NANOMALAYSIA®

KEMENTERIAN SAINS, TEKNOLOGI DAN INOVASI
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

Benefits of EV With Due Consideration To Circularity of End of Life Batteries

Dr. Rezal Khairi Ahmad

26 October 2023

Nurturing technology innovation from the goals and the gaps

NANOMALAYSIA®

Malaysia's lead agency to commercialise nanotechnology

A business entity in the form of a Company Limited by Guarantee ("CLBG") under the Ministry of Science, Technology and Innovation ("MOSTI") entrusted to focus on the commercialisation and development of nanotechnology towards Industrial Revolution & **technology sovereignty**

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MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

The Impending Risk of Climate Change

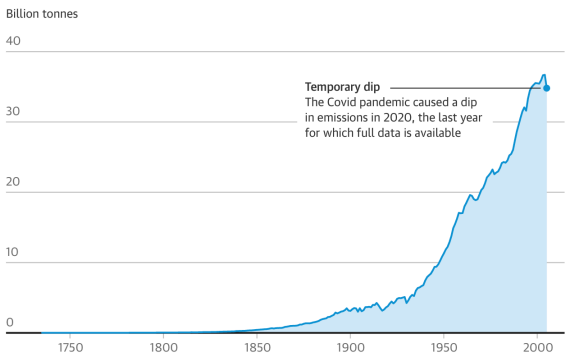
Intense Droughts

Severe Fires

Rising Sea Levels

- Implications of climate change in 2030-2050 if no actions are taken:
  - GHG emissions projected to increase by 50%, primarily due to a 70% growth in energy-related CO2 emissions
  - Atmospheric concentration of GHGs could reach 685 ppm CO2 equivalent by 2050, resulting in global average temperature to rise 3°C to 6°C

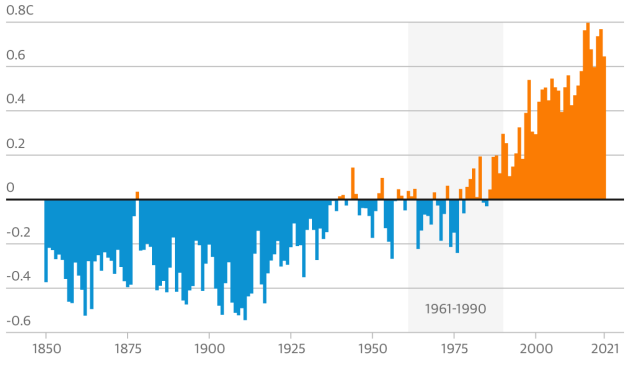
CO2 emissions from fossil fuel burning



Guardian graphic. Source: Our World in Data

Global average temperature change

Relative to the 1961-1990 average

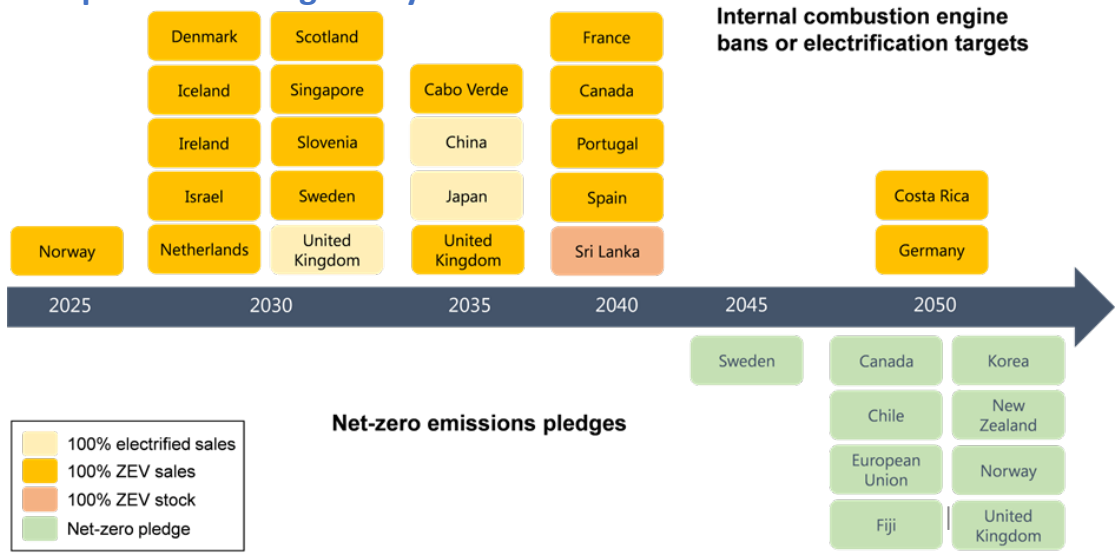


Guardian graphic. Source: Met Office

PARIS AGREEMENT

- Hold the increase in global temperature to well below 2°C and pursue efforts to limit the increase to 1.5°C above pre-industrial levels
- Review countries NDC every 5 years
- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development

- Countries to phase-out their ICEs and pivot towards EVs for decarbonisation efforts, with more than 20 countries announcing their commitment.
- Up to **11.9% reduction in CO_2 emission can be achieved for full EV implementation globally.**



EVs: A Green Solution to Global Warming

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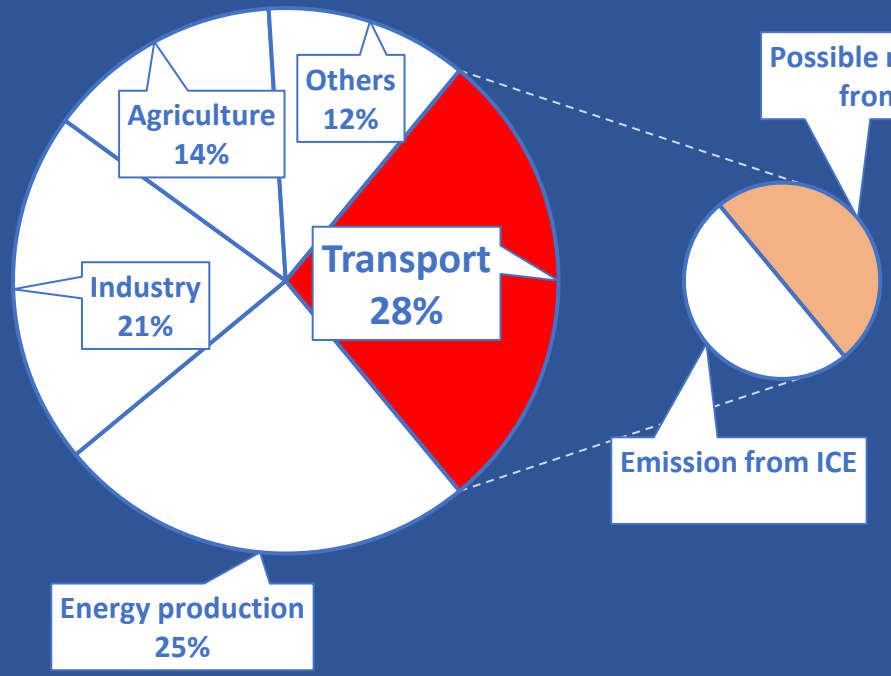
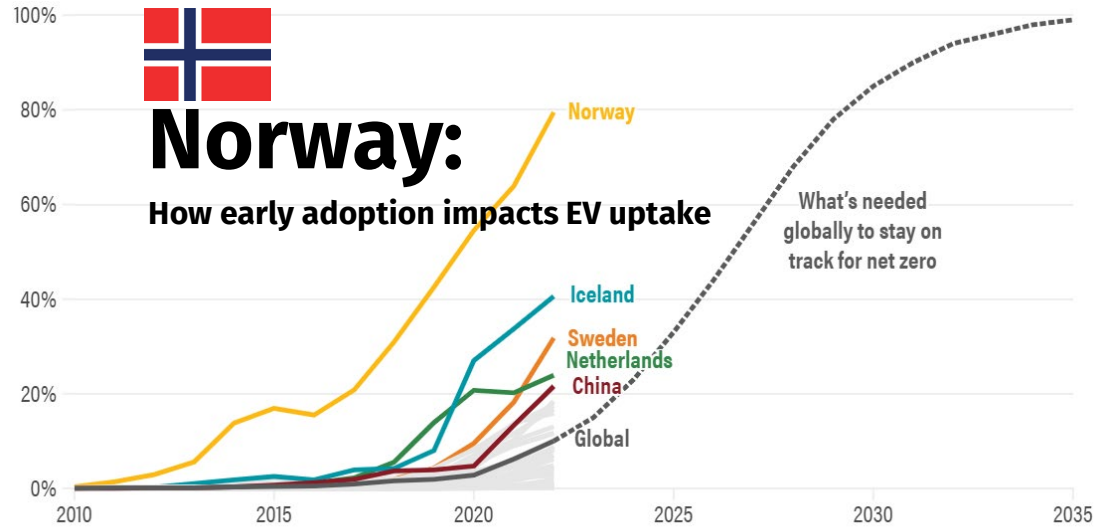
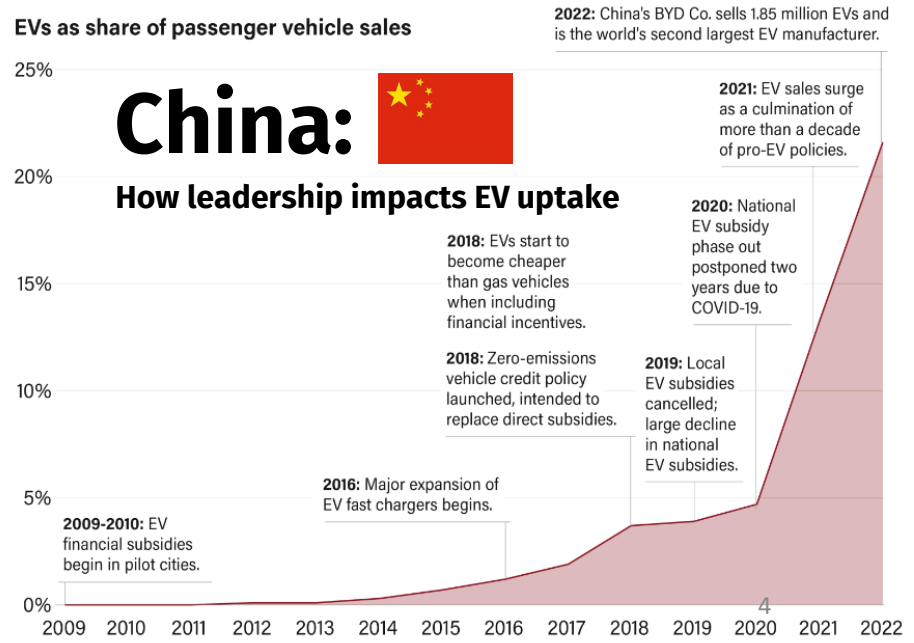
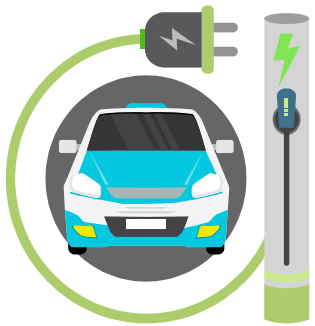
TOTAL GLOBAL GHG EMISSION BY SECTOR:



50%
Reduction of CO2 emission
From the zero tailpipe emission







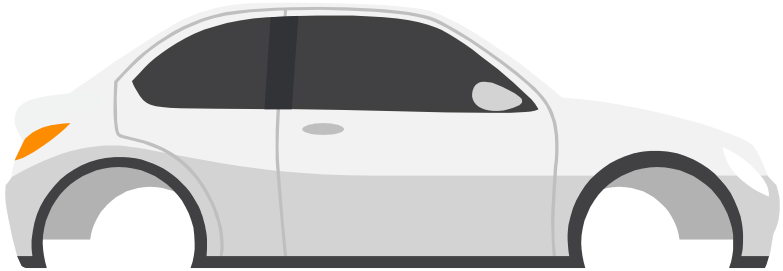
1.5
Gigatonc CO2
Prevented by 2030 from transitioning to EV.

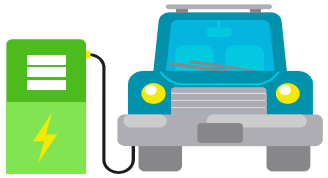
MYR4k
Savings annually
On Fuel Cost (X70 vs BYD Dolphin for 70km/day journey/month)

2.5mil
Oil barrels/day
Reduction from EV usage (IEA estimation)

Source: https://www.wri.org/insights/countries-adopting-electric-vehicles-fastest

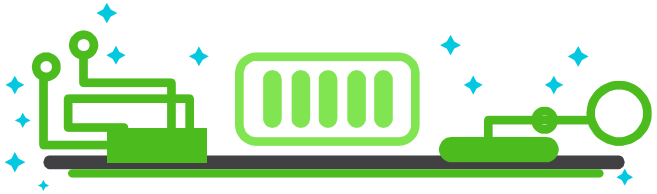
Carbon Footprint of a Typical EV





13-20 million tons equivalent — **Manufacturing Emissions** — **13-20 million tons equivalent**

Almost equivalent CO2 emissions largely due to battery production (8-12 metric tons)



0.25 kg CO2 / km — **Charging Emission** — **1.43 kg CO2 / km**

EVs generally have lower emissions during charging and operation than ICE vehicles, influenced by electricity sources for EVs and fuel efficiency for ICE vehicles.

30-40% lower — **Maintenance and Tires**

EVs convincingly outperform ICE vehicles, emitting significantly fewer maintenance and tire-related emissions thanks to their streamlined design

Source: IEA, Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle, IEA, Paris https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-bev-and-ice-vehicle, IEA. Licence: CC BY 4.0

Greening EVs: Emission Reduction Through Component Recycling

EV Component Recycling

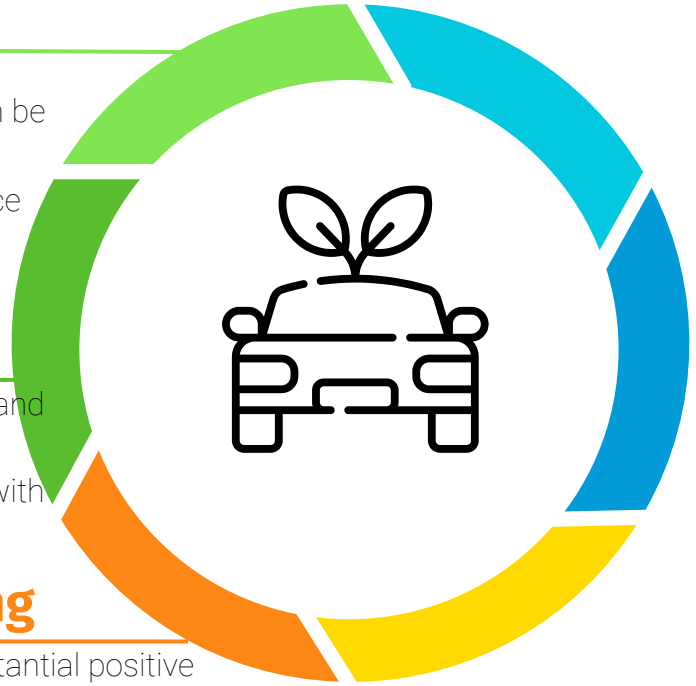
By reusing components (other than batteries and electronics) in the recycling process, emissions can be reduced by 30% through the conservation of energy-intensive manufacturing, decreased resource extraction, and the promotion of sustainability

Battery Recycling

Prevents the need for emissions-intensive mining and manufacturing processes, resulting in a saving of around 20 tons of CO_2 per recycled battery, with additional benefits in resource conservation.

Motor & Electronics Recycling

Reusing motors and electronics can have a substantial positive effect on the environment, resulting in emissions that are up to 15% lower compared to the manufacturing of new components



Overall Lifecycle Assesment

Evaluates the complete environmental impact of an EV considering manufacturing, operation, and disposal emissions. Recycling substantially reduces emissions—up to a substantial 25% —by minimizing the environmental impact of producing new components

Source: IEA, Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle, IEA, Paris https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-bev-and-ice-vehicle, IEA. Licence: CC BY 4.0

End of Life Batteries: Available and Future Batteries

Available Batteries

Lead-Acid batteries

Commonly used in conventional vehicles and other applications. Highly recyclable, with a recycling rate of approximately 95%. This means that a significant portion of lead-acid batteries can be collected, processed, and reused, reducing environmental impact.

Lithium Ions Batteries

Prevalent in EV's. Recycling rates typically range from 50% to 70%. While recycling lithium-ion batteries is feasible, the rates can vary due to factors like collection infrastructure and economic incentives.

Nickel-Metal Hydride (NiMH) Batteries

NiMH batteries are used in some hybrid vehicles and other applications. They are also recyclable, but recycling rates may vary from 50-70%.

Future Batteries

✓ Solid-State Batteries

An emerging technology known for their potential to offer higher energy density and improved safety. Recycling practices for solid-state batteries are still evolving as the technology matures.

Higher energy density	Complex manufacturing
Improved safety	Recycling Challenges (still in development)

✓ Sodium-based Batteries

Garnered attention for their potential to store more energy efficiently. Recycling methods for these batteries are also in development and may contribute to future sustainability

High energy density	Limited cycle life
Abundant materials	Recycling Challenges (still in development)

✓ Graphene-based Batteries

Utilize graphene material and offer advantages such as rapid charging and potentially reduced environmental impact. Recycling processes for are being explored.

Rapid charging	Cost and scalability
Environmental Benefits (carbon-based)	Recycling Challenges (still in development)

✓ *signifies project currently NMB embarking on*

Enter: National Energy Storage Technology Initiative (NESTI)

Creating the Circular Economy for Energy Storage

NESTI

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Phytomining

Reuse & Recycling

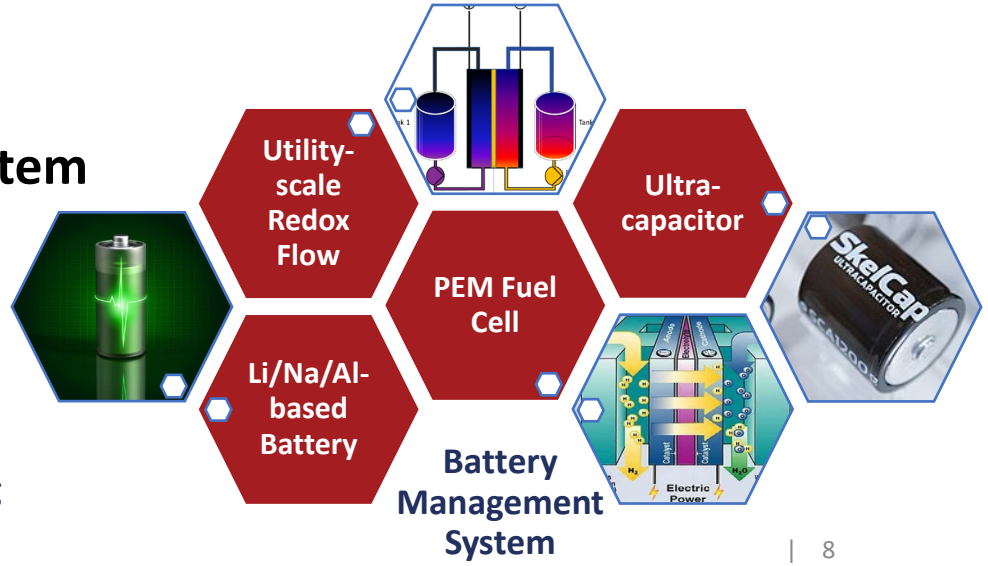
Sustainability

Component

- **Electrode**
  - Anode-Cathode
- **Electrolyte**
  - Solid/liquid state
- **Catalyst**
- **Separator/ Membrane**

NESTI Lifecycle

System



Application

- Vehicle
- Personal
- Off-grid
- Emergency

Portable

- 2-Wheeler
- 4-Wheeler
- Thermal Management

Mobility

- Nanogrid
- Home Energy Storage

Stationary

Battery Testing Facility

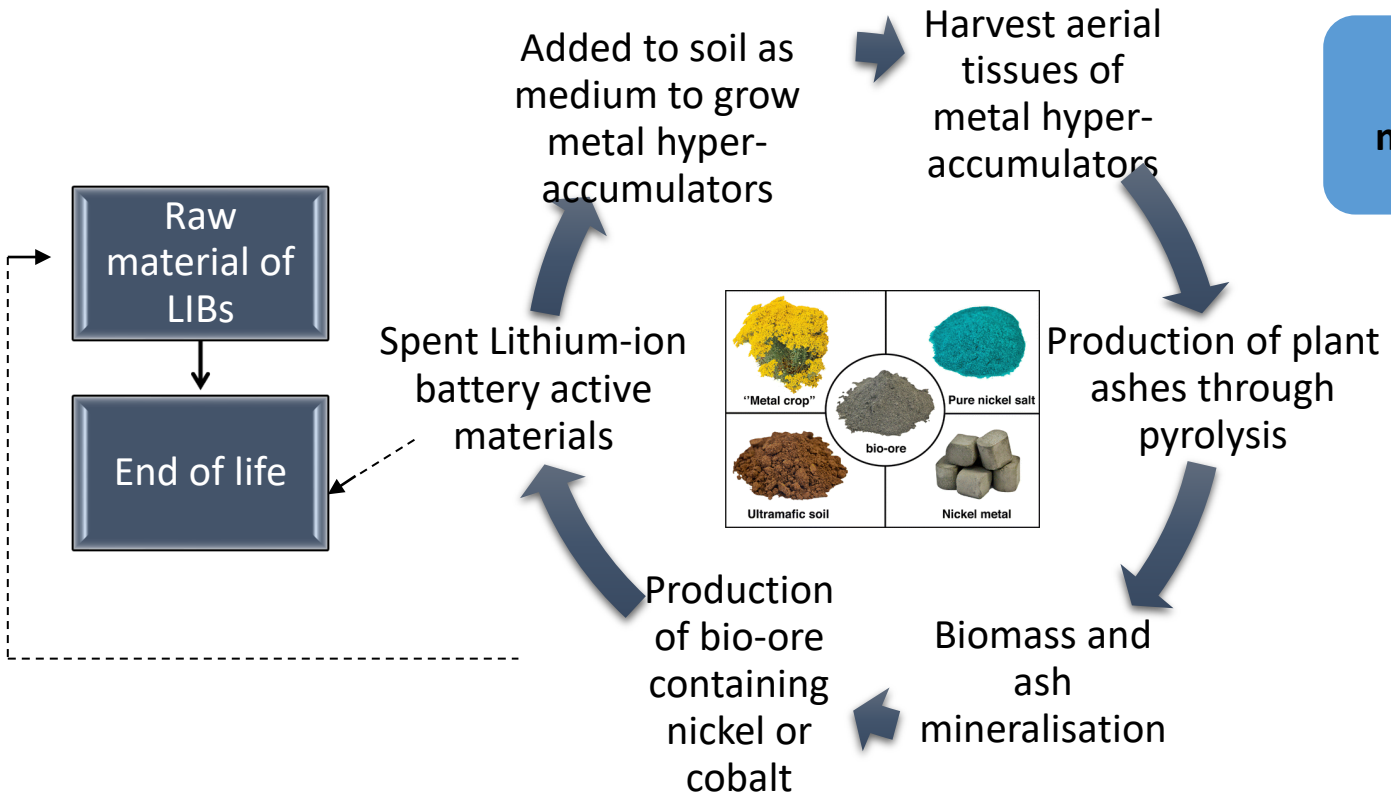
Battery Manufacturing Plant

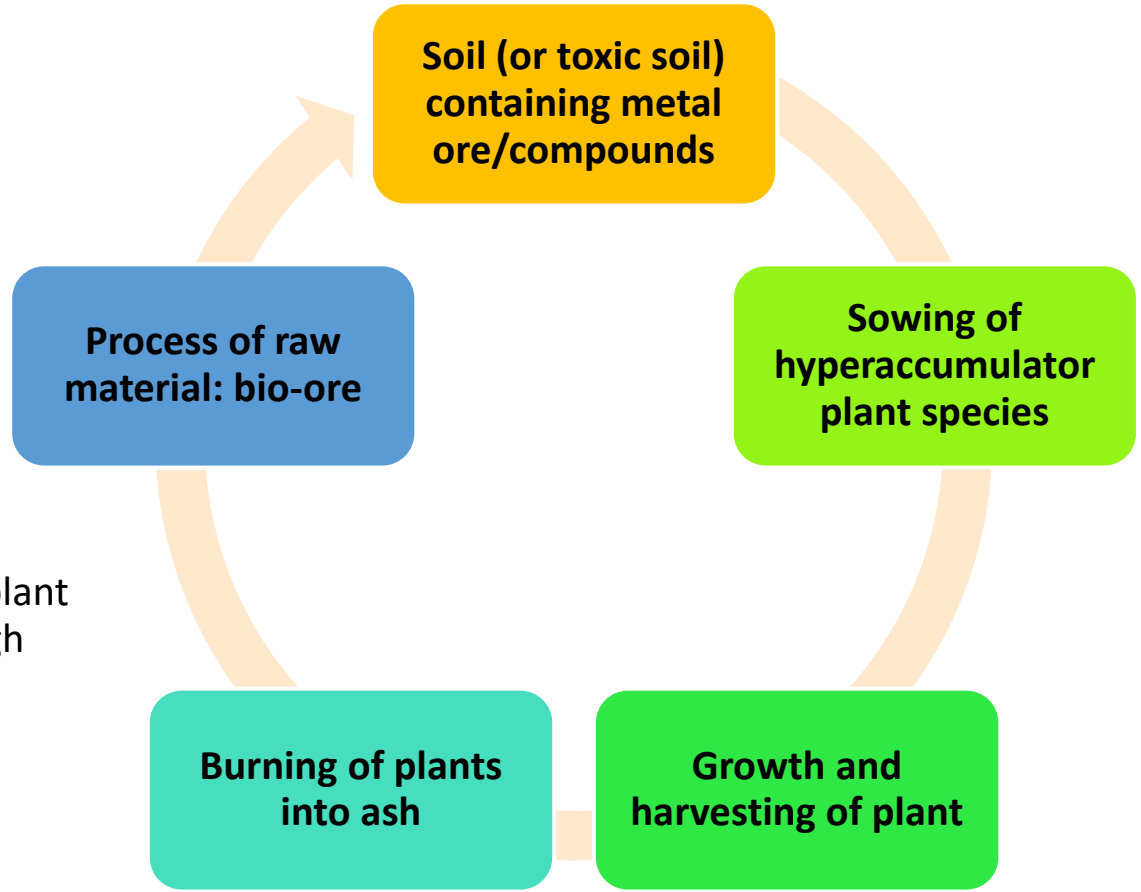
National Energy Storage Technology Initiative (NESTI)

Second Life of Batteries: Phytomining

Phytomining

The use of plants to remove metals from sub-economic ore bodies or contaminated mine sites with the additional aim of recovery of economic amount of metals (Chaney et al 1998).





Cyclic Representation of Phytomining Process

Exploring NMB's Other Innovative Initiatives for Carbon Footprint Reduction

HEBATT (Hydrogen – Electric Vehicle – Battery) Laboratory was launched on 20th September 2022 by

YB DATO' SRI DR. ADHAM BIN BABA

Former Minister of Science, Technology and Innovation

A Strategic Collaboration Between

NANOMALAYSIA®

IBC International Battery Center Sdn. Bhd.

HEBATT HYDROGEN-ELECTRIC VEHICLE-BATTERY

PRIMARY FOCUS FOR HEBATT

- Create and nurture a local ecosystem for battery production and local expertise to drive the National Green Economy agenda.
- As a Centre of Excellence for local battery research and fabrication.
- Research into production of graphene-based composite lithium-ion battery that will have ultra-large capacity and quick charge and discharge capacity.
- Research into graphene enhanced aluminium-ion batteries that are claimed to be better than lithium ion, where aluminium can be mined locally.
- Produce pouch cell battery as an alternative to cylindrical batteries, which is lighter and can store high power and energy density

Graphene-Based Li-ion Pouch Cell Developed at HEBATT

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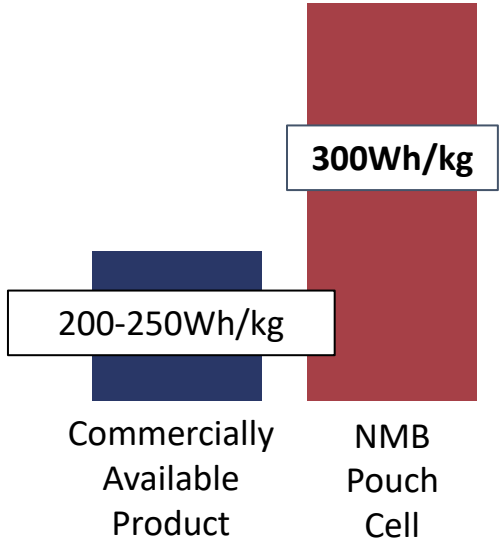
Energy Density Comparison



166.2 *mAh/g* *STORAGE CAPACITY*

75% *CAPACITY RETENTION*

700 *CYCLES TESTED, RETAINING >30%*

Other Programs Undertaken by NMB:

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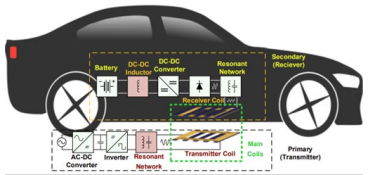
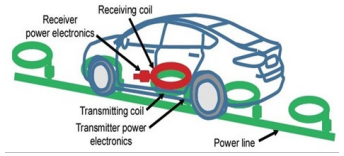
NREGS
NANOTECH REMOTE ENERGY SYSTEM

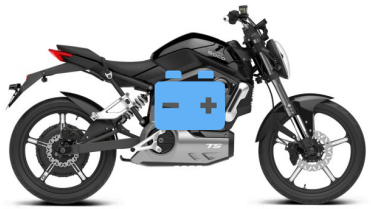


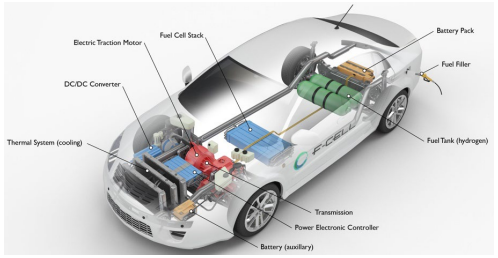
Static charging



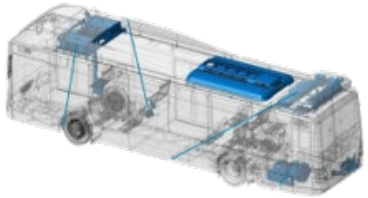
Dynamic charging

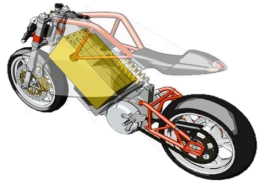
EMERGE





REVIVE





CLEVER

UNIVERSITI TENAGA NASIONAL

UTHM
Universiti Tun Hussein Onn Malaysia

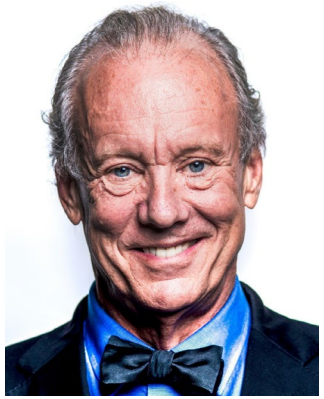
EduCity
ISKANDAR

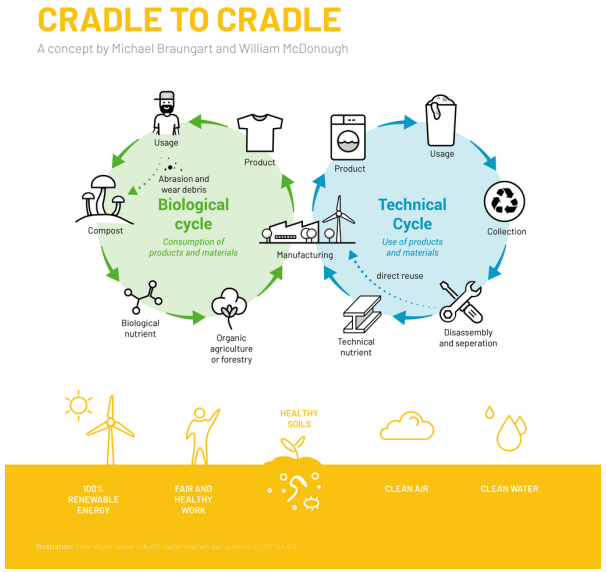
UTM
UNIVERSITI TEKNOLOGI MALAYSIA

Call for Action:

"Circularity is about **designing systems** that **regenerate and restore**, not **deplete and dispose**."

- *William McDonough, Architect and Designer, Cradle-to-Cradle Design*





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Thank You

NanoMalaysia Berhad

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