EPSRC
Engineering and Physical Sciences Research Council

Newcastle University

Biological Engineering: Wastewater Innovation at Scale

BE:WISE Facility

Phase 1 Build

NORTHUMBRIAN WATER living water

Wastewater challenges ... affordability

2.6 Billion people without sanitation

(42% of the world's population)

30% Water

40% Wastewater
- Aeration

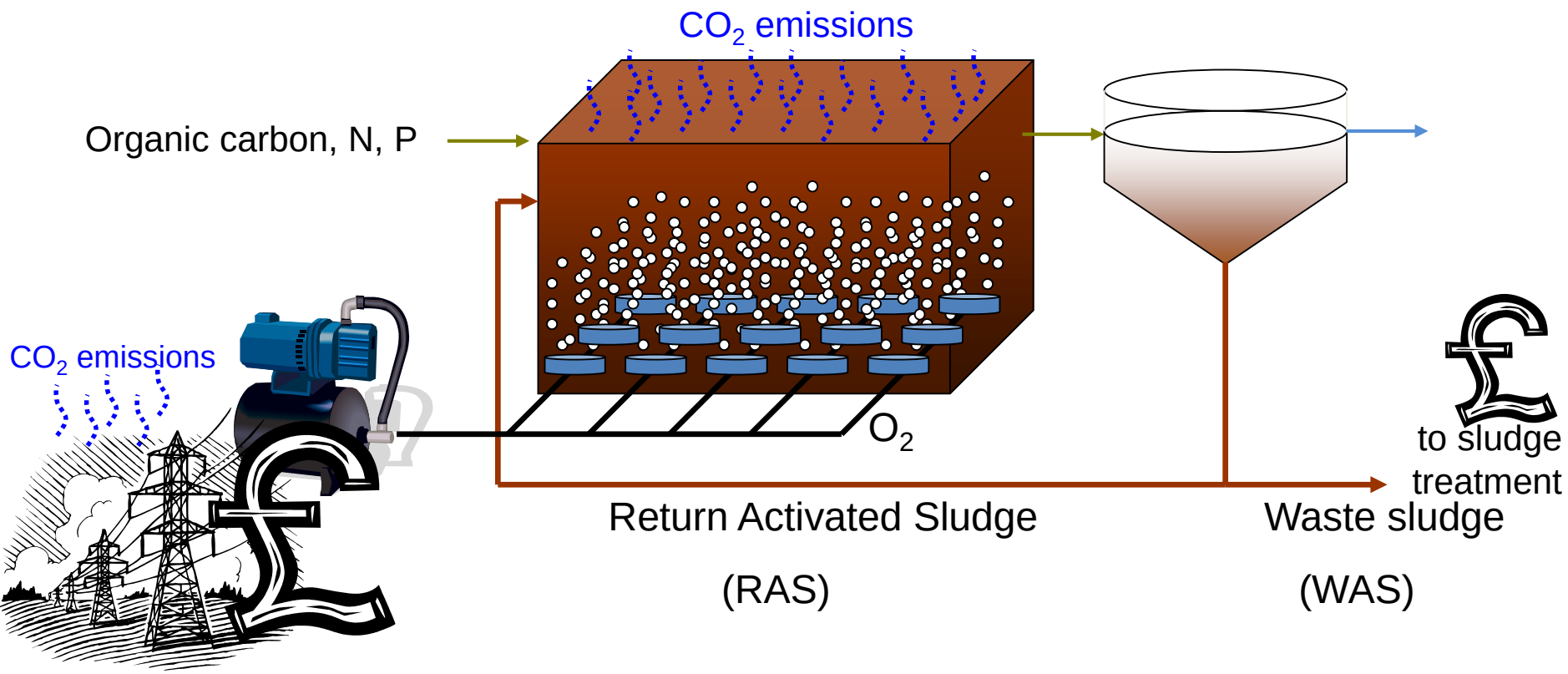
30% Financing cost:
- 25 years for fixtures
- 50 years for concrete!

£100 billion invested in the UK alone since 1998

Wastewater challenges...sustainability

UK Water Industry:

- 3% total UK electricity – up to 1% on aeration alone
- 4 M tonnes total CO_2 emission; 0.5% total UK emissions



Wastewater challenges…scaling up experiments

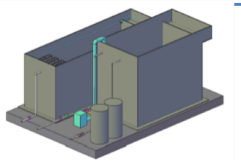
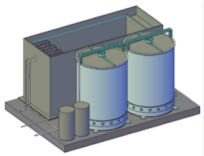
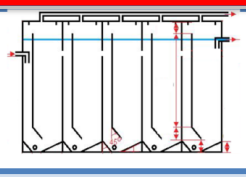
	Laboratory	Pilot-scale
		
Replication	High	Rare
Cost	£100's	£100,000's
No. bacteria	10^{11}; 100,000 million	10^{15}; quadrillion
Diversity	~20% of full-scale	~90% of full-scale
Practitioner credibility	Low	High

£££

Thanks to:
Bruce Jefferson & Ana Soares

EPSRC-funded BE:WISE Research Facility

Key features of the BE:WISE pilot scale sewage treatment plants

				
Activated sludge	Trickling filter	Anaerobic baffled membrane reactor	Microbial electrochemical fuel cell	Wetlands/ Lagoons
Reactor vol.: 3 m^3	2 m^3	12 m^3	1 m^3	5 m^3
Transportable, plug-and-play skid mounted units; flexible piping between modular tanks; adjustable variable speed pumps				
pH & temperature data-logging				
pH control; with wi-fi/networked instrument signaling				
Level sensors w/feedback control & remote alarms				
Multiple sampling ports				
Dissolved oxygen (DO) probes				
Secondary clarifier tanks				
Variable air supply controllable by ammonia & DO concentrations	Accessible & removable segments to allow study of biology, geometry & properties of different filter materials	Gas headspace ports for gas composition & flow measurement in each compartment	Removable electrode cassettes whose number & material can be altered	Insert media modifiable; can be fitted with weirs
Adjustable baffles		Removable membrane		

European first

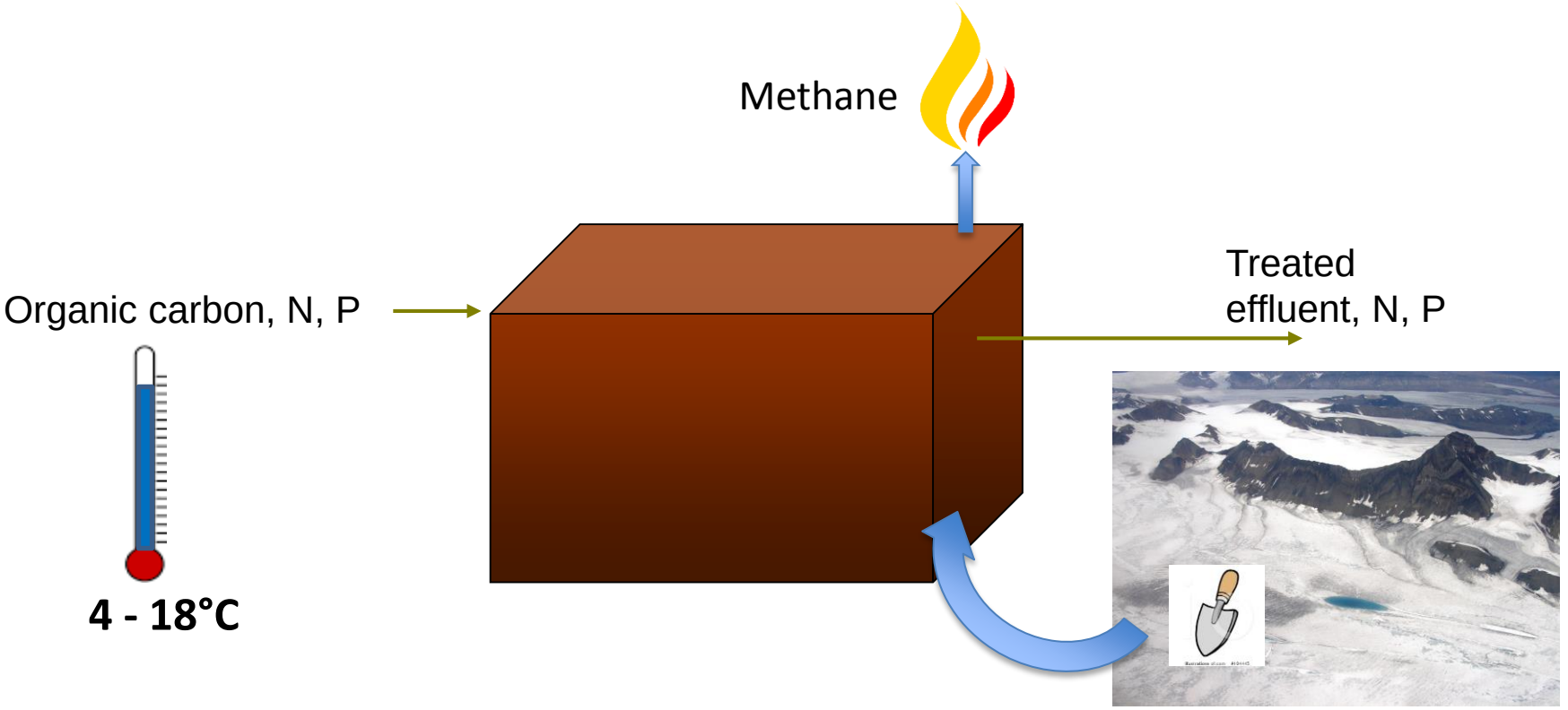
Open to international researchers

NU key node in major international doctoral training programmes:

- UK (5 universities)
- Europe (5 universities)
- USA (4 universities)

Sustainable technologies

Methane-producing low temperature anaerobic treatment with cold-adapted microbes



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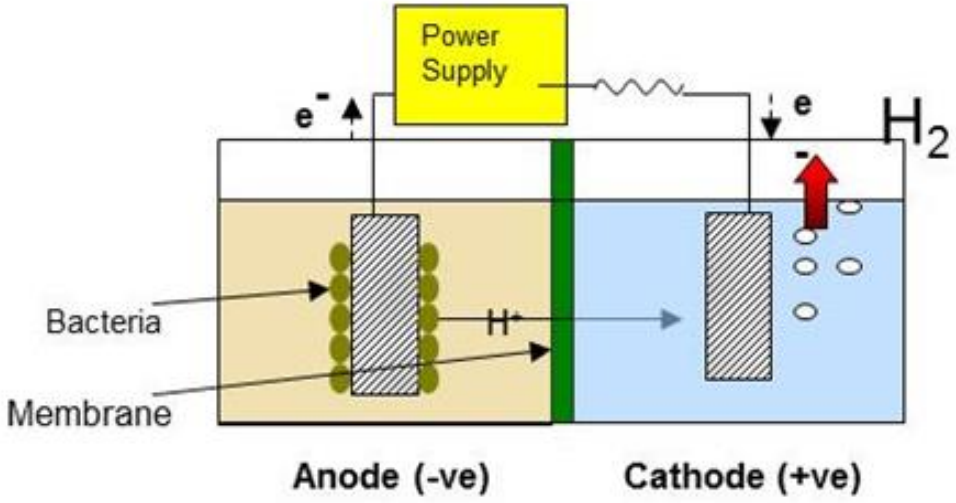
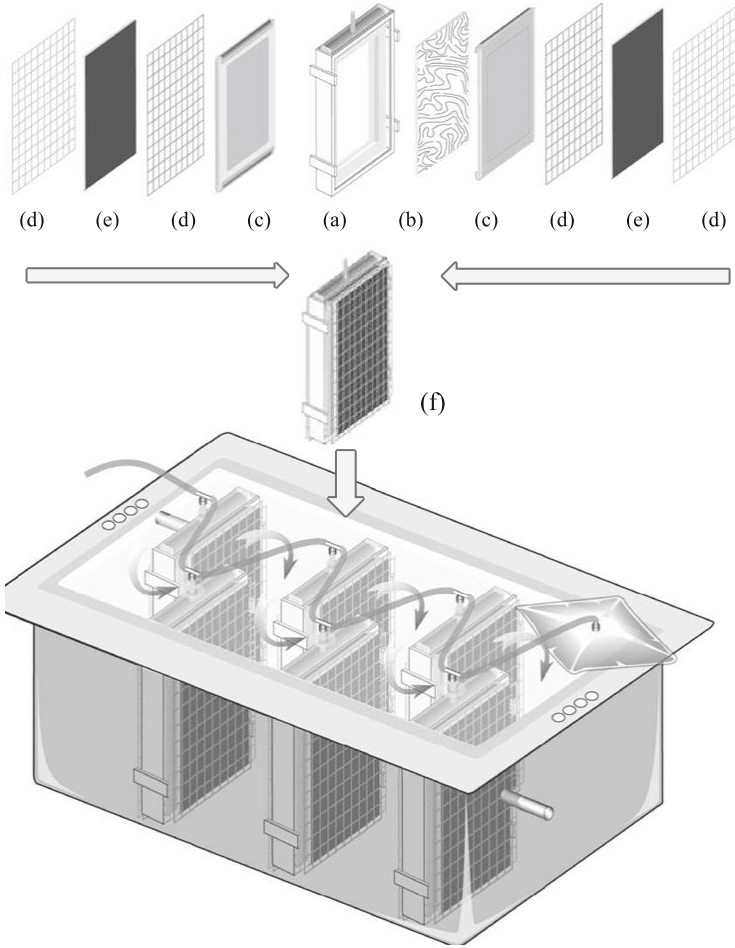
Petropolous *et al.*, submitted

Sustainable technologies

H_2-producing Microbial Electrolysis Cell (MEC)





World's first working proof-of-concept MEC using real wastewater

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Heidrich *et al.*, 2013, Appl. Microbiol. Biotechnol.

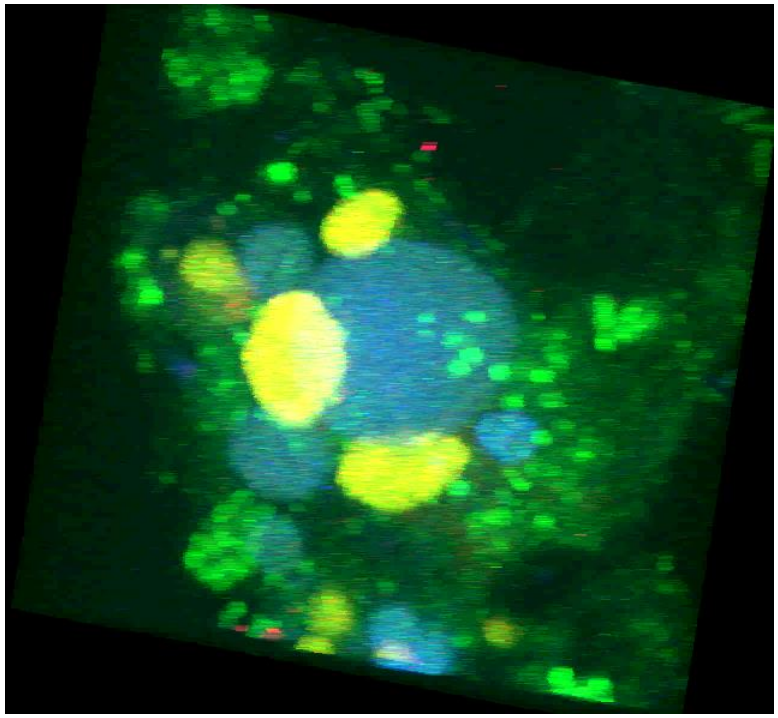
Innovation is Slow & Expensive

Pilot Scale experiments/trials:
£100,000's > 1 year

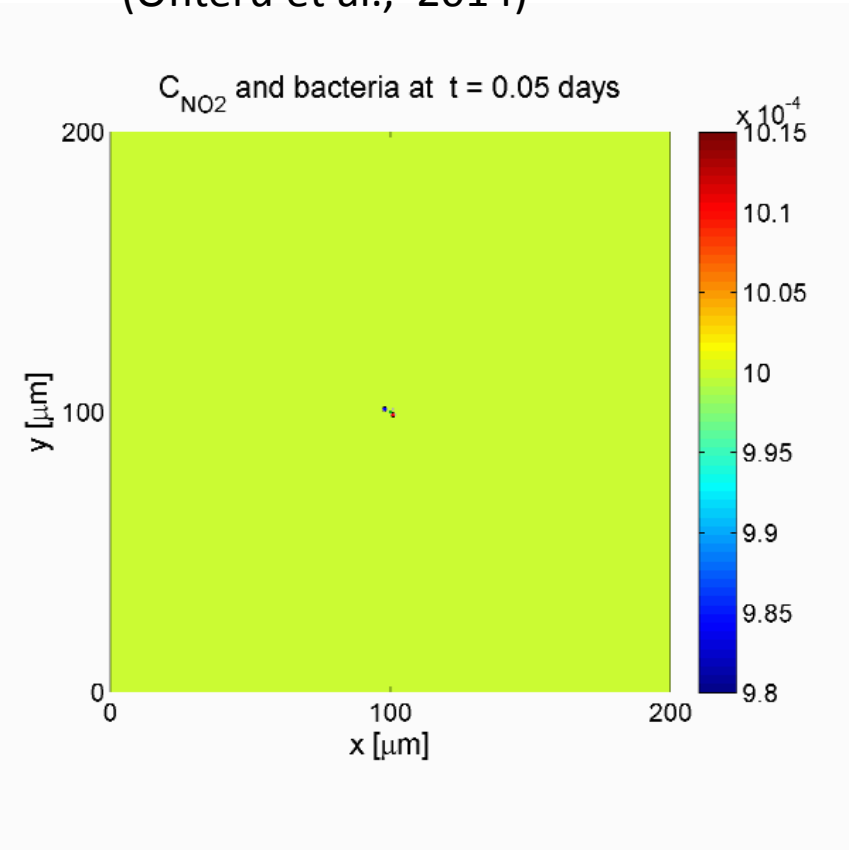
BMW use testing

Simulation is possible: But not credible

A Floc of Bacteria

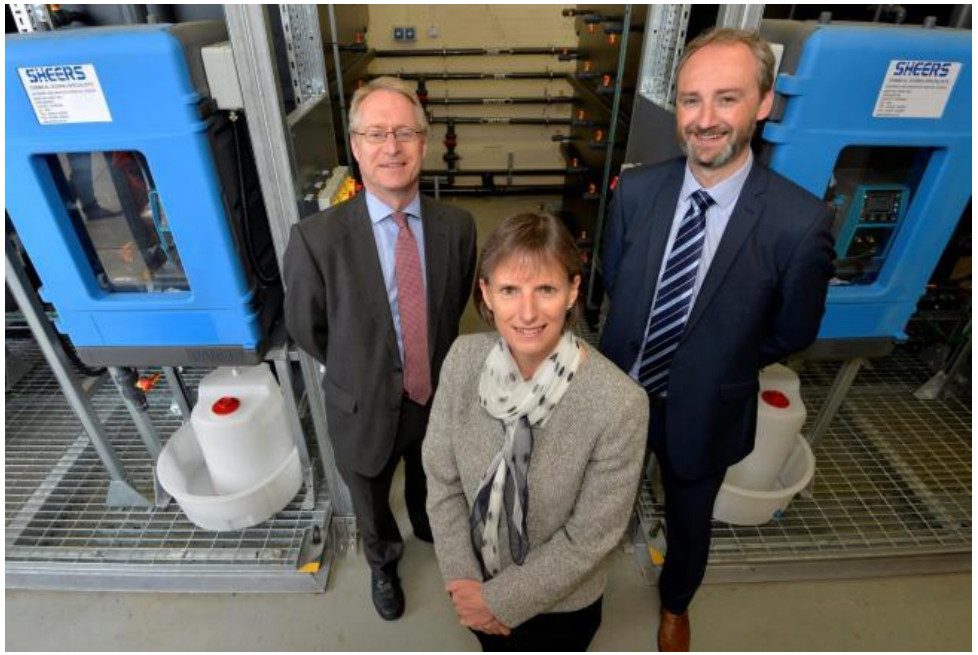


A model of a Floc
(Ofiteru et al., 2014)



Validation

- Validation
  - Of models
  - Highly visible Pilot Plant
  - Close collaboration



Heidi Mottram CEO Northumbrian Water

https://www.youtube.com/watch?v=VIsaF9KN8Gg

The Northern Echo

Darlington

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European first as £1.7m Birtley waste water treatment centre opens

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…or new research facility which will allow scientists to discover more sustainable and affordabl… …treat wastewater has been opened at a sewage treatment works in the north east.