Cymru Manufacturing Solutions Wales

Ideas to build a better future for Our company, Wales, Britain and the World.

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Battery Recycling & Repurposing

As everyone is aware, the UK has enshrined within law its intention to reduce Carbon emissions.

In an announcement before COP26 in 2021 which the UK hosted; the Government stated the intention to reduce Carbon Emission levels by 78% in comparison to 1990 levels by the year 2035.

A large part of this commitment is the banning of the new sales of petrol and diesel vehicle from 2030 which has been matched by EU proposals. Hybrid sales will be allowed until 2035, when only the new sales of purely electric vehicles will be allowed.
The United States has also stated its intention to only allow eV sales from this date.
We are proposing that we look into the potential recycling and repurposing of all types of rechargeable “spent” batteries.

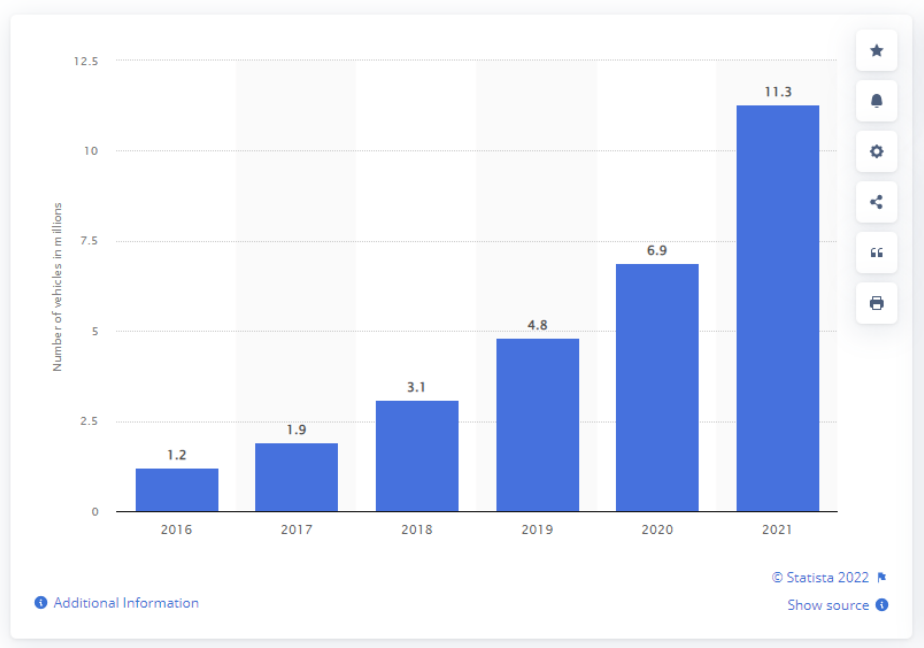
EV / Scooter Batteries

Personal Electronics

Professional Equipment

Based on 2021 UK data there are 441,000 electric cars on UK roads.
Electric vehicle registrations will only grow with 64000 EV registration being made in the 1st quarter of 2022.
A 102% rise on the same period in 2021.

(in millions)



On the back of this commitment, the UK government has allocated a £12 billion budget to fund a “Green Industrial Revolution” aimed at encouraging businesses and creating jobs in the UK’s industrial heartlands such as Wales.
We have an opportunity to be a part of this new growing movement.

Currently manufacturers are generally providing an 8-year 100,000 miles warranty for their EVs with their indication being that the batteries may outlast the vehicle.
However, what happens when these vehicles do reach the end of their useful life or the batteries need replacing?

"*The active battery recycling market is in its infancy, as car batteries are so reliable and long-lived. But we can expect to see huge growth in recycling technologies. It makes neither economic nor environmental sense for EV batteries to be dumped in landfill – it just won't happen*." (National grid Head of Future Markets, Graeme Cooper)The economics of such recycling would reduce the reliance on the mining of these minerals. Typically, the mines for these minerals are located in Russia, Africa, Asia, Australia and South America.

With the invasion of Ukraine, Russia, Europe's nearest source of many of these minerals has been lost through government sanctions.

There are also social concerns over illegal mining in countries such as Democratic Republic of Congo and the use of child labour.

Some manufacturers such as Volvo have introduced block chain technology to track the provenance of the battery materials.

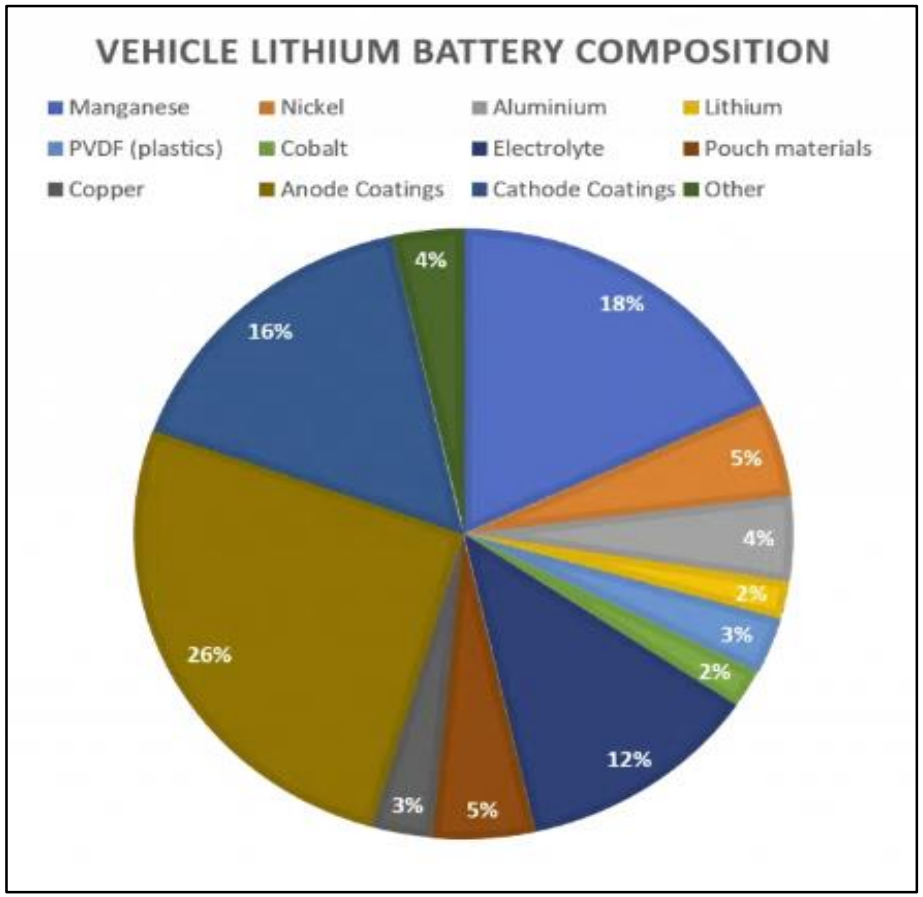
If we can resource or repurpose these batteries (and others such as cell phone batteries) we could see a revenue source for many years to come.

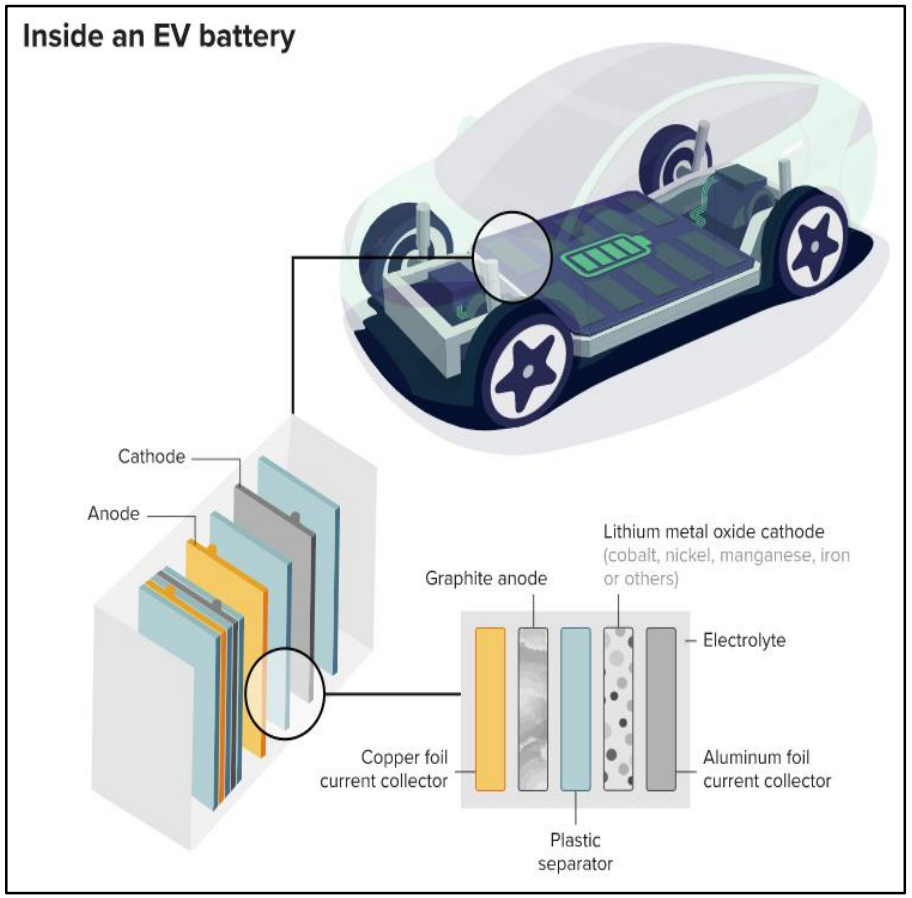
ELECTRIC CAR BATTERY RECYCLING

At the end of a battery's life, up to 95% of the elements used in manufacture can be recycled and used to make new EV batteries.

Demand for the constituent materials will only grow as prices drop so mining and transporting these materials over thousands of miles will become less desirable.

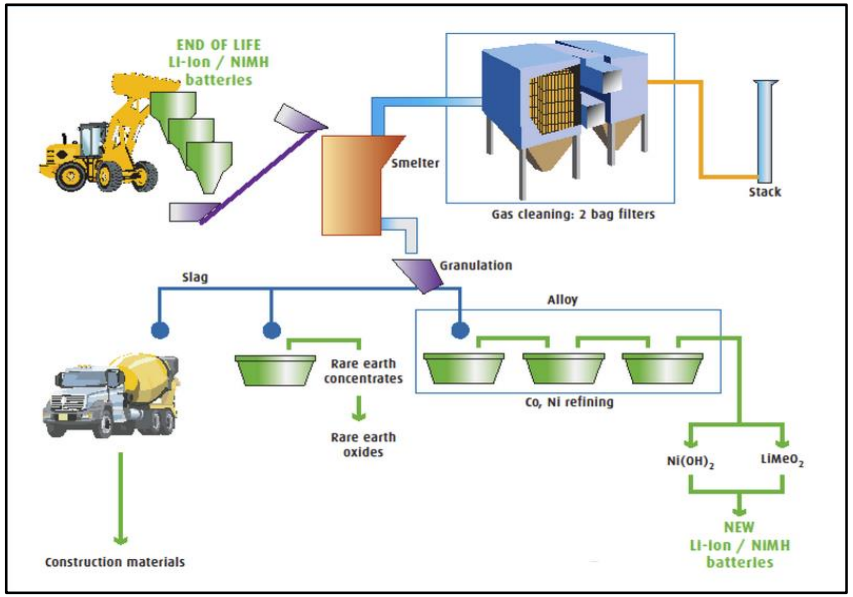
The key minerals constituting a battery are Lithium, Aluminium, Cobalt, Nickel and Copper. Lithium and Aluminium which are mainly lost in ‘slag’ waste whereas Cobalt, Nickel and Copper can be recovered.



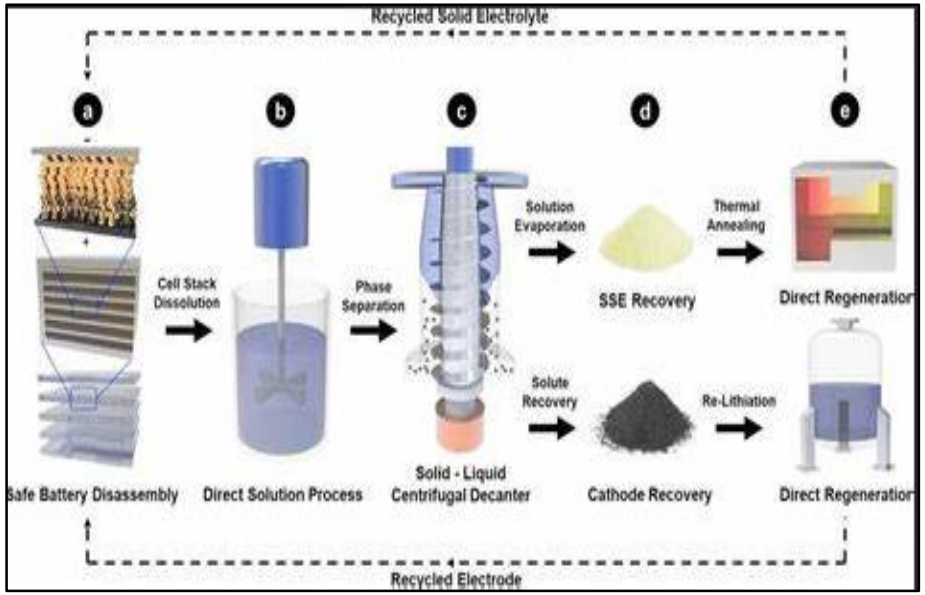


The current methods of extracting the minerals from spent batteries are Pyrometallurgy and Hydrometallurgy.

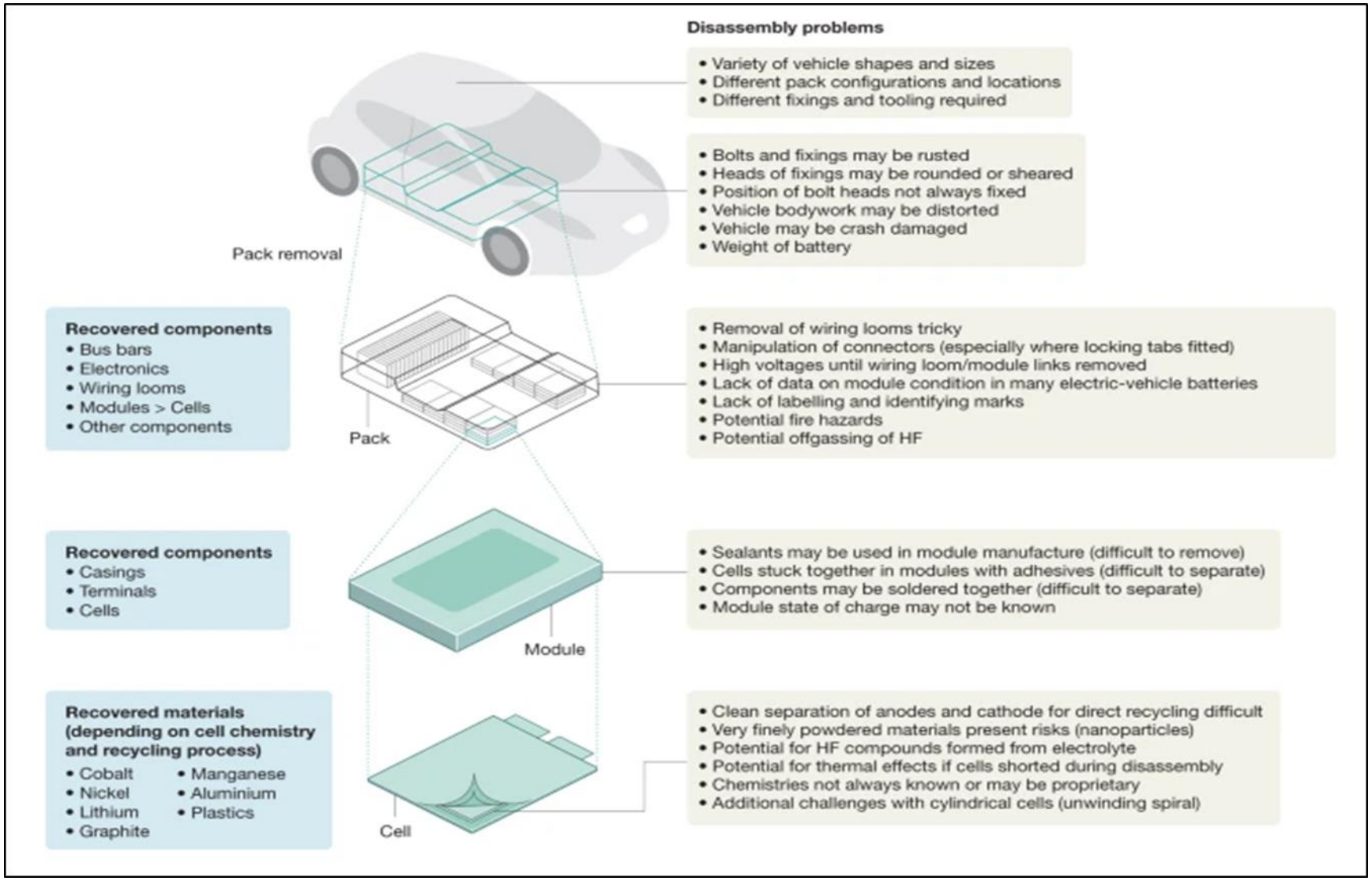
Pyrometallurgy



Hydrometallurgy



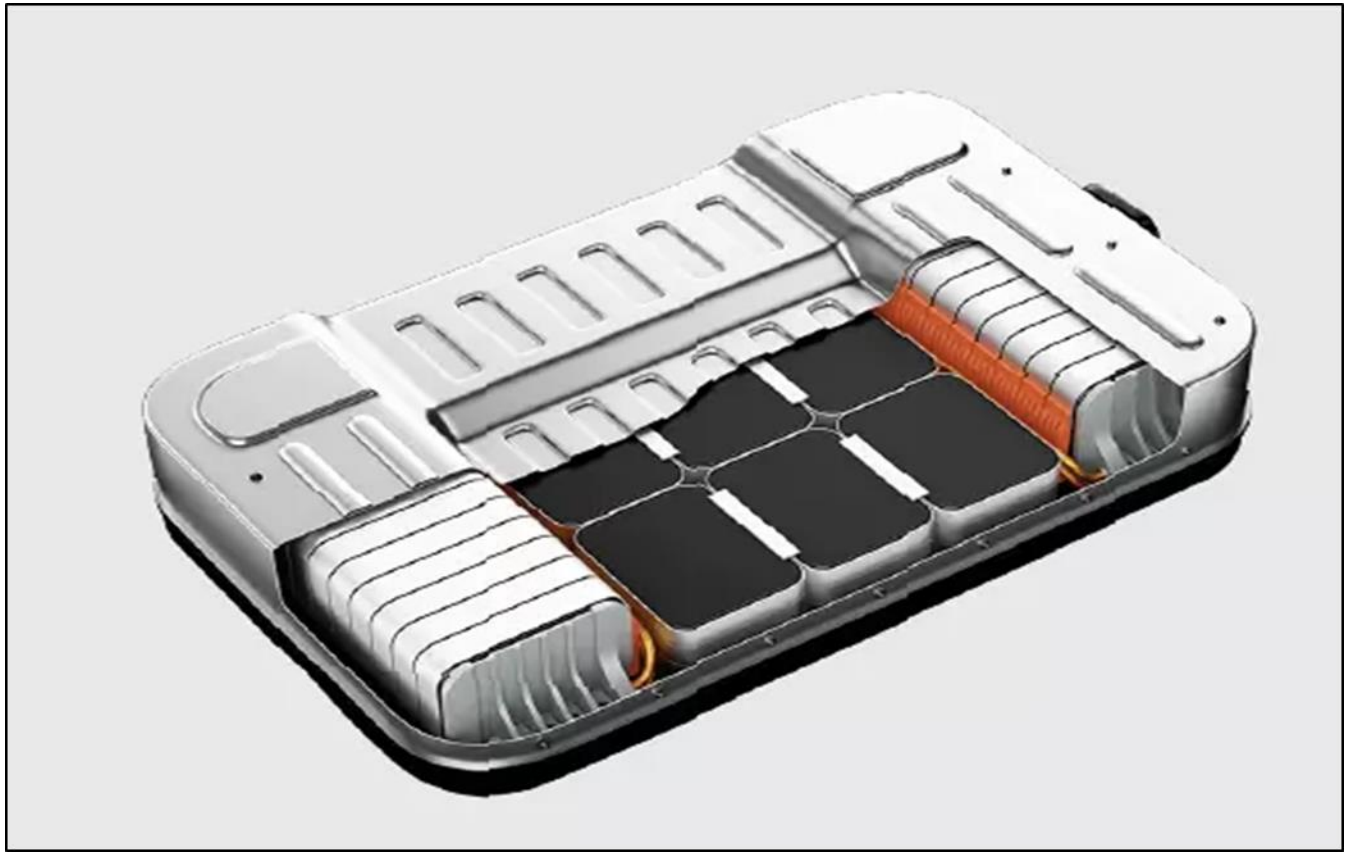
The current methods of Pyrometallurgy and Hydrometallurgy recycling will be finessed in coming years, as well the battery designs to optimise the separation and recycling process of end-of-life batteries.


Disassembly problems
• Variety of vehicle shapes and sizes
• Different pack configurations and locations
• Different fixings and tooling required
• Bolts and fixings may be rusted
• Heads of fixings may be rounded or sheared
• Position of bolt heads not always fixed
• Vehicle bodywork may be distorted
• Vehicle may be crash damaged
• Weight of battery
Pack removal
Recovered components
• Bus bars
• Electronics
• Wiring looms
• Modules > Cells
• Other components
Pack
• Removal of wiring looms tricky
• Manipulation of connectors (especially where locking tabs fitted)
• High voltages until wiring loom/module links removed
• Lack of data on module condition in many electric-vehicle batteries
• Lack of labelling and identifying marks
• Potential fire hazards
• Potential offgassing of HF
Recovered components
• Casings
• Terminals
• Cells
Module
• Sealants may be used in module manufacture (difficult to remove)
• Cells stuck together in modules with adhesives (difficult to separate)
• Components may be soldered together (difficult to separate)
• Module state of charge may not be known
Recovered materials (depending on cell chemistry and recycling process)
• Cobalt
• Nickel
• Lithium
• Graphite
• Manganese
• Aluminium
• Plastics
Cell
• Clean separation of anodes and cathode for direct recycling difficult
• Very finely powdered materials present risks (nanoparticles)
• Potential for HF compounds formed from electrolyte
• Potential for thermal effects if cells shorted during disassembly
• Chemistries not always known or may be proprietary
• Additional challenges with cylindrical cells (unwinding spiral)

Britain lags behind much of the developed world in the capacity for performing such processes.

The UK Office for Zero Emission Vehicles (OZEV) has launched a £7million competition for on-vehicle solutions that address challenges associated with the transition to zero emission vehicles, including the improvement of sustainability.

Maybe this is a problem that does not fully exist as yet, but eventually it will be an issue of what to do with these batteries as time goes on.



The repurposing of such batteries sees them primarily used as storage units for renewable energy sources such as solar panels or wind generators.

Some Vehicle OEMs have begun applying these:

- Nissan uses retired EV cells as a back up power source for the Amsterdam Arena, entertainment venue and home ground of Ajax.
- Toyota will install cells outside convenience store in Japan to transfer the energy generated from solar cells to power the equipment such as fridges and lights inside.
- Renault are developing Powervault, a home energy storage system with sister company Nissan developing Xstorage.

AUTOMOTIVE

AEROSPACE

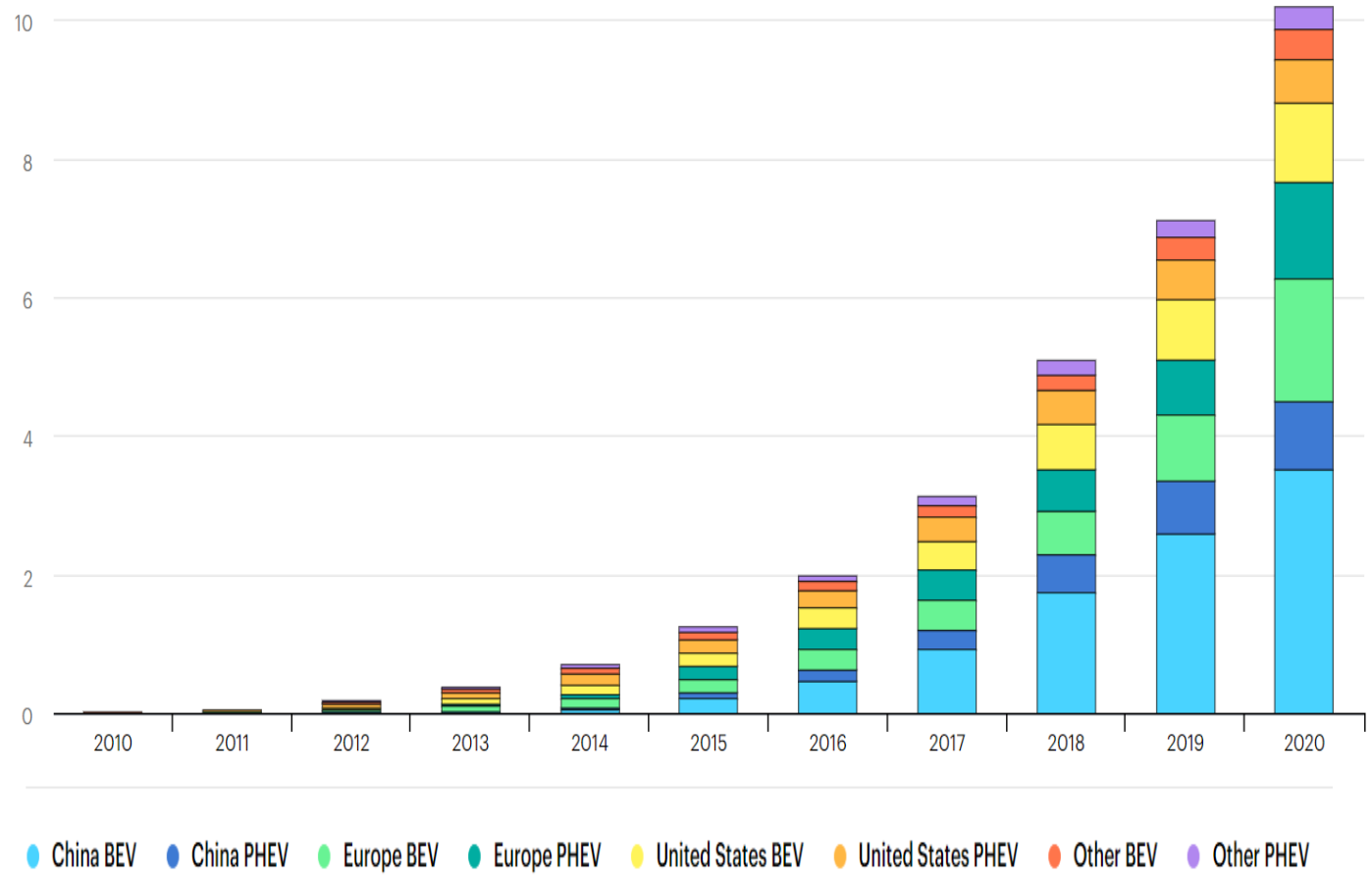
MEDICAL DEVICES

CMSW

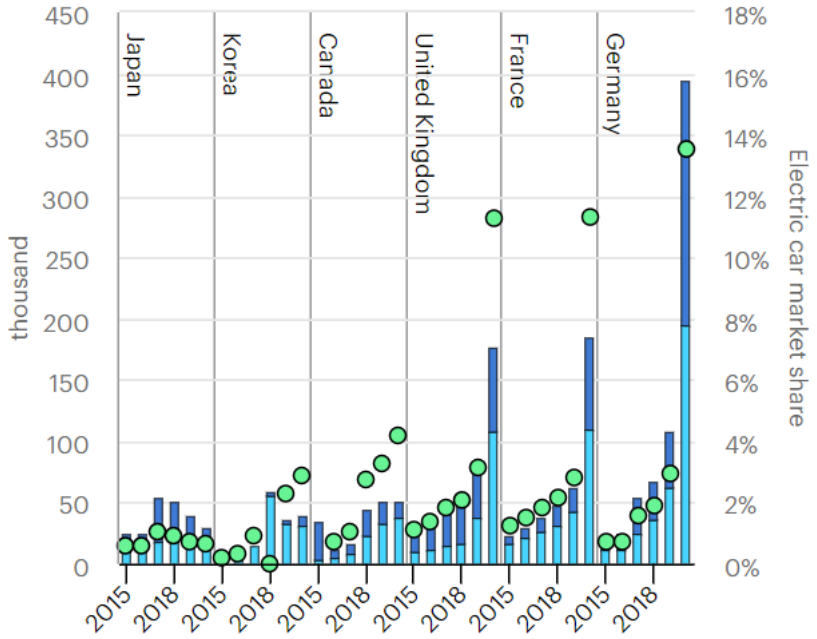
CYMRU MANUFACTURING SOLUTIONS WALES

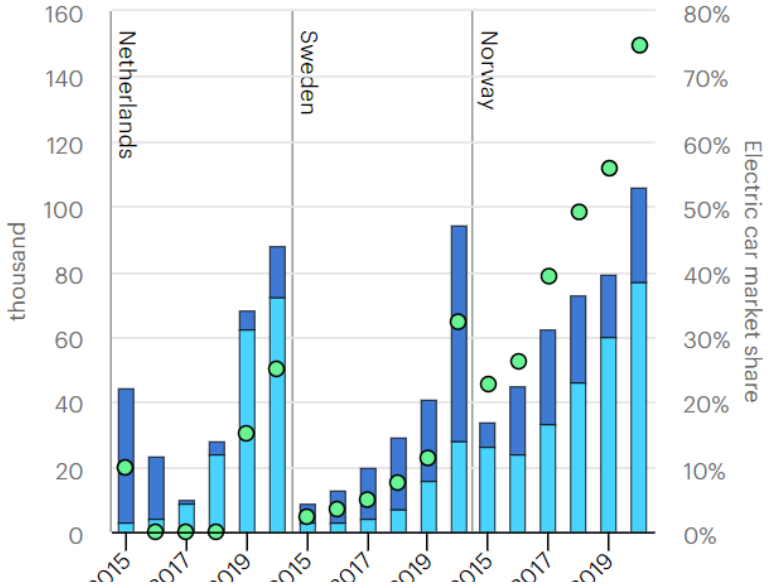
Ensure and secure the company’s future - Maintain our commitment with the environment - Implement circular economy

Electric cars on the road (global)



Market share





IEA, 2021

Veolia in the UK

Press Releases / Veolia announces its first electric vehicl...

Press releases listing 10 JAN

Urban mining will unlock UK's lithium-ion battery reserves

Hydrovolt (Hydro + Northvolt JV, Norway – Sweeden)

Revolt

Europe's largest electric vehicle battery recycling plant begins operations

15 May, 2022

As commercial recycling operations start at Hydrovolt in Norway, joint venture partners look towards European expansion.

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Media > Johnson Matthey signs its first fuel cell recycling contract in China

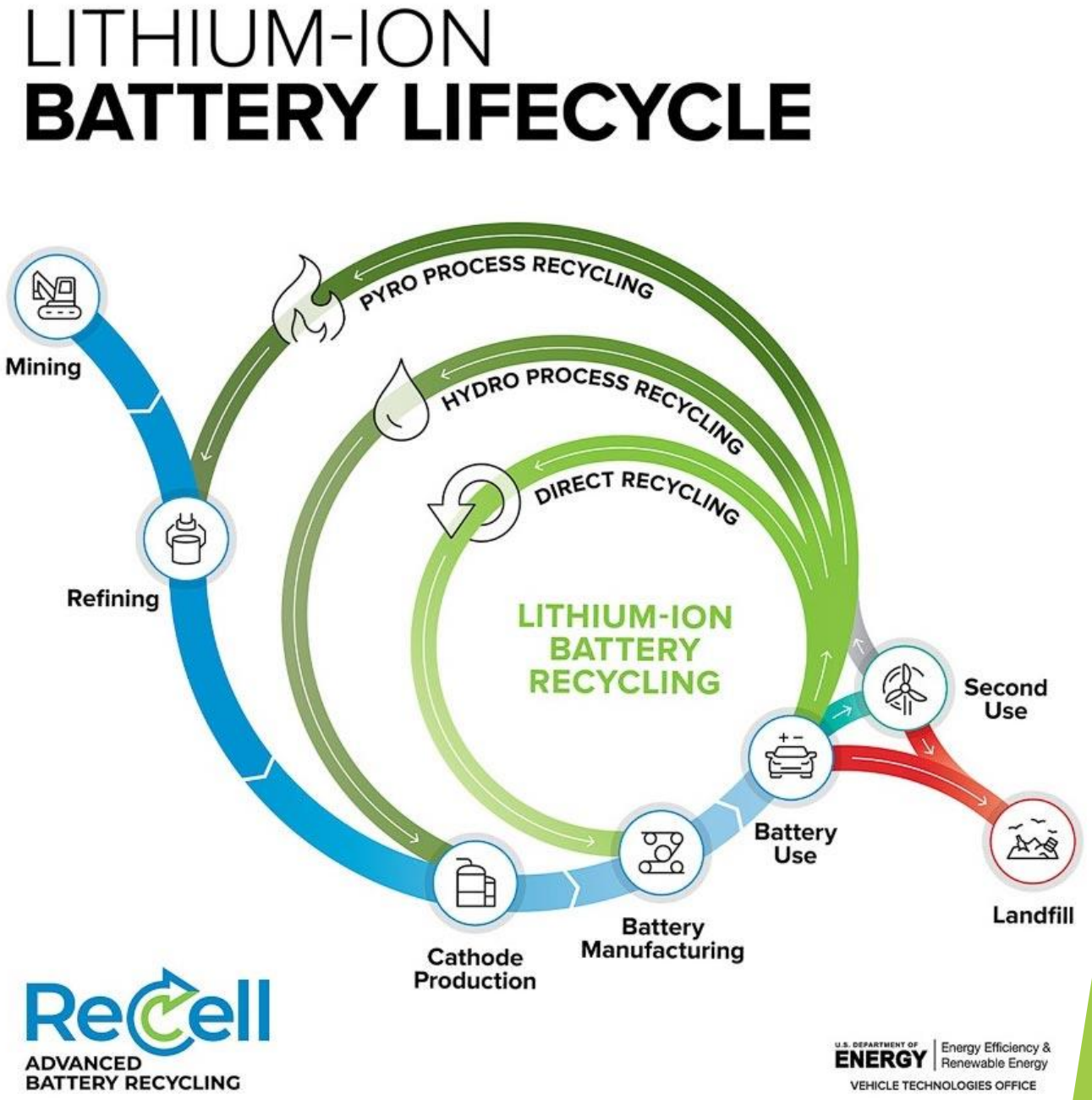
Johnson Matthey signs its first fuel cell recycling contract in China

06 October 2022

UK – China collaboration

Circular economy

- Security of supply of these scarce elements
- Key role in transition to renewables
- If recycled batteries from electric vehicles no longer usable for cars -> second use (i.e. electronic components)



Recell, 2022

As explained in introduction, from 2035, as per the schedule proposed by the UK government, it is expected to have all new passenger vehicles to be free from Carbon emissions.
If Electric batteries were to be implemented on the new cars from 2035, there will be a soaring demand for the battery materials.

When these batteries reach end of life, then they need to be recycled and re-used to achieve the best out of them. Typical battery life of an electric car is 10 years or 10,000 miles (Reference: How long do electric car batteries last? | RAC Drive).

The current situation with the end of life batteries is customers selling back their cars to the dealers or the manufacturer itself. The manufacturer will then send it to the recycling centres in mainland Europe, china etc.
The biggest expenditure is with the transportation of the end of life batteries. If we can tap it in a way to avoid transportation by recycling the batteries, it would be a great economic benefit to the company and boost the cash flow within the company.

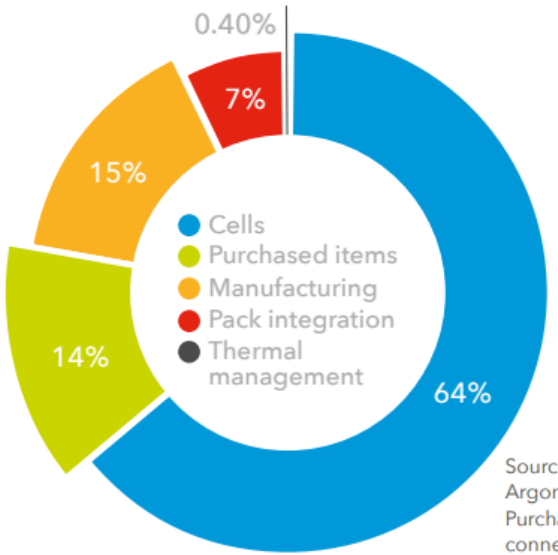
These end of life batteries can be processed / disassembled to extract the valuable materials from them. They are then, either re-used/re-cycled to put it back into the battery system or into another form like renewable energy, manufacturing of different items etc. Further explanation is in the next slides.

This is a great opportunity for our Organisation to invest in re-cycling/re-using of the batteries.

In 2018, the average values for end of life battery packs were around £1200 for BEV packs and £260 for PHEV packs. In BEVs the average value per pack for non-cell components was estimated at an average of £128 (source: WMG; International Dismantlers Information System (IDIS), vehicle manufacturer's websites).

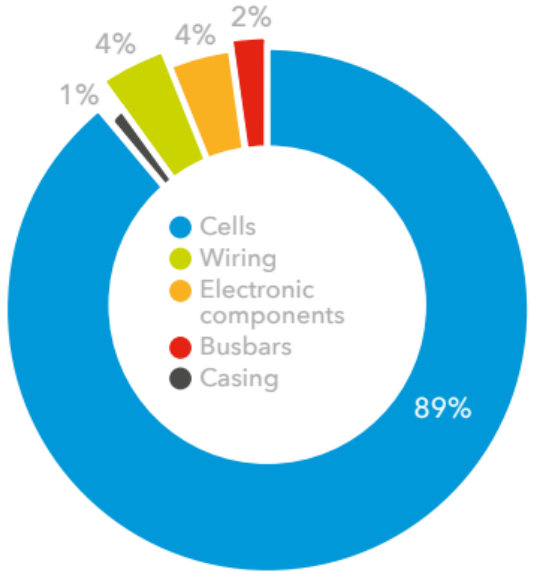
The value content in an end of life battery differs significantly from the cost breakdown for a new battery. The cost of cells in a new battery represents around 64% of the total cost whereas in an end of life pack the cells account for almost 90% of the value in the pack.

FIG 2 Cost of New Pack



Source: BatPaC Model Software, Argonne National Laboratory[1]. Purchased items refers to connectors, busars, etc.

Value in EoL Packs

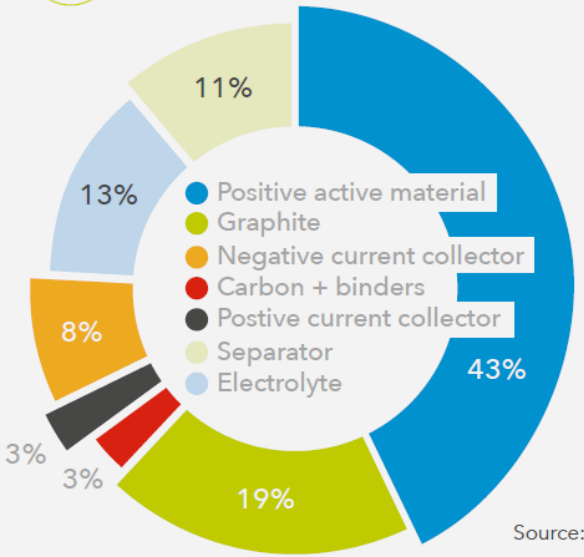


▶**Lithium Ion Electric Vehicle Batteries**: The study demonstrates a promising & appreciable return on investment with a perfect road map to the circular economy. The battery components or the batteries themselves can be re-used for other applications like manufacturing other components by melting, in renewable energy facilities etc according to the latest research. It's time to get serious about recycling lithium-ion batteries (acs.org)

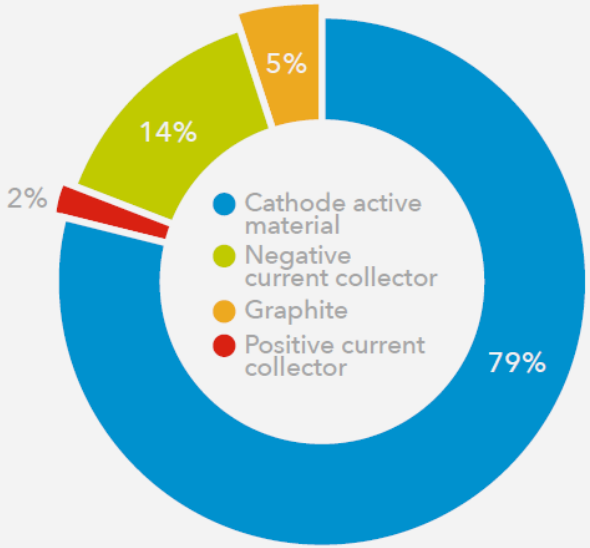
▶This is an extract of an article showing about how much value the cells of a battery cost (Source: 22350m_wmg_battery_recycling_report_v7.pdf (warwick.ac.uk)

There is also a difference in the values between new cells and end of life cells. In new cells, the cathode material and the anode current collector make up 51% of the costs, but comprise 93% of the value in end of life cells. It must be noted that not every recycler will be able to realise the total value in the cells as only dedicated hydromatellurgical recovery processes are able to recover metals such as lithium and manganese. Recyclers which only recover the black mass and sell it onto a metal refiner will claim a much lower value.

FIG 3 Cost of New Cells



Value in End of Life Cells



Source: BatPaC Model Software

If we are able to recover the cells and recycle them to re-use or refurbish, it brings an unbelievable return on investment. The materials used in the batteries are currently mined and extracted through processing. The demand for the battery is going to be sky rocketing by 2040 and the natural resources may even become extinct in the next 100 years. The cost of the batteries will increase year by year. This is not a good situation for any country or the companies.

Different investment methods are discussed in following sections.

E.g. Britishvolt.

These are very well placed to take up these initiatives with the budget they can allocate every year.
The internal Research and Development departments of the companies can significantly contribute towards conceptualising, prototyping and testing.
Glencore and Britishvolt to build 'battery recycling ecosystem' in the UK (circularonline.co.uk)

Private company Investments

Research Institutions

EV Battery Recycling: Source of Finance?

Government Grants

Why Invest? What investors look for?

Partnerships & Collaboration

E.g. Universities and private organisations.

Collaboration with private companies and universities

E.g. UK Govt.

The UK Govt, as a part of Green Revolution, has allocated a budget of £12 billion.
The Ten Point Plan for a Green Industrial Revolution (HTML version) - GOV.UK (www.gov.uk)

Lithium-Ion Batteries Work Earns Nobel Prize in Chemistry for 3 Scientists – 2019.

John B. Goodenough, M. Stanley Whittingham and Akira Yoshino were recognized for research that has “laid the foundation of a wireless, fossil fuel-free society.”

The New York Times

Recycling Li-Ion Batteries

Should we do it?

Can we do it?

Where do we go?

What comes next?

Should we do it?

National grid Head of Future Markets, Graeme Cooper:

"…we can expect to see huge growth in recycling technologies. It makes neither economic nor environmental sense for EV batteries to be dumped in landfill…"

Should we do it?

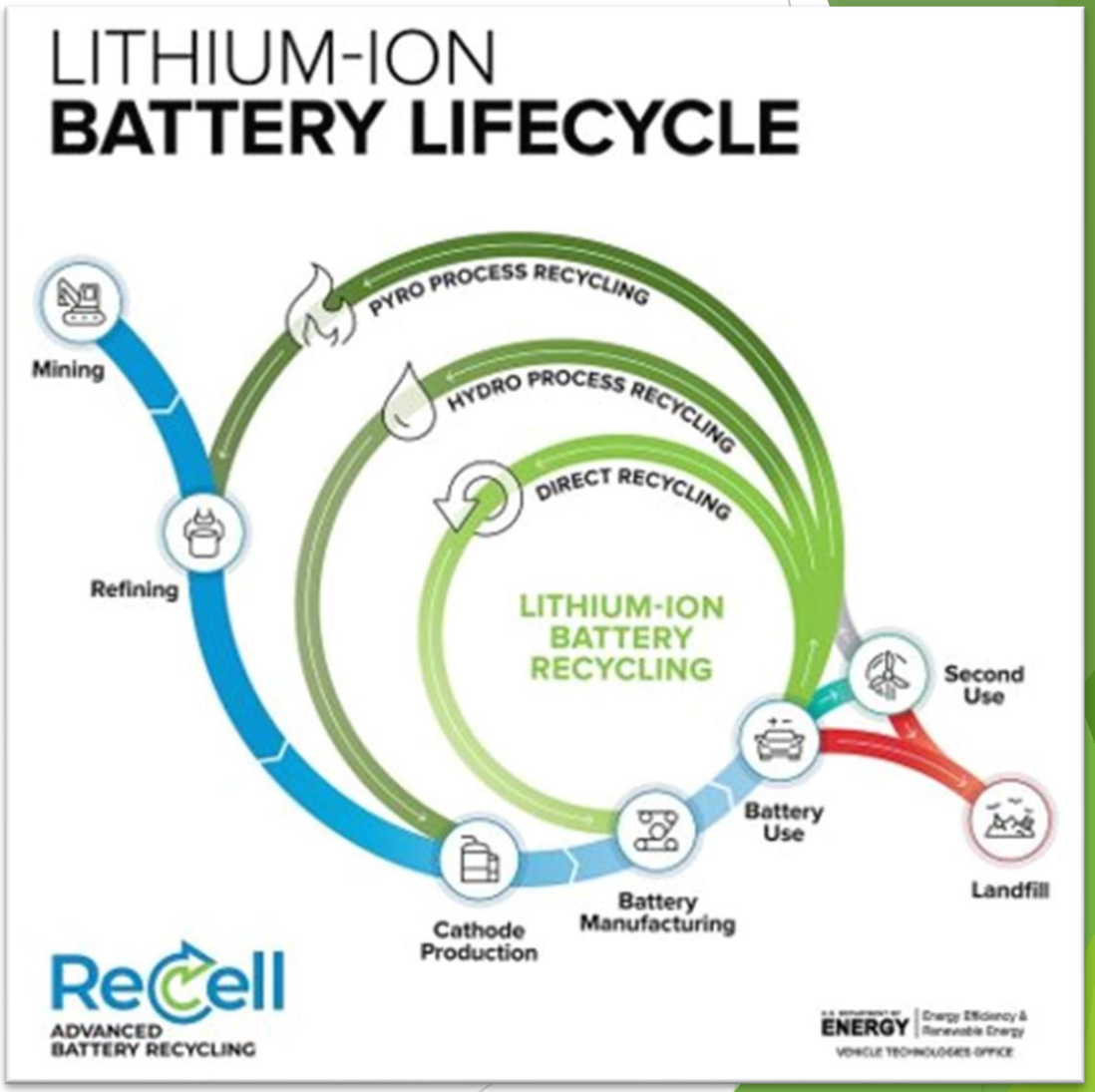
Private company Investments

Research Institutions

EV Battery Recycling: Source of Finance?

Government Grants

Partnerships & Collaboration



Can we do it?

Recycling batteries using physical separation techniques offers a number of important benefits.

- *There is no change in the chemistry or structure of material;*
- *Separation based on different physical properties of the material;*
- *Low energy usage;*
- *Adapting existing and proven technology;*
- *Low operating costs;*
- *Enables the concentration of individual materials for expensive downstream processes, reducing overall processing costs;*

Ferrous and Non-Ferrous Metal Separation

ElectroStatic Separation
for 2mm- particles

Can we do it?

Using the shredding process we would obtain 2 products :

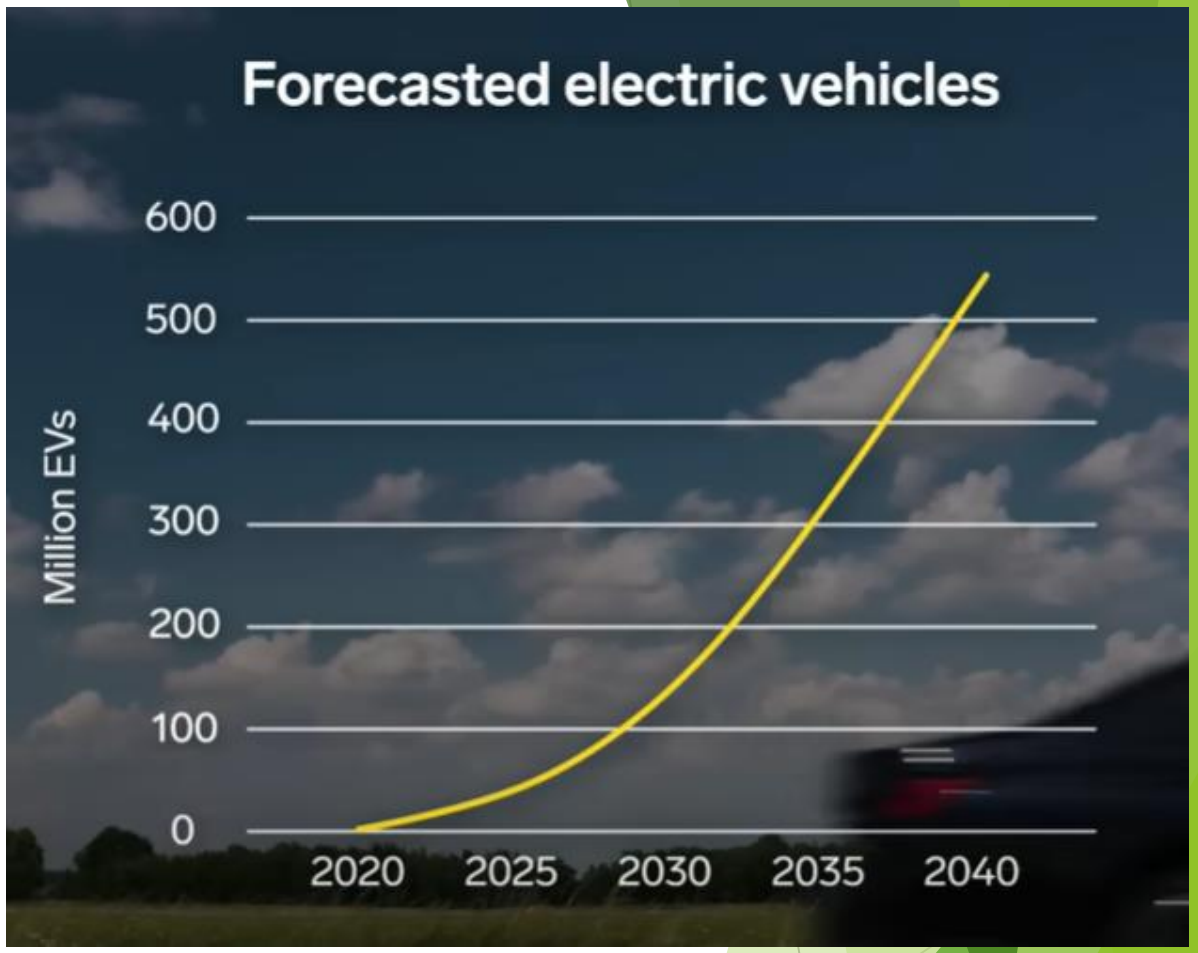
Metallic foil – which can sell for it's copper content

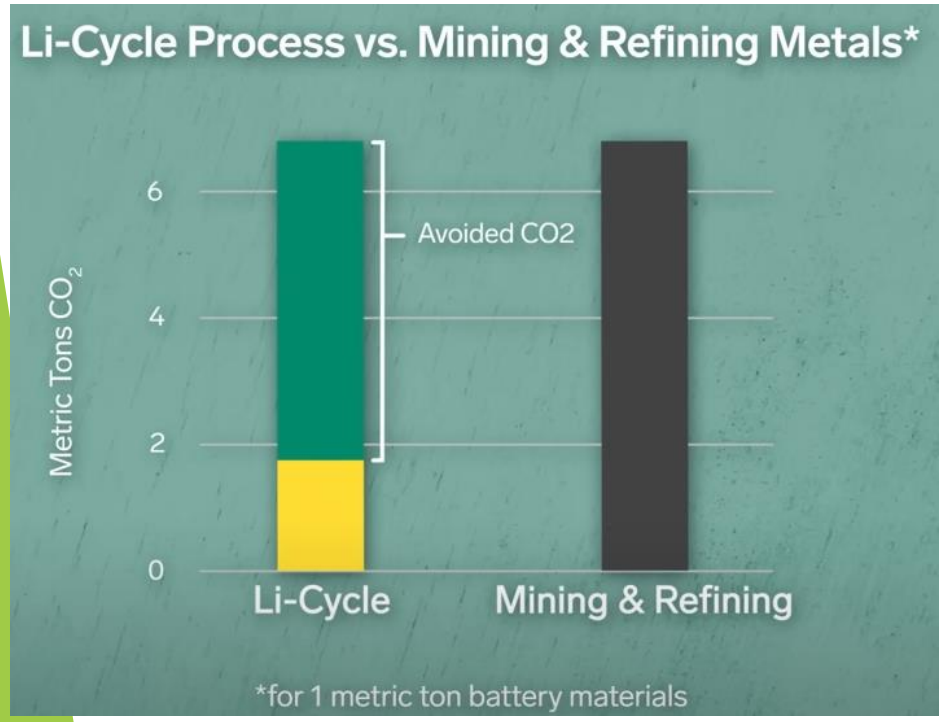
Black mass – containing valuable metals like Nickel and Manganese – in scarce supply on the planet, and predicted to be exhausted within a decade at Current mining scales

At the moment Most Lithium-ion battery recyclers don't recover lithium, so in the future, with developing technology processes, more value can be recycled from the Back Mass.

Can we do it?

Based on comparisons with Li-Cycle in the USA,
CMSW could produce up to 10,000 tonnes of batteries/year
@ £ 3000/t it would mean a turnover of £ 35M/year.





This is the equivalent of 30,000 electric vehicles / year.

Main benefits of recycling:

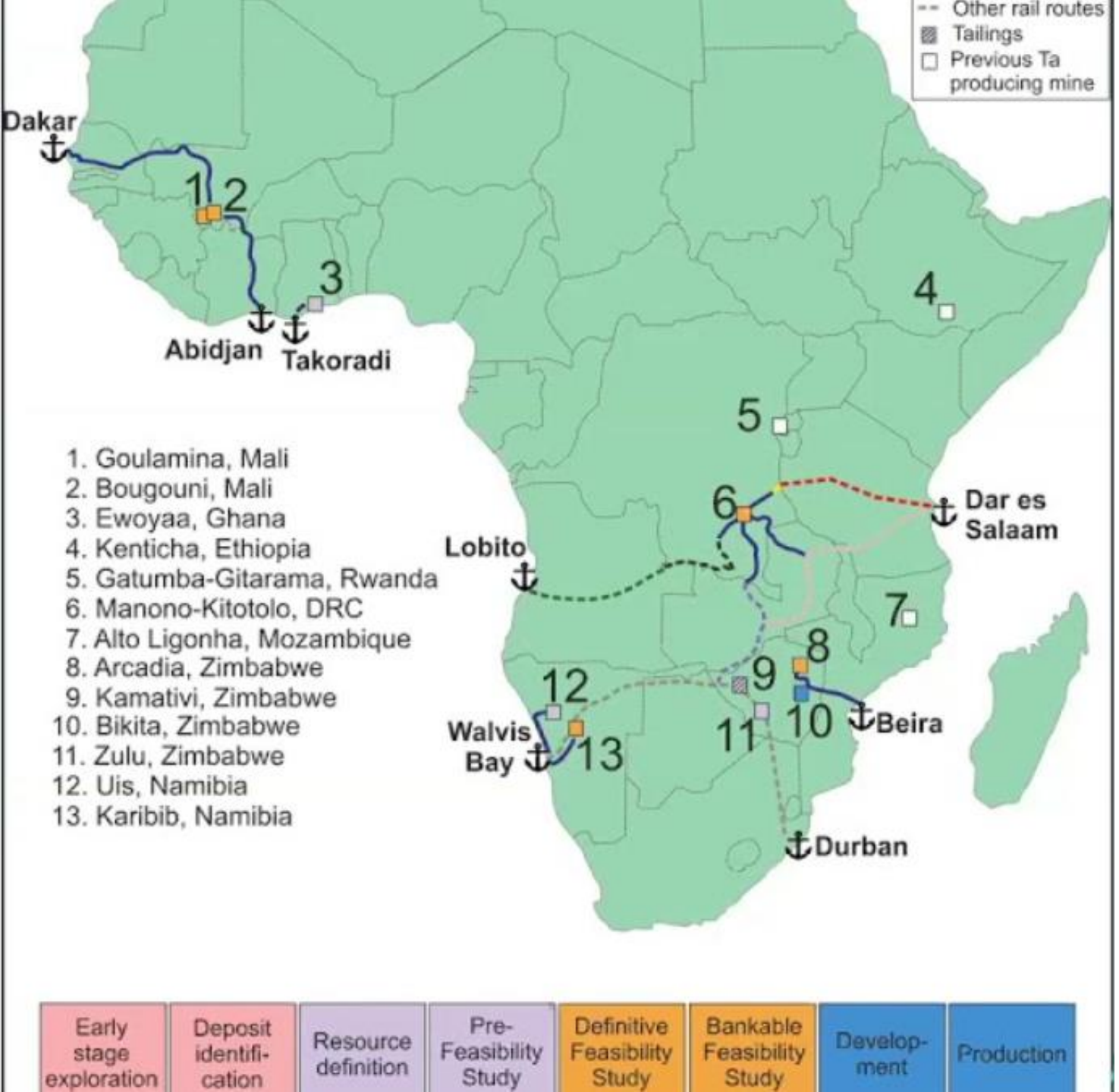
- Reduce CO2 emissions 5 times compared to mining & refining
- Cheaper batteries ➔ Less expensive electric cars

Where do we go?
Wales ➔India

Why India?

- India set to overtake China's population
- India has a very ambitious plan to – go electric by 2038
- The young generation of Indians, specifically young engineers are more attracted towards cars – it is expected to become the world largest EV market.

Where do we go? Wales ➔Africa



Why Africa?

- Earth mining ➔Urban mining

- Give mining communities repurposed batteries for storing energy / solar panels.

- Partner with companies like Mintek in South Africa , early stages, community based initiatives.

What comes next for CMSW?

Bio-renewables

Green and Blue Hydrogen

Should we do it?

YES

Can we do it?

YES

Where do we go?

Wales ➔ Worldwide

What comes next?

Net Zero products

AUTOMOTIVE

AEROSPACE

MEDICAL DEVICES

CMSW

CYMRU MANUFACTURING SOLUTIONS WALES

BATTERY RECYCLING

BIOFUELS
CATALYSTS

HYDROGEN
ZERO EMMISIONS

THANK YOU!

CMSW

CYMRU MANUFACTURING SOLUTIONS WALES

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