

***MAT-UK:
Materials for
Electrical
Energy Storage***

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Background:

- ⊕ Energy storage is essential when ~15% of energy comes from renewable, i.e. intermittent or random sources
 - ⊕ Ensure continuous supply
 - ⊕ Restrict “I²R” losses during transmission
- ⊕ Hydrogen discussed by Prof Edwards, electrochemical methods discussed here
- ⊕ Electrification of transport system means greater unification of domestic or industrial sectors with transport

Status of Energy Storage

- ⊕ Only pumped hydro is deployed (e.g. Dinorwig), geographical limitations restrict growth
 - ⊕ Compressed air not feasible in UK
- ⊕ Flow battery, Regenesys inactive, Plurion under development
- ⊕ Conventional batteries – ubiquitous
- ⊕ Need specific solutions for UK

Technologies Recommended by MAT-UK TDS group

⊕ Incremental development:

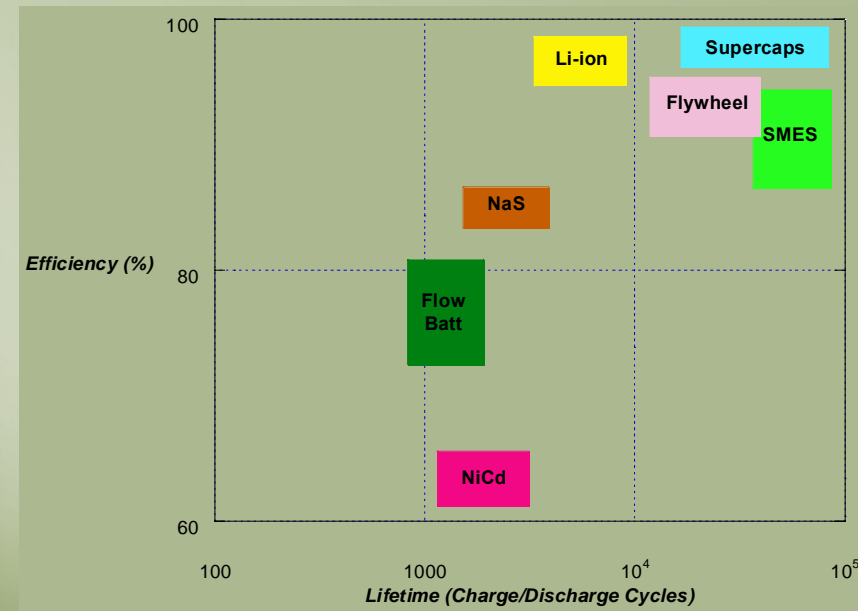
- ⊕ Secondary Li-ion battery
- ⊕ Flow battery

⊕ Disruptive technologies:

- ⊕ Supercapacitors
- ⊕ Superconducting magnetic energy storage

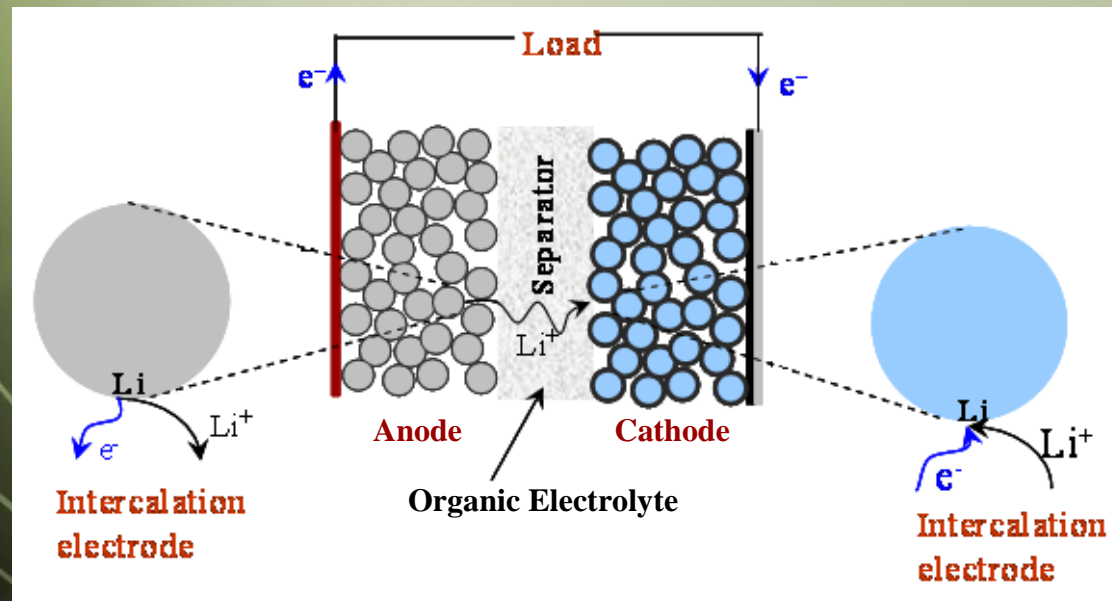
Technologies

- ⊕ Cost
- ⊕ Lifetime
- ⊕ Cycle efficiency
- ⊕ Power density
- ⊕ Energy density
- ⊕ Modularity
- ⊕ Self-discharge



Li-ion batteries

⊕ Principles of operation:

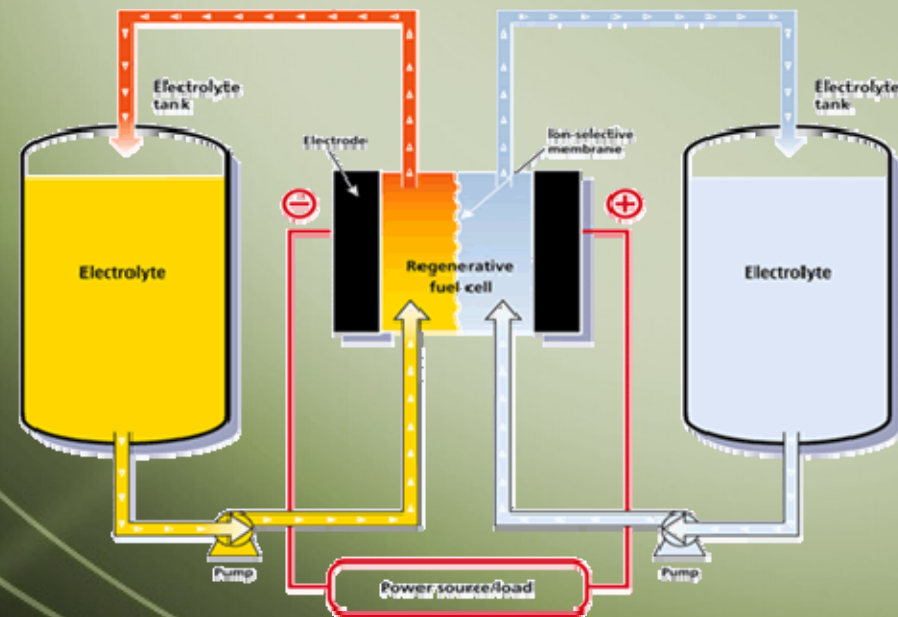


Li-ion batteries

- ⊕ Applications: Portable electronics, automotive, microgrid
- ⊕ Materials challenges: New cheaper, lighter, environmentally friendly anode materials
- ⊕ UK status: High interest in advanced batteries, Fife batteries, QinetiQ, Cenex
- ⊕ The way forward for UK: New materials development, control electronics, defence applications

Flow batteries

⊕ Principles of operation:

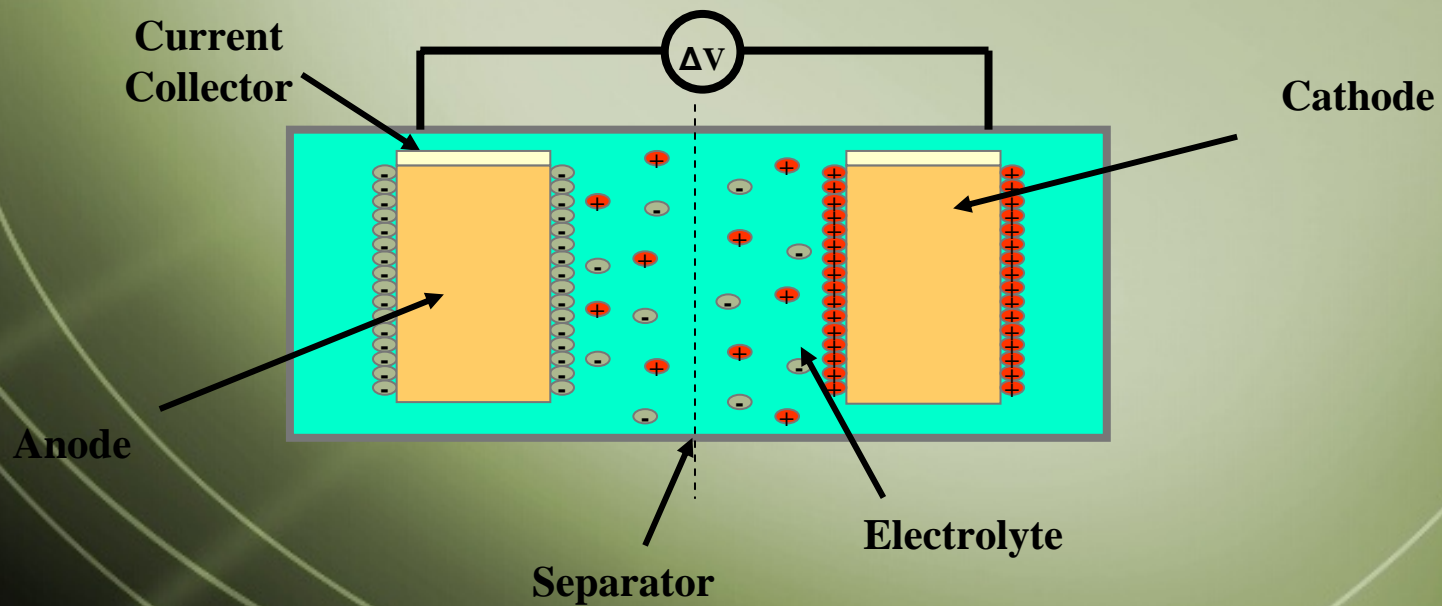


Flow batteries

- ⊕ Applications: Grid energy storage
- ⊕ Materials challenges: Corrosive resistant materials, membrane development
- ⊕ UK status: Plurion, Regeneration
- ⊕ The way forward for UK: Link with Materials and Chem Eng community, establish research base

Supercapacitors

⊕ Principles of operation:

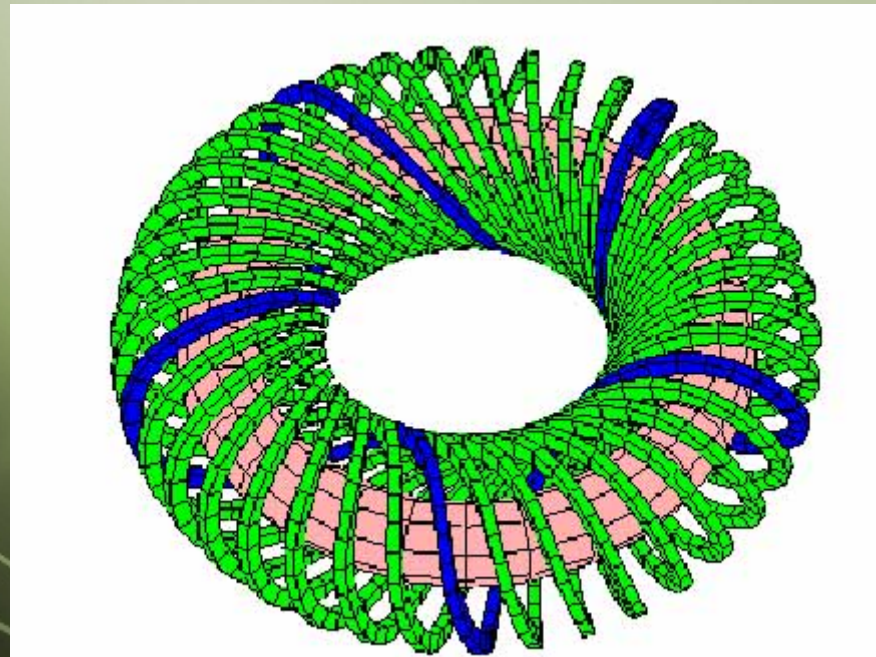


Supercapacitors

- ⊕ Applications: Power smoothing, battery/FC lifetime extension, automotive
- ⊕ Materials challenges: Electrolytes for low self discharge, higher voltage operation, carbons
- ⊕ UK status: All individual component manufacture present
- ⊕ The way forward for UK: Industrial collaboration to form manufacturing base, defence applications

Superconducting Magnetic Energy Storage

⊕ Principles of operation:



Superconducting Magnetic Energy Storage

- ⊕ Applications: Power smoothing, energy storage for grid
- ⊕ Materials challenges: HT superconducting materials, bulk manufacture
- ⊕ UK status: Established expertise in magnetic materials, no demonstration
- ⊕ The way forward for UK: Bring together disparate/dispersed industry and academia

Recommendations - UK Perspective

- ⊕ Urgent need to develop UK Energy storage forum to bring together
 - ⊕ Electrical supply industry
 - ⊕ Developers and Manufacturers
 - ⊕ Research and Consulting
- ⊕ Objectives: Plan for future, promote new industry in UK, organise meetings/workshops
- ⊕ Funding, membership fees, government seeding

Recommendations -Research

⊕ Energy storage covered by EPSRC:

- ⊕ Li batteries and supercapacitors
- ⊕ Hydrogen storage and fuel cells

⊕ Not covered by EPSRC:

- ⊕ Materials for flow batteries
- ⊕ Applied superconductivity materials
- ⊕ Overarching research

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