

Repurposing of Lithium-ion Batteries

Launch of a Whitepaper on Technology and Market Insights



SINGAPORE
BATTERY
CONSORTIUM

Catalyzing Battery Collaborations in Singapore and Beyond

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Our Mission

To foster strategic R&D partnerships amongst public research performers and industry players in the development and advancement of battery technologies. We aim to develop and catalyze the local ecosystem in battery related technologies through this platform.

Our Vision

To be the leading regional platform impacting the growth and translation of advanced battery related technologies through innovation driven partnerships. We aim to make Singapore the authoritative voice in battery related technologies and a place for private companies, public stakeholders and researchers to come for innovation

**THE LOCAL AND REGIONAL PLATFORM
FACILITATING INTERACTIONS AMONGST
PUBLIC AND PRIVATE PERFORMERS**

Battery Pack & Modules

- *End-users, product players*
- *Pack suppliers*
- *Cooling, BMS solutions*
- *Design, materials solutions*
- *Test bedding*

Battery Materials & Cells

- *Cells manufacturer*
- *Materials supplier*
- *Pilot cell production and testing*

Battery Reuse & Recycling

- *Recycling industry*
- *Raw material companies*
- *Support in process development*
- *Scale up testing*

Steering Committee



Observer



Strategic Partners





A Whitepaper Launch on:

Repurposing of Lithium-ion Batteries Technology and Market Insights

Content Outline

- I. Background Introduction
- II. Global Trend and Market Overview for Second Life Batteries
- III. Value Chain and Key Players in Second Life Battery Market
- IV. Key Challenges and Technology Gap in Battery Repurposing
 - Challenges in Battery Repurposing
 - Cost of Battery Repurposing
 - Standards for Battery Repurposing
- V. Innovation Landscape and Technology Review
 - Patent Landscape for Battery Diagnostic, Grading, Sorting and Rejuvenation
 - Patent Landscape for Battery Disassembly
 - Emerging Technologies for Battery Diagnostic, Grading and Sorting
 - Emerging Technologies for Battery Rejuvenation and Regeneration
 - Emerging Technologies for Battery Disassembly and Automation
- VI. Opportunity for Singapore in Battery Repurposing
 - Overview of Singapore Ecosystem
 - Case Examples for Second Life Battery Implementation
 - Future Outlook



Contact us for any queries and access to the whitepaper
contact@batteryconsortium.sg
www.batteryconsortium.sg

SBC & The Singapore Ecosystem

GenPlus[®]
POWERING A SUSTAINABLE FUTURE

ROVILUS
Energize Perfection

ARKEMA
INNOVATIVE CHEMISTRY

 **NANYANG
TECHNOLOGICAL
UNIVERSITY**
SINGAPORE

 **SINGAPORE
BATTERY
CONSORTIUM**

SWTIA
SINGAPORE UNIVERSITY OF
TECHNOLOGY AND DESIGN


greenU·ION

 **NUS**
National University
of Singapore

 **Temasek**
POLYTECHNIC


durapower

 **Agency for
Science, Technology
and Research**
SINGAPORE

 **SYH**
SECURE DATA DESTRUCTION
ELECTRONIC WASTE RECYCLING



VDE
RENEWABLES

SIEMENS
Ingenuity for life

 **BEYOND LIMITS**

 **SPgroup**

HIOKI



durapower

20 Countries, 45 Cities & Growing



E-Mobility Platforms



Specialty Platforms



Stationary Applications





Deployment of 2nd life batteries for ESS by DP

- >10MWh 2nd life ESS deployed
- Use cases includes EV charging, Peak shaving, Microgrids



GenPlus[®]

POWERING A SUSTAINABLE FUTURE

Evaluates and deploys retired EV batteries for 2nd life application



Large local configurable capacity @SG for growth

- Processing capability of up to 60MWh/year in Phase 1
- Potential to grow to 200MWh/year with current facility



Factory process based on UL 1974

- Visual and physical inspection
- Remaining usable capacity and cycle life
- Self discharge evaluation
- BMS evaluation

Focus on sustainable and responsible processes



- Regenerative chargers to minimize energy use in battery testing



- Waste sorted, recycled where possible
- Proper and responsible disposal process



MOU signed in 2020

Areas of Partnership

Underwriters Laboratories and Singapore Battery Consortium Sign Agreement to Collaborate on Battery Technology

<https://ul.org/SBC>

- Battery standards awareness and education
- Outreach for battery safety science
- Build global partnerships

UL 1974 Standard for Evaluation for Repurposing Batteries

- National standard for both the US and Canada.
- Joint webinar sessions, consultations with experts

Look out for upcoming Masterclass series in **Jan 2021** Batteries Safety & Standards



Engaging sessions on battery safety science and standards



Chemistry to System Design of Lithium-Ion Batteries

19th Nov ,11am

Comprehensive & fast design of multi physics simulation for new and 2nd life batteries



SBC – VDE Webinar July 2020
Battery Handling / Safety / Transport

Look out for upcoming **Battery Training Workshop (Dec 2020)**, covering battery handling, safety, transport, including special training session by Hioki



Upcoming Research Plans

- Battery Analytics for New and 2nd Life Batteries
- Advancing Refurbishment and Direct Recycling Methods.



To advance strategic Public-Private R&D partnerships in Battery Technologies



Singapore startup claims breakthrough in Lithium-ion battery recycling

Singapore-based Green Li-ion says its tech can ease the looming e-waste crisis by dramatically increasing the efficiency and profitability of rechargeable battery recycling.



SYH
SECURE DATA DESTRUCTION
ELECTRONIC WASTE RECYCLING

Lithium Battery Recycling

- Proprietary technology to recycle lithium-ion batteries, recovering metals such as cobalt, copper and lithium.
- Approved Lithium ion battery recycler by NEA since December 2017.

Smelting (Pyro-metallurgy) Facility in Singapore

- New modern, highly-advanced smelting facility in Singapore to extract and recover metals and materials from waste materials and metal scraps.
- Aggregate processing capacity of ~1,000 tons per month with the capability of processing waste battery powders.



**PRODUCES 99.9%
PURE BATTERY
CATHODE**

Greener Chemistry

- Zero Toxic Discharge
- Efficient co-precipitation
- Reusable solutions

Purer

- High purity recovery
- LFP processing
- Recovery of Li and Co

Faster

- Faster than current pyro and hydro
- Process all batteries
- No sorting required



Singapore facility capable of recycling 14 tonnes per day

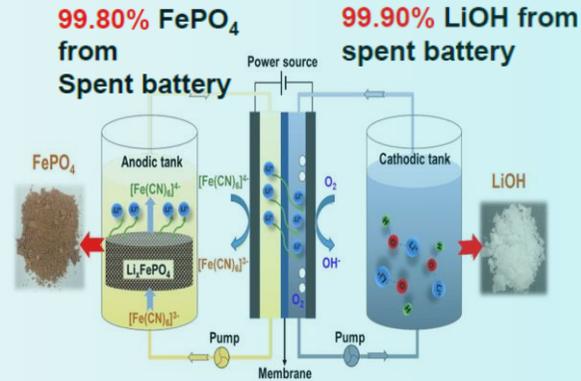
Advanced redox process for extraction of FePO_4 and Li

Singapore – CEA Alliance for Research in Circular Economy (SCARCE) @NTU

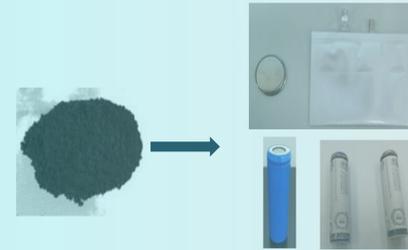


NUS-Temasek Polytechnic

- Hydrometallurgy and electrochemical method
- Use of ferricyanide-based leaching solution to recover FePO_4 and LiOH (99.9% purity) from spent LFP battery



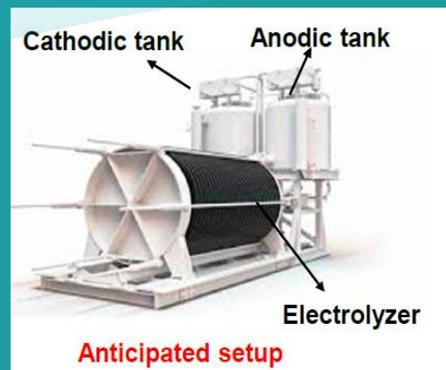
Recycling of lithium-ion batteries



Refabricated new batteries

- Recover materials from spent LIBs and convert them into useful second life electrode materials
- Develop efficient mechanical separation methods
- Work on environment-friendly hydrometallurgical processes

- Cost effective
- Low chemical usage
- Continuous process
- No secondary pollution



ScienceDaily

Your source for the latest research news

Date: August 26, 2020

Scientists use fruit peel to turn old batteries into new

- Hydrometallurgy
- Replacing acid precipitating extraction with fruit waste
- Organic acid in citrus fruit waste





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**FOCUS
AREA**



Battery Materials



Battery Cells
Production



Battery Reuse
and Recycling



Battery Packs
and Modules

Steering Committee



Observer



Strategic Partners



SNAP SHOT OF THE CONSORTIUM

29 Industry Members



- Battery materials/cells
- Battery modules/packs
- Battery Reuse/Recycling

56 Scientist/Academics



- 4 Universities, 5 Polytechnics
- 10 Research Institutes
- >3000 papers, >90 IPs

Multiple Activities



- Market intelligence, project scoping, stakeholders engagement
- Tech road mapping, whitepapers
- Seminars, workshops, roundtables, exhibition, conferences