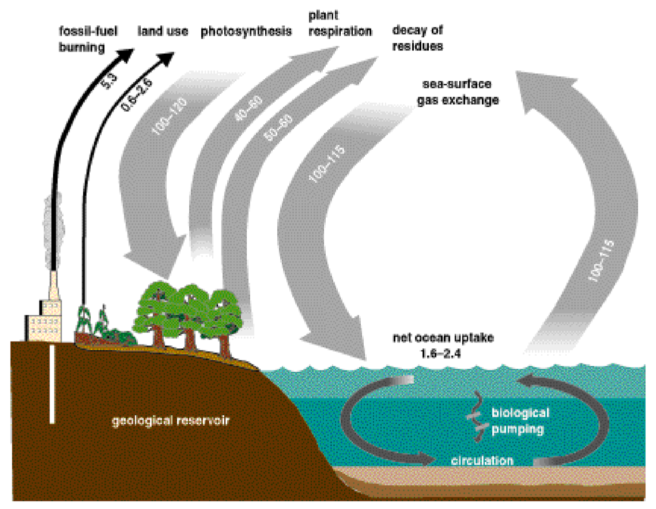
Resource recovery from wastewater with Bioelectrochemical Systems

Introduction

The demand for mineral and energy resources is increasing rapidly due to the growing world population and rising economies. Organic waste generated by humans alone has an energy content of ca. 600 – 1200 TWh/yr. Energy use for a domestic aerobic wastewater treatment plant treating 1000 m^3 of wastewater daily is estimated at 2-4 x 10^3 kWh per day.

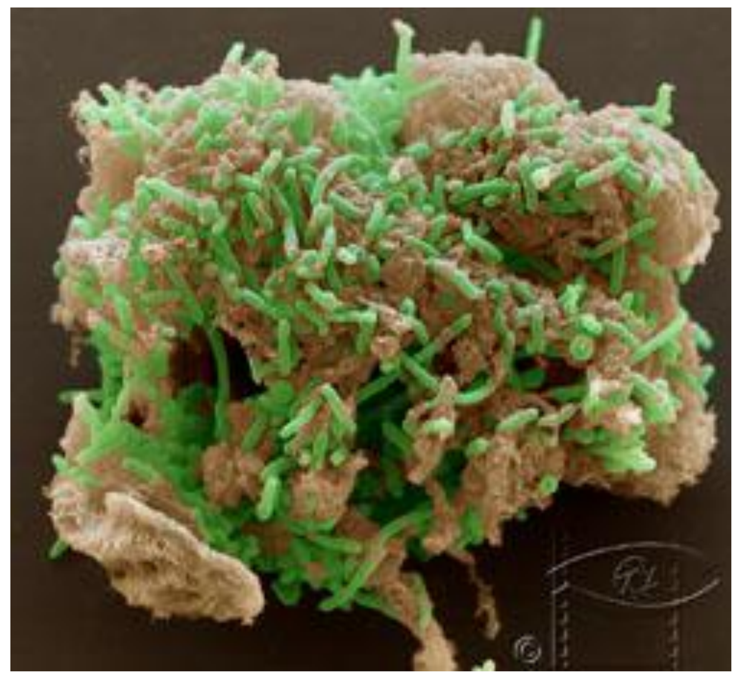
Microorganisms play a central role in global elemental cycles. Metal oxide reduction can account for 30-90% of organic carbon turnover in marine sediments and may be highly significant for organic carbon mineralization in low sulfate environments.

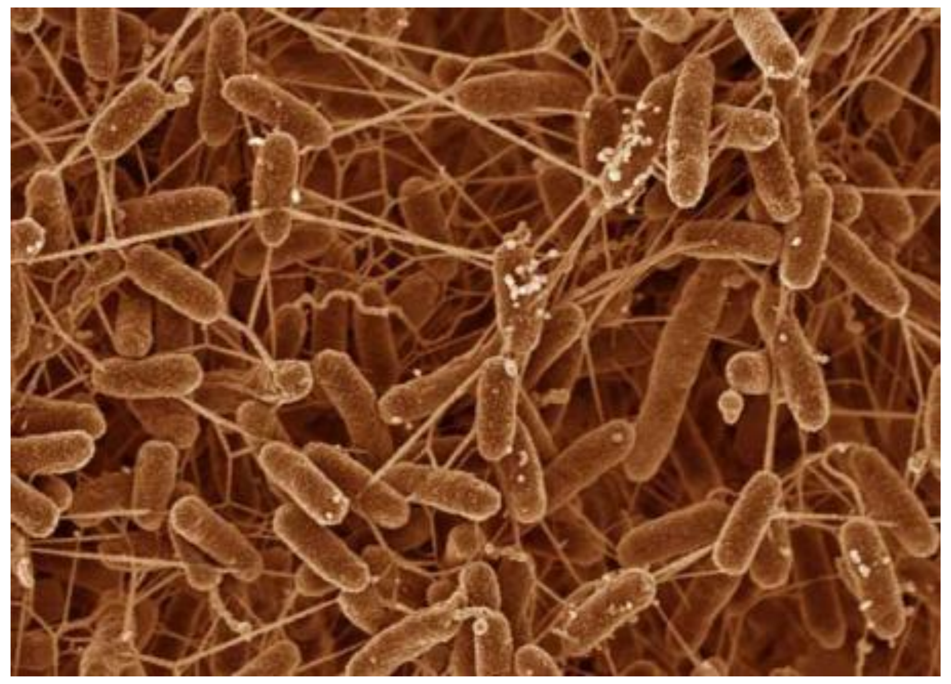


Microbial metal oxide reducing bacteria have evolved mechanisms that allow them to transfer electrons to solid phase electron acceptors are exploited in microbial bioelectrochemical systems with electrodes as e^- acceptors/donors.

Bioelectrochemical Systems

In Bioelectrochemical Systems (BES), living microorganisms convert chemical energy from organic waste into electricity or hydrogen or other chemical products using microbial electrolysis cells (MECs)). This emerging technology can provide the solution to combine waste treatment and resource recovery with positive impacts on the environment and society. Main BES applications to explore: a) metal recovery from wastewater; b) CO_2 reduction to produce valuable chemicals; c) salt recovery and energy production.





Aims and Objectives

To develop integrated BES to use the energy in waste and biomass to recover valuable mineral resources.

The main objectives:

- Identify novel approaches that can be used for resource recovery using an integrated bioelectrochemical system combining anodic organic carbon oxidation and cathodic reductions as a first step towards an integrated system
- Carry out economic and environmental impact evaluations on the processes and systems based on mass-energy balance, material/energy requirements and thermodynamics.

Benefits of the approach

The use of BES for resource recovery benefits both the environment & the economy:

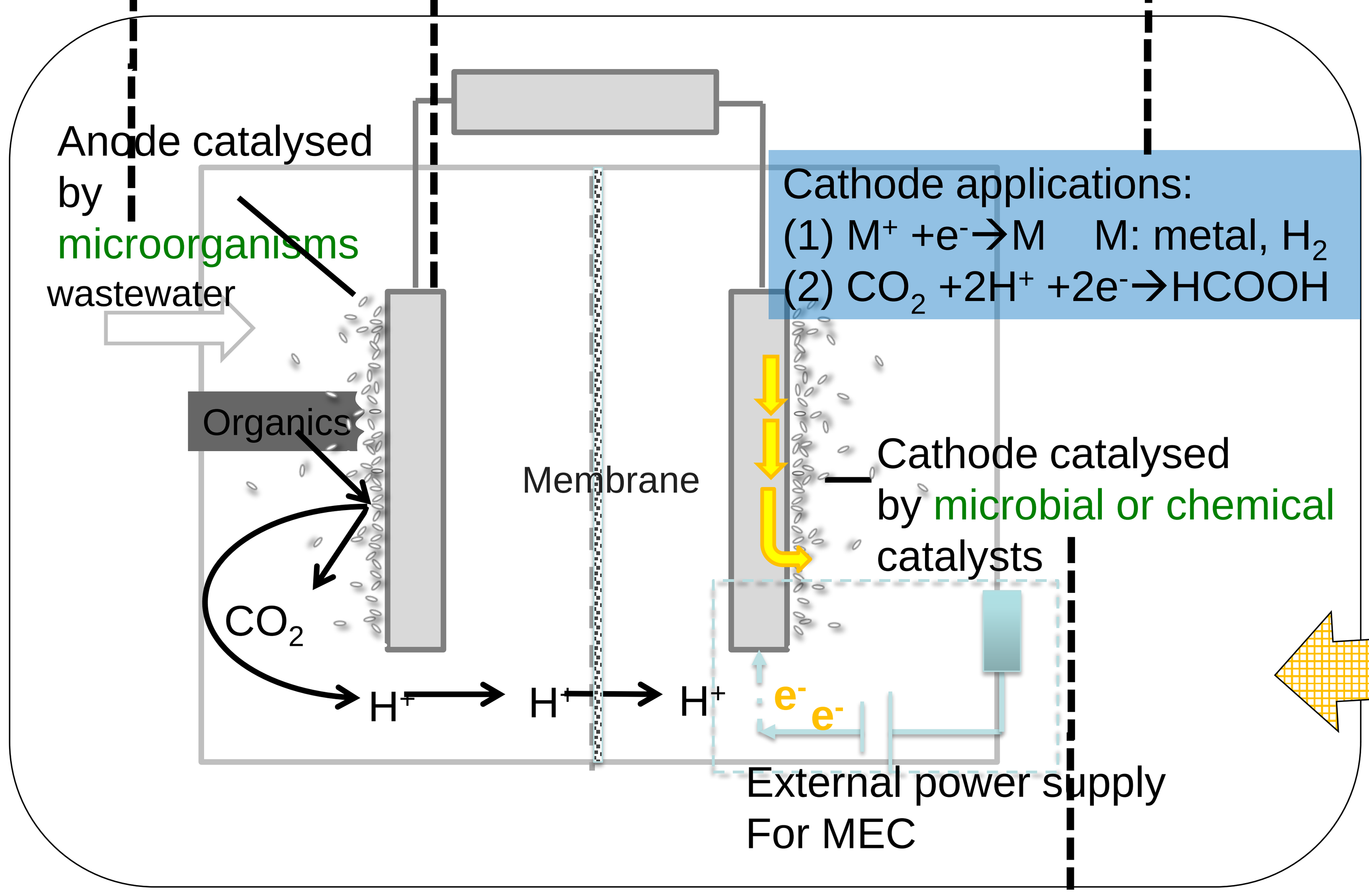
- Reduction of energy required for wastewater treatment process
- Sustainable production/recovery of high value substances from waste
- Renewable energy and resource

Microbial ecology modelling

Carbon Materials

Bioremediation&Bioproduction

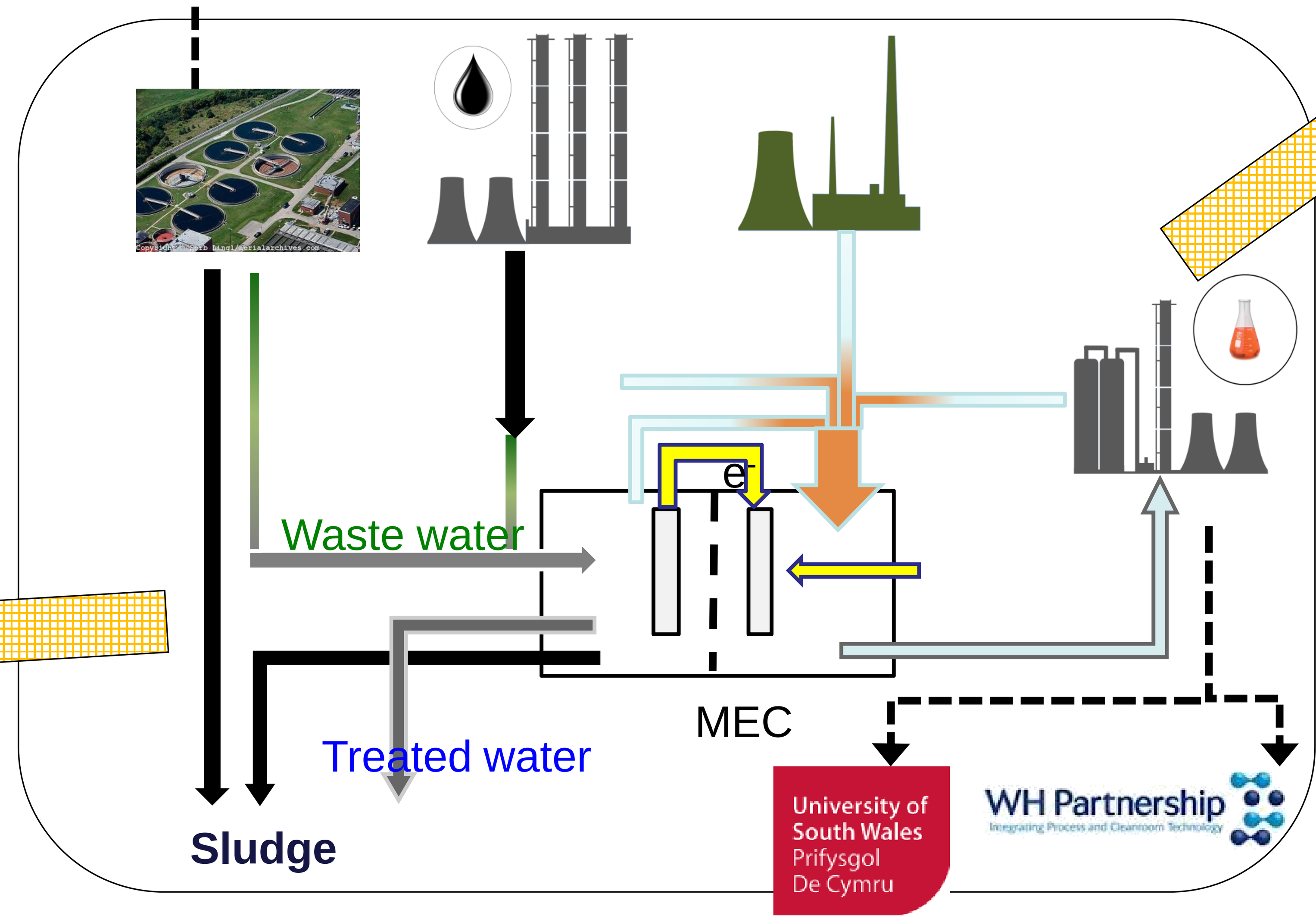
Metal recovery & CO_2 reduction



Economic evaluation

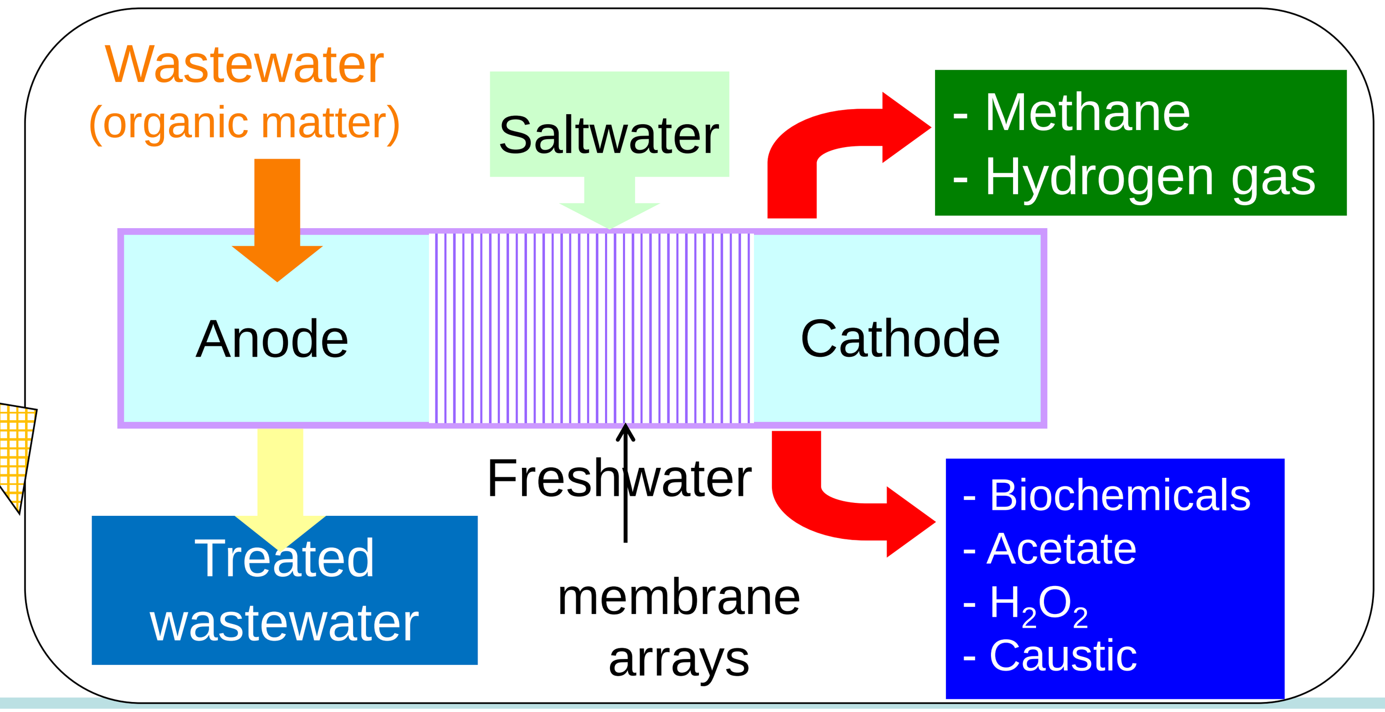
Microbial metal reduction

Integrated BES combining wastewater treatment and resource recovery



System development & scale up

Salt recovery & Energy generation



Contact

Professor Ian Head (PI)
Prof of Environmental Microbiology
Email: ian.head@ncl.ac.uk Tel: +44 (0) 191 246 4806
School of Civil Engineering and Geosciences
Newcastle University, Newcastle upon Tyne, NE1 7RU, UK

Dr. Eileen Yu (CoI), Email: eileen.yu@ncl.ac.uk
Professor Keith Scott (CoI)
Prof of electrochemcial Engineering
Email: keith.scott@ncl.ac.uk
Professor Tom Curtis (CoI)
Prof of Environmental Engineering
Email: tom.curtis@ncl.ac.uk
Dr. Jing Kang (RA), Email: jing.kang@ncl.ac.uk