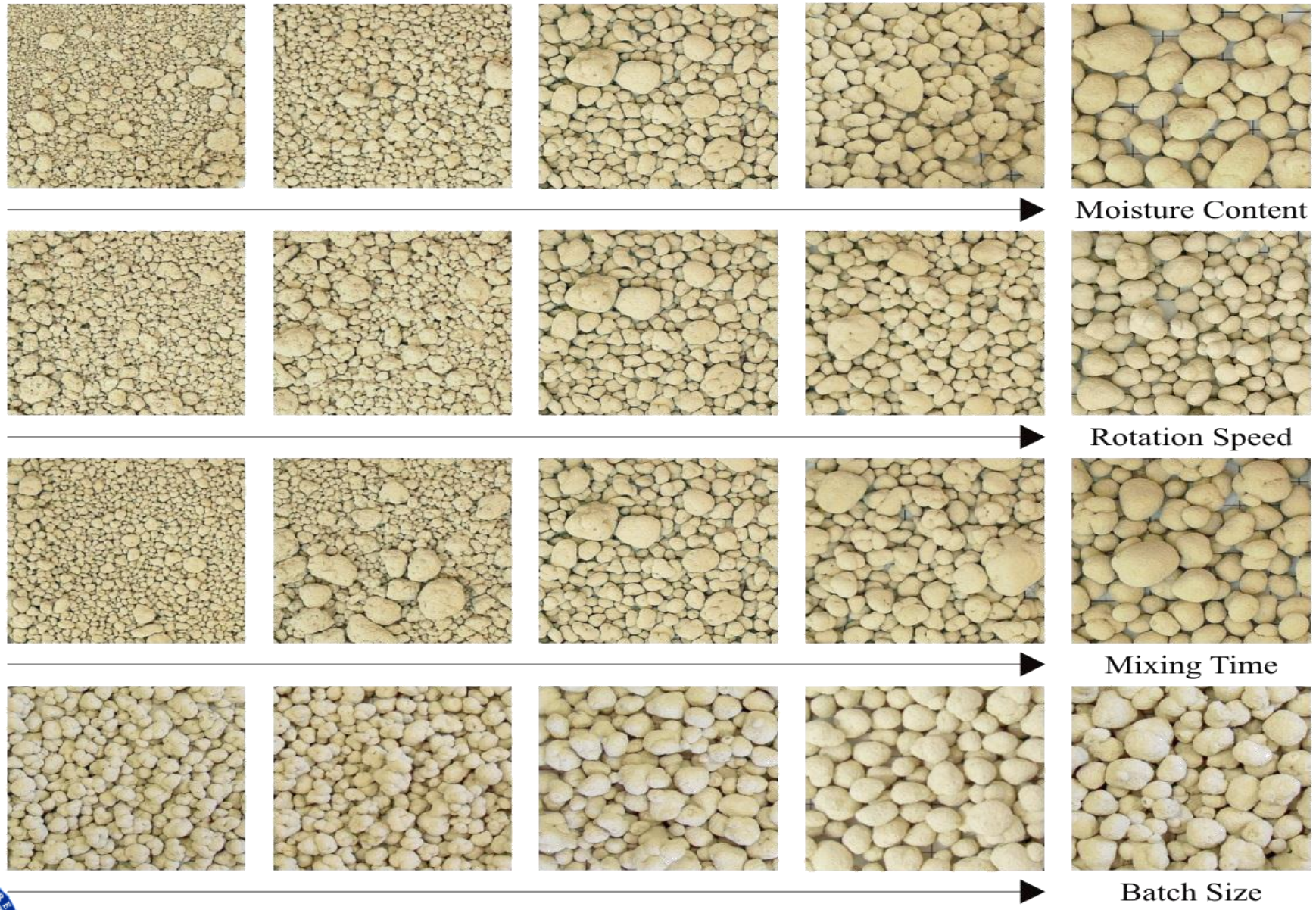
Paper Ash

Wood Ash

Metal Dust


Relative Stength of ACT Pellets (Aardelite =1)
Relative Strength
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Aardelite
Leca
Bauxite
Biomass Ash
Clinical Ash
Galligu
MSWI BA
MSWI FA
Paper Ash 1
Quarry Fines
Steel Sludge
Wood Ash

Processing variables:



Development of carbonated construction materials

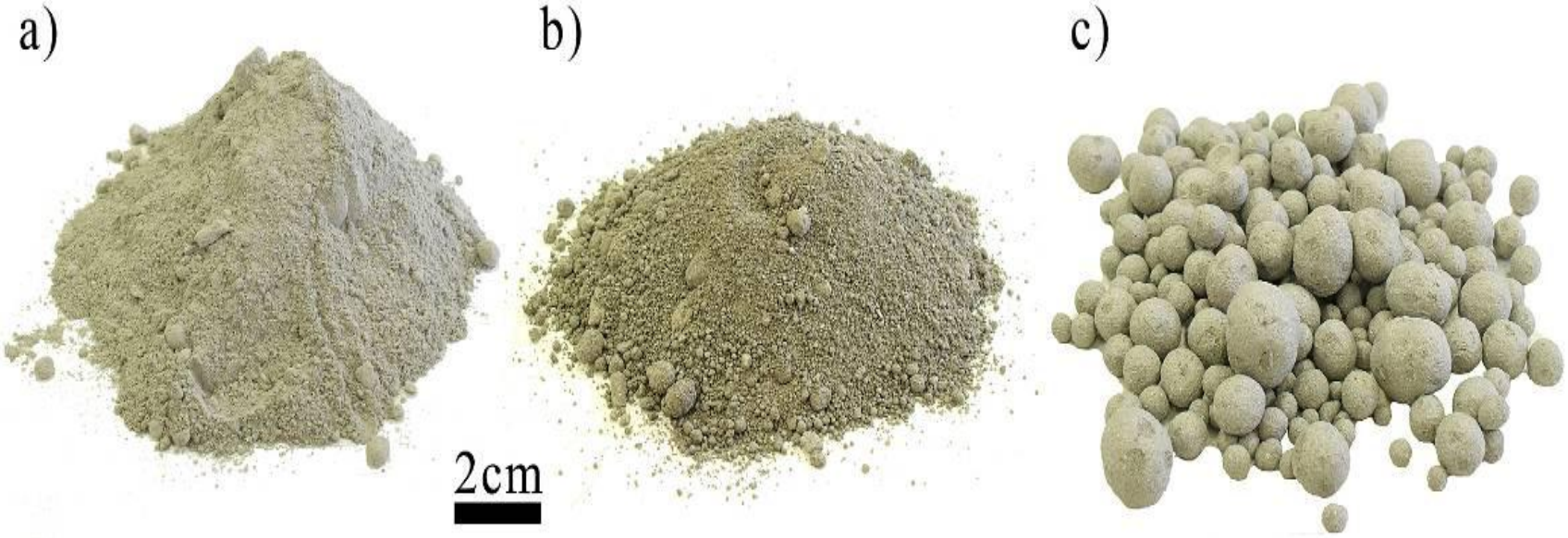


Figure 1: a) untreated fly ash. b) granulated fly ash. c) pelletised fly ash (MSWI)

UNIVERSITY of GREENWICH

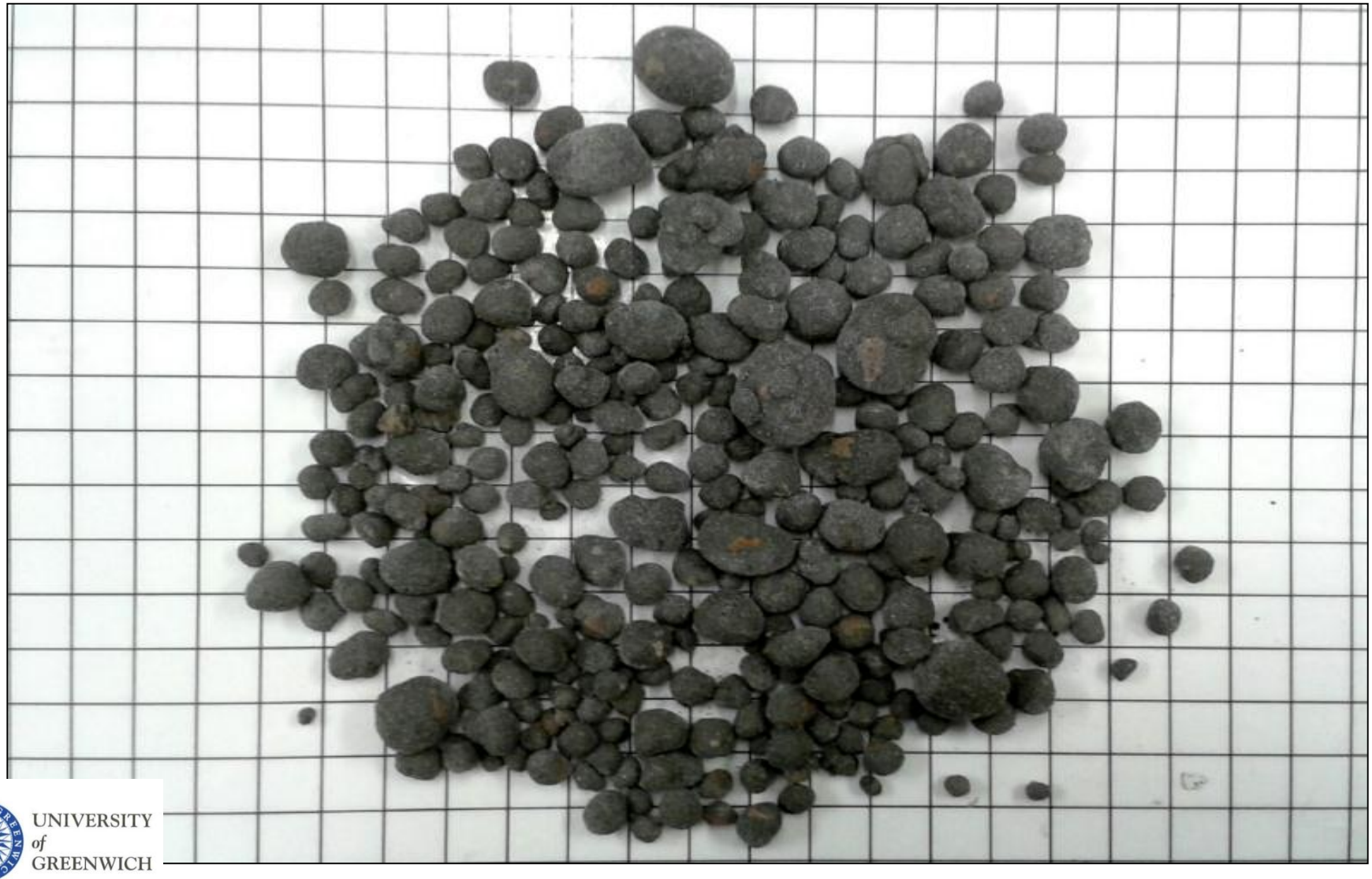
Pelletised Paper Ash

UNIVERSITY of GREENWICH

Pelletised Steel Slag

UNIVERSITY of GREENWICH

Carbonated Dross



UNIVERSITY of GREENWICH

Pelletised FBA and PFA

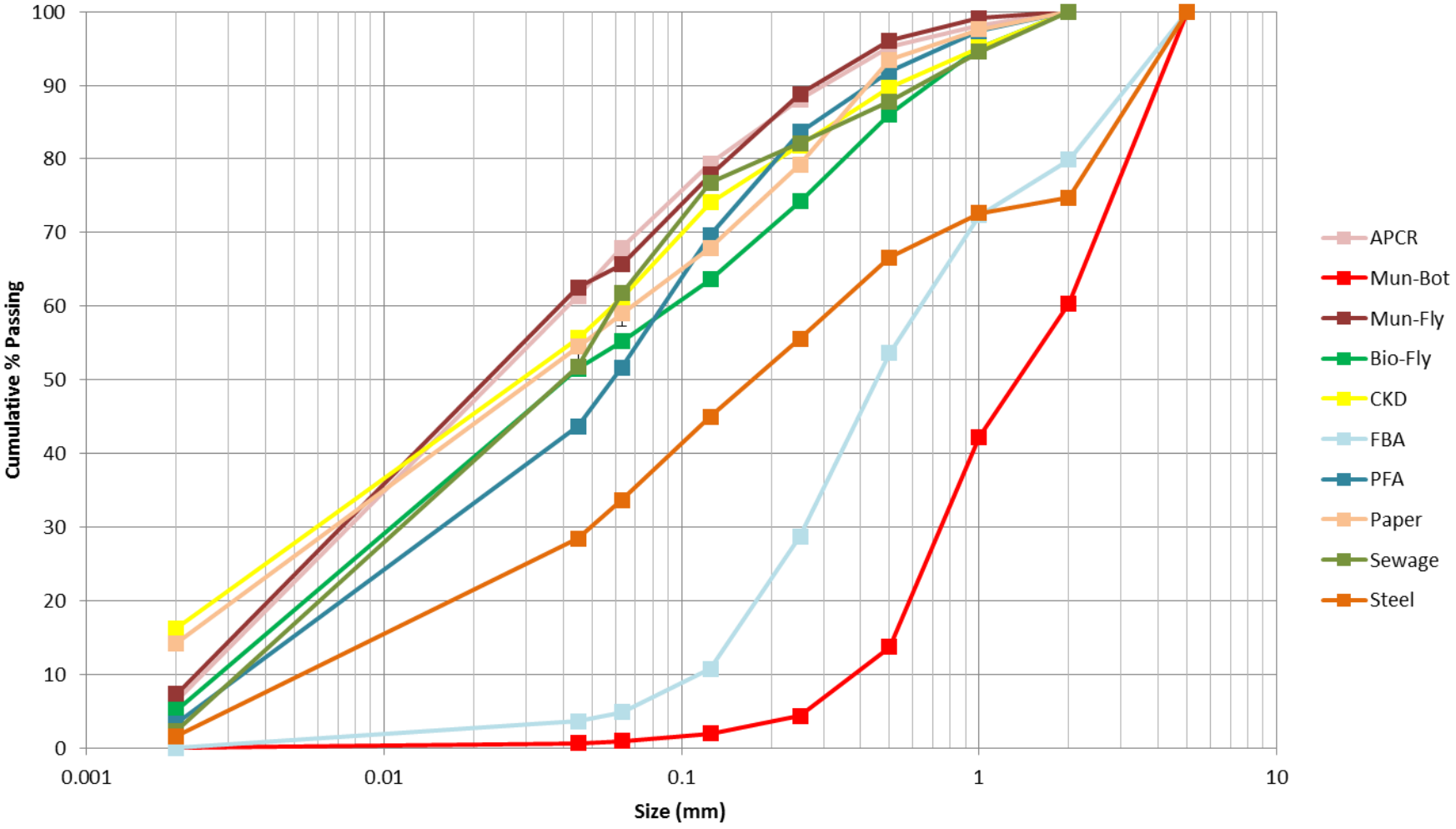
Bulk production

- Two 100kg bulk samples produced and being tested by UPJV for ‘fitness for purpose’
- French biomass used for bulk aggregate production, and now being tested
- Consortium of French incinerators with interest in the potential of the technology
- Developments in use of biomass waste to produce novel materials

Academic progress

- Data obtained form characterisation phase has led to a successful MPhil programme and:
  - x4 Undergraduate ERASMUS traineeships (x3 France and x 1Germany)
  - x2 Masters ERASMUS (Italy)
  - x1 Doctoral Training (Italy (ERASMUS))

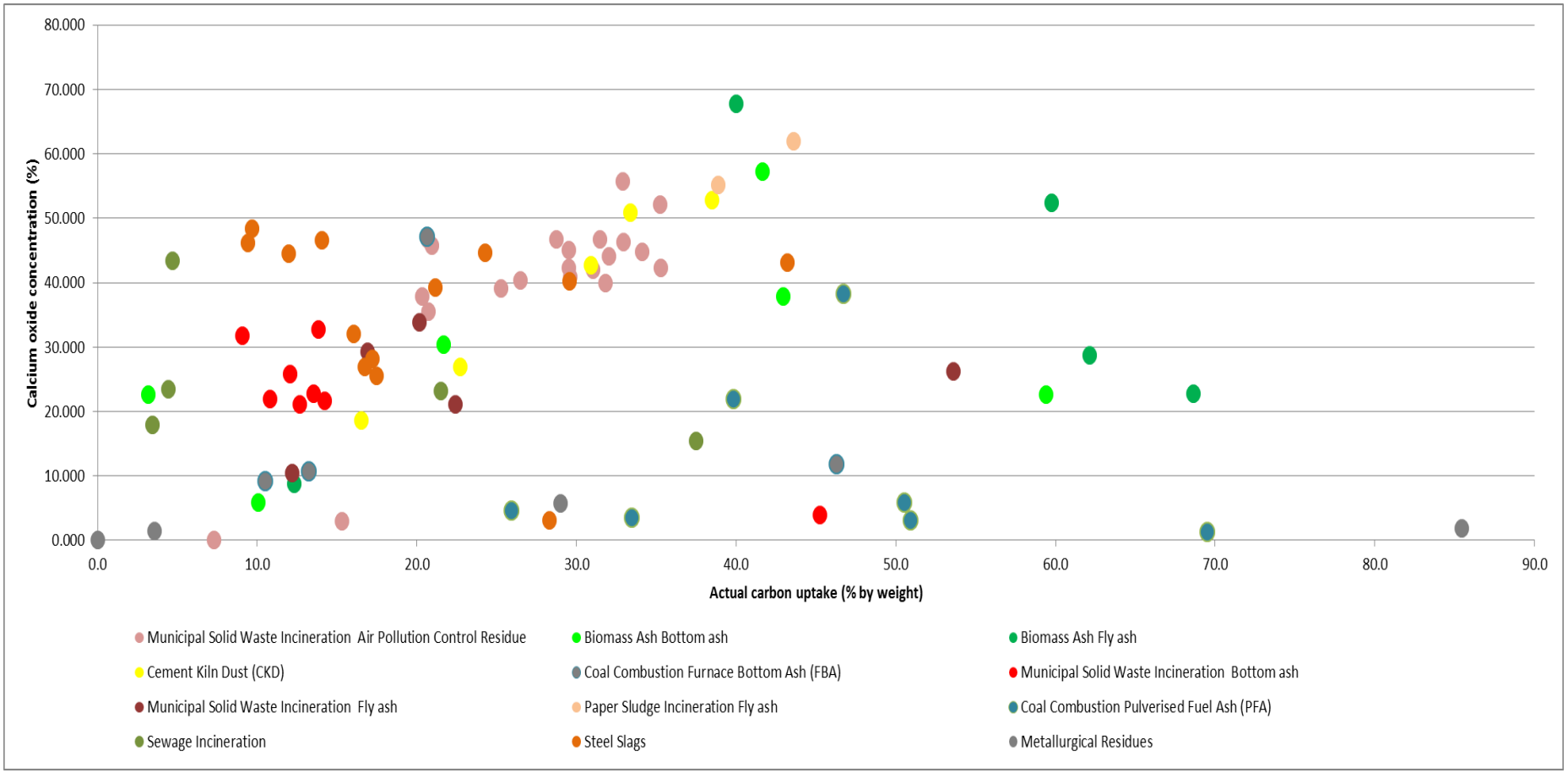
Particle Size Distribution



UNIVERSITY of GREENWICH

CO_2 prediction

Based on Ca and Mg content?

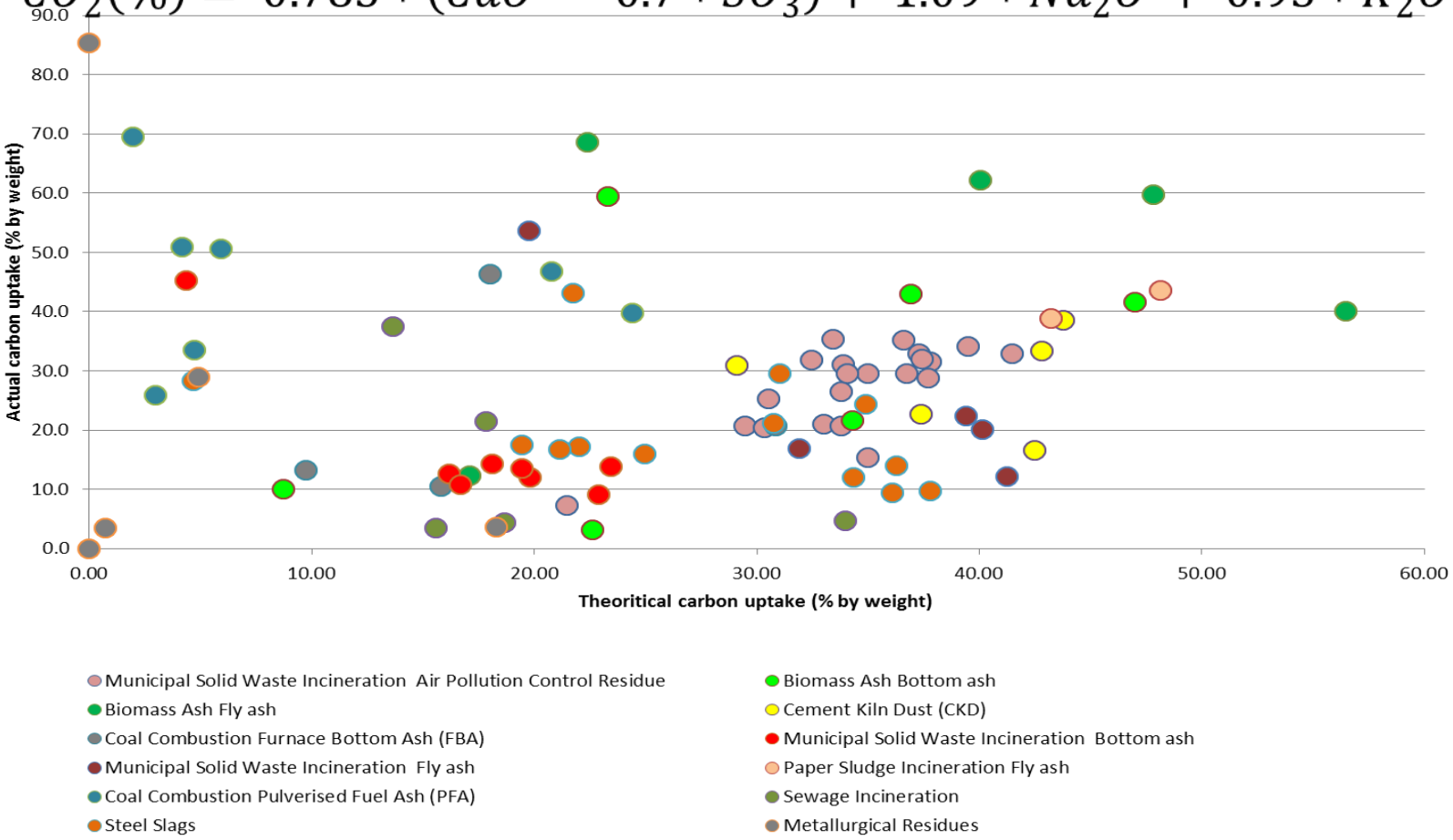


UNIVERSITY of GREENWICH

Theoretical vs. Actual Uptake

- Steinour equation (1959): Based upon the concentration of 4 oxides obtained from XRF analysis

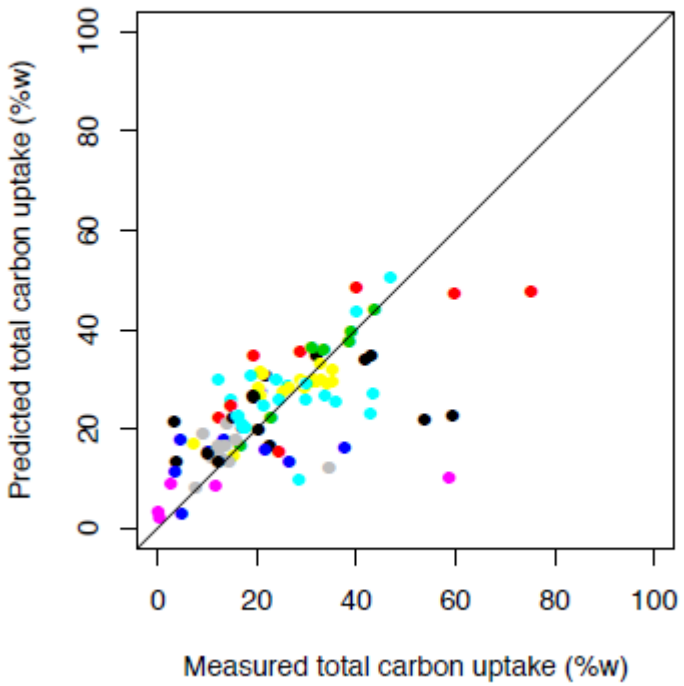
$$CO_2(\%) = 0.785 * (CaO - 0.7 * SO_3) + 1.09 * Na_2O + 0.93 * K_2O$$

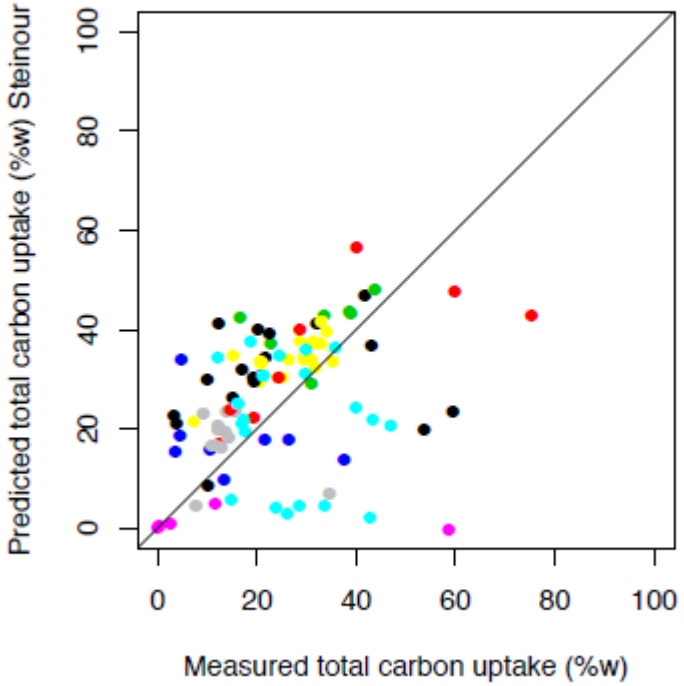


CO_2 prediction issues

- Based on stochiometry, current models (Steinour, Huntzinger and Polettini) over estimate CO_2 uptake potential
- Current data set is being used to modify/produce new model for improved prediction
- New wastes can be used to test the revised model
- Will be a significant academic deliverable if realised
- Data set is currently the largest known(?) comprising chemical, mineralogical and CO2 uptake data.

C uptake = - 0.99668 + 0.78383CaO + 2.52743MgO - 5.43891Al2O3 +16.22471P2O5 - 1.73700Fe2O3 - 3.56960K2O - 2.00282Na2O - 0.82960SiO2





Summary

- Project is entering its final phase and attracting wider attention
- Bulk samples are being produced and tested
- Embodied carbon being evaluated
- A life cycle analysis is underway
- Improved prediction of carbon uptake
- Engagement of waste and materials users in France and UK
- Foundations for a Centre of expertise-SAPICO3:
- Cross-border Centre for Carbonation Technology (C3T)