

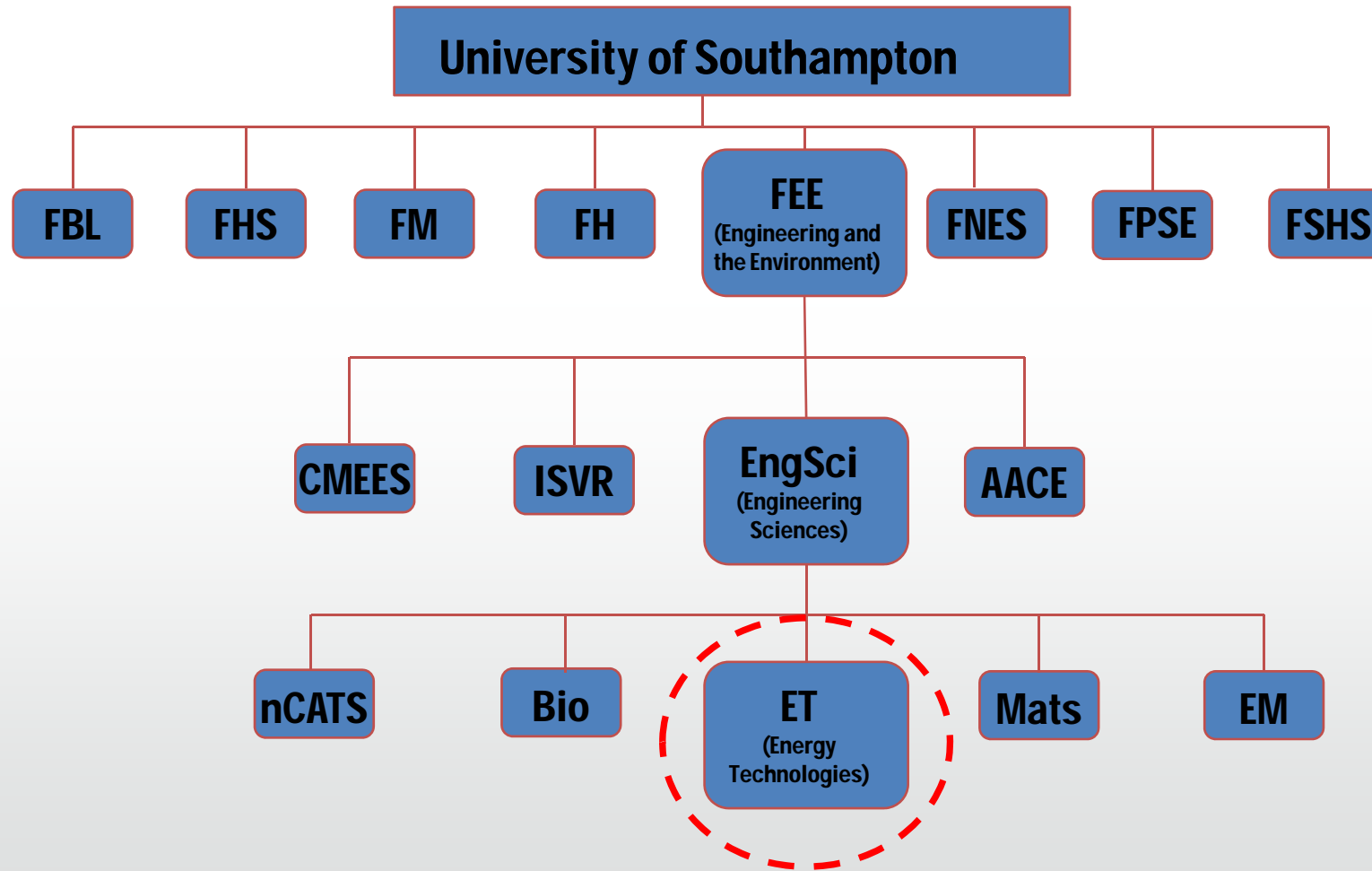
Energy Storage for Marine Use - Opportunities

Prof Andy Cruden, Head of Energy Technology Research Group

a.j.cruden@soton.ac.uk

 023-8059-7660

Energy Technology Research Group - Organisation



Maritime Sector - Context

- *The UK Maritime Industry is worth some £13.8bn to the UK economy and over 260,000 jobs (ref: Maritime UK)*
- *This sector urgently needs to address carbon emissions*
- *Currently not directly regulated within the UK's commitment to an overall 80% reduction in CO₂ emissions by 2050 (Climate Change Act (2008)) however there is growing recognition this sector will be required to contribute to overall carbon reduction targets*

Maritime Sector - Context

- *Significant potential for this sector to learn and study deployment of clean technologies*
- *Could use more electric/hybrid technologies for ship propulsion and 'hotel' loads, including ship-to-shore connections*
- *For example the UK transport sector reduced carbon emissions by 12% and saw new car efficiency (inc. internal combustion engine (ICE) vehicles) improve by 19% from 2007-2012 (ref: Committee on Climate Change)*

Maritime Sector - Context

- *The scale (power and energy rating) of propulsion unit and energy demand is significantly greater per ship than per car, hence both technical and economic challenges require to be examined in detail;*
- *The marine environment, and global shipping patterns, impose a unique set of operating and maintenance criteria, including high utilisation (c.f. to cars), limited service access, harsh physical environment, end-of-life issues, safety and longer service life, compared to land-based transport systems.*

Current Maritime Hybrids



- CalMac hybrid ferries in Scotland
- Diesel/electric hybrid with electric propulsion
- 700kWh Lithium-ion batteries (over 2 packs) onboard
- At least 20% reduction in fuel & CO₂ – batteries charged overnight from mains

New Harbour Infrastructure

- Ship-to-shore facilities, where vessels are powered from mains electricity in harbour are increasingly common to tackle emissions, noise and vibration



Image: http://www.worldportsource.com/images/ports/USA/CA/Long_Beach_Aerial.ss.jpg

- (Image – port of Los Angeles)

Battery Testing - Capability



- Undertaking cycle tests of 3 x electric vehicle battery packs (each one 43kWh)
- Studying degradation due to different cycle patterns
- 60kVA bidirectional inverter from battery to 3 phase mains

Battery Testing – Different Batteries

- Have two different lithium-ion battery chemistries to test
- Lithium manganese system illustrated (12.5kWh)

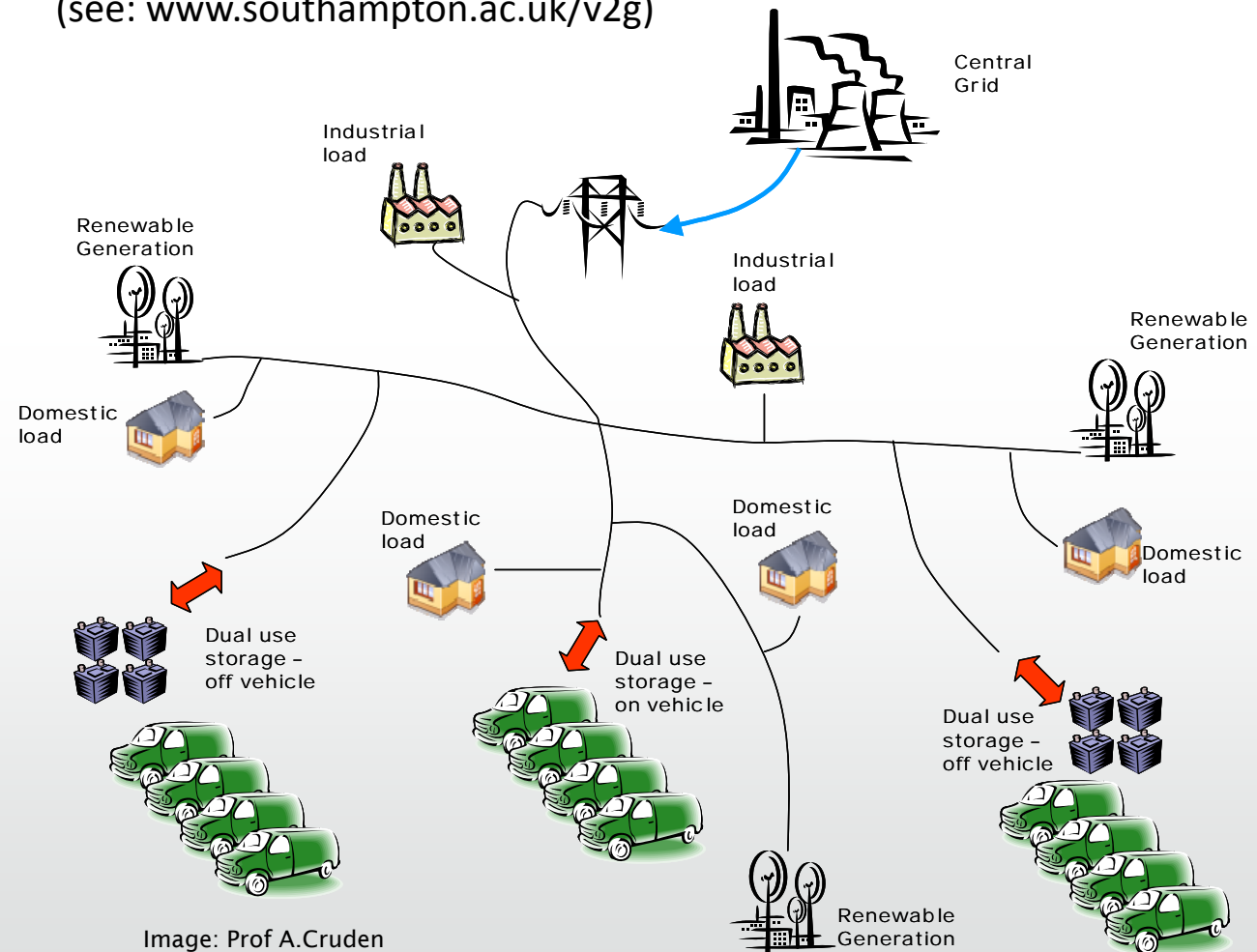


Image: Prof A.Crudem

Modelling and Simulation - e.g. Vehicle to Grid (V2G)

(see: www.southampton.ac.uk/v2g)

- Aggregated use of EV batteries to provide grid support
- Ongoing work in:
 - System control and modelling
 - Battery degradation
 - EV Communications and control algorithms
 - Power electronic converters

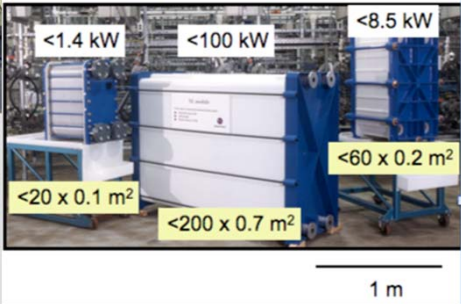
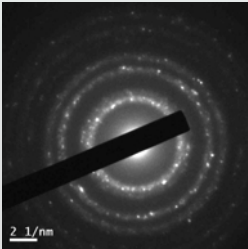
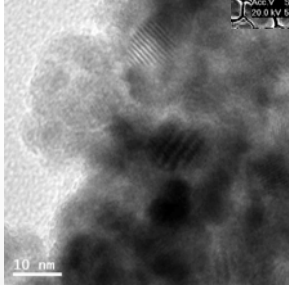
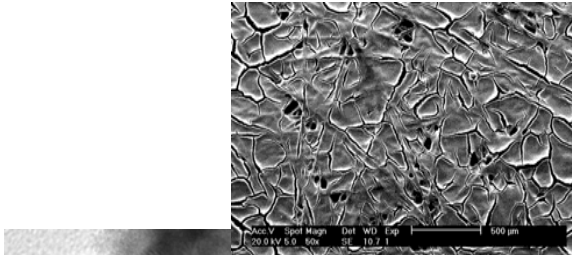
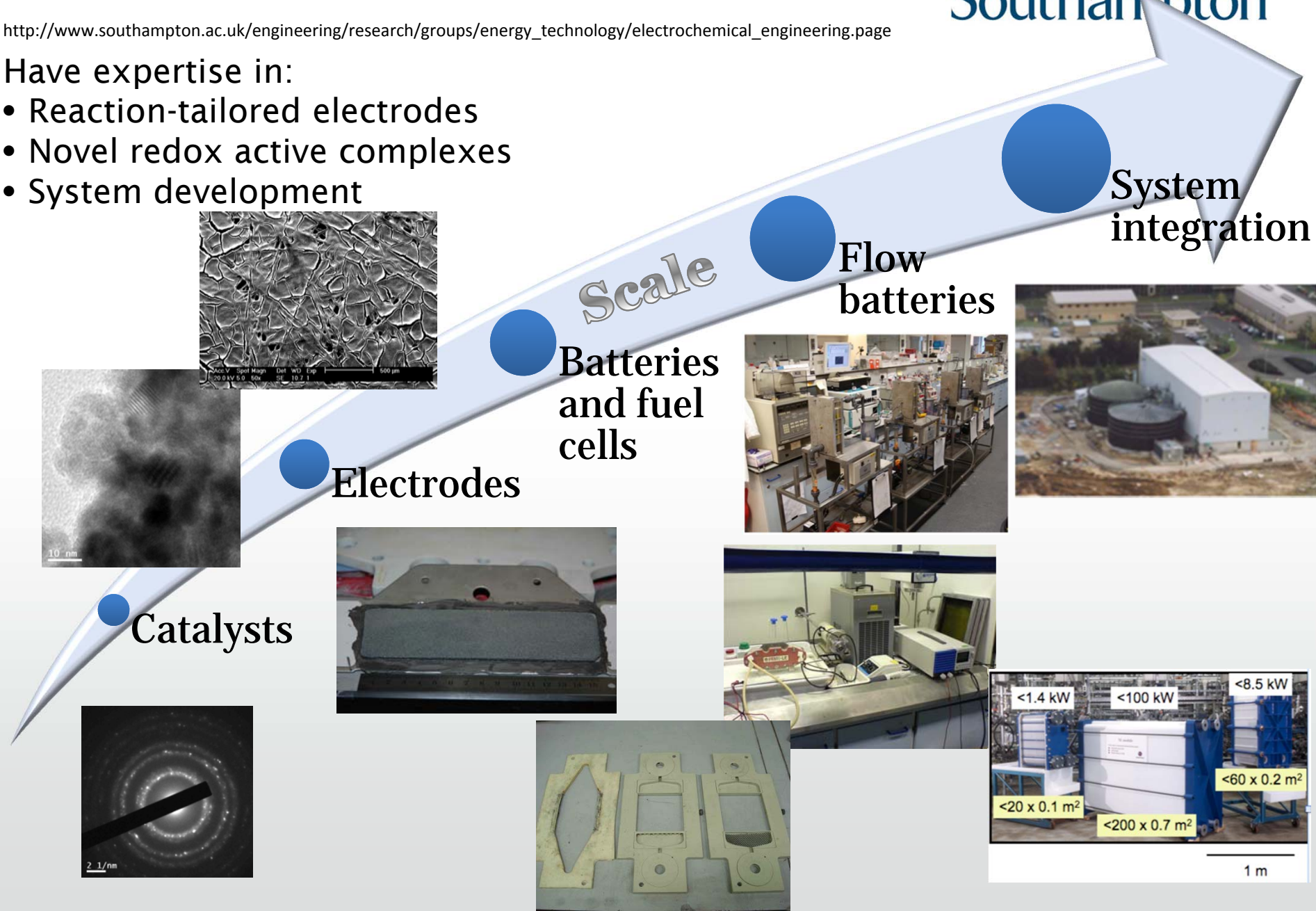


Flow batteries & materials

http://www.southampton.ac.uk/engineering/research/groups/energy_technology/electrochemical_engineering.page

Have expertise in:

- Reaction-tailored electrodes
- Novel redox active complexes
- System development



Energy Storage – Current Projects

- Co-Investigator on new EPSRC Supergen Energy Storage (ref: EP/L019469/1), investigating electrochemical, thermal and mechanical storage (£4m)
 - Li-ion, Na-ion and supercaps all relevant to transport
- ISIS project – 8 days of beam-time over 2 yrs to study degradation of LiMn_2O_4 & LiFePO_4
www.southampton.ac.uk/engineering/about/staff/ajc1f11.page?#research
- EPSRC Vehicle Electrical Systems Integration (VESI) project – drives, converters, passives and demonstrators
 - www.warwick.ac.uk/vesi

EPSRC CDT in 'Energy Storage and its Applications'

- Joint Sheffield/Soton CDT:
 - 60 students over 5 years
 - Electrochemical
 - SMES
 - Mechanical
 - Thermal
- First intake in Oct 2014
- Access significant energy storage expertise across both Universities

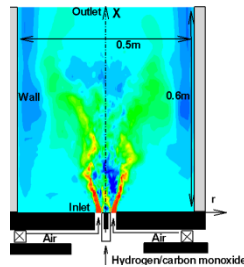
www.energystorage-cdt.ac.uk



Energy Technology Research Group - Capabilities



Magnetic Gears



High Hydrogen Content Combustion Modelling



Flow Batteries



Electrodes and battery materials



Electric and Hybrid Vehicles



Rolling Road Dyno



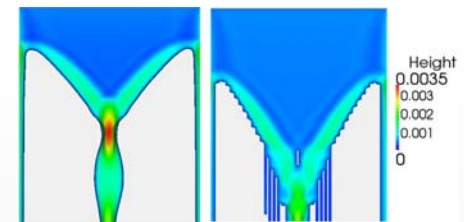
Cryostats and superconductors



Li-ion Battery Systems and Power Electronics

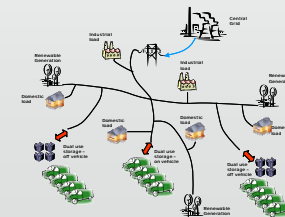


CDT in Energy Storage and its Applications, joint with Sheffield Univ



Carbon (CO₂) capture and sequestration

Vehicle-to-Grid (V2G) – large scale Energy Storage



Staff Contact:
Prof Andy Cruden
a.j.cruden@soton.ac.uk
Tel: 023 8059 7760

Energy Technology Research Group - Capabilities



Prof Andy Cruden
a.j.cruden@soton.ac.uk
Tel: 023-8059-7660
Head of Energy Technology Research Group

ET
(Energy Technologies)



13 Academic Staff
7 Postdocs
25 PhD students
2 Technicians

