Repurposing of Lithium-ion Batteries

Launch of a Whitepaper on Technology and Market Insights

SINGAPORE BATTERY CONSORTIUM

Catalyzing Battery Collaborations in Singapore and Beyond

Dr. CHIAM Sing Yang
Director, Singapore Battery Consortium

IPI SINGAPORE

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

SINGAPORE BATTERY CONSORTIUM

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

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

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

Agency for Science, Technology and Research SINGAPORE

National Research Foundation Prime Minister's Office Singapore

EDB singapore

Enterprise Singapore

Nanyang Technological University

NUS National University of Singapore

Observer

Energy Market Authority
Smart Energy, Sustainable Future

Strategic Partners

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UL

Lux Research

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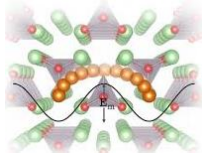
Current Consortium Members

Materials



Cells

Modules & Packs

Recycling

Testing Certification Standards

29 Industry Members

volt14 Batteries Redefined

2Dto3D

NIPPON CHEMICAL INDUSTRIAL

Regentech

ARKEMA INNOVATIVE CHEMISTRY

CRODA Innovation you can build on™

GREEN ENERGY INVESTMENT HOLDIN GREEN WASTE RECYCLING COMPANY

UNIGRID BATTERY

muRata INNOVATOR IN ELECTRONICS

durapower

LiRON

ATL

ROVILUS Energize Perfection

Energeia Labs 恩能吉尔实验室

GenPlus® POWERING A SUSTAINABLE FUTURE

orient TECHNOLOGY

JIOS AEROGEL

greenLi-ion

SYH SECURE DATA DESTRUCTION ELECTRONIC WASTE RECYCLING

VDE RENEWABLES

Product Players/End Users

ROLLS ROYCE

SPgroup

ION MOBILITY

HUAWEI

Solution Providers

SIEMENS Ingenuity for life

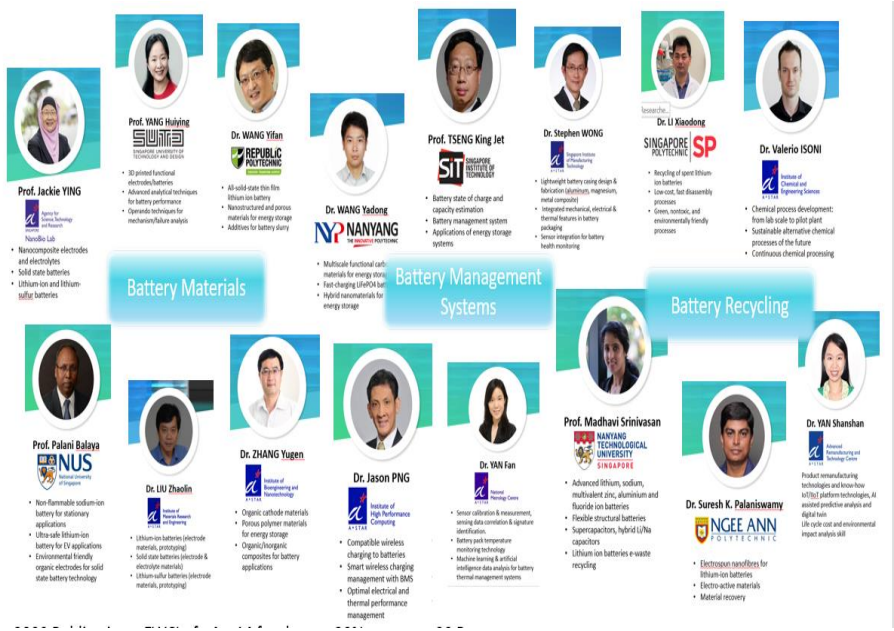
HIOKI

BEYOND LIMITS

Activities & Events

- Market & Technology intelligence
- Project scoping
- Stakeholders engagement
- Seminars, workshops, roundtables, exhibition, conferences

More than 50 IHL Members



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Repurposing of Lithium-ion Batteries

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

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Contact us for any queries and access to the whitepaper

contact@batteryconsortium.sg
www.batteryconsortium.sg

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SBC & The Singapore Ecosystem

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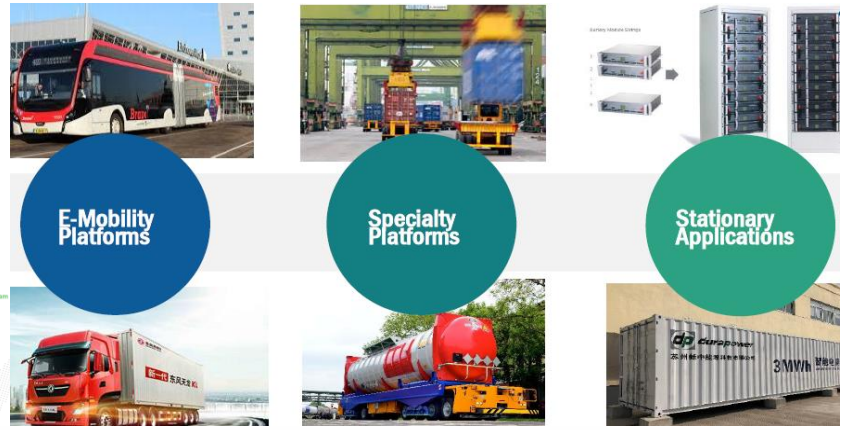
Singapore Battery Repurposing Ecosystem

durapower



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

Singapore Battery Repurposing Ecosystem

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MOU signed in 2020

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

https://ul.org/SBC

Areas of Partnership

- 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

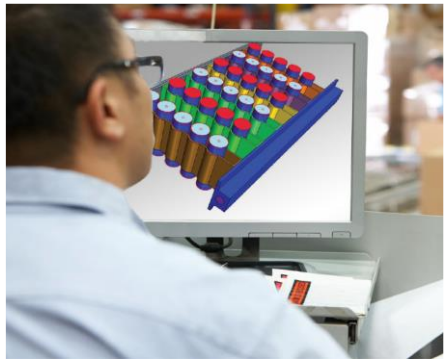
Look out for upcoming Masterclass series in Jan 2021 Batteries Safety & Standards

Engaging sessions on battery safety science and standards

SIEMENS
Ingenuity for life

Chemistry to System Design of Lithium-Ion Batteries

19th Nov ,11am



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

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VDE RENEWABLES

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

HIOKI

Upcoming Research Plans

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

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Singapore Battery Recycling Ecosystem

greenLi-ion

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.

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

SMCI Group
Resources for the future

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.

Singapore facility capable of recycling 14 tonnes per day

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Singapore Battery Recycling Ecosystem

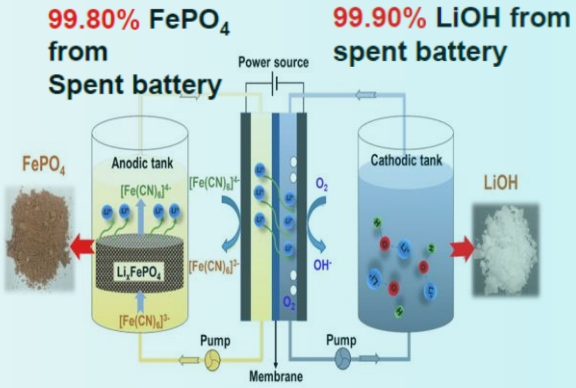
Advanced redox process for extraction of $FePO_4$ and Li

NUS National University of Singapore

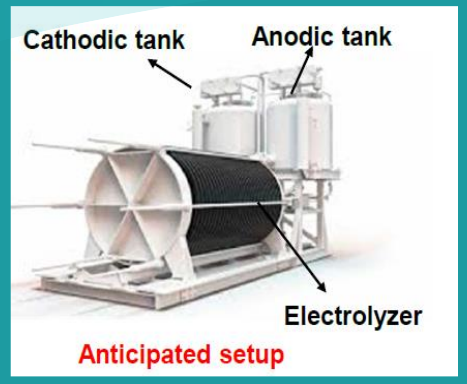
Temasek POLYTECHNIC

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



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



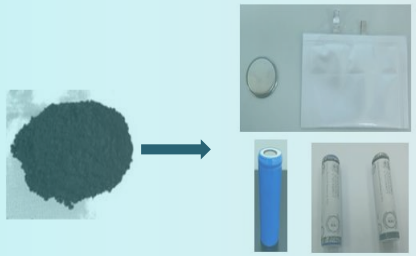
Anticipated setup

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

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

cea

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

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

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UL

LUX Research

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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