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Circular Economy Innovations for Resilient, Competitive and Sustainable Battery Technologies (CIRCUBATT)

Deliverable 1.6: Social Life Cycle Assessment

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List of figures

Figure 1: Methodology framework 15

Figure 2: Articles collection and selection process 17

Figure 3: S-LCA Framework for EVB second-life applications 18

Figure 4: Subcategories for performance and impact assessment 18

Figure 5: Demographic of respondents 20

Figure 6: Radar chart for performance assessment across five categories 28

Figure 7: Performance contribution per subcategory 30

Figure 8: Overall impact assessment per category 32

Figure 9: Impact contribution per subcategory 36

Figure 10: Overall performance assessment using stochastic experts' weights ... 41

Figure 11: Performance contribution using stochastic experts' weights 43

Figure 12: Overall impact assessment using stochastic experts' weights 43

Figure 13: Subcategory impact contribution using stochastic experts' weights 45

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List of tables

Table 1: Stakeholder counts 20

Table 2: Country counts 21

Table 3: Descriptive statistics for deterministic and stochastic weights by subcategory 26

Table 4: Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) results 39

Table 5: Quantified social performance and impact assessment 46

Table 6: Summary of social value, hotspots and value propositions 48

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List of acronyms

BaaS: Battery-as-a-Service

BESS: Battery Energy Storage System

CIRCUBATT: Circular Economy Innovations for Resilient, Competitive, and Sustainable Battery Technologies

EoL: End-of-Life

EVBs: Electric Vehicle Batteries

EVs: Electric Vehicles

IP: Intellectual Property

LCA: Life Cycle Assessment

MCDA: Multiple-Criteria Decision Analysis

OAT: One-at-a-time

PSILCA: Product Social Impact Life Cycle Assessment

SHDB: Social Hotspots Database

S-LCA: Social Life Cycle Assessment

UNEP: United Nations Environment Programme

VIP: Variable Interdependent Parameter

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Table of contents

1 Executive summary 8
2 Introduction 10
2.1 Overview and context of Deliverable (D1.6) 10
2.2 Aim and Objectives 11
2.3 Deliverable (D1.6) outputs summary 12
2.4 Deliverable (D1.6) report structure 13
3 Research Method and Data 14
3.1 Research methodology framework 14
3.2 Goal, scope and system boundaries 15
3.3 Categories, Subcategories and indicators selection 16
3.4 Social lifecycle inventory (Data collection) 18
3.4.1 Round 1 survey 19
3.4.2 Round 2 survey 19
3.4.3 Online database collection 21
3.5 Expert-based subcategory weights 22
3.6 Social lifecycle performance and impact assessment 23
3.6.1 Indicator normalisation 23
3.6.2 Social performance and impact measurements – additive aggregation model 24
3.6.3 Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) sensitivity analysis 25
4 Main Findings and Discussion 25
4.1 Expert-based subcategory weights 25
4.2 Social Performance Assessment 27
4.2.1 Overall performance assessment using deterministic experts' weights 27
4.2.2 Performance contribution per subcategory towards their own category using deterministic experts' weights 28

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4.3 Social Impact Assessment 30
4.3.1 Overall impact assessment using fixed experts' weights 30
4.3.2 Impact contribution per subcategory towards their own category using deterministic experts' weights 32
4.3.3 Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) sensitivity analysis 36
4.4 Sensitivity Analysis 40
4.4.1 Overall performance assessment and performance contribution using stochastic experts' weights 40
4.4.2 Overall impact assessment and contribution using stochastic experts' weights 43
5 Social Benefits, Hotspots and Value Propositions 45
6 Conclusion and Future Direction 52
7 References 53
Annex 57
Annex 1. The key reviewed documents 57
Annex 2. Round 1 Survey 68
Annex 3. Round 2 Survey 72
Annex 4. Round 2 survey insights on open-text inputs 87

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1 Executive summary

Deliverable D1.6 provides the first (interim) pathway-based S-LCA of second-life electric vehicle battery (EVB) applications within Battery as a Service (BaaS) contexts under the Horizon Europe CIRCUBATT project. It supports WP1 decision making by comparing the prospective social performance and impacts of four representative second-life pathways and by translating the findings into actionable business model guidance.

The assessment is pathway-based and prospective, covering the second-life EVB supply chain from the retirement decision point through preparation, deployment/use, and handover to end-of-second-life management. Four pathways are compared: A) Energy Arbitrage & Grid Services, B) Backup Power & Resilience, C) Portable & Off-Grid Uses, and D) Urban Mobility.

The study adapts the UNEP S-LCA Guidelines in six steps: (1) goal/scope/system boundaries; (2) category–subcategory–indicator selection; (3) expert-based subcategory weighting; (4) social inventory/data collection; (5) performance and impact assessment with transparent aggregation; and (6) sensitivity/robustness analysis. Round-1 expert survey (n = 10) established weights; Round-2 stakeholder survey (n = 165 valid responses, 21 countries) estimated prospective impacts; secondary data from EU/European sources complemented the inventory. Robustness was tested via Monte Carlo (100,000 scenarios) plus Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) sensitivity analysis.

Five stakeholder groups are assessed—workers, value-chain actors, consumers, large society (EU/national), and local communities—using a framework of 36 subcategories, 56 performance indicators, and 58 impact indicators. Expert weighting consistently prioritised health & safety, living conditions (workers/consumers/society/communities), and for value-chain actors IP rights and fair competition.

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Headline findings show current social performance to be positive across all stakeholder categories, signalling a supportive environment for scaling second-life models. Expected impacts, however, are asymmetric: workers and consumers are projected to gain the most, while local communities and large society register negative perceived net impacts, mainly due to stakeholder concerns over safety, distributional fairness, accessibility, siting, and community acceptance; value-chain actors anticipate mixed outcomes given fair-competition and intellectual-property (IP) uncertainties.

Within the current interim assessment, the pathway comparison shows a directionally clear and relatively robust pattern: Pathway B (Backup & Resilience) appears to have the most favourable social profile, Pathways A (Energy Arbitrage) and C (Portable/Off-Grid) form a middle tier, and Pathway D (Urban Mobility) shows the weakest profile overall. However, the absolute differences remain modest at the category level and the ranking remains stable under extensive weighting uncertainty.

Hotspots concentrate around working time and pay gaps, consumer privacy/cybersecurity, fair-competition and IP risks, societal concerns over technology accessibility and corruption, and community vulnerabilities linked to living conditions, local employment intensity, cultural/indigenous rights, and siting/proximity. Priority actions therefore include strengthening labour protections and benefits; codifying EVB/BESS safety standards, certification, and training; clarifying IP/competition rules with interoperable data/standards; embedding privacy-by-design with responsive feedback channels; and pursuing early community engagement, careful siting, and targeted local hiring and supplier policies.

Robustness checks suggest that both hotspot diagnoses and the pathway ordering persist across 100,000 weighting scenarios and VIP/OAT tests. As an interim, perception-based assessment (April 2026), results may evolve with market, policy, and technology maturity; the final D1.6 (June 2027) will refine indicators, expand AI-enabled evidence, and deliver implementation-ready guidance to support D1.2 and WP1 business-model design.

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2 Introduction

CIRCUBATT is a Horizon Europe-funded project dedicated to advancing circular, competitive and sustainable solutions for second-life and end-of-life (EoL) batteries across Europe. By integrating AI-enabled analytics and digital lifecycle tools, the project aims to enhance transparency, safety, circularity and environmental responsibility throughout the battery value chain. Coordinated by the University of Greenwich (UK), CIRCUBATT brings together academic and industrial partners to co-develop innovative business models and explore new technologies that reduce environmental impact, supporting a resilient European battery value chain. Within this context, WP1 focuses on business model development and decision support for Battery-as-a-Service (BaaS) and second-life applications.

2.1 Overview and context of Deliverable (D1.6)

With the rapid diffusion of electric vehicles (EVs), increasing volumes of electric vehicle batteries (EVBs) are approaching end-of-first-life while still retaining substantial functional capacity (typically around 60-80%). This creates a growing opportunity for second-life applications, but also a decision point: alternative repurposing pathways involve different supply chain configurations, stakeholder exposure, and governance arrangements, and therefore can lead to markedly different sustainability outcomes.

Deliverable D1.6 is produced under the Horizon Europe CIRCUBATT project and focuses on the social dimension of BaaS and second-life EVB value chains. While second-life options have been increasingly assessed through technical feasibility and environmental performance (Montes et al., 2022; Philippot et al., 2022), a consistent and decision-oriented approach to anticipate, compare, and interpret social impacts and social value creation across alternative pathways remains underdeveloped for practice-oriented pathway selection and business model design.

In practice, second-life EVBs can be integrated into multiple pathways, each characterised by distinct supply chain structures, stakeholder involvement, and governance arrangements. These differences imply that social impacts are not uniform, but pathway-specific. Building on prior studies and industry-oriented assessments (Bobba et al., 2018; Montes et al., 2022; Neubauer et al., 2015), D1.6 develops a pathway-based Social Life Cycle Assessment (S-LCA) framework,

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aligned with the UNEP Guidelines for S-LCA, to support comparative assessment across four representative second-life pathways: (A) Energy Arbitrage & Grid Services, (B) Backup Power & Resilience, (C) Portable & Off-Grid Uses, and (D) Urban Mobility.

This report constitutes the first (interim) version of D1.6 (April 2026). It sets out the methodological framework, defines scope and system boundaries, establishes the social impact categories and indicators, and reports initial evidence collection, assessment, and sensitivity analysis to enable pathway comparison. The deliverable provides structured inputs to *Deliverable D1.2 (End-of-Life Battery-as-a-Service Business Model Handbook)* by translating S-LCA findings into pathway-relevant social insights (e.g., social hotspots, social value propositions, and action plans). The final version (June 2027) will consolidate additional AI-driven evidence, refine indicators and stakeholder mappings for social impact evaluation, providing a more comprehensive comparative assessment and set of decision-support outputs.

2.2 Aim and Objectives

D1.6 aims to develop and operationalise a pathway-based S-LCA framework that supports the comparative assessment of prospective social impacts and social value creation across second-life EVB supply chains in BaaS contexts, and to translate assessment results into actionable managerial insights.

The objectives of this deliverable are to:

- Define the goal, scope, system boundaries, and stakeholder groups for a pathway-based S-LCA of second-life EVB supply chains (Pathways A-D), ensuring comparability while reflecting pathway-specific contexts.
- Develop a UNEP-aligned S-LCA assessment architecture (categories, subcategories, indicators) and a practical data strategy to populate the social life cycle inventory.
- Assess and compare pathway-level social performance and impacts analysis through transparent weighting and aggregation (Multiple-Criteria Decision Analysis (MCDA)) across stakeholder groups and impact categories.
- Test robustness and translate insights into decision support, including sensitivity analyses and pathway-specific social hotspots, benefits, and

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actionable value propositions.

Overall, these objectives ensure that D1.6 delivers a transparent and comparable pathway-based S-LCA approach and converts assessment results into decision-support outputs that inform D1.2 and subsequent WP1 business model development.

2.3 Deliverable (D1.6) outputs summary

This interim D1.6 report (April 2026) provides a pathway-based S-LCA methodological framework for second-life EVB supply chains, aligned with UNEP S-LCA phases (goal & scope, inventory, impact assessment, interpretation).

- A structured set of social impact categories, subcategories and indicators, including rationale and data requirements.
- A social life cycle inventory approach, including Round 1 and 2 survey design, primary and secondary data collection, and outputs.
- Expert-based subcategory weights to support prioritisation and pathway comparison.
- Initial pathway comparison results for social performance assessment and social impact assessment.
- Sensitivity analysis results (e.g., VIP and OAT) to test robustness and sensitivity of the developed models.
- Managerial insights translating assessment outputs into social benefits, hotspots, value propositions and action plan.

The social performance assessment shows that circular business models for retired EVBs offer clear social benefits overall but also reveal important tensions between current conditions and future expectations. While the existing system is viewed positively, especially by large society and local communities, stakeholders express notable scepticism about the social impacts of new circular business models. This results in negative overall impact scores for these groups, reflecting uncertainties about technological change, economic implications, and community level effects.

Value chain actors also anticipate mixed outcomes: although their current social performance is positive, projected impacts decrease substantially, indicating perceived risks around market competition, intellectual property, and regulatory clarity. In contrast, consumers and workers remain optimistic, with strongly positive

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impact scores suggesting that circular EVB pathways could improve consumer well-being, strengthen safety and transparency, and enhance working conditions.

The consolidated hotspot analysis identifies strong contributions in areas such as labour rights, supplier relationships, poverty alleviation, sustainability commitments, and health and safety. However, several critical risks persist, including extended working hours, pay inequalities, fair-competition concerns, corruption risks, uneven technological development, consumer data privacy issues, and community-specific vulnerabilities.

Across all pathways, impact differences are small at the category level, meaning no single model emerges as clearly socially superior without pathway-level analysis. To complement these findings, a pairwise comparison of the four pathways – Energy Arbitrage (A), Backup & Resilience (B), Portable/Off-grid (C) and Urban Mobility (D) – examined how often one pathway socially outperforms another under diverse expert weighting schemes (section 4.3.3). The results reveal a consistent and robust ranking. Backup & Resilience (B) emerges as the most socially favourable option within the current model, showing a stable advantage over the other pathways across most weighting scenarios. Energy Arbitrage (A) and Portable/Off-grid (C) form a middle tier with largely comparable social performance, showing no systematic dominance between them. Urban Mobility (D) ranks lowest overall, being consistently outperformed by B and C, and only marginally behind A. Sensitivity tests, including OAT analysis, support the robustness of these results.

The resulting social value propositions outline targeted strategies that amplify the identified benefits while mitigating risks (Table 6). These include strengthening labour protections, enhancing transparency and data governance, improving community engagement, safeguarding cultural and indigenous rights, and clarifying competition and IP frameworks. Together, these insights provide a robust foundation for socially responsible design and implementation of second-life EVB business models.

2.4 Deliverable (D1.6) report structure

Section 1 - Executive summary. This section presents a concise overview of the deliverable's purpose, approach, key interim findings, and main outputs, highlighting pathway comparison headlines, hotspots, and actionable insights.

Section 2 - Introduction. This section sets out the context and motivation for D1.6, clarifies the aim and objectives, summarises the deliverable outputs, and clarifies the positioning of this interim report (April 2026) relative to the final report (June

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2027).

Section 3 – Research Method and Data. This section details the methodological design and evidence base underpinning the pathway-based S-LCA framework, including goal and scope definition, system boundaries, indicator collections and inventory, expert-based weighting, aggregation procedures and robustness testing.

Section 4 – Main Findings and Discussion. This section reports and interprets the interim assessment results, including expert-based weights, pathway-level social performance and impact assessment outcomes, and sensitivity analysis.

Section 5 – Social Benefits, Hotspots and Value Propositions. This section translates the S-LCA findings into pathway-relevant decision support, summarising key social benefits, hotspots and social value propositions, and proposing practical actions through a social mitigation plan.

Section 6 – Conclusions and Future Direction. This section concludes the interim report by summarising key findings and specifying next steps towards the final D1.6 report (June 2027).

3 Research Method and Data

3.1 Research methodology framework

Our research design adapts the UNEP's S-LCA Guideline (Benoît Norris et al., 2020) through six main steps (Figure 1): (1) defining the goal, scope, and system boundaries for comparing four second-life pathways; (2) selecting category, subcategory, and indicator through literature and industry document review; (3) validating and weighting subcategories through a Round 1 expert survey; 4) compiling the social lifecycle inventory through primary and secondary data collection; (5) conducting social performance and impact assessment; and (6) visualising, interpreting and validating the results through sensitivity analysis.

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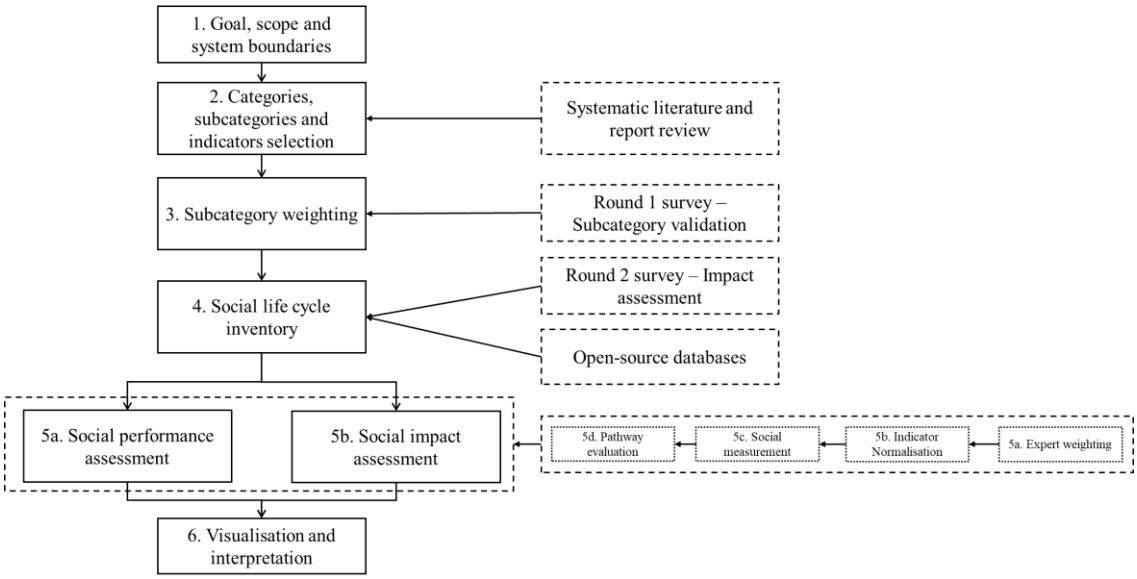


Figure 1: Methodology framework

3.2 Goal, scope and system boundaries

As shown in Figure 1, this section operationalises Step 1 of our design, which adapts the UNEP S-LCA Guidelines to a pathway-based assessment of second-life EVB applications. The goal, scope and system boundary decisions established here provide the basis for subsequent steps: Step 2 (indicator selection), Step 3 (expert weighting), Step 4 (inventory compilation), Step 5 (performance/impact assessment), and Step 6 (visualisation and interpretation).

The goal of D1.6 is to enable a comparative S-LCA of second-life EVB applications in BaaS contexts by comparing four representative pathways (A-D). The framework is designed to identify and assess potential positive and negative social performance and social impacts associated with applying these pathways to retired (end-of-first-life) EVBs entering second-life. The intended users of this assessment are businesses, policymakers, and wider stakeholders, who require transparent evidence to support pathway selection, governance design, and business model development.

The assessment compares:

1) Pathway A – Energy Arbitrage & Grid Services
2) Pathway B – Backup Power & Resilience
3) Pathway C – Portable & Off-Grid Uses
4) Pathway D – Urban Mobility

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Consistent with UNEP S-LCA, the assessment covers both positive and negative social topics across relevant stakeholder groups and impact categories (defined in Section 3.3). The scope is pathway-based and prospective: it focuses on how differences in stakeholder exposure and governance arrangements across pathways can shape social outcomes, rather than assessing a single firm or a single site.

In S-LCA, unlike environmental LCA, which typically models impact pathways based on physical flows, assessment often requires combining performance information with prospective interpretation of social consequences (Ciroth & Franze, 2011). In line with the UNEP S-LCA approach, this deliverable distinguishes between social performance assessment and social impact assessment. **Social performance assessment** evaluates the current status of relevant actors/sectors against selected indicators, interpreted in relation to the country/region context, whereas **social impact assessment** considers the expected positive and negative consequences associated with pathway-specific configurations and behaviours across selected social subcategories and categories from stakeholder perspectives.

To ensure pathway comparability, the system boundary covers the second-life EVB chain from the retirement decision point through second-life preparation, deployment or use, and the handover to end-of-second-life management. The unit of analysis is the pathway-level second-life EVB application system (A-D). Results are reported at stakeholder and category/subcategory levels and subsequently aggregated to support pathway comparison (see Sections 3.5-3.6 and Section 4).

3.3 Categories, Subcategories and indicators selection

Building on UNEP Guidelines for S-LCA of Products (Benoît Norris et al., 2020), we first reviewed widely used S-LCA sources and databases, including the Social Hotspots Database (Benoit-Norris et al., 2012), the PSILCA database (Maister et al., 2020), and prior applied studies such as the LCA of an ecolabeled notebook (Ciroth & Franze, 2011). These sources commonly structure S-LCA frameworks into categories, sub-categories, and indicators. Recognising that not all indicators are equally relevant to EoL EVB applications. For example, child labour is critical in upstream battery raw-material extraction but less applicable at EoL recycling. Thus, we refined the framework through a systematic review of academic literature applying S-LCA to EV, EVB and battery energy storage systems (BESS), using

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targeted keyword combinations (Figure 2). Figure 2 shows the process of selecting relevant papers. Annex 1 shows the key reviewed documents to aid our categories, subcategories and indicators selection process.

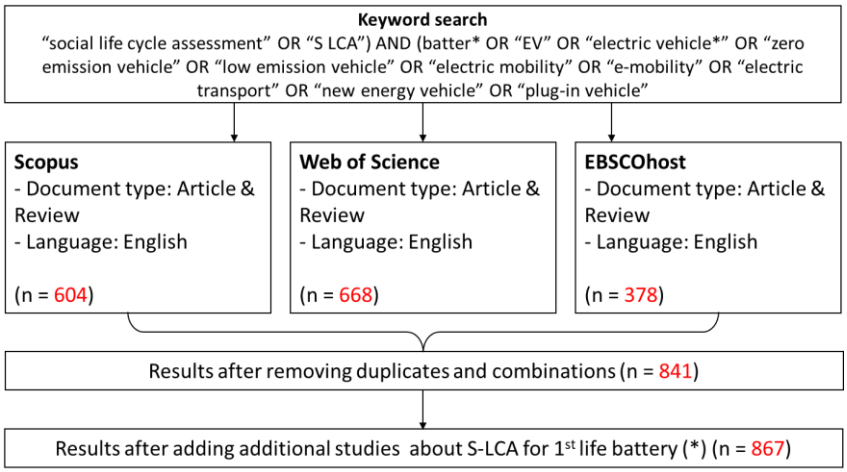
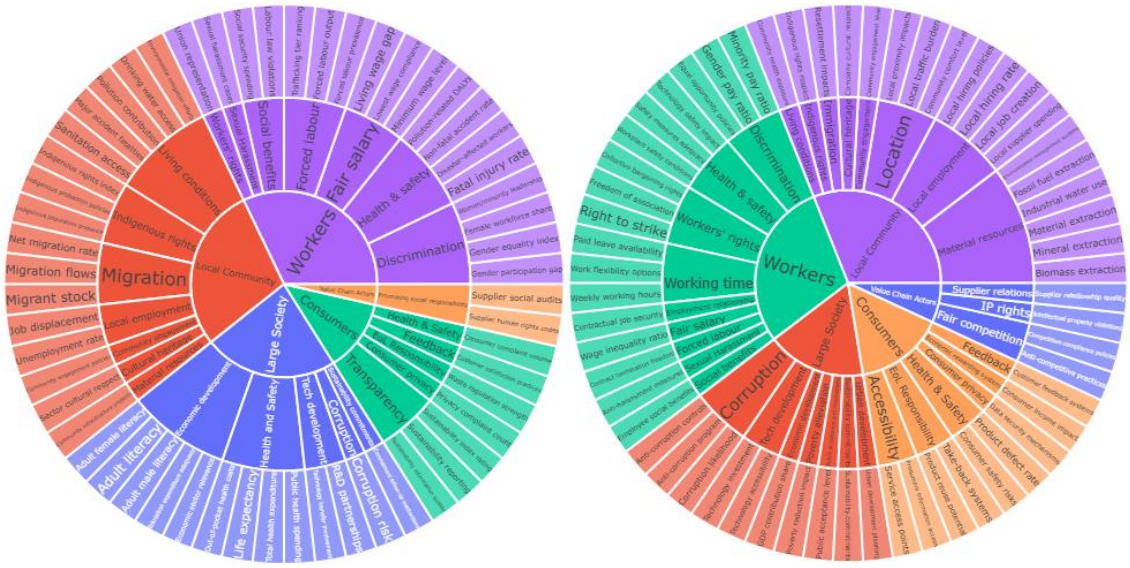


Figure 2: Articles collection and selection process

We developed a context-specific S-LCA framework comprising five stakeholder groups – workers, value chain actors, consumers, society, and local communities – covering 36 sub-categories, 56 performance indicators, and 58 impact indicators. The workers category captures well-being, welfare, rights, and safety for employees involved in current or emerging business models. Value chain actors (excluding consumers) reflect interactions and relationships between focal firms and partners such as suppliers. Society refers to EU/national-level impacts, including economic development, poverty, and broader social conditions. Consumers encompass well-being, acceptance, engagement, and user-related risks. Local communities capture place-based impacts where business models are implemented, such as resource use, cultural heritage, local employment, and spatial considerations.

Figure 3 and Figure 4 show the lists of indicators and sub-categories for performance and impact assessment. In the Annex 1, we also specify the indicators that will be used to measure performance and impact.

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(a) Performance Assessment (b) Impact Assessment

Figure 3: S-LCA Framework for EVB second-life applications

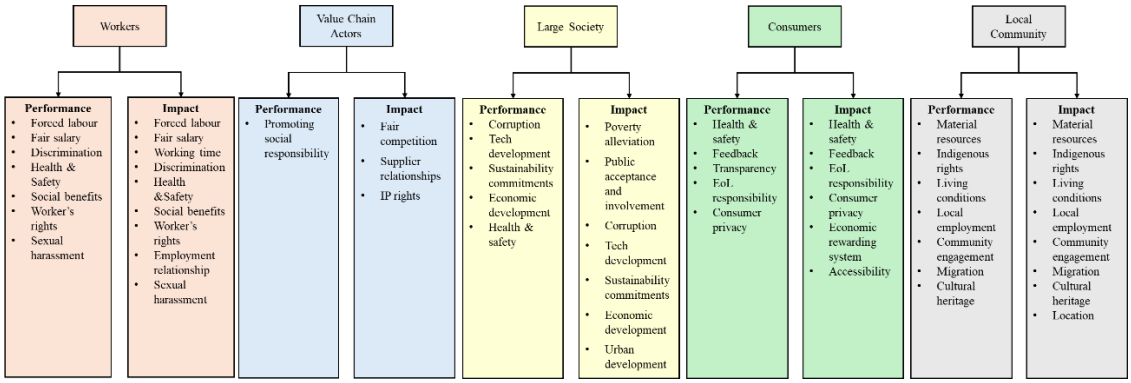


Figure 4: Subcategories for performance and impact assessment

3.4 Social lifecycle inventory (Data collection)

In this section, we describe how the data was collected and constructed. The use of questionnaires is necessary because this study is based on the novel business models developed in the CIRCUBATT project for which relevant social data are not yet available in existing databases. For example, social indicators associated with newly created job roles, such as repurposing engineers, are not documented, including information on salary ranges, working conditions, or skill requirements. Similarly, social and health-related indicators, such as health and safety levels

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associated with the use of EoL BESS in residential solar panel applications, are not captured in current datasets.

There are other methods that rely on simulation tools (e.g., SimaPro) and existing social databases such as the SHDB or PSILCA. However, the applicability of these approaches in S-LCA is debated in this context, as social impacts of business models are often shaped by organisational behaviour toward stakeholders rather than by physical product functions, making product-based functional units difficult to define (Osorio-Tejada et al., 2020; Sánchez et al., 2024). While these tools are well suited to established industries and supply chains, they are limited in representing innovative organisational practices and novel business configurations.

In the absence of empirical social data for these emerging contexts, expert and stakeholder knowledge provides a valuable source of information. Questionnaires enable the collection of predictive and qualitative data based on professional experience and informed judgement, allowing anticipated social impacts to be assessed where historical data do not exist. Online databases capturing the macro-level social landscape in the EU and Europe can complement this study by providing contextual benchmarks for current social readiness and targeted social outcomes following the implementation of the new business models.

3.4.1 Round 1 survey

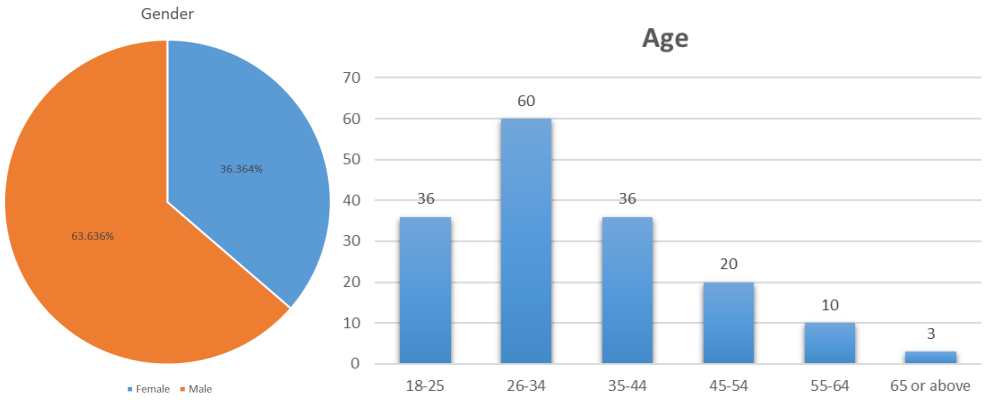
To address the research questions, data collection followed a two-round approach. In Round 1, we validated and ranked the importance of S-LCA sub-categories through an expert survey (Round 1), designed to assess their relative relevance and importance. Ten experts from battery manufacturing, technology development, EV manufacturing, and academia participated, including six industry experts (60%), three researchers (30%), and one scientist/standardisation expert (10%). Experts rated 36 sub-categories within their respective stakeholder groups on a scale from 0 (not relevant) to 5 (extremely important). The full survey 1 is provided in the Annex 2.

3.4.2 Round 2 survey

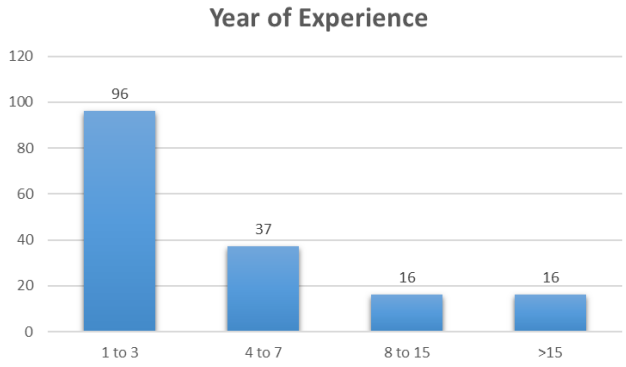
In Round 2, we conducted the S-LCA impact assessment by developing indicator-level survey questions to estimate potential future positive and negative impacts and the effectiveness of existing or proposed mitigation measures. This survey was implemented using Qualtrics, with participants recruited via Prolific to ensure appropriate stakeholder representation. Prolific is a well-known survey service with a wide pool of domain experts, especially in automotive and energy sectors.

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Responses from Prolific have been shown to be more reliable than those from Connect or MTurk. Kay (2025) found substantially more contradictory responses on Connect and MTurk compared to Prolific. A total of 231 responses were collected, of which 165 valid responses were retained after removing incomplete entries; Demographic descriptions of respondents are reported in Figure 5, Table 1 and Table 2. The full round 2 survey is provided in the Annex 3.



(a) (b)



(c)

Figure 5: Demographic of respondents

Table 1: Stakeholder counts

Stakeholder Type	Frequency	Percent
EV/Battery Consumers	38	23.0
Residents	30	18.2
(Renewable) Energy Provider/Energy Generators/Utility Provider/Trader/Grid Operators etc	15	9.1
Academic or Research Institution	15	9.1
Government/Regulatory Body	12	7.3
Transportation/Logistics Companies	12	7.3
Non-governmental organisation	11	6.7

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Local Businesses	10	6.1
Large Electric Vehicles (EV) Manufacturers (e.g., cars, automotive, trains, planes, ships)	7	4.2
Light Mobility End Consumers (e.g., e-bikes, e-scooters)	7	4.2
EV Retailer	4	2.4
Battery Remanufacturer, Recycler, Repurposer	2	1.2
Battery Manufacturer & Technology Developer	1	0.6
Light Mobility Manufacturers (e.g., e-bikes, e-scooters)	1	0.6
Total	**165**	**100.0**

Table 2: Country counts

Country	Count	Percentage
United Kingdom	36	21.8
Portugal	26	15.8
Germany	24	14.5
Italy	14	8.5
Poland	12	7.3
Greece	11	6.7
Spain	9	5.5
France	8	4.8
Hungary	6	3.6
Netherlands	4	2.4
Austria	2	1.2
Estonia	2	1.2
Finland	2	1.2
Sweden	2	1.2
Belgium	1	0.6
Croatia	1	0.6
Czechia	1	0.6
Ireland	1	0.6
Slovakia	1	0.6
Slovenia	1	0.6
Switzerland	1	0.6
Total	165	100.0

3.4.3 Online database collection

For indicators defined and measured at the regional or national level where organisations operate, we collected the most recent data available from online databases. The raw values include both numeric and qualitative types and are primarily drawn from sources within the EU or Europe. To support normalisation (Section 3.6.1), we also recorded the highest (max) and lowest (min) values observed in the EU or Europe. This EU-focused approach ensures that the analysis reflects the social conditions relevant to the context in which the new business models will operate, while also highlighting relative differences and areas for improvement among European countries. Global data were used for benchmarking only when no country-level information was available within Europe, ensuring that

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international values are applied sparingly and only when necessary for completeness. This is because using global minima could introduce extreme values from developing regions that are not representative of the European context. This method balances the need for comparability, relevance, and meaningful interpretation of social performance. A few indicators were not applicable or available at the EU or European level such as youth literacy rate, external health expenditure.

3.5 Expert-based subcategory weights

With the results from Round 1 – Survey, we construct two separate sets of weights. The first set, referred to as deterministic weights or fixed expert weights, assigns a specific importance value to each subcategory. Let $p = 1, \dots, P$ denote the experts and $j = 1, \dots, J$ the subcategories. The mathematical formulation is as follows:

$$wd_j = \frac{1}{P}\sum_{p=1}^{p}\frac{r_{pj}}{\sum_{j=1}^{J} r_{pj}}, \quad if \sum_{j=1}^{J} r_{pj} > 0 \tag{1}$$

with:

$$w_j > 0, \qquad \sum_{j=1}^{J} w_j = 1$$

where r_{pj} is the importance score assigned by expert p to subcategory j, and wd_j denotes the deterministic weight of subcategory j across all experts P.

The second set of weights, referred to as stochastic weights or mixing weights, incorporates Monte Carlo simulation to account for uncertainty in the importance rankings. This approach is adapted from Du et al. (2019). Let $\mathrm{m} = (m_1, \dots, m_t)$ denote the expert mixture coefficients. The expert mixtures are sampled as follows:

$$m \sim Dirichlet(1, \dots, 1) \tag{2}$$

with:

$$m_t^p \geq 0, \qquad \sum_{t=1}^{T} m_t^p = 1$$

For each Monte Carlo iteration $t = 1, \dots, T$, the stochastic weight for each subcategory is calculated as follows:

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$$ws_j^t = m_t \,.\, wd_j \quad (3)$$

where m_t^p denotes the mixture coefficient t for expert p, and ws_j^t represents the stochastic weight of subcategory j in iteration t. The iterations (e.g., scenarios) capture the possible ways in which experts may weigh the subcategories.

3.6 Social lifecycle performance and impact assessment

3.6.1 Indicator normalisation

In this section, the expected social performance and impacts are assessed in terms of whether they represent benefits or risks to relevant stakeholders. To enable aggregation and comparison across indicators, subcategories, and categories measured in different units, all raw indicator values are scaled to a common range from −1 (very negative) to +1 (very positive), consistent with the MCDA framework.

Two types of raw data are used in the performance assessment: quantitative and qualitative data. Quantitative indicators are collected from online databases and measured at the EU or European level, with corresponding minimum and maximum values identified within the EU or, where necessary, globally, as discussed in Section 3.5. Qualitative indicators capture the presence of relevant policies or initiatives and are represented using a binary scale (0 or 1).

For the impact assessment, social impacts are measured through the survey using multiple question formats. These include Likert-scale questions ranging from 0 to 5 and numeric questions (e.g., *"How positive or negative do you think the working conditions will be?"* and *"Please indicate the expected number of paid annual leave days offered to workers/staff, excluding public holidays, in the context of second-life EVB applications."*). Additional question formats include percentage responses ranging from −100% to 100% and a three-point ranking scale. As these latter formats are already expressed on a ratio scale or can be directly mapped to the −1 to +1 range, they are scaled or assigned accordingly.

All quantitative data from online databases and Likert-scale responses from Round 2 of the survey are subsequently normalised to a single scale ranging from −1 to +1. Responses are scaled to a range from −1 (very negative) to +1 (very positive).

Let $r = 1, \dots, R$ denote the respondents and $i = 1, \dots, I$ the indicators within each subcategory. Let x_{ri} be the value given by respondent r for indicator i. The average value for each indicator can be generalised as follows:

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$$\bar{x}_i = \frac{1}{R}\sum_{r=1}^{R} x_{ri} \quad (4)$$

The normalised value for each subcategory *j* is calculated as follows:

$$v_j = \frac{1}{\mathrm{I}}\sum_{i=1}^{\mathrm{I}}\left(-1 + 2 \times \frac{\bar{x}_i - x_i^{min}}{x_i^{max} - x_i^{min}}\right) \quad (5)$$

where $x_i^{\min}$ and $x_i^{\max}$ denote the minimum and maximum possible (or observed) values for indicator i. For reverse-coded indicators, v_j^{reverse} is defined as the negated value of v_j. For each pathway score, we apply the same Eq. (4) and Eq. (5) but consider only the responses from participants who indicated that they had previously experienced the products or services within that pathway. This ensures a more accurate estimation of impacts for each pathway.

3.6.2 Social performance and impact measurements – additive aggregation model

- *Overall and pathway-specific assessment using deterministic weights*

We calculate the overall and pathway-specific impact scores for each category using the deterministic weights $\mathrm{wd_j}$ and the normalised values v_j as follows:

$$Score^{fixed} = \sum_{j=1}^{J}\left(v_j \times \mathrm{wd_j}\right) \quad (6)$$

- *Overall and pathway-specific assessment using stochastic weights*

Since the stochastic weights are defined across scenarios t (i.e., iterations for each subcategory) according to Eq. (3), the impact score for each category under each scenario is calculated as follows:

$$Score^{t} = \sum_{j=1}^{J}\left(v_j \times ws_j^t\right) \quad (7)$$

The above equations will be applied for both social performance and impact assessments. Notably, the composition of sub-categories within each category differs between the performance and impact assessments (see Figure 4). When a sub-category is not considered in their assessment, we omit that subcategory from the equations, indicating that it does not contribute to the assessed social

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performance or expected social impact under the current analysis.

3.6.3 Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) sensitivity analysis

Variable Interdependent Parameters (VIP) are part of additive value functions used to rank decision alternatives (i.e., pathways) based on multiple subcategories and indicators (Dias & Climaco, 2000; Du et al., 2019). VIP analysis identifies the extreme bounds (i.e., minimum and maximum) of the difference in overall impacts between two pathways. Let a_1 and a_2 denote two pathways being compared, $c = 1, \dots, C$ denote the categories. The difference in the normalised value for each subcategory is calculated as follows:

$$\Delta V_j = v_j(a1) - v_j(a2) \tag{8}$$

Then, the difference in the normalised value for each category, as assessed by each expert, can be formulated as follows:

$$D_p^{(c)} = \sum_{j=1}^{J} w_{pj}\, \Delta V_j \tag{9}$$

with

$$w_{pj} = \frac{r_{pj}}{\sum_{j=1}^{J} r_{pj}}$$

We obtain D as a matrix of overall impact differences corresponding to the p experts and c categories. From these values, we compute the minimum, maximum, mean, and standard deviation, and assess how often one pathway outperforms the other. To examine the sensitivity of expert scoring, we further apply an OAT analysis by removing one expert at a time from the difference set and recomputing the minimum, maximum, mean, standard deviation, and frequency.

4 Main Findings and Discussion

4.1 Expert-based subcategory weights

The weighting results are presented in the Table 3. Several key insights emerge. First, all subcategories within each category are scaled to a common range of 0 to 1. Two sets of expert weights are applied. Deterministic expert weights are fixed weights that sum to 1 across all subcategories within a category and are derived from Eq. (1). Stochastic expert weights are mixing weights generated from 100,000

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Monte Carlo scenarios based on the inputs of 10 experts, allowing uncertainty in expert judgments to be explicitly accounted for (Eq. (3)).

Across categories, health and safety and living conditions consistently receive the highest weights for workers, consumers, EU/national-level society and local communities. This is intuitive, as the assessed business models – particularly those involving EoL EVB – may raise concerns and scepticism about safety, risk, or public acceptance despite formal certification.

IP rights and fair competition emerge as the most important subcategories for developing new supply chains. While this emphasis is common, it remains challenging in the European context, where energy markets are unevenly structured despite policy goals promoting structural separation between producers, suppliers, and sellers, as seen in countries such as the UK (Duong et al., 2026; Hajiyev et al., 2021). This issue leads to the concerns of IP when they are collaborations among firms. In contrast, several countries, including France, argue for maintaining large, vertically integrated monopoly firms, citing their ability to attract investment, ease of regulation, and stronger global competitiveness (Hajiyev et al., 2021).

Finally, the mean weights are consistent across the deterministic and stochastic approaches, and the associated standard deviations are small. This indicates a high level of reliability and consistency in expert judgments. These weights are therefore suitable for scaling the final category-level social impact scores in subsequent stages of the analysis.

Table 3: Descriptive statistics for deterministic and stochastic weights by subcategory

Category	Subcategory	Deterministic Expert Weights[1]				Stochastics Expert Weights[2]			
		Mean	Std.	Min	Max	Mean	Std.	Min	Max
Workers	Forced labour	0.106	0.046	0	0.154	0.107	0.013	0.031	0.144
	Fair salary	0.107	0.021	0.062	0.143	0.107	0.006	0.072	0.134
	Working time	0.119	0.024	0.095	0.182	0.119	0.007	0.101	0.166
	Discrimination	0.096	0.04	0	0.143	0.096	0.012	0.025	0.131
	Health & safety	**0.156**	**0.041**	**0.111**	**0.25**	**0.156**	**0.012**	**0.122**	**0.23**
	Social benefits	0.104	0.036	0.075	0.188	0.104	0.01	0.08	0.171
	Workers' rights	0.114	0.027	0.075	0.182	0.114	0.008	0.085	0.165
	Employment relationship	0.106	0.037	0.057	0.182	0.106	0.011	0.069	0.167
	Sexual Harassment	0.092	0.038	0	0.132	0.092	0.011	0.022	0.124
Value Chain Actors	**Fair competition**	**0.253**	**0.066**	**0.143**	**0.385**	**0.253**	**0.019**	**0.169**	**0.352**
	Promoting social responsibility	0.231	0.04	0.143	0.267	0.231	0.012	0.163	0.262
	Supplier relations	0.224	0.054	0.133	0.312	0.224	0.016	0.155	0.289
	IP rights	**0.293**	**0.114**	**0.154**	**0.571**	**0.293**	**0.033**	**0.189**	**0.502**

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Large Society	Poverty alleviation	0.106	0.03	0.037	0.133	0.106	0.009	0.056	0.128
	Public acceptance and involvement	0.134	0.046	0.088	0.25	0.134	0.013	0.097	0.224
	Corruption	0.12	0.031	0.071	0.167	0.12	0.009	0.082	0.156
	Tech development	0.127	0.022	0.083	0.148	0.127	0.006	0.094	0.145
	Sustainability commitments	0.134	0.019	0.103	0.167	0.134	0.005	0.111	0.158
	Economic development	0.124	0.027	0.071	0.172	0.124	0.008	0.087	0.159
	Health & safety	**0.135**	**0.016**	**0.115**	**0.167**	**0.135**	**0.004**	**0.118**	**0.159**
	Urban development	0.118	0.044	0	0.148	0.118	0.013	0.027	0.145
Consumers	**Health & Safety**	**0.164**	**0.027**	**0.125**	**0.208**	**0.164**	**0.008**	**0.134**	**0.197**
	Feedback	0.132	0.023	0.083	0.154	0.132	0.007	0.095	0.149
	Transparency	0.147	0.021	0.115	0.19	0.147	0.006	0.125	0.181
	EoL Responsibility	0.153	0.016	0.125	0.179	0.153	0.005	0.132	0.173
	Consumer privacy	0.14	0.023	0.091	0.167	0.14	0.007	0.102	0.161
	Economic rewarding system	0.139	0.028	0.095	0.192	0.139	0.008	0.106	0.176
	Accessibility	0.126	0.029	0.077	0.156	0.126	0.008	0.089	0.15
Local Community	Material resources	0.136	0.028	0.083	0.167	0.136	0.008	0.097	0.162
	Indigenous rights	0.141	0.031	0.083	0.2	0.141	0.009	0.095	0.186
	Living conditions	**0.163**	**0.038**	**0.121**	**0.25**	**0.163**	**0.011**	**0.131**	**0.228**
	Local employment	0.12	0.026	0.083	0.167	0.12	0.007	0.09	0.155
	Community engagement	0.116	0.023	0.083	0.167	0.116	0.007	0.092	0.155
	Migration	0.092	0.037	0	0.125	0.092	0.011	0.027	0.119
	Cultural heritage	0.112	0.035	0.042	0.152	0.112	0.01	0.061	0.143
	Location	0.12	0.037	0.061	0.167	0.12	0.011	0.075	0.16
1. N = 10 experts **2. N = 100,000 scenarios generated from 10 experts**									

4.2 Social Performance Assessment

4.2.1 Overall performance assessment using deterministic experts' weights

In this section, we assess the current social performance across the EU and wider European landscape using Eq. (6). Figure 6 presents a radar chart illustrating the overall performance across the five stakeholder categories: *Workers, Value Chain Actors, Large Society, Consumers,* and *Local Communities*.

Overall, all categories show positive performance scores, indicating a robust and favourable social landscape for the automotive and energy sectors. These results suggest that existing policies, institutional structures, and societal conditions form a strong foundation for the adoption and scaling of circular business models for

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second-life EVBs.

However, despite this generally strong position, the scores for Consumers and Workers remain noticeably lower (approximately around 0.1) compared to other categories. This indicates that, while external stakeholders – such as governments, local communities, and value chain partners – tend to benefit under current conditions, concerns persist regarding worker-related conditions and consumer-facing aspects within the sector.

To better understand these disparities, the following section disaggregates the results and examines performance at the subcategory level, identifying the factors driving these differences and highlighting areas requiring targeted intervention.

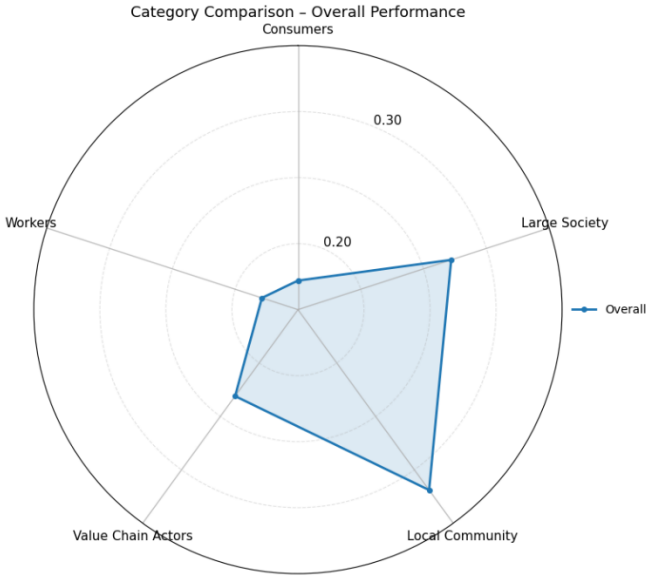


Figure 6: Radar chart for performance assessment across five categories

4.2.2 Performance contribution per subcategory towards their own category using deterministic experts' weights

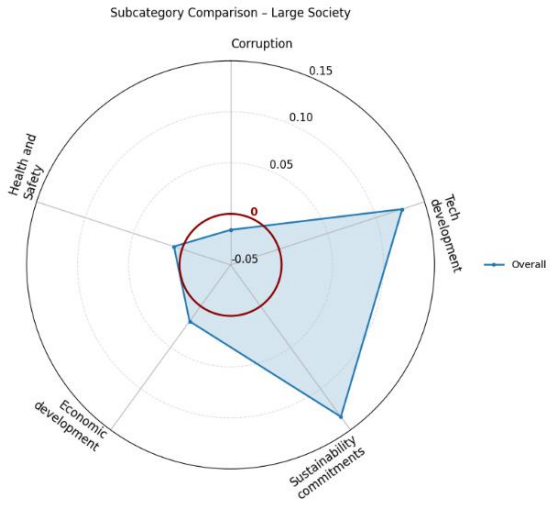
In Figure 6, the results reveal two strong positive-performing stakeholder groups: Large Society and Local Communities. For Large Society, the strongest social boosters are linked to technology development and sustainability commitments, both of which reflect Europe's established innovation ecosystem and robust policy frameworks (Figure 7a). Local Communities also demonstrate consistently strong scores, driven by factors such as respect for cultural heritage, protection of indigenous rights, favourable living conditions, high potential for local employment, and active community engagement (Figure 7b). These findings suggest that community-level integration of second-life EVB business models is well supported

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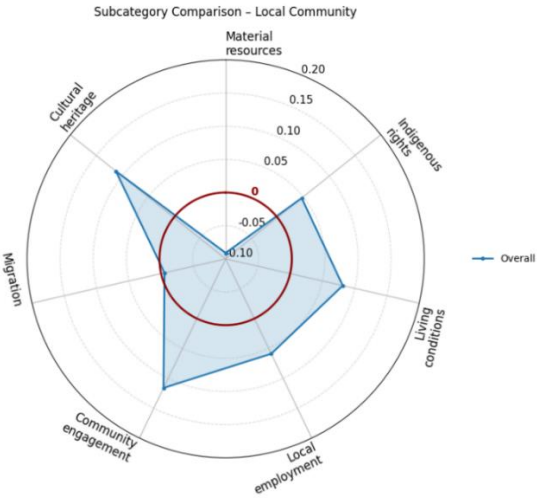
by existing social structures and local capacities.

In contrast, two social weaker-but-positive performance emerge among Workers and Consumers. For Workers, the subcategories of worker's rights and social benefits show negative values, indicating gaps in areas such as labour protections, access to social welfare, and perceived fairness of working conditions (Figure 7c). For Consumers, the primary hotspot is consumer privacy, where concerns related to data handling, digital monitoring, and protection of personal information remain evident (Figure 7d). These results highlight the need for targeted interventions to improve both labour conditions and consumer-facing data governance.

For Value Chain Actors, only one subcategory is assessed: promotion of social responsibility (Figure 7e). The corresponding results are positive, showing that firms operating within or adjacent to second-life EVB value chains already demonstrate strong commitments to ethical practices, responsible conduct, and stakeholder engagement. This provides a strong foundation for further collaborative governance as circular business models evolve.



(a)



(b)

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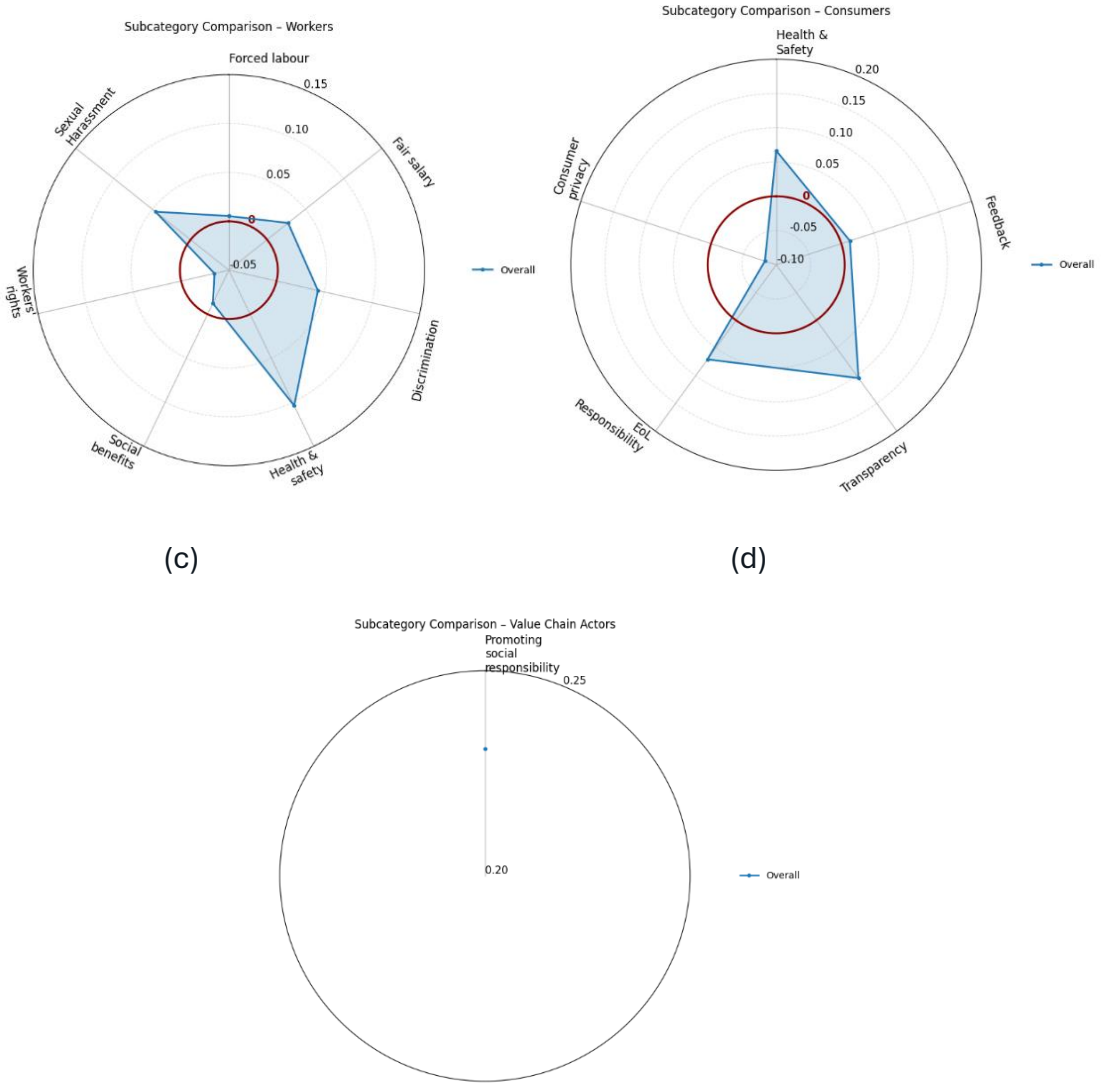


Figure 7: Performance contribution per subcategory

4.3 Social Impact Assessment

4.3.1 Overall impact assessment using fixed experts' weights

Resulting from Eq. (6), Figure 8 illustrates the overall social impact scores per category. *Value chain actors* exhibit positive but relatively modest impacts, reflecting inherent tensions among social subcategories within this group. These trade-offs suggest that social value creation is not uniformly distributed and may involve conflicting outcomes across dimensions.

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Two stakeholder groups – *workers and consumers* – emerge as the primary contributors to social benefits. This finding supports key propositions of sustainability-dominant logic theory proposed by Batista et al. (2023). Social responsibility can be seen as an endogenous driver of economic value creation, which is reflected in the positive social value delivered to consumers. Product longevity can be assessed through prolonged utility and enhanced recoverability through durability, repairability, recyclability, and disassembly. While these attributes may appear less directly relevant to workers, they are ultimately dependent on worker wellbeing; without healthy and fairly treated workers, sustainable-by-design practices cannot be effectively implemented.

Two clear areas of perceived social concerns/hotspots are identified: *local communities and broader EU/national-level society*. This can be explained by their position as external or indirect stakeholders, who are less directly involved in value creation and therefore have limited visibility of the economic and social benefits associated with these prospective business models. As many of the pathways are forward-looking and not widely implemented, these stakeholders may perceive the promised benefits as uncertain or abstract, while potential risks appear more salient. In addition, the reuse of EoL EVBs can generate scepticism related to safety, environmental impacts, and long-term reliability, further reinforcing negative expectations. These findings suggest that indirect stakeholders may discount future value while overweighting perceived risks, highlighting their influential role in shaping social acceptance and legitimacy despite their limited direct participation in the supply chain. Satisfying these groups and gaining broad societal acceptance is therefore essential, not only because of spillover effects on potential consumers, but also because it can reshape the regulatory landscape in ways that are more favourable to business development and long-term value creation.

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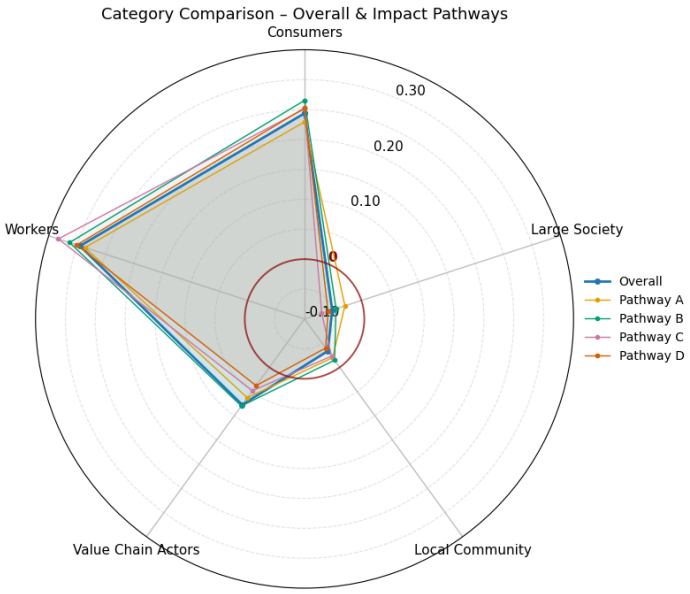


Figure 8: Overall impact assessment per category

4.3.2 Impact contribution per subcategory towards their own category using deterministic experts' weights

Across all pathways, most worker-related subcategories show positive social impacts, aligning with the overall category assessment (Figure 9a). Nevertheless, *working time* and *discrimination* stand out as notable social hotspots. Survey findings reveal stakeholder concerns about fairness in working hours and entitlement to holiday leave within emerging business models. Reported paid leave in Europe averages 25 days per year compared to the minimum of 20 days observed in the United States and to a maximum of 43 days in Germany. Average weekly working hours are 36, closer to 42 hours in South Africa than to 26 hours in Germany. In addition, discrimination-related insights highlight persistent worries about pay gaps between men and women, as well as disparities affecting minority groups. Collectively, these variations point to perceived inequalities in labour conditions across regions and pathways for 2nd life EVB applications, underscoring the need for targeted improvements in social performance.

Impacts for *value chain actors* are heterogeneous, particularly regarding fair competition and intellectual property (IP) rights (Figure 9b). Only Pathway B yields positive impacts for *IP protection*, while the other pathways are perceived as more vulnerable – largely due to their reliance on digital platforms and tracking technologies that may be exposed to cybersecurity risks. Pathway B's grid-independent configuration, typically deployed for backup services, is

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commonly implemented by established firms with mature cybersecurity infrastructures in place, in contrast to Pathways C and D. Pathway A faces the highest exposure to risk because its BESS operates in connection with national or regional grids, while the other pathways require only partial grid connectivity for charging and service provision.

Fair competition scores also vary substantially across pathways. Pathway A performs positively, whereas Pathways B, C, and D score negatively, reflecting perceived imbalances in market structures and competitive dynamics. Pathway A's significantly positive score stems from its integration into the highly regulated energy sector, where clearly defined supply chain roles, from generators and grid operators to suppliers and end users, help ensure transparent and equitable market functioning. Mechanisms such as pay-as-clear pricing, where all generators receive the same market-clearing price, and pay-as-bid models, which allow producers to submit competitive bids based on their marginal costs, further reinforce fairness by preventing discriminatory pricing and promoting efficiency[1]. These features make BESS applications within grid optimisation more predictable, transparent, and competitively balanced than the emerging business models characterising the other pathways.

Although most subcategories within the large-society dimension demonstrate positive social value, the overall category score is driven downward by negative impact related to *economic contribution* and *technology development* (Figure 9c). Survey respondents estimate that these business model pathways could contribute approximately 14 % to GDP – an exceptionally high value for a single industry sector. This reflects the scaling of the indicator (0–100 %) rather than an actual economic burden; in practice, a 14 % expected contribution signals that these pathways could act as substantial socio-economic boosters.

However, the performance of technology-related subcategories dampens the overall score. Technology accessibility and affordability for developing countries is low (2.9/5), and reported investment into these regions is only about 20 % of operating revenue, indicating limited scalability. While the underlying technologies, particularly BESS, are advanced and capable of delivering significant societal benefits, their high capital costs restrict widespread deployment. As a result, the social value that could be created through broader diffusion and technology inclusion remains constrained.

[1] https://energy.ec.europa.eu/topics/markets-and-consumers/electricity-market-design_en

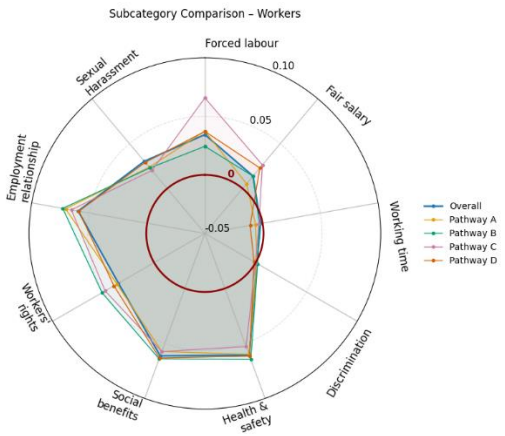
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Consumers generally perceive the new business models as valuable and relevant for future daily use, supporting economic value creation and the triple bottom line (Figure 9d). Nevertheless, privacy concerns persist across most pathways, except Pathway B. This aligns with IP-rights findings, as consumers must connect to digital platforms for monitoring and control, increasing exposure to cybersecurity risks.

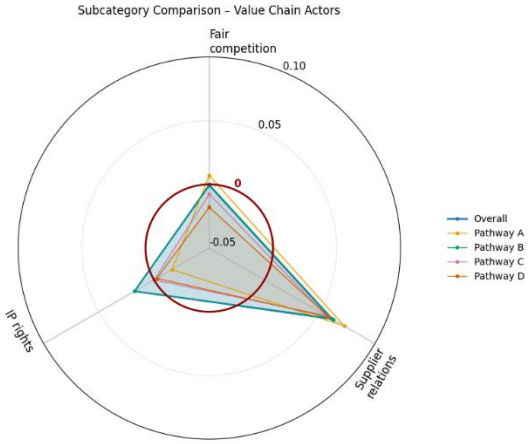
Local communities represent the most consistent social hotspot, with negative scores across multiple subcategories (Figure 9e). Concerns relate to location impacts (average 2.9/5), cultural heritage (3.6/5, reverse coded), respect for indigenous rights (2.9/5), and limited local employment. Respondents expect approximately 52.83% of the workforce to be hired locally and only 30% of new jobs relative to existing energy-sector employment. Large-scale BESS installations are perceived as hazardous and space-intensive, potentially affecting housing, ecosystems, and culturally significant sites. Their proximity to urban areas, necessary for economic efficiency, creates trade-offs between economic and social benefits.

At the same time, immigration, community engagement, and resource-related subcategories score positively. The reuse of EoL EVB reduces demand for raw material extraction and lowers mining pressures, thereby supporting local resource sustainability. Pathway D is the only pathway that does not show a positive score for material use because it targets consumer-level light-mobility applications. Although repurposed EVBs can contribute to resource conservation, the additional materials required to manufacture large volumes of light-mobility products may offset these benefits. Moreover, the high level of technical expertise required across most pathways may constrain local employment opportunities and increase reliance on migrant labour. These dynamic highlights a tension between economic efficiency and inclusive social outcomes, as technological advancement does not automatically translate into broad-based local job creation.

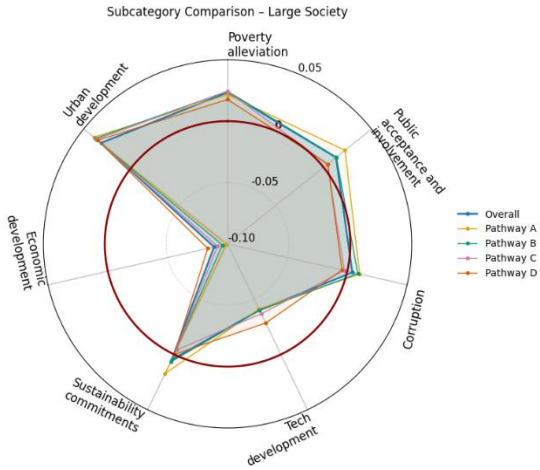
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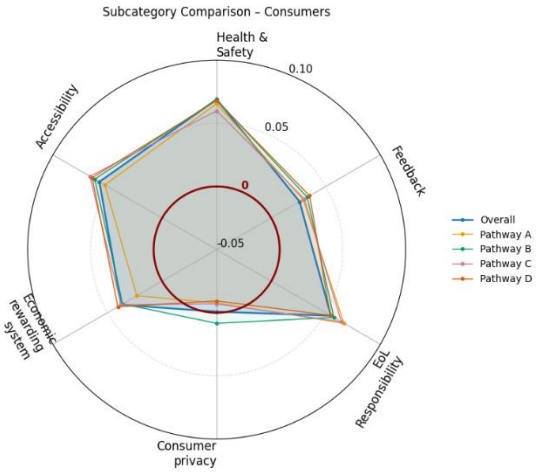
(a)



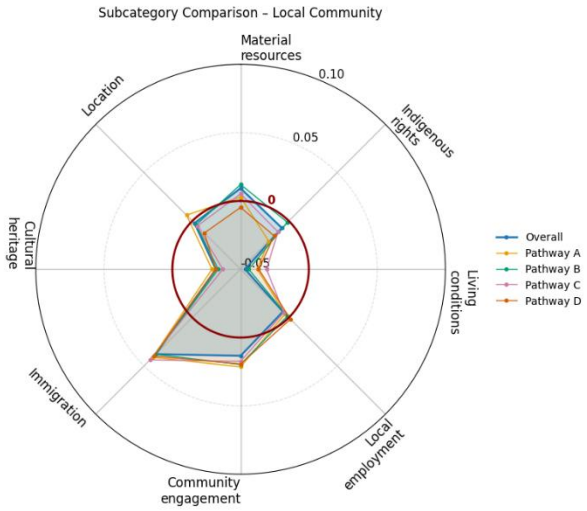
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(e)

Figure 9: Impact contribution per subcategory

4.3.3 Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) sensitivity analysis

This subsection presents the results of the pairwise social impact comparison across the four pathways: A (Energy Arbitrage), B (Backup & Resilience), C (Portable/Off-grid) and D (Urban Mobility). The analysis is based on Eq. (8) and Eq. (9), as described in Section 3.6.3, and quantifies how often one pathway socially outperforms another under varying expert weighting schemes. Table 4 summarises the numerical outcomes; the key insights and their practical implications are interpreted below.

- **A vs B – Energy Arbitrage vs Backup & Resilience**
  - Pathway A is generally socially worse than Pathway B, with highly stable results.
  - Mean difference is clearly negative (≈ –0.0139).
  - Approximately 76% of all weighting combinations favour Pathway B.
  - Worst-case disadvantage for A is substantial (–0.0557); Best-case advantage for A is minimal (+0.0206).

Backup & Resilience (Pathway B) tends to deliver more favourable social outcomes than large-scale energy-market applications (Pathway A), even under vastly different expert priorities. These results suggest structural social advantages in favour of Pathway B.

- **B vs D – Backup & Resilience vs Urban Mobility**
  - This comparison shows the strongest and most stable advantage across all pairings.
  - Mean difference is clearly positive (+0.0214).
  - Only ~4% of all cases show D performing better than B.
  - Minimum difference is close to zero, with no substantial negative outliers.

From a social perspective, Backup & Resilience (B) shows a highly stable advantage over Urban Mobility (D). This reflects strong structural advantages for B, largely independent of weighting preferences or expert bias.

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- **B vs C – Backup & Resilience vs Portable / Off-grid**
  - Pathway B generally shows a stable advantage over Pathway C.
  - Mean difference is positive (+0.0119).
  - Only ~16% of weighting combinations favour C.
  - The uncertainty interval is narrow, indicating high stability.

Backup & Resilience (B) is socially robust relative to portable/off-grid applications (C). When combined with the subcategory-level analysis (Section 4.3.2), this ranking remains strongly supported.

- **A vs C – Energy Arbitrage vs Portable / Off-grid**
  - Social impacts between A and C are very similar.
  - Mean difference is almost zero (–0.002).
  - Roughly 46% of cases show A performing worse than C, indicating near balance.
  - Worst-case disadvantage for A: –0.0665; Best-case advantage for A: +0.0525.

Energy Arbitrage (A) and Portable/Off-grid uses (C) exhibit comparable social performance across most scenarios. Neither pathway shows clear systemic dominance over the other.

- **A vs D – Energy Arbitrage vs Urban Mobility**
  - Pathway A performs slightly better than Pathway D.
  - Mean difference is positive (+0.0075).
  - Approximately 60% of cases favour A.
  - Worst-case disadvantage for A: –0.0285; Best-case advantage: +0.045.

Energy Arbitrage (A) tends to outperform Urban Mobility (D), although the margin is modest. Results are stable across varying weighting profiles.

- **C vs D – Portable / Off-grid vs Urban Mobility**
  - Pathway C performs better than Pathway D.
  - Mean difference is positive (+0.0096).
  - Around 64% of cases favour C.

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- Both worst- and best-case differences remain positive (0.0193 to 0.0487).

Portable/off-grid applications (C) generally achieve stronger social outcomes than Urban Mobility (D), with consistent direction and stability in results.

Overall, the results suggest *a robust social preference* for Backup and Resilience applications (Pathway B), followed by a middle tier comprising Energy Arbitrage (Pathway A) and Portable Off-grid uses (Pathway C), and a consistently weaker social performance for Urban Mobility applications (Pathway D). The results are still consistent when we apply the OAT analysis demonstrating the consistency in expert's opinion and the stability and robustness of our results.

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Table 4: Variable Interdependent Parameter (VIP) and One-at-a-time (OAT) results

Pair	Metric	Original	Without Expert 1	Without Expert 2	Without Expert 3	Without Expert 4	Without Expert 5	Without Expert 6	Without Expert 7	Without Expert 8	Without Expert 9	Without Expert 10
A vs B	Minimum (VIP analysis)	-0.0557	-0.0557	-0.0557	-0.0557	-0.0557	-0.0557	-0.0557	-0.0406	-0.0557	-0.0557	-0.0557
	Maximum (VIP analysis)	0.0206	0.0206	0.0206	0.0206	0.0206	0.0206	0.0206	0.0184	0.0206	0.0206	0.0206
	Mean	-0.0139	-0.0141	-0.0137	-0.0139	-0.0143	-0.0141	-0.0138	-0.0133	-0.0137	-0.0142	-0.0141
	Std Dev	0.0198	0.0193	0.0202	0.0199	0.02	0.0201	0.0197	0.019	0.0197	0.0199	0.0199
	% of cases with ΔI < 0	76	77.7778	75.5556	75.5556	75.5556	75.5556	75.5556	75.5556	75.5556	77.7778	75.5556
A vs C	Minimum (VIP analysis)	-0.0665	-0.0665	-0.0622	-0.0665	-0.0665	-0.0665	-0.0665	-0.0665	-0.0665	-0.0665	-0.0665
	Maximum (VIP analysis)	0.0525	0.0525	0.0525	0.0525	0.0525	0.0525	0.0525	0.0475	0.0525	0.0525	0.0525
	Mean	-0.002	-0.0022	-0.0011	-0.0019	-0.0022	-0.0021	-0.0024	-0.0013	-0.0031	-0.0021	-0.002
	Std Dev	0.0317	0.0317	0.0315	0.0315	0.0314	0.0319	0.0322	0.031	0.0323	0.0313	0.0317
	% of cases with ΔI < 0	46	46.6667	46.6667	46.6667	46.6667	46.6667	46.6667	42.2222	46.6667	44.4444	46.6667
A vs D	Minimum (VIP analysis)	-0.0285	-0.0285	-0.0285	-0.0285	-0.0285	-0.0285	-0.027	-0.0285	-0.0285	-0.0285	-0.0285
	Maximum (VIP analysis)	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.0415	0.045
	Mean	0.0075	0.0073	0.0082	0.0075	0.0072	0.0075	0.0078	0.008	0.0071	0.0071	0.0075
	Std Dev	0.0231	0.0234	0.0231	0.0231	0.0231	0.0234	0.0231	0.0232	0.0232	0.0228	0.0231
	% of cases with ΔI < 0	40	42.2222	40	40	40	40	40	37.7778	40	40	40
B vs C	Minimum (VIP analysis)	-0.0437	-0.0437	-0.043	-0.0437	-0.0437	-0.0437	-0.0437	-0.0437	-0.0437	-0.0437	-0.0437
	Maximum (VIP analysis)	0.0426	0.0426	0.0426	0.0426	0.0426	0.0426	0.0426	0.0331	0.0426	0.0426	0.0426
	Mean	0.0119	0.0119	0.0126	0.012	0.0121	0.0121	0.0114	0.012	0.0107	0.0121	0.012
	Std Dev	0.0209	0.0215	0.0201	0.0205	0.0207	0.0212	0.0217	0.0196	0.0214	0.0206	0.0211
	% of cases with ΔI < 0	16	15.5556	15.5556	15.5556	15.5556	15.5556	17.7778	15.5556	17.7778	15.5556	15.5556
B vs D	Minimum (VIP analysis)	-0.0006	-0.0006	0	-0.0006	-0.0006	-0.0006	-0.0006	-0.0006	-0.0006	-0.0006	-0.0006
	Maximum (VIP analysis)	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0517	0.0441	0.0517	0.0517	0.0517
	Mean	0.0214	0.0213	0.0218	0.0214	0.0215	0.0216	0.0216	0.0213	0.0209	0.0214	0.0216
	Std Dev	0.0135	0.0134	0.0129	0.0136	0.0138	0.0137	0.0134	0.0131	0.0137	0.0137	0.0138
	% of cases with ΔI < 0	4	4.4444	2.2222	4.4444	4.4444	4.4444	4.4444	2.2222	4.4444	4.4444	4.4444
C vs D	Minimum (VIP analysis)	-0.0193	-0.0193	-0.0193	-0.0193	-0.0193	-0.0193	-0.0163	-0.0193	-0.0193	-0.0193	-0.0193
	Maximum (VIP analysis)	0.0487	0.0444	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487	0.0487
	Mean	0.0096	0.0094	0.0093	0.0094	0.0094	0.0095	0.0102	0.0094	0.0102	0.0093	0.0095
	Std Dev	0.0168	0.0162	0.0163	0.017	0.0169	0.0171	0.0169	0.0165	0.0173	0.0166	0.017
	% of cases with ΔI < 0	36	35.5556	35.5556	37.7778	37.7778	37.7778	35.5556	35.5556	33.3333	35.5556	35.5556

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4.4 Sensitivity Analysis

In this section, we evaluate the sensitivity and robustness of the social performance and impact assessment results presented in Sections 0 and 4.3. To capture uncertainty in expert judgements and weighting preferences, we employed a Monte Carlo simulation approach based on Eq. (3). Following the method of Du et al. (2019), stochastic weight distributions were generated for the ten participating experts, resulting in 100,000 simulated scenarios. Each scenario represents a unique set of weighting configurations across all subcategories, ensuring a comprehensive exploration of all plausible variations in expert emphasis and judgement.

Using these 100,000 sets of weights, we recalculated both the performance and impact scores using Eq. (7). This enabled a systematic examination of how changes in expert weighting influence the ranking and relative social performance of the pathways. The resulting distributions and comparative outcomes are visualised and discussed in the following subsections, allowing us to assess the stability, consistency, and robustness of our main findings under a wide range of uncertainty conditions.

4.4.1 Overall performance assessment and performance contribution using stochastic experts' weights

Across all categories, the Monte Carlo simulations reveal a degree of variation, with values generally ranging from approximately 0.2 to 0.7 (Figure 10). Despite this spread, the central 50% of the distribution and the overall mean remain closely aligned with the results reported in Section 4.3.1. Importantly, no outliers were observed, indicating that the model behaves consistently across the full range of weighting scenarios and that the original results are robust to uncertainty in expert judgments.

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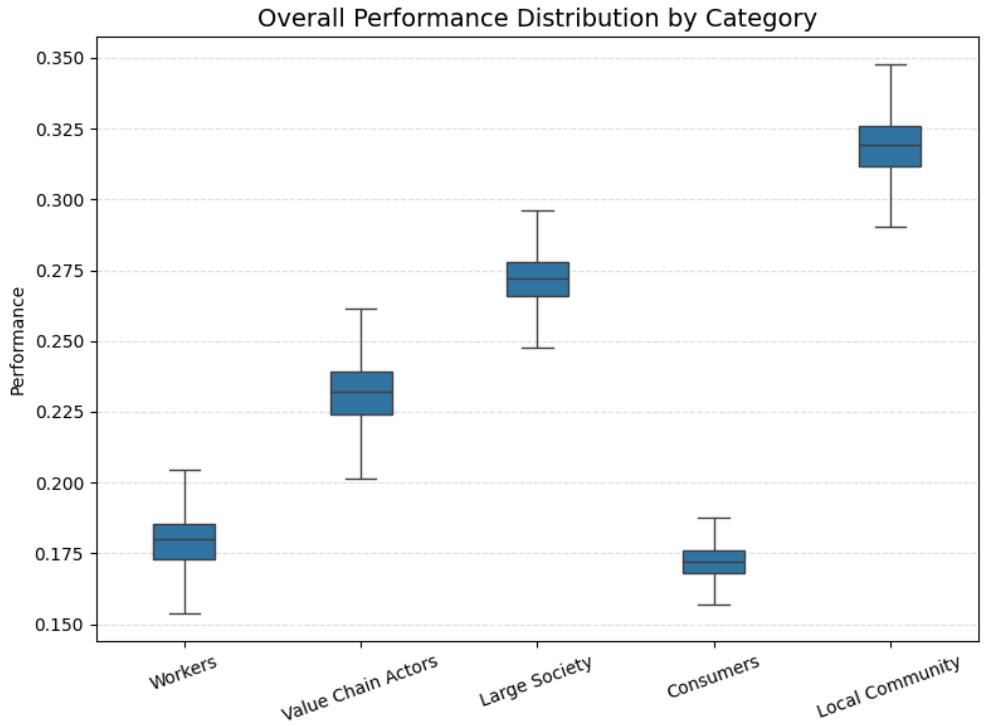
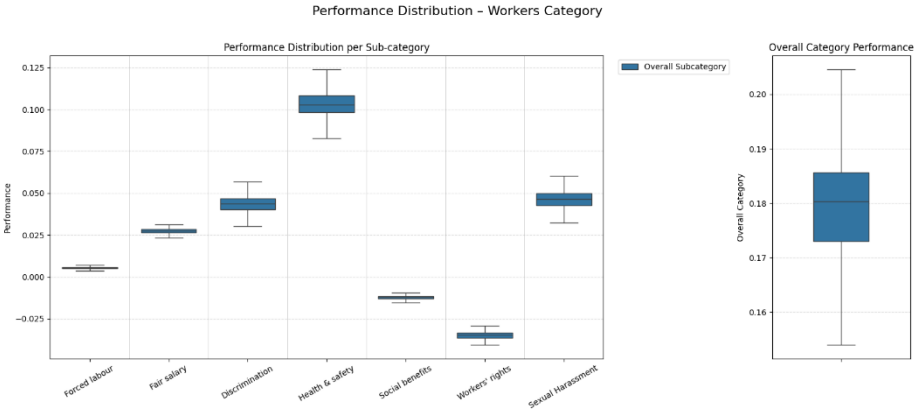


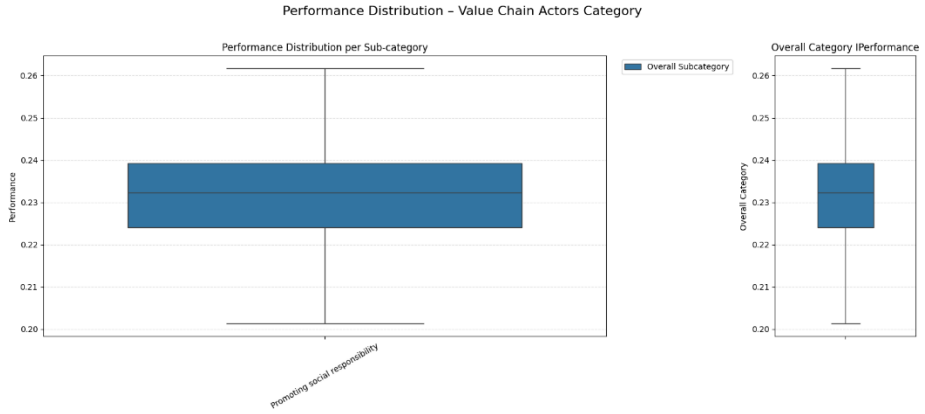
Figure 10: Overall performance assessment using stochastic experts' weights

At the subcategory level, the sensitivity analysis similarly reveals variation in performance contributions, with values ranging from below 0.1 to approximately 0.7 (Figure 11). Nevertheless, the overall patterns remain fully consistent with the findings presented in Section 0. As with the category-level results, no outliers were detected, indicating that the subcategory contributions are stable across the full range of weighting scenarios and that the underlying results are robust to uncertainty in expert inputs.

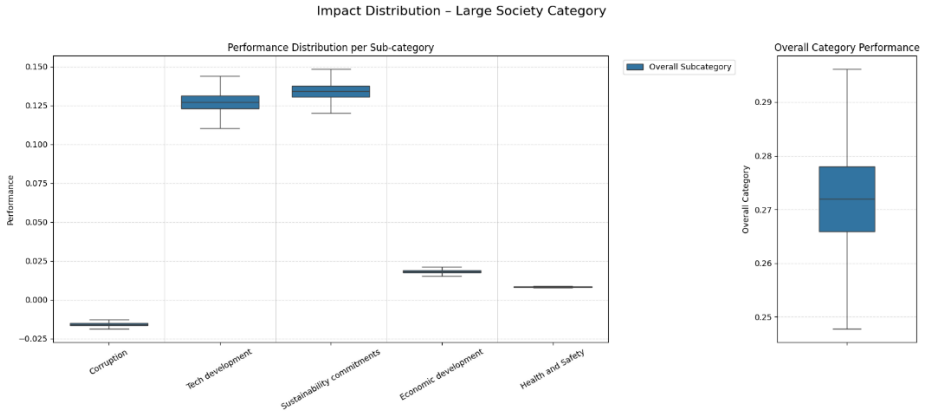


(a)

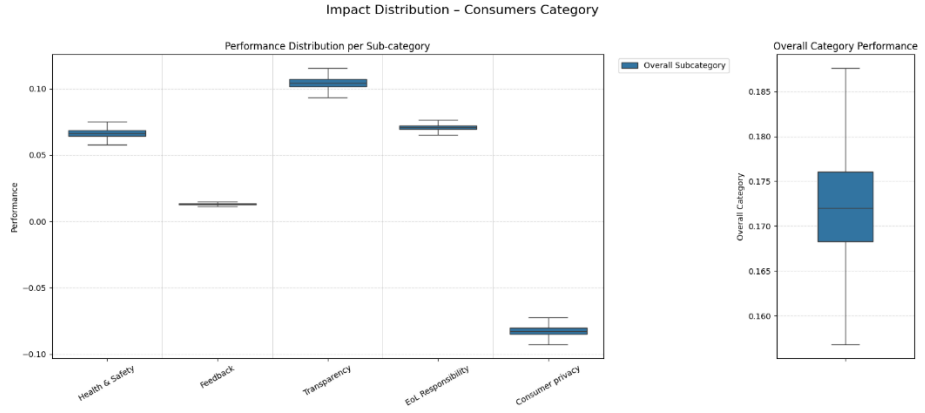
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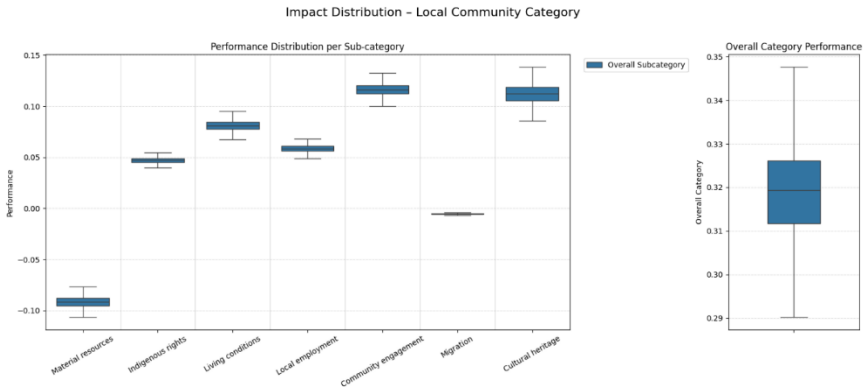


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(e)

Figure 11: Performance contribution using stochastic experts' weights

4.4.2 Overall impact assessment and contribution using stochastic experts' weights

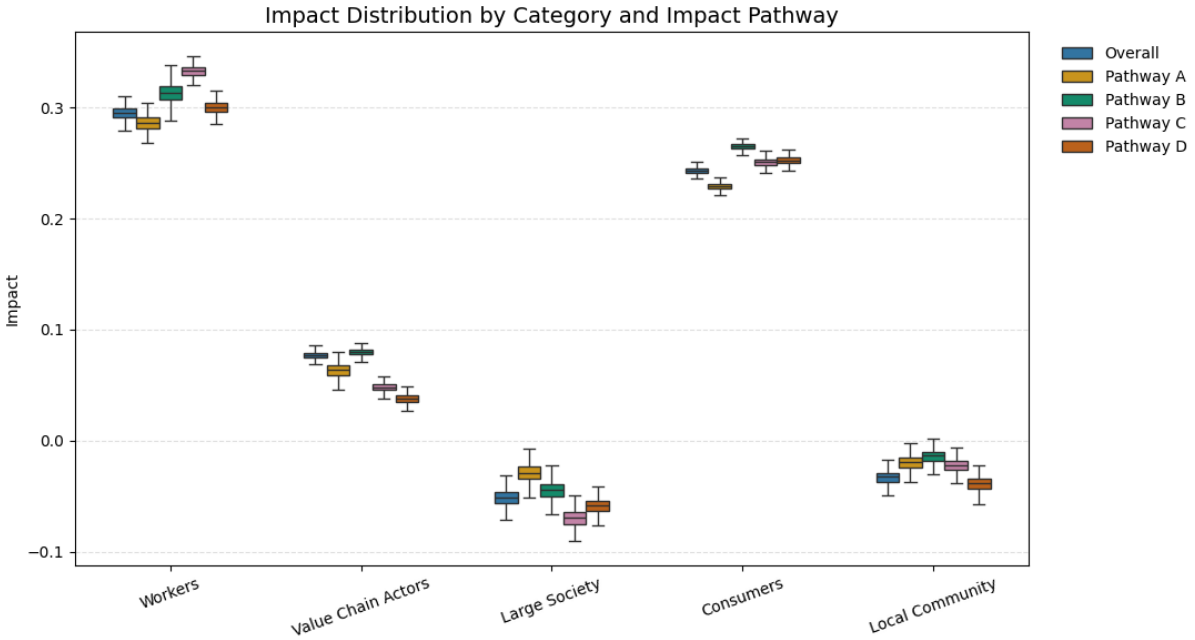
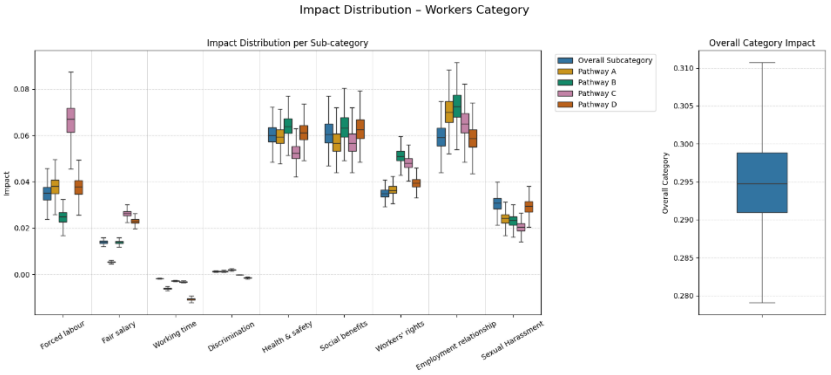


Figure 12: Overall impact assessment using stochastic experts' weights

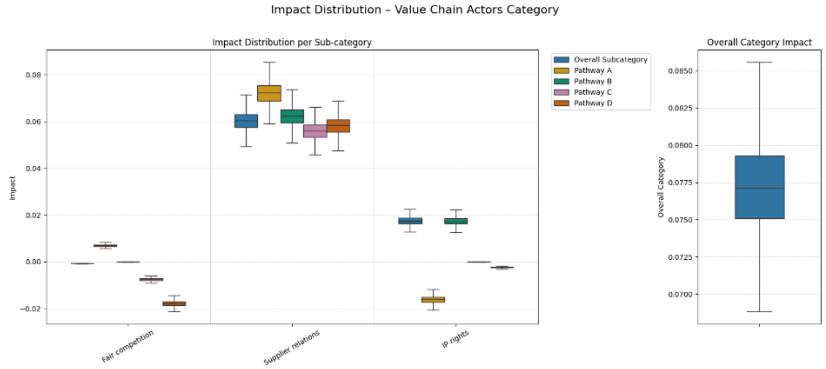
Similarly to the performance assessment, we evaluated the robustness and stability of the impact assessment across the 100,000 Monte-Carlo-generated weighting scenarios. The resulting distributions confirm that both the overall impact scores and the

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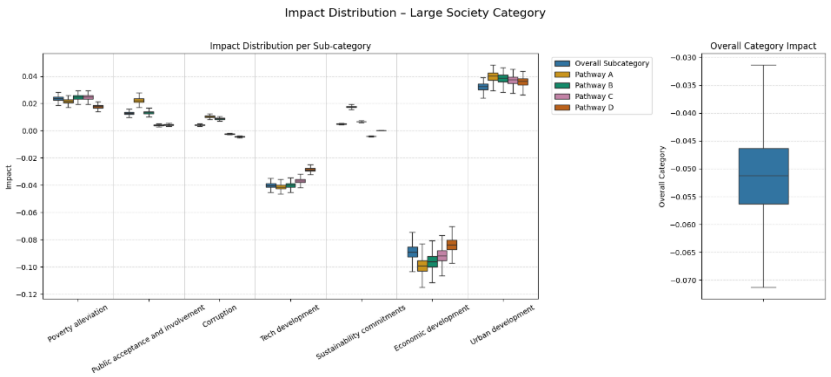
pathway-level outcomes remain fully consistent with the results reported in Section 4.3.1, demonstrating strong stability under uncertainty (Figure 12). Likewise, the contribution of each subcategory to its respective category aligns closely with the findings presented in Section 4.3.2, further confirming the robustness of the impact assessment at a more granular level (Figure 13).



(a)

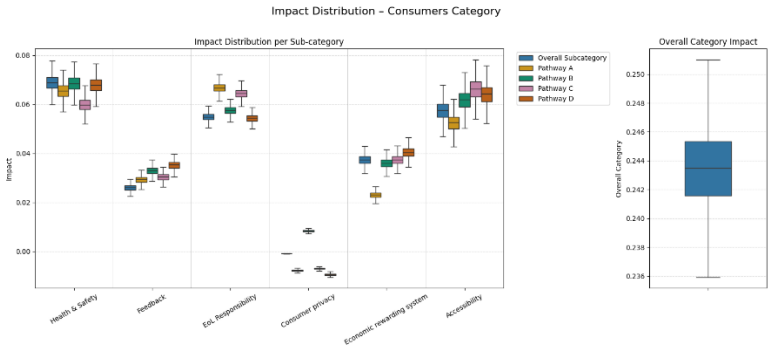


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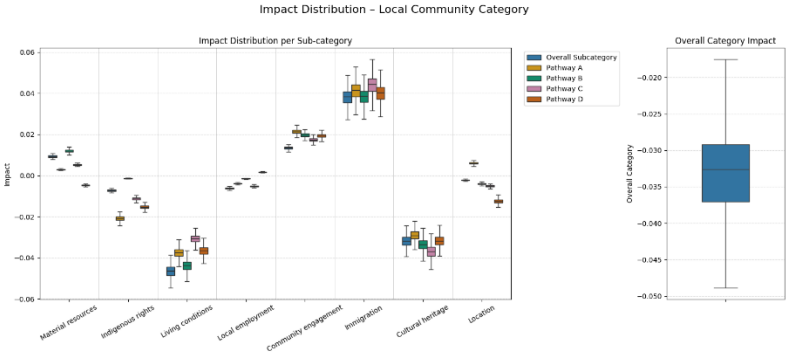


(c)

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(d)



(e)

Figure 13: Subcategory impact contribution using stochastic experts' weights

5 Social Benefits, Hotspots and Value Propositions

In this section, we synthesise the results from the preceding analyses and translate them into a set of social benefits and hotspots across the assessed stakeholder groups. Building on these findings, we then develop the corresponding social value propositions for the proposed circular business models for retired electric vehicle batteries (EVBs). This integrated view enables a clearer understanding of where social value is created, where risks or concerns emerge, and how future pathways can be designed to maximise positive societal outcomes.

In Table 5, the overall social performance assessment indicates positive results across all categories. However, the findings also highlight several important contradictions that merit closer examination. Notably, the categories representing *large society* and *local communities* receive the highest scores in the current performance assessment, demonstrating strong perceived benefits under existing conditions. Yet, when

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stakeholders were asked to evaluate the potential impacts of new business models based on retired EVBs at European, national, or local levels, their responses revealed substantial scepticism, resulting in negative impact values. This suggests a gap between the perceived benefits of the status quo and the uncertainties stakeholders associate with transitioning to emerging circular business models.

A similar pattern is observed among *value chain actors*. While their overall social performance score reaches 0.231, the impact assessment related to future business model implementation drops considerably, to approximately 0.07. This decline indicates that although value chain actors currently experience positive social performance, they anticipate potential risks, disruptions, or unproven benefits associated with the proposed pathways.

In contrast, *consumers* and *workers* appear to benefit more clearly from the introduction of these new circular business models. Their impact assessments remain strongly positive, signalling that the pathways could enhance consumer well-being and create improved working conditions or opportunities within the sector.

When comparing impact scores across the different pathways, the results remain consistent within each category. However, the magnitude of variation among pathways is small and not sufficiently distinct to determine which pathway performs better or is socially superior. For this reason, the detailed comparative analysis presented in Section 4.3.3 becomes essential, as it provides the additional insights needed to differentiate and interpret pathway-specific social implications more effectively.

Table 5: Quantified social performance and impact assessment

Categories	Overall Performance	Overall Impact	Pathway A Impact	Pathway B Impact	Pathway C Impact	Pathway D Impact
Consumers	0.172	0.243801	0.229424	0.265391	0.251265	0.252662
Large Society	0.271993	-0.051371	-0.028967	-0.044539	-0.069748	-0.058704
Local Community	0.318927	-0.033742	-0.019991	-0.014588	-0.023123	-0.0399
Value Chain Actors	0.231	0.077403	0.062928	0.079852	0.04841	0.037878
Workers	0.178716	0.295022	0.286292	0.31336	0.333096	0.300473

The consolidated summary of social benefits, social hotspots, and associated value

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propositions is presented in Table 6. The structure of the social value propositions follows the Value Proposition Canvas framework (Meng et al., 2020), enabling a clear mapping between identified social gains and pains, and the corresponding gain creators and pain relievers. These proposed strategies can be further strengthened by qualitative survey responses from stakeholders, which provide deeper insights into local concerns, expectations, and priorities (see Annex 4).

Across most subcategories, the assessment reveals predominantly positive contributions (indicated in green), such as in areas related to forced labour avoidance, supplier relationship quality, poverty alleviation, organisational sustainability commitments, economic contribution, public acceptance, occupational health and safety, and community engagement. These strengths suggest that circular business models for second-life EVBs have substantial potential to reinforce ethical, safe, and socially responsible practices across the lifecycle.

Despite these benefits, several critical social risks (highlighted in red) remain and warrant proactive mitigation. For workers, concerns persist regarding extended working hours and pay gaps, which may intensify if new responsibilities arise from circular activities. For value-chain actors, issues surrounding fair competition and IP rights emerge as significant challenges, particularly as novel technologies, proprietary data, and new partnerships become more central in circular supply chains. Broader societal risks include corruption risk, uneven technological development, consumer privacy concerns related to data-rich battery management systems, and a range of vulnerabilities for local communities. These include impacts on living conditions, pressures on local employment, protection of indigenous rights, preservation of cultural heritage, and sensitivities related to location-specific development.

The corresponding social value propositions outline actionable strategies to address these risks while amplifying positive outcomes in Table 6. Collectively, these strategies form a coherent framework for embedding social responsibility into the design and implementation of second-life EVB pathways.

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Table 6: Summary of social value, hotspots and value propositions

Category	Subcategory	Overall Performance	Impact Pathway Overall	Impact Pathway A	Impact Pathway B	Impact Pathway C	Impact Pathway D	Social value propositions
Workers	Forced labour	0.0054	0.0344	0.0373	0.0244	0.0657	0.0371	Gain creators: Ensure the right to freely terminate employment contracts within legal frameworks.
	Fair salary	0.0274	0.0139	0.0053	0.0138	0.0263	0.023	Gain creators: Maintain a reasonable salary ratio between lowest- and highest-paid roles (e.g., €26k–€93k; ~€60k gap from worker to management), aligned with stakeholder expectations.
	Working time		-0.0018	-0.0061	-0.0028	-0.0032	-0.0108	Pain relievers: Address long working hours (avg. 36 hrs/week vs. Germany's 26 hrs). Increase annual leave (25 days vs. German average of 42 days). Pilot a 4-day working week using rotating shifts to maintain productivity. Germany demonstrates productivity gains from shorter workweeks[2].
	Discrimination	0.0433	0.0012	0.0013	0.002	-0.0002	-0.0016	Pain relievers: Tackle persistent gender and minority pay gaps (avg. −4.6 and −5.9 with high SD). Strengthen equal-opportunity policies and skills-development pathways for career progression.
	Health & safety	0.1038	0.0606	0.0599	0.0645	0.0528	0.0616	Gain creators: Maintain safe working conditions perceived by stakeholders. Implement clear standards for EVB/BESS technologies. Provide comprehensive safety training and ensure PPE usage. Support mental health to mitigate stress from digital/AI systems. Enforce labour law compliance and employer accountability.
	Social benefits	-0.0123	0.0614	0.0574	0.0641	0.0574	0.0633	Gain creators: Improve currently negative benefits through: health insurance, pension fund, childcare access, education support, and accommodation

[2] German firms tested 4-day workweek — here's the outcome

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Category	Subcategory	Overall Performance	Impact Pathway Overall	Pathway A	Pathway B	Pathway C	Pathway D	Social value propositions
								assistance.
	Worker's rights	-0.0349	0.0351	0.0366	0.0513	0.0483	0.0396	Gain creators: Reinforce rights to association, collective bargaining, and striking.
	Employment relationship		0.0597	0.0707	0.0731	0.0657	0.0592	Gain creators: Ensure employment contracts comply with regional and EU labour laws.
	Sexual harassment	0.046	0.0304	0.0239	0.023	0.0202	0.0291	Gain creators: Apply strict zero-tolerance policies with severe penalties. Establish anonymous reporting channels and active monitoring. Conduct regular training and awareness sessions.
Value chain actors	Fair competition		-0.0008	0.007	0	-0.0076	-0.0179	Pain relievers: Strengthen enforcement of anti-competitive legislation (e.g., Article 101 TFEU). Clarify how regulations apply to emerging second-life EVB markets (see D1.9 Policy Recommendations).
	Promoting social responsibility	0.231						Gain creators: Maintain strong CSR practices and social-enterprise commitments.
	Supplier relationships		0.0604	0.0722	0.0623	0.056	0.0582	Gain creators: Ensure timely payments, sufficient lead time, predictable volume fluctuations, and collaborative communication on quality issues.
	IP rights		0.0178	-0.0163	0.0176	0	-0.0024	Pain relievers: Prevent IP violations through clear contractual IP clauses. Establish transparent co-development agreements before collaborative projects.
Large Society	Poverty alleviation		0.0234	0.0216	0.0244	0.0244	0.0177	Gain creators: Leverage new business models to contribute to poverty reduction.
	Public acceptance and involvement		0.013	0.0223	0.0134	0.004	0.0045	Gain creators: Build on positive public attitudes and willingness to participate. Highlight infrastructure benefits such as backup storage systems.
	Corruption	-0.0157	0.0042	0.0104	0.0088	-0.0024	-0.0043	Gain creators: Strengthen anti-corruption mechanisms through transparent procurement, clear audit trails, and public reporting.

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Category	Subcategory	Overall Performance	Impact Overall	Impact Pathway A	Impact Pathway B	Impact Pathway C	Impact Pathway D	Social value propositions
								Provide confidential whistleblowing channels with protection against retaliation.
	Technology development	0.127	-0.0401	-0.0412	-0.0399	-0.0368	-0.0285	Pain relievers: Improve usability and affordability of technologies via R&D investment. Develop turnkey systems and favour recyclable materials.
	Sustainability commitments	0.134	0.0049	0.0174	0.0067	-0.004	0	Gain creators: Maintain sustainability compliance across all pathways. Impacts on Pathways C and D remain minor.
	Economic development	0.0183	-0.0887	-0.0988	-0.0957	-0.0915	-0.0835	Gain creators: Although benchmarked negatively, potential economic contribution is high (~14%). Support growth through subsidies, behaviour change, and attracting foreign investment.
	Health & safety	0.0083						Gain creators: Promote awareness of the safety and non-harmful nature of BESS systems.
	Urban development		0.0318	0.0393	0.0378	0.0366	0.0354	Gain creators: Support positive impacts on urban development. Expand BESS deployment in large buildings and public infrastructure.
Consumers	Health & safety	0.0665	0.069	0.0656	0.0687	0.06	0.068	Gain creators: Promote awareness of the safety and non-harmful nature of BESS systems.
	Feedback mechanism	0.0132	0.026	0.0293	0.033	0.0304	0.0352	Gain creators: Provide flexible, accessible, and anonymous channels for consumer feedback.
	Transparency	0.1044						Gain creators: Improve transparency of circular supply chains, especially end-of-life handling of 2nd/3rd life batteries.
	EoL responsibility	0.0705	0.0547	0.0666	0.0574	0.0643	0.0542	
	Consumer privacy	-0.0826	-0.0008	-0.0078	0.0084	-0.007	-0.0093	Pain relievers: Strengthen data-protection safeguards, particularly for Pathways A, C, and D. Pathway B is quite mature inherited from enterprise' infrastructure.

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Category	Subcategory	Overall Performance	Impact Pathway Overall	Impact Pathway A	Impact Pathway B	Impact Pathway C	Impact Pathway D	Social value propositions
	Economic rewarding system		0.0375	0.0232	0.0361	0.0375	0.0405	Gain creators: Offer flexible revenue options (energy arbitrage, peak shaving). Provide incentives for reducing peak-time energy use.
	Accessibility		0.0575	0.0525	0.0617	0.0662	0.064	Gain creators: Ensure easy access through digital channels (internet, VPP). Improve transparency in information sharing.
Local community	Material resources	-0.0911	0.0093	0.0029	0.012	0.0052	-0.0047	Gain creators: Reduce reliance on natural resources by extending battery life cycles. Lower environmental impacts compared to first-life battery production.
	Indigenous rights	0.047	-0.0073	-0.0209	-0.0014	-0.0113	-0.0153	Pain relievers: Minimise negative impacts on local populations. Enhance education and skills training to support local employment.
	Living conditions	0.0815	-0.0467	-0.0377	-0.044	-0.031	-0.0367	
	Local employment	0.0589	-0.0061	-0.0038	-0.0015	-0.0052	0.0017	
	Community engagement	0.116	0.0134	0.0215	0.0197	0.0174	0.0193	Gain creators: Increase community involvement through events, workshops, and public-awareness campaigns.
	Migration	-0.0053	0.0378	0.041	0.0381	0.0438	0.0399	Gain creators: Support positive effects for skilled immigrants engaged in the new business models.
	Cultural heritage	0.112	-0.0319	-0.029	-0.0336	-0.037	-0.0317	Pain relievers: Respect local cultural heritage, language, and traditions. Strengthen policies protecting cultural sites and practices.
	Location		-0.0022	0.006	-0.0039	-0.0051	-0.0124	Pain relievers: Reduce facility proximity to residential or cultural areas. Prioritise placement in industrial parks or designated zones.

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6 Conclusion and Future Direction

This interim report (D1.6) delivers a pathway-based S-LCA framework for comparing the prospective social performance and impacts of second-life EVB applications in BaaS contexts. Building on the UNEP S-LCA Guidelines and a structured indicator architecture, the deliverable integrates (i) stakeholder- and subcategory-level assessment, (ii) expert-based weighting and transparent aggregation, and (iii) robustness testing, and translates the resulting evidence into actionable insights (hotspots, benefits and social value propositions) to inform Deliverable D1.2 and WP1 business model development.

The interim results indicate that current social performance is overall positive across stakeholder categories, while revealing persistent hotspots around workers' rights, social benefits and consumer privacy, which require targeted governance and capability improvements as second-life markets scale. The expected social impact assessment further points to a distributional asymmetry: workers and consumers are expected to capture clearer positive value, whereas local communities and large society as a whole show negative perceived net impacts under uncertainty. This underlines the importance of credible safety management, transparent communication, and value sharing mechanisms to secure social acceptance. Finally, although pathway-level differences appear modest at the category level, the sensitivity analyses support a relatively robust ordering across weighting scenarios within the current interim model: Pathway B shows the most favourable social profile, Pathways A and C form a middle tier, and Pathway D shows the weakest profile on social outcomes. This provides a stable but still provisional baseline for WP1 decision support.

Overall, this interim deliverable establishes a transparent and reproducible foundation for pathway-based social assessment in second-life EVB systems. As a limitation, the expected-impact results reflect stakeholder perceptions captured now; while these views provide a useful basis for near-term exploratory insights, they may evolve as technologies, markets and societal expectations shift in the longer future. As an interim report (April 2026), the framework and initial results are currently based on the current available evidence and data. The final report (June 2027) will consolidate richer evidence and data (including AI-enabled evidence) to provide stronger, implementation-oriented decision support for responsible scaling of BaaS and second-life EVB pathways across Europe.

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8 References

Batista, L., Seuring, S., Genovese, A., Sarkis, J., & Sohal, A. (2023). Theorising circular economy and sustainable operations and supply chain management: a sustainability-dominant logic. *International Journal of Operations & Production Management*, *43*(4), 581–594. https://doi.org/10.1108/IJOPM-12-2022-0765

Benoît Norris, C., Traverso, M., Neugebauer, S., Ekener, E., Schaubroeck, T., Russo Garrido, S., Berger, M., Valdivia, S., Lehmann, A., Finkbeiner, M., & Arcese, G. (2020). *Guidelines for Social Life Cycle Assessment of Products and Organizations*. https://wedocs.unep.org/items/4018c2ec-3ab6-4df3-8ca8-f1c7313a14ed

Benoit-Norris, C., Cavan, D. A., & Norris, G. (2012). Identifying Social Impacts in Product Supply Chains:Overview and Application of the Social Hotspot Database. *Sustainability 2012, Vol. 4, Pages 1946-1965*, *4*(9), 1946–1965. https://doi.org/10.3390/SU4091946

Bobba, S., Podias, A., Di Persio, F., Messagie, M., Tecchio, P., Cusenza, M. A., Eynard, U., Mathieux, F., & Pfrang, A. (2018). Sustainability Assessment of Second Life Application of Automotive Batteries (SASLAB): JRC Exploratory Research (2016-2017): Final technical report: August 2018. *JRC Technical Reports*.

Ciroth, A., & Franze, J. (2011). *LCA of an Ecolabeled Notebook Consideration of Social and Environmental Impacts Along the Entire Life Cycle*. GreenDeltaTC GmbH,. https://www.greendelta.com/wp-content/uploads/2017/03/LCA_laptop_final.pdf

Dias, L. C., & Climaco, J. N. (2000). Additive aggregation with variable interdependent parameters: The VIP analysis software. *Journal of the Operational Research Society*, *51*(9), 1070–1082. https://doi.org/10.1057/PALGRAVE.JORS.2601012;WGROUP:STRING:PUBLICATION

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Du, C., Dias, L. C., & Freire, F. (2019). Robust multi-criteria weighting in comparative LCA and S-LCA: A case study of sugarcane production in Brazil. *Journal of Cleaner Production*, *218*, 708–717. https://doi.org/10.1016/J.JCLEPRO.2019.02.035

Duong, Q. H., Arranz, C. F. A., Xu, M., Zhou, L., & Sun, W. (2026). Towards Web3- and metaverse-enabled decentralisation of electric vehicle battery closed-loop supply chains: insights from advanced text mining techniques. *Transportation Research Part E: Logistics and Transportation Review*, *206*, 104583. https://doi.org/10.1016/J.TRE.2025.104583

Erum Hassan, S., Andruetto, C., & Posch, A. (2024). The role of battery electric vehicles in off-peak hour deliveries: Sustainability assessment of a case study in Stockholm. *Cleaner Logistics and Supply Chain*, *13*(10), 100175. https://doi.org/10.1016/j.clscn.2024.100175

Fleischmann, J., Hanicke, M., Horetsky, E., Ibrahim, D., Jautelat, S., Linder, M., Schaufuss, P., Torscht, L., & van de Rijt, A. (2023, January 16). *Lithium-ion battery demand forecast for 2030 | McKinsey*. McKinsey. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/battery-2030-resilient-sustainable-and-circular#/

Gompf, K., Traverso, M., & Hetterich, J. (2022). Applying social life cycle assessment to evaluate the use phase of mobility services: a case study in Berlin. *The International Journal of Life Cycle Assessment*, *27*(4), 603–622. https://doi.org/10.1007/s11367-022-02051-y

Hajiyev, N., Mansura, M., Sverdlikova, E., Safronov, R., & Vityutina, T. (2021). Oligopoly trends in energy markets: Causes, crisis of competition, and sectoral development strategies. *International Journal of Energy Economics and Policy*, *11*(6), 392–400. https://doi.org/10.32479/IJEEP.11634

Hallste Pérez, T., Rodríguez-Chueca, J., & Pérez Rodríguez, J. (2023). Inclusion of key social indices for a comparative assessment of the sustainability of the life cycle of current and future electricity generation in Spain: A proposed methodology. *Science of The Total Environment*, *899*(7), 165541. https://doi.org/10.1016/j.scitotenv.2023.165541

Kaiser, S., Oliveira, M., Vassillo, C., Orlandini, G., & Zucaro, A. (2022). Social and Environmental Assessment of a Solidarity Oriented Energy Community: A Case-Study in San Giovanni a Teduccio, Napoli (IT). *Energies*, *15*(4), 1557. https://doi.org/10.3390/en15041557

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Kay, C. S. (2025). Why you shouldn't trust data collected on MTurk. *Behavior Research Methods*, *57*(12), 340. https://doi.org/10.3758/s13428-025-02852-7

Koese, M., Blanco, C. F., Vert, V. B., & Vijver, M. G. (2023). A social life cycle assessment of vanadium redox flow and lithium-ion batteries for energy storage. *Journal of Industrial Ecology*, *27*(1), 223–237. https://doi.org/10.1111/jiec.13347

Lobato, J., Fernández-Marchante, C. M., Rodrigo, M. A., Sáez, C., Lacasa, E., & Cañizares, P. (n.d.). *Social Life Cycle Assessment. Survey Part 1*. MACGHYVER. Retrieved February 17, 2026, from https://greenhydrogen-pathfinder.eu/?p=2323

Maister, K., Di Noi, C., Ciroth, A., & Srocka, M. (2020). *A Product Social Impact Life Cycle Assessment database*. https://psilca.net/wp-content/uploads/2020/06/PSILCA_documentation_v3.pdf

Meng, L., Somenahalli, S., & Berry, S. (2020). Policy implementation of multi-modal (shared) mobility: review of a supply-demand value proposition canvas. *Transport Reviews*, *40*(5), 670–684. https://doi.org/10.1080/01441647.2020.1758237;PAGE:STRING:ARTICLE/CHAPTER

Montes, T., Etxandi-Santolaya, M., Eichman, J., Ferreira, V. J., Trilla, L., & Corchero, C. (2022). Procedure for Assessing the Suitability of Battery Second Life Applications after EV First Life. *Batteries 2022, Vol. 8, Page 122*, *8*(9), 122. https://doi.org/10.3390/BATTERIES8090122

Neubauer, J. S., Wood, E., & Pesaran, A. (2015). A Second Life for Electric Vehicle Batteries: Answering Questions on Battery Degradation and Value. *SAE International Journal of Materials and Manufacturing*, *8*(2). https://doi.org/10.4271/2015-01-1306

Nubi, O., Morse, S., & Murphy, R. J. (2021). A Prospective Social Life Cycle Assessment (sLCA) of Electricity Generation from Municipal Solid Waste in Nigeria. *Sustainability*, *13*(18), 10177. https://doi.org/10.3390/su131810177

Osorio-Tejada, J. L., Llera-Sastresa, E., Scarpellini, S., & Hashim, A. H. (2020). An integrated social life cycle assessment of freight transport systems. *The International Journal of Life Cycle Assessment*, *25*(6), 1088–1105. https://doi.org/10.1007/s11367-019-01692-w

Philippot, M., Costa, D., Hosen, M. S., Senécat, A., Brouwers, E., Nanini-Maury, E., Van Mierlo, J., & Messagie, M. (2022). Environmental impact of the second life of an automotive battery: Reuse and repurpose based on ageing tests. *Journal of Cleaner Production*, *366*, 132872. https://doi.org/10.1016/J.JCLEPRO.2022.132872

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Sánchez, A., Benveniste, G., Ferreira, V. J., Bulfaro, I., Igualada, L., & Corchero, C. (2024). Methodology for social life cycle impact assessment enhanced with gender aspects applied to electric vehicle Li-ion batteries. *The International Journal of Life Cycle Assessment 2024 30:6*, *30*(6), 1229–1245. https://doi.org/10.1007/S11367-024-02329-3

Thies, C., Kieckhäfer, K., Spengler, T. S., & Sodhi, M. S. (2019). Assessment of social sustainability hotspots in the supply chain of lithium-ion batteries. *Procedia CIRP*, *80*(1), 292–297. https://doi.org/10.1016/j.procir.2018.12.009

TranSensus LCA. (2023). *Towards a European-wide harmonised transport-specific LCA Approach TranSensus LCA Deliverable D1.1 Review of current practices on life cycle approaches along the electromobility value chain*. https://ec.europa.eu/info/funding-tenders/opportunities/grants/docs/080166e500d396c9/Attachment_0.pdf

Vanhatalo, A. (2024). *Social life cycle assessment framework for 2nd and 3rd life cycle electric vehicle batteries*. https://lutpub.lut.fi/handle/10024/168244

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them.

Annex

Annex 1. The key reviewed documents

Category	Subcategory	Indicator	Type of assessment	Documents													
				Sánchez et al. (2024)	Thies et al. (2019)	Koese et al. (2023)	Gompf et al. (2022)	Nubi et al. (2021)	Kaiser et al. (2022)	Erum Hassan et al. (2024)	Vanhatalo (2024)	Hallste Pérez et al. (2023)	TranSensus LCA (2023)	Lobato et al. (n.d.)	Fleischmann et al. (2023)	LCA of an Ecolabeled Notebook	PSILCA	SHDB
Workers	Forced labour	Goods produced by forced labour	Performance			✓											✓	
		Percentage/Frequency of forced labour; vulnerability index for forced labour	Performance	✓	✓	✓			✓	✓							✓	
		Tier placement referring to trafficking in persons	Performance			✓											✓	✓
		Freedom to terminate their employment contracts within prevailing limits	Impact	✓	✓				✓	✓								
	Fair salary	Living cost, per month	Performance	✓	✓			✓						✓			✓	✓
		Minimum wage, per month	Performance	✓	✓					✓			✓				✓	✓
		Wage level of the worker with lowest income in the sector compared with highest income/national average and description of payment performance of the sector/enterprise Lowest-paid worker, compared to the minimum wage	Performance & Impact	✓	✓	✓		✓	✓	✓	✓	✓				✓		
	Working time	Number of days without work per week/Paid leave	Impact	✓	✓											✓		
		Hours of work per employee, per week	Impact	✓	✓	✓				✓	✓						✓	✓

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		Possibility of flexible work	Impact	✓	✓		✓											
	Discrimination	Men-vs-Women in the sectoral labour force	Performance	✓	✓	✓				✓				✓			✓	✓
		Gender gap in labour-force participation (0-1, parity)		✓	✓	✓				✓				✓			✓	✓
		Country gender index ranking	Performance	✓	✓					✓				✓		✓		
		Presence of formal policies of equal opportunities/discrimination prevention, recruitment policies, maternity, paternity leave	Impact	✓	✓		✓			✓						✓		
		Share of women and minorities of personnel (in directive positions?)	Performance									✓				✓		
		Ratio of salary of women to wages of men in sector/company; Ratio of salary of minority groups to wages of majority group in sector/company	Impact	✓	✓	✓								✓		✓	✓	✓
	Health and Safety	The potential of technology to affect the health and safety of workers during the manufacturing and/or end-of-life phase	Impact	✓	✓													
		Workplace hazards, working conditions & protections/protective equipment	Impact	✓	✓			✓								✓		
		Appropriate safety education	Impact	✓	✓			✓										

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		and training provided to employees																
		Non-fatal Accident rate at workplace of the country/sector/organisation	Performance	✓	✓	✓					✓	✓						✓
		Injuries or Fatal accidents at workplace	Performance			✓		✓				✓					✓	✓
		DALYS due to indoor and outdoor air and water pollution	Performance			✓		✓									✓	✓
		Workers affected by natural disasters	Performance			✓											✓	✓
	Social benefits/Social security	Social security expenditures of the country/sector	Performance			✓				✓			✓			✓	✓	✓
		List of social benefits provided to workers (e.g. health insurance, pension fund, childcare, education, and accommodation)	Impact	✓	✓					✓	✓		✓					
		Evidence of violations of laws and employment regulations	Performance			✓											✓	✓
	Workers' rights	Trade union density; Presence of unions within the sector/organisation and description of their influence	Performance	✓	✓	✓				✓		✓					✓	✓
		Right of Association	Impact	✓	✓	✓	✓			✓	✓	✓					✓	✓
		Right of Collective bargaining	Impact	✓	✓	✓	✓			✓	✓	✓					✓	✓
		Right to strike	Impact	✓	✓	✓				✓		✓					✓	✓
	Employment relationship	Employment relationship protected by contract in line with regional employment	Impact								✓							

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		contract law and EU regulation																
	Sexual harassment	Number of sexual harassment incidents	Performance	✓	✓						✓							
		Efforts by the organisation to reduce the risk of sexual harassment		✓	✓													
Value Chain Actors	Fair competition	Presence of anti-competitive behaviour or violation of anti-trust and monopoly legislation	Impact				✓									✓	✓	✓
		Presence and the extent of policies to prevent anti-competitive behaviour	Impact				✓											
	Promoting social responsibility	Presence of codes of conduct that protect human rights of workers among suppliers	Performance								✓					✓		
		The presence of regulation about auditing suppliers with regard to social responsibility	Performance	✓	✓		✓				✓					✓		
	Supplier relationships	Interaction of the company with suppliers (payment on time, sufficient lead time, reasonable volume fluctuations, appropriate communication, collaboration regarding quality issues)	Impact				✓			✓						✓		
	Respect of intellectual property rights	Measures the extent of actions or Violations of the company against intellectual property rights	Impact				✓				✓					✓		
EU/National-level	Poverty	Poverty alleviation	Impact	✓	✓													

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level Society	alleviation																	
	Public acceptance and involvement	Extent of public acceptance for the business models	Impact					✓	✓									
	Corruption	Risk of corruption in country/sector	Performance	✓	✓				✓		✓					✓		
		Presence of an anti-corruption program in the company	Impact	✓	✓						✓					✓		
		Presence of co-operations with internal and external controls to prevent corruption	Impact	✓	✓						✓					✓		
		Presence of co-operations with internal and external controls to prevent corruption	Impact	✓	✓											✓		
	Technology development	Involvement of the company in technology transfer projects	Performance	✓	✓					✓	✓					✓		
		Presence of partnerships regarding research and development	Performance	✓	✓				✓	✓						✓		
		Investments in technology development	Impact								✓	✓				✓		
		The technology accessible and affordable to developing countries	Impact	✓	✓				✓									
	Public commitments to sustainable issues	Presence/Proportion of publicly available promises or agreements on sustainable issues and complaints to the non-fulfilment of these commitments	Impact	✓	✓				✓	✓	✓	✓				✓		
		Presence of mechanisms to follow up the realization of	Performance	✓	✓				✓	✓								

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		promises																
	Contribution to economic development	Economic situation of the country/region and relevance of the considered sector for the (local) economy	Performance	✓	✓					✓						✓		
		Percentage contribution of the business models to the GDP of countries/regions	Impact					✓										
		Contribution level of the product/sector/company to economic development	Impact	✓	✓	✓		✓		✓	✓					✓		
		Adequacy public expenditure on education	Performance			✓					✓						✓	
		Adult illiteracy rate (15+ years), male	Performance			✓											✓	
		Adult illiteracy rate (15+ years), female	Performance			✓											✓	
		Adult illiteracy rate (15+ years), total	Performance			✓											✓	
		Youth illiteracy rate, male	Performance			✓											✓	
		Youth illiteracy rate, female	Performance			✓											✓	
		Youth illiteracy rate, total	Performance			✓											✓	
	Health and Safety	Health expenditure, total	Performance			✓	✓										✓	✓
		Health expenditure, public	Performance			✓	✓										✓	✓
		Health expenditure, out-of-pocket	Performance			✓	✓										✓	✓
		Health expenditure, external resources	Performance			✓	✓										✓	✓
		Domestic and External Health Expenditure	Performance				✓										✓	✓

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		Life expectancy at birth	Performance			✓											✓	✓
	Urban development	Urban development plans	Impact				✓											
Consumers	Health and Safety	(Potential) risks/accidents of the product regarding consumers' health and safety	Impact				✓				✓		✓			✓		
		Presence/Number of consumer complaints	Performance	✓	✓		✓									✓		
		Number of defects detected per production batch	Impact	✓	✓													
	Feedback mechanism	Presence of feedback mechanisms	Impact	✓	✓		✓		✓	✓	✓			✓		✓		
		Practices related to customer satisfaction	Performance						✓	✓						✓		
	Transparency	Publication of a sustainability report, availability of sustainability information on the website, and other communication tools	Performance	✓	✓					✓						✓		
		Quality of the provided information regarding sustainability/Clear information is provided to consumers on end-of-life options	Performance	✓	✓											✓		
		Company/Country/Region rating in sustainability indices	Performance	✓	✓											✓		
	End of Life responsibility	Strength of national/company legislation (infrastructure) covering product/components disposal and recycling other	Performance	✓	✓											✓		

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		than landfill and incineration																
		Possibility of the product to be reused for other purposes	Impact	✓	✓						✓							
		Structuring of the take back system including consumer involvement	Impact								✓					✓		
	Consumer privacy	Data privacy - A mechanism for ensuring security breaches	Impact				✓				✓		✓					
		Number of consumer complaints related to data/consumer privacy breaches	Performance							✓								
	Economic rewarding system	Impact of the new business models on Monthly Income of Consumers (e.g., sell energy as credits)	Impact					✓										
	Accessibility	Do second-life EVB prosumers have free access to objective information about energy use and sources of electricity?	Impact						✓									
		Number of Point of Sales/Access to services/Choices in the new business models options	Impact				✓		✓									
Local Community	Access to material resources/land rights	Extraction of material resources	Impact	✓	✓				✓							✓		
		Existence of projects to improve community infrastructure	Performance	✓	✓						✓					✓		
		Level of industrial water use (related to total withdrawal)	Impact	✓	✓	✓											✓	

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		Level of industrial water use (related to renewable water resources)	Impact			✓											✓	
		Extraction of biomass (related to area)	Impact			✓											✓	
		Extraction of biomass (related to population)	Impact			✓											✓	
		Extraction of fossil fuels	Impact			✓											✓	
		Extraction of industrial and construction minerals	Impact			✓											✓	
		Presence of Certified environmental management systems (CMEs)	Impact	✓	✓	✓										✓	✓	
	Respect of indigenous rights	Respect of the company regarding indigenous rights	Impact			✓										✓		
		Strength of policies to protect indigenous community members	Performance			✓									✓	✓		
		Presence of indigenous population	Performance												✓			✓
		Indigenous People Rights Protection Index	Performance												✓		✓	✓
	Safe and healthy living condition	Exposure of the local community to injuries, harm, and contagious diseases as a result of the company's activity	Impact	✓	✓			✓	✓							✓		
		Management/Sector effort to improve the environmental performance/minimise the use of hazardous substances	Performance	✓	✓					✓						✓		

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		Pollution level of the country/region and contribution of the sector/company to the environmental (air, water, land, noise)	Performance	✓	✓	✓		✓		✓						✓	✓	
		Fatalities due to large accidents	Performance									✓						
		Drinking water coverage	Performance			✓											✓	✓
		Sanitation coverage	Performance			✓											✓	✓
	Local employment	Percentage of work force hired locally	Impact	✓	✓		✓			✓	✓	✓				✓		
		Strength of policies on local hiring preferences	Impact	✓	✓					✓	✓							
		Percentage of local jobs created about final product unit	Impact	✓	✓		✓	✓			✓							
		Job losses due to the business models	Performance								✓							
		Percentage of spending on locally-based suppliers		✓	✓											✓		
		Unemployment rate in the country/region	Performance	✓	✓	✓										✓	✓	✓
	Community engagement	Presence of policies regarding community engagement at company level	Performance							✓						✓		
		Description and the extent of community engagement of the sector/company	Impact				✓			✓						✓		
	Delocalisation and Migration	Number of individuals who resettle that can be attributed	Impact	✓	✓											✓		

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		to the sector/organisation; immigrant policies																
		International migrant workers in the sector	Performance			✓											✓	✓
		International Migrant Stock	Performance			✓											✓	✓
		Net migration rate	Performance			✓											✓	✓
		Migration flows	Performance			✓												
	Cultural heritage	Respect of the sector/company regarding local cultural heritage including language, social and religious practices, knowledge and traditional craftsmanship as well as cultural spaces and objects and does not determine them in any way	Performance						✓							✓		
		Strength of policies to protect cultural heritage	Impact						✓							✓		
	Location	The effect proximity of a plant on local residents (e.g., public health, environmental problems, sale or rent of properties); involuntary relocation	Impact					✓	✓									
		Local traffic burden in the implementation of a waste to energy plant	Impact					✓										
		Level of comfort of having a plant within local vicinity	Impact					✓										

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Annex 2. Round 1 Survey

The CIRCUBATT project is funded by EU and coordinated the University of Greenwich, UK, seeking to transform the European battery sector by integrating AI, data analytics, and sustainable practices across entire battery lifecycle to enhance competitiveness and sustainability. This survey aims to gather insights from a diverse range of stakeholders to help develop **a Social Lifecycle Assessment framework** for evaluating the potential social impacts/risks of new business models for End-of-Life Electric Vehicle Battery within their value chain in Europe. Your feedback will be valuable in ensuring that the framework is comprehensive, effective, and aligned with our case. Your responses will be kept confidential and used exclusively for this project. Your data will be stored securely with our encrypted location and will not be shared without your consent. This survey would take approximately 5-7 minutes to complete. If you have any questions about this survey or the CIRCUBATT project, please contact Deliverable leader: Dr. James Quang Duong at quang.duong@gre.ac.uk or learn more here: https://circubatt-project.eu/. Thank you very much for your contribution!

Informed Consent Before proceeding with the survey, please read and indicate your consent: I have read the information sheet about this study

- I have had an opportunity to ask questions about this study via email
- I have received enough information about this study
- I understand that I am free to withdraw from this study at any time before submitting my responses
- I understand that I can also withdraw my data after submission by emailing the research team with my response ID within 30 calendar days of completion

I agree to take part in this study I understand that anonymised research data may be used for future research projects

- I agree to all of the above and consent to participate in this study (1)
- I do not consent to participate (If you select this option and click next the survey will end) (2)

Business models This survey seeks your expert input on the social aspects of new business models that **reuse end-of-life (EoL) electric vehicle (EV) batteries**. These second-life batteries are repurposed as energy storage systems across different sectors. You'll be asked to assess the social relevance and importance of various sustainability subcategories across four key use cases: **Business Pathways A. Energy Arbitrage & Grid Services** – Batteries store low-cost electricity and release it when prices are high, saving or earning money while supporting grid stability (e.g., frequency regulation). **B. Backup Power & Resilience** – Batteries provide backup power during outages, from critical loads (e.g., hospitals) to full-site or off-grid supply for remote operations. **C. Portable & Off-Grid Uses** – Batteries power mobile, remote, or off-grid needs such as work sites, emergency response, or

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recreational vehicles. **D. Urban Mobility & Recycling** – Batteries are reused in small electric vehicles; where reuse isn't viable, they are directed to recycling and material recovery.

Q1 What is your current job position?

- Industry expert (e.g., engineer, technical specialist) (1)
- Business representative/Manager/CEO/Founder (2)
- Policymaker (3)
- Scholar/Researcher (4)
- Other, please specify. (5)

_____

Q2 What is your organisation's or your role within the EV battery ecosystem?

- Battery Manufacturer & Technology Developer (1)
- Battery Remanufacturer, Recycler, Repurposer (2)
- Electric Vehicles (EV) Manufacturers (e.g., cars, e-bike, e-scooter) (3)
- Sustainability/Environmental Policy Maker (4)
- Government/Regulatory Body (5)
- (Renewable) Energy/Utility Provider/Trader (6)
- EV/Battery Retailer (7)
- Transportation/Logistics (8)
- Non-governmental organisation (9)
- Academic or Research Institution (10)
- Local Businesses or Residentials (11)
- EV/Battery Consumers (12)
- Other, please specify (13)

_____

Q3 How **important** are these categories to evaluating social impacts/risks from the new EVB BaaS Business Models?

	Not Applicable/ Relevant	Applicable but not Important	Slightly Important	Moderately Important	Very Important	Critically Important
Workers						
Forced labour (e.g., Involuntary work, threat, imprisonment, trafficking)						
Fair salary						
Working time/hours						
Equal opportunities/Discriminati						

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on (e.g., genders, ethnicities)	
Workers' health and safety	
Social benefits/Social security (e.g., insurance, childcare, pension, violations of employment regulations)	
Workers' rights (e.g., trade union, association, collective bargaining, strike)	
Employment relationship (e.g., contract complied with EU/country-level law and regulation)	
Sexual harassment	
Value Chain Actors	
Fair competition (e.g., among suppliers, providers)	
Promoting social responsibility (e.g., among supply chain members/suppliers)	
Supplier relationships (e.g., commitment, advanced planning)	
Respect of intellectual property rights	
EU/National-level Society	
Poverty alleviation	
Public involvement and acceptance	
Corruption	
Technology development for large society	
Public commitments to sustainable issues (e.g., carbon footprints, unemployment)	
Contribution to economic development	
Society's health and safety	
Urban development (e.g., public transport,	

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infrastructure)	
	Consumer
Consumer's health and safety	
Feedback mechanism (e.g., complains or satisfaction)	
Transparency (e.g., information, sustainability, norms/laws compliance)	
End of 2nd life responsibility (e.g., disposal, recycle)	
Consumer privacy (e.g., data)	
Economic rewarding system (e.g., financial incentives, credits)	
Accessibility (e.g., a variety of products/service, information)	
	Local Community
Respect to local material resources/land rights	
Respect the rights and interests of indigenous people (e.g., native, local people, minorities)	
Safe and healthy living condition	
Local employment (e.g., create fair and meaningful job opportunities)	
Community engagement (involve local communities in decision-making or keep them informed about activities that may affect them)	
Impact of migrant labour on local community	
Respect of the cultural heritage (e.g., language, customs, physical spaces)	
Location proximity of battery infrastructure to the local community	

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Annex 3. Round 2 Survey

Survey on the Expected Social Impacts of Retired EV Batteries Applications – Prolific

Introduction The CIRCUBATT project, funded by the EU and coordinated by the University of Greenwich (UK), aims to transform the European battery sector by applying AI, data analytics, and sustainable practices across the full battery lifecycle. This survey seeks your expert input on the social aspects of new second-life applications for retired electric vehicle batteries (EVB), including: - Repurposing retired EVB into second-life applications such as energy storage - Battery-as-a-Service (BaaS) models that offer flexible ownership, leasing, or subscription-based access to batteries. You will be asked to assess the potential social impacts of organisations within second-life EVB supply chains across different social subcategories. Your feedback will help ensure the framework is comprehensive, effective, and well-aligned with project goals. All responses are confidential, stored securely, and used only for this project. The survey will take about 25–30 minutes to complete. For questions, please contact Dr. James Quang Duong (Deliverable Leader) at quang.duong@gre.ac.uk or visit circubatt-project.eu . Thank you for your valuable contribution!

Consent question Informed Consent Before proceeding with the survey, please read and indicate your consent:

- I have read the information sheet about this study
- I have had an opportunity to ask questions about this study via email
- I have received enough information about this study I understand that I am free to withdraw from this study at any time before submitting my responses
- I understand that I can also withdraw my data after submission by emailing the research team with my response ID within 30 calendar days of completion
- I agree to take part in this study I understand that anonymised research data may be used for future research projects
    - I agree to all of the above and consent to participate in this study
    - I do not consent to participate (If you select this option and click next the survey will end)

Q1.1 What is your age?

- 18-25
- 26-34
- 35-44
- 45-54
- 55-64
- 65 or above

Q1.2 What is your gender?

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- Male
- Female
- Non-binary / third gender
- Prefer not to say

Q1.3 Which group do you primarily belong to?

- Battery Manufacturer & Technology Developer
- Large Electric Vehicles (EV) Manufacturers (e.g., cars, automotive, trains, planes, ships)
- EV Retailer
- Battery Retailer
- Transportation/Logistics Companies
- Battery Remanufacturer, Recycler, Repurposer
- Battery Energy Storage Developers
- (Renewable) Energy Provider/Energy Generators/Utility Provider/Trader/Grid Operators etc
- Light Mobility Manufacturers (e.g., e-bikes, e-scooters)
- Battery End Consumers
- Light Mobility End Consumers (e.g., e-bikes, e-scooters)
- Government/Regulatory Body
- Non-governmental organization
- Academic or Research Institution
- Local Businesses
- Local Residents

Q1.3a Which position are you currently holding in your business?

- Worker/Staff
- Manager/Business Representative
- CEO/Founder

Q1.4 How many years of experience do you have in energy, automotive, or recycling-related fields?

- 1-3
- 4-7
- 8-15
- >15

Q1.5 Which country are you based?

Q2.1 Please rate the following questions/statements in a 5-point Likert scale in the context of second-life EVB applications

How ***likely*** do you think ***discrimination based on gender*** would	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)

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occur? (1)					
How ***likely*** do you think ***discrimination based on disability*** would occur? (2)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think ***discrimination based on minority status*** would occur? (3)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think ***discrimination based on ethnicity*** would occur? (4)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think ***sexual harassment*** would occur? (5)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** is it that **new developed technologies** would ***negatively affect workers' health and safety***? (6)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think workers/staff will have ***the right of association (e.g., form or join groups/unions)*** ? (7)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think workers/staff will have ***the right of collective bargaining***? (8)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***likely*** do you think	○ Very	○ Unlikel	○ Neut	○ Likely	○ Very

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workers/staff will have ***the right to strike***? (9)	unlikely (1)	y (2)	ral (3)	(4)	likely (5)
How ***likely*** do you think workers/staff will have ***the right to be protected by a employment contract aligned with regional and EU labour laws***? (10)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
To ***what extent do you agree*** that workers/staff would be ***free to terminate your employment contract*** without being constrained (forced labour)? (11)	○ Strongly disagree (very constrained) (1)	○ Disagree (2)	○ Neutral (3)	○ Agree (4)	○ Strongly agree (fully free) (5)
How ***positive or negative*** do you think the ***working conditions*** will be? (12)	○ Extremely negative (poor conditions) (1)	○ Somewhat negative (2)	○ Neither positive nor negative (3)	○ Somewhat positive (4)	○ Extremely positive (excellent conditions) (5)
How ***important*** is it for workers/staff to have access to ***health insurance***? (13)	○ Not at all important (1)	○ Slightly important (2)	○ Neutral (3)	○ Very important (4)	○ Extremely important (5)
How ***important*** is it for workers/staff to have access to ***pension fund***? (14)	○ Not at all important (1)	○ Slightly important (2)	○ Neutral (3)	○ Very important (4)	○ Extremely important (5)
How ***important*** is it for workers/staff to have access to ***childcare***? (15)	○ Not at all important (1)	○ Slightly important (2)	○ Neutral (3)	○ Very important (4)	○ Extremely important (5)
How ***important*** is it for workers/staff to	○ Not at	○ Slightly	○ Neut	○ Very	○ Extrem

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have access to ***education***? (16)	all important (1)	important (2)	ral (3)	important (4)	ely important (5)
How ***important*** is it for workers/staff to have access to ***accommodation***? (17)	○ Not at all important (1)	○ Slightly important (2)	○ Neut ral (3)	○ Very important (4)	○ Extrem ely important (5)

Q2.1a What measures could reduce health and safety risks related to new technology? (Optional)

Q2.1b What measures would most effectively reduce sexual harassment/discrimination risks? (Optional)

Q2.2 Which measures do you think would be the most effective to prevent forced labour in the context of second-life EVB applications? Please click and drag to rank from the most to the least effective.

_____ Conducting regular audits and monitoring
_____ Providing worker education and awareness programmes
_____ Implementing social and labour standards in supply chains
_____ Establishing grievance mechanisms
_____ Engaging in multi-stakeholder initiatives (e.g., collaborating with other organisations)
_____ Other, please specify.

Q2.3 Please indicate the expected number of paid annual leave days offered to workers/staff excluding public holidays in the context of second-life EVB applications.

	1 4 8 11 14 17 21 24 27 30 34 37 40 43 47 50
From 1 to 50 days ()	

Q2.4 How many hours per week would workers/staff expected to work in the context of second-life EVB applications?

Q2.5 Do you expect flexible work arrangements (e.g., remote work, hybrid, flexible hours) to be available in the context of second-life EVB applications?

- No
- Maybe
- Yes

Q2.6 What average annual salary range (€) would you expect workers/staff to get paid for the **lowest-** and **highest-**paid positions in the context of second-life EVB applications? Please specify the position if possible.

Q2.7 What do you think will be the % pay gap in the context of second-life EVB applications between? (0% = parity, negative = women/minorities earn less, positive = women/minorities earn more

-100 -80 -60 -40 -20 0 20 40 60 80 100

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Women and Men ()	
Minority and Majority Ethnic groups ()	

Q2.8 Please review the following current health and safety measures in the context of second-life EVB applications - Rate how effective you think it currently is (1 = Very ineffective, 5 = Very effective). - ⇅ Please drag and reorder the statements: move the most important ones to the top of the list.

	Not Needed (1)	Very ineffective (2)	Ineffective (3)	Neutral (4)	Effective (5)	Very effective (6)
Health and Safety Training (1)	○	○	○	○	○	○
Protective Equipments (2)	○	○	○	○	○	○
Formal Policies (3)	○	○	○	○	○	○
Hazard Prevention Measures (e.g., engineering controls, maintenance) (4)	○	○	○	○	○	○

Q3.1 Please rate the following questions/statements in a 5-point Likert scale in the context of second-life EVB applications

How do you think relationships between the focal company and its suppliers will be in terms of ***timely payment***? (1)	○ Very negative – frequent poor practices (1)	○ Negative – some harmful practices (2)	○ Neutral – no strong positive or negative (3)	○ Positive – generally good practices (4)	○ Very positive – highly collaborative and fair (5)
How do you think relationships between the focal company and its suppliers will be in terms of ***having sufficient lead time***? (2)	○ Very negative – frequent poor practices (1)	○ Negative – some harmful practices (2)	○ Neutral – no strong positive or negative (3)	○ Positive – generally good practices (4)	○ Very positive – highly collaborative and fair (5)
How do you think relationships	○ Very negative –	○ Negative – some	○ Neutral – no	○ Positive – generally	○ Very positive –

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between the focal company and its suppliers will be in terms of ***having reasonable volume fluctuations in orders***? (3)	frequent poor practices (1)	harmful practices (2)	strong positive or negative (3)	good practices (4)	highly collaborative and fair (5)
How do you think relationships between the focal company and its suppliers will be in terms of ***having appropriate communication***? (4)	○ Very negative – frequent poor practices (1)	○ Negative – some harmful practices (2)	○ Neutral – no strong positive or negative (3)	○ Positive – generally good practices (4)	○ Very positive – highly collaborative and fair (5)
How do you think relationships between the focal company and its suppliers will be in terms of ***having collaboration on quality issues***? (5)	○ Very negative – frequent poor practices (1)	○ Negative – some harmful practices (2)	○ Neutral – no strong positive or negative (3)	○ Positive – generally good practices (4)	○ Very positive – highly collaborative and fair (5)
How ***likely*** is it that companies will need to ***engage in anti-competitive behaviour or violate anti-trust and monopoly legislation***? (6)	○ Extremely unlikely – strong fair-competition culture (1)	○ Somewhat unlikely – rare issues (2)	○ Neutral – uncertain (3)	○ Somewhat likely – some violations expected (4)	○ Extremely likely – frequent or severe violations (5)
How ***effective*** do you think ***current anti-competitive behaviour prevention policies*** will be? (7)	○ Not effective at all – little to no impact (1)	○ Slightly effective Ineffective – some risks remain (2)	○ Neutral – no major effect (3)	○ Very effective – most risks addressed (4)	○ Extremely effective – strongly prevent violations (5)
How ***likely*** is it that second-life EVB supply chains will ***violate***	○ Extremely unlikely – strong IP respect (1)	○ Somewhat unlikely – rare risks (2)	○ Neutral (3)	○ Somewhat likely – some violations	○ Extremely likely – frequent violations

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intellectual property rights? (8)			expected (4)	(5)

Q3.1a What other measures could best prevent anti-competitive behaviour in the context of second-life EVB applications? (Optional)

Q3.1b What actions could ensure strong protection of intellectual property rights? (Optional)

Q4.1 Please rate the following questions/statements in a 5-point Likert scale in the context of second-life EVB applications

How positively or negatively second-life EVB applications will contribute to ***poverty reduction***? (1)	○ Very negatively – worsening poverty (1)	○ Negatively – some harm to low-income groups (2)	○ Neutral – little to no effect (3)	○ Positively – some positive impact (4)	○ Very positively – significant poverty reduction (5)
To what extent the public will ***accept*** **the construction of the business infrastructure/facilities** (e.g., plants, warehouses) in the town/region? (2)	○ Strongly oppose – widespread rejection (1)	○ Oppose – some public resistance (2)	○ Neutral – indifferent or mixed (3)	○ Accept – generally supportive (4)	○ Strongly accept – very supportive (5)
How ***likely*** is it that ***corruption will occur***? (3)	○ Very unlikely – strong integrity culture (1)	○ Unlikely – rare incidents (2)	○ Neutral – uncertain (3)	○ Likely – some corruption expected (4)	○ Very likely – widespread corruption (5)
How ***effective*** do you think ***an anti-corruption programme*** will be? (4)	○ Very ineffective – no real impact (1)	○ Ineffective – some risks remain (2)	○ Neutral – no major effect (3)	○ Effective – most risks addressed (4)	○ Very effective – strongly reduces corruption (5)
How ***positively or negatively*** do you think if companies ***cooperate with internal and external anti-corruption controls***? (5)	○ Very negatively – actively obstructive (1)	○ Negatively – some resistance (2)	○ Neutral – no strong effect (3)	○ Positively – mostly cooperative (4)	○ Very positively – fully transparent and cooperative (5)
Do you think the ***developed technology*** will be ***accessible*** to developing	○ Completely inaccessibl	○ Inaccessible – significant	○ Neutral – uncertai	○ Accessible – some	○ Very accessible (5)

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countries? (6)	e (1)	barriers (2)	n (3)	limitations (4)	
Do you think the ***developed technology*** will be ***affordable*** to developing countries? (7)	Not affordable at all (1)	Slightly not affordable (2)	Neutral – uncertain (3)	Affordable (4)	Very affordable (5)
How well do you think companies will ***comply*** with its ***public commitments to sustainability***? (8)	Very poorly – frequent non-compliance (1)	Poorly – some commitments not met (2)	Neutral – uncertain (3)	Well – mostly compliant (4)	Very well – fully honours commitments (5)
How ***positively or negatively*** do you think second-life EVB applications will ***affect urban development***? (9)	Very negatively – strongly harms urban development (1)	Negatively – some negative impacts (2)	Neutral – no major effect (3)	Positively – moderate improvements (4)	Very positively – strongly supports sustainable urban growth (5)

Q4.1a Follow-up: Why large society/community would oppose second-life EVB applications and what actions could improve public acceptance of the project? (Optional)

Q4.1b Follow-up: What actions could help ensure sustainability commitments are fulfilled? (Optional)

Q4.1c Follow-up: What measures could enhance positive urban development impacts? (Optional)

Q4.2 How many percent of operating revenue do you think will be invested in research and development (R&D) in the context of second-life EVB applications?

Q4.3 How many percent do you think second-life EVB applications will contribute to the GDP of your country/EU or sector?

	0 10 20 30 40 50 60 70 80 90 100
From 0-100% ()	

Q5.1 Please rate the following questions/statements in a 5-point Likert scale in the context of second-life EVB applications

How ***risky*** do you think second-life EVB applications	Very low risk (safe) (1)	Low risk (2)	Neutral (3)	High risk (4)	Very high risk (dangerous

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is in terms of ***causing accidents or harm to consumers***? (1)					) (5)
How ***positively or negatively*** do you perceive on current ***feedback mechanisms*** for consumers? (2)	○ Very negatively (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)
How ***likely*** is it that second-life EVB applications can further be ***reused, repurposed, or recycled*** after its primary use? (3)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
How ***positively*** do you think consumers would ***respond to a structured take-back system*** that requires their involvement? (4)	○ Very negative (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)
How ***likely*** do you think ***data breaches*** will be? (5)	○ Very unlikely (1)	○ Unlikely (2)	○ Neutral (3)	○ Likely (4)	○ Very likely (5)
To what extent do you think second-life EVB applications will ***positively or negatively affect consumers'***	○ Very negatively (loss) (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (gain through saving or selling energy) (5)

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monthly income? (6)					
How ***positively or negatively*** do you think if consumers ***have free access to information*** about energy use and electricity sources? (7)	○ Very negatively (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)
How ***positively or negatively*** do you think if companies can offer ***a variety of points of sales, products, and services***? (8)	○ Very negatively (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)

Q5.1a Q4a. Why is current feedback mechanisms negative and what types of feedback mechanisms would be most effective? (Optional)

Q5.1b What security measures would best prevent data breaches? (Optional)

Q5.2 What percentage of product defects do you anticipate per production batch in the context of second-life EVB applications?

	0 10 20 30 40 50 60 70 80 90 100
From 0%-100% ()	

Q5.3 What are health and safety measures do you think are most needed to protect consumers in the context of second-life EVB applications?

Q6.1 Please rate the following questions/statements in a 5-point Likert scale in the context of second-life EVB applications

To what extent will second-life EVB applications require extraction of ***material resources***? (1)	○ Very low (1)	○ Low (2)	○ Moderate (3)	○ High (4)	○ Very high (5)
To what extent will second-life EVB applications require extraction of ***water***? (2)	○ Very low (1)	○ Low (2)	○ Moderate (3)	○ High (4)	○ Very high (5)
To what extent will second-life EVB applications	○ Ver	○ Low (2)	○ Modera	○ High (4)	○ Very

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require extraction of ***biomass relative to land area and local population***? (3)	y low (1)		te (3)		high (5)
To what extent will second-life EVB applications require extraction of ***fossil fuels***? (4)	○ Very low (1)	○ Low (2)	○ Moderate (3)	○ High (4)	○ Very high (5)
To what extent will second-life EVB applications require extraction of ***industrial and construction minerals***? (5)	○ Very low (1)	○ Low (2)	○ Moderate (3)	○ High (4)	○ Very high (5)
How ***positively or negatively*** do you think if second-life EVB applications has ***certified environmental management systems***? (6)	○ Very negatively (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)
How ***positively or negatively*** that second-life EVB applications will impact ***indigenous people (native/local people)***? (7)	○ Very negatively (1)	○ Negatively (2)	○ Neutral (3)	○ Positively (4)	○ Very positively (5)
How ***likely*** is it that second-life EVB applications will expose the local community to ***injuries or harm***? (8)	○ Very likely (harmful) (1)	○ Likely (2)	○ Neutral (3)	○ Unlikely (4)	○ Very unlikely (safe) (5)
How ***likely*** is it that second-life EVB applications will expose the local community to ***contagious diseases***? (9)	○ Very likely (harmful) (1)	○ Likely (2)	○ Neutral (3)	○ Unlikely (4)	○ Very unlikely (safe) (5)
How ***important*** is it for second-life EVB applications to prefer ***hiring local employees***? (10)	○ Not important (1)	○ Slightly important (2)	○ Neutral (3)	○ Important (4)	○ Very important (5)

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To what extent do you think second-life EVB applications will ***engage with the local community***? (11)	○ Not at all (1)	○ Slightly (2)	○ Moderately (3)	○ Significantly (4)	○ Fully engaged (5)
How ***likely*** are any culturally important places or elements ***negatively affected*** by second-life EVB applications (e.g., buildings, natural places, art, language, customs, religion)? (12)	○ Severe impact (1)	○ Significant impact (2)	○ Moderate impact (3)	○ Minor impact (4)	○ No impact (5)
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***public health***? (13)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ High (4)	○ Very comfortable (5)
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***environmental issues (waste, emissions)***? (14)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***aesthetics***? (15)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)
How ***comfortable or concerned*** are you with having	○ Very concern	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)

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the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***safety***? (16)	ed (1)				
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***property values***? (17)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***economic activity***? (18)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)
How ***comfortable or concerned*** are you with having the business infrastructure/facility (e.g., plants) nearby your local vicinity regarding ***traffic***? (19)	○ Very concerned (1)	○ Concerned (2)	○ Neutral (3)	○ Comfortable (4)	○ Very comfortable (5)

Q6.1a Follow-up: What policies could better protect indigenous rights? (Optional)
Q6.1b Follow-up: What measures could protect the local community from either injuries, harm, or contagious diseases? (Optional)
Q6.1c Follow-up: What are culturally important places or elements negatively impacted and how? (Optional)
Q6.1d Follow-up: Which concerns are most important to address, if no option, please input your own opinion? (Ranking question - Optional)

_____ Public health
_____ Environmental issues (waste, emissions)
_____ Safety
_____ Aesthetics
_____ Property values
_____ Economic activity
_____ Traffic

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_____ Other, please specify

Q6.2 Please drag the scale to provide the percentage for each of the following questions in the context of second-life EVB applications.

	0 10 20 30 40 50 60 70 80 90 100
How ***many percentages*** of the workforce do you expect to be ***hired locally*** compared to the total workforce need? ()	
What ***percentage of local jobs*** do you expect second-life EVB applications to ***create*** relative to current total jobs in the energy, battery, and EV market? ()	
What ***percentage of the workforce*** do you expect from ***immigrant labour*** compared to the total workforce need? ()	
What ***percentage of spending*** do you expect to ***allocate to local suppliers***? ()	

Q6.2a Can you provide some examples of newly created jobs for local community? (Optional)

Q7.1 How would you rate your level of experience with second-life EV battery applications? Or do you suggest any other second-life EV battery applications?

	I have never heard of them	I have heard of them but have no experience	I have experience of them
A. Energy Arbitrage & Grid Services – Batteries store low-cost electricity and release it when prices are high, supporting grid stability.	○	○	○
B. Backup Power & Resilience – Batteries provide backup power during outages, from critical loads (e.g., hospitals) to full-site or off-grid supply.	○	○	○
C. Portable & Off-Grid Uses – Batteries power mobile, remote, or off-grid needs (e.g., work sites, emergency response, recreational E vehicles).	○	○	○
D. Urban Mobility – Batteries are repurposed in small electric vehicles (e.g., e-bikes, e-scooters).	○	○	○
Other, please specify	○	○	○

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Annex 4. Round 2 survey insights on open-text inputs

Open questions and stakeholders' response	Insights on stakeholders' open text inputs
Question 2.1a: *What measures could reduce health and safety risks related to new technology?* **Stakeholders' response:** (1) Strict monitoring (2) Clear regulations and standards for the safe use of new technologies; Comprehensive training programs for workers to use new tools safely; Support for mental health to address stress or burnout linked to digital/AI technologies; Strong enforcement of labour laws and accountability for employers. (3) Training and certification should be made a priority for all workers to improve safety standards and monitor a data driven health and safety system (4) identity thefts and influences of social media, like body ideal (5) Medical surveillance (6) Strong regulation (7) Health and safety legislation (8) PPE, proper disposal practices, collaboration with government to ensure on-site health and safety requirements. (9) With the increase of cost optimized production technologies, demand for human employment will reduce and based on competition for available workplaces and unemployment health and safety risks will rise. To minimize this, human workforce must be employed alternatively or some governmental subventions towards people must be funded by tech companies (at least partial). The cost of unemployment with tech development cannot be left to governments. (10) less time of exposure (11) Good health and safety regulations, strict monitoring and audits (12) better employee benefits which would lead to less accidents	Overall, responses converge on a variety of mitigation logic: (i) regulatory and enforcement foundations (clear standards, legislation, and compliance monitoring or audits), (ii) competence building through training and certification to close capability gaps introduced by new tools and digital systems, and (iii) operational controls that reduce real-world exposure and incidents (e.g., PPE, safe handling/disposal practices, health surveillance, and limiting exposure time). In addition, respondents highlighted emerging risk domains that extend beyond traditional occupational safety, including psychosocial pressures associated with digital/AI-enabled work (stress, burnout) and broader digital harms (e.g., privacy and identity-related risks), as well as job displacement and associated health and safety vulnerabilities. Collectively, these insights suggest that pathway comparison should not be limited to technical hazards alone; it should also consider differences in governance maturity (the strength of standards and enforcement), workforce capability and preparedness (training coverage and certification), and the wider socio-economic conditions shaped by technology adoption (employment stability and wellbeing protection).
Question 2.1b: *What measures would most effectively reduce sexual harassment/discrimination risks?* **Stakeholders' response:** (1) Strict rules (2) More harsh sentences for those who commit such thing (3) Consequences for the ones doing them. Big ones. (4) Clear zero-tolerance policies against harassment and discrimination, communicated to all workers; Anonymous reporting channels; Independent investigations; Active monitoring. (5) Proactive actions and close monitoring of groups (6) A fair, unbiased reporting system should be put in place and a robust awareness campaign launched (7) Tougher penalties for molesters	Overall, respondents converge on a package that combines prevention and accountability. First, they emphasise the importance of clear zero-tolerance rules and codes of conduct, with clear guidance on unacceptable behaviours and consistent communication to all workers and contractors. This should be backed by visible sanctions, including disciplinary actions, termination and escalation to legal authorities. Respondents repeatedly highlight safe reporting mechanisms (including anonymous options), coupled with independent and transparent investigation

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(8) Better worker's rights legislation (9) Detailed seminars informing about what right and what's wrong while at job, informing about discriminations and racist behaviors. (10) Training for the staff (11) Training in what constitutes sexual harassment and discrimination and the risks associated (12) severe penalties, including immediate termination of employment contracts. Report such cases to the police. (13) proper surveillance (14) Clear guidelines, a no-tolerance policy (15) encouraging victims of sexual harassment to come forward, no shaming and lending a sympathetic ear. Making sure that investigations are thorough and when the person is found guilty, they are fired. That is the only measure that will be effective (16) education from very old age. (17) hard punishment (18) a strong leadership commitment and safe reporting mechanisms (19) Monitoring measures (20) Sanctions any Kind of harassment (21) An independent worker rights and ethics person/team should be setup so workers can anonymously or not talk to. Regular 3rd-party auditing practices to make sure that there are rail guards in place to prevent these risks. (22) I believe it would be important to assess people's previous work behavior in order to guarantee no one - regardless of their gender - has tendencies to discriminate. I also believe some easy and free courses or workshops on discrimination and sexual harassment on labour settings could be beneficial, but it might be a challenge if the employees are from different generations and/or countries. (23) Equity, Equality, restrict behaviors related to sexual harassment/discrimination risks (24) The same amount if gender in a group, given to them the same rights and gave to them a sense of a team (25) Have clear and real consequences on those actions and provide a safe environment for the person affected to communicate what has happened (26) Education. A formal direct employee whose role is to ensure safety and be the point of contact for complaints. (27) Open communication, clear policies, hiring of women at management/ senior level (28) ensure code of conduct following (29) I think that educating people on what sexual harassments actually is would help. I think that some might think that their actions are just silly when it is harassments. And telling them that any form of harassments will have repercussions. (30) There should be mandatory regular training for all employees on conduct and bystander intervention. There must be independent, transparent investigation processes and meaningful disciplinary consequences. (31) Mass communication on the effects of sexual discrimination.	processes to reduce fear of retaliation and perceived bias. Several responses further suggest that these systems should be reinforced through active monitoring, dedicated ethics or worker-rights roles, and third-party auditing, signalling that organisations should treat harassment and discrimination risks as a governance priority. In parallel, participants stress the need for regular training and awareness-building to clarify boundaries, particularly where teams are diverse and include different generations, cultural backgrounds, or cross-border work arrangements. Training is perceived not only as compliance education, but also to align understanding of what constitutes harassment or discrimination, encourage bystander intervention, and strengthen shared norms of respectful conduct. Finally, several responses indicate that sustained risk reduction depends on leadership commitment and organisational fairness, including representation in management and equal opportunities and pay. These factors shape workplace culture and psychological safety, influence whether victims feel able to report incidents without shame and ultimately determine how effectively policies are implemented in practice. Thus, the responses imply that effective mitigation requires an integrated set of measures across rules and sanctions, reporting and investigation capacity, and culture and equity interventions, rather than reliance on any single tool.

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(32) make example of people being toxic (harassment or discrimination, or other thing) (33) have a bigger control and attention to the worker's (a good HR) and equality at the opportunities and payments	
Question 3.1a: *What other measures could best prevent anti-competitive behaviour in the context of second-life EVB applications?* **Stakeholders' response:** (1) Strong regulations (2) Promote team-building sessions to strengthen relationships and offer competitive salaries to maintain high levels of motivation. (3) More transparency between competitors (4) I dont know but I am sure that if major governing bodies are involved (EU, US government), this phenomenon could definetely be reduced (5) Anti-exclusive agreements prohibit exclusive contracts that prevent venues, transport providers, or vendors from using competing EVB systems. (6) Transparent data management and sharing for lifecycle and performance tracking (7) Honesty from all envolved. (8) Politicians have to oversee the operations. (9) Government subsidies could promote new entries to the market. (10) Better Communication (11) No cartel agreements. Governmental controls (12) measures should focus on promoting standardization, transparency, and interoperability, as well as establishing clear regulations and incentives. Key actions include mandating open standards for battery data and design. (13) Prevent Monopoly like situations. Stimulate different companies. (14) have a regulatory organism and have frequent audits in terms of market competition (15) National regulation and international control of subsidies with the imposition of tariffs when necessary (16) Incentivize cooperation between companies in compatible aspects of the supply chain (17) There should be support for independent third-party refurbishment and testing services.	Overall, responses frame anti-competitive risk prevention as a combination of regulatory enforcement, information transparency, and ecosystem design measures. First, participants suggest strong regulatory oversight and consistent enforcement, including the establishment or strengthening of dedicated competition authorities, frequent audits, and coordinated market manipulation. Then, several responses extend this governance perspective to the international level, noting that cross-border market dynamics, such as subsidies, tariffs, and policy interventions, can shape competition conditions and therefore require coordinated monitoring and rule-setting by major governing bodies. Meanwhile, respondents highlight that anti-competitive behaviour is often enabled by information asymmetries and therefore advocate for greater transparency and open information flows. This includes clearer communication among market actors, disclosure expectations, and, more concretely, transparent data management and sharing for battery lifecycle and performance tracking. Building on this, many responses propose structural measures to reduce exclusionary conduct, notably standardisation and interoperability, and restrictions on exclusive agreements. Several respondents further emphasise using incentives and policy tools to lower entry barriers, stimulate diverse participation, and prevent monopoly structures from emerging. To summarise, these insights suggest that competition-related risks in second-life EVB markets are driven not only by firm conduct but also by governance maturity, data openness, and ecosystem architecture (e.g., standards, interoperability, contracting practices).
Question 3.1b: *What actions could ensure strong protection of intellectual property rights?* **Stakeholders' response:** (1) by having these rights in clear writing/documentation	Overall, respondents describe IPR protection as a layered control package, which has clear legal definitions and formal IP instruments, supported by government regulation and enforceable laws. This is complemented by contractual safeguards (NDAs and confidentiality

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(2) Sign confidentiality contracts (3) Strong regulations by governments and laws that cover these topics (4) Employee training, collaboration with authorities, monitoring (5) coded batteries (6) Copyright (7) Trademarks, staff signing NDAs (8) Some sort of government regulation ensuring IP is maintained by original battery manufacturers, maybe some sort of compensation or subsidy. (9) combine formal legal measures with internal security and enforcement strategies. (10) Government should take measures to ensure the strong protection of intellectual property. (11) have a regulatory organism and have frequent audits in terms of intellectual property rights (12) Strong company data security policy	clauses) to manage knowledge sharing across multi-actor second-life supply chains. Several responses stress the need to combine formal legal measures with internal governance, including employee training, monitoring and collaboration with authorities, alongside technical and data-security measures (e.g., cybersecurity policies and traceability/coded battery approaches). Finally, proposals for audits and regulatory oversight and, in some cases, policy-based incentives or compensation mechanisms suggest that effective IPR protection depends not only on firm practices, but also on governance maturity and the availability of credible enforcement infrastructures.
Question 4.1a: *Follow-up: Why would large society/community oppose second-life EVB applications and what actions could improve public acceptance of the project?* **Stakeholders' response:** (1) Clearer goals. (2) An opposition could occur if the negatives were more than the benefits of second-life EVB applications. Also, there is always opposition to anything new introduced. (3) In general, the public is always sceptical but can be persuaded. (4) Privacy Concerns - Fear of personal data being collected, tracked, or misused. (5) Presumed safety concerns like toxic chemicals and gases, and limited knowledge of how second hand EVB differs from other waste would be the mostly likely reason why the community will oppose EVB application. Community engagement and awareness campaigns detailing the environmental, social and economic benefits of EVB should be implemented early enough (6) For safety reasons and to develop in isolated areas. (7) i think there is still a lot of information that needs to be given out to prevent any opposition (8) more expertise wise applications, wider array of people to pick. (9) The added traffic from vehicles accessing the sites, potential pollution. To improve public acceptance the company could create a community park, share parking spaces. (10) There may be some public distrust with the recycling of batteries. Educational campaigns could be helpful explaining their safety and benefits to the environment. (11) Environmental impact. Avoidance of soil pollution. (12) Concerns over safety, potential environmental contamination, and lack of transparency in the process (13) People are often against new things because of fear about the	Overall, responses suggest that community opposition is most likely to arise from high-risk perceptions, especially fears of fire, toxic leaks, explosions, and environmental contamination, combined with limited public understanding of how second-life EVBs differ from waste and how risks are controlled across the full lifecycle. Several responses imply that even where the probability of severe incidents is low, the perceived severity and uncertainty surrounding batteries and new technology can dominate public judgment, particularly when communities lack accessible information about safety standards, monitoring practices, and emergency response plans. Respondents also highlight the central role of trust and procedural legitimacy. Unclear project goals, limited transparency about processes, and perceived unfairness in decision-making can amplify opposition even when the project's environmental benefits are compelling. Practical, place-based issues further reinforce resistance. Concerns about traffic, local pollution, noise, and visual intrusion translate broader risk perceptions into everyday lived impacts, strengthening NIMBY dynamics and lowering tolerance for uncertainty. Respondents also note that these conditions create ground for misinformation and scaremongering. To improve acceptance, participants point to a package of mutually reinforcing actions rather than any single intervention: (i) early, proactive and transparent

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unknown. Communication will be key. (14) Because the public always see the negative side of the project, only few can or want to understand (15) I think, in the case of Portugal, there would be lobbies from certain groups and/or families because they tend to only think about their own success. Thus, once again, there should be a guarantee that personal connections would not be the leading way to success and that the opportunities would be distributed amongst the ones that actually have the know-how and the capacities to do certain task. It should also be explained to everyone in the community, in an accessible way. (16) They would see as it polluting (environmentally and visually) their town (17) Oppose - risk of pollution; traffic related to project (18) just a fact of life that people are NIMBY (not in my back yard) , the added effect of batteries and the technology would be easy to scaremonger the public into believing it is toxic/harmful to the environment. (19) potential health and safety risk to life from working with the evb's. more education of how safe this is would help i would say (20) One of the reasons for opposing it will be fear of fire, toxic leaks, explosions, or health effects from repurposed batteries. The best way to address this is to conduct proactive, transparent communication. Early and clear education on safety standards will greatly help. (21) it would oppose if it may cause harm to the community. To improve acceptance, conducting educative bootcamps is essential (22) Fear of undisposable waste	communication that clarifies goals, responsibilities, and evidence of safety; (ii) accessible education and engagement delivered in non-technical language and sustained over time; (iii) visible safety assurance and environmental safeguards, including compliance with standards, monitoring and emergency preparedness; (iv) local impact mitigation with tangible community benefits (e.g., traffic management, site design, shared facilities or community amenities); and (v) credible governance mechanisms that demonstrate fairness, independent oversight or third-party verification. Hence, these insights imply that building public acceptance requires integrating technical risk management with social trust-building, local impact management, and procedural fairness throughout project planning and implementation.
Question 4.1b: *Follow-up: What actions could help ensure sustainability commitments are fulfilled?* **Stakeholders' response:** (1) Regular inspections. (2) Strict rules but they need to be applied to everyone, not just Europe, for example. We can't have sustainability rules in Europe and then import everything from China where are no rules at all (3) Give companies fiscal incentives to do so. (4) Companies should always be in touch with governing bodies or organisations responsible for sustainability and be made sure that they follow all the respectable laws and regulations. (5) Set Clear, Measurable Goals - Define specific environmental, social, and economic targets with timelines; Stakeholder Engagement â€“ Involve employees, users, and partners in sustainability initiatives to encourage accountability. (6) Government funding towards set goals (7) Monitoring and auditing of production journey (8) Constant high standard audits for environmental compliance and measuring of sustainability key performance indicators (9) Strong legislation and regulation (10) Rich government policy on company sustainability behaviours	Overall, respondents treat the fulfilment of sustainability commitments primarily as a governance challenge, rather than a communication exercise. They emphasise that commitments are most likely to be delivered when they are translated into clear, measurable goals and KPIs with timelines, supported by defined responsibilities and decision rights, and then tracked through continuous monitoring, high-standard audits, and transparent reporting across the value chain. A recurrent message is that accountability depends on credible enforcement. Respondents highlight the need for robust legislation, consistent application of rules, and meaningful sanctions for non-compliance, noting that commitments weaken when enforcement is uneven or selective. Many responses further stress the role of economic levers, such as tax incentives, subsidies, targeted funding, and penalties, to align sustainability performance with business incentives. Trust and accountability are perceived to be strengthened through independent third-party oversight and public

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along with strong enforcement. (11) Continued controls of the production (12) information about climate control way for sustainability to the higher ranks. (13) Donate part of profits to carbon offset projects, e.g. planting trees. (14) Public oversight, maybe a board or third party that audits the company. (15) Enforce EU Policies. Adopt policies by diffusion of other countries which proved to be a good example. Create sanctions for the companies (16) Environmental reports (17) frequent audits and sanctions (18) I think the easiest way is the wallet. If companies are penalized if they don't achieve set goals, they will be incentivized to do it. (19) I think it would be relevant to have an objective third-party responsible for ensuring that everything is being followed through. (20) Tax incentives for meeting and exceeding these goals. (21) Implement energy and resource efficiency programs, promote workforce sustainability training (22) reducing corruption (23) to make technology more payable (24) environmental impact education	scrutiny, such as external audits and boards. Several respondents also underline the importance of cross-border supply chain alignment: sustainability commitments can be undermined if strict rules apply in one region while inputs are sourced from less regulated contexts. Finally, respondents recognise enabling conditions within organisations and systems. Internal capability building, including workforce sustainability training and escalation of sustainability information to senior leadership, is viewed as necessary to convert goals into operational routines. Alongside this, integrity safeguards (e.g., reducing corruption) are seen as essential to protect enforcement credibility. The above responses suggest that sustainability commitments are most likely to be fulfilled when governance, incentives, verification, and organisational capability are designed as an integrated package rather than treated as separate initiatives.
Question 4.1c: *Follow-up: What measures could enhance positive urban development impacts?* **Stakeholders' response:** (1) Integrated Urban Planning - Coordinate EVB systems with public transport, pedestrian zones, and cycling infrastructure; Smart Mobility Solutions - Use real-time data to optimize traffic flow, reduce congestion, and improve accessibility; Public-Private Collaboration - Work with local authorities, businesses, and NGOs to align projects with community needs. (2) Community engagement (3) Charging facilities locally (4) High wages (5) Full transparency, taking measures to avoid the risk of environmental contamination, and ensure that rules will be followed (6) planting trees and cleaning waters (7) A lot of information and communication and involve the locals, showing the project (8) There should be a strong cooperation because the local communities and the infrastructure's builders in order to guarantee that all voices are heard and the best can be done. (9) Tax incentives (10) creation of employment (11) Mandatory local committees made up of all stakeholders (12) Engaging the community before building	Overall, respondents suggest that positive urban development impacts are maximised when second-life EVB initiatives are embedded into wider urban planning and mobility systems, rather than implemented as isolated infrastructure. This includes coordinating with public transport and active mobility networks and using data-enabled smart mobility approaches to reduce congestion. At the governance level, respondents emphasise public-private collaboration and multi-stakeholder structures (e.g., local committees) to ensure that projects align with community needs and that local voices are represented. Participants also highlight the importance of early and continuous community engagement, alongside transparent communication and strong environmental safeguards to maintain trust. Finally, tangible local benefits, such as local charging facilities, employment creation and fair wages, supported by tax incentives and visible environmental improvements, are viewed as key levers for strengthening the perceived value and legitimacy of urban deployments.

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Question 5.1a: *Why is current feedback mechanisms negative and what types of feedback mechanisms would be most effective?* **Stakeholders' response:** (1) Lack of Transparency - Users often do not see how their feedback is used, making the process feel ineffective. (2) Not much data available on safety and how to report issues (3) Feedback from consumer to NGOs and to politicians. (4) Because usually when there is change people tend to be worried, it's a good thing because then people get to ask questions and maybe even the people trying to implement this might find problems and find solutions (5) Being able to contact a human assistant to report any relevant feedback. Current trends tend to rely more on automatic response systems and AI to attend this kind of queries, which often results in increased frustration from the contacting part.	Respondents indicate that negative perceptions of current feedback mechanisms are primarily due to a lack of transparency and weak responsiveness: users often cannot see how feedback is processed or whether it leads to action, which makes the system feel ineffective. This problem is amplified in second-life EVB contexts by limited accessible safety information and unclear reporting routes for incidents or concerns. Effective mechanisms are therefore described as those that establish a visible, clear timeline and communicated outcomes, provide trusted safety reporting guidance, and offer multiple escalation pathways, including independent channels such as NGOs. Finally, respondents caution that over-reliance on automated or AI-only interfaces can increase frustration, suggesting that human-accessible support remains essential, particularly for safety-critical or sensitive issues.
Question 5.1b: *What security measures would best prevent data breaches?* **Stakeholders' response:** (1) Delete any details after one year. Complete wipe from cloud-based info (2) Clear privacy options. (3) Software Updates & Patch Management -Keep all systems up to date to prevent exploitation of known vulnerabilities. (4) effective use of GPDR, strong database encryption (5) Personal data security handling (6) Internal trainings and seasonal check ins to ensure data breaches don't happen internally due to social engineering or phishing attacks. (7) extra IT budget and professionalisms (8) Invest in a good Cybersec. Team and their technologies. (9) External Security experts, Security Tests, establish and follow Security Standards, Audits. (10) Have good cybersafe and provide companies with regular training on it (11) End-to-end encryption for all stored and transmitted sensitive data.	Respondents propose an approach to preventing data breaches that combines data minimisation and retention controls, privacy governance and compliance, and core technical safeguards. Several responses prioritise reducing the exposed data footprint through clear retention limits and secure deletion, alongside transparent privacy options and effective GDPR governance for personal data handling. Participants also stress that breaches are often enabled by human factors, recommending regular staff training and check-ins to mitigate phishing and social engineering risks. Finally, respondents highlight the importance of resourcing (IT budget, cybersecurity teams) and independent assurance through external experts, security testing, standards, and audits to sustain security maturity over time.
Question 5.3: *What are health and safety measures do you think are most needed to protect consumers in the context of second-life EVB applications?* **Stakeholders' response (examples):** (1) Protection from toxic materials and fire risks. (2) Product warranty is important, and tests should be made to protect	Overall, respondents prioritise consumer protection through a full-chain safety package that treats second-life EVB applications as a system requiring controls from market entry to end-of-life. At the front end, they emphasise rigorous battery screening, standardised testing, and certification for consumer safety, ensuring

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consumers from being exposed to any kind of harm (3) Very strict rules with policies that are enforced and regularly checked and fined if not maintained to a certain standard. (4) Robust standards for battery testing, safe handling, fire prevention, and end-of-life recycling. (5) guides and training videos are the most needed as they can be easily shared (6) ensure that the only functional ones are repurposed and avoid any toxic exposure (7) Containers with strong protection, placed in a local free of people (8) Provide adequate education and instructions at all stages. (9) Have high standards for quality and battery life metrics to avoid potential hazards with second-life EVB products (10) Rigorous battery health assessments and certification, strict adherence to safety standards. Use of certified workshops with trained staff, continuous monitoring via battery management systems, clear labelling. As well as traceability through battery passports, and comprehensive risk management to prevent hazards. (11) Standardized testing and certifications to keep consumers safe (12) Data Privacy & Security - Protect personal and payment information to prevent identity theft or fraud. (13) establishing rigorous standards for testing and certification, implementing advanced Battery Management Systems (BMS), ensuring robust thermal management, and providing transparent consumer information (14) Good cooling systems to stop batteries from getting too hot or catching fire, Careful checks and tests to make sure only safe batteries get reused. (15) All batteries should undergo strict testing and subsequent certification before they are released into the market. The health and lifespan of the battery should be made transparent and clear by clear labelling and detailed consumer guidance (16) Battery Screening and Traceability, Safe Pack Design for Repurposing, Thermal Runaway & Fire Protection, Electrical Safety and Isolation, Consumer-Level Installation & Maintenance Protocols, End-of-Life & Recycling Pathway, Testing, Certification, and Regulatory Oversight, Information Transparency (17) To protect consumers in second-life EV battery applications, it is essential to ensure rigorous testing of battery health and safety, reliable fire and thermal management systems, and proper installation standards. Clear labelling and user information must be provided, along with full traceability and defined responsibilities across the value chain. Finally, specific certification schemes and safe end-of-life management are needed to guarantee overall safety and consumer confidence. (18) Ensure that all reused batteries undergo rigorous testing and certification to confirm their safety, stability, and remaining capacity. There should be clear labelling and transparent information about performance as it helps users understand what they are buying. Strict standards for transport, storage, and installation should be followed to reduce risks of overheating or fire. Proper recycling and disposal of	that only batteries meeting defined thresholds for health and remaining capacity are repurposed and placed on the market. The most salient consumer concerns relate to thermal runaway and fire risk, which respondents treat as the dominant high-consequence hazard. This drives recommendations around thermal management and cooling, safe pack design, electrical isolation, and engineered protections against chemical spills and gas leaks. Importantly, respondents also highlight that consumer protection cannot rely on one-time testing alone; instead, it requires continuous risk control during use, including BMS-enabled monitoring and fault detection to identify anomalies early and prevent escalation. Many suggestions focus on certified installation and service networks, trained personnel, clear maintenance protocols, and practical consumer-facing guidance that is easy to understand. Respondents also connect consumer protection to end-of-life responsibility, calling for clear recycling and disposal pathways for degraded cells so that safety is maintained beyond the use phase and consumers are not left uncertain about how to handle products at retirement. Finally, several responses recognise that in data-enabled second-life applications where monitoring, passports, or platform-based services may involve consumer data, privacy and data security become a complementary protection layer. Thus, the responses imply that effective consumer protection requires integrated measures across technical design, standards and enforcement and transparent information and accountability mechanisms.

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degraded cells, along with built-in monitoring systems that detect faults early, are also essential. Also, educating consumers on safe use and maintenance, and having clear emergency or recall procedures in place is important to help build trust and keep users safe. (19) Reused batteries should have clear labels with safety warnings, and it should be clear how they should be safely recycled or disposed of (20) Adequate instructions and warnings about correct usage and disposal of products (21) Required bms functions to run the batteries and prevent thermal runaway would be critical. Beyond that some standard safety measures should be implemented to prevent chemical spill and gas leak (22) All second-life applications need the same quality standards as new applications (23) Providing instructions on how to act in case of an emergency, and designing products that are inherently safer at the cost of performance	
Question 6.1a: *Follow-up: What policies could better protect indigenous rights?* **Stakeholders' response:** (1) Conservation policies (2) Collaboration with indigenous groups. (3) A screening with them before going forward with the product/application.	These responses suggest a clear policy direction: indigenous rights are best protected through a combination of conservation and land/ecosystem safeguards, structured collaboration with indigenous groups, and early-stage screening and consultation mechanisms before projects or applications proceed. These suggestions reflect an emphasis on prevention and procedural legitimacy.
Question 6.1b: *Follow-up: What measures could protect the local community from either injuries, harm, or contagious diseases?* **Stakeholders' response:** (1) Keep the sites audited and make sure breaches are reported (2) Keep the facilities away from communities. (3) Public awareness, environmental sanitation, organisational and government policies (4) Cooperative development of the plants and infrastructure. (5) Prioritize safety and standards and practices. (6) Good safety rules, clear signs and warnings, clean work areas, health check programs	Respondents propose an approach that combines continuous oversight (regular audits, monitoring and breach reporting) with careful siting and physical separation of facilities from residential areas. Respondents also emphasise the role of public health actions and the importance of baseline safety management, such as clear rules, signage and warnings, clean work areas, and health-check programmes to prevent harm and detect risks early.
Question 6.1c: *Follow-up: What are culturally important places or elements negatively impacted and how?* **Stakeholders' response:** (1) I can foresee infrastructure being placed in cultural significant places as the groups effected may not be able to prevent introduction of facilities. (2) Forests are getting chopped down for wood and more place to build	Respondents describe cultural impacts as primarily driven by infrastructure siting and land-use change, and affected groups may have limited capacity to prevent such developments. In addition, respondents highlight risks to sacred or heritage landscapes, large installations near protected areas, burial grounds, or pilgrimage routes can generate visual intrusion.

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concrete buildings (3) with the industrialization there is always the risk of losing culturally important places or elements (4) community gathering spaces that could be affected by noise (5) Sacred or heritage landscapes. Large-scale energy storage facilities sited near protected areas, burial grounds, or pilgrimage routes can cause visual intrusion and spiritual disturbance.	These insights suggest that protecting cultural heritage requires early-stage screening and participatory siting decisions, combined with design measures that minimise landscape intrusion, noise, and other local disruptions.
Question 6.2a: *Can you provide some examples of newly created jobs for local community?* **Stakeholders' response:** (1) Battery repurposing technicians, Energy storage installers, Battery logistics coordinators (2) Engineers, factory floor jobs, administration (3) Maintenance technicians, Safety engineers (4) Anything related to the application, from workers directly working to the batteries, from staff working on companies' offices, truckers moving materials, miners possibly needing to contribute minerals to the facility and any other job that is involved on the first hand applications. (5) Lots of new jobs can be created, if the workforce brings their families more schools and their staff are needed, more apartments and housing might be needed so more building opportunities. (6) Battery refurbishment technicians and Environmental compliance officers (7) Diagnostic technicians, Recycling and recovery staff, AI specialist and data analyst (8) sustainable agriculture technicians, air conditioning pump installers (9) Community liaisons, security, inspectors, floor employees, management. (10) Testers, Refurbishes, Mid-level managers, (11) installation and generation of energy from renewable energy sources: photovoltaic panels (12) New Energy related jobs (13) manual worker at production line for batteries recycling factory (14) technicians, safety guards, security, compliance officers (15) Battery Engineer, Battery Sourcing, Materials Sourcing, Stock Control, Warehousing, EV Engineer, Mechanic, Health and Safety Advisor, Chemical Engineer (16) health and safety officer, monitoring and evaluation officer (17) Battery inspection and diagnostics technician, Local maintenance and repair technician	Respondents describe that direct employment opportunities cluster around core operations such as battery inspection or diagnostics, repurposing and refurbishment, recycling and recovery, and the installation and maintenance of deployed energy systems. These are complemented by supporting roles in logistics, transportation, warehousing, sourcing, and administration, as well as governance-related jobs such as health and safety officers, environmental compliance staff, inspectors, and monitoring and evaluation functions. A smaller set of responses points to emerging digital roles (e.g., AI specialists and data analysts) aligned with data-enabled battery management and traceability. Finally, some respondents emphasise indirect community benefits through increased demand for local services and infrastructure, such as housing, schools, and construction.

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