UQTR
Université du Québec à Trois-Rivières

93E CONGRÈS Acfas

Optimiser la circularité des batteries de véhicules électriques par la logistique partagée et l'économie de l'usage

Optimizing the Circularity of Electric Vehicle Batteries through Shared Logistics and the Usage Economy

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mai 2026

Poly Circle X.0

POLYTECHNIQUE MONTRÉAL

Presentation Agenda

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SECOND
Problem Definition

THIRD
Research Gap

FOURTH
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SIXTH
Results & Key Insights

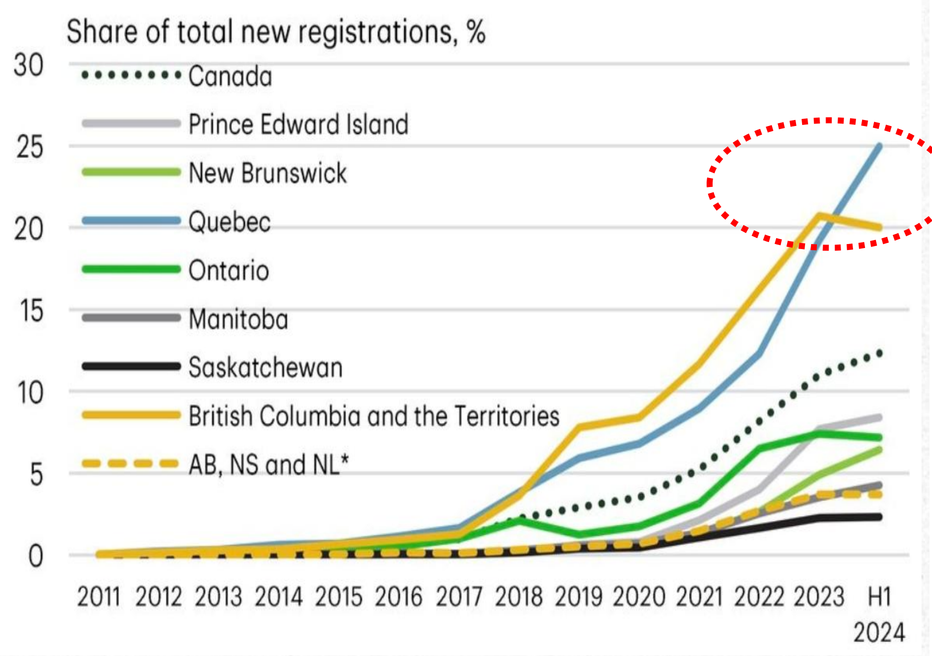
SEVENTH
Conclusion

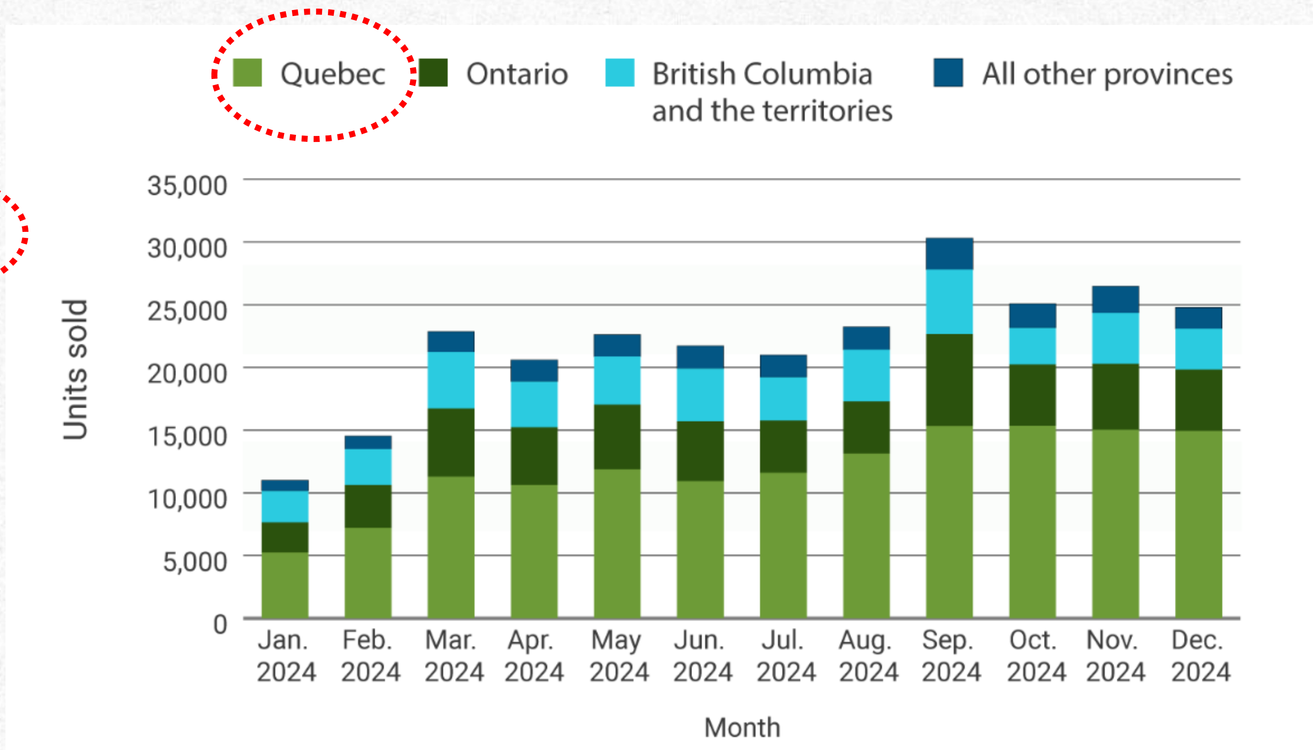
FIRST

Motivation & Context

Motivation & Context

- Rapid growth of electric vehicles
- Surge in end-of-life battery flows
- Pressure on logistics and sustainability





Source: https://www.statcan.gc.ca/o1/en/plus/7915-2024-one-seven-new-vehicles-sold-canada-were-zero-emission?

SECOND

Problem Definition

01

The popularity of EVs worldwide

02

EVBs

03

Shorter First Life than EVs

04

When batteries leave vehicles, they are still valuable

05

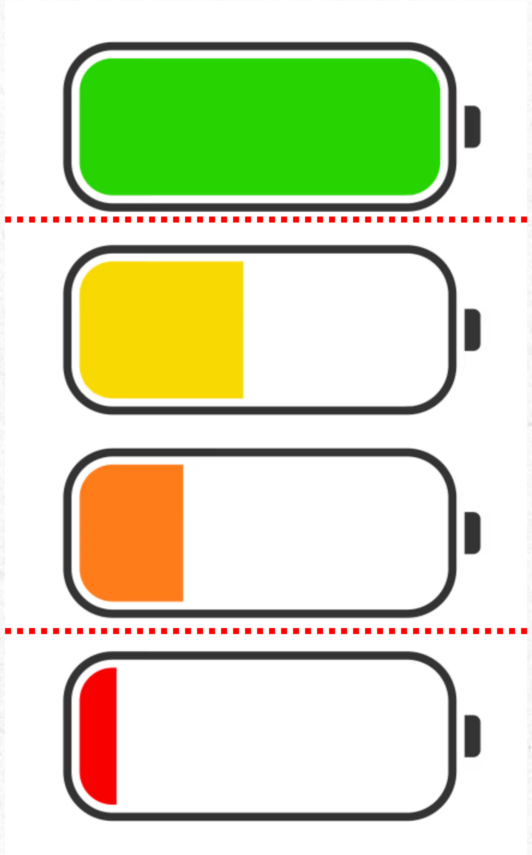
SOH (70-80%)

SECOND

Problem Definition

SOH tells us how ‘healthy’ the ba

They are still valuable, especially because they contain critical raw materials such as lithium, nickel, and cobalt.

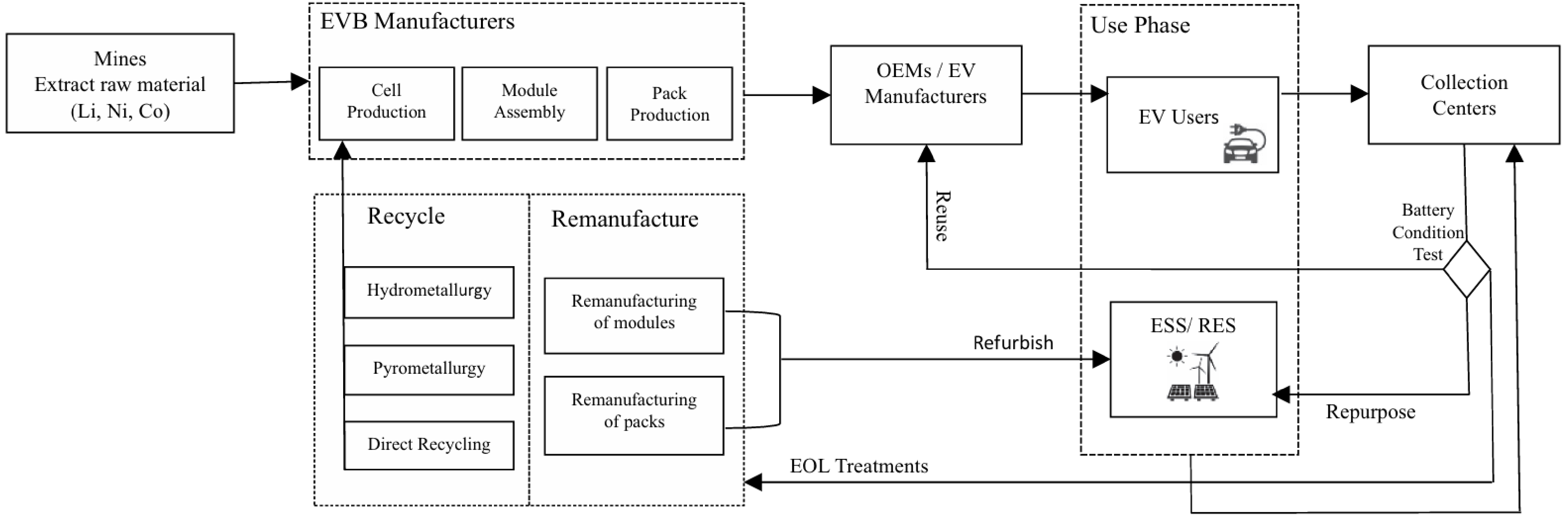


100% SOH → brand new battery

70–80% SOH → still usable (second life)

Over 12 million EVBs will reach end-of-life by 2030.

<70% SOH → end-of-life / recycling



Closed-loop supply chain for electric vehicle battery.

THIRD

Research Gap

Research Gaps

- High operational costs
- Lack of coordination among stakeholders
- Fragmented and inefficient networks
- Uncertainty in return quantity and quality
- Limited infrastructure for collection and processing

Challenges in Current Reverse Logistics and CLSC Systems

THIRD

Research Gap

Research Gaps

1 From an optimization perspective

- Limited ability to incorporate **collaboration among multiple actors**
- Shared use of logistics infrastructures is rarely considered

2 From a business model perspective

- Circular business models are conceptually well-developed, with limited integration of sharing economy principles
- However, they mainly lack **quantitative validation**
- Their **economic and operational feasibility** remains uncertain

FOURTH

Research Objectives

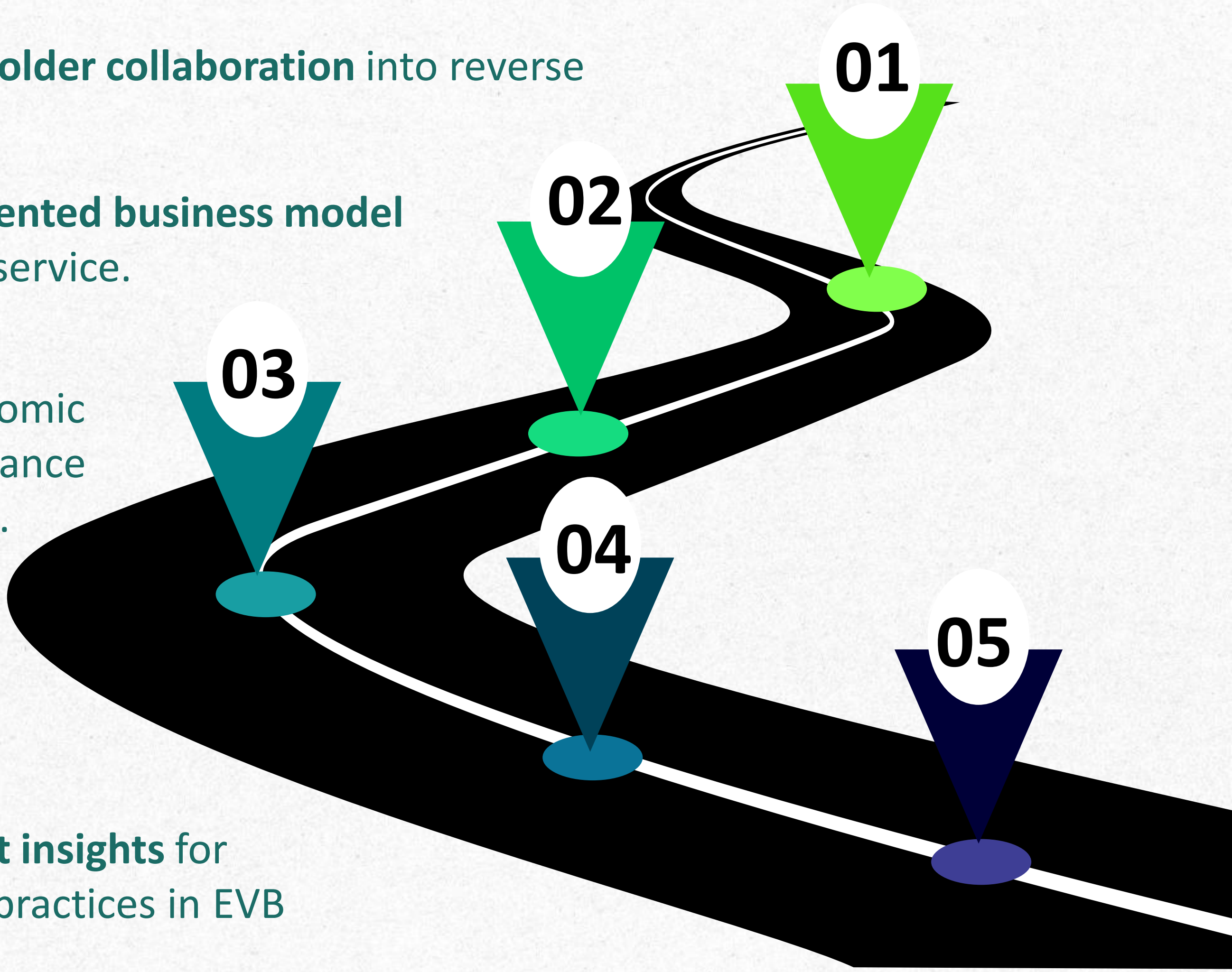
First — To incorporate **multi-stakeholder collaboration** into reverse logistics systems.

Second — To design a **feasible use-oriented business model** shifting from ownership to service.

Third — To develop a **quantitative framework** evaluating economic and environmental performance of shared logistics networks.

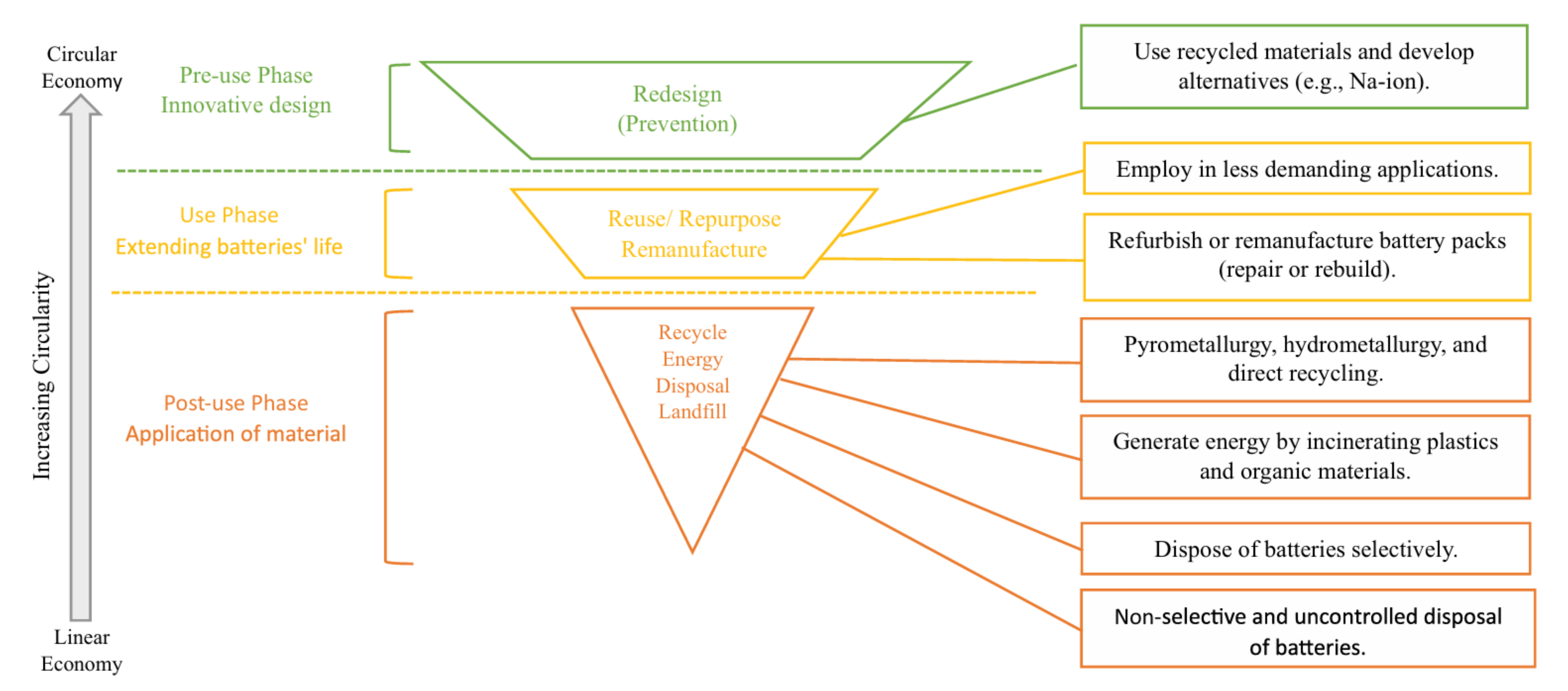
Fourth — To assess the impact of **sharing economy** on:
recovery costs
network efficiency

Fifth — To provide **decision-support insights** for adopting sharing economy practices in EVB industry.



FIFTH

Proposed Approach



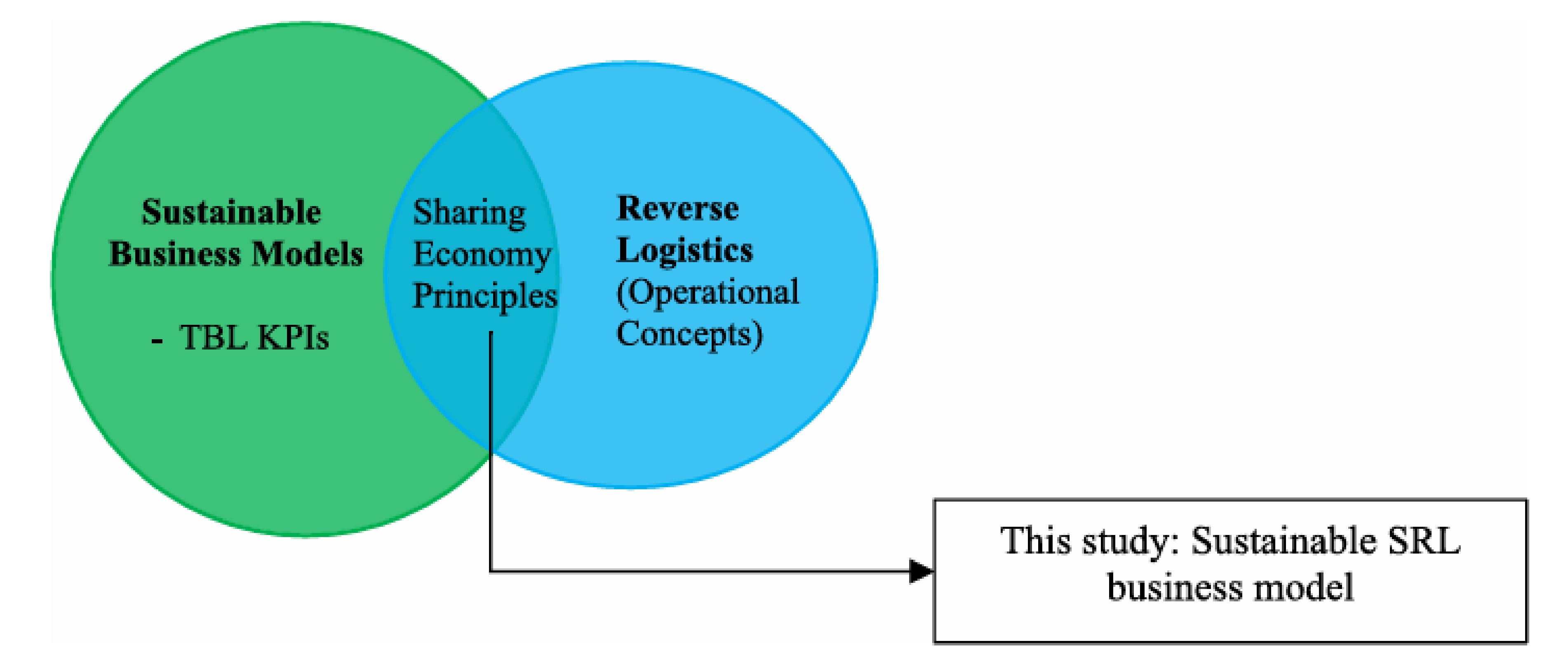
Electric vehicle battery waste hierarchy model.

Source: Mahboubi, A., Keivanpour, S., & Lamghari, A. (2025). *Promoting circular systems in electric vehicle batteries: A use-oriented business model with sharing economy and reverse logistics integration*. International Journal of Green Energy. https://doi.org/10.1080/15435075.2025.2553177

FIFTH

Proposed Approach

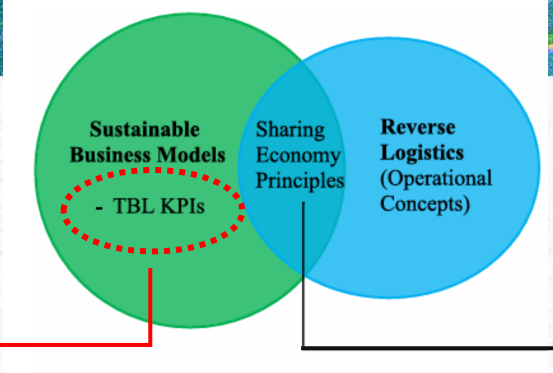
Sharing Economy + Reverse Logistics = Shared Reverse Logistics

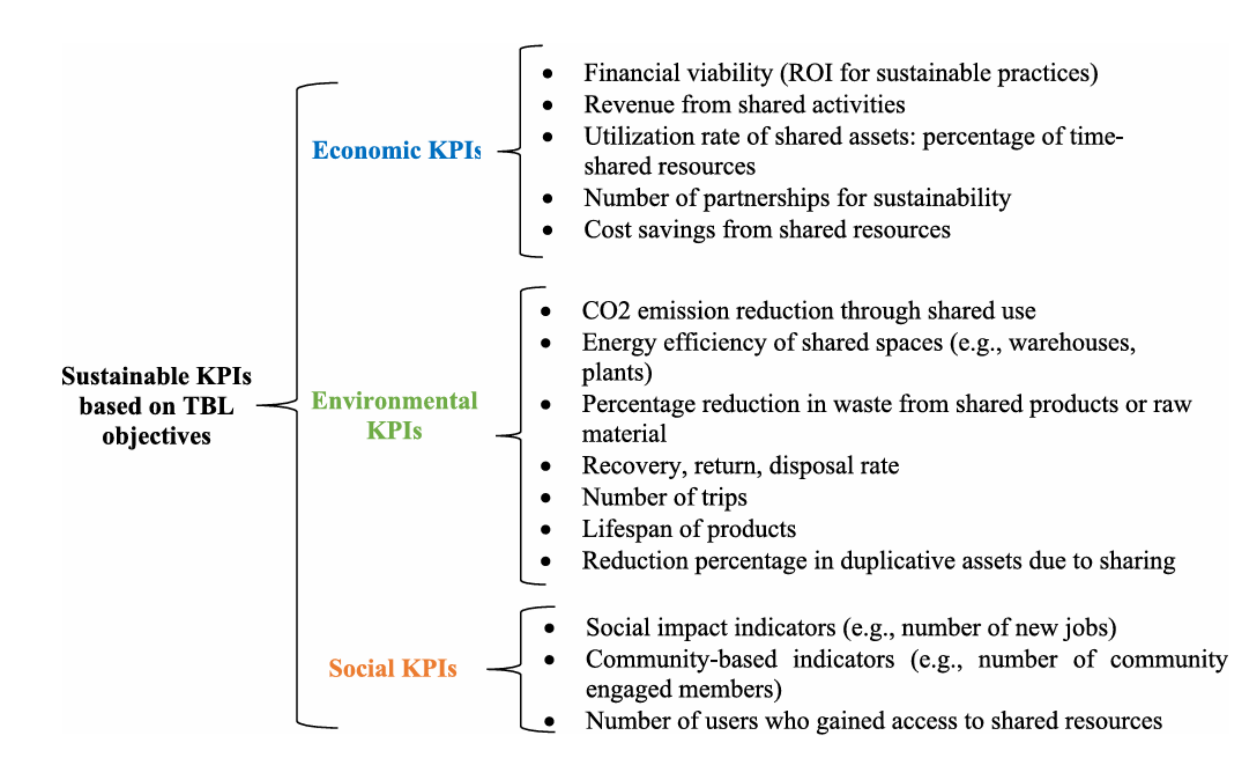


Mahboubi, A., Kazemi Miyangaskary, M., Keivanpour, S., & Lamghari, A. (2025). *The sustainable shared reverse logistics framework: A blueprint for EV battery recovery*. Circular Economy and Sustainability. https://doi.org/10.1007/s43615-025-00623-2

FIFTH

Proposed Approach

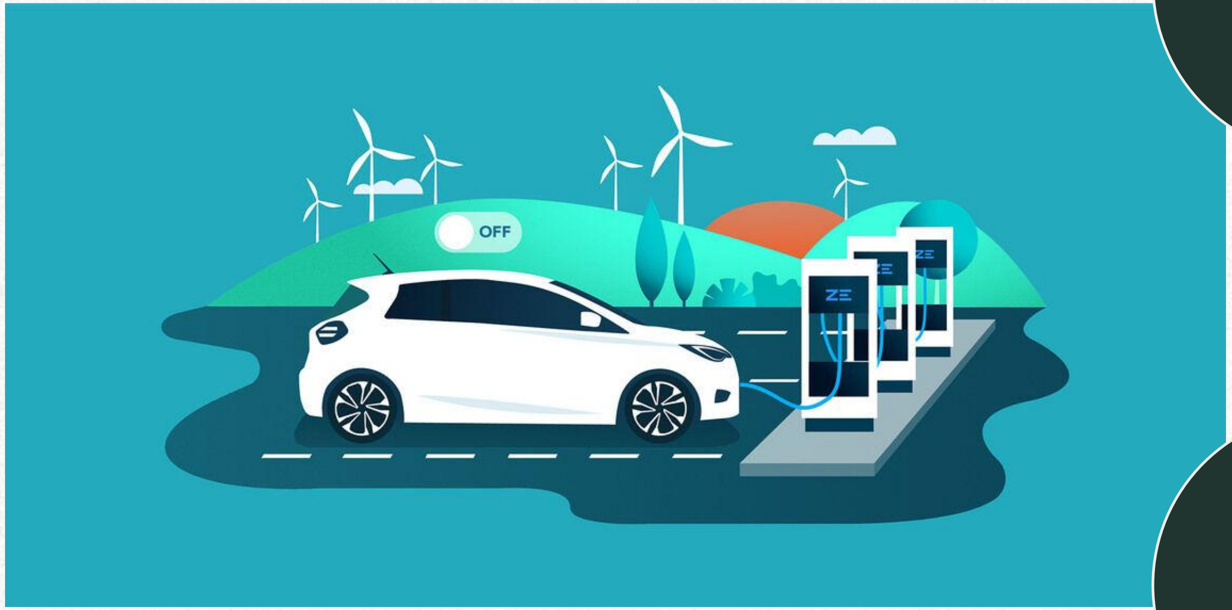




Shared Reverse Logistics

- Transportation Sharing
- Facility (or Capacity) Sharing
- Used Parts Sharing

Use-oriented Business Model



Battery Swapping System (BSS)

Battery-as-a-Service (BaaS)

Users access the product without owning it.

SIXTH

Results & Key Insights

These models shift from **ownership to access** =>more efficient and circular use of EV batteries.

Battery Swapping System (BSS)

+

Battery-as-a-Service (BaaS)

→

Users access the product without owning it.

BSS	BaaS
Users exchange depleted batteries for charged ones.	Battery is provided as a service, separate from the vehicle.
Example: • Swap stations for EVs	**Examples:** • Pay-per-use battery • Subscription-based battery usage
Key Ideas: • Reduces charging time • Enables shared battery infrastructure	**Key Ideas:** • Customers buy the EV without the battery • Battery is managed by a service provider

BaaS

BSS

Baseline

Mathematical Optimization Model (MILP)

- Trade-off: Economic & Environment Objectives

$$\max Z_1 = \sum_{t \in T} [Re_t - (FC_t + FLC_t + SC_t + RLC_t + IC_t)]$$

Revenue | Fixed Cost | Forward Logistics Cost | Shortage Cost | RL Cost | Inventory Cost

$$min\ Z_2 = \sum_{t \in T} (GHG_t^{elect} + GHG_t^{trans})$$

Max Profit

Min GHG emissions

SIXTH

Results & Key Insights

Criteria	Baseline (CLSC)	BSS	BaaS
System Type	Traditional (No sharing)	Infrastructure sharing	Ownership-based model
Profit	Reference	+0.5% to +0.6%	+11%
GHG Emissions	Reference	−2% to −4%	Improved via higher recovery efficiency
Recovery Volume	Low	Slight improvement	~4× increase
Battery Flow Control	Low	Medium	High
Coordination Level	Fragmented	Shared infrastructure	Centralized coordination
Overall Performance	Weak	Moderate improvement	Strong improvement

Conclusion

Q&A

Thank You for Your Attention ☺

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