# Waterworks sludge management in a sustainable world: novel value-added alum sludge products for harmful gas purification

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# Overview

Introduction

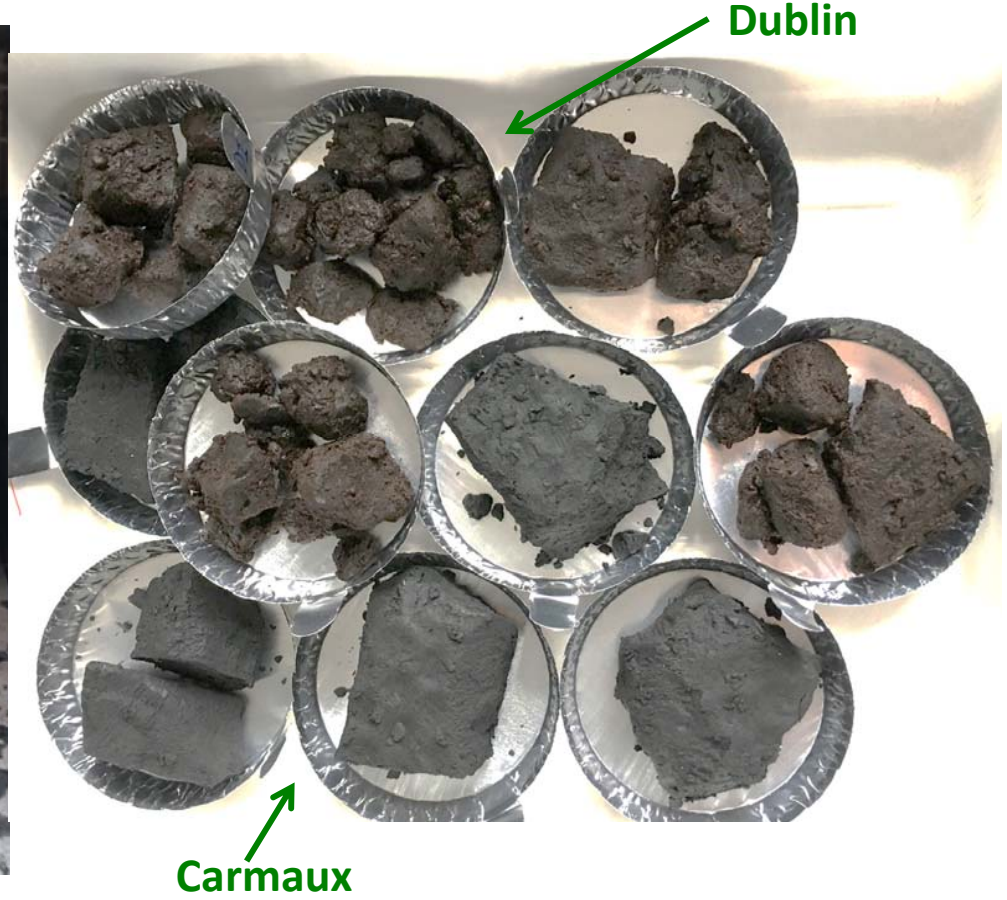
Genesis of the idea

Results & perspective

# Alum Sludge

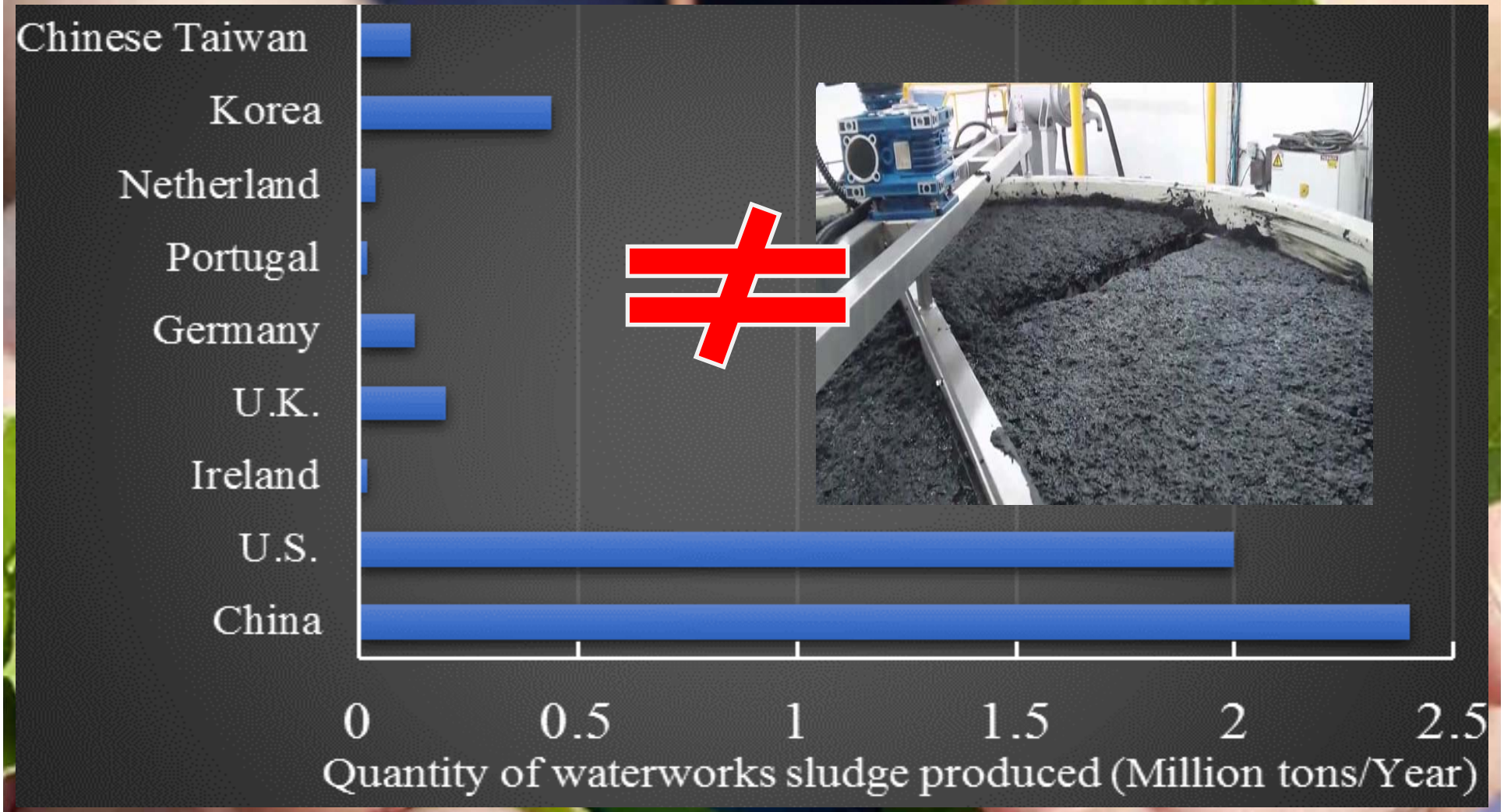
-**Easily, largely & locally available by-product** from WTP where **aluminium sulphate** is used as the coagulant for raw water purification


Ballymore Eustace water treatment plant, Dublin, Ireland




Two sources of alum sludge:
Carmaux water treatment plant (Pitch-Black)
Dublin water treatment plant (Dark brown)

# Worldwide inevitable by-product




**Drinking water treatment plant (DWTP) sludge often WRONGLY associated with waste water treatment plant (WWTP) sludge**

# Alum sludge characterisation

| Characteristic | Dublin | Carmaux |
|---|---|---|
| $S_P$(BET) ($m^2/g$) | 46.9 | 257.1 |
| pH | 6.9 | 10.0 |

| Class | Elements | Dublin (mg/kg) | Carmaux (mg/kg) |
|---|---|---|---|
| Amphoteric | Al | 17983 | 17581 |
| Alkaline-earth metal | Ca | 2673 | 21156 |
| | Ba | 14 | 119 |
| Heavy metal | Mg, Mn, Sn, Zn | 421 | 620 |
| Alkali metal | As, Na | 149 | 266 |
| Transition metal | K, Fe, Mo | 4210 | 9483 |
| Others | Si, P | 106 | 3015 |

✓ The specific surface area of Carmaux is 5 times larger than that of Dublin

⇔ Since the different water treatment plant process

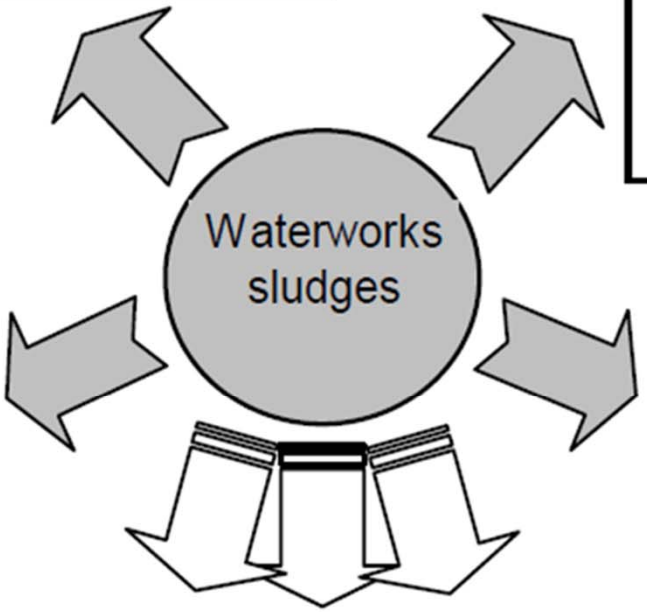
# Alum sludge reusing--state of art

Use in building & construction materials
- Brick making
- Cement & cementitious materials
- Pavement & geotechnical works

Use in wastewater treatment
- Coagulant recovery & reuse
- As coagulant
- As adsorbent
- As co-conditioner
- As a substrate in CWs

**10 Years !!**

Land based applications
- Structural soil improvement
- Buffering soil qualities
- Reducing nutrients in laden soils & runoffs




Other uses; e.g.
- Animal feed
- Improving sewage sludge digestion
- Silvicultural & gardening application

Future developments

**This study !**

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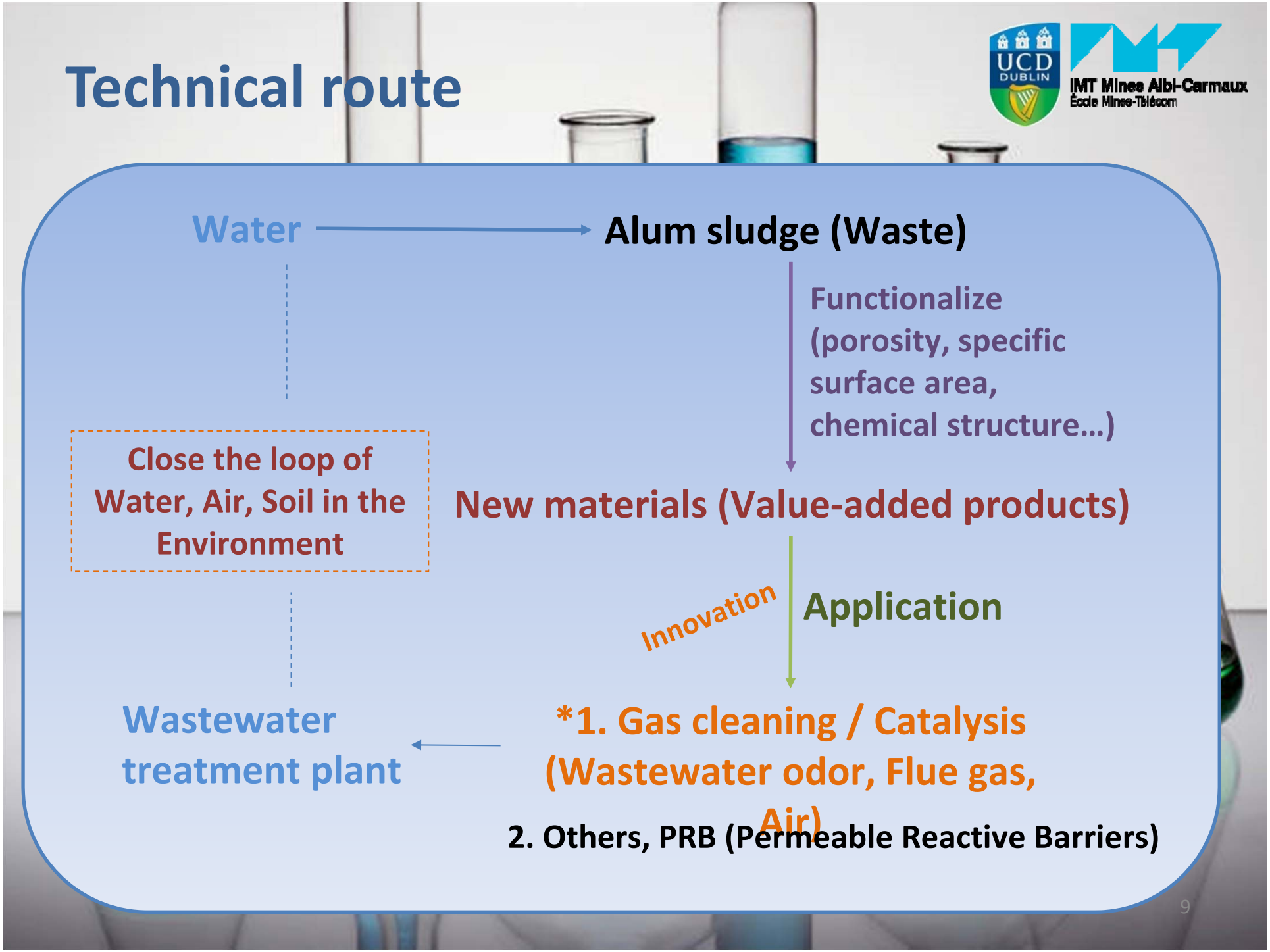
# Release of unpleasant odours in WWTP


**Public concerns over the release of odours from these facilities have increased in recent years.**

# Technical route



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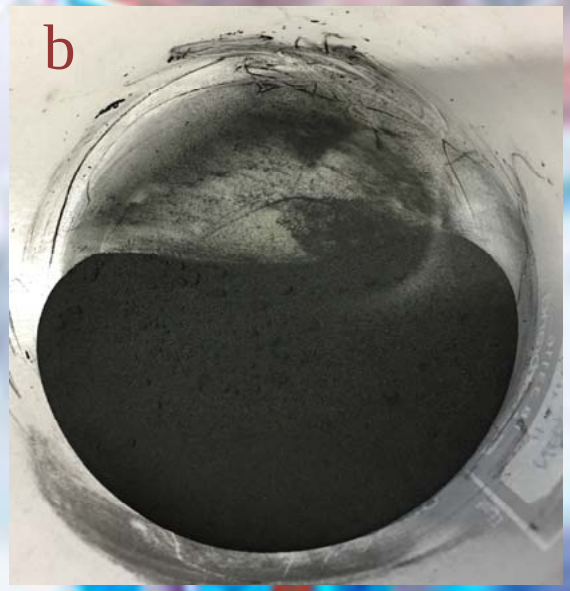
# Novel Alum Sludge Based Sorbents

In total, **12 kinds** of novel alum sludge based sorbents, which starting from **two sources** of alum sludge mixing with CaHA ($CaCO_3$+$H_3PO_4$) under different Ca/P ratio (1.67 &1) were successfully synthesized.


DUB+CaHA

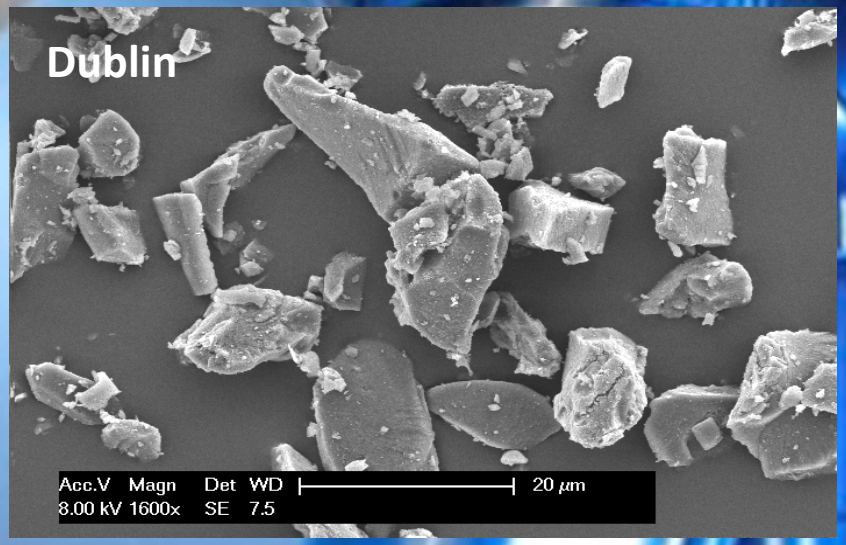


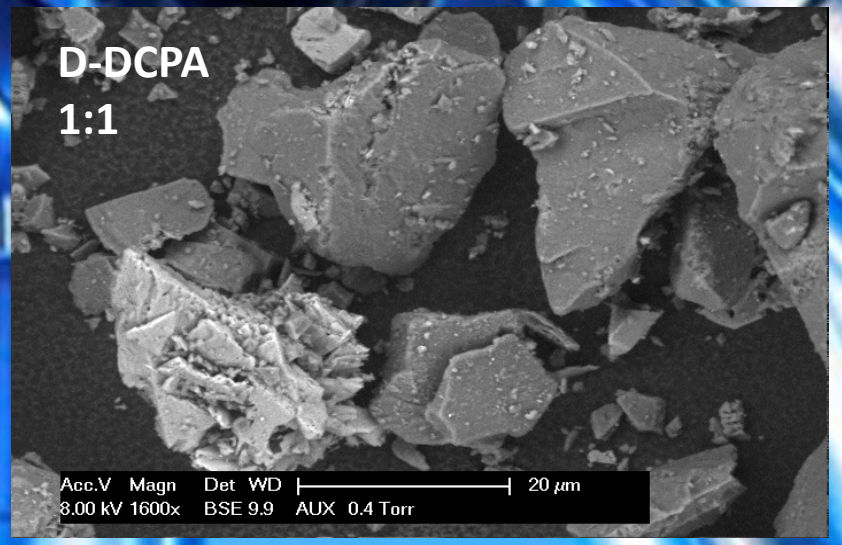

CAR+CaHA

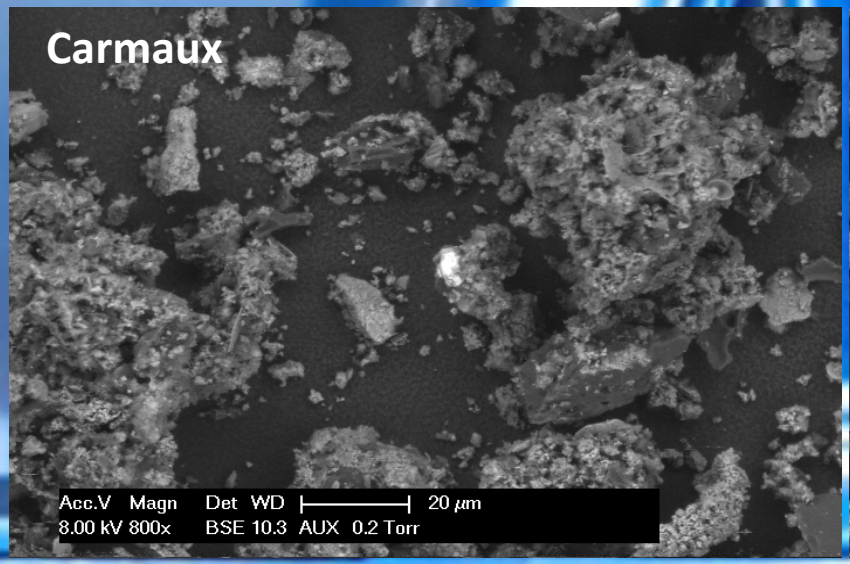

DUB+CaHA

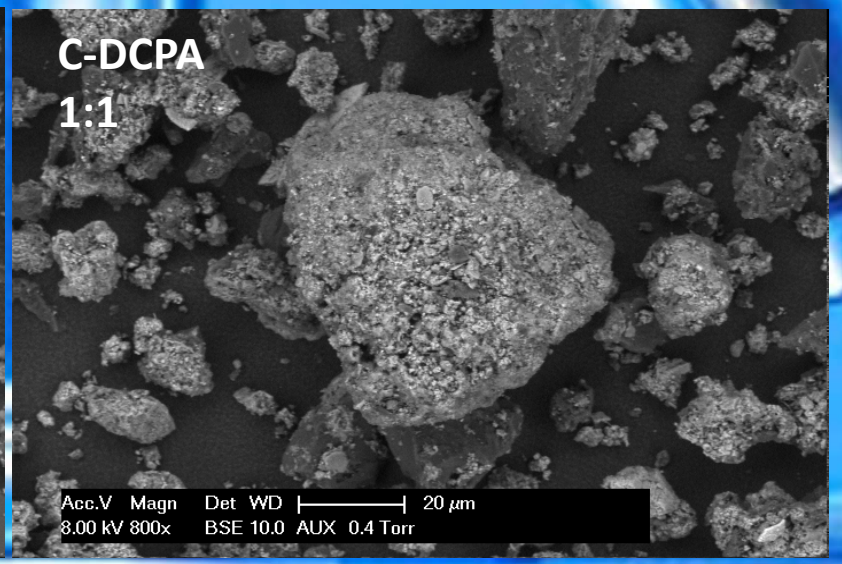
| Name | 22℃ CaHA | 40℃ CaHA | DCPA |
|---|---|---|---|
| Dublin | 9:1&1:1 (By weight) | 9:1&1:1 | 9:1&1:1 |
| Carmaux | 9:1&1:1 | 9:1&1:1 | 9:1&1:1 |

# SEM of raw sludge & novel sorbents



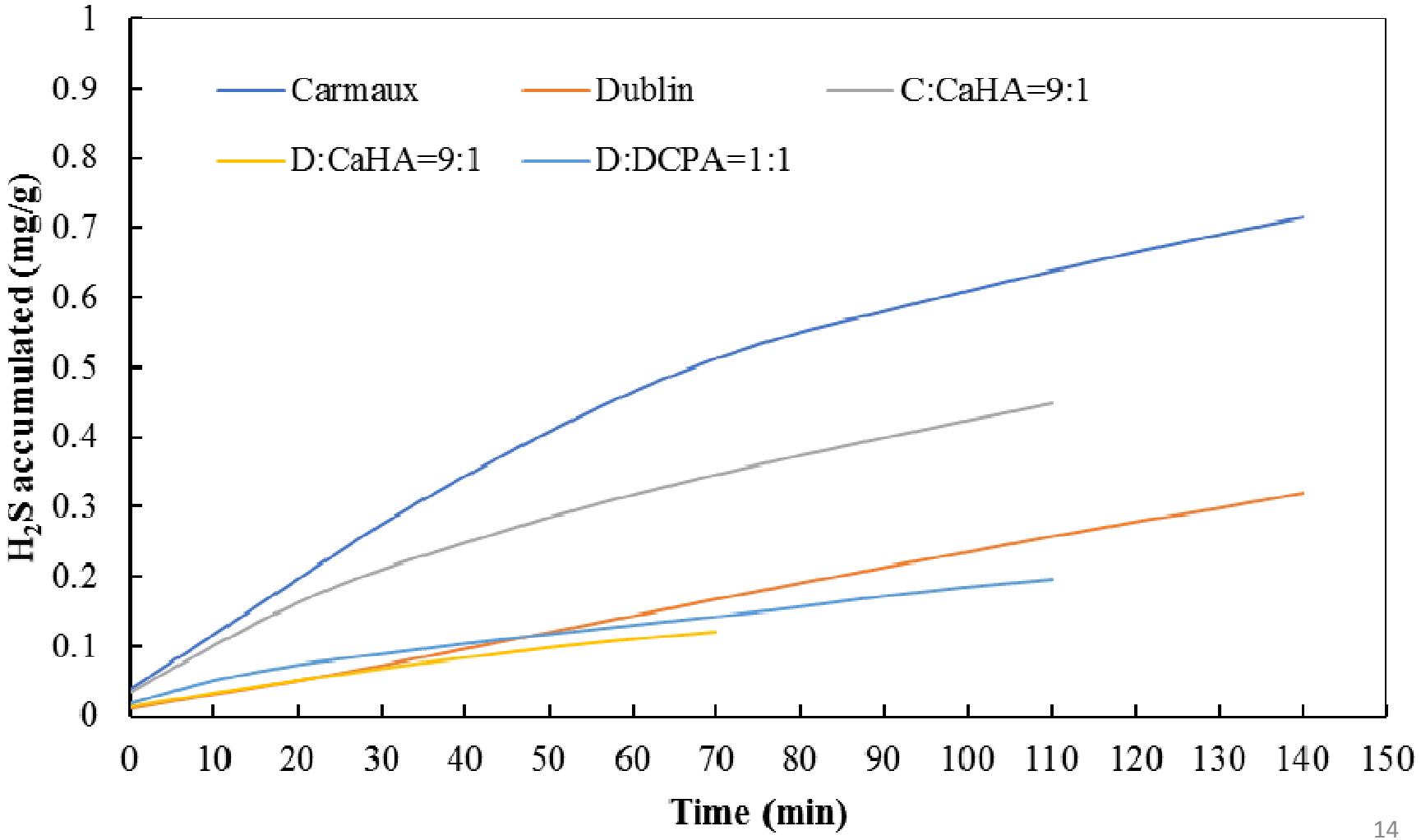



# Experimental setup

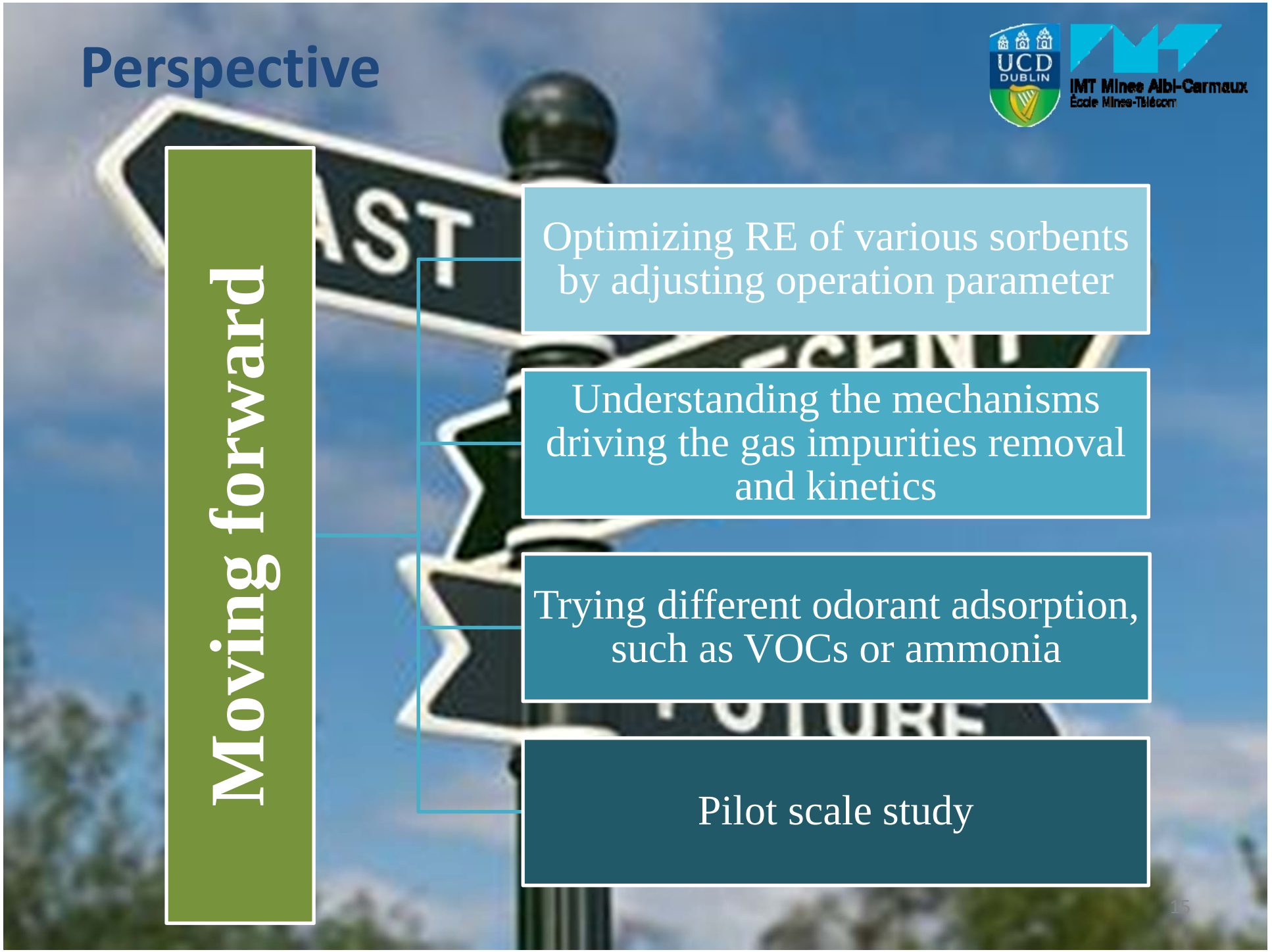
**Model syngas:**
30%$H_2$+15%$CO_2$+15%$CH_4$ +40%CO+$H_2S$ (200 ppm)

**Operation parameter:**
*Ambient condition
*Sorbent depth:2-3 cm
*EBRT (Empty Bed Residence Time):3-5 s
*Flow rate 2.3-3.6 L/h
*μ GC for effluent gas analyzing

# Quantity of accumulated $H_2S$ into different sorbents



# Perspective



## Moving forward

- Optimizing RE of various sorbents by adjusting operation parameter
- Understanding the mechanisms driving the gas impurities removal and kinetics
- Trying different odorant adsorption, such as VOCs or ammonia
- Pilot scale study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