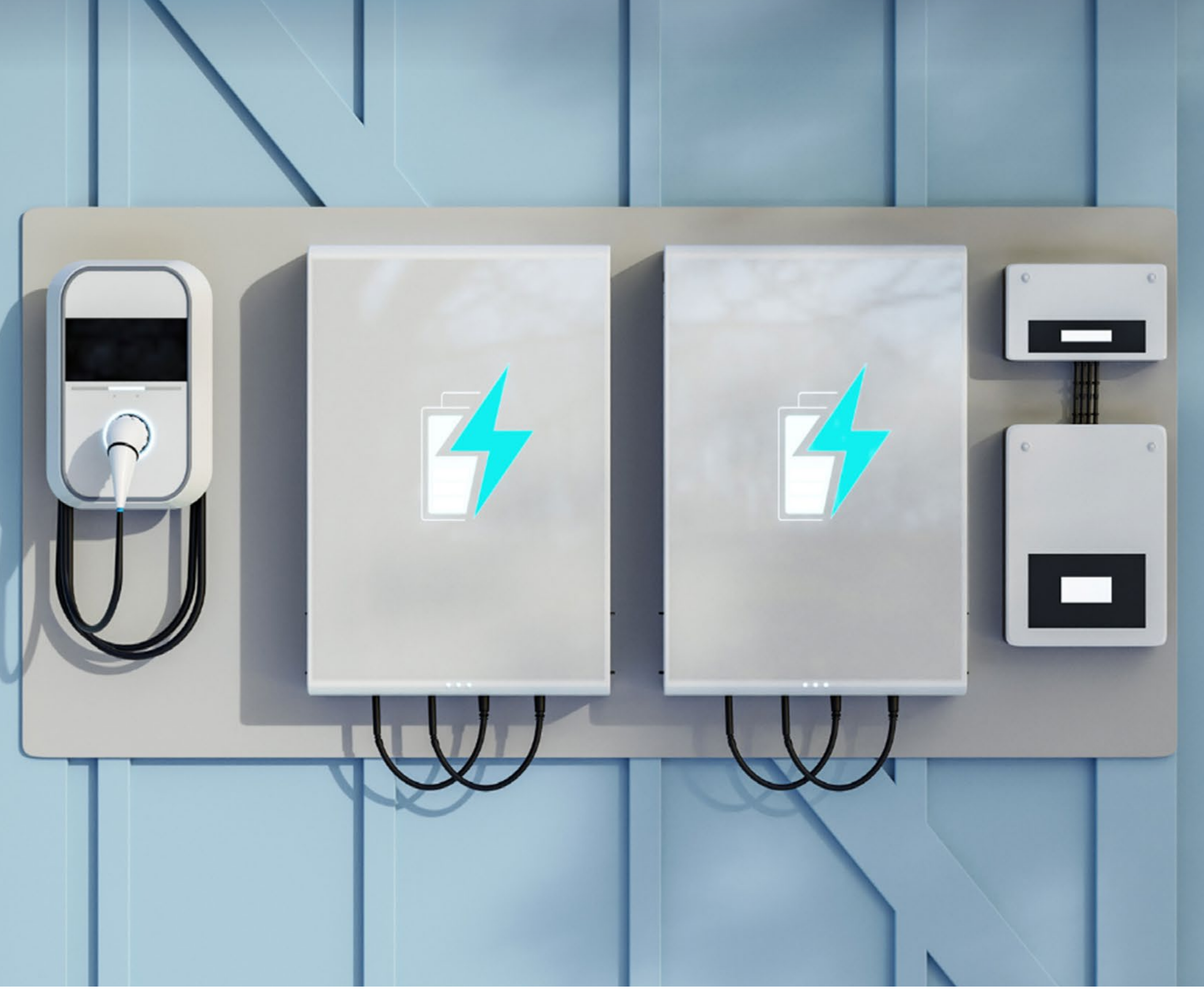
HOUSEHOLD BATTERY ENERGY STORAGE SYSTEMS COLLECTIONS PILOT

FINAL REPORT

OCTOBER 2025



ACKNOWLEDGEMENTS

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We extend our gratitude to Katharine Hole, CEO of the Association for the Battery Recycling Industry (ABRI), for her ongoing support and invaluable knowledge.

SMART ENERGY COUNCIL

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EXECUTIVE SUMMARY

The Pilot Program for Household Battery Energy Storage Systems (BESS) was undertaken to better understand the current and future volume of end-of-life (EoL) Household BESS and to identify priority actions to support their safe collection, storage, and recycling.

While the collections pilot confirmed that formal collection volumes are currently low, a comprehensive national installer survey conducted in parallel revealed this is a symptom of a current market inefficiency. The findings show that EoL batteries are already being decommissioned but are often being stored indefinitely at installer premises due to significant logistical, regulatory, and financial barriers. This results in distributed and unmanaged storage, which poses a safety risk.

Delivered by Smart Energy Council in collaboration with the Association for the Battery Recycling Industry (ABRI), and Queensland government partners, the program combined a desktop review (delivered by SLR Consulting), an industry workshop, a collection pilot, and a national installer survey. The pilot confirmed that battery waste volumes remain very low, as most household systems are still operational and consumers tend to add new batteries rather than replace existing ones. Action is required now to strengthen existing systems and processes for collection as volumes grow over the next decade.

The findings also showed that batteries are lasting longer than originally predicted, with typical lifespans approaching ten years. These findings align with the Smart Energy Council's revised forecasts, which incorporate real-world data and consider the impact of the Queensland Cheaper Home Batteries Scheme, expected to accelerate new installations in the coming years.

The national installer survey results revealed that battery decommissioning is infrequent, and most removed batteries are stored temporarily by installers

due to a lack of suitable collection points. Participants expressed strong concern about safety risks, unclear regulatory obligations, and the high cost of transport and disposal, while awareness of existing Codes of Practice was low. Most installers indicated interest in training and certification programs to improve safe handling and compliance.

A key finding from the survey is the identification of a "willingness-capability gap". Installers expressed a high degree of concern for the environmental impact of EoL batteries, indicating a strong motivation to act responsibly. However, this willingness is limited by a lack of practical capability, including the absence of accessible drop-off locations and prohibitive costs. The survey also reveals these burdens are greater for small and medium-sized enterprises (SMEs), placing them at a competitive disadvantage and creating market imbalances.

Findings from an industry workshop also highlighted similar risk categories, including undefined formal processes, regulatory ambiguity, insufficient funding, and the absence of specialist waste facilities. These shared themes reinforce the need for coordinated guidance and long-term infrastructure investment across local, state and federal jurisdictions. Pleasing work is already underway, including the Queensland Solar Panel Recovery Pilot, the Consumer-Scale Battery Stewardship Pilot, and the development of national product stewardship frameworks through the Department of Climate Change, Energy, the Environment and Water (DCCEEW) — all of which provide a foundation that should now be accelerated to achieve cohesive, large-scale implementation.

The pilot found that the main barriers to effective end-of-life management are logistical, regulatory, and financial, rather than technical. Recycling capacity exists in Australia, but the systems required to collect, package, and transport batteries safely need further development to support scale.

KEY RECOMMENDATIONS:

- **Address "stranded" batteries:** Develop pathways to manage the current inventory of "stranded" (informally stored) EoL batteries.
- **Establish collection network:** Invest in accessible collection infrastructure, with a focus on regional and remote drop-off sites to close the capability gap for installers.
- **Create an equitable funding model:** Design and implement a sustainable funding mechanism, such as an upstream levy[1], to remove the cost burden as a barrier to proper disposal.
- **Develop clear Codes of Practice and training:** Introduce practical training and clear guidelines for removal, transport, and storage to empower installers and ensure safety.
- **Introduce training and accreditation programs** for installers.
- **Invest in collection infrastructure and regional drop-off sites.**
- **Continue data collection and forecasting refinement** to guide policy and investment.

Overall, the pilot highlights that now is the time to act. Although current waste volumes are low, the rapid expansion of home battery adoption — driven by programs such as the Cheaper Home Batteries Scheme — means the next decade will see growing demand for safe, coordinated, and well-funded end-of-life management systems.

1 An upstream levy is a funding mechanism where a small fee is applied at the beginning of a product's life cycle — usually when the product (in this case, a battery) is manufactured, imported, or first sold — rather than when it reaches end of life.

1. INTRODUCTION

Queensland's remarkable transition towards a renewable energy future, underpinned by an unprecedented uptake of Consumer Energy Resources such as rooftop solar, household batteries and electric vehicles, has positioned the state as a national leader in clean energy adoption. This success, however, is creating an urgent and largely unaddressed challenge: a future wave of hazardous end-of-life (EoL) batteries. The very technologies powering Queensland's energy independence are set to become a significant environmental and logistical liability without a proactive and comprehensive management strategy. This report, developed in conjunction with the Solar Panel Recovery Pilot, forms part of a broader initiative to address end-of-life management across the renewable energy system. Together, these pilots provide critical insights that can transform this impending waste problem into a foundational pillar of a thriving circular economy, aligning with the state's ambitious industry development goals.

The scale of the issue is rapidly expanding. Driven by a massive existing base of over one million rooftop solar households, compelling government incentives and rising consumer concern over electricity costs, the installation of home battery systems is accelerating[2]. While only around 30,000–35,000 Queensland households currently have a home battery system, this number is projected to grow fivefold by 2030 under programs such as the Cheaper Home Batteries Scheme. This policy-driven acceleration is creating a concentrated wave of battery deployments that will, in 10-15 years, become a synchronised wave of EoL units, placing immense strain on any future collection and recycling infrastructure.

Concurrently, the Queensland Government's Battery Industry Strategy identifies a significant economic opportunity in developing a domestic battery supply chain, with the potential to contribute $1.3 billion in Gross Value Added and create 9,100 jobs by 2030[3].

EoL batteries represent the critical feedstock required to establish the metals and critical minerals recycling and resource recovery sector that is central to driving investment. The industry workshop further demonstrated that Queensland stakeholders view EoL battery management as both a safety and regulatory priority. The workshop identified that a lack of harmonised standards and funding arrangements could constrain the development of a safe and efficient reverse-logistics network for residential systems. To bridge the gap between the accelerating waste arising and the strategic economic opportunity, this report shares the findings for this three-stage project. Each stage (Desktop study & workshop, Collections trial, and Policy and regulatory recommendations) is designed to gather essential information, insights and evidence to help inform the development of a comprehensive scheme, guide policy development and industry management opportunities and test effective approaches for recovering and processing household battery energy storage systems (BESS).

2. PURPOSE

The purpose of this report is to document the outcomes, insights, and learnings from the Pilot Program for Household BESS undertaken in Queensland.

The program was established to improve understanding of the expected volumes of consumer scale BESS reaching EoL, how they are currently being managed, and what systems, infrastructure, and regulatory mechanisms are required to safely and efficiently handle these products in the future.

This pilot sought to address key knowledge gaps in how to build on existing frameworks to support a circular economy for EoL Household BESS. The project commenced with a desk top study which was supported by an industry workshop. The desktop study, Queensland Household BESS Recycling Scan, highlighted significant uncertainty around future waste volumes and the absence of established collection and transport frameworks for Household BESS. The collections pilot aimed to test practical pathways for the collection, storage, and recycling of EoL Household BESS and to assess the feasibility of scaling these processes under real market conditions. Through the collection of real-world data, stakeholder engagement, and pilot logistics, the project's findings are important to inform policy makers. It is important to note that this pilot and its findings are focused primarily on lithium-ion and other modern battery chemistries,

2 Queensland Government, Department of State Development and Infrastructure. (2024). Queensland Battery Industry Strategy 2024–2030. Brisbane: Queensland Government. https://ambc.au/wp-content/uploads/2024/08/queensland-battery-industry-strategy.pdf

3 Research heralds growth and opportunity for Queensland's battery industry https://www.statedevelopment.qld.gov.au/news-and-events/research-heralds-growth-and-opportunity-for-queenslands-battery-industry

as well-established, commercially viable recycling pathways already exist for traditional lead-acid batteries.

The findings from the pilot inform both forecasting and policy development by providing evidence-based insights into battery lifespans, consumer behaviour, and logistical challenges.

The pilot found that battery systems are lasting longer than previously assumed, that collection volumes remain very low, and that the most critical barriers to responsible management of EoL Household BESS are logistics, safety guidance, and regulatory clarity, rather than recycling capacity itself.

Ultimately, this report contributes to efforts to build on existing industry infrastructure and regulatory tools to establish a fit for purpose sustainable and coordinated framework for the management of EoL Household BESS. It supports government and industry stakeholders by identifying practical challenges, highlighting best practices, setting out a roadmap for action and providing the foundation for future stewardship models and infrastructure planning, in Queensland and across Australia.

The objectives of this pilot program are to:

- Identify opportunities and challenges specific to consumer-scale BESS;
- Gather information to guide government policy development and inform industry management practices;
- Test and evaluate effective approaches for the collection, recovery, and processing of consumer-scale BESS; and
- Improve understanding of battery management and materials recovery pathways in Queensland to help inform future national stewardship frameworks.

3. STAGE 1 — DESKTOP STUDY AND INDUSTRY CONSULTATION

This foundational stage (desktop study followed by industry consultation) was necessary to accurately quantify, characterise, and forecast the emerging EoL Household BESS stream. It was conducted in four distinct phases:

- **Consultation & Design:** Establishing the framework for the study.
- **Data Gathering & Analysis:** Synthesising demographic data, market penetration rates, and battery lifecycle information to model the timing and magnitude of the future waste wave.
- **Infrastructure & Regulatory Review:** Researching existing regulations, identifying infrastructure gaps, and assessing the materials recovery ecosystem.
- **Reporting & Recommendations:** Synthesising findings to inform the subsequent pilot and policy stages.

The Desktop Study, summarised in SLR Consulting's report "Queensland Consumer BESS Battery Recycling Scan[4]", and the industry workshop, summarised in ABRI's report "Queensland Residential Battery End of Life Management Workshop[5]", established an evidence base for subsequent project stages. The reports covered projections of EoL Household BESS accumulation, research and analysis of current regulations, guidelines, and best practices, identification of potential environmental and health hazards, evaluation of existing infrastructure to manage these risks, and an assessment of the materials recovery ecosystem's stability, capacity, and potential for growth in line with market demands.

The project identified that the EoL Household BESS waste stream presents unique logistical and safety challenges. Household BESS are dense, heavy and chemically complex, with individual units typically weighing between 50 and 150 kilograms and containing mixtures of metals, electrolytes, and reactive compounds that vary depending on chemistry and manufacturer. These batteries are also electrically energised and potentially hazardous, capable of generating thermal runaway, fire, or toxic gas release if damaged or mishandled. Their combined characteristics — weight, volatility, and chemical variability create a high-risk and high-cost transport profile, requiring specialist containment, trained operators, and route planning to minimise fire and environmental risk. As noted in both the Industry Workshop and SLR's 2025 report, these constraints make the safe collection, aggregation, and transport of batteries one of the most significant barriers to scaling BESS recycling infrastructure in Queensland and Australia more broadly.

4 Queensland Consumer BESS Battery Recycling Scan, Project Report, Association of the Battery Recycling Industry, Prepared by SLR Consulting Australia (SLR Project No.: 620.041484.00001), 28 January 2025.

5 Queensland Residential Battery End of Life Management Workshop, Association for the Battery Recycling Industry, Prepared by Mendham Consultants Pty Ltd (Document No 0608242032), 3 February2025.

3.1 Forecasting the End-of-Life Wave

Understanding the growth of EoL Household BESS is difficult as no statistics are currently kept. In order to understand the magnitude of the problem, forecasts were developed independently by SLR consulting as part of the Desktop Study, and independently by the Smart Energy Council. A comparative analysis of these forecasts can be found in the report on "Forecasting the EoL Batteries — Comparative Study[6]". The forecast made by the Smart Energy Council found that short-term waste volumes will be far lower than the SLR estimates, with only around 326 units predicted for Queensland in 2025 compared to 7,800 units in the desktop study.

The difference stems from estimates in battery lifespans, the influence of the Cheaper Home Batteries Scheme (CHBS), and the trend for consumers to add rather than replace systems. These assumptions are supported by findings from other sources including Installer surveys, recycler and collector interviews, and the pilot collections themselves.

While recycling capacity is adequate, the findings highlight that collection logistics and regulatory frameworks are the key priorities as waste volumes grow in the coming decade.

More detailed information on the estimates can be found in the document called "Forecasting the EoL Batteries — Comparative Study[7]", created by the Smart Energy Council.

3.2 Infrastructure and Ecosystem Mapping

An effective strategy for recovering and processing EoL household BESS must be built on a clear understanding of Queensland's existing waste infrastructure. A preliminary assessment reveals a lack of specialised capacity and sufficient data for robust planning.

- **Current Data Limitations:** The Australian Waste and Resource Recovery Infrastructure Database, the primary tool for assessment, appears outdated, with hazardous waste facility data last updated in 2021[8]. Its categorization is also generic, failing to specify capabilities for handling the unique hazards of lithium-ion batteries.
- **Infrastructure limitations:** Relying on this data creates a risk of assuming sufficient capacity exists. A facility licensed for other hazardous waste is not automatically equipped or permitted to handle Class 9 Dangerous Goods like lithium-ion batteries.

This data gap makes on-the-ground intelligence gathering an essential part of the project.

3.3 Review of Legislative Framework

Queensland's existing environmental and waste management legislation provides a solid foundation but was not designed for the unique challenges of a diffuse, hazardous consumer waste stream like EoL Household BESS.

- **Waste Reduction and Recycling Act 2011 (WRR Act):** This Act establishes the state's overarching policy, including the "polluter pays" and "product stewardship" principles. It provides the ideal enabling framework for a product stewardship scheme, but does not currently mandate one for batteries[9].
- **Environmental Protection Regulation 2019 (EP Regulation):** This regulation provides the regulatory framework for the management of different categories of waste including category 1 and category 2 regulated waste, and general waste. It establishes tracking, transport and licensing requirements for these waste types. With an estimated 30,000–35,000 household battery systems currently installed across Queensland and rapid growth projected under programs such as the Cheaper Home Batteries Scheme, the application of these requirements to this potentially hazardous waste stream from EoL Household BESS may require further consideration and refinement[10].
- **Work Health and Safety Regulation 2011 (WHS Regulation):** This regulation establishes the legal framework for managing risks to health and safety

6 Forecasting the EoL Batteries — Comparative Study [Unpublished], Prepared by Smart Energy Council, currently under review.

7 Forecasting the EoL Batteries — Comparative Study [Unpublished], Prepared by Smart Energy Council, currently under review.

8 Australian waste and resource recovery infrastructure database https://www.dcceew.gov.au/environment/protection/publications/waste-resource-recovery-infrastructure-db

9 Waste Reduction and Recycling Act 2011. Reprint current from 19 September 2024 to date (accessed 10 November 2025 at 10:58) https://www.legislation.qld.gov.au/view/html/inforce/current/act-2011-031

10 Environmental Protection Regulation 2019 - Queensland Legislation https://www.legislation.qld.gov.au/view/html/inforce/current/sl-2019-0155

in Queensland workplaces. It sets out specific duties for the storage, handling, and transport of hazardous chemicals and dangerous goods, including lithium-ion batteries classified as Class 9 miscellaneous dangerous goods. The regulation requires businesses to identify hazards, assess and control risks, and ensure that workers are properly trained and equipped to manage potential fire, explosion, or chemical exposure incidents associated with battery handling and disposal.

- **The Australian Dangerous Goods Code** covers national standards and requirements for transporting dangerous goods by road and rail. Household BESS are considered Class 9: Miscellaneous dangerous substances and articles
- **The Regulatory Mismatch:** The current framework is structured for identifiable, centralized industry waste generators. This "industry waste vs. consumer product" mismatch demonstrates that the existing framework is ill-equipped to manage a hazardous product distributed at a massive scale into residential homes. Feedback recorded through the Industry Workshop aligns with this conclusion, noting uncertainty in the classification of damaged lithium-ion batteries under Schedule 11 of the Work Health and Safety Regulation. Participants identified that dangerous goods provisions do not distinguish sub-UN[11] numbers for specific components released from damaged batteries, creating ambiguity for contractors and recyclers handling Class 9 materials.

4. STAGE 2 - COLLECTIONS PILOT

This practical stage, run in parallel with Smart Energy Council's Household Solar Panel Recovery Pilot, was essential to de-risk and optimise the complex "reverse logistics" of recovering a hazardous waste stream from potentially over one million solar PV systems and an estimated 30,000–35,000 consumer-scale battery systems (CSBESS) installed across Queensland. The pilot aimed to test collection models, establish real-world costs, and validate safety protocols, moving from theoretical planning to a proven operational model.

4.1 Collections Pilot Objectives

The pilot's primary objectives were to:

- Test and optimise the efficiency and scalability of different logistical models.
- Accurately determine the true end-to-end costs of a compliant collection program to inform a sustainable funding model.
- Gather critical behavioural insights from consumers and small businesses to design a user-friendly system and effective education campaigns.
- Validate and refine safety protocols for handling, storage, and transport.
- Verify the genuine operational capability and capacity of waste management facilities, creating a confirmed map of industry partners.

4.2 Pilot Design and Preparation

In partnership with our operations partner, New Limit, significant preparatory work was undertaken to design an end-to-end collection method focused on the safety challenges of transporting and storing Household BESS.

The initial design involved:

- Scouting potential collection locations, including leveraging the existing Solar Panel Recovery Pilot trial's metro and regional sites.
- Identifying and engaging with Queensland-based battery recyclers.
- Vetting logistics providers licensed as Regulated Waste Transporters under ERA 57, and qualified for the transport of Dangerous Goods (Class 9).
- Procuring specialised equipment (e.g., fire-safe galvanised bins) for collection sites.
- Developing booking and tracking software to manage the collection process and provide reporting.

However, this preparatory work quickly identified significant regulatory and safety barriers. The original model, which considered using retail partners (e.g., Rexell) or installer premises as consolidation points, was deemed unviable. Interviews with collection partners revealed that the stringent fire safety and

11 Sub-UN numbers are extensions of the main United Nations (UN) dangerous goods identification numbers, which are used internationally to classify and label hazardous substances. While a main UN number (e.g., UN3480 – Lithium-ion batteries) identifies the general type of dangerous good, sub-UN numbers or special provisions specify more detailed information — such as the condition of the item (e.g., damaged, defective, or contained in equipment). The absence of clear sub-UN classifications for components from damaged batteries can cause confusion about correct handling, packaging, and transport requirements.

licensing requirements for storing lithium-ion batteries — which differ significantly from solar panels or other e-waste — made this model impractical and high-risk. For example, potential partners in regional areas (e.g., Townsville) lacked the necessary permits to act as a battery collection point.

4.3 Final Pilot Methodology (As Implemented)

Given the unacceptable storage risks and licensing barriers of a consolidation model at the current stage of market development, the pilot methodology was pivoted to a direct-to-recycler model.

- **Recycling Partner:** Ecocycle, a recycler with over 10 years of experience, was engaged as the sole recycling partner for the trial, with collections directed to their facility in Hemmant, QLD.
- **Collection Model:** Installers booked their battery collections via a dedicated software portal. After a safety screening (to ensure batteries were not damaged or swollen), they were given a reference number to drop the batteries directly at Ecocycle's licensed facility.
- **Rationale:** This model immediately eliminated the storage risk and licensing complexities associated with intermediate aggregation sites.
- **Tracking and Verification:** The booking system provided dangerous goods manifests and reference numbers. Upon arrival at Ecocycle, quantities were verified against the booking information to ensure accurate tracking. New Limit provided training to Ecocycle on this acceptance system and conducted site visits to ensure the process was operating smoothly.

4.4 Collection Pilot Outcomes and Data

The collections pilot was operational from May 1, 2025, to July 31, 2025.

During this three-month window, the pilot processed two bookings, resulting in the collection of 15 batteries, totalling 1,199 kg.

BOOKING DATE	CONTRACTOR ID	QTY DELIVERING (UNITS)	RECEIVED DATE	QTY RECEIVED (KG)
26/05/25	07251	5	02/06/25	331 kg
02/07/25	48821	10	08/07/25	868 kg

While the number of collections was extremely low, partners reported that the transactions themselves occurred "reasonably flawlessly," validating the technical feasibility of the direct-to-recycler booking and drop-off model.

4.4.1 Context for Low Collection Volume

The low volume was not a failure of the pilot's logistics but rather a critical finding about the current market. The small numbers collected reflected four main factors:

1. **Market Immaturity and Revised Forecasts:** The pilot confirmed that fewer lithium-ion batteries are currently reaching their natural EoL than lead acid batteries, that have an existing pathway to metal recyclers[12]. The industry is still too young to establish definitive lifecycle patterns. Recycler interviews confirmed that the vast majority of batteries they receive are warranty returns, unsold inventory, or damaged units, not decommissioned EoL systems. This aligns with the Smart Energy Council's revised, lower forecasts for battery waste.

2. **Pilot Operational Delays:** The battery pilot launched on May 1, after the highly successful and oversubscribed solar panel collections pilot had already finished at the end of April. This "missed opportunity" severely limited installer engagement and eliminated the possibility of joint collections (i.e., installers dropping off panels and batteries at the same time).

3. **Installer Behaviour and Battery Type:** The pilot and accompanying solar installer survey, revealed that installers have a well-established and often rebated recycling path for lead-acid batteries via scrap metal dealers. As a result, the pilot collected no lead-acid batteries. Instead, all batteries received were lithium-ion units, primarily Lithium Iron Phosphate (LFP) types, which are now common in new household installations but still relatively uncommon in the current end-of-

12 Lithium-ion batteries are lighter, more efficient, and last longer (10–15 years) than lead-acid systems (3–5 years) but require stricter handling due to fire and thermal runaway risks. Lead-acid batteries are cheaper but bulkier and degrade faster. Source: Queensland Government, Battery Buyers Guide – Battery System Set-ups, 2024. https://www.qld.gov.au/housing/buying-owning-home/energy-water-home/solar/battery-buyers-guide/battery-system-set-ups.

life stream due to their longer service life and recent market entry. Installers also expressed greater concern and unfamiliarity with handling lithium-ion systems compared to lead-acid, reflecting the need for clearer guidance and safety training as volumes increase.

4. **"Stranded Batteries" due to Market Failures:** The low collection volume observed in the pilot does not reflect a lack of EoL batteries. Instead, it confirms the significant barriers identified in the industry-wide survey (see Section 4.9). The survey found that installers are already decommissioning batteries but are storing them indefinitely in 'yards' and 'workshops' due to the high 'cost of disposal' (a key concern for 93 respondents) and 'finding a suitable drop-off location' (a concern for 97 respondents). This cost is not trivial: at a gate fee of $8.50/kg, a single 100kg household battery costs an installer $850 to dispose of before transport—a prohibitive cost that directly explains the stockpiling. The pilot's low uptake is therefore a direct symptom of these existing market failures, not an indication of low need.

4.4.2 Pilot Costs

The pilot also served to quantify the costs associated with the direct-to-recycler model.

- **Logistics Costs:** Not applicable. The direct-to-recycler model meant that installers were responsible for their own transport to the Ecocycle facility. Therefore, no separate logistics costs were incurred by the pilot program.
- **Recycling Costs:** The costs for recycling the lithium-ion batteries were confirmed to be in the range of $8.50 — $14.95 per kilo by our recycling partner (Ecocycle).

4.5 Recycler Processing and Pathways

The pilot provided clear insights into the EoL processing pathway for lithium-ion batteries in Australia.

1. **Intake (QLD):** At the Ecocycle facility in Hemmant, batteries are safety-checked, and their voltage is verified.

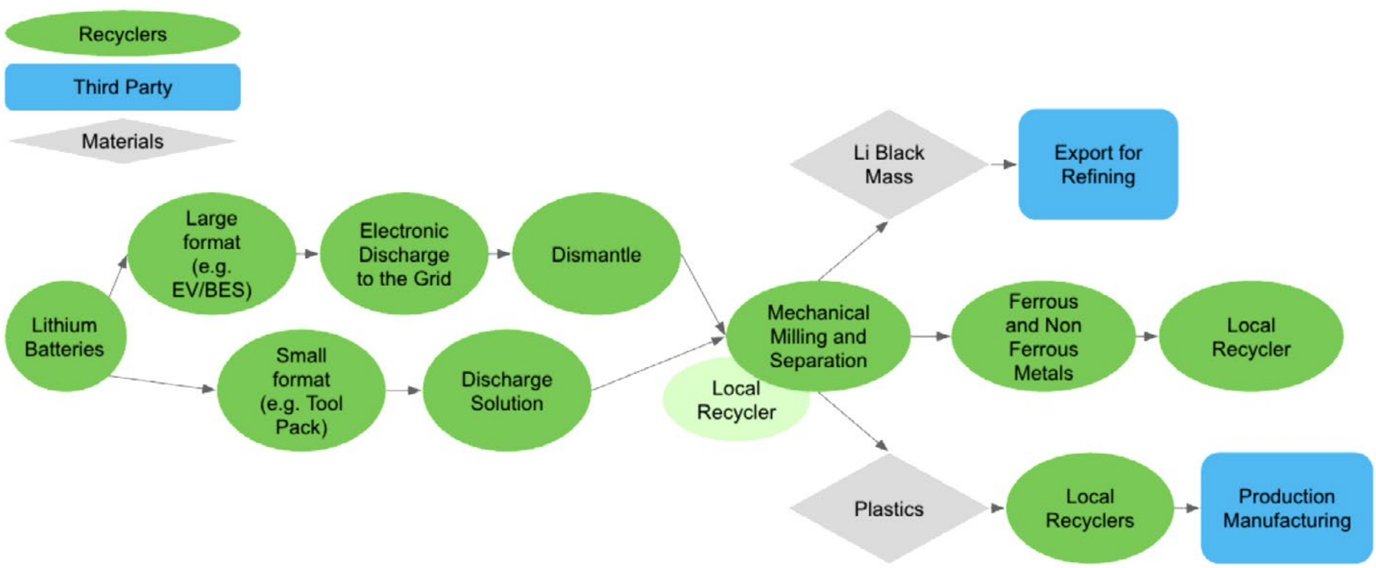
2. **Discharge (QLD):** Batteries are discharged to "true zero" DC volts, bypassing the internal Battery Management System which normally stops discharge at a safe level. This is a critical safety step before transport and processing.

3. **Transport:** The discharged batteries are then shipped to Ecocycle's specialised battery processing facility in Melbourne.

4. **Processing (VIC):** In Melbourne, the batteries are dismantled and put through a shredding and mechanical separation process before being recovered for reprocessing.

4.6 Recycler Material Recovery

The following flowchart, provided by the recycler, outlines the processing path for lithium batteries.



The downstream pathway for these materials is split between onshore and offshore processing, as detailed below:

PROCESSING STAGE	DESTINATION	MATERIAL TYPE	CURRENT VOLUME STATUS (ESTIMATED)
Stage 1: Mechanical Pre-Processing	Onshore (Domestic Facility)	Bulk Metals (Copper, Steel, Aluminium) & Black Mass Production	100% of Input Tonnage is processed here.
Stage 2: Hydro-metallurgical Refining	Offshore	Black Mass (Critical Minerals Concentrate)	100% of Black Mass is currently shipped offshore for high-purity refining.

Currently, the technology for the final, high-purity hydrometallurgical refining of Black Mass is not yet commercialised at scale in Australia. Therefore, the resultant Black Mass must be exported for advanced downstream processing before its constituent critical minerals can re-enter the battery manufacturing supply chain.

According to recyclers, the high capital cost to build a domestic hydrometallurgical refinery is not yet viable given the low volumes of EoL batteries in Australia. Australian companies and universities are leading research into black mass recovery technology drawing on Australia's metallurgical expertise. In addition to private sector investment, over the past decade, the Australian Research Council has funded over $17 million to support battery recycling research. Ecocycle is currently working closely with a number of partners in Australia to accelerate the development of domestic commercial black mass processing.

4.7 Assessment of Collection Challenges (Learnings)

The pilot and accompanying interviews successfully identified the primary barriers to a scaled-up collection program.

- **Logistics Costs and Dangerous Goods Classification:** This remains the single greatest challenge. The classification of lithium-ion batteries as Class 9 Dangerous Goods triggers high-cost and high-complexity requirements for packaging, placarding, and licensed transport. Even in our direct-to-recycler model, this cost and complexity were simply transferred to the installer.
- **Regulatory and Licensing Barriers:** The pilot confirmed that using consolidation points (like retail stores or installer workshops) is not currently viable. The strict licensing required for storing even small quantities of lithium-ion batteries in Queensland — which are subject to different regulatory controls than lead-acid and other chemistries — is a barrier that most businesses cannot overcome.. This regulatory complexity was the primary reason for pivoting to the direct-to-recycler model[13].
- **Installer Behaviour and Education:** A major gap exists between lead-acid and lithium-ion batteries. Lead-acid battery recycling practices are well established, clear and relatively straightforward as the batteries are standardised and installers are financially incentivised to recycle lead-acid batteries. In contrast, they are uncertain what to do with lithium-ion batteries, concerned about the safety risks, and unaware of a clear disposal pathway. This leads to batteries being unsafely stored at depots or left with the homeowner, creating significant fire risks. Globally this is a challenge and there is much work underway, including in Australia to bolster current frameworks.

4.8 Assessment Against Objectives

Despite the low collection volumes, the pilot was highly successful in meeting its core strategic objectives.

13 Under Queensland's Work Health and Safety Regulation 2011 and the Australian Dangerous Goods (ADG) Code, lithium-ion batteries are classified as Dangerous Goods, Class 9. Storage and transport require strict fire safety measures, including ventilated, non-combustible enclosures, temperature control, and isolation from ignition sources. Facilities may also require fire suppression systems, spill containment, and Regulated Waste (ERA 57) licensing. Because of these elevated fire and environmental risks, insurance premiums and liability conditions for sites storing lithium-ion batteries are significantly higher than for traditional lead-acid systems.

4.8.1 Test the collection and logistical processes

The pilot successfully designed and evaluated two logistical models. The initial "consolidation-point" model, which proposed using installer premises or retail outlets as collection hubs, was assessed and rejected due to licensing, fire-safety, and insurance constraints under Queensland's Dangerous Goods and Regulated Waste (ERA 57) frameworks. The alternative "direct-to-recycler" model—where installers book drop-offs directly with a licensed recycler—was trialled and validated as a technically functional, low-risk, and compliant collection method. While the model's scalability could not be tested due to limited waste volumes, it proved practical for early-stage recovery operations.

4.8.2 Assess the feasibility and effectiveness of different collection methods

The trial confirmed that direct delivery to a licensed recycling facility is currently the only feasible method for safely managing household BESS in Queensland. Consolidation points were deemed unviable because of complex regulatory requirements and elevated fire and insurance risks. The direct-to-recycler pathway achieved full traceability, eliminated intermediary storage risks, and complied with all relevant environmental and dangerous-goods legislation, establishing a strong baseline model for future stewardship frameworks.

4.8.3 Assess the challenges associated with transporting and storing EoL CSBESS, including safety considerations and cost optimisation

The pilot identified transport and storage management as the most significant operational challenges. Using the direct-to-recycler model removed the need for intermediate transport and aggregation, thereby reducing overall transport costs and safety exposure. However, it also shifted the logistics burden directly to installers, who must now coordinate compliant delivery to a licensed facility—creating a financial disincentive for participation.

The pilot also successfully quantified the end-to-end recycling costs, which were paid by the program at a rate of $8.50 – $14.95 per kg, confirming the high financial barrier for installers.

The trial also confirmed that storing lithium-ion batteries presents ongoing safety and insurance challenges. Requirements for fire-resistant enclosures, spill containment, ventilation, and isolation from ignition sources make it impractical for most small businesses to act as collection points without significant investment.

4.9 National Installer Survey: Current Market Conditions and Installer Perspectives

To complement the findings of the Queensland Collections Pilot, the Smart Energy Council (SEC) conducted a national survey between August and October 2025 to gather industry insights on current battery installation and disposal practices. The survey, distributed through the SEC's installer network, received 198 responses—around 40% from Queensland—from solar and battery installers, retailers, and recyclers of varying business sizes. Participants answered 17 questions covering installation volumes, battery chemistries, disposal and storage practices, safety awareness, and attitudes toward stewardship participation and cost responsibility. The results reveal a strong environmental commitment across the sector but also widespread barriers related to infrastructure, regulation, cost, and safety, providing important context for understanding the practical challenges of developing an effective national battery stewardship framework.

4.9.1 The 'Willingness-Capability Gap'

A key insight from the survey is the identification of a "willingness-capability gap". Data shows the industry's primary concern is "The environmental impact of battery composition," with 138 of 198 respondents rating it as a high concern—outranking practical issues like cost or logistics. This indicates a strong intrinsic motivation for responsible disposal. However, this willingness is significantly limited by a lack of practical capability.

4.9.2 Infrastructure and Economic Barriers

The survey identifies the key barriers to responsible action. The "Lack of clear recovery/recycling locations" was the most frequently cited challenge. This infrastructure gap, combined with high costs for transport and disposal, creates a system with financial disincentives for responsible behaviour.

The table below presents the aggregated Installer Concern Levels Regarding EoL Battery Handling.

CONCERN AREA	NOT AT ALL CONCERNED	MODERATELY CONCERNED	QUITE CONCERNED	VERY CONCERNED	TOTAL RESPONSES
The environmental impact of batteries composition	7	53	52	86	198
Finding a suitable drop-off location	15	45	52	76	188
The cost of disposal (gate fees)	11	44	50	75	180
The cost of transport	17	47	52	60	176
Safety risks (e.g., fire, chemical leaks)	10	55	41	63	169
Regulatory requirements	24	45	50	44	163

Source: Data synthesised from survey responses. Note: “Slightly concerned” responses from the raw data have been grouped under “Moderately concerned” for clarity, and totals do not match the overall respondent count as not all respondents answered every question.

4.9.3 The Financial Impasse

The survey results show a clear division within the industry regarding who should bear the financial cost of a battery stewardship program. Approximately 31% of respondents believe the homeowner should be responsible, while 29% support a shared responsibility model involving multiple stakeholders. A further 23% believe manufacturers should carry the cost, with smaller proportions nominating the government (10%), other entities (4%), or installers (3%).

This lack of consensus highlights the need for a mandated, upstream funding mechanism to ensure a consistent and equitable approach across the market, preventing cost burdens from falling unevenly on specific participants.

4.9.4 Disproportionate Burden on SMEs and Regional Operators

The challenges of EoL household BESS management are experienced differently across the industry. The data reveals that burdens are greater for smaller, low-volume businesses (0-5 installations/month), who report “substantially higher levels of concern regarding costs and safety risks” compared to their high-volume counterparts. This is amplified by geography, with logistical challenges related to distance creating significant difficulties for regional operators in states like Queensland, where installers report having “no viable, legal pathway” for recovery/recycling and/or disposal.

5. STAGE 3 — POLICY AND REGULATORY LEARNINGS

The findings indicate that while Queensland’s existing environmental and safety regulations provide a solid foundation for managing hazardous waste, they were not designed for a diffuse, consumer-scale hazardous product such as household BESS. As a result, the challenge lies less in legislative absence and more in policy alignment and stewardship design.

5.1 Identified Gaps in the Current Framework

The current regulatory system clearly defines how licensed operators must handle, store, and process regulated waste. However, it does not yet include mechanisms to ensure that EoL household BESS are collected from consumers or financed under a stewardship model. This absence of a coordinated product-stewardship approach leaves many batteries stranded at installer premises or in homes.

Table 5.1: Analysis of Queensland and National Regulatory Frameworks for EoL Battery Management.

BATTERY LIFECYCLE STAGE	RELEVANT LEGISLATION / STANDARD	ASSESSMENT OF ADEQUACY	IDENTIFIED GAP / REQUIRED ACTION
Point of Sale	Waste Reduction and Recycling Act 2011 (WRR Act)	Provides enabling policy through the polluter-pays and product-stewardship principles	No mandatory scheme or funding mechanism. A national or state-based product-stewardship framework is required to drive EoL recovery.
Installation	Environmental Protection Regulation 2019 (EP Regulation)	Provides licensing and tracking framework for regulated waste	Does not require installers to take back old units or verify EoL pathways. This is a policy gap best addressed through a future stewardship obligation rather than licensing.
Collection (Household / Installer)	WRR Act 2011	Reactive only – relies on illegal-dumping provisions	No proactive collection mandate for consumer batteries. Responsibility for recovery should be embedded within a product-stewardship framework rather than litter legislation.
Temporary Storage / Aggregation	EP Regulation 2019	Adequate – regulated waste storage is covered under Environmental Authority conditions and Schedule 2 Part 12 (ERA 57 and ERA 60)	Storage standards exist but require clarity for lithium-ion batteries (e.g. fire-safety and insurance controls). Improved guidance and Codes of Practice would help small operators comply.
Transport	Australian Dangerous Goods (ADG) Code – Edition 7.9 and Work Health and Safety Regulation 2011	Comprehensive framework for dangerous goods transport	Cost and complexity remain barriers for small installers. Further clarity on sub-UN numbers and classification of damaged batteries would reduce risk and uncertainty.
Recycling / Disposal	EP Regulation 2019 and Environmental Authorities (ERA 54, ERA 57, ERA 60)	Licensing and safety requirements are clear for waste operators	No policy preference for recycling over disposal and no link to domestic supply-chain development. Need to embed resource-recovery priorities within future stewardship frameworks.

5.2 Maximising the Existing Legislative Framework

Queensland already has a comprehensive environmental-protection and waste-management regime. Its effectiveness could be strengthened through:

- **Policy integration rather than new regulation** — Leverage the EP Regulation 2019 and WRR Act 2011 to support product stewardship and require producers or importers to contribute to EoL recovery.
- **Clearer operational guidance** — Develop Codes of Practice detailing how existing licensing requirements apply to battery storage, handling and transport (e.g. fire controls, segregation, and insurance expectations).
- **National consistency** — Align Queensland requirements with the Australian Dangerous Goods Code and national guidelines for EoL lithium-ion battery management being developed through the Heads of EPAs.
- **Stewardship mandate** — Introduce a collection and funding obligation through a product-stewardship scheme to fill the policy gap around take-back and financing, rather than through licensing under the EP Reg.
- **Prioritising recycling over disposal** — Amend policy settings or program funding to favour onshore recycling and materials recovery consistent with the Queensland Battery Industry Strategy (2024–2030).

5.3 The Path Forward: Principles for Effective Policy

To address the identified gaps and create a best-practice framework, the development of recommendations will be guided by a set of clear principles to ensure the proposed solution is equitable, economically sustainable, and aligned with Queensland's broader strategic goals.

- **Extended Producer Responsibility:** This will be the core principle. The companies that manufacture, import, and sell batteries into the Queensland market should be made financially and operationally responsible for their EoL management.
- **Prioritisation of Safety:** All recommendations will place the highest priority on the safety of the public, workers, and the environment, proposing clear and enforceable standards for collection, storage, and transport.
- **First-response protocols and training pathways:** Outcomes of the Workshop highlighted that future guidance should also address first-response protocols for battery-related incidents and promote training pathways through recognised trade and regulatory bodies. Participants supported the creation of a professional certifying body or continuous-development program for contractors managing residential energy-storage systems.
- **Economic Sustainability and Equity:** The framework must be economically sustainable, fairly allocating costs across the supply chain and removing the economic incentives for illegal dumping.
- **Integration with the Circular Economy:** Recommendations will be explicitly designed to support the objectives of the Queensland Battery Industry Strategy, encouraging high-value recovery and channeling resources back into domestic manufacturing.
- **National Harmonisation and Simplicity:** Policies will, wherever practicable, align with national frameworks to reduce the regulatory burden on industry and ensure the system is simple and accessible for consumers.

5.4 Action Underway

It is important to note that nationally, action is already underway but needs acceleration. Pleasingly over the last 12 months since this work was undertaken the following is being progressed:

- **Standards Australia** is developing a used lithium battery packing and transport guideline, which will help address the lack of clear guidance and safety awareness identified in the installer survey.
- The **Victorian EPA** (on behalf of the Heads of EPAs) is developing a National Guideline for Managing EoL Lithium-ion Batteries[14], helping to create the national consistency this report calls for.
- **ARC Centre for Battery Recycling** through the University of Wollongong[15] is looking at reverse logistics, which is critical to solving the complex transport and cost barriers.
- The **Local Government Battery Collection Program**[16]. This program is a key first step in closing the infrastructure gap, particularly the "Lack of clear recovery/recycling locations" identified as the top barrier by installers.
- **Queensland Government Resource Recovery Boost Fund**[17]. This fund provides a mechanism to co-invest in the critical infrastructure needed to create a viable, large-scale collection network.

6. KEY FINDINGS AND CONCLUSIONS

The Pilot Program for Household BESS has provided a critical, evidence-based foundation for action. The low collection numbers from the pilot should not be interpreted as a lack of urgency. When combined with the national survey findings, they indicate a current market inefficiency. The survey confirms that EoL batteries are a present-day issue, with units already being stored in workshops and yards across the country. The pilot's low volume is a direct result of the high cost and logistical barriers that prevent these batteries from being managed through formal channels.

Therefore, the combined findings from the pilot and survey indicate a clear need for timely action. It is important to implement the systems and policies needed to manage the batteries that are already at EoL, in addition to preparing for those expected in the next decade. Our key messages are:

- We have gained valuable insights and are beginning to make progress.
- An action plan is essential to support rapid acceleration and coordination.
- Securing critical minerals and increasing recycled content will provide long-term benefits, supporting Australia's battery manufacturing goals.

14 https://www.epa.vic.gov.au/2018-storage-and-management-waste-batteries-guideline

15 https://www.batteryrecycling.org.au/

16 https://www.qld.gov.au/__data/assets/pdf_file/0029/588620/local-government-battery-collection-program-guidelines.pdf

17 https://www.qld.gov.au/environment/circular-economy-waste-reduction/funding-grants/resource-recovery-boost-fund

6.1 Market Maturity and Waste Generation

The program confirmed that EoL household BESS volumes remain very low across Queensland and nationally, despite the rapidly growing installation base. Only a small number of batteries were collected during the pilot, indicating that most household systems are still within their operational lifespan and performing well. The findings are consistent with installer feedback that consumers are expanding their systems rather than replacing them, resulting in slower waste generation than earlier forecasts suggested.

This aligns with data from the Comparative Forecast Report on Future Waste Batteries in Australia[18], which showed that short-term waste volumes are likely to be far lower than predicted in earlier desktop models that assumed shorter five-year lifespans. The pilot program instead supports an average battery lifespan of around ten years, influenced by better system durability, improved installation practices, and ongoing performance optimisation.

6.2 Survey Insights: Installer Practices and Behaviour

The installer survey conducted as part of the pilot provided a strong evidence base for understanding real-world EoL household BESS management behaviour. Key findings include:

- **Low rates of decommissioning:** Most installers reported that they rarely remove an existing battery when installing a new one, confirming that system upgrades are typically additive rather than replacement-based.
- **Battery chemistry:** The majority of decommissioned systems were lithium-ion, with lead-acid batteries accounting for only a small number of older, off-grid systems.
- **Storage and handling:** Installers commonly store removed batteries temporarily, often at their own premises or on customer sites, due to the absence of suitable drop-off facilities. Storage durations vary, but extended storage periods raise safety and liability concerns.
- **Cost recovery:** Very few installers charge a removal or disposal fee, absorbing the costs[19] themselves. Where fees are applied, they range from approximately $25 – $75 per unit, suggesting that battery disposal is not yet financially sustainable for small operators.
- **Safety and regulatory awareness:** Respondents expressed high concern about fire and chemical hazards, transport and disposal costs, and regulatory compliance. Awareness of existing Codes of Practice was limited, with few able to identify or reference the key frameworks that currently govern safe management of energy storage systems, which include:
  - Work Health and Safety Regulation 2011 (Qld) – establishes general obligations for managing hazardous chemicals and dangerous goods, including lithium-ion batteries classified under Dangerous Goods Class 9.
  - Australian Dangerous Goods (ADG) Code – Edition 7.9 (2023) – outlines packaging, labelling, and transport requirements for dangerous goods, including specific provisions for lithium-ion and lead-acid batteries (UN3480, UN3481, UN2794, UN2800).
  - AS/NZS 5139:2019 – Electrical installations – Safety of battery systems for use with power conversion equipment – provides installation and safety requirements for household and commercial battery systems, including separation distances, ventilation, and fire safety.
  - AS/NZS IEC 62619:2017 – Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for industrial batteries – defines the minimum safety standards for lithium-ion and similar chemistries.
  - Safe Work Australia – Code of Practice: Managing Risks of Hazardous Chemicals in the Workplace (2021) – provides guidance on risk assessment, storage, and emergency planning for hazardous substances, applicable to battery storage and recycling operations.
  - Queensland Fire and Emergency Services (QFES) – Battery Storage Safety Guidance (2023) – outlines fire prevention measures and emergency response requirements for energy storage systems in residential and commercial premises.

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18 Comparison of Forecast Models for Future Waste Batteries in Queensland, Prepared by Smart Energy Council and ABRI, October 2025

19 The cost per unit reported by installers in the survey generally reflects a partial cost recovery for the immediate handling and logistics of removing and disposing of a household battery, not the full cost of compliant end-of-life management.

- **Training needs:** Installers prioritised training in safe storage and transport, regulatory obligations, and emergency response for thermal runaway events.
- **Equity and Accessibility for SMEs and Regional Operators:** The framework must be designed to be inclusive, ensuring low administrative burdens and providing tangible mechanisms to overcome the disproportionate costs and logistical challenges faced by small and geographically isolated businesses.
- **Stewardship and accreditation:** Most respondents expressed willingness to participate in a national stewardship scheme or accreditation program, recognising the need for consistent, industry-wide standards.

These findings confirm that while technical knowledge within the industry is developing, there remains a significant gap in regulatory clarity and practical infrastructure for managing EoL household batteries safely and economically.

6.3 Barriers to Effective End-of-Life Management

Across both the pilot and the industry survey, several recurring barriers were identified:

- Lack of accessible collection and drop-off facilities, particularly outside major urban areas.
- Licensed transport, specialised packaging, and interstate haulage drive up costs, while differing waste rules between states add further complexity.
- Limited guidance on packaging, storage, and safe transport of lithium-ion batteries.
- Low awareness of existing regulations and safety codes among installers and small operators.
- Absence of financial incentives or support for proper disposal, leading to batteries being left on-site or stored indefinitely.

The Industry Workshop categorised similar systemic issues, stressing that the absence of a dedicated funding policy, limited insurance options, and geographic disparities between metropolitan and

regional areas remain key factors elevating costs and discouraging compliance with regulated waste, safety, and transport requirements.

These factors suggest that the principal challenge for EoL battery management in Australia is not recycling capacity — since commercial recyclers already operate at the national level — but rather the lack of accessible collection and logistics infrastructure, particularly in Queensland, to move batteries safely and economically from homes to recycling facilities.

6.4 Policy and Stewardship Implications

The pilot's outcomes underline the need for coordinated policy action and industry collaboration. Several key implications emerge:

- The Cheaper Home Batteries Scheme is expected to accelerate installation rates, meaning that waste volumes will grow rapidly in the next decade even if they are currently low.
- A national battery stewardship framework is required to standardise responsibilities, cost recovery mechanisms, and safe handling procedures.
- Development of Codes of Practice for collection, storage, and transport should be prioritised to support installers and reduce safety risks.
- The Industry Workshop recommends specific Queensland Codes of Practice for residential, mobile, and mixed-battery systems, alongside a Battery Passport system for supply chain traceability and data capture.
- Accreditation or certification programs for installers and industry professionals should be introduced to improve professional standards, reduce liability concerns, and increase consumer confidence.
- Data collection through ongoing pilot programs and installer reporting will be essential to refine waste forecasts and infrastructure planning.

6.5 Conclusions

The Pilot Program for Household BESS has demonstrated that Australia is still in the early stages of developing a comprehensive EoL management system for household batteries. Current waste volumes are small, but logistical, regulatory, and financial barriers already limit safe disposal options for installers and consumers alike. To ensure readiness for future volumes, governments and industry must act now to:

- Establish clear guidelines and regulatory consistency,
- Support collection infrastructure and funding mechanisms, and
- Build industry capacity through training and certification.

The low collection numbers from the pilot must not be interpreted as a lack of urgency. When combined with findings from the SEC Stewardship Industry Survey, they highlight a clear and growing "willingness-capability gap" in the current system — one where strong environmental intent (willingness) exists across the industry but is constrained by limited infrastructure, funding, and regulatory clarity (capability).

The survey confirms that EoL batteries are not a future problem; they are a current one, with batteries already 'stranded' in workshops and yards across the country. The pilot's low volume is a result of the high cost and logistical barriers that prevent these batteries from being safely managed.