



Future
Leaders
Fellowships



Sustainable Electrodes for Advanced Flow Batteries

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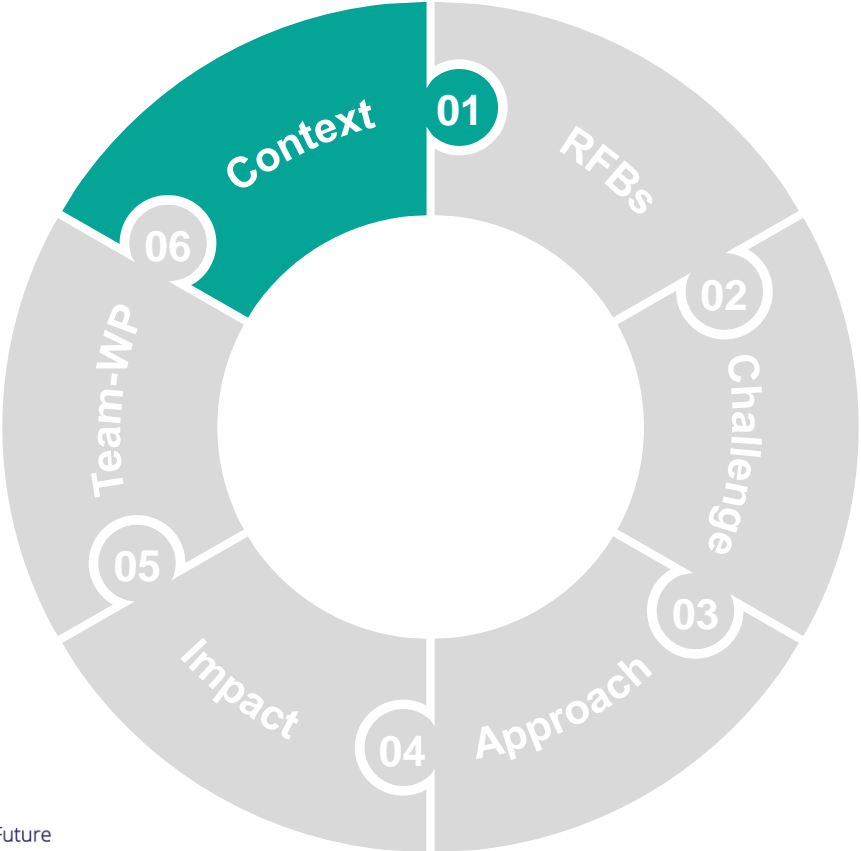
Queen Mary University of London



Sustainable Electrodes for Advanced Flow Batteries



- Global warming, air quality, sustainability, energy security – an increase in installed renewable and clean sources of electricity are vital to solve our energy problems and battle climate change

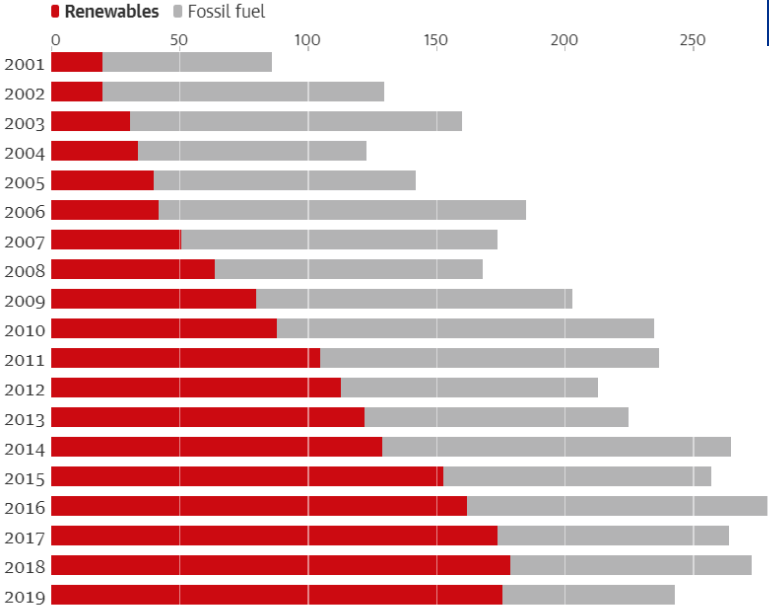


Sustainable Electrodes for Advanced Flow Batteries

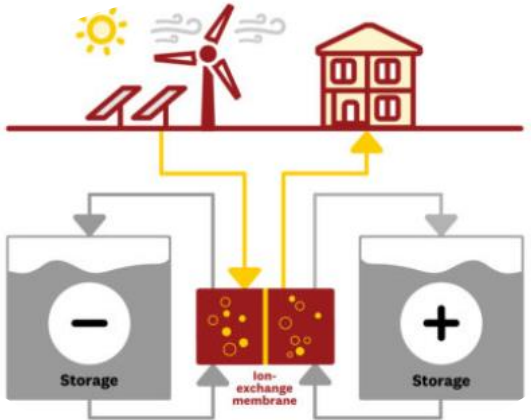
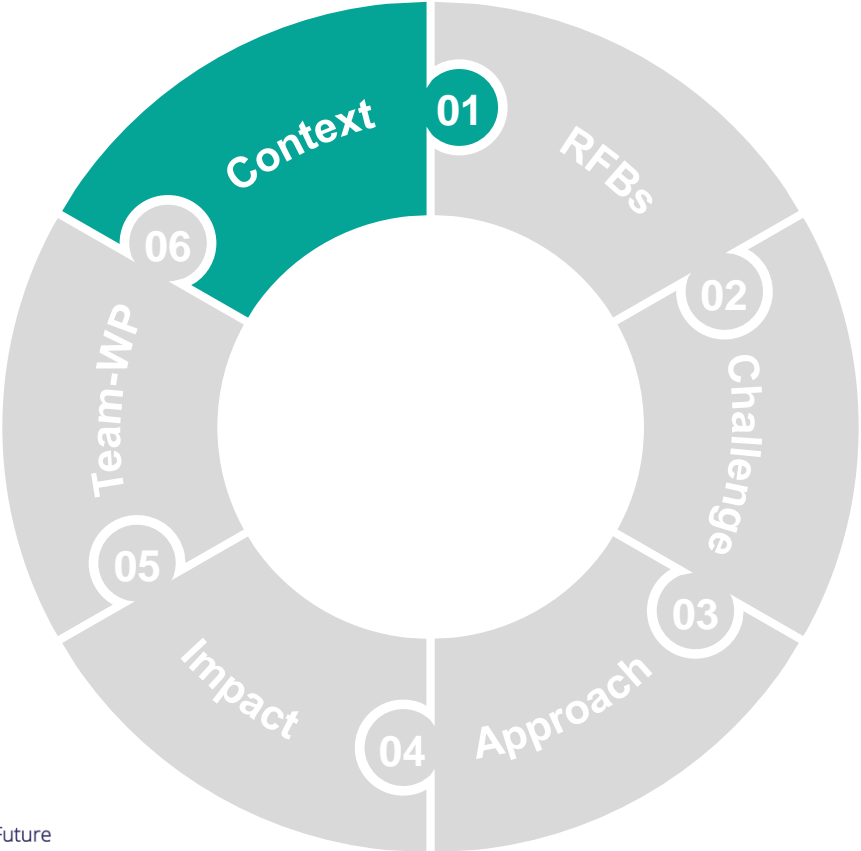


Almost 75% of new electricity capacity was renewable in 2019

New capacity installed each year (gigawatts)

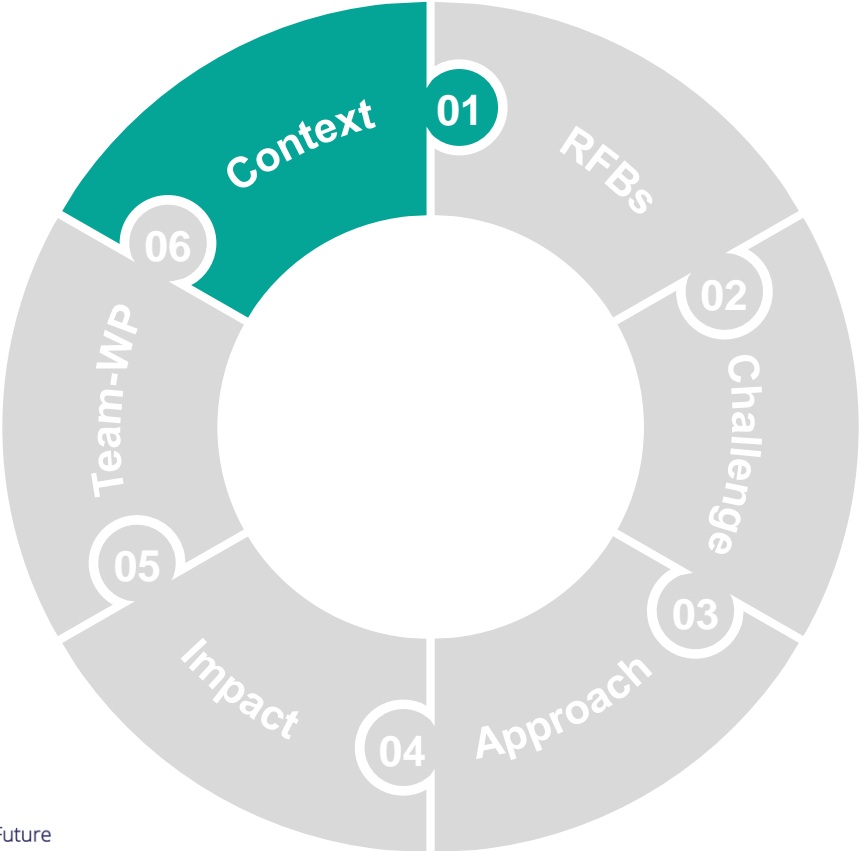


Guardian graphic | Source: Irena



Redox Flow Battery

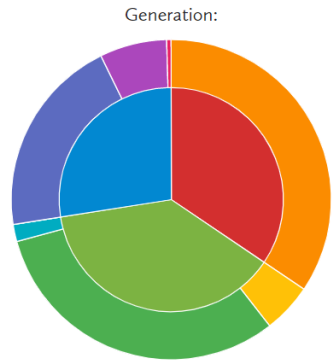
Sustainable Electrodes for Advanced Flow Batteries



National Grid: Live Status (4:15pm 20/10/2020)

The National Grid is Great Britain's electricity transmission network, distributing the electrical power generated in England, Scotland, and Wales, and transferring energy between Great Britain and Ireland, France, and the Netherlands.

35.2GW demand



Note: this pie chart shows generation only, and excludes interconnectors

30.5% fossil fuels

Coal	0.00GW	0.0%
Oil	0.00GW	0.0%
Gas (open cycle) ⓘ	0.00GW	0.0%
Gas (combined cycle) ⓘ	10.72GW	30.5%

24.3% other energy

Pumped storage ⓘ	0.00GW	0.0%
Nuclear	6.30GW	17.9%
Biomass	2.11GW	6.0%
Other	0.14GW	0.4%

33.6% renewable energy

Solar photovoltaic	1.56GW	4.4%
Wind	9.74GW	27.7%
Hydroelectric	0.54GW	1.5%

11.6% interconnectors

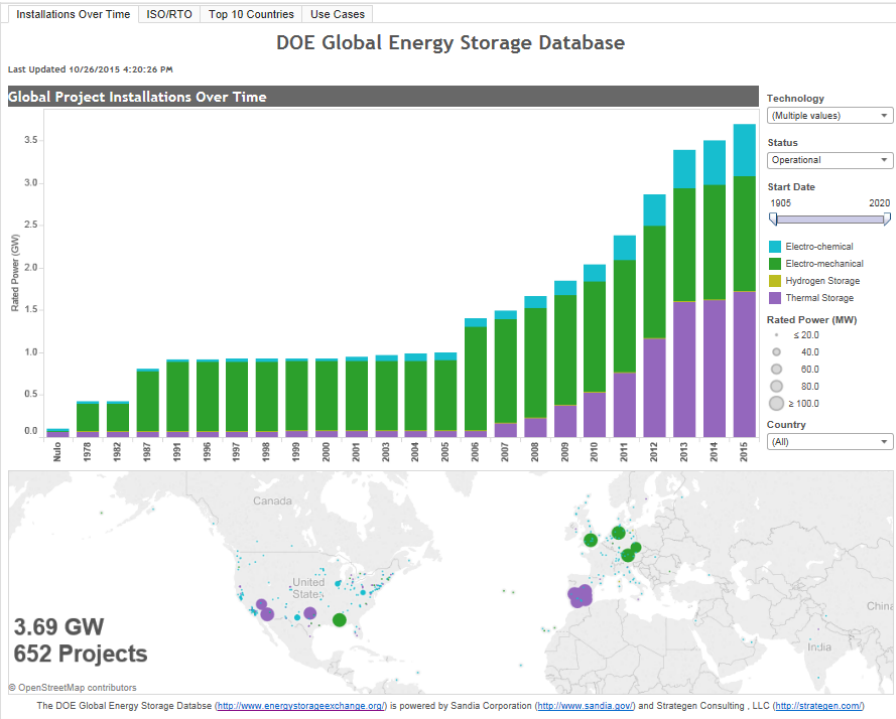
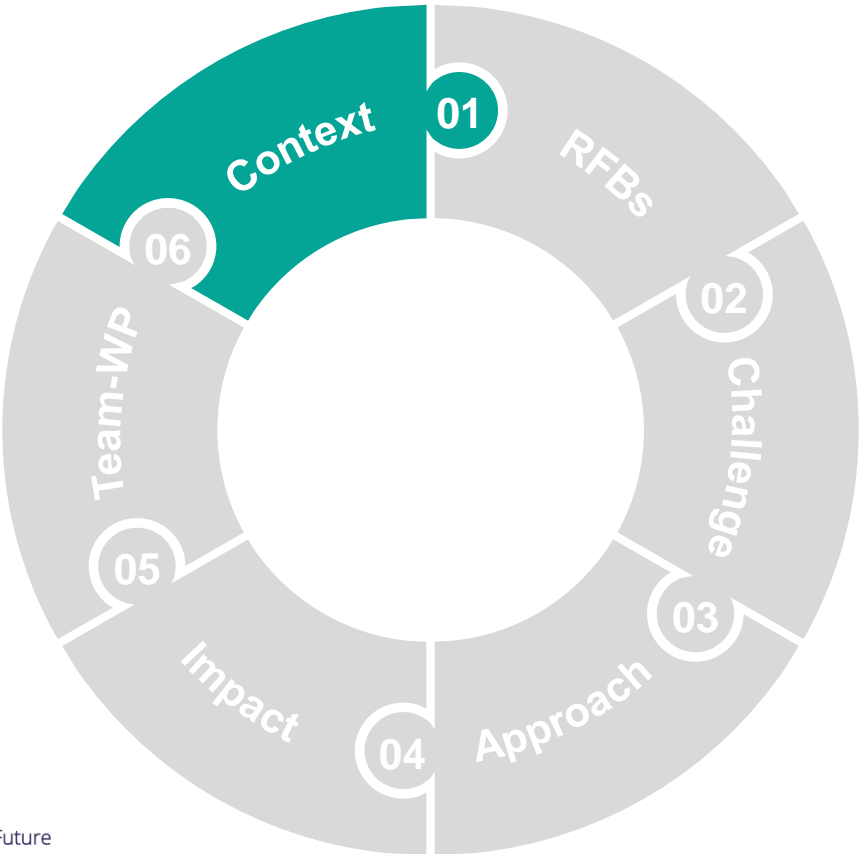
HVDC Moyle ⓘ	0.08GW	0.2%
HVDC Cross-Channel ⓘ	1.83GW	5.2%
BritNed ⓘ	0.99GW	2.8%
East-West Interconnector ⓘ	0.15GW	0.4%
Nemo Link ⓘ	1.02GW	2.9%

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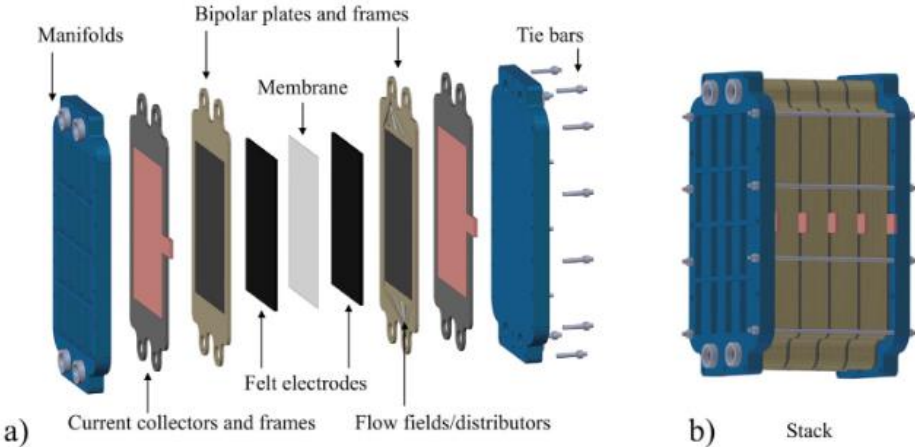
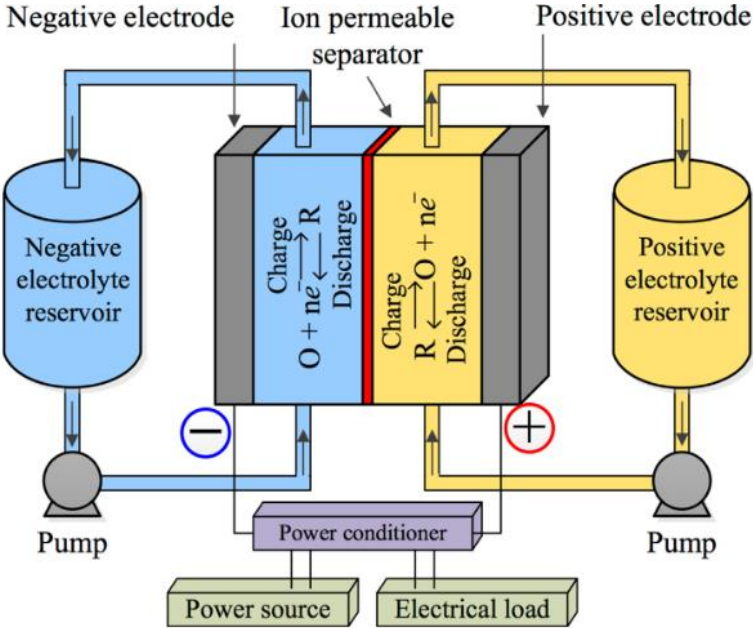
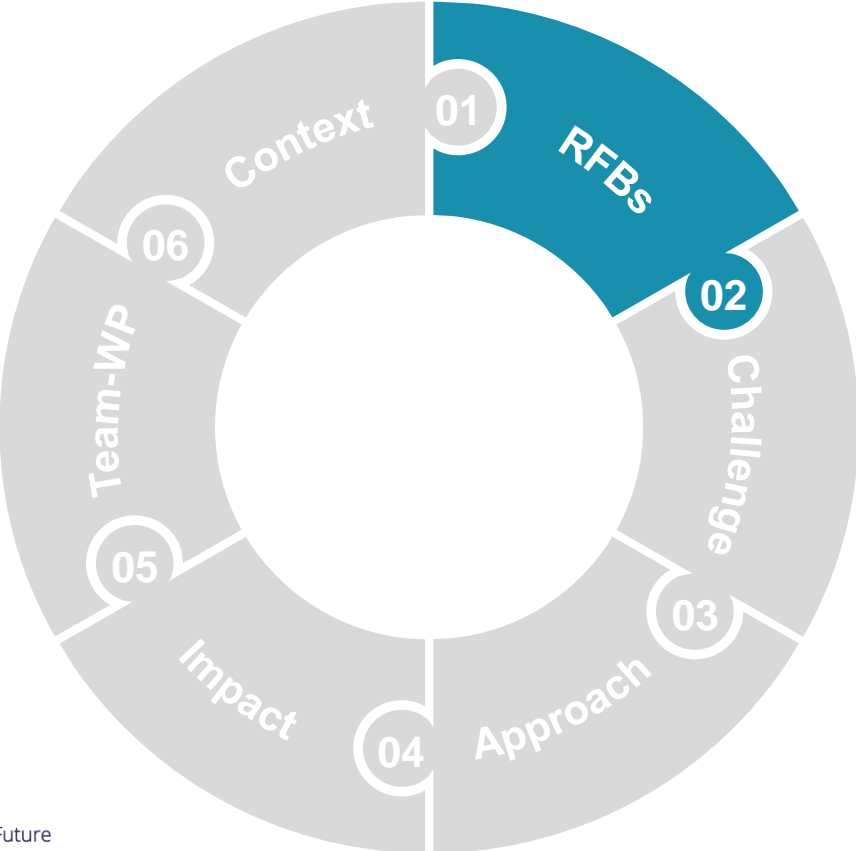


Electricity storage is widely regarded to be the single most important technological breakthrough likely to happen over the period to 2030 and a complete 'game changer' in the way that the power system operates

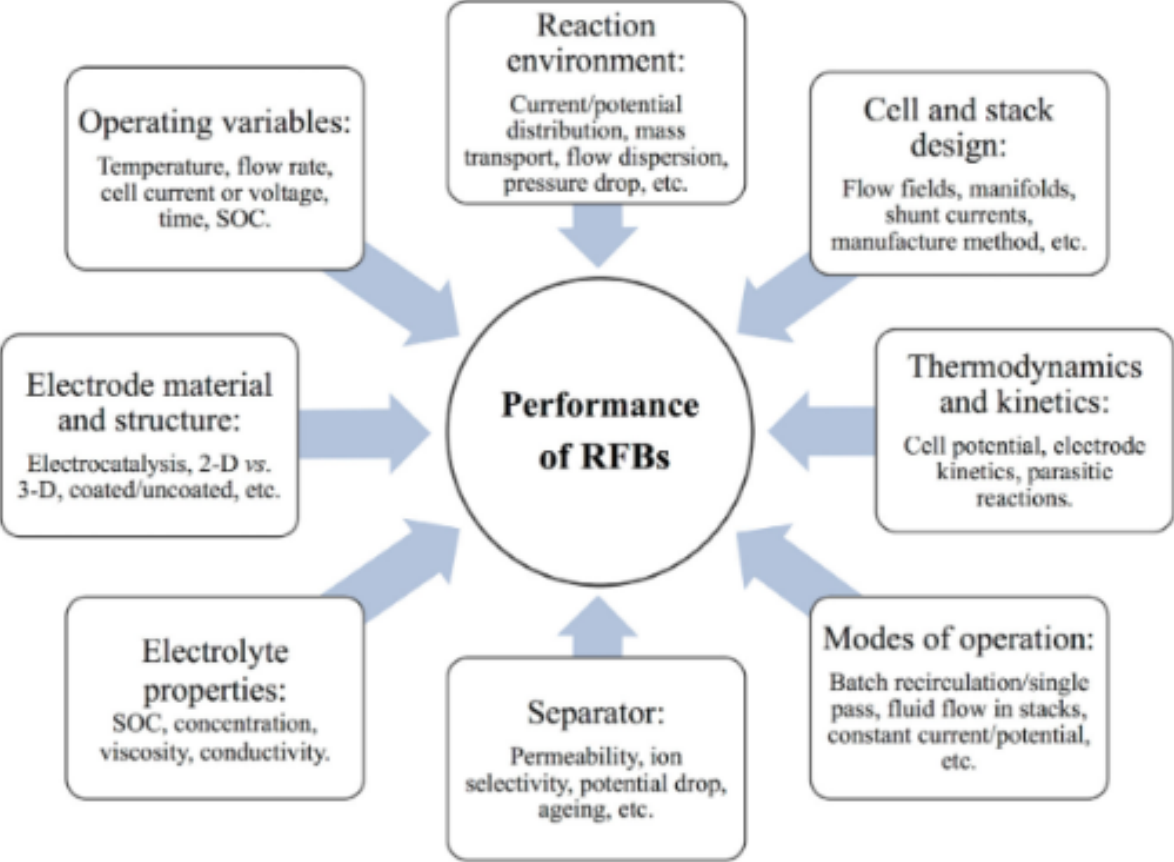
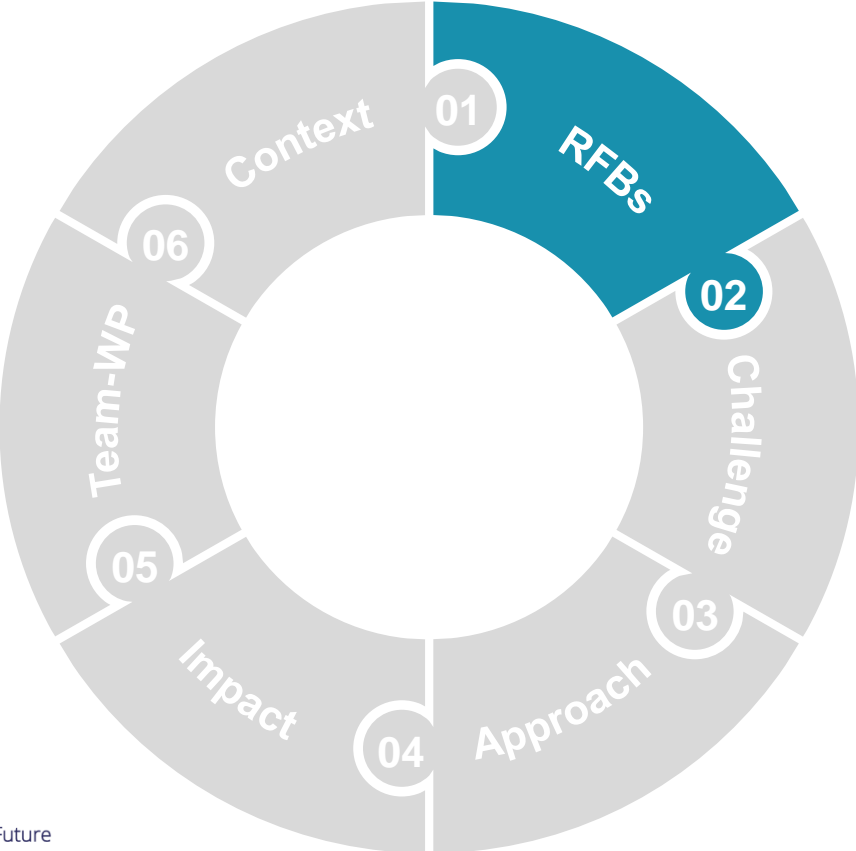
Energy UK report 2016



Sustainable Electrodes for Advanced Flow Batteries



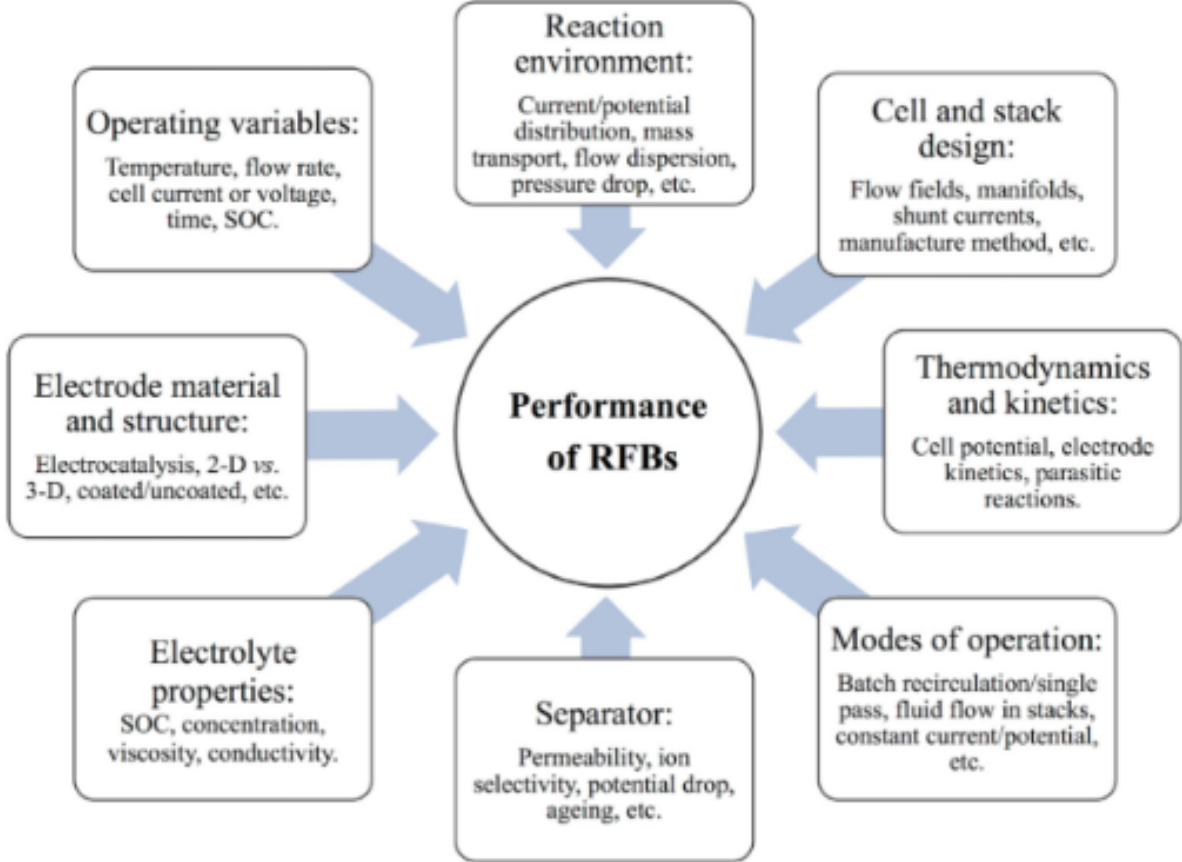
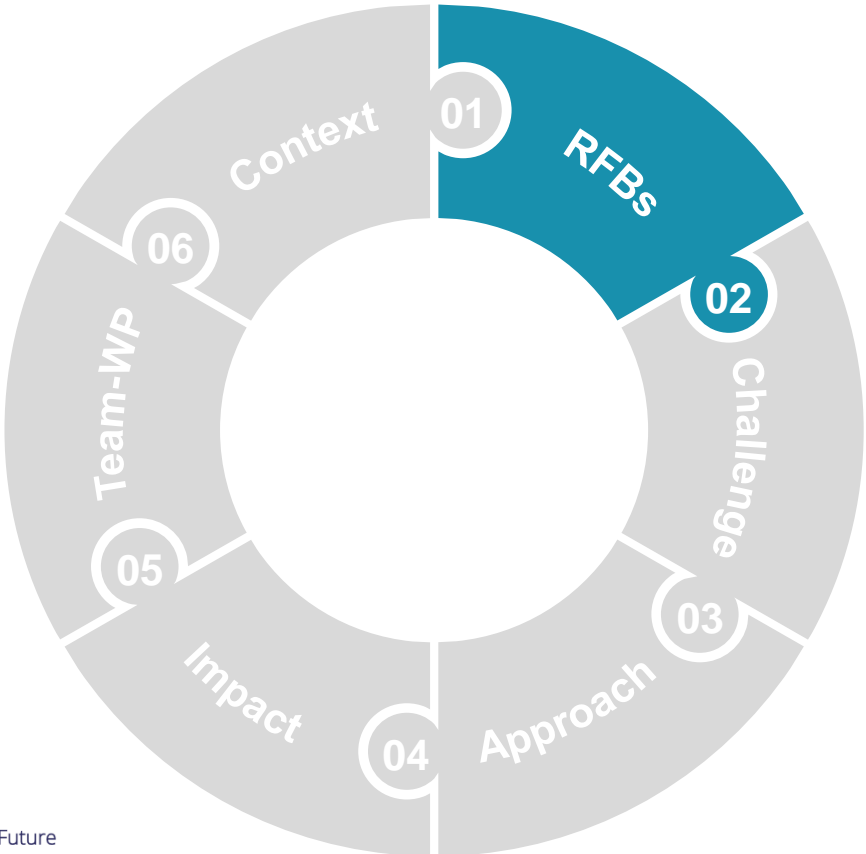
Sustainable Electrodes for Advanced Flow Batteries



Sustainable Electrodes for Advanced Flow Batteries



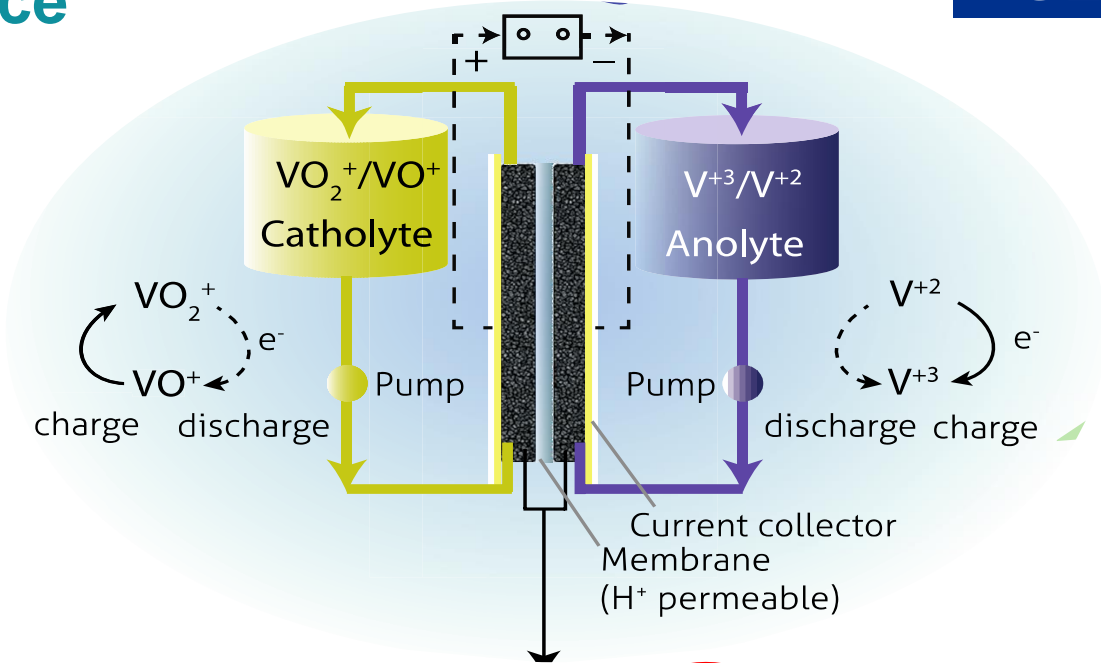
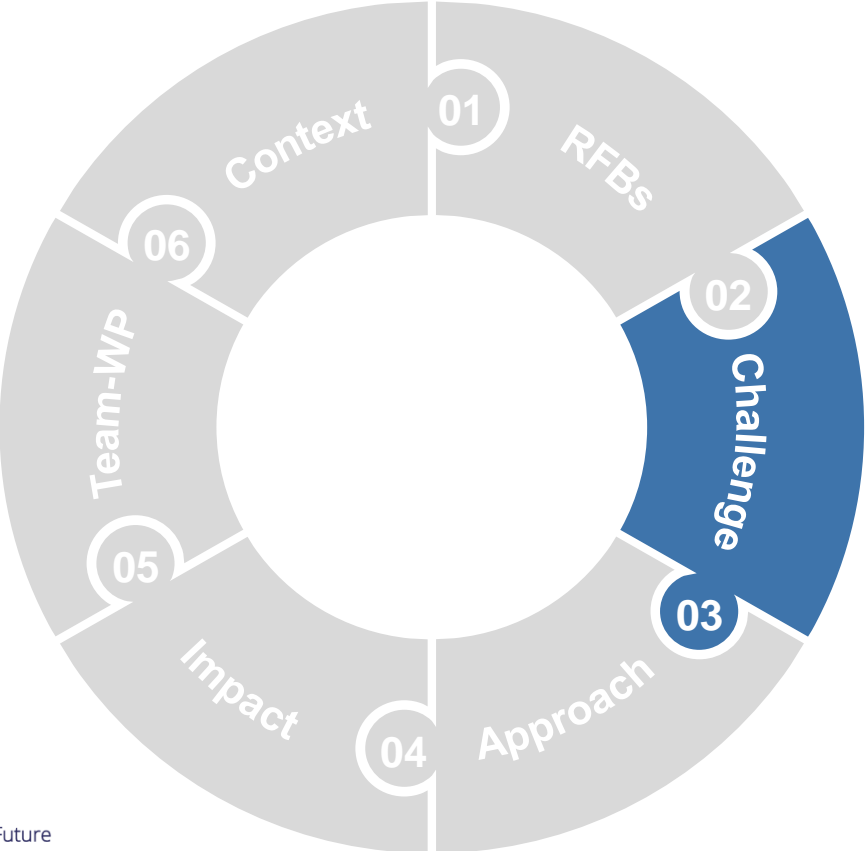
Increase sustainability and improve performance



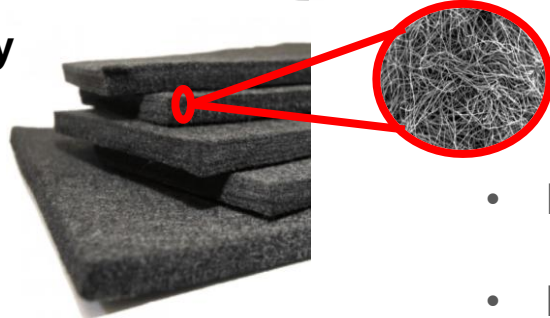
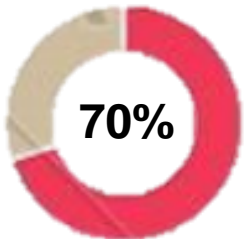
Sustainable Electrodes for Advanced Flow Batteries



Increase sustainability and improve performance



Losses in efficiency



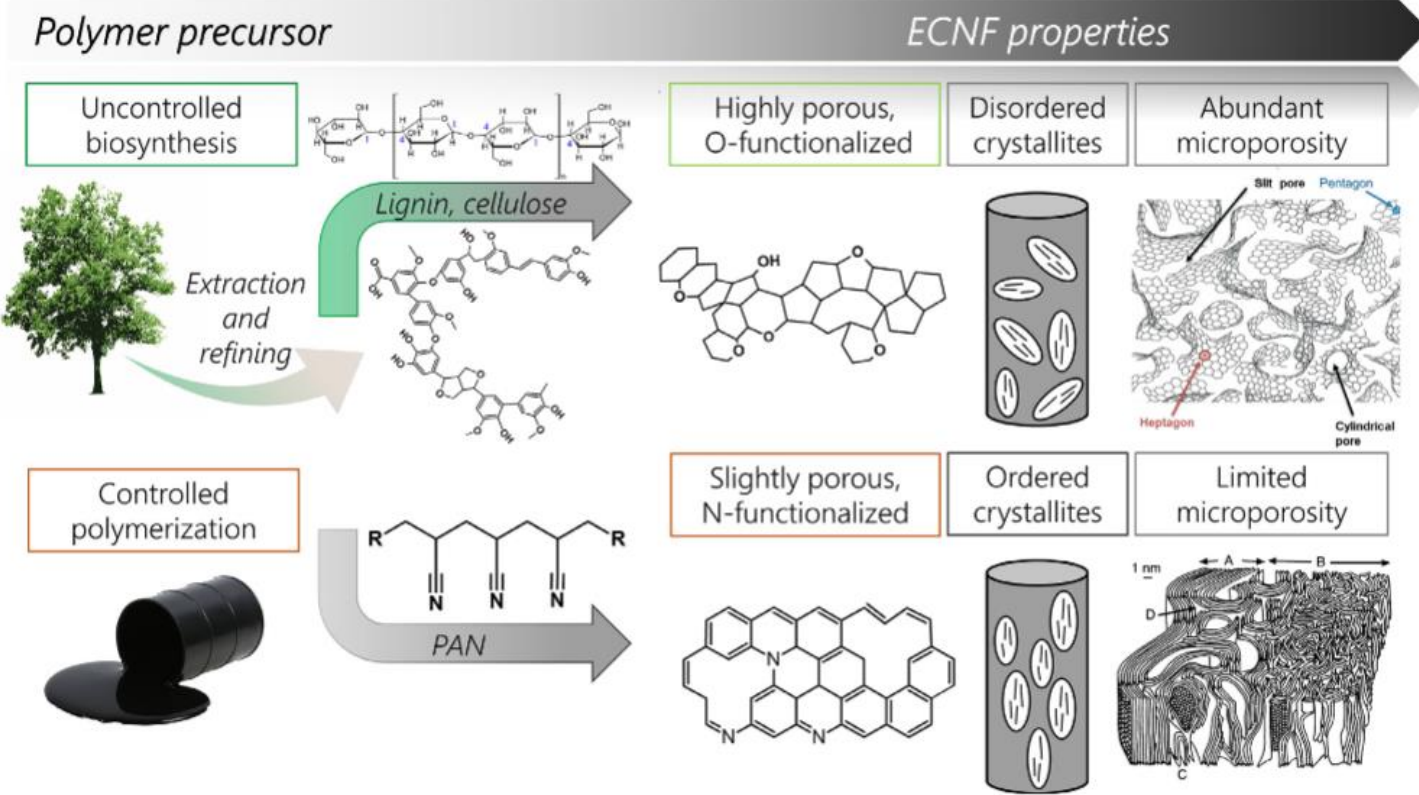
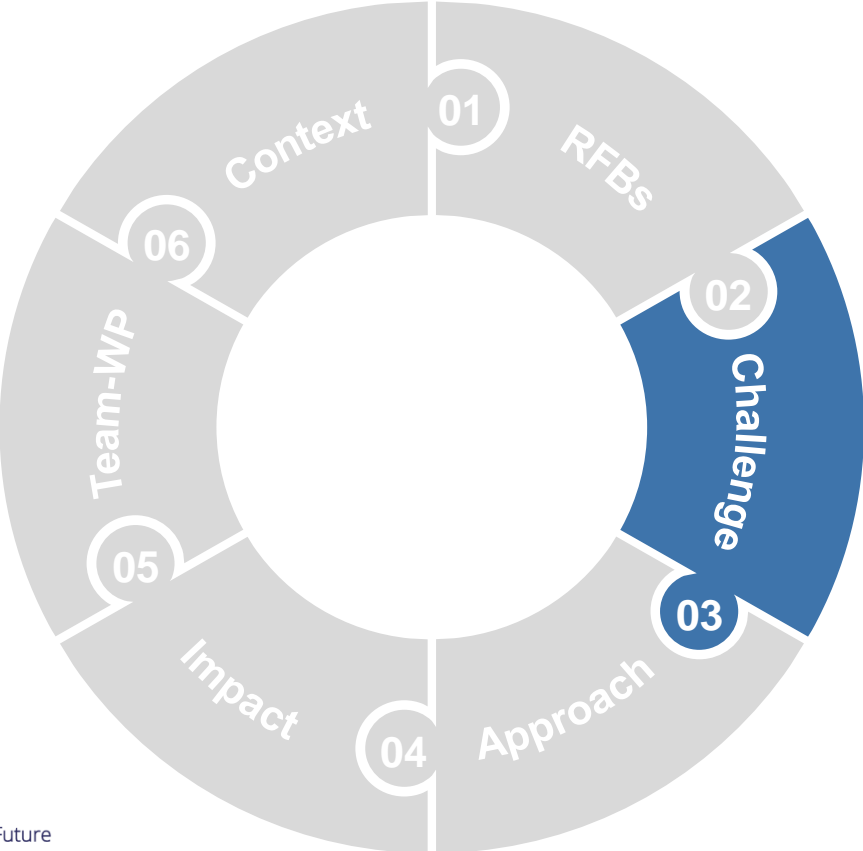
- PAN- based electrodes
- Not optimised for flow battery applications

Energies 2016, 9, 627.

Sustainable Electrodes for Advanced Flow Batteries



Increase sustainability and improve performance

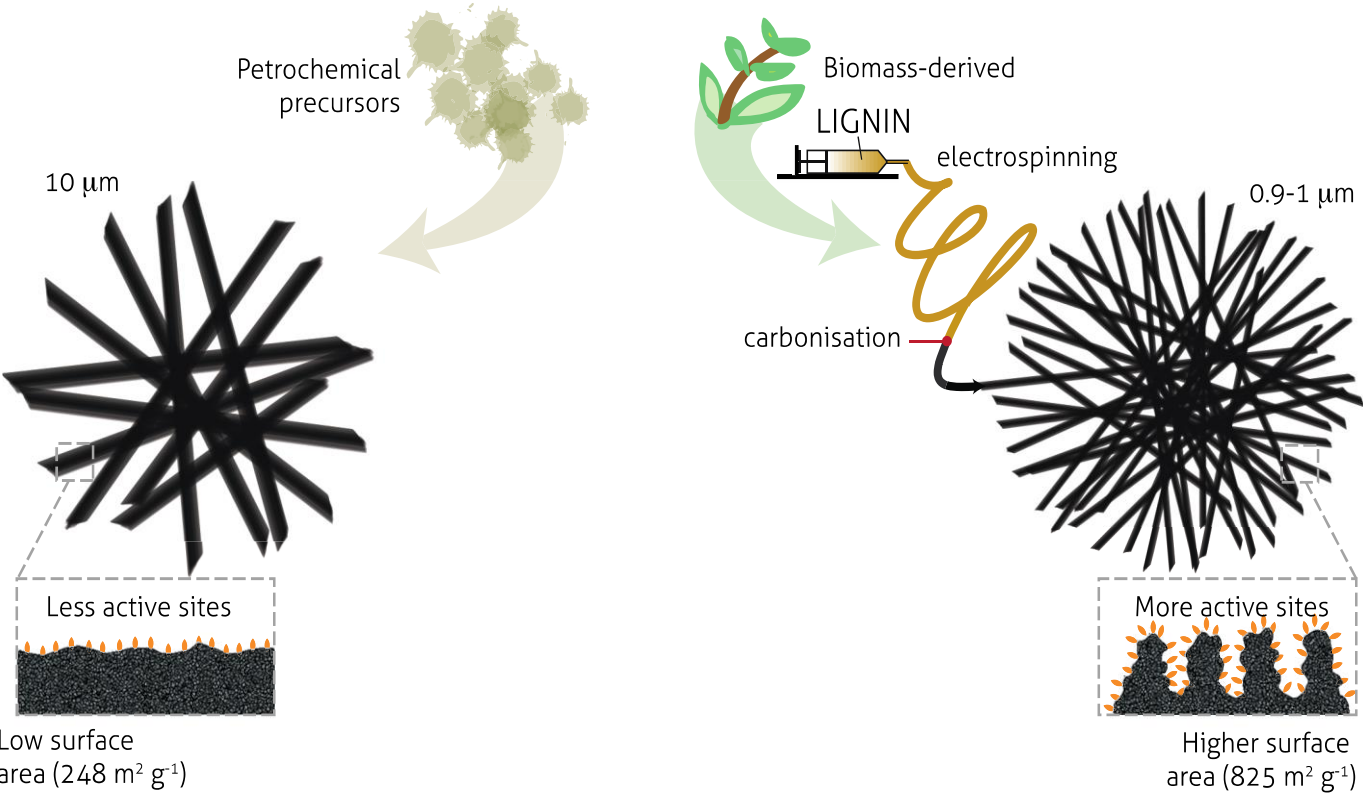
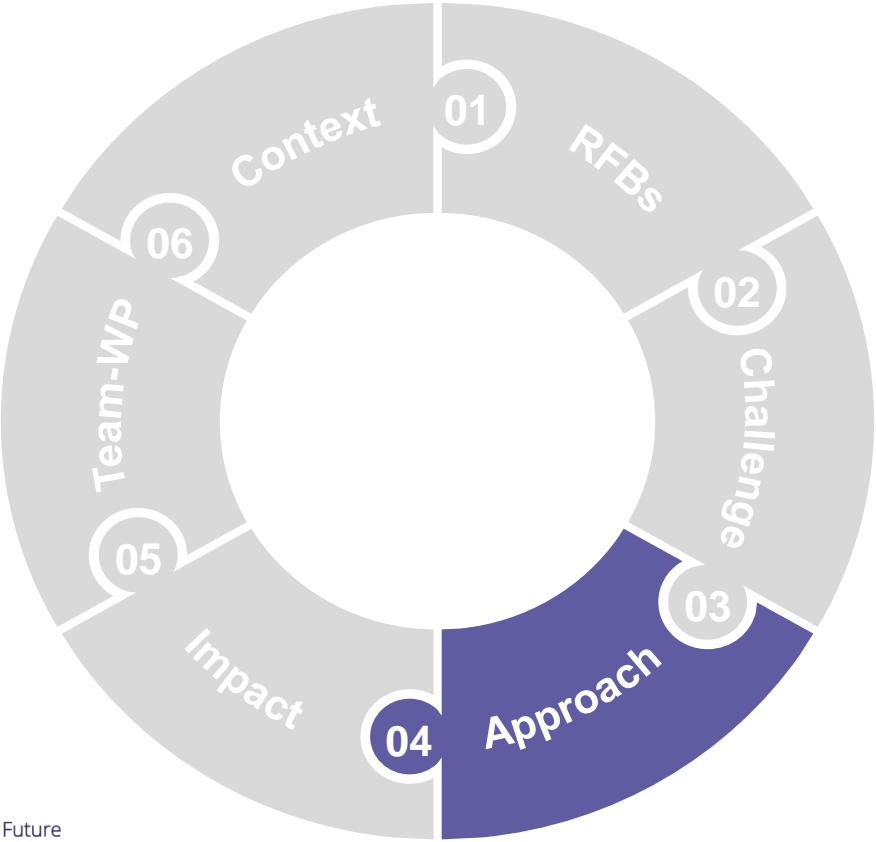


Sustainable Electrodes for Advanced Flow Batteries



Biomass-derived precursors and Electrospinning

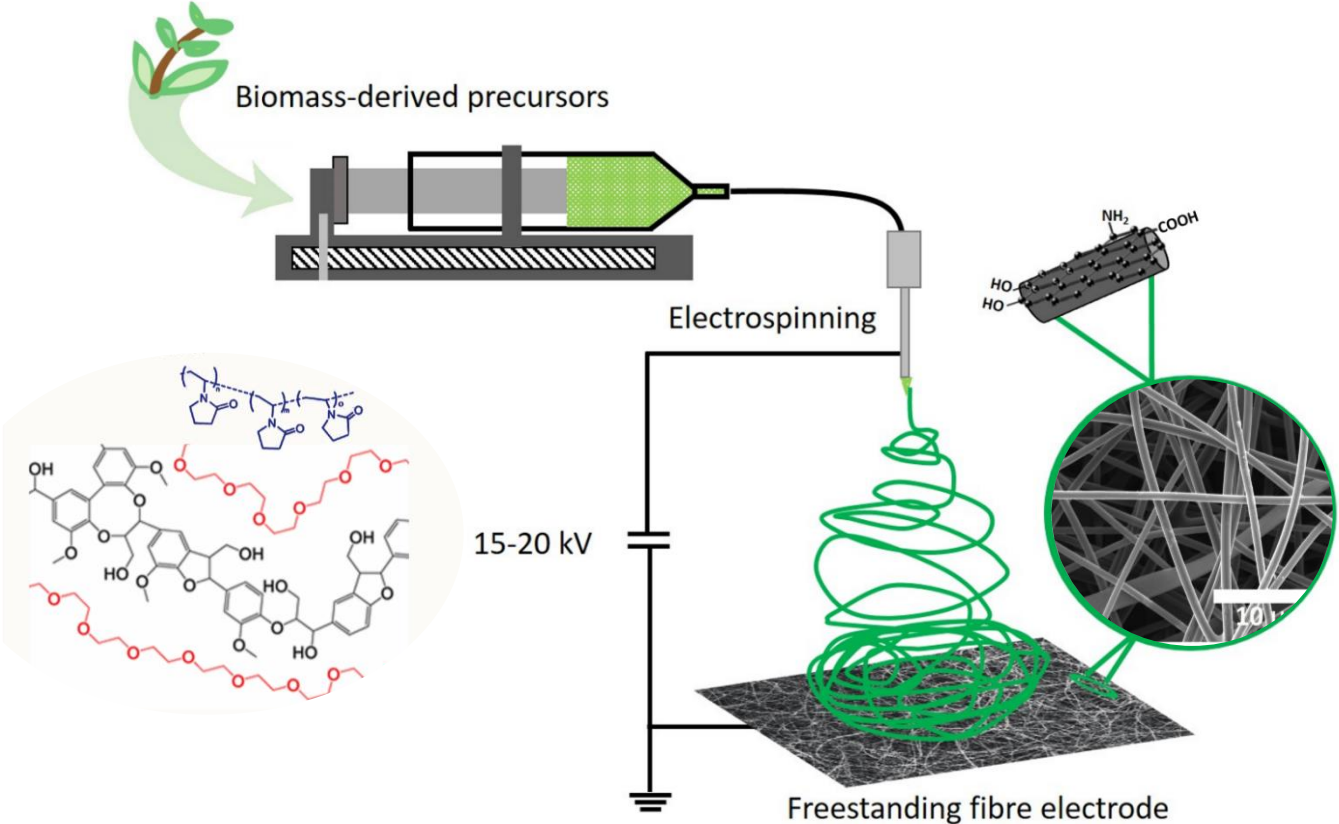
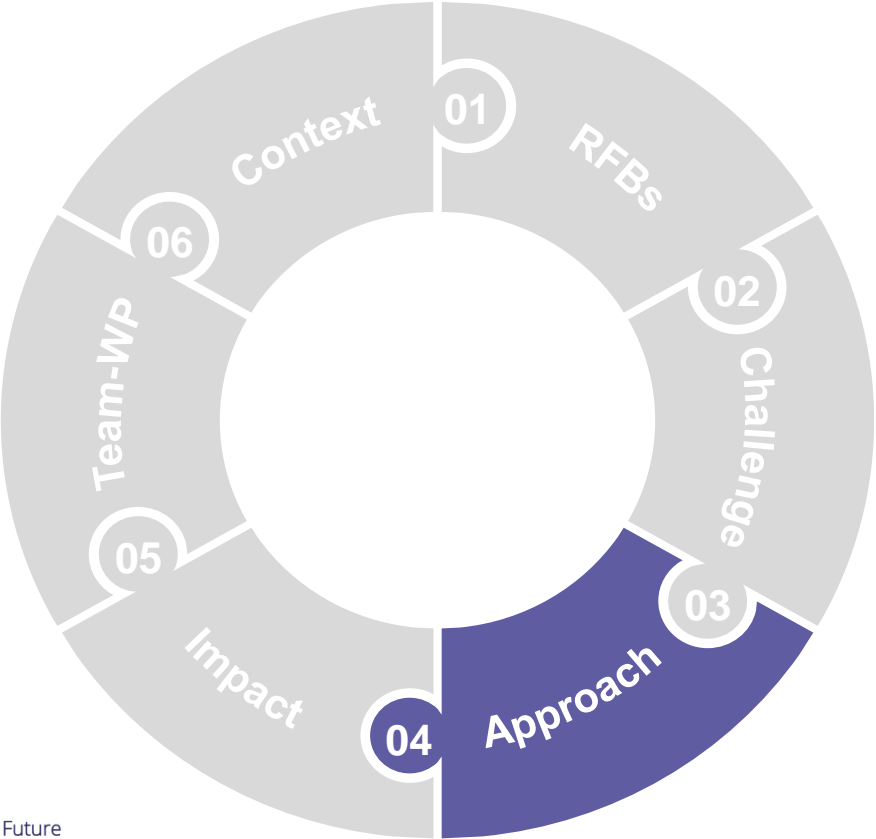
Combined with in situ and operando techniques



Sustainable Electrodes for Advanced Flow Batteries



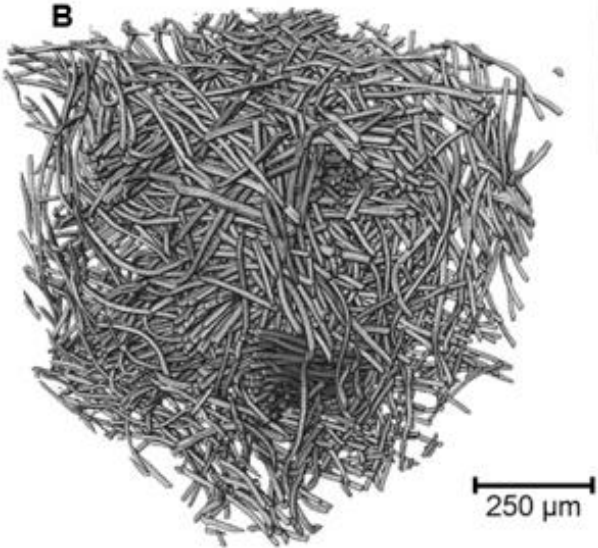
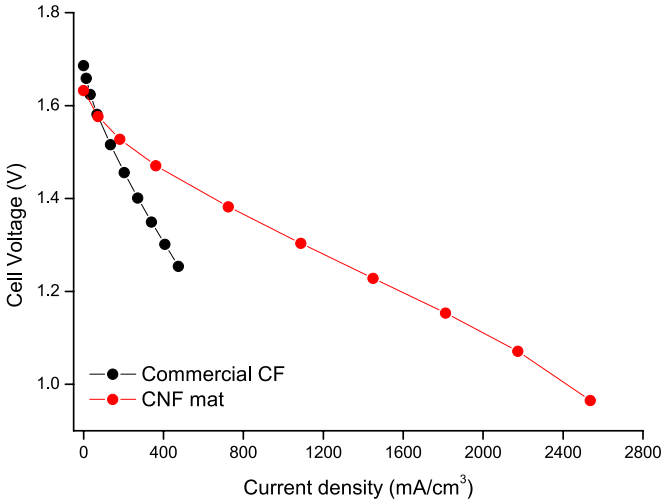
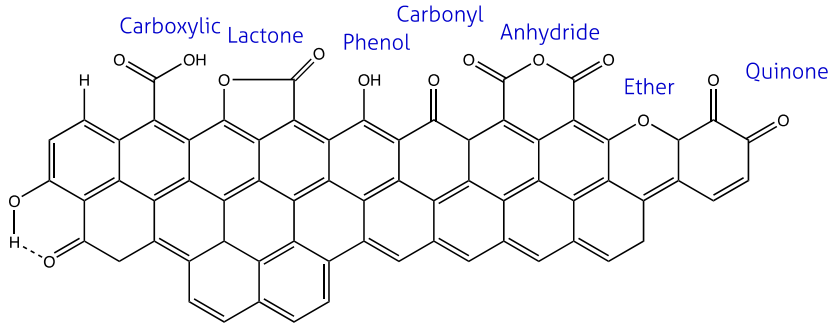
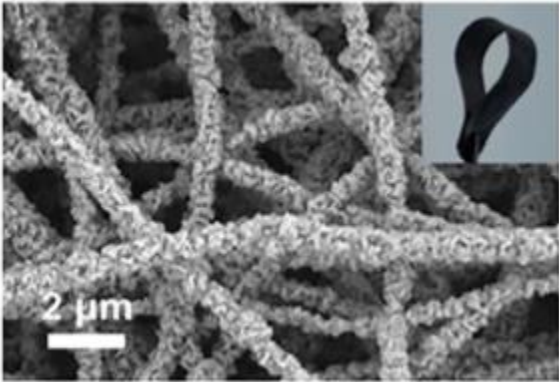
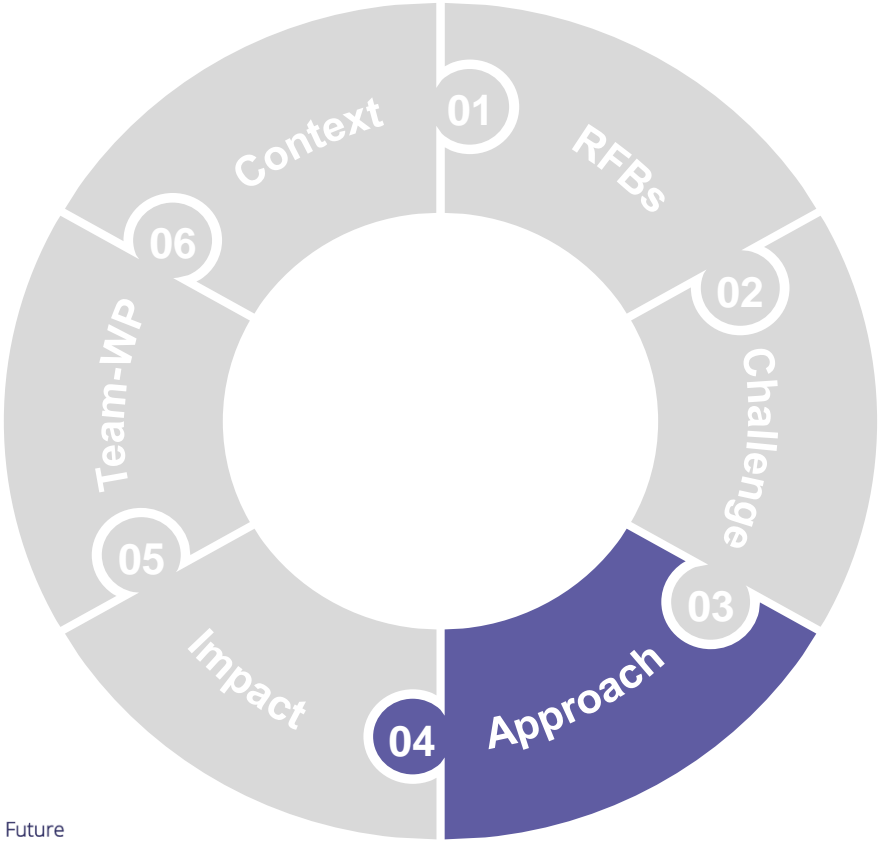
Biomass-derived precursors and Electrospinning



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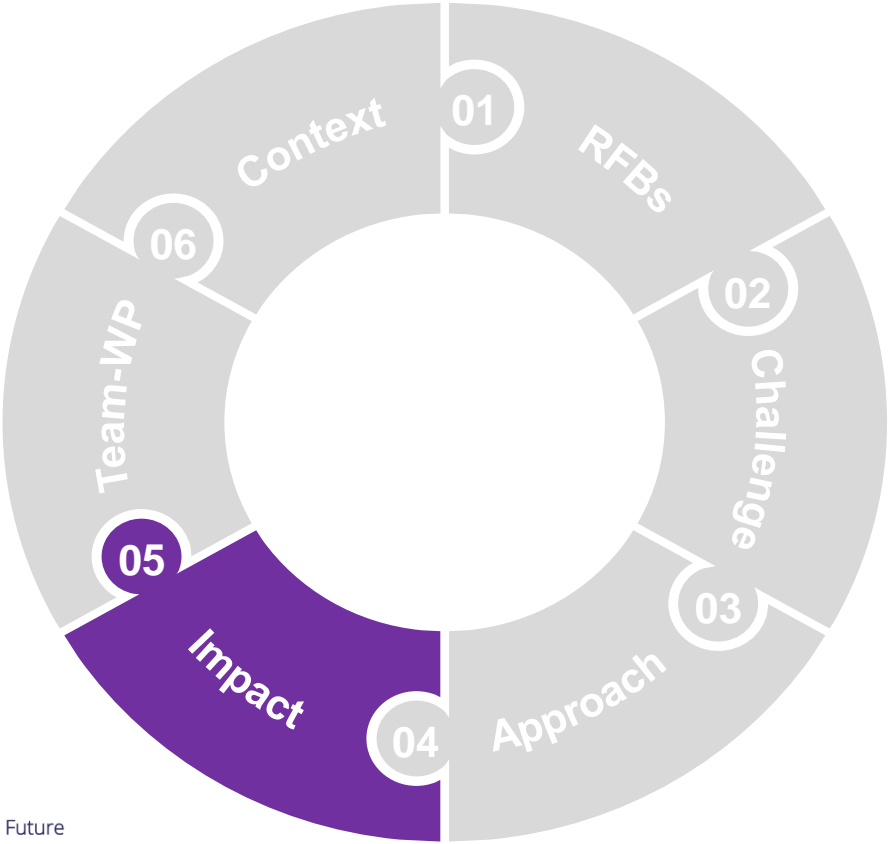
Biomass-derived precursors and Electrospinning



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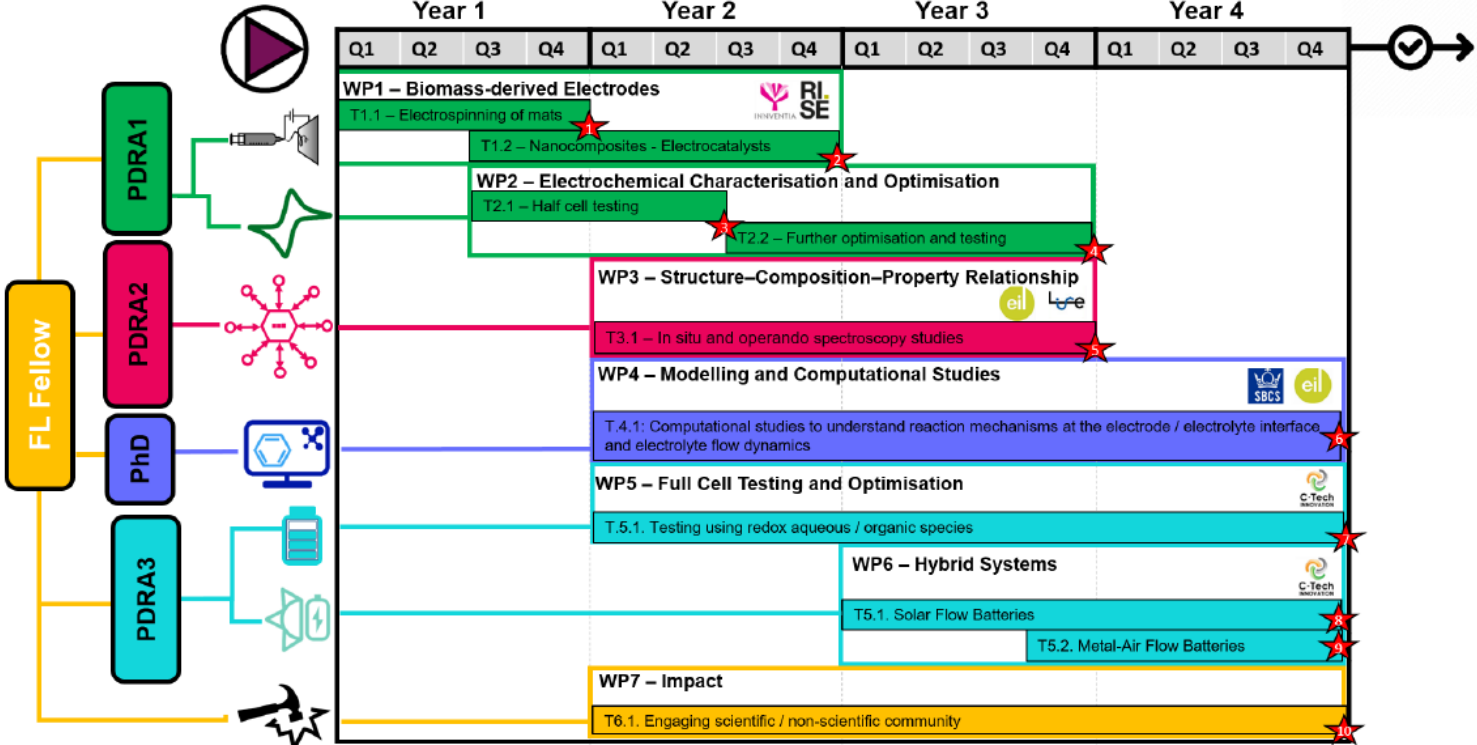
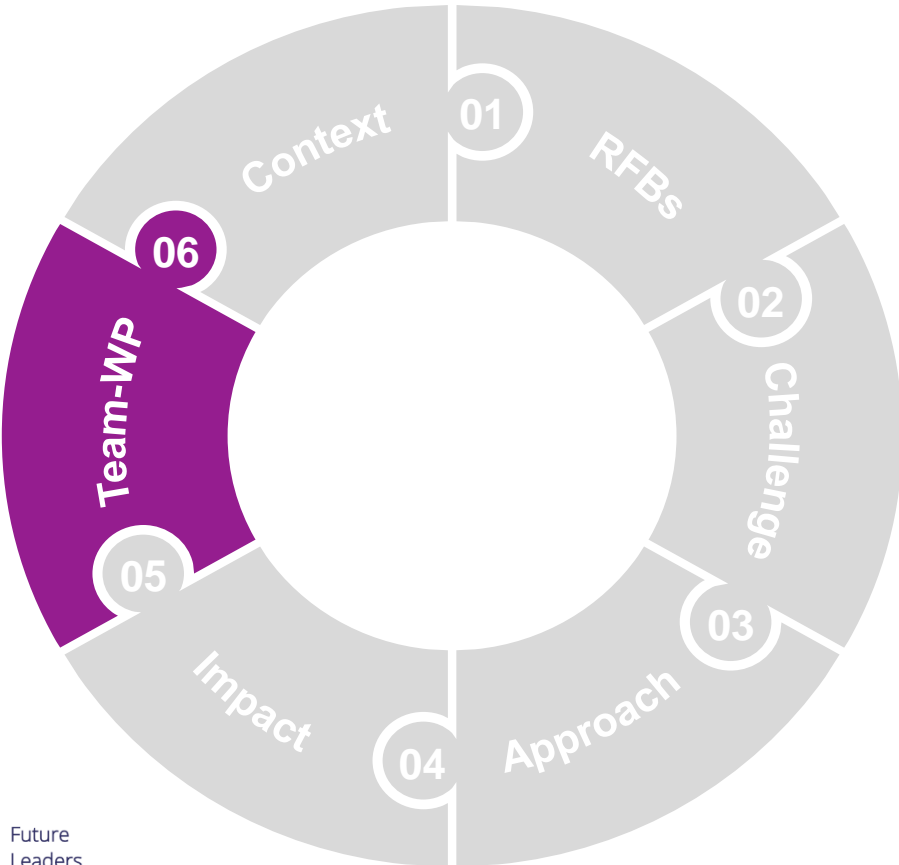
Shaping the next generation of materials for grid-scale energy storage



	Redox Flow Battery	Li-ion battery
Power/Energy	Independent Power-Energy Capacity	Energy and power Related
Electrolyte	<ul style="list-style-type: none"> • Non-toxic, non-flammable • Completely recycle • Expensive 	<ul style="list-style-type: none"> • Flammable • Non-recyclable • Low-cost
Life Cycle	10,000 – 25,000	10,000
Round-trip efficiency	60-80%	> 99%
Initial Capital Cost	1000 - 500 \$/kWh *	400 \$/kWh
LCOS	LOW	HIGH

- Key timing for innovation in grid-scale energy storage technologies
- Flow batteries *versus* Li-ion batteries
- Materials with targeted properties for flow batteries

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Thanks!
Any questions?

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