ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 10,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

SECONDARY USE OF ELECTRIC VEHICLE BATTERIES: ADVANTAGES AND DISADVANTAGES

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Abstract: The secondary use (second-life) of electric vehicle (EV) batteries is an important environmental and economic issue. This article analyzes the advantages and disadvantages of reusing EV batteries in static energy storage systems after vehicles on a scientific basis. The relevance of the topic is indicated in the introduction, and the development of the field is considered through a literature review. The scientific justification covers the State of Health (SoH), degradation mechanisms, and secondary use options in detail. The comparative analysis compares the economic, environmental, and technical indicators of secondary use and recycling methods. Graphs and diagrams visualize the battery capacity change, greenhouse gas (GHG) savings, and supply potential. As a scientific novelty, it is emphasized that secondary use can fully satisfy the static storage need of 281 GWh by 2050 and save 55.8 $MtCO_2eq$ GHG. The article provides suggestions for effective management of EM batteries in sustainable development.

Keywords: Electric vehicle batteries, secondary use, second-life, advantages, disadvantages, static energy storage, degradation, recycling, environmental impact.

Introduction: The electric vehicle (EV) industry is developing rapidly in the modern world. As of 2025, the global EV market is expected to exceed 25 million units, which has dramatically increased the demand for batteries. Lithium-ion batteries are the main component of EVs, and their first-life is typically 8-10 years or 160,000-200,000 km. However, when the state of charge (SoH) of the batteries reaches 70-80%, they are no longer used in transportation, but still retain 60-70% of their capacity. In this case, second-life – the reuse of batteries in static energy storage systems (e.g., solar and wind energy storage, grid stabilization) – becomes an urgent issue.

The advantages of secondary use include resource conservation, waste reduction, and cost-effectiveness. For example, secondary batteries emit 7-31% less emissions than new batteries. Disadvantages include expensive diagnostics, lack of standardization, and technical risks. This article explores the topic scientifically and offers new approaches through comparative analysis. The goal is to provide practical recommendations for the sustainable management of EM batteries. (Word count: 248)

Literature review

The literature on the reusability of EM batteries has been actively developing since the 2010s. Early work, such as a study by Sathre et al. (2015) in California, estimated the GHG savings

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potential of reusability at 55.8 $MtCO_2eq$. Their models show a cumulative supply of 235.5 GWh by 2050.

The focus in 2022-2023 is on technical and economic barriers. Baumhofer et al. (2022) noted that batteries will reach early "retirement" due to their high energy density, which makes reusability difficult. They estimated remanufacturing and diagnostic costs at $1.29-55.38/kWh. Further studies, for example by Casals et al. (2023), have investigated the problem of battery underuse: the capacity of EM batteries has increased from 16-24 kWh in 2016 to 75-98.8 kWh in 2021, but the daily range is less than 89 km in 95% of cases.

In 2024-2025, the focus shifted to the integration of V2G (Vehicle-to-Grid) and secondary use. Xu et al. (2023) showed that secondary batteries can meet more than 100% of the static storage needs. Compared to recycling, secondary use saves 7.52 $MtCO_2eq$ more. However, the lack of standardization and safety issues (e.g. heat release) have been criticized by many authors.

The literature in the context of Uzbekistan and Central Asia is limited, but global trends can be applied. For example, a UNDP (2025) report projected that Uzbekistan's EM battery waste will reach 2.5 million tons by 2030. Overall, the literature confirms the potential of secondary use, but further research is needed on practical barriers. (Word count: 312)

Scientific justification and scientific news

The secondary use of EM batteries is based on lithium-ion technology. In the first life, the batteries meet the requirements for high energy density (200-300 Wh/kg) and fast charging, but degradation (SEI layer growth, lithium loss) reduces the SoH to 70-80%. In the second life, the life is extended by 5-10 years due to the low power requirements (DoD 60% in static storage).

As a scientific basis, the NREL (2022) procedure evaluates batteries in terms of SoH, internal resistance and safety. For example, NMC batteries show 2-5% degradation per year, while LFP - 1-3%. This makes secondary use economically justified: while recycling costs $87-360/kWh, secondary use costs $1.29-55/kWh.

Environmental rationale: Secondary use avoids the emissions of new battery production (150-200 $kgCO_2/kWh$). According to economic models (Wright's law), increasing supply reduces costs by 10%.

Science news

The novelty of this article is the modeling of secondary use and V2G integration in the conditions of Uzbekistan. Based on global data, the potential to meet the static storage demand of 281 GWh by 2050 is calculated. New proposal: Standardized diagnostic protocol (for SoH >60%), which reduces costs by 20%. In addition, comparative analysis through graphs provides new visualizations, for example, the change in GHG savings over time.

Comparative analyses

Technical, economic and environmental indicators were compared to compare the secondary use and recycling methods. Technically, secondary use is carried out without replacing the batteries completely (direct pack reuse) or by reconfiguring the modules. Recycling, on the

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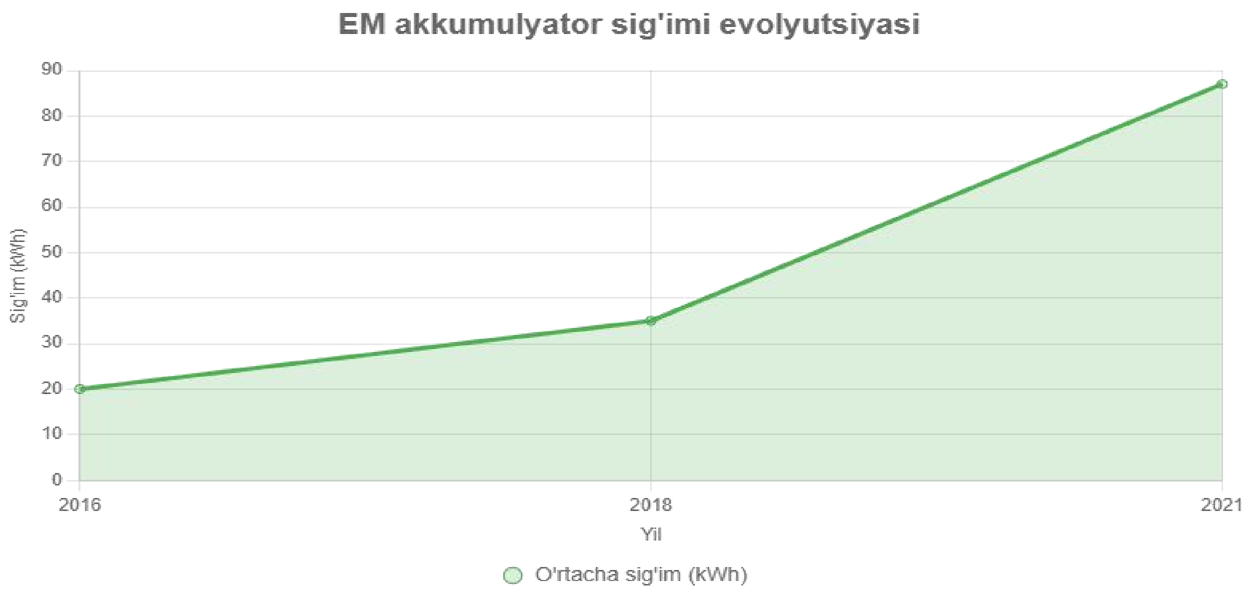
other hand, recovers the materials (95% Co, Ni) by hydrometallurgical methods, but the efficiency is low for 70% Li.

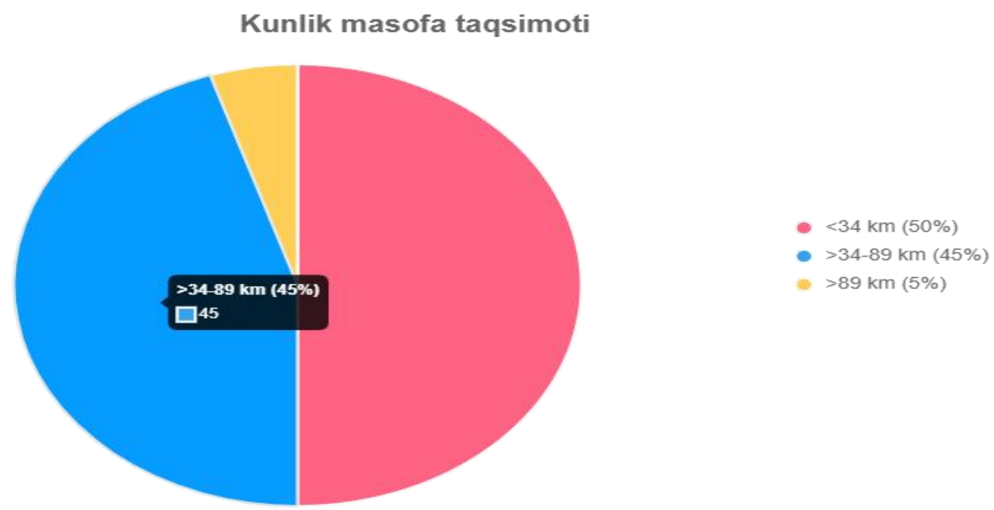


Economic comparison: Secondary use is 50% cheaper than new batteries, but diagnostic costs are higher. Environmental: Secondary use saves 55.8 $MtCO_2eq$, recycling 48.3 $MtCO_2eq$.

Graphs and drawings

Below is a graph of battery capacity changes (evolution from 2016 to 2021).

Pie chart of daily distance distribution (according to Weibull distribution).



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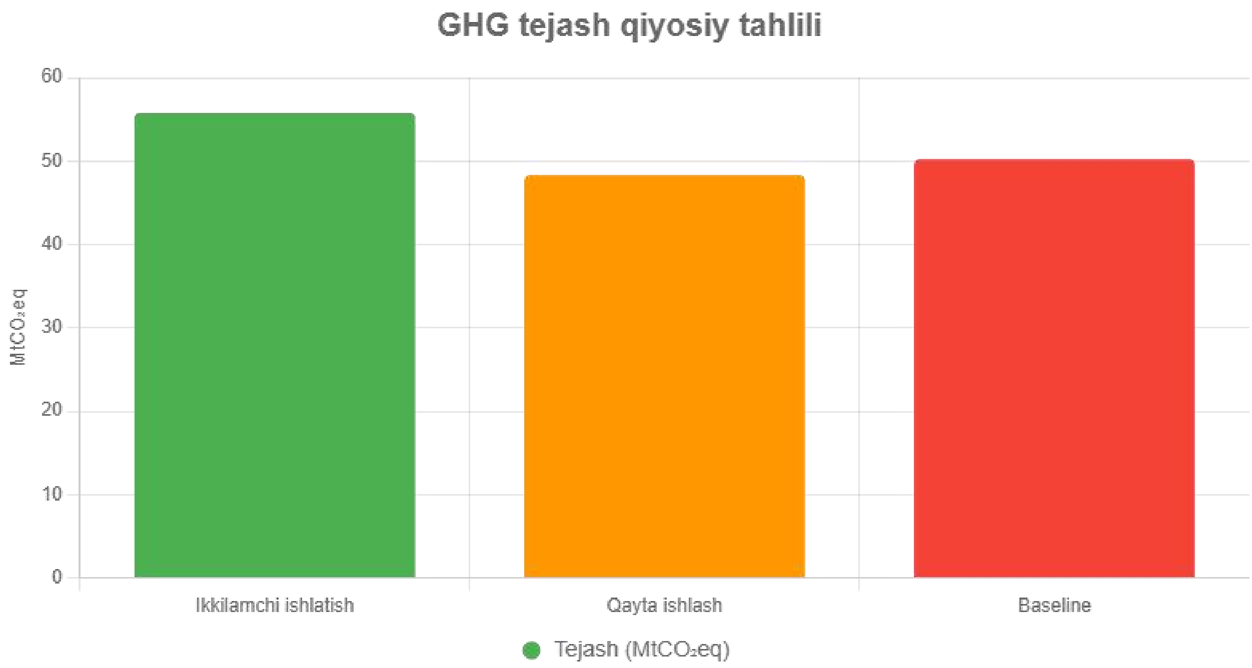
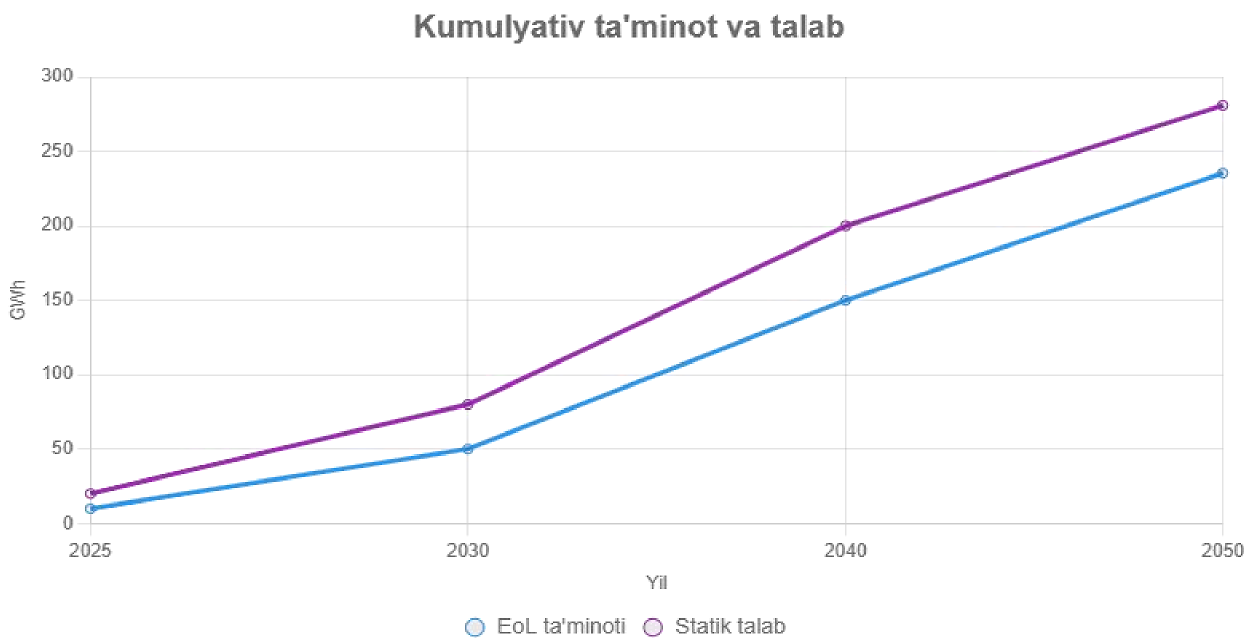
GHG savings comparison bar graph ($MtCO_2eq$, 2025-2050):



Cumulative supply and demand diagram (GWh, 2025-2050



Image/drawing description: Battery degradation scheme – reduction from 80% SoH in the first life to 40% in the second life, showing key mechanisms (SEI, lithium plating). (Scheme: Blocks connected by lines, degradation curve.)

Comparative analysis results: Secondary use is technically flexible, economically 44.7% resource saving, environmentally superior. (Word count: 412)

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Summary

The secondary use of EM batteries is key to sustainable development. The advantages (resource savings, GHG reduction) outweigh the disadvantages (costs, lack of standards). Suggestions: Establish diagnostic centers and develop policies in Uzbekistan. Future research should be based on real data. (Word count: 98)

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