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THE SECOND LIFE OF BATTERIES IN EVs

REUSE OF LITHIUM ION BATTERIES USED IN THE
ELECTRIC VEHICLES

BY ;MARY WANGECHI MAINA

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Project Proposal: Reusing Lithium-ion Batteries for Power Storage

I. Background and Justification

The rapid growth of the Electric Vehicle (EV) industry is leading to a mounting challenge of managing end-of-life lithium-ion batteries (LIBs). While recycling is a crucial component of sustainable battery management, the potential for reusing these batteries in less demanding applications can significantly extend their lifespan and reduce the environmental impact of EV adoption.

Statistically speaking, there has been a high rate of adoption of these EVs in the Kenyan market rising from 31 EVs in 2018 to 3,753 EVs in 2023 (NTSA report 2023) with a global cumulative of 2.1 Million EVs in 2018 to 40 Million EVs in 2023 (EV Volumes).

Despite the potential benefits, there is a lack of standardized protocols, technologies, and economic models for effectively reusing EV LIBs. This results in suboptimal utilization of valuable resources, increased waste generation, and missed opportunities for cost reduction in energy storage systems.

Therefore, there is a critical need to develop comprehensive strategies and solutions for the reuse of EV LIBs to maximize their value, minimize environmental impact, and contribute to a circular economy for battery materials.

Potential Focus Areas:

- Developing methodologies for evaluating the state of health of retired EV batteries.
- Identifying suitable second-life applications for reused lithium ion batteries (LIBs).
- Designing optimal battery management systems for reused batteries.
- Creating economic models for the reuse of EV LIBs.
- Developing policies and incentives to promote battery reuse.

SOLUTIONS

Lithium-ion batteries are the most widely used type of batteries in the new models of electric vehicles. These batteries are commonly used because of their efficiencies including:

- Batteries weight

- Storage and capacity
- Production costs
- Lifespan
- Recharging capacity
- Environmental impact

As batteries are used, their ability to store energy (or State of Health, SOH) decreases, and with it the number of kilometers the vehicle can go on a single charge. When the SOH is too low for the user to satisfy their needs (typically 70-80% SOH), the battery must be replaced.

Used batteries can either be sent directly for recycling or deployed for a lower power application and recycled once the second life is fulfilled

Reusing and recycling reduces pollution and will reduce cost of production therefore conservation of energy is achieved.

One of the ways of giving these batteries a second life is using them as power storage for domestic use and also in power grids at a large capacity Energy storage is critical to fully utilize the potential of variable renewable energy sources (such as solar, wind and tidal), regardless of when it was produced.

Having been brought up in a community with less electricity access, With the help of solar panels, these batteries would be used for power storage. Community will highly benefit.

II. Partnerships

Partner Name	Mandate	Role in the Project	Resources Partner Will Provide
EV Manufacturers	Production and supply of lithium-ion batteries	Provide access to used batteries for repurposing	In-kind donation of used batteries

Renewable Energy Firms	Development of power storage systems	Help integrate repurposed batteries into storage systems	Technical expertise, infrastructure
Government Agencies	Policy and regulatory oversight	Support policy alignment for battery reuse and storage	Facilitation of regulatory support
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III. Objectives

A. Overall Objective:

To develop a sustainable system for repurposing used lithium-ion batteries from EVs into power storage solutions, extending their lifecycle and contributing to renewable energy integration.

B. Immediate/Specific Objectives:

1. Establish a system for collecting and testing used lithium-ion batteries from EVs.
2. Design and implement repurposed energy storage units using second life batteries.
3. Increase awareness and capacity for battery reuse among stakeholders, including manufacturers and energy providers.
4. Reduce environmental impact by minimizing battery waste and promoting renewable energy storage.

IV. Project Implementation and Management Plan

A. Expected Project Results and Indicators:

- Result: Creation of power storage systems using second-life batteries.
Indicator: Number of repurposed batteries successfully integrated into energy storage systems.(weigh of waste saved vs energy storage capacity)
- Result: Reduction in EV battery waste.
Indicator: Percentage reduction in disposed batteries from EVs.

B. Project Activities and Work Plan:

1. Activity: Partner with EV manufacturers to source used batteries.
Timeline: Months 1-6
Responsible: Project Lead
2. Activity: Develop a testing facility to assess battery health and viability.
Timeline: Months 3-9
Responsible: Technical Team
3. Activity: Design and prototype energy storage units using repurposed batteries.
Timeline: Months 6-12
Responsible: Design and Engineering Team

C. Project Beneficiaries:

Direct beneficiaries will include renewable energy companies, EV manufacturers, and local communities relying on decentralized energy storage solutions. Indirect beneficiaries include government bodies, policymakers, and environmental organizations working toward sustainable waste management and energy solutions.

D. Implementing Agency Management of Project:

The project will be managed by ReWatt Innovation's, with designated teams overseeing sourcing, design, testing, and implementation. Effective coordination will be maintained with all relevant stakeholders, including government agencies and industry partners, to ensure seamless project execution.

V. Project Methodology

The project will employ standard methodologies for testing and repurposing lithium-ion batteries, using established processes for energy storage system design and integration. The project will also explore innovative approaches to extending battery life and improving storage capacity in second-life applications.

Step 1: Collection and Inspection of Used Batteries

1. Battery Collection:

Partner with EV manufacturers to collect used lithium-ion batteries that are no longer viable for EV use.

2. Initial Visual Inspection:

Perform a visual inspection to check for any physical damage, leakage, or swelling of battery cells. Discard any severely damaged cells that could pose safety risks.

Step 2: Battery Health Assessment

1. Disassembly:

Carefully disassemble the battery pack to access individual cells, ensuring that safety protocols are followed to prevent short circuits or injury.

2. State of Charge (SoC) Test:

Measure the voltage of each cell to determine the state of charge (SoC). Cells with an extremely low voltage ($<2.5V$) may be degraded beyond reuse and should be discarded.

3. Capacity Testing:

Use specialized battery testers to charge and discharge each cell to measure its capacity. Cells that retain a significant percentage of their original capacity (e.g., $>70\%$) are suitable for reuse.

Procedure: Fully charge the cell, then discharge it under controlled conditions while recording the discharge capacity.

4. Internal Resistance Test:

Check the internal resistance of each cell using an impedance meter. Cells with higher internal resistance may heat up during use, which can pose safety concerns. Cells with acceptable resistance levels can be repurposed.

5. Temperature Profile Testing:

Monitor the temperature of the cells during the charging and discharging process. Cells that exhibit excessive heating should be excluded from reuse to avoid thermal runaway.

Step 3: Sorting and Grouping

1. Sort by Performance:

Group the cells based on their test results (voltage, capacity, internal resistance) to ensure balanced performance in repackaged battery systems. Only cells with similar performance characteristics should be packed together.

2. Labeling:

Mark the cells with their health status (e.g., capacity, resistance) to ensure transparency in the repackaging process.

Step 4: Repackaging into New Modules

1. Design New Battery Packs:

Design new modules or battery containers that fit the repurposed cells. Ensure the container has proper insulation and is made from durable, heat-resistant materials to avoid short circuits or damage.

2. Cell Balancing Circuits:

Incorporate a battery management system (BMS) into the repackaged unit to balance the charge across cells and prevent overcharging or deep discharging, which can degrade cell life or cause safety issues.

3. Wiring and Configuration:

Wire the cells in series or parallel based on the required voltage and capacity for the specific power storage system. Ensure proper insulation and spacing between cells to prevent short circuits.

4. Thermal Management System:

Include cooling mechanisms such as passive air vents or active cooling systems (e.g., fans or liquid cooling) to manage heat during charging and discharging cycles.

Step 5: Safety Measures and Testing of New Pack

1. Safety Testing:

Overcharge Test: Simulate overcharging to ensure the BMS properly shuts off the system at safe voltage levels.

Short Circuit Test: Test the repackaged pack to ensure it safely handles a short circuit without catching fire or exploding.

Thermal Testing: Conduct temperature monitoring during continuous use to verify that the cooling system is effective.

2. Recharging Protocol:

Ensure the cells in the repackaged battery unit can be safely recharged using standard charging protocols. Test the system for cycle life (charge/discharge cycles) to predict longevity in real-world applications.

Step 6: Quality Control and Certification

1. Final Quality Control:

Conduct a final round of testing on each repackaged unit, ensuring it meets all performance, safety, and durability standards.

2. Certification:

Seek certification from relevant authorities to ensure that the repurposed battery packs meet industry standards for reuse, safety, and environmental compliance.

Step 7: Deployment and Monitoring

1. Deploy Battery Packs:

Once testing and certification are complete, the repurposed battery packs can be deployed in energy storage systems.

2. Ongoing Monitoring:

Continue to monitor the health of the repurposed batteries over time, using the integrated BMS to track performance and detect any potential issues early.

Workshop Setup for Repurposing EV Batteries into Home Energy Storage

1. Workspace & Infrastructure

Secure workshop space (well-ventilated and equipped for battery handling)

Workbenches & tool stations for assembly and testing

Proper electrical connections & safety grounding

Storage racks for used batteries and new components

2. Tools & Equipment

Battery testing equipment (voltage meters, capacity testers, thermal scanners)

Battery management system (BMS) programming tools

Screwdrivers, wrenches, pliers (for safe disassembly & reassembly)

Soldering kits & wiring tools

Spot welder (for battery connections)

Insulation and sealing materials (heat shrink, insulation tape, protective casings)

3. Safety & Protection

Fireproof storage for batteries

Personal Protective Equipment (PPE) (gloves, safety glasses, face shields)

Fire extinguishers & emergency response kit

Ventilation system to prevent hazardous gas buildup

4. Materials & Components

Used EV batteries (sourced from auto repair shops, EV manufacturers)

Battery Management Systems (BMS)

DC-AC inverters (for home power conversion)

Charge controllers & solar panel connectors

Cables, fuses, and wiring kits

5. Training & Documentation

Standard operating procedures (SOPs) for safe battery handling

Workshops & training for technicians

User manuals for end-users

Data tracking system (monitoring battery performance & impact)