



## CIRCULAR economy innovations for resilient, competitive and sustainable BATTERY technologies

### *D1.2 End-of-Life BaaS Business Model Handbook*

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## List of acronyms

BaaS – Battery-as-a-Service  
BESS – Battery Energy Storage System  
BMC – Business Model Canvas  
BMS – Battery Management System  
BTM – Behind-the-meter  
CAPEX – Capital Expenditure  
DBP – Digital Battery Passport  
DSCR – Debt Service Coverage Ratio  
DSO – Distribution System Operator  
EMS – Energy Management System  
EoL – End-of-life  
EPR – Extended Producer Responsibility  
ETS – EU Emissions Trading System  
EVB – Electric Vehicle Battery  
FTM – Front-of-the-meter  
HaaS – Hardware-as-a-Service  
ISO – Independent System Operator  
LCOS – Levelised Cost of Storage  
M&V – Measurement and Verification  
OEM – Original Equipment Manufacturer  
OPEX – Operating Expenditure  
REC – Renewable Energy Certificate  
ROI – Return on Investment  
RUL – Remaining Useful Life  
SLA – Service Level Agreement  
SoC – State of Charge  
SoH – State of Health  
SPV – Special Purpose Vehicle  
TSO – Transmission System Operator  
UPS – Uninterruptible Power Supply  
USP – Unique Selling Proposition  
VPC – Value Proposition Canvas

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## Executive Summary

This interim handbook translates the CIRCUBATT Task 1.2 work into a pathway-based guide for developing second-life Battery-as-a-Service (BaaS) business models. It focuses on how retired electric vehicle batteries (EVBs) can be organised into service offerings, rather than treated only as assets for one-off resale. The handbook brings together customer needs, service design, revenue logic, operational requirements and sustainability considerations to support future BaaS development and validation.

Four pathways are developed. Pathway A positions second-life EVBs as grid optimisation assets for energy arbitrage, ancillary services and peak shaving. Pathway B focuses on managed resilience for customers requiring reliable site-level power. Pathway C addresses portable and temporary power needs in mobile, emergency and off-grid settings. Pathway D examines selected light mobility applications and defines the boundary between direct second-life reuse and applications better suited to remanufacturing or recycling.

Across the pathways, the report applies a business model development process covering problem definition, Unique Selling Proposition (USP), market segmentation and positioning, pricing strategy, operational delivery and Business Model Canvas (BMC) synthesis. It also identifies cross-pathway issues, including revenue mechanisms, cost drivers, risk allocation, bankability and end-of-life (EoL) recovery.

The main output is a set of structured BaaS pathway models that can inform stakeholder engagement, pilot selection and further refinement within CIRCUBATT. The handbook shows that BaaS can support second-life EVB deployment by reducing customer ownership burden, enabling provider-led lifecycle management and linking battery reuse and repurposing to circular value creation.

# 1 Introduction

Battery-as-a-Service (BaaS) provides a promising business model approach for supporting the second-life and end-of-life (EoL) use of electric vehicle batteries (EVBs). As increasing numbers of EVBs reach the end of their first automotive life, there is a growing need to identify commercially viable and sustainable pathways for extending their useful life before final recycling or material recovery. Although retired EVBs may still retain technical value, their reuse and repurposing are affected by uncertainty around state of health (SoH), remaining useful life (RUL), degradation behaviour, safety, performance reliability, maintenance needs and EoL responsibility (Börner et al., 2022; Martinez-Laserna et al., 2018). These uncertainties can limit the attractiveness of conventional one-off battery sales.

BaaS offers a way to address these barriers by shifting the business model logic from product ownership to service access (Zhou et al., 2025). Under a BaaS model, the provider can retain ownership of battery assets and offer customers access to battery-enabled services through leasing, subscription, performance-based or service-based arrangements. This allows the provider to manage battery monitoring, maintenance, replacement, lifecycle control and final recovery, while customers benefit from battery-enabled services without taking full ownership and technical responsibility for the asset.

This report forms part of *Deliverable D1.2 - the BaaS Business Model Handbook*, developed under Task 1.2 of the CIRCUBATT project. The purpose of the handbook is to provide structured guidance for developing future second-life EVB BaaS business models. It builds on previous project work, academic and industry insights, and stakeholder inputs and co-creation activities to support the design of BaaS models that are commercially viable, operationally implementable and aligned with circular economy and sustainability objectives. Four BaaS pathways are examined in this report:

- 1) **Pathway A – Grid Optimisers**, which focuses on energy value optimisation through energy arbitrage, grid ancillary services and peak shaving;
- 2) **Pathway B – Grid Independents**, which focuses on managed resilience, site-level energy security and operational continuity;
- 3) **Pathway C – Mobile Power Users**, which focuses on flexible, clean and portable power for temporary, emergency and off-grid applications;
- 4) **Pathway D – Consumer & Light Mobility**, which focuses on selective module-level reuse for compact mobility applications, while clarifying the boundary between viable second-life repurposing and applications better suited to remanufacturing, recycling or material recovery.

The report first presents the methodology and business model design tools used in the handbook. It then outlines the cross-pathway commercial foundations, including profitability logic, revenue streams, policy & subsidy levers, cost structures, risk allocation and bankability. A common operational framework is also provided to explain how second-life EVBs can be sourced, screened, repurposed, deployed, monitored, maintained, redeployed and finally recovered.

The handbook then develops each pathway in detail. For each pathway, the report identifies customer problems and Unique Selling Propositions (USPs), examines segmentation, targeting, positioning, customer relationships; identifies relevant channels; outlines pricing strategies, and synthesises each business model

using the BMC. This structure is intended to ensure that each pathway is assessed not only as a technical application for second-life EVBs, but also as a service-based business model with defined customers, value propositions, revenue logic, operational requirements and sustainability contributions.

## 2 Methodology

### 2.1 Stepwise business model development process

Task 1.2 develops EoL BaaS business models through a structured stepwise process. Building on previous reviews, academic research, and stakeholder insights, the process supports the co-creation of commercially viable, implementable, and sustainable BaaS models for second-life EVB.

This handbook follows six structured business model development steps covering: (1) defining second-life BaaS pathways and their profitability logic, (2) establishing operational practices, (3) defining customer problems to solve and detailing the USP, (4) identifying target markets and marketing approaches, (5) developing pricing strategies and (6) synthesising each pathway through the BMC.

### 2.2 Business model design tools

#### 2.2.1 Value Proposition Canvas (VPC) and Value Hierarchy for Unique Selling Proposition (USP)

The VPC is applied to structure the problem–solution fit of different second-life EVB deployment pathways and to develop the USP for second-life BaaS. Rather than describing second-life battery applications only from a technical perspective, the VPC helps translate customer needs into business model value propositions by linking what customers are trying to achieve with the products, services and service logic provided through BaaS.

Following Osterwalder et al. (2015), the customer side of the VPC includes customer jobs, pains and gains. Customer jobs refer to what customers are trying to get done. Pains refer to the negative outcomes, risks or obstacles that make these jobs difficult. Gains refer to the outcomes and benefits customers seek. The value side of the VPC includes products and services, pain relievers, and gain creators. In the BaaS setting, products and services describe the BaaS-based offering. Pain relievers explain how the BaaS offering reduces customer pains. Gain creators explain how the offering creates additional value. These elements are synthesised into the value proposition and further translated into the USP, which explains why customers may choose a second-life BaaS solution.

In addition to the VPC, this handbook draws on value hierarchy thinking, including the Elements of Value approach, to further articulate the sustainable value created by each pathway. For organisational customers, such as public infrastructure operators, communities, industrial users, utilities or mobility operators, the B2B value logic may include basic requirements such as safety, reliability and compliance; functional value such as power continuity, grid flexibility, or operational resilience; ease of doing business value such as reduced monitoring, maintenance and lifecycle management burden; individual value such as increased confidence and reduced uncertainty; and inspirational value such as social responsibility and sustainability impact (Almquist et al., 2018). For consumer-facing or end-user pathways, the value hierarchy may also include B2C elements such as convenience, reduced

anxiety, affordability, environmental responsibility and social impact (Almquist et al., 2016). Therefore, the value hierarchy is used flexibly as a supporting lens to strengthen pathway-level USP development, rather than as a separate assessment framework.

## 2.2.2 Method for Marketing Approaches: Segmentation, Targeting and Positioning

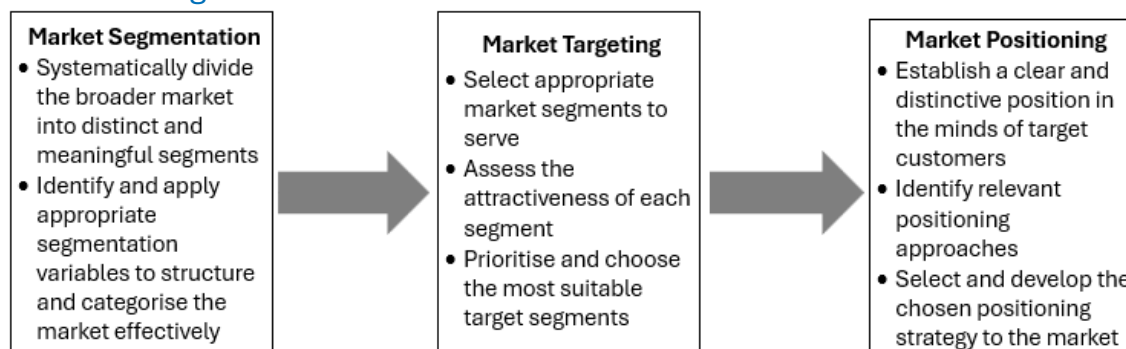


Figure 1. Segmentation-Targeting-Positioning Logic

The handbook applies the Segmentation–Targeting–Positioning (STP) logic (

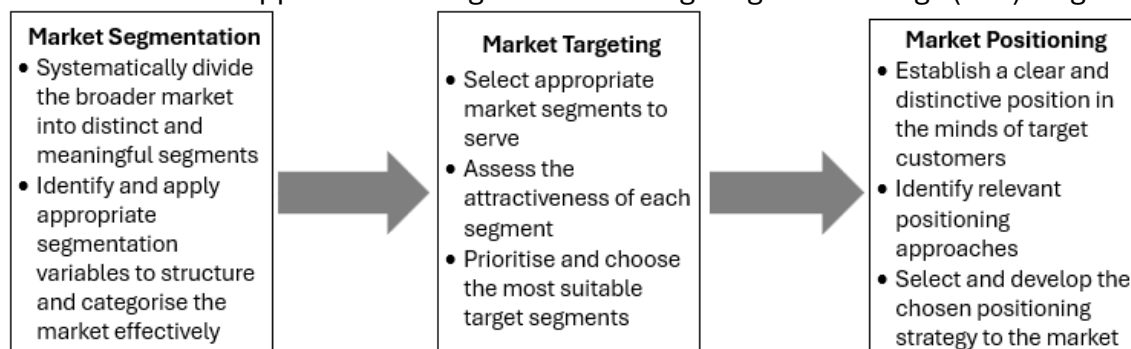


Figure 1). Segmentation divides the market into customer groups with different needs, characteristics, or behaviours. Targeting evaluates which segments are most attractive and suitable for BaaS deployment. Positioning defines how each BaaS pathway creates a distinctive value proposition for selected customers. The segmentation and targeting analysis provide the foundation for positioning strategy, which concerns the management of how a product, service, or brand is perceived through carefully designed communication activities, including the content, format, timing, frequency, and delivery of messages. Equally important is how customers interpret and experience the proposed value; understanding customer perspectives is essential for credibility and long-term trust.

Drawing upon established literature on marketing positioning, including attribute-based, benefit-based, competitor-based, user-based, emotional, and value-based positioning approaches (Kotler et al., 2019; Saqib, 2023), this Handbook synthesises nine positioning strategies relevant to the second-life battery market. These include feature-driven positioning, problem–solution positioning, target-driven positioning, competition-driven positioning, de-positioning, emotional positioning, benefit-driven positioning, aspirational positioning, and value positioning.

## 2.2.3 Business Model Canvas

The Business Model Canvas (BMC) is used as the final synthesis tool for each pathway. Building on the conventional BMC logic, it brings together the key outputs from the previous sections, including customer segments, value propositions, customer

relationships, channels, revenue streams, cost structure, key activities, key resources and key partners (Osterwalder & Pigneur, 2010).

### 3 Pathways to profitability

#### 3.1 The CIRCUBATT Second-Life Revenue Pathway Classification

The CIRCUBATT framework identifies four commercially distinct second-life revenue pathways, derived through a structured mixed-methods approach combining structured literature and industry review with iterative stakeholder co-creation and cross-work-package validation (see Deliverable 1.4, Section 2). The intersection of the two dimensions produces four distinct and internally coherent commercial pathways, summarised in Table 1 below.

*Table 1. CIRCUBATT Second-Life Pathway Classification Framework*

|                  | Market-facing<br>(external revenue streams)       | Customer-facing<br>(on-site/service value) |
|------------------|---------------------------------------------------|--------------------------------------------|
| Central-<br>ised | Pathway A: Grid Optimisers                        | Pathway C: Mobile Power Users              |
| Distrib-<br>uted | (Structurally limited / no<br>standalone pathway) | Pathway B: Grid Independents               |
|                  |                                                   | Pathway D: Consumer & Light Mobility       |

Table 1 and Figure 2 map the predominant commercial and operational orientation of each pathway. In this framework, “market-facing” refers to value that is substantially influenced by external electricity price, tariff, or grid service signals, whereas “customer-facing” refers to value realised primarily through bilateral service outcomes delivered to an identifiable customer. “Centralised” refers to centralised ownership, operational control or aggregation and does not necessarily require the physical co-location of all battery assets.

The value realisation interface is a primary determinant of both the pricing mechanism and the counterparty risk profile of a BaaS arrangement. The detailed pricing strategies associated with each pathway are explained in the corresponding sections. Under a market-facing configuration, the battery asset responds to external electricity markets or system signals, including wholesale spot markets, balancing mechanism and ancillary service auctions. This exposes the operator to price or market signals that are not fully controlled through a bilateral customer contract. By contrast, in a customer-facing configuration, value is realised primarily through a bilateral relationship in which the operator delivers a measurable service, such as cost savings, energy availability, resilience or operational uptime, to an identifiable counterparty that pays according to a pre-agreed schedule.

The asset management and deployment architecture is also the primary determinant of the cost structure and operational risk profile of each pathway. A centralised or aggregated architecture concentrates ownership, operational control and coordination under a single operational entity, enabling economies of scale in monitoring, dispatch, and maintenance, and allowing aggregated participation in markets that impose minimum capacity or technical qualification requirements. A distributed architecture disaggregates assets across multiple sites or end-users, distributing both capital requirements and operational risk across the network, whilst increasing per-unit coordination, monitoring and service delivery costs.

**Pathway A (Grid Optimisers)** predominantly occupies the centralised or aggre-

gated, market-facing quadrant. It includes utility-scale, aggregated and selected behind-the-meter (BTM) battery systems whose common logic is the active optimisation of battery operation in response to electricity price or grid service. Value is generated or preserved through value stacking, including ancillary services, wholesale energy arbitrage, capacity market participation, peak-demand reduction and avoided grid reinforcement.

**Pathway B (Grid Independents)** occupies the distributed, customer-facing quadrant. It comprises BTM, microgrid and off-grid battery systems deployed across critical public infrastructure, commercial and digital facilities, rural and remote communities, and industrial weak-grid or off-grid sites. The primary value proposition is site-level energy security, operational continuity and resilience in contexts where grid supply is weak, unstable, or costly. Value is realised through avoided outages, reduced diesel dependence, lower backup-power costs and, where applicable, lower peak-demand charges and improved on-site renewable self-consumption, without direct exposure to wholesale electricity markets.

**Pathway C (Mobile Power Users)** occupies the centralised, customer-facing quadrant. It comprises centrally owned and managed fleets of modular, transportable second-life battery systems that are deployed temporarily across construction sites, events, and other mobile or off-grid settings. Although the units are physically distributed during service delivery, charging, and maintenance remain centrally coordinated. Revenue is predominantly generated through leasing contracts priced per day of deployment or per unit of energy delivered.

**Pathway D (Consumer & Light Mobility)** constitutes the second distributed, customer-facing pathway. It targets highly distributed battery applications across suitable urban and light-mobility systems, including e-bike and e-scooter fleets. Potential revenue is driven by high-frequency usage models, relying predominantly on subscription-based access, pay-per-use, or battery-swapping fees. This pathway focuses primarily on module-level testing, reconfiguration and integration for suitable light mobility applications. Applications requiring extensive cell-level dismantling and rebuilding are treated as remanufacturing or recycling boundary cases rather than standard second-life BaaS pathways.

Figure 2 maps the four pathways against the two dimensions of value interface and asset management and deployment architecture, and summarises their sub-pathways, principal target users and primary profitability logic. No standalone pathway is defined for the distributed market-facing quadrant. Individual distributed assets may be unable to meet market access, technical qualification or minimum capacity requirements independently. However, aggregation may enable these assets to participate in external electricity and ancillary service markets. Each pathway is then developed in full in Sections 5 to 8.

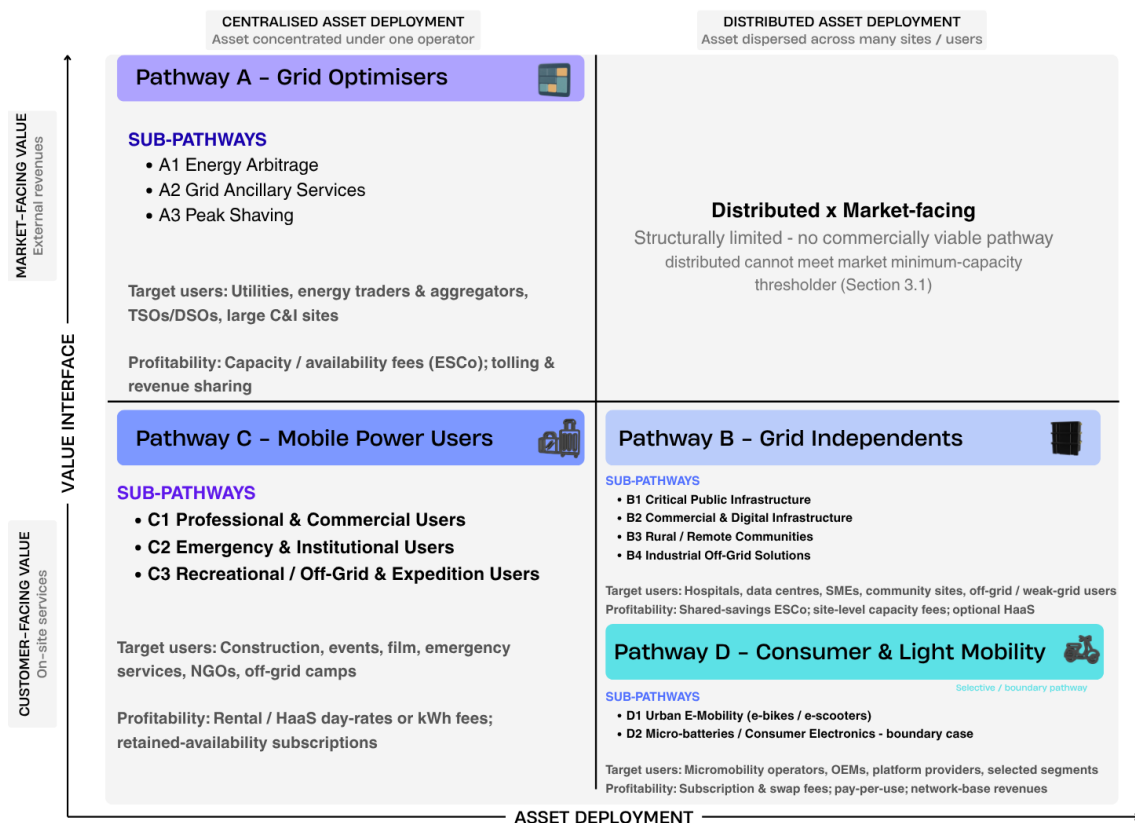


Figure 2. CIRCUBATT pathways mapped by value interface and asset deployment

## 3.2 BaaS Archetypes and Revenue Pathway Matching

The following four BaaS archetypes operate across the identified pathways, with financial structures selected based on risk allocation and contract duration rather than rigid pathway boundaries.

### 3.2.1 Battery Leasing and Energy Service Contracts (ESCo)

Battery leasing restructures the commercial barrier to entry by detaching the upfront cost of battery procurement and repurposing from the physical infrastructure installation. Under a standard leasing architecture, the operator provides the asset to the end-user for a fixed monthly capacity fee, typically denominated in €/kWh or €/kW per month, over a contracted term calibrated to the forecasted RUL of the degraded cells. This structure allows the operator to amortise repurposing and system integration costs with highly predictable cash flows.

As deployments scale in technical complexity and capital intensity, the standard fixed-fee leasing model frequently transitions into an advanced ESCo framework. Under an ESCo, the service provider ceases to charge for nominal physical capacity and instead extracts a fee based on guaranteed, measurable operational outcomes. For Pathway A, the ESCo operator assumes direct accountability for navigating wholesale market volatility, deploying proprietary dispatch algorithms to secure ancillary revenues, and charging a management fee indexed to realised market income. For complex BTM microgrids in Pathway B, an ESCo provider can guarantee critical operational outcomes – such as 99.9% resilience uptime, thereby absorbing the liability of hardware failure that the end user is unwilling to bear.

### 3.2.2 Dynamic Revenue Sharing and Shared Savings

Dynamic revenue sharing and shared-savings agreements dictate that the operator

is compensated entirely based on the generation of a measurable monetary profit or cost avoidance. In this architecture, the service provider absorbs both the technological degradation risk of the second-life asset and the financial market risk of external price fluctuations.

In the distributed, customer-facing context of Pathway B, this manifests as the shared-saving model. The service provider finances, deploys, and operates the system, recovering its investment exclusively through a contractually defined percentage of the verified economic savings delivered. The primary financial design challenge is baseline volatility and regulatory tariff risk: commercially bankable contracts must incorporate dynamic pass-through clauses that automatically adjust the savings calculation methodology in response to published tariff revisions or implement a minimum guaranteed fee structure that provides the operator with a firm revenue floor independent of network pricing movements.

### 3.2.3 Hardware-as-a-Service (HaaS) and Rental Logic

Rental Logic is the definitive commercial architecture for Pathway C. The centralised dimension in this context denotes the concentration of operational control, fleet management, and maintenance at a primary depot, a hub-and-spoke operational model that enables the operator to manage the degradation risk of heterogeneous second-life cells across the entire fleet as an aggregate, and to perform mandatory safety recertifications between deployments. Day-rate fees and kilowatt-hour-delivered pricing emerge as the structurally sound financial mechanisms, reflecting the transactional value of temporary energy provision rather than long-term asset economics.

HaaS represents a longer-term financing mechanism, applicable to sophisticated commercial entities within Pathways B and A. A utility or large industrial facility may possess its own proprietary energy management system and established trading algorithms yet seek an off-balance-sheet hardware provision to avoid the capital expenditure and residual value risk associated with second-life battery ownership.

### 3.2.4 Battery Swapping and Subscription Logic

Battery swapping represents a potentially important physical and operational architecture for selected Pathway D applications, particularly standardised, high-utilisation light mobility fleets. Under this model, the central operator retains control over the charging process through operator-managed swap stations, enabling the use of controlled charging algorithms and depth-of-discharge limits to protect battery performance. Building and maintaining a distributed swap network requires substantial upfront capital expenditure. Fixed monthly subscriptions, often structured into tiers based on swap frequency or geographic coverage, can provide predictable recurring revenue to support the recovery of network infrastructure and operating costs.

Table 2 summarises the dynamic alignment between BaaS archetypes and the commercial pathways.

*Table 2. BaaS Archetypes - Payment Logic and Multi-Pathway Relevance*

| Archetype                     | Payment Logic                                              | Primary Pathway Fit                                                          | Secondary / Alternative Pathway Fit                                                      | Commercial Rationale for Overlap                                                        |
|-------------------------------|------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| <b>Battery Leasing / EScO</b> | Fixed monthly capacity fee or outcome-based management fee | <b>Pathway A:</b> Manages high upfront CAPEX for utility-scale grid integra- | <b>Pathway B:</b> Provides budget certainty for risk-averse commercial facilities avoid- | Clients lacking technical expertise require the operator to absorb performance risk re- |

|                                                   |                                                                                  |                                                                                                                                     |                                                                                                                                                                    |                                                                                                                                |
|---------------------------------------------------|----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|                                                   |                                                                                  | tion.                                                                                                                               | ing revenue sharing.                                                                                                                                               | ardless of scale.                                                                                                              |
| <b>Revenue Shar-<br/>ing / Shared<br/>Savings</b> | Contractual %<br>share of verified<br>cost savings                               | <b>Pathway B:</b> Zero<br>CAPEX for client; op-<br>erator manages SoH<br>risk; savings-linked<br>model incentivises<br>performance. | <b>Pathway A:</b> Aligns<br>operator incentives<br>with volatile whole-<br>sale market arbitrage<br>and ancillary reve-<br>nues.                                   | Effective whenever the<br>economic value gen-<br>erated is highly varia-<br>ble and cannot be<br>guaranteed by a fixed<br>fee. |
| <b>HaaS / Rental</b>                              | Day-rate, or<br>kWh-delivered<br>fee, or fixed hard-<br>ware availability<br>fee | <b>Pathway C:</b> Short-<br>duration contracts<br>for temporary mobile<br>power deployments.                                        | <b>Pathway A &amp; B:</b> Suit-<br>able for technically<br>mature clients who<br>want off-balance-<br>sheet hardware with-<br>out software/dis-<br>patch services. | Separates the finan-<br>cial provision of the<br>physical asset from<br>the operational logic<br>of its dispatch.              |
| <b>Subscription<br/>and Pay-per-<br/>Swap</b>     | Fixed monthly<br>subscription or<br>per-swap event<br>fee                        | <b>Pathway D:</b> Secures<br>predictable cash<br>flow to amortise<br>dense urban swap<br>infrastructure.                            | <b>Pathway C:</b> Provides<br>long-term project<br>sites with guaran-<br>teed power availabil-<br>ity without tracking<br>daily usage metrics.                     | Prioritises end-user<br>convenience and sta-<br>ble recurring revenue<br>over complex perfor-<br>mance auditing.               |

### 3.3 Revenue Generation: Primary, Secondary, and Value-added Streams

Exclusive reliance on primary service income introduces financial fragility into second-life battery business models. The principle of layered revenue stacking requires combining primary service revenues with secondary streams including carbon credit monetisation, digital battery passport data services, and EoL material recovery credits. Table 3 presents the complete revenue stack for each pathway.

Table 3. Revenue Generation Stack by Pathway

| Revenue Type                                        | Pathway A                                                      | Pathway B                                                                 | Pathway C                                                         | Pathway D                                                          |
|-----------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------|
| <b>Primary service revenue</b>                      | Capacity / ESCo<br>fee OR Toll-<br>ing/Revenue<br>sharing      | Shared savings<br>% OR Fixed<br>HaaS lease                                | Rental / kWh fee<br>OR Retained<br>availability sub-<br>scription | Subscription /<br>swap fee                                         |
| <b>Ancillary market revenue</b>                     | High (frequency<br>regulation, re-<br>serve)                   | Low-Medium<br>(where local tar-<br>iff structures al-<br>low aggregation) | None                                                              | None                                                               |
| <b>Carbon credit / REC<br/>monetisation</b>         | High potential                                                 | Medium poten-<br>tial                                                     | Low (displace-<br>ment of diesel)                                 | Low-Medium                                                         |
| <b>Data / Digital Battery<br/>Passport services</b> | Medium                                                         | Medium                                                                    | Low-Medium                                                        | High (fleet analyt-<br>ics)                                        |
| <b>EoL material recovery</b>                        | High (scale ena-<br>bles volume re-<br>cycling con-<br>tracts) | Medium                                                                    | Medium                                                            | High (dense fleet<br>enables central-<br>ised EoL pro-<br>cessing) |
| <b>Value-added services</b>                         | SoH certifica-<br>tion, annual per-<br>formance re-<br>ports   | SoH dash-<br>boards, energy<br>audit updates                              | Guaranteed re-<br>deployment SLA,<br>rapid replace-<br>ment       | Fleet manage-<br>ment integration,<br>B2B analytics                |

Operators should note that voluntary carbon credits have no compliance value under the EU Emissions Trading System (ETS) and must be kept analytically separate from EU ETS price scenario planning (Senken, 2026).

EoL material recovery may provide a terminal value contribution, subject to recycling costs, material prices and contractual arrangements. By pre-contracting recy-

cling services, operators may establish a contractual price floor for recovered materials, subject to counterparty and market conditions, thereby partially offsetting the costs associated with Extended Producer Responsibility (EPR) obligations.

### 3.4 Policy and Subsidy Levers

The European policy landscape provides a material set of financial support mechanisms that can significantly improve the economics of BaaS deployment across all four pathways. At the EU level, the EU Innovation Fund provides critical grant funding for commercial-scale low-carbon technologies, and the European Investment Bank's energy demonstration programmes provide concessional financing that can reduce financing costs and improve projected debt service coverage and overall project bankability.

At the national level, energy storage incentive schemes differ materially by Member State. In the UK, grid-scale storage draws on a layered revenue stack in which the Capacity Market provides a contracted, multi-year availability payment that mitigates downside risk against the volatility of merchant trading. In France, the TURPE 7 tariff structure from August 2026 will reward distribution-connected storage for discharging during constrained periods, creating a new locational signal relevant for Pathway B shared-savings modelling.

EPR obligations under the EU Batteries Regulation create a complex dual dynamic for BaaS operators: they function simultaneously as a profound balance sheet liability and an indirect competitive advantage relative to traditional battery-scale businesses. For BaaS operators who actively repurpose their own inventory and therefore assume the legal status of a producer, retaining ownership of fleets across the asset lifecycle provides a structural advantage in planning and contracting for end-of-life processing. This logistical control enables operators to negotiate volume-based recycling contracts and potentially benefit from eco-modulated EPR fees that reward batteries engineered for superior recyclability or extended service life (EUROMOT, 2025).

### 3.5 Cost Structures and Financial Implications

A rigorous understanding of the cost architecture underpinning each pathway is essential for establishing minimum viable pricing floors. Second-life battery cost structures diverge fundamentally from first-life commodity deployments. The initial financial advantage of acquiring degraded cells at a discount is heavily offset by the intense (re-)processing, testing, and integration costs required to extract reliable system-level performance from highly heterogeneous battery batches. Consequently, achieving Levelised Cost of Storage (LCOS) parity with declining first-life lithium-ion prices depends not only on driving down repurposing costs through highly automated testing protocols, but also on leveraging historical operational data to streamline the initial degradation assessment.

Table 4 provides a comparative qualitative overview of cost intensity across pathways, highlighting where the principal margin compression risks are concentrated for each business model type.

*Table 4. Comparative Cost Intensity by Pathway (Qualitative Assessment)*

| Cost Component                               | Pathway A | Pathway B | Pathway C   | Pathway D       |
|----------------------------------------------|-----------|-----------|-------------|-----------------|
| <b>Battery acquisition &amp; repurposing</b> | High      | Medium    | Medium      | Medium          |
| <b>System integration infrastruc-</b>        | Very High | Medium    | Medium (de- | High (swap net- |

| ture                                      |        |            | pot)       | work)                   |
|-------------------------------------------|--------|------------|------------|-------------------------|
| <b>O&amp;M and BMS software</b>           | High   | Medium     | Medium     | Medium–High             |
| <b>Logistics and redeployment</b>         | Low    | Low        | Very High  | High (swap operations)  |
| <b>Insurance and liability</b>            | Medium | Low–Medium | High       | Medium                  |
| <b>Data management and DBP compliance</b> | Medium | Medium     | Low–Medium | High (fleet-scale data) |

### 3.6 Financial Risk Allocation and Bankability

The bankability of second-life BaaS deployments, defined as their capacity to attract non-recourse or infrastructure-grade debt financing, depends on the structural allocation of technological degradation risk and the contractual mitigation of cash flow volatility. Lenders may be unwilling to underwrite the inherent SoH uncertainty of repurposed cells unless the operator’s financial architecture explicitly isolates the debt service from terminal performance failures.

Across all pathways, securing commercial debt requires operators to present stress-tested financial projections demonstrating that the pricing strategy can sustain debt service coverage even if degradation accelerates beyond the baseline forecast. Table 5 provides a consolidated risk and bankability assessment across the four pathways.

*Table 5. Financial Risk and Bankability Assessment by Pathway*

| Risk / Bankability Factor                | Pathway A                                                                                                                          | Pathway B                                                                                                                        | Pathway C                                                                                                                                 | Pathway D                                                                                                                                |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Revenue predictability</b>            | <b>Fixed ESCo:</b> High.<br><b>Tolling Agreement:</b> Highly volatile; requires contractual minimum revenue floors to secure debt. | <b>Shared-Savings:</b> Medium; fluctuates with site load.<br><b>HaaS Fixed Lease:</b> High; provides corporate OPEX certainty.   | <b>Day-Rate Rental:</b> Low–Medium; vulnerable to idle inventory.<br><b>Retained Subscription:</b> High; guarantees multi-month baseline. | <b>Tiered Subscription:</b> Medium–High; generates predictable recurring cash flows.<br><b>Pay-per-swap:</b> Low.                        |
| <b>Technology &amp; degradation risk</b> | Managed via strict SoH floor clauses, upfront capacity over-provisioning, and algorithmic dispatch limits.                         | <b>Shared-Savings:</b> Operator manages via software dispatch.<br><b>HaaS:</b> Operator manages via 99% uptime SLAs.             | Managed via short contract duration and mandatory physical recertification at the central depot between deployments.                      | Managed via centralised charging protocols and hard-capped depth-of-discharge limits enforced by swap station hardware.                  |
| <b>Market &amp; tariff risk</b>          | Severe exposure to wholesale electricity price and ancillary market volatility; mitigated by margin-split adjustments.             | High exposure to distribution network tariff changes; mitigated by dynamic pass-through clauses or fixed-lease alternatives.     | Low exposure to energy markets; primary exposure is to seasonal project demand and logistics inflation.                                   | Low exposure to energy markets; primary risk stems from urban mobility regulations and municipal charging infrastructure policy.         |
| <b>Bankability (debt finance access)</b> | High under fixed-capacity ESCos. Tolling agreements require strict Debt Service Coverage Ratio (DSCR) floors to be bankable.       | <b>Shared-Savings:</b> Requires SPV portfolio aggregation.<br><b>HaaS:</b> High standalone bankability against corporate credit. | Medium. Relies heavily on operating rental structures and the enforcement of minimum billable utilisation thresholds.                     | Medium. Recurring subscription revenue supports debt, but extreme upfront infrastructure CAPEX for swap networks is a severe constraint. |

The following sections explain how each pathway operates and outline their respective pricing strategies in detail.

## 4 Operational Practices

### 4.1 Supply Chain Configuration and Implementation

Across the four BaaS pathways, operational value is delivered through a circular service chain that connects EoL EVB sourcing, repurposing, battery system configuration, deployment, service delivery, monitoring, maintenance, redeployment, and final recovery. The BaaS provider plays a central coordinating role in this chain by converting retired EVBs into service-ready battery assets and managing their technical performance over time.

The supply chain begins with EoL EVB collectors, retailers, dismantlers, OEM-related sources, or other battery owners. Batteries are then screened, tested, graded, and repurposed before being allocated to suitable second-life applications. Infrastructure and service partners may support deployment, installation, monitoring, maintenance, transport, software integration, and EoL handling. This creates a circular operational system in which battery ownership, technical responsibility, and lifecycle accountability remain largely with the provider rather than being fully transferred to the customer (see Figure 3). All pathways deliver value through two linked process chains (see Figure 4):

1. **Order to Deployment** is the end-to-end process through which a customer need is translated into a deployed battery-enabled service.
2. **Service Activation to Performance Delivery** is the post-deployment process through which the promised service continues to be delivered over the operating life. The two process chains and their circular linkage are illustrated in the figure below.

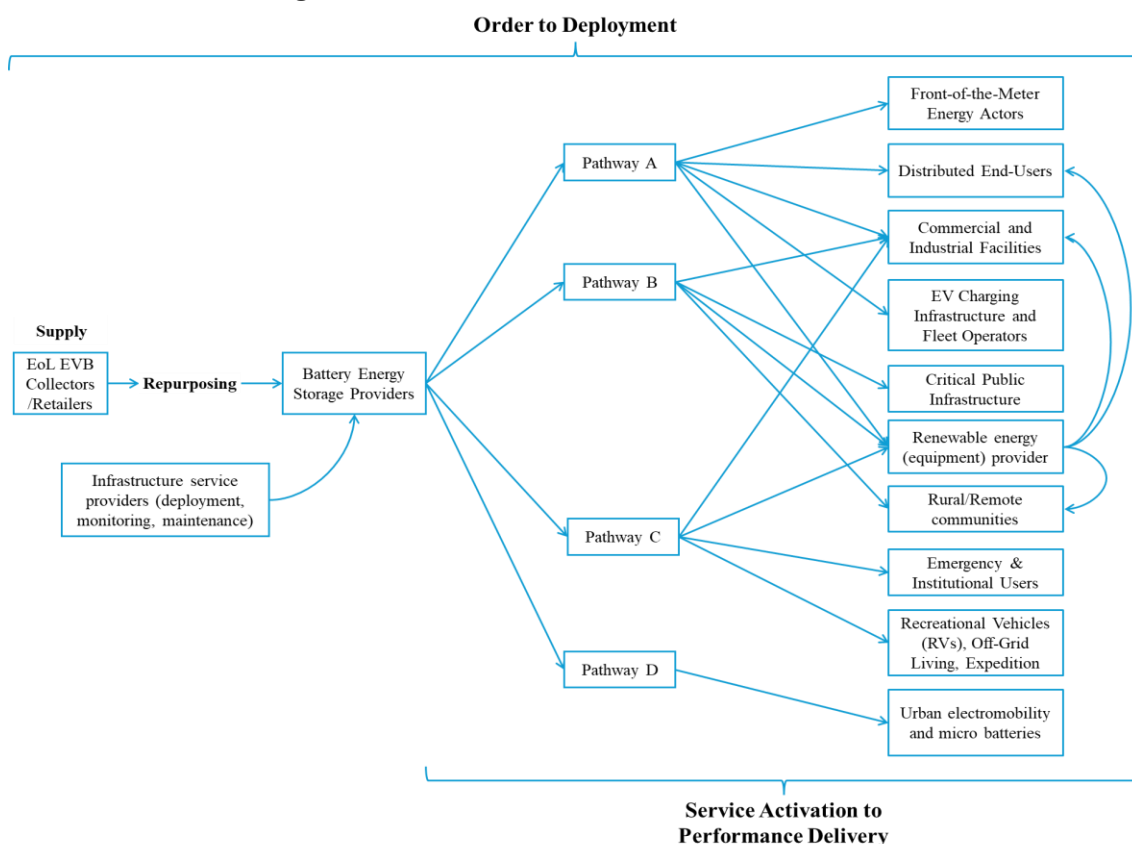


Figure 3. CIRCUBATT operational ecosystem and pathway-to-customer mapping

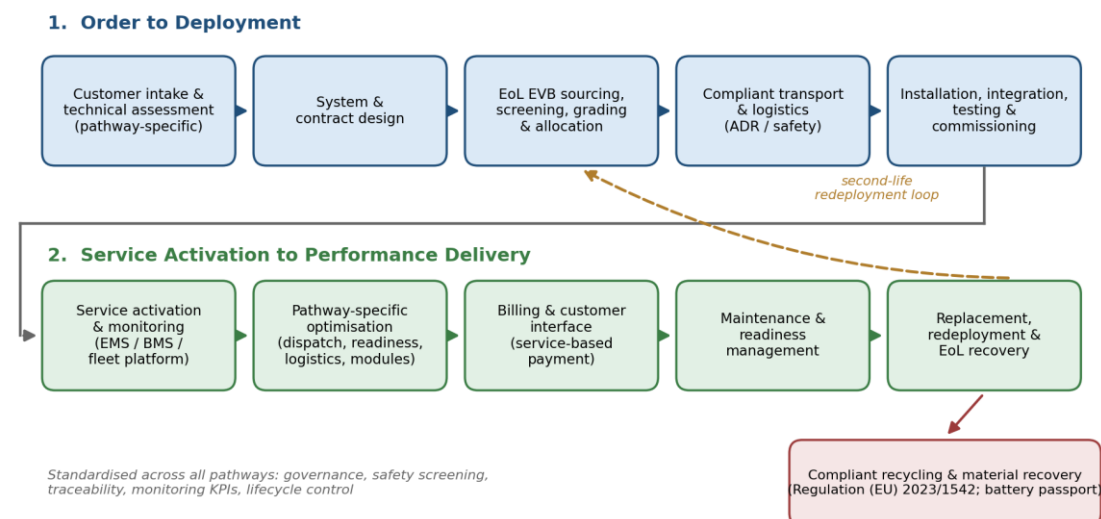


Figure 4. Second-life BaaS operational process chains: order to deployment and service activation to performance delivery

These two process chains provide a common operational backbone for all pathways. Standardisation should apply across customer intake, safety screening, transport compliance, testing, monitoring, maintenance and EoL documentation. This is important because second-life EVBs introduce additional uncertainty around SoH, degradation, safety, compatibility, and RUL.

However, operational practices must also differ across pathways because each pathway places different demands on the battery system:

- **Pathway A – Grid Optimisers** requires market-facing and grid-interactive operation. The provider must manage dispatch, grid compliance, forecasting, communication systems, and performance monitoring because the battery is used to create financial and grid value through electricity market or grid-service functions.
- **Pathway B – Grid Independents** requires reliability-focused and site-level operation. The provider must ensure that the system remains available for backup, continuity, or off-grid supply, even where the system is used infrequently. Readiness testing, critical-load mapping, and resilience monitoring are therefore central.
- **Pathway C – Mobile Power Users** requires fleet-based and logistics-intensive operation. The provider must manage transportable battery units, charging between deployments, physical inspection, redeployment scheduling, and availability across temporary or mobile customer sites.
- **Pathway D – Consumer and Light Mobility** require module-level integration and replacement-cycle management. The provider must assess whether EVB modules are suitable for smaller mobility applications and manage testing, product integration, replacement, and end-of-life routing. Where cell-level reuse is required, the process may move beyond direct second-life reuse into remanufacturing or recycling.

Thus, the operational framework should be standardised at the level of governance, safety, traceability, and monitoring, but differentiated at the level of technical configuration, service delivery, asset mobility, and replacement practice.

## 4.2 Order to Deployment

The process begins with **customer onboarding and technical assessment**. At this stage, the provider evaluates whether the customer needs a BaaS model and identifies the most appropriate battery-enabled service configuration. The assessment should cover energy demand, required power rating, load profile, service duration, operating environment, available space, safety requirements, electrical infrastructure, customer constraints, and expected service outcomes.

The **technical assessment** differs by pathway. For *Pathway A*, the provider assesses grid connection, market or grid-service requirements, dispatch potential, communication infrastructure, and the ability of the system to respond to external price or grid signals. For *Pathway B*, the provider assesses critical loads, outage exposure, backup duration, power quality needs, and whether the system must support islanded or off-grid operation. For *Pathway C*, the provider assesses mobility requirements, deployment duration, site access, charging logistics, transport needs, ruggedisation, and whether the unit must be rapidly redeployed. For *Pathway D*, the provider assesses battery module suitability, size and weight constraints, safety requirements, product integration, and whether the application remains a valid second-life use case.

The next step is **system and contract design**. The provider configures the battery-enabled solution by matching battery condition and system design to the intended application. For stationary applications (pathways A and B), this involves a BESS configuration combining batteries, power electronics, controls, safety systems, monitoring systems, and, where relevant, renewable generation or charging infrastructure (Asian Development Bank, 2020). For mobile applications, the system may be configured as portable units, trailers, modular containers, or plug-and-play power systems. For light mobility applications, the battery may be integrated into a smaller product rather than deployed as a standalone BESS.

A key operational requirement across all pathways is **battery sourcing and compliant logistics**. Retired EVBs must be collected, screened, graded, and classified before deployment. This should include checks on SoH, safety condition, physical damage, chemistry, module consistency, expected degradation, and RUL. Battery allocation should reflect application requirements. Higher-performing batteries may be directed to more demanding applications, while lower-demand applications may accept batteries with different performance profiles. Batteries that are damaged, unsafe, or unsuitable for reuse should be routed to compliant recycling or material recovery.

**Transport and handling** must comply with relevant dangerous-goods and battery safety requirements (BATRAW, 2024). If batteries are undamaged and meet the relevant test requirements, less restrictive packaging rules apply; otherwise, more stringent ADR provisions are triggered (UNECE, 2023). This means protecting batteries against short circuit, impact, thermal risk, and unsafe handling during collection, storage, transport, installation, and redeployment. Traceability should be maintained throughout the process so that the provider can track battery origin, test results, movement, configuration, service history, and final recovery route.

Deployment then moves into **installation, integration, testing, and commissioning**. For Pathways A and B, this usually involves electrical integration, grid or site connection, non-energised checks, energisation, commissioning, and performance

validation under relevant operating scenarios (Booth et al., 2019). For Pathway C, commissioning also includes transport readiness, plug-and-play functionality, charging procedures, physical safety checks, and redeployment readiness. For Pathway D, commissioning focuses on module integration, BMS compatibility, product-level safety, certification, and performance validation in the target mobility application.

### 4.3 Service Activation to Performance Delivery

After commissioning, the workflow shifts to **service activation and performance delivery**. The provider activates the monitoring and control systems and begins tracking battery and system performance through the EMS, BMS, digital platform, or fleet-management system. Core monitored variables should include SoC, temperature, voltage behaviour, cycle count, alarms, utilisation, system availability, degradation, and RUL.

The **optimisation logic** differs across pathways. In Pathway A, optimisation focuses on responsive dispatch, market or grid-service participation, availability, and system performance under externally driven operating signals. In Pathway B, optimisation prioritises reliability, backup readiness, power continuity, and protection of critical loads. In Pathway C, optimisation focuses on unit availability, charging schedules, logistics, redeployment planning, and matching portable units to customer requirements. In Pathway D, optimisation focuses on module-level degradation, fleet uptime, replacement cycles, and safe operation.

The commercial layer is delivered through **billing and customer interface management**. Depending on the service model, billing may be linked to service availability, energy delivered, contracted capacity, rental duration, usage intensity, verified savings, or battery replacement services (see section 3.2-3.3).

Long-term value delivery depends on **maintenance and readiness management**. Maintenance should include remote diagnostics, periodic inspection, software updates, safety testing, performance verification, and planned replacement. The intensity of maintenance varies by pathway. Pathway A requires close monitoring as system performance affects grid and market-facing service delivery. Pathway B requires periodic testing because backup and resilience services may be used infrequently but must work when needed. Pathway C requires inspection between deployments because portable units are transported, handled, and reused across multiple sites. Pathway D requires module-level monitoring and replacement planning because light mobility applications often involve frequent cycling and physical integration into smaller products.

### 4.4 Replacement, redeployment, and end-of-life recovery

Finally, the process includes battery replacement, redeployment, and EoL recovery. Under a circular BaaS model, batteries are not treated as disposable components. Instead, performance data is used to determine whether packs or modules should remain in service, be upgraded, be prepared for second-life redeployment, or be routed to compliant recycling. Regulation (EU) 2023/1542 (European Union, 2023) provides the European lifecycle framework for collection, repurposing, recycling, and producer responsibility, while the battery passport is intended to support traceability and information sharing across these stages.

## 5 Pathway A – Grid Optimisers

**Pathway A: Grid Optimisers** focuses on using battery storage as an optimisation asset for arbitrage, ancillary services, peak shaving, and other grid-related value streams. In this pathway, batteries are typically deployed as stationary BESS assets either front-of-the-meter (FTM) or BTM, depending on the customer and revenue logic. Their role is to store electricity when it is cheap, abundant, or locally available, and discharge it when electricity is more valuable, when grid support is required, or when site demand peaks. Value is therefore created through price-spread optimisation, grid stabilisation, reduced demand charges, and the ability to stack multiple energy-market and site-level services.

### 5.1 Problem definition and unique selling proposition (USP)

This section develops the problem–solution fit and USP for Pathway A. The analysis is organised around the three main value creation mechanisms of Pathway A: A1 Energy Arbitrage, A2 Grid Ancillary Services and A3 Peak Shaving.

#### 5.1.1 Sub-pathway Value Proposition Canvas (VPC) and Problem–USP fit

As shown in Figure 5, the core customer job for **A1 Energy Arbitrage** is to store low-cost or surplus electricity and use or sell it during high-value periods. The resulting USP is energy value optimisation by storing low-cost or surplus electricity and using or selling it during high-value periods through service-managed second-life BESS.

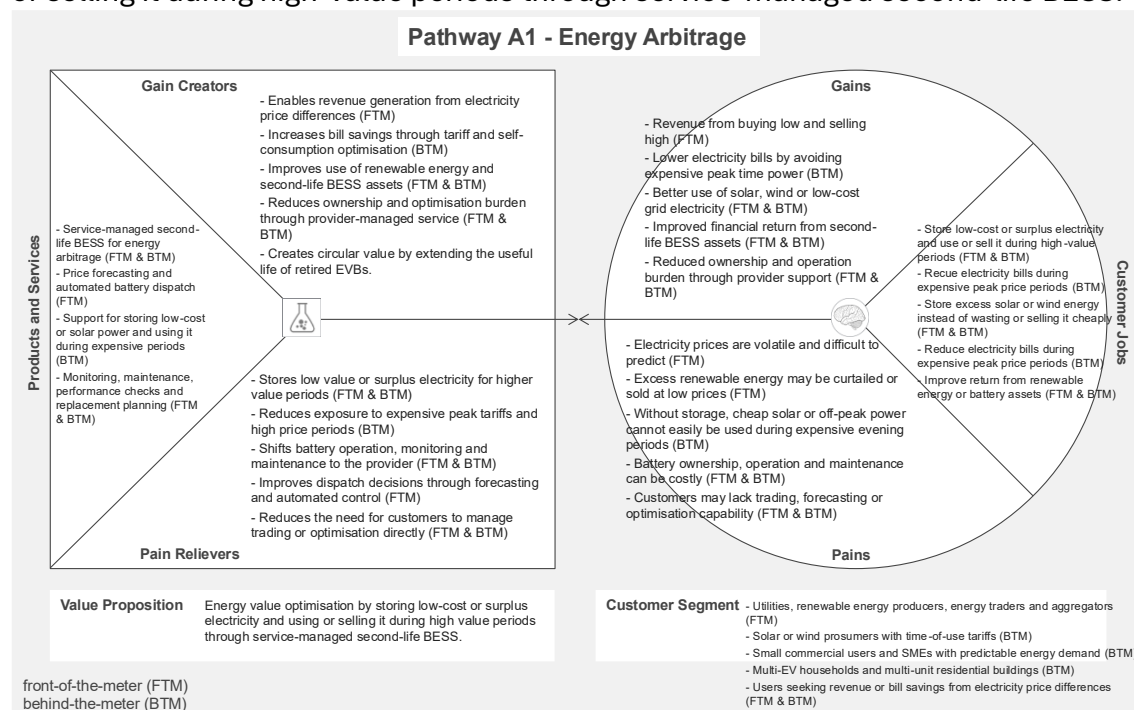


Figure 5. VPC for A1 Energy Arbitrage

As presented in Figure 6, the core customer job for **A2 Grid Ancillary Services** is to use second-life BESS to support real-time grid stability through fast response services such as frequency regulation, voltage support and reserve capacity. This pathway involves grid operators, TSOs, ISOs, utilities, energy storage aggregators, and renewable project developers. The resulting USP is grid stability and ancillary service value through service-managed second-life BESS with aggregator support.

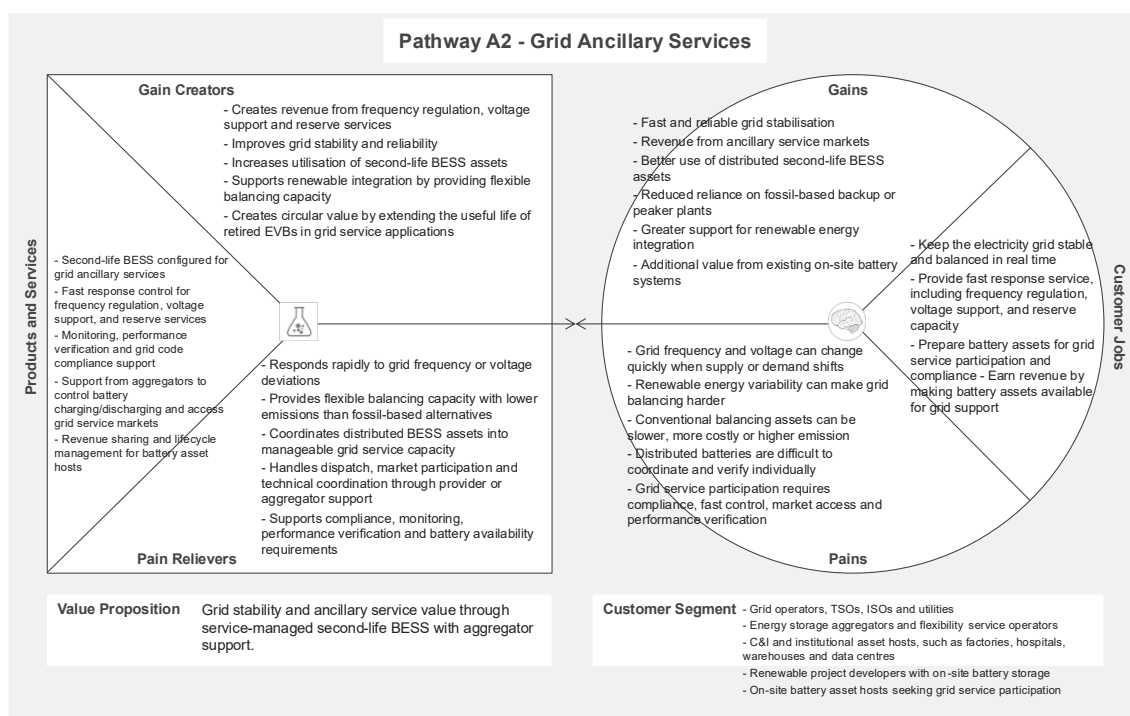


Figure 6. VPC for A2 Grid Ancillary Services

In Figure 7, A3 **Peak Shaving** aims to reduce peak electricity demand during high-load periods. This pathway is mainly relevant for commercial and industrial facilities, data centres, logistics hubs, hotels, large commercial buildings, EV charging hubs and fleet charging depots that face high demand charges, peak tariffs, load spikes or grid capacity limits. The resulting USP is peak cost reduction and grid capacity relief through service-managed second-life BESS for peak shaving.

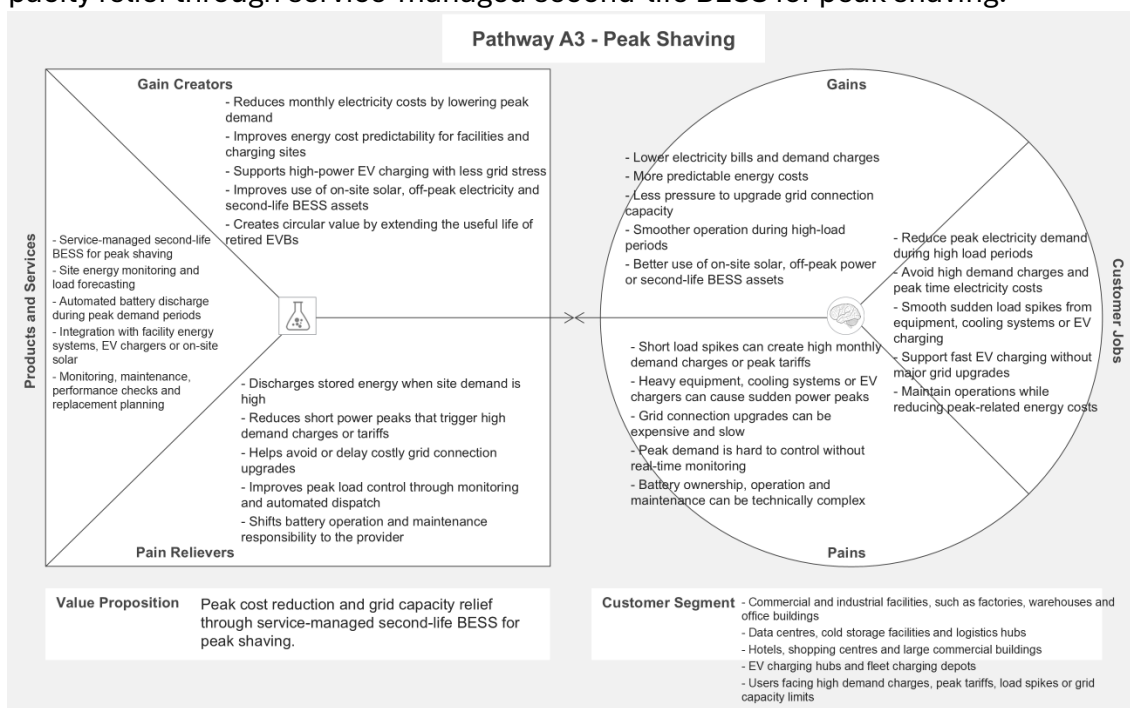


Figure 7. VPC for A3 Peak Shaving

### 5.1.2 Sustainable USP of Pathway A

The three VPC figures in Section 5.1.1 show that Pathway A is unified by the broader

objective of creating energy value from grid-connected second-life BESS. While all three sub-pathways use second-life battery storage to optimise electricity use, they create value in different ways. Table 6 shows the USP of each sub-pathway when addressing their core problems.

*Table 6. Problem–USP summary for Pathway A sub-pathways*

| Sub-pathway                | Core problem                                                                                                                                                        | Resulting USP                                                                                                                                                    |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A1 Energy Arbitrage        | Customers need to capture value from electricity price differences but face price volatility, forecasting uncertainty and battery ownership and optimisation costs. | Energy value optimisation by storing low-cost or surplus electricity and using or selling it during high-value periods through service-managed second-life BESS. |
| A2 Grid Ancillary Services | Grid operators and aggregators need fast, reliable flexibility resources to stabilise electricity systems.                                                          | Grid stability and ancillary service value through service-managed second-life BESS with aggregator support.                                                     |
| A3 Peak Shaving            | Commercial, industrial and EV charging users face costly peak demand charges, peak tariffs, load spikes and grid capacity constraints.                              | Peak cost reduction and grid capacity relief through service-managed second-life BESS for peak shaving.                                                          |

Across these three sub-pathways, the sustainable USP of Pathway A is to provide energy value optimisation through service-managed second-life BESS. Customers are accessing a managed energy optimisation service that can generate revenue, reduce electricity costs, improve asset utilisation and support grid flexibility.

Interpreted through the value hierarchy introduced in Section 2.2, Pathway A meets table-stakes expectations of safety, reliability and grid compliance; creates functional value through arbitrage, ancillary services and peak shaving; eases doing business by shifting monitoring, optimisation and replacement planning to the provider; builds decision-maker confidence; and delivers inspirational value through circular battery reuse and lower-carbon flexibility.

Economically, Pathway A generates market revenue while reducing bills, demand charges and peak tariffs; environmentally, it extends EVB life and improves renewable utilisation; socially, it supports a more stable, flexible and efficient electricity system (see Deliverable 1.6). Its core value lies in converting retired EVBs into service-managed energy optimisation assets.

## 5.2 Marketing Approaches: Segmentation, Targeting and Positioning

### 5.2.1 Segmentation and targeting

The market segmentation for Pathway A is based on the primary purpose of the target customer: creating financial and grid value from electricity price variation, grid-service markets, and demand-cost reduction. Following the STP logic (Section 2.2.2), this pathway adopts a differentiated marketing strategy, as BaaS-BESS solutions can serve several customer groups with different value-creation mechanisms, market participation roles, technical requirements, and buying behaviours. Table 7 provides full details of Pathway A – Segmentation and Targeting. These sub-pathways are supported by real-world cases and evidence from industry and policy reports:

For **A1 – Energy Arbitrage: Price-Spread Optimisation Users**, the relevance is well illustrated by Volkswagen Group Charging GmbH, operating under the brand

Elli, and its second-life BESS deployment in Baunatal, Germany<sup>1</sup>. Elli deployed a 560 kWh second-life BESS for automated intraday trading on the German electricity market through EPEX Spot. This makes the case particularly relevant to FTM energy actors. The system is not only a technical storage unit but also a digital energy trading testbed, where software enables communication between the trading platform and the physical battery asset<sup>2</sup>. This supports the logic of arbitrage because the BESS can respond to market price signals and capture value by charging and discharging at economically favourable times. Value is created through the integration of second-life batteries, control software, market participation and automated dispatch rather than battery ownership alone.

For **A2 – Grid Ancillary Services: Grid-Service Revenue and Stability User**, the relevance is demonstrated by the Johan Cruijff ArenA in Amsterdam, where Nissan, Eaton, The Mobility House, BAM, and the stadium deployed a 3 MW/2.8 MWh energy storage system using second-life and new Nissan LEAF batteries. The system provides backup power, stores solar energy from the stadium roof, flattens peaks during concerts and events, and can support grid ancillary services such as frequency regulation and balancing through interaction with the Dutch electricity system<sup>3</sup>. The stadium acts as the physical host, while technical partners manage the battery system and its wider energy functions. It therefore illustrates how commercial sites can participate in grid-support functions without becoming energy-market specialists themselves.

For **A3 – Peak Shaving: Demand-Cost Reduction Users**, the relevance is illustrated by Porsche's second-life BESS at its Leipzig plant in Germany<sup>4</sup>. Porsche deployed 4,400 used Taycan battery modules from pre-series, works, and development vehicles into a stationary BESS with 5 MW of power and 10 MWh of energy capacity. The system is connected through inverters and medium-voltage transformers and is designed for more than ten years of stationary use, with individual modules replaceable if required. The storage system is partly supplied by the plant's own 9.4 MW solar installation and is used to reduce peak loads when demand rises. Peak-load capping reduces grid charges, improves renewable self-consumption and defers grid reinforcement, while planned participation in the balancing market demonstrates value stacking.

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<sup>1</sup> [VW Subsidiary Embraces Automated Energy Trading – Value](#)

<sup>2</sup> [ELLI Partners With Collect To Become The First Automotive Company To Trade On EPEX Spot | Collect Energy](#)

<sup>3</sup> [Johan Cruijff ArenA | The 3 megawatt energy storage system in Johan...](#)

<sup>4</sup> [Second Life concept: how used Taycan batteries became an energy storage system for the Leipzig plant - Porsche Newsroom](#)

Table 7. Pathway A Segmentation and Targeting

| Segment                     | Sub-segment                                                                           | Description                                                                                                                                                                | Use Case Example                                                                                                                                        | Key Characteristics                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                          |                                                                                                                                                                                |                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                  |
|-----------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             |                                                                                       |                                                                                                                                                                            |                                                                                                                                                         | Energy Role                                                                                                                                                                                                                                   | Customer Profile                                                                                                                                                                                                                                         | Operating Context                                                                                                                                                              | Key Value and Economic Focus                                                                                                                                                                                              | Procurement Complexity                                                                                                                                                                                                                                                           |
| A1. Energy Arbitrage        | <b>FTM Energy Actors: Utilities, Renewable Producers, Energy Traders, Aggregators</b> | Large-scale BaaS-BESS used to buy electricity at low prices and sell at high prices. This includes renewable energy shifting, wholesale trading, and grid-level arbitrage. | Volkswagen Group Charging GmbH, operating under the brand Elli, and its second-life BESS deployment in Baunatal, Germany.                               | <b>Energy role:</b> Price-spread optimisation and market trading.<br><b>Coverage:</b> Grid-scale or aggregated systems. Usage is continuous and driven by wholesale, intraday, or real-time market price signals.                             | <b>Customer profile:</b> Energy-sector actors including utilities, independent power producers, renewable operators, energy traders, and aggregators. <b>Scale:</b> Large organisations; scale-up to enterprise-level actors.                            | Liberalised electricity markets with high renewable penetration, price volatility, curtailment risk, and access to wholesale or intraday trading platforms.                    | <b>Key value:</b> Revenue optimisation and renewable energy monetisation. <b>Economic focus:</b> Capturing price spreads, reducing curtailment, improving asset utilisation, and increasing trading revenue.              | <b>Procurement complexity:</b> High due to market access, trading software, technical integration, and regulatory requirements. Investment-driven buyers with long project cycles, strong ROI orientation, and reliance on forecasting and optimisation tools.                   |
|                             | <b>Distributed End-Users: Prosumers, SMEs, EV Households, Multi-unit Buildings</b>    | BTM BaaS-BESS used to store cheap electricity from the grid or local renewables and avoid expensive peak tariffs.                                                          | Residential or small commercial users on time-of-use tariffs using BESS to store solar or off-peak electricity and discharge during peak-price periods. | <b>Energy role:</b> BTM cost optimisation.<br><b>Coverage:</b> Household-, building-, or facility-level. Usage is normally daily and aligned with time-of-use tariffs, solar production, EV charging patterns, and predictable load profiles. | <b>Customer profile:</b> Residential and small commercial users, including solar prosumers, SMEs, multi-EV households, and property managers. <b>Scale:</b> Individual households to small and medium organisations; early adopters to mainstream users. | Urban and suburban areas with time-of-use tariffs, smart meters, rooftop solar adoption, weak export compensation, or high peak electricity prices.                            | <b>Key value:</b> Energy bill reduction and energy independence. <b>Economic focus:</b> Maximising solar ROI, avoiding expensive peak electricity, reducing EV charging costs, and lowering shared building energy costs. | <b>Procurement complexity:</b> Low to medium depending on system size and ownership model.<br><br>Price-sensitive users with short-to-medium buying cycles, preferring low upfront cost, subscription models, or shared-savings contracts.                                       |
| A2. Grid Ancillary Services | <b>Grid Operators and System Buyers: TSOs, ISOs, Utilities</b>                        | Procurement of services such as frequency regulation, voltage support, spinning reserves, and balancing services via BaaS-BESS.                                            | Mercedes-Benz Energy, GETEC ENERGIE, and The Mobility House storage systems in Lünen and Elverlingsen, Germany.                                         | <b>Energy role:</b> Grid stabilisation and ancillary service provision. <b>Coverage:</b> System-wide transmission or distribution network support. Usage is high-frequency, short-duration, and signal-driven for real-time grid balancing.   | <b>Customer profile:</b> Public, regulated, or semi-regulated energy-system actors, including TSOs, ISOs, DSOs, and utilities. <b>Scale:</b> Large institutional organisations; mature system operators.                                                 | Advanced electricity systems with ancillary service markets, high renewable integration, grid volatility, and strict technical requirements for power quality and reliability. | <b>Key value:</b> Grid reliability, stability, and compliance. <b>Economic focus:</b> Avoided fossil-based balancing, reduced system instability, lower balancing costs, and improved renewable integration.              | <b>Procurement complexity:</b> Very high due to prequalification, grid-code compliance, communication requirements, and performance verification.<br><br>Long procurement cycles, contract-based purchasing, strict technical due diligence, and very low tolerance for failure. |
|                             | <b>Coordinators and Asset Hosts: Aggregators</b>                                      | Aggregation of distributed BESS to provide ancillary services and enable value stacking                                                                                    | Johan Cruijff ArenA in Amsterdam, where the stadium acts as                                                                                             | <b>Energy role:</b> Aggregated grid-service participation and                                                                                                                                                                                 | <b>Customer profile:</b> Mixed actors including energy aggregators, C&I sites,                                                                                                                                                                           | Regions with distributed energy resource participation frame-                                                                                                                  | <b>Key value:</b> Multi-stream revenue generation and asset optimi-                                                                                                                                                       | <b>Procurement complexity:</b> Medium to high depending on asset owner-                                                                                                                                                                                                          |

|                  |                                                                                 |                                                                                                       |                                                                                         |                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                |                                                                                                                                                                              |                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                       |
|------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | <b>tors, C&amp;I Users, Renewable Operators, Households</b>                     | across arbitrage, demand response, peak shaving, backup power, and grid services.                     | an asset host and technical partners manage wider energy and grid-service functions.    | value stacking. <b>Coverage:</b> Distributed, multi-site, or site-hosted systems. Usage is continuous, software-controlled, and driven by grid signals or aggregator dispatch.                                                     | renewable operators, and residential hosts. <b>Scale:</b> SMEs to enterprise-level asset hosts; aggregator portfolios can operate at large scale.                                                                                              | works, smart grid infrastructure, demand-response programmes, and aggregator market access.                                                                                  | sation. <b>Economic focus:</b> Turning on-site batteries from cost-saving assets into revenue-generating assets through value stacking.                                                                                               | ship and market participation model.<br><br>Commercially oriented buyers with medium buying cycles, motivated by additional revenue, shared savings, and system optimisation.                                                                                         |
| A3. Peak Shaving | <b>Commercial and Industrial Facilities: Factories, Data Centres, Buildings</b> | BaaS-BESS used to reduce peak demand and demand charges by discharging during high-load periods.      | Porsche's second-life BESS at its Leipzig plant in Germany.                             | <b>Energy role:</b> Peak-load reduction and facility energy management. <b>Coverage:</b> Facility-level. Usage is daily or event-driven depending on machinery start-up, HVAC demand, production peaks, or high-occupancy periods. | <b>Customer profile:</b> Industrial and commercial users such as manufacturing plants, data centres, warehouses, shopping malls, hotels, offices, and cold storage facilities. <b>Scale:</b> Medium to large organisations; mature operations. | Industrial zones and commercial hubs with high demand charges, constrained grid connections, variable facility loads, or high-power equipment.                               | <b>Key value:</b> Demand-cost reduction and operational cost control. <b>Economic focus:</b> Reducing demand charges, avoiding peak tariffs, improving self-consumption, and deferring grid upgrades.                                 | <b>Procurement complexity:</b> Medium to high due to sizing, EMS integration, site assessment, and payback evaluation.<br><br>ROI-driven buyers with clear payback expectations, medium procurement cycles, and strong sensitivity to electricity cost structures.    |
|                  | <b>EV Charging Infrastructure and Fleet Operators</b>                           | BaaS-BESS used to buffer high-power EV charging demand, reduce grid upgrades, and avoid peak tariffs. | Renault and Connected Energy E-STOR highway charging deployment in Belgium and Germany. | <b>Energy role:</b> Charging-load buffering and grid-connection support. <b>Coverage:</b> Site-level charging hubs or fleet depots. Usage is demand-driven and peaks when multiple vehicles charge simultaneously.                 | <b>Customer profile:</b> Public charging networks, motorway charging hubs, fleet depots, logistics firms, bus depots, and truck charging operators. <b>Scale:</b> Scale-up to enterprise-level mobility and infrastructure operators.          | Urban areas, highways, logistics hubs, and depot locations with high EV adoption, fast-charging demand, limited grid capacity, or expensive grid reinforcement requirements. | <b>Key value:</b> Fast-charging enablement and grid-upgrade avoidance. <b>Economic focus:</b> Reducing demand charges, avoiding costly grid reinforcement, improving charger availability, and supporting scalable EV infrastructure. | <b>Procurement complexity:</b> High due to grid connection, charger integration, uptime requirements, and infrastructure planning.<br><br>Investment-driven buyers with medium-to-long planning cycles, prioritising uptime, scalability, and long-term cost savings. |

### 5.2.2 Positioning and customer relationship

- **A1 – Energy Arbitrage: Price-Spread Optimisation Users**

This segment is fundamentally driven by financial optimisation and market opportunity capture. Regardless of whether customers operate at FTM or BTM, their primary concern is likely to be: *“How can electricity price fluctuations be converted into measurable financial returns without increasing operational complexity?”* Consequently, a benefit-driven positioning strategy is particularly appropriate, as it highlights revenue generation, and optimisation outcomes achieved through intelligent energy management.

Customers within this segment are likely to value transparent performance reporting, and continuous optimisation services. Furthermore, customers are likely to appreciate clear visibility of realised arbitrage revenue, and battery performance through digital dashboards and reporting tools. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a service partnership, built upon transparency, measurable financial outcomes and continuous performance improvement.

- **A2 – Grid Ancillary Services: Grid-Service Revenue and Stability Users**

A representative concern for organisations within this segment is likely to be: *“How can battery assets generate revenue while meeting the technical and compliance requirements of grid-service markets?”* In response to this priority, a problem-solution positioning strategy is particularly appropriate, as it addresses the complexity of market qualification, compliance, coordination and performance management.

Customers within this segment are likely to place significant importance on technical expertise, regulatory knowledge and operational reliability. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a technical coordination partnership, founded upon trust, regulatory competence and long-term operational collaboration.

- **A3 – Peak Shaving: Demand-Cost Reduction Users**

This segment is primarily motivated by cost reduction, operational efficiency and infrastructure optimisation. A central question for organisations within this segment is likely to be: *“How can peak-demand costs be reduced without compromising operational performance or requiring expensive grid upgrades?”* Consequently, a benefit-driven positioning strategy is highly relevant, as it emphasises measurable cost savings, improved energy efficiency and enhanced utilisation of existing infrastructure.

Customers within this segment are likely to value dependable service delivery, predictable cost savings and straightforward performance measurement. Accordingly, the most appropriate customer relationship approach for this segment can be characterised as a cost-optimisation partnership, centred on operational efficiency, measurable financial outcomes, and long-term performance assurance.

## 5.3 Channels

Channels refer to the means through which an organisation communicates with, reaches, delivers value to, and maintains relationships with its customer segments. They are not merely communication routes, but rather an integrated system that connects customer needs with value delivery, thereby shaping how effectively a business model is experienced in practice.

Consistency and holism must be maintained throughout the discussion of VPC,

BMC and STP frameworks. While the understanding of what customer relationship needs to be built, the selection of channels should also reinforce the intended marketing positioning and influence customer perception in a coherent manner. Moreover, similar to customer relationship strategies, appropriate channel strategies should also be identified and tailored for each Pathway A segment.

- **A1 – Energy Arbitrage: Price-Spread Optimisation Users**

Appropriate channels are likely to include energy trading conferences, renewable energy forums, energy consultants and specialist industry publications. Engagement through these channels can strengthen the provider's positioning as an intelligent energy optimisation partner capable of transforming electricity price volatility into measurable financial value through advanced analytics, forecasting, and automated dispatch capabilities.

- **A2 – Grid Ancillary Services: Grid-Service Revenue and Stability Users**

Effective channels are likely to include transmission and distribution industry forums, energy storage associations, aggregator networks, regulatory consultations, and specialist power-system conferences. Communication through these channels enables the provider to demonstrate expertise in ancillary service participation, compliance management, and battery performance optimisation. At the same time, it reinforces the provider's positioning as a trusted partner capable of navigating the technical and regulatory complexities associated with grid-service markets.

- **A3 – Peak Shaving: Demand-Cost Reduction Users**

The selected channels should emphasise operational efficiency, financial performance, and infrastructure optimisation. Appropriate channels include direct B2B sales, energy management consultants, commercial and industrial associations, industry case studies and sector-specific conferences. These channels can communicate the financial benefits of peak shaving, including avoided demand charges and deferred grid investment, while positioning the provider as a practical partner for cost reduction, operational continuity and future energy flexibility.

## 5.4 Pricing strategy

In **Quadrant: centralised x market-facing** (Table 1), Pathway A serves customers creating financial and grid value from electricity price variation, grid-service markets and demand-cost reduction: energy-arbitrage actors (A1), grid ancillary service buyers (A2) and peak-shaving commercial and industrial facilities (A3). Because value is realised at the external market interface, the pricing logic must simultaneously amortise capital-intensive, long-lived assets and split volatile market margin.

### 5.4.1 Primary mechanism – capacity-based and outcome-linked pricing

Grid optimiser deployments are capital-intensive and rely on long-term contracts. The primary fixed capacity fee (€/kW or €/kWh per month) is calibrated against a projected degradation curve. This follows the established Energy Performance Contract / Energy Service Contract (ESCO) logic, in which the provider installs and operates the equipment under a multi-year performance guarantee and is paid from the value delivered, with contract terms typically ranging from a few years to two decades (IEA, 2018; U.S. Department of Energy, 2024). The handbook's analysis is that two clauses are required to protect the operator over a decade-long horizon: a SoH floor clause obliging the operator to augment capacity at its own expense, or accept a proportional fee reduction, if degradation breaches a contracted threshold; and

an inflation-indexation clause preserving the operator's real yield against erosion of a fixed nominal fee. Where the fee is wrapped into an outcome-based ESCo, it is made conditional on technical performance such as minimum available capacity during peak hours and sub-second frequency response, mirroring the savings- or performance-guarantee structure standard in energy performance contracting (IEA, 2018).

#### 5.4.2 Secondary mechanisms – tolling and dynamic revenue sharing

When the operator participates directly in wholesale markets, the pricing mechanics shift from capital amortisation to margin splitting. The contract defines a financial baseline – frequently a minimum guaranteed revenue floor covering operations-and-maintenance costs – with arbitrage and ancillary service profits above that baseline shared contractually. The economic rationale, supported by published second-life techno-economic modelling, is that aggressive cycling for arbitrage raises revenue but accelerates cell degradation (Li et al., 2023); the handbook's analysis is therefore that the profit-share percentage must be set high enough to offset the accelerated depreciation of second-life cells, and that tolling structures require a minimum operational-uptime clause to prevent the operator idling the asset during marginal pricing periods.

#### 5.4.3 Calibration baseline, risk mitigation and bankability

Pricing is calibrated against projected residual life and ancillary-market revenue forecasts and mitigated through inflation-indexation and SoH floor clauses. The bankability of the capacity-based model in this quadrant is evidenced by infrastructure-grade investor participation. Connected Energy (UK), which integrates retired EV packs into containerised systems and operates them under long-term service arrangements, secured a £15 million round in 2022 from investors including the infrastructure asset manager Macquarie and the commodity-trading firm Mercuria, and has set out plans for a 20 MW/40 MWh utility-scale system fed by a contracted flow of OEM batteries (Connected Energy, 2022). Internationally, Sumitomo Corporation's reused-EV-battery storage facility at Chitose, Japan, was the first such system on Japan's wide-area extra-high-voltage grid operated by a non-utility, entering the country's supply-and-demand-adjustment and capacity markets (Sumitomo Corporation, 2023). Because Japanese ancillary-market structures differ from European frequency-containment-reserve and capacity-market arrangements, this case is read as proof of concept for the market-participation revenue model rather than a directly transferable template.

### 5.5 Business Model Canvas

Figure 8 synthesises the BMC for Pathway A integrating the problem–solution fit, customer segments, relationship and channel strategies, pricing logic, key operational requirements, partner network, cost structure and revenue streams.

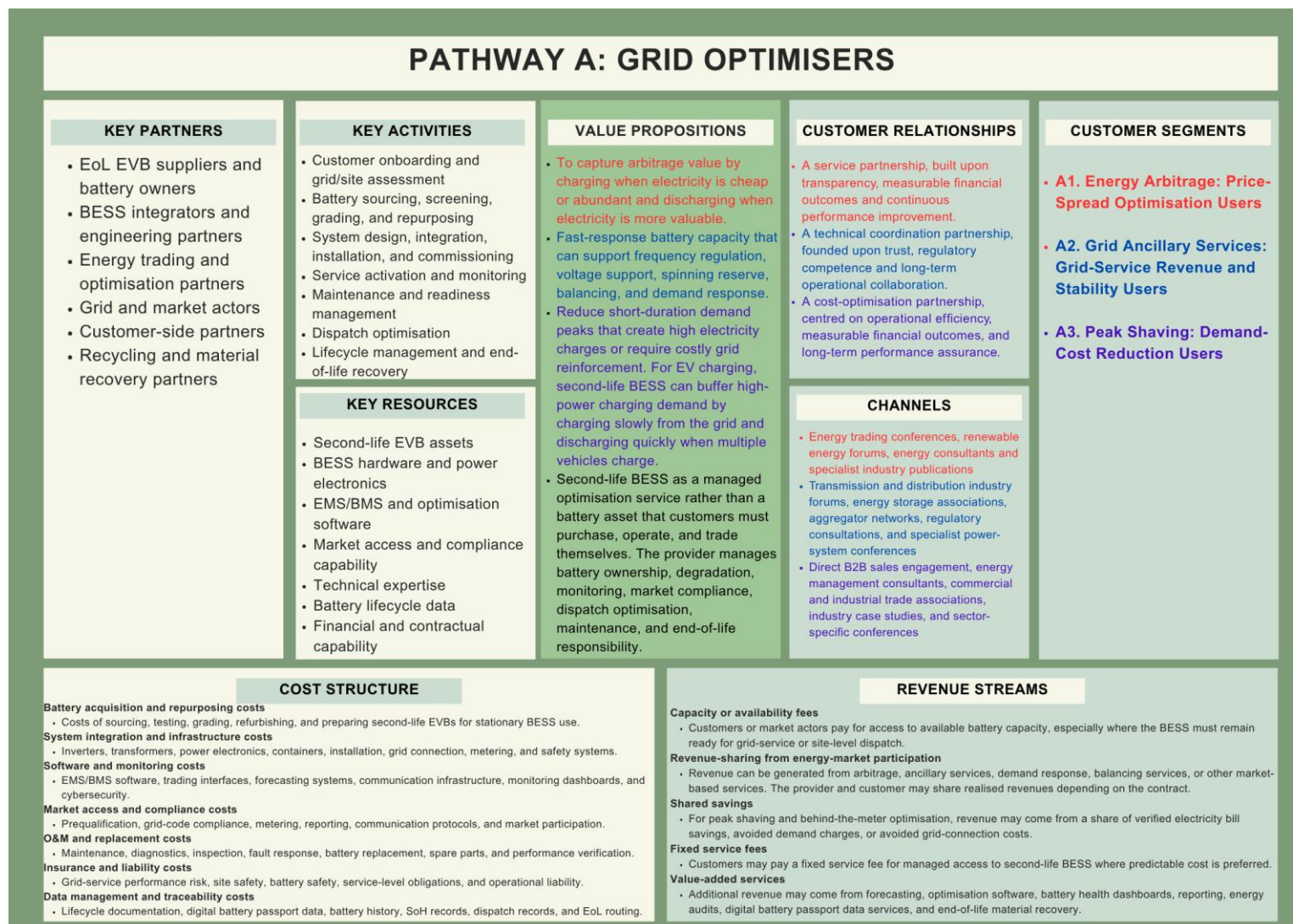


Figure 8. Pathway A – Business Model Canvas

## 6 Pathway B – Grid Independents

**Pathway B: Grid Independents** focuses on energy security, operational continuity, and cost avoidance. In this pathway, batteries are typically installed BTM at commercial, industrial, or critical service sites such as hospitals, data centres, telecom towers, and manufacturing facilities. Their role is to provide instantaneous backup power during grid interruptions, reduce dependence on diesel generators, and support continuous operations where power reliability is essential. Value is therefore created locally, through avoided outages, reduced fuel dependence, lower peak demand charges, and improved use of on-site renewable energy.

### 6.1 Problem definition and unique selling proposition (USP)

This section develops the problem–solution fit and USP for Pathway B. The analysis is organised around the four main value creation mechanisms of Pathway B: B1 Critical Public Infrastructure, B2 Commercial and Digital Infrastructure, B3 Rural/Remote Communities, and B4 Industrial Off-grid Solutions.

#### 6.1.1 Sub-pathway Value Proposition Canvas and Problem–USP fit

As shown in Figure 9, the core customer job for **B1 Critical Public Infrastructure** is to keep essential public services running during grid interruptions by protecting selected critical circuits and loads. The resulting USP is backup power for essential public services through service-managed second-life BaaS.

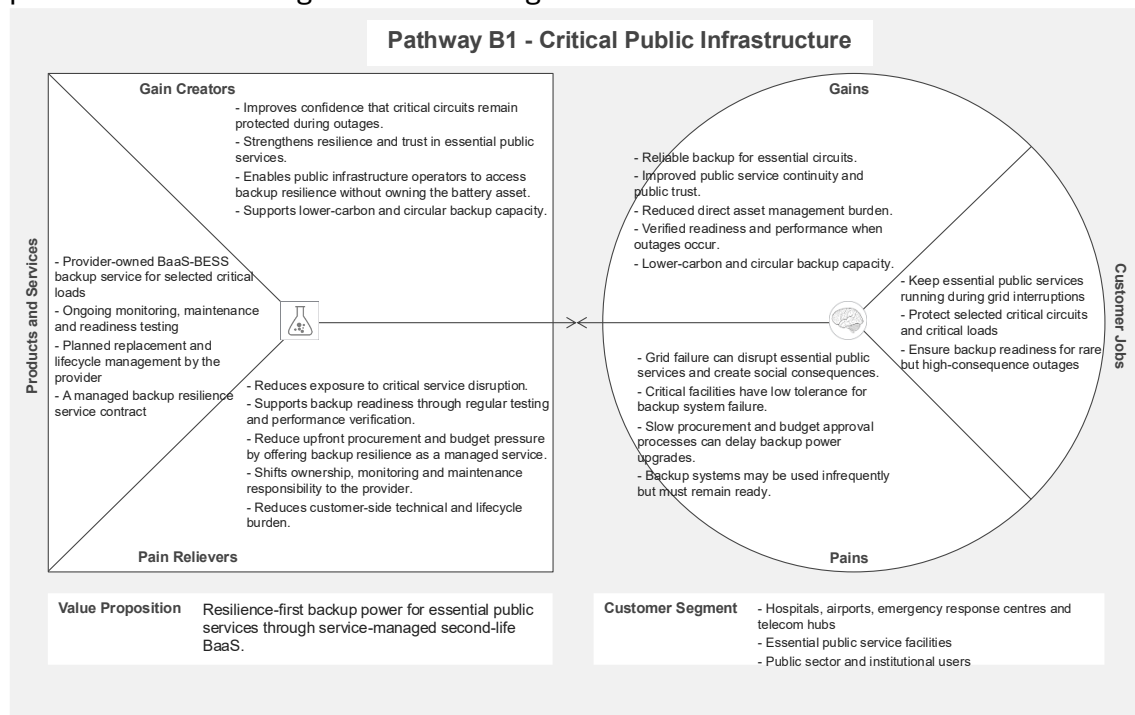


Figure 9. VPC for B1 Critical Public Infrastructure

As presented in Figure 10, **B2 Commercial and Digital Infrastructure** focuses on customers that require uninterrupted operation of critical business and digital systems, such as data centres, IT facilities, server rooms, financial systems and digital communication infrastructure. The resulting USP is reliable zero-downtime backup for critical business and digital systems through UPS-integrated BaaS.

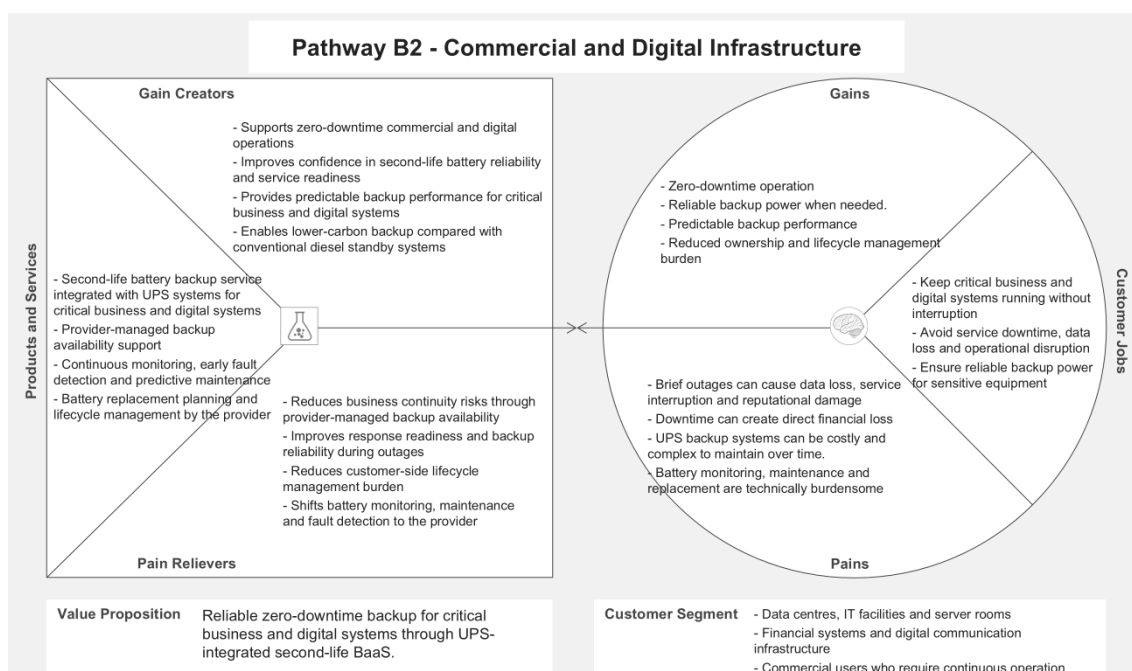


Figure 10. VPC for B2 Commercial and Digital Infrastructure

As shown in Figure 11, the core customer job for **B3 Rural/Remote Communities** is to maintain reliable household and community-level electricity access in weak-grid, remote or isolated areas. These communities need to keep local services such as schools, clinics and water systems running, while improving local energy autonomy and reducing dependence on diesel or unstable grid supply. The resulting USP is community energy resilience and local autonomy through managed second-life battery microgrids.

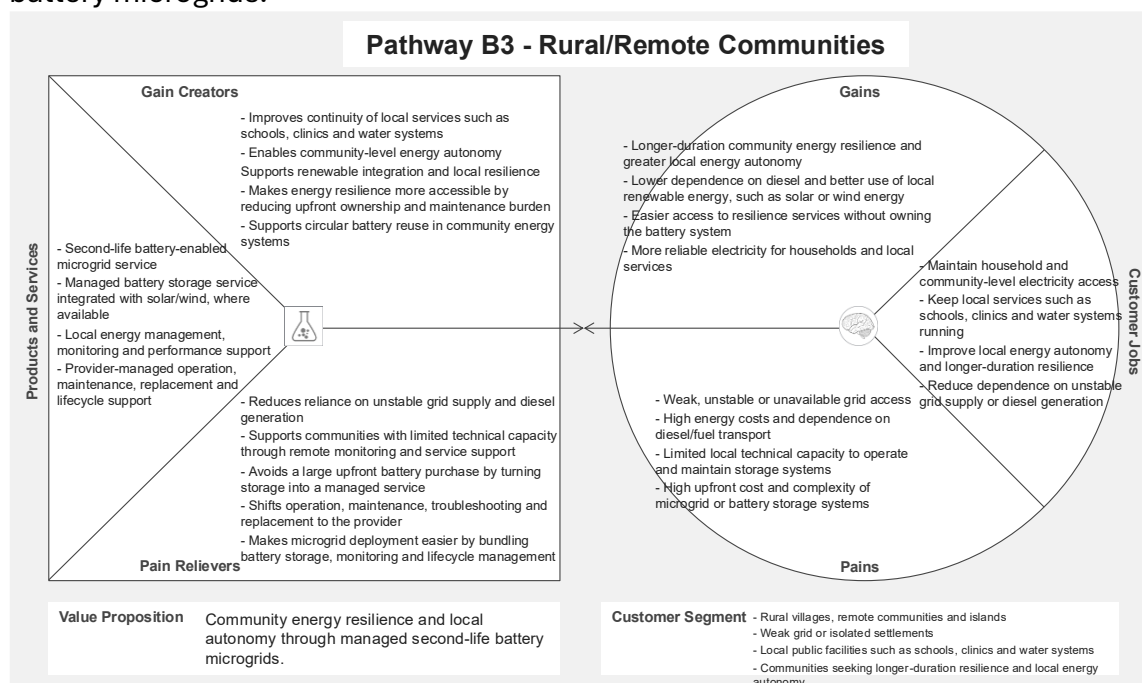


Figure 11. VPC for B3 Rural/Remote Communities

As shown in Figure 12, the core customer job for **B4 Industrial Off-grid Solutions** is to secure reliable 24/7 power for industrial operations where grid access is una-

available, unreliable or too costly. These users need continuous power for remote or weak-grid sites, while reducing dependence on diesel-based or fuel-based power systems. The resulting USP is reliable off-grid power for remote industrial operations through managed second-life battery services.

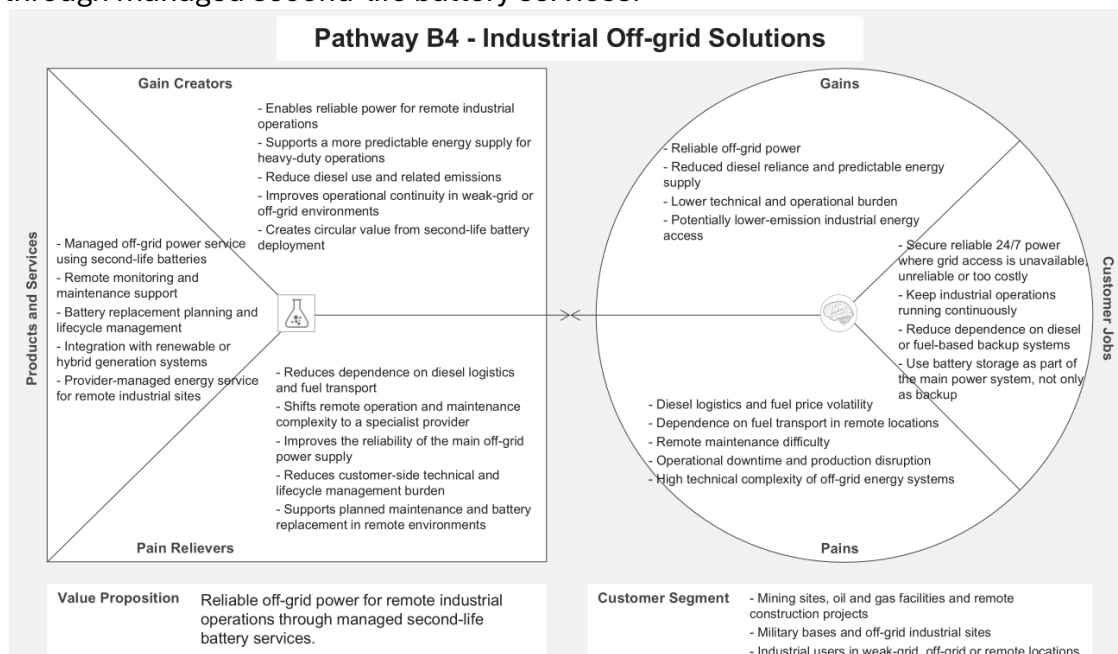


Figure 12. VPC for B4 Industrial Off-grid Solutions

### 6.1.2 Sustainable USP of Pathway B

The four VPC figures in Section 6.1.1 show that Pathway B is unified by the broader objective of energy security and resilience, while each sub-pathway contributes to the sustainable USP of Pathway B in a different way. Table 8. Problem–USP summary for Pathway B sub-pathways shows the USP of each sub-pathway when addressing their core problems.

Table 8. Problem–USP summary for Pathway B sub-pathways

| Sub-pathway                              | Core problem                                                                                                                    | Resulting USP                                                                                                    |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| B1 Critical Public Infrastructure        | Essential public services must continue during grid interruptions, but backup systems must remain highly reliable and ready.    | Resilience-first backup power for essential public services through service-managed second-life BaaS.            |
| B2 Commercial and Digital Infrastructure | Commercial and digital systems cannot tolerate downtime, data loss or service disruption.                                       | Reliable zero-downtime backup for critical business and digital systems through UPS-integrated second-life BaaS. |
| B3 Rural/Remote Communities              | Communities need longer-duration energy resilience, local energy autonomy and reduced dependence on diesel or weak grid supply. | Community energy resilience and local autonomy through managed second-life battery microgrids.                   |
| B4 Industrial Off-grid Solutions         | Remote, weak-grid or off-grid industrial sites require reliable power for continuous operations.                                | Reliable off-grid power for remote industrial operations through managed second-life battery services.           |

Across these four sub-pathways, the sustainable USP of Pathway B is to provide energy security and resilience through circular, service-managed second-life battery systems. Customers are not simply purchasing repurposed batteries; they are accessing reliable power continuity, reduced outage exposure and provider-man-

aged reliability in contexts where energy resilience is critical.

Interpreted through the B2B value hierarchy introduced in Section 2.2, Pathway B meets table-stakes expectations of safety, compliance and technical performance; creates functional value through reliable backup, zero-downtime continuity, microgrid resilience and off-grid power; eases doing business by shifting monitoring, maintenance and lifecycle responsibility to the provider; builds decision-maker confidence; and delivers inspirational value through circular reuse, reduced diesel dependence and community energy resilience.

Economically, Pathway B removes upfront ownership burden and internal lifecycle management costs; environmentally, it extends EVB life and complements renewable integration; socially, it improves power continuity for essential public services, communities and remote operations. Its core value lies in converting battery repurposing into a managed resilience service.

## 6.2 Marketing Approaches: Segmentation, Targeting and Positioning

### 6.2.1 Segmentation and targeting

The market segmentation for Pathway B (Table 9) is based on the primary purpose of the target customer: maintaining reliable electricity access when the grid is unstable, unavailable, or insufficient. These sub-pathways are supported by the following real-world case studies:

For **B1 – Critical Public Infrastructure: Resilience-First Users**, the relevance is illustrated by Heathrow Airport outage in March 2025 showing this vulnerability: a fire at the North Hyde substation caused the airport to close and disrupted flights, passengers, homes, and businesses across the surrounding area. NESO's final review linked the incident to a preventable technical fault associated with moisture entering high-voltage equipment, showing how failures in upstream grid assets can cascade into major disruption for essential infrastructure<sup>5</sup>. In contrast, the [PIONEER](#) project at Rome Fiumicino Airport demonstrates a proactive resilience pathway using second-life EVB. The project integrates a 22 MW solar plant with a 2.5 MW/10 MWh battery energy storage system assembled from more than 750 repurposed EVBs, supporting airport energy needs while advancing circular battery reuse and decarbonisation<sup>6</sup>. Together, the cases illustrate the potential relevance of BaaS-BESS through managed, resilient, and lower-carbon backup capacity without requiring the customer to directly own or manage the battery assets.

For **B2 – Commercial Firms: Continuity-First, Zero-Downtime Users**, the relevance is illustrated by the 2024 Google Cloud outage in Frankfurt, where a power failure and cooling issue caused part of the europe-west3-c zone to shut down, resulting in around 12 hours of degraded services<sup>7</sup>. The incident shows how failures in critical power infrastructure can quickly disrupt cloud and data-centre operations. A corresponding solution can be demonstrated by the Eaton–Nissan collaboration<sup>8</sup>, where a UPS-integrated energy storage system using second-life Nissan LEAF bat-

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<sup>5</sup> Heathrow substation fire 'caused by fault first identified seven years ago' | Heathrow airport | The Guardian

<sup>6</sup> PIONEER: decarbonising airport operations with second-life car batteries - European Climate, Infrastructure and Environment Executive Agency

<sup>7</sup> Google Cloud has 12-hour outage in europe-west3 region

<sup>8</sup> Eaton and Nissan team up for energy storage - DCD

teries was designed for applications such as IT rooms and small data centres. The example illustrates the technical potential for rapid-response backup and reduced diesel dependence.

For **B3 – Rural and Remote Communities: Community Resilience Users**, the relevance is illustrated by the second-life EVB storage system deployed in Melilla, Spain, an isolated energy system that operates independently from the mainland Spanish and Moroccan electricity grids and is therefore vulnerable to supply disruptions and demand fluctuations<sup>9</sup>. To strengthen system resilience, a hybrid backup storage system was implemented at the local thermal power plant, integrating 48 second-life Nissan LEAF batteries alongside new battery units within a grid-connected BESS configuration. This system provides approximately 4 MW of storage capacity and enables short-duration energy dispatch during peak demand or outage events. The BESS functions as a critical flexibility asset by stabilising frequency, mitigating overload risks, and ensuring continuity of electricity supply for around 90,000 residents. By repurposing EVBs that have reached end-of-vehicle-life, the system demonstrates how circular energy solutions can simultaneously address grid reliability and resource efficiency. This case provides a representative example of how second-life EVB can be integrated into existing energy infrastructure to support system balancing, reduce reliance on conventional backup generation, and enable more flexible and resilient electricity systems in constrained contexts.

For **B4 – Industrial Firms Operating in Rural or Remote Areas: Off-Grid Power Users**, the relevance is well illustrated by the Eaton microgrid deployed at its manufacturing facility in Wadeville, South Africa, a context characterised by unreliable grid supply, frequent load-shedding, and high operational risk for industrial users<sup>10</sup>. To address these challenges, the facility implemented a hybrid microgrid integrating rooftop solar PV, a BESS, and backup generation within a controllable local energy system. A key feature of the system is the use of second-life Nissan LEAF batteries, which are repurposed into the storage component and enable the system to store renewable generation, stabilise supply, and provide energy during interruptions. The battery system functions as a core component of the site's electricity infrastructure, allowing the facility to operate autonomously in the event of grid outages and significantly reducing dependence on diesel-based backup generation. This configuration demonstrates how an industrial facility operating under weak-grid or quasi off-grid conditions can move beyond reliance on conventional fossil-based supply and instead depend on a microgrid architecture tailored to its operational needs. Reported outcomes include substantial reductions in electricity costs, improved system uptime, and lower fuel consumption, highlighting the economic and operational value of integrating second-life EVB into industrial energy systems. The case supports the logic of B4 by showing that the primary value proposition lies in ensuring continuous electricity supply and operational reliability for industrial users, rather than in revenue optimisation or participation in wider energy markets.

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<sup>9</sup> [Enel + Nissan LEAF second life battery storage project goes online](#)

<sup>10</sup> [Nissan partners with Enel to launch innovative “Second Life” storage system for used electric car batteries](#)

Table 9. Pathway B Segmentation and Targeting

| Segment                                                        | Description                                                                                                                                                                                                                           | Use Case Example                                                                                                                                       | Key Characteristics                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                           |                                                                                                                           |                                                                                                                                                                                  |                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                |                                                                                                                                                                                                                                       |                                                                                                                                                        | Energy Role                                                                                                                                                                                                                                         | Customer Profile                                                                                                                                                                                                                                          | Operating Context                                                                                                         | Key Value and Economic Focus                                                                                                                                                     | Procurement Complexity                                                                                                                                                                                                                                 |
| <b>B1. Critical Public Infrastructure (Resilience-first)</b>   | Backup power for large public service buildings. The purpose of BESS is not to power the entire facility, but to ensure that the most essential, pre-selected circuits remain operational during outages.                             | The PIONEER project at Rome Fiumicino Airport                                                                                                          | <b>Energy role:</b> Backup power for essential loads.<br><b>Coverage:</b> Selected critical functions or areas for short-duration, intermittent, prolonged, or unpredictable outages.                                                               | <b>Customer profile:</b> Public-sector and large institutional users such as airports, hospitals, telecom towers, and emergency response centres.<br><b>Scale:</b> Medium to large organisations; scale-up or enterprise-level users.                     | Grid-unstable regions or high-intensity public-service environments requiring uninterrupted essential operations.         | <b>Key value:</b> Public resilience and failure mitigation. <b>Economic focus:</b> Social continuity, public service protection, and avoided disruption to society.              | <b>Procurement complexity:</b> Very high due to public procurement, safety requirements, and long approval cycles.<br><br>Low-frequency, long-cycle purchase; relatively price-insensitive because service continuity is critical.                     |
| <b>B2. Commercial firms (Continuity-first, zero tolerance)</b> | UPS-type power solution that maintains continuous electricity during outages, voltage spikes, or voltage drops. The focus is instantaneous and seamless backup for business-critical systems.                                         | Eaton–Nissan collaboration, where a UPS-BESS using second-life Nissan LEAF batteries was suitable for IT rooms and small data centres                  | <b>Energy role:</b> UPS and power stabilisation. <b>Coverage:</b> Selected essential systems for short-duration outages or power quality disturbances.                                                                                              | <b>Customer profile:</b> Private-sector organisations such as data centres, IT facilities, financial systems, server rooms, and digital communication infrastructure.<br><b>Scale:</b> Medium to large organisations; scale-up or enterprise-level users. | High-intensity commercial environments where uninterrupted digital or technical operations are required.                  | <b>Key value:</b> Operational continuity and failure prevention.<br><b>Economic focus:</b> Revenue protection, service uptime, data protection, and reputational risk reduction. | <b>Procurement complexity:</b> Medium to high due to technical integration and service-level requirements.<br><br>Long-cycle purchase due to less frequent replacement, but cost-sensitive because lifecycle battery cost and uptime guarantee matter. |
| <b>B3. Rural/Remote communities</b>                            | Full-facility or isolated-system and community energy resilience. The application is often based on solar/wind/turbine-powered microgrids that charge batteries during generation periods and provide longer-term electricity access. | Second-life EV BESS deployed in Melilla, Spain, an isolated energy system operating independently from mainland Spanish and Moroccan electricity grids | <b>Energy role:</b> Core community energy supply and resilience support. <b>Coverage:</b> All essential community functions over longer periods, including households, public buildings, lighting, water systems, and communication infrastructure. | <b>Customer profile:</b> Rural villages, remote communities, indigenous communities, islands, and off-grid or weak-grid settlements. <b>Scale:</b> Small to medium communities; local community or household-level users.                                 | Rural, remote, islanded, or weak-grid locations where grid connection is unavailable, unstable, or difficult to maintain. | <b>Key value:</b> Energy access and community resilience. <b>Economic focus:</b> Affordability, reduced diesel dependence, and long-term access to reliable electricity.         | <b>Procurement complexity:</b> Medium, often involving local government, public-private partnerships, or community-level financing. Bulk or need-based purchasing; price-sensitive due to limited community budgets.                                   |
| <b>B4. Industrial firms operating in rural/remote areas</b>    | Industrial off-grid solution where the second-life battery is a central component of the site's electric-                                                                                                                             | Eaton microgrid deployed at its manufacturing facility in Wadeville,                                                                                   | <b>Energy role:</b> Core operational power supply.<br><b>Coverage:</b> All operational functions on a permanent                                                                                                                                     | <b>Customer profile:</b> Industrial users such as mining sites, oil and gas facilities, remote construction pro-                                                                                                                                          | Rural, remote, weak-grid, or quasi off-grid industrial locations where                                                    | <b>Key value:</b> Operational reliability and energy autonomy.<br><b>Economic focus:</b>                                                                                         | <b>Procurement complexity:</b> High due to system sizing, technical integration, reliability requirements, and                                                                                                                                         |



ity system. It is typically combined with renewables and sometimes diesel generators to provide stable power for operations.

South Africa

or near-permanent basis, supporting 24/7 site operation.

jects, military bases, and off-grid industrial facilities.  
**Scale:** Medium to large industrial users; startup, scale-up, or enterprise-level operations.

grid connection is unavailable, impractical, unreliable, or too costly.

Productivity, uptime, reduced diesel use, and avoided operational disruption.

long-term service contracts. Need-based but high-intensity purchasing; relatively price-insensitive where power reliability directly affects productivity.

### 6.2.2 Positioning and customer relationship

- **B1 – Critical Public Infrastructure**

This segment is characterised by resilience requirements, risk aversion, and mission-critical operational responsibilities. A central question for organisations within this segment is therefore likely to be: *“How can critical public services be maintained without interruption during power outages or energy disruptions?”* Consequently, a problem–solution positioning strategy that emphasises the mitigation of infrastructure vulnerability and the prevention of critical service disruption is highly relevant.

Customers within this segment are therefore likely to value dedicated account management, regular and transparent communication, and sustained long-term engagement. In addition, robust risk management arrangements, for instance, clearly defined emergency support protocols and responsive technical assistance, are typically regarded as essential components of the service offering. Accordingly, the most appropriate customer relationship approach for this segment can be characterised as a strategic institutional partnership, built upon reliability, accountability, and long-term operational trust.

- **B2 – Commercial Firms**

Different from the previous segment, commercial firms are primarily ROI-driven, operationally focused and highly sensitive to performance efficiency. A central concern for organisations within this segment is likely to be: *“How can costly downtime be minimised while maintaining seamless business operations?”* In response to this priority, a benefit-driven positioning strategy is particularly appropriate, as it enables providers to emphasise operational continuity, efficiency, and the reduction of business interruption risks.

Customers within this segment are therefore likely to value high-quality service management, rapid technical responsiveness, and proactive maintenance programmes that minimise operational disruption. Furthermore, the integration of real-time monitoring dashboards and performance analytics can significantly enhance perceived value by improving transparency, operational oversight, and decision-making capability. Collectively, these elements support the development of a performance-based partnership model, in which customer relationships are built around measurable outcomes, responsiveness, and operational reliability.

- **B3 – Rural / Remote Communities**

This segment is closely associated with social development, sustainability, and community self-reliance. Organisations and stakeholders within this segment are typically concerned with questions such as: *“How can affordable, reliable and sustainable energy access be achieved for the community?”* In this context, aspirational positioning represents a particularly effective strategy, as it emphasises the broader social outcome of empowering communities through sustainable energy independence and long-term resilience.

Customers within this segment are also likely to place significant value on strong local relationships and community engagement. Trust can therefore be developed more effectively through participatory approaches, including community training initiatives, financing support schemes, co-development activities, and other forms of inclusive engagement. As a result, the most suitable customer relationship approach for this segment is a community-centred collaborative partnership,

grounded in trust-building, inclusivity, and long-term social commitment.

- **B4 – Industrial Firms in Remote Areas**

This segment is primarily concerned with addressing challenges associated with off-grid reliability, fuel dependency, and unstable remote power systems. Compared with the other Pathway B segments, it is typically more technically sophisticated, productivity-driven, and engineering-oriented. A representative concern for organisations within this segment is likely to be: *“How can continuous industrial-scale off-grid power be maintained reliably and efficiently?”* Accordingly, a problem–solution positioning strategy is particularly appropriate, as it directly addresses operational vulnerabilities and infrastructure reliability challenges.

Customers within this segment are likely to place strong emphasis on engineering credibility, technical competence, and operational reliability. They are also expected to value ongoing technical consultation, specialist support services, and regular engineering-focused engagement meetings that facilitate performance optimisation and risk mitigation. Given the long-term and infrastructure-intensive nature of this segment, the most suitable customer relationship approach can be characterised as an industrial infrastructure partnership, built upon technical trust, long-term operational support, and collaborative problem-solving.

## 6.3 Channels

- **B1 – Critical Public Infrastructure**

The channels selected for this segment should reinforce institutional credibility, public trust, and perceptions of operational resilience. Effective channels for engaging customers within this segment are therefore likely to include government procurement systems, public infrastructure frameworks, policy forums, sector-specific programmes, and professional conferences or institutional engagement platforms. These channels facilitate access to decision-makers and strengthen legitimacy, compliance, and long-term strategic alignment with public sector priorities.

- **B2 – Commercial Firms**

As the preferred relationship approach for this segment is centred on a performance-based partnership model, with particular emphasis placed on operational efficiency, return on investment (ROI), and technical reliability, the selected channels should reinforce these priorities. Accordingly, the most suitable channels are likely to include direct B2B sales engagement, sector-specific consultants, technical and industry-focused events, industry case studies, and professional social media platforms such as LinkedIn thought leadership activities. Communication through these channels can strengthen the positioning of the provider as a credible and results-oriented solution partner capable of enhancing operational performance, minimising downtime, and delivering measurable business value.

- **B3 – Rural / Remote Communities**

To support a community-centred customer relationship approach focused on sustainability, inclusiveness, and energy independence, the marketing channels selected for this segment should reinforce perceptions of accessibility, social legitimacy, and community engagement. Appropriate channels are therefore likely to include NGOs, local authorities, community energy initiatives, sustainability programmes and regional development agencies. Engagement through these channels can strengthen trust and local participation, while also positioning the provider as a

socially responsible and community-oriented partner committed to long-term regional development and sustainable energy access.

- **B4 – Industrial Firms in Remote Areas**

To align with the industrial infrastructure partnership approach, which emphasises technical competence, engineering credibility, and operational reliability, the channels selected for this segment should reinforce perceptions of engineering capability, system robustness, and long-term industrial performance. Appropriate channels are therefore likely to include collaboration with energy consultants, renewable energy integration partners, industrial engineering networks, specialist industry forums, and industrial decarbonisation initiatives.

## 6.4 Pricing strategy

**In Quadrant: distributed x customer-facing** (Table 1), Pathway B comprises behind-the-meter systems serving critical public infrastructure (B1), commercial and digital infrastructure (B2), rural and remote communities (B3) and industrial off-grid users (B4). Value is realised locally through avoided outages, reduced diesel dependence, lower peak-demand charges and improved on-site renewable self-consumption without direct exposure to wholesale markets.

### 6.4.1 Primary mechanism – shared-savings pricing

The primary mechanism is the shared-savings agreement, a long-established energy performance contracting model in which the provider finances, installs and operates the system at little or no upfront cost to the host and is paid a pre-determined share of verified savings (IEA, 2018; U.S. Department of Energy, 2024). In the storage context the battery reduces peak-demand (capacity) charges and increases on-site photovoltaic self-consumption; commercial deployments of this exact structure are documented, in which the host takes little or no risk while the provider retains a share of the utility-bill savings and any market revenues in return for installing, maintaining and operating the system (Peak Power Energy, 2024). The principal risk is tariff volatility: the value of peak-demand savings depends on prevailing distribution-network tariffs, which can be revised over a multi-year contract. The handbook's analysis is that bankable contracts must therefore include dynamic pass-through clauses that adjust the savings calculation in line with published tariff revisions, or a minimum guarantee fee providing a revenue floor; the model is intrinsically performance-aligned, since the operator is paid only on delivered savings related to a pre-installation measurement-and-verification (M&V) baseline.

### 6.4.2 Secondary mechanism – fixed-fee HaaS equipment lease

A secondary mechanism is required for large, creditworthy clients that demand absolute operating-expenditure predictability and reject variable revenue sharing. For these, the operator substitutes the variable savings share with a flat monthly HaaS equipment-provision fee, forgoing savings upside in exchange for guaranteed cash flow. The handbook's analysis is that, even under a fixed fee, the operator should guarantee a minimum system uptime (commonly around 99%), with technical failure triggering automated rebates, so that hardware risk remains with the operator.

### 6.4.3 Calibration baseline, risk mitigation and a binding supply-side caveat

Shared-savings pricing is calibrated on pre-installation M&V energy audits; the dominant operating cost is analytical – continuous M&V to reconcile dispatch data against the host's utility bills and tariffs. A material caveat must be stated. The

shared-savings economics assume a supply of genuine post-automotive second-life modules at cost points materially below new cells. The strongest European Pathway B operator, Voltfang, which repurposes EVB into stationary systems and serves clients including Aldi Nord, Alba Group, Fiege Logistik and Goldbeck, raised a €15 million Series B in 2025 and opened a 6,000 m<sup>2</sup> Aachen facility scalable to 1 GWh (Siemer, 2025; Voltfang, 2025). However, its co-founder has stated publicly that genuine second-life modules are very difficult to obtain in sufficient quantity, forcing the company to rely substantially on unused automotive surplus ('new-life') modules, which are a different product category and do not carry the same cost discount (Murray, 2025). Pathway B pricing should therefore be stress-tested against an input-cost scenario in which the second-life discount is materially smaller than assumed – a parameter for subsequent dynamic financial modelling.

## 6.5 Business Model Canvas

Figure 13 synthesises the BMC for Pathway B integrating the problem–solution fit, customer segments, relationship and channel strategies, pricing logic, key operational requirements, partner network, cost structure and revenue streams discussed in the previous sections.

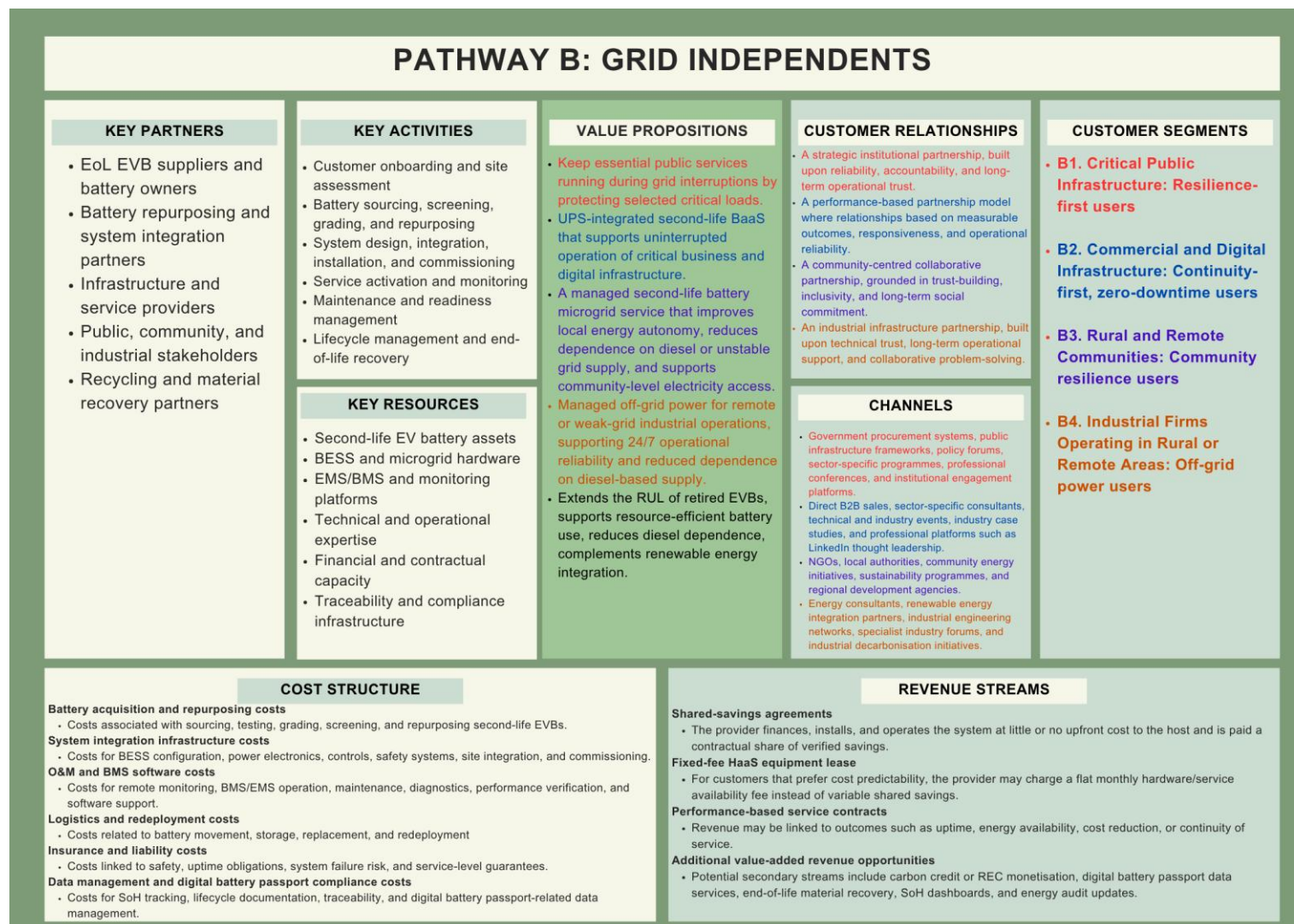


Figure 13. Pathway B – Business Model Canvas

## 7 Pathway C – Mobile Power Users

**Pathway C: Mobile Power Users** focuses on bringing energy to locations where permanent power infrastructure is unavailable, unsuitable, delayed, or only needed for a limited period. In this pathway, batteries are typically configured as modular, transportable BESS units, such as power carts, battery trailers, mobile charging units, or portable power stations. Their role is to replace or supplement diesel and petrol generators for construction sites, events, filming locations, emergency response, field operations, camping, recreational vehicles, and off-grid travel. Value is therefore created through mobility, flexibility, quiet operation, reduced fumes, lower fuel dependence, and rapid access to temporary power.

### 7.1 Problem definition and unique selling proposition (USP)

This section develops the problem–solution fit and USP for Pathway C. Building on the pathway overview above, the VPC analysis is organised around the three main customer groups: C1 Professional and Commercial Users, C2 Emergency and Institutional Users, and C3 Recreational Vehicles, Off-grid Living and Expedition Travel.

#### 7.1.1 Sub-pathway Value Proposition Canvas and Problem–USP fit

As shown in Figure 14, the core customer job for **C1 Professional and Commercial Users** is to access reliable portable power for temporary worksites, filming, events and mobile commercial activities where grid power is unavailable, not connected or unsuitable. The resulting USP is clean and flexible temporary power for professional worksites and events through portable second-life battery services.

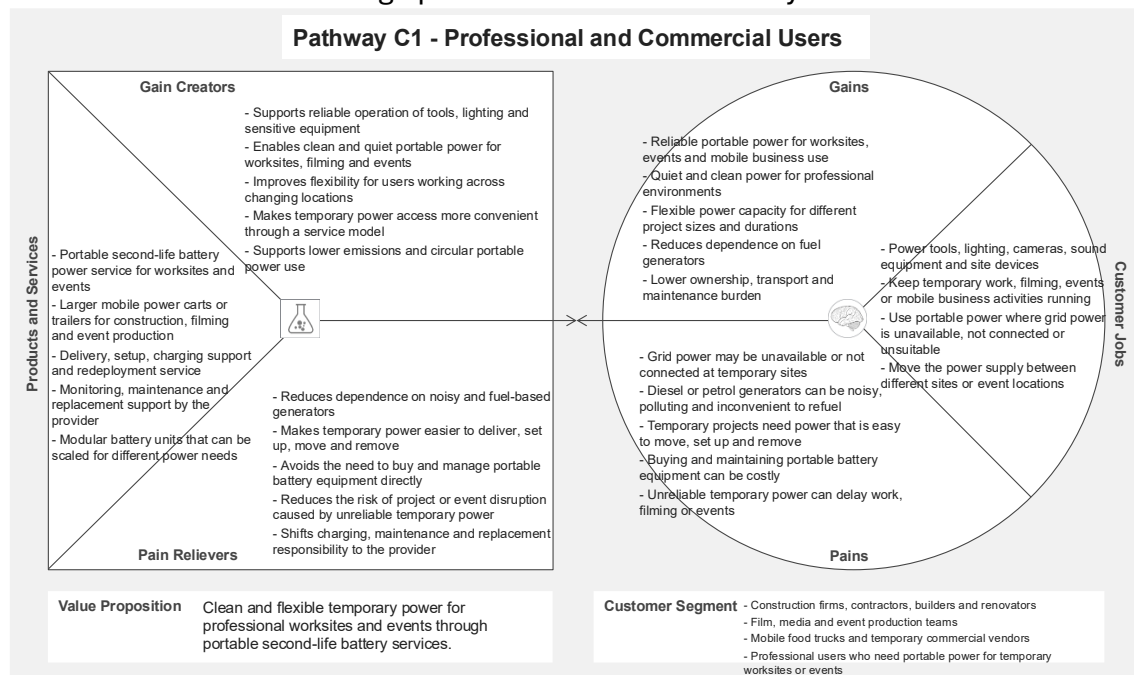


Figure 14. VPC for C1 Professional and Commercial Users

As presented in Figure 15, the core customer job for **C2 Emergency and Institutional Users** is to access reliable portable power quickly during emergencies, disaster response or field operations. The resulting USP is ready-to-deploy emergency power for critical operations through portable second-life battery services.

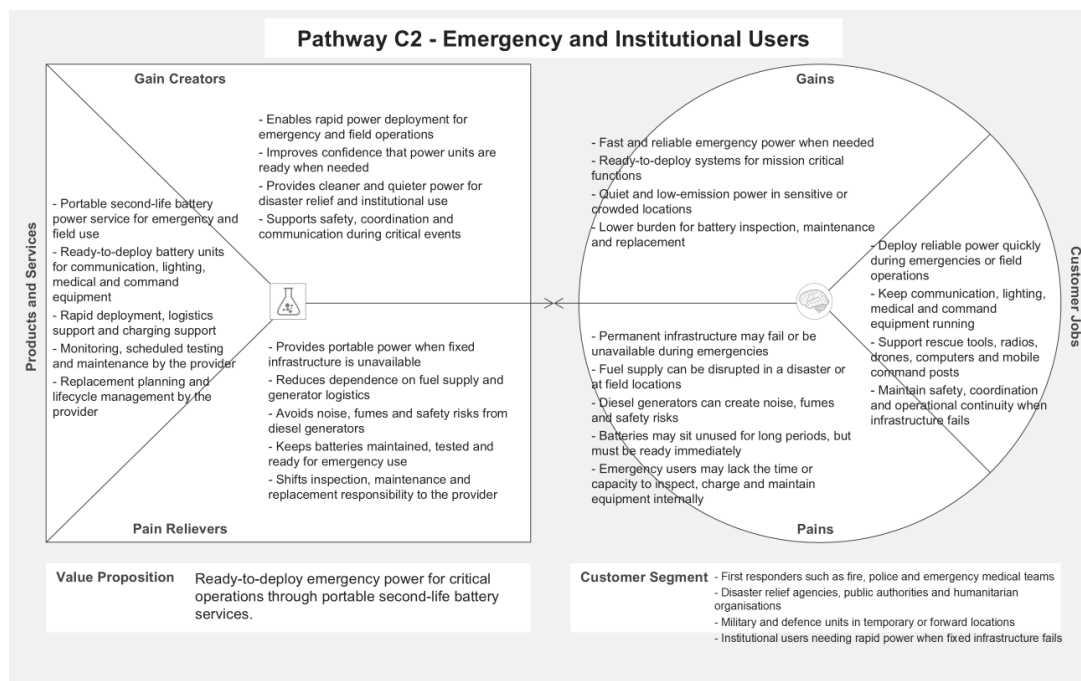


Figure 15. VPC for C2 Emergency and Institutional Users

As shown in Figure 16, **C3 Recreational Vehicles, Off-grid Living and Expedition Travel** is to access quiet, convenient and reliable mobile power during camping, boating, expedition travel or off-grid living, these users need to keep daily living equipment, such as lights, fridges, phones, laptops, water pumps and small appliances, running where grid or charging access is limited. The resulting USP is quiet and convenient mobile power for off-grid travel and living through portable second-life battery services.

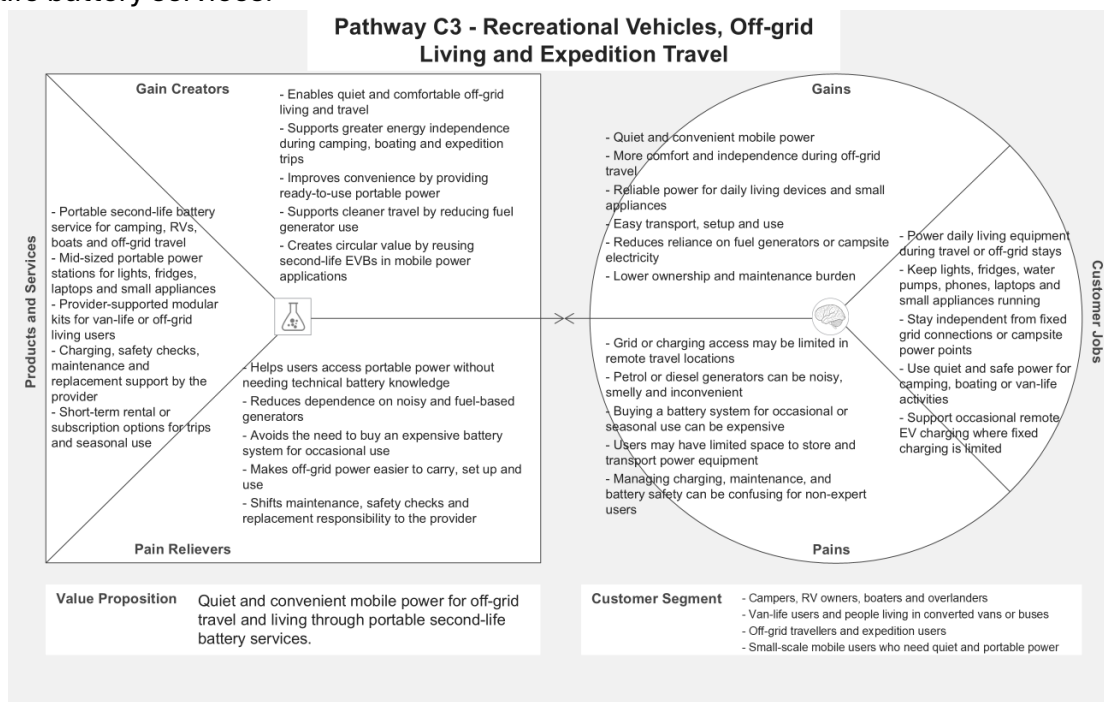


Figure 16. VPC for C3 Recreational Vehicles, Off-grid Living and Expedition Travel

### 7.1.2 Sustainable USP of Pathway C

The three VPC figures in Section 7.1.1 collectively show that Pathway C centres on the provision of portable, clean and reliable electricity for temporary, mobile and off-grid settings. While the three sub-pathways share this common pathway logic, they address different usage contexts and customer needs. Table 10 shows the USP of each sub-pathway when addressing their core problems.

*Table 10. Problem–USP summary for Pathway C sub-pathways*

| Sub-pathway                                                     | Core problem                                                                                                                                   | Resulting USP                                                                                                           |
|-----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| C1 Professional and Commercial Users                            | Temporary worksites, events and mobile commercial activities need reliable power where grid access is unavailable, unsuitable or inconvenient. | Clean and flexible temporary power for professional worksites and events through portable second-life battery services. |
| C2 Emergency and Institutional Users                            | Emergency and field operations need rapidly deployable power when fixed infrastructure fails or is unavailable.                                | Ready-to-deploy emergency power for mission-critical operations through portable second-life battery services.          |
| C3 Recreational Vehicles, Off-grid Living and Expedition Travel | Mobile lifestyle users need quiet, convenient and reliable power for off-grid travel, leisure and living.                                      | Quiet and convenient mobile power for off-grid travel and living through portable second-life battery services.         |

The sustainable USP of Pathway C is therefore to deliver silent, fume-free and reliable portable power through service-managed second-life battery systems. Instead of purchasing portable batteries outright, customers gain access to flexible power availability, reduced ownership burden and provider-supported reliability across temporary, mobile, emergency and off-grid applications. Compared with traditional diesel or petrol generators, second-life battery solutions can reduce noise, fumes, fuel dependence and emissions while enabling operations in remote, temporary or challenging contexts.

Interpreted through the value hierarchy introduced in Section 2.2.1, C1 and C2 follow the B2B logic of table-stakes safety and readiness, functional temporary and emergency power, reduced customer burden and confidence value, while C3 aligns with B2C elements of convenience, reduced anxiety, greater independence and cleaner travel through circular reuse of retired EVBs.

Economically, Pathway C avoids outright purchase costs and reduces fuel-related operating costs; environmentally, it extends EVB life and displaces diesel or petrol generation; socially, it improves access to safe, quiet and reliable power across worksites, emergency response and off-grid living. Its core value lies in turning battery reuse into a flexible, service-managed portable power solution.

## 7.2 Marketing Approaches: Segmentation, Targeting and Positioning

### 7.2.1 Segmentation and targeting

The market segmentation for Pathway C (Table 11) is based on the primary purpose of the target customer: accessing portable, clean, and reliable electricity in temporary, mobile, or off-grid operating environments. These sub-pathways are supported by real-world cases and illustrative evidence:

For **C1 – Professional and Commercial Users: Mobile Worksite and Temporary Power Users**, the relevance is illustrated by Zenobē’s second-life battery de-

ploysments for construction and temporary power applications. Zenobē partnered with Select, a subsidiary of Laing O'Rourke, to supply 20 portable battery units made from refurbished electric bus batteries for use as temporary power sources on construction sites<sup>11,12</sup>. Each unit can store approximately 150 kWh of energy and can be used across applications such as construction power, lifting solutions, and electric vehicle charging, providing a cleaner alternative to diesel generators. The BaaS logic is clear: Zenobē emphasises flexible funding and technical support, allowing customers to access the technology and sustainability benefits without taking direct ownership of the battery assets. The same logic also applies to film, media, and event production. Zenobē's PowerSkid is a second-life BESS with continuous power output of up to 160 kW depending on configuration, designed for mobile and off-grid applications including building sites, festivals, events, filming locations, and off-grid EV charging stations<sup>13</sup>. The system was used to support Massive Attack's ACT 1.5 event, where second-life battery modules repurposed from electric trucks and buses provided emission-free and noise-free power on location.

For **C2 – Emergency and Institutional Users: Rapid Deployment and Mission-Critical Users**, the relevance is illustrated by an Atlas Public Policy report<sup>14</sup>. A mobile charging system supports the emergency services and disaster relief sub-segment because it demonstrates how second-life EVBs can be repurposed into compact, transportable power units. In disaster settings, where fuel supply chains may be disrupted and generator operation may be constrained by noise, fumes, or safety risks, portable battery systems provide instant deployment, low operational complexity, and emission-free electricity. Atlas Public Policy Report also identifies second-life EVBs in mobile charging systems as relevant for remote, disaster-stricken, and defence-related locations, including remote parks and military forward bases where grid extension may be costly or impractical.

For **C3 – Recreational Vehicles, Off-Grid Living, and Expedition Travel: Mobile Lifestyle and Energy Independence Users**, the relevance is illustrated by the Nissan x OPUS concept camper, which integrates Nissan Energy ROAM, a portable and weatherproof power pack using lithium-ion cells recovered from first-generation Nissan electric vehicles<sup>15</sup>. The unit provides 700 Wh of storage capacity and 1 kW of power output and supports both 230V and 12V circuits. Mounted in a compartment at the front of the OPUS camper, it can support off-grid camping power for around seven days with assistance from a solar panel accessory. The system enables campers to use lighting, refrigeration, small appliances, device charging, and other comfort-related functions without relying on fossil-fuel generators. This addresses the key recreational-user requirements of quiet operation, reduced fumes, environmental protection, and convenience. The case also shows how second-life EVB can support new business opportunities beyond conventional stationary storage. By integrating recovered EVB cells into a portable power pack for camping and leisure, Nissan demonstrates that second-life batteries can be adapted into modular products for mobility-oriented users. This reinforces the logic of C3 by showing that the primary value proposition lies in enabling off-grid energy independence and mobile convenience, rather than backup resilience or industrial productivity.

<sup>11</sup> [Zenobē to supply old bus batteries to Select for 2nd Life usage - electrive.com](#)

<sup>12</sup> [Zenobe to make use of second-life batteries - routeone](#)

<sup>13</sup> [Zenobe uses Dumarey Green Power 2nd life batteries for Revolutionary Massive Attack gig - Dumarey - Group](#)

<sup>14</sup> [Second-Life Electric Vehicle Batteries in Mobile Charging Systems](#)

<sup>15</sup> [Nissan x OPUS concept camper uses second-life EV batteries to power 'off-grid' adventures](#)

Table 11. Pathway C Segmentation and Targeting

| Segment                                                                    | Description                                                                                                                                                                                                                                                                                                                                                                              | Use Case Example                                                                                                                                                             | Key Characteristics                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                            |                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                              | Energy Role                                                                                                                                                                                                                                                                                                                                                                                                                       | Customer Profile                                                                                                                                                                                                                                                                                                                                                                                              | Operating Context                                                                                                                                                                                                                                                 | Key Value and Economic Focus                                                                                                                                                                                                                                       | Procurement Complexity                                                                                                                                                                                                                                                                                                 |
| <b>C1. Professional &amp; Commercial Users</b>                             | Portable battery storage can be used in construction, trade jobs, film, media, and event production. It can run power tools such as saws, drills, grinders, compressors, lighting towers, and cordless tool charging stations before utility power is connected. It can also power sensitive cameras, sound recording equipment, lighting, speakers, amplifiers, and kitchen appliances. | Zenobē–Select / Laing O'Rourke portable second-life battery units; Zenobē PowerSkid for building sites, festivals, events, and filming locations.                            | <b>Energy role:</b> Temporary worksite and event power.<br><b>Coverage:</b> Powers all relevant functions or areas for a defined project or event period. Usage varies from hours for small jobs and events to days, weeks, months, or longer construction projects. Modular or stackable units can support varying power demands, such as smaller units for lighting and larger configurations for machinery or event equipment. | <b>Customer profile:</b> Private-sector professional and commercial users, including contractors, builders, renovators, mobile welders, landscape architects, film crews, documentary makers, wedding photographers/videographers, concert organisers, and mobile food truck operators.<br><b>Scale:</b> Small trade jobs and events to large construction or event sites; startup to enterprise-level users. | Temporary, mobile, or project-based sites where grid power is unavailable, not yet connected, constrained, or unsuitable due to noise, fumes, fuel logistics, or power quality requirements. The location is variable and depends on project or event deployment. | <b>Key value:</b> Mobile productivity and clean temporary power. <b>Economic focus:</b> Reducing diesel use, lowering fuel logistics, enabling quiet operation, supporting indoor use, and improving project sustainability without sacrificing operational power. | <b>Procurement complexity:</b> Low to medium, depending on site size, power rating, and project duration.<br><br>Project-based and relatively short buying cycle due to intense but temporary use. Customers are price-sensitive and often prefer rental, subscription, or service-based access rather than ownership. |
| <b>C2. Emergency &amp; Institutional Users</b>                             | Portable battery systems can provide rapidly deployable power during emergencies, disaster response and field operations where grid infrastructure is unavailable, damaged or unreliable. Applications include emergency lighting, communications equipment, medical devices, rescue-tool charging, drones, surveillance systems and mobile command facilities.                          | Illustrative mobile charging and emergency power applications are discussed in the Atlas Public Policy report on second-life EVBs in remote and disaster-stricken locations. | Rapidly deployable emergency and mission-critical power. Systems may support selected critical functions for periods ranging from several hours to multiple days or weeks.                                                                                                                                                                                                                                                        | <u>Sector:</u> Public sector<br><u>Size:</u> Large organisations<br><u>Stage:</u> Scale-up or enterprise                                                                                                                                                                                                                                                                                                      | Disaster zones, temporary field facilities, remote locations, damaged-grid environments and emergency response settings where fuel logistics, noise, fumes or generator availability create operational constraints.                                              | Readiness, rapid deployment, safe and quiet operation, and reduced fuel-logistics dependence. Economic value is primarily associated with avoided disruption and improved emergency response capability rather than routine electricity cost savings.              | Public organisations who have short buying cycle length due to the intense use<br><br>Price sensitivity                                                                                                                                                                                                                |
| <b>C3. Recreational Vehicles (RVs), Off-Grid Living, Expedition Travel</b> | Portable plug-and-play battery systems can provide auxiliary and living power for recreational vehicles, campsites, boats, expedition travel and off-grid accommodation. They can support lighting, refrigeration, device charging, water pumps, laptops and small appliances where fixed grid or charging infrastructure is limited.                                                    | The Nissan x OPUS concept camper integrates the Nissan Energy ROAM portable power pack made from recovered EV battery cells.                                                 | Portable auxiliary and off-grid living power for periods ranging from several hours to multiple days or weeks.                                                                                                                                                                                                                                                                                                                    | <u>Sector:</u> Private sector<br><u>Size:</u> SMEs, local communities, off-grid household size.<br><u>Stage:</u> small and medium enterprises or households/individuals                                                                                                                                                                                                                                       | Campsites, remote travel routes, recreational sites, boats, off-grid properties and locations where grid access is unavailable, inconvenient or environmentally undesirable.                                                                                      | Convenience, quiet operation, reduced fumes, energy independence and compatibility with renewable charging. Economic value arises from avoiding generator fuel and maintenance costs while improving user comfort and mobility.                                    | Local firms, consumers with low, bulk or need-based buying frequency.<br><br>Price sensitivity                                                                                                                                                                                                                         |

### 7.2.2 Positioning and customer relationship

- **C1 – Professional and Commercial Users**

This segment is primarily driven by operational flexibility, project delivery, and access to reliable temporary power. Whether operating on construction sites, film locations, event venues, or mobile commercial settings, a representative concern for organisations within this segment is likely to be: *“How can reliable and flexible power be accessed quickly without the cost, complexity, and environmental limitations of conventional generators?”* Consequently, a problem–solution positioning strategy is particularly appropriate.

Transparent rental arrangements, logistics support, and proactive maintenance services can strengthen customer confidence by reducing operational uncertainty. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a project-support partnership, built upon flexibility, responsiveness, and operational reliability.

- **C2 – Emergency and Institutional Users**

A central concern for organisations within this segment is likely to be: *“How can critical operations be supported with reliable power when conventional infrastructure is unavailable or compromised?”* In response to this priority, a problem–solution positioning strategy is particularly appropriate, as it emphasises readiness, resilience, and rapid deployment capability.

Because batteries may remain idle for extended periods before becoming essential during emergency situations, confidence in system readiness is particularly important. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a mission-critical support partnership, founded upon trust, preparedness, accountability, and long-term operational assurance.

- **C3 – Recreational Vehicles, Off-Grid Living, and Expedition Travel**

This segment is closely associated with personal freedom, energy independence, and lifestyle enhancement. Customers within this segment are typically concerned with questions such as: *“How can reliable electricity be accessed anywhere without sacrificing comfort, convenience, or environmental responsibility?”*

Customers within this segment are likely to value convenience, simplicity, and ease of use. Community engagement, user education, and peer recommendations may also play an important role in building trust and encouraging adoption. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a lifestyle-oriented service partnership.

## 7.3 Channels

- **C1 – Professional and Commercial Users**

The appropriate channels are therefore likely to include construction industry networks, equipment rental platforms, trade associations, event management networks, film and media production communities, and specialist industry exhibitions.

- **C2 – Emergency and Institutional Users**

Effective channels are likely to include public procurement frameworks, emergency management networks, humanitarian organisations, defence and security exhibitions. Furthermore, participation in emergency response exercises, demonstration projects, and resilience planning initiatives can reinforce the provider's positioning as a trusted partner for mission-critical operations.

- **C3 – Recreational Vehicles, Off-Grid Living, and Expedition Travel**

To support the lifestyle-oriented service partnership approach adopted for this segment, the selected channels should reinforce perceptions of convenience, mobility, sustainability and energy independence. Appropriate channels are therefore likely to include recreational vehicle dealerships, camping and outdoor recreation networks, travel and adventure exhibitions. Digital channels, including social media communities, online reviews, influencer partnerships, and user-generated content, are also likely to play an important role in customer engagement and trust-building.

## 7.4 Pricing strategy

**In Quadrant: centralised x customer-facing** (Table 1) Pathway C comprises centrally managed fleets of modular, transportable second-life systems deployed to temporary or off-grid sites: professional and commercial worksites and events (C1), emergency and institutional rapid-deployment users (C2) and recreational and off-grid-living users (C3). The centralised dimension denotes concentration of operational control, fleet management and maintenance at a primary depot; the customer-facing dimension means value is delivered at distributed temporary sites where the battery substitutes for diesel generation.

### 7.4.1 Primary mechanism – day-rate and utilisation-based pricing

Pathway C operates on a short-duration pricing structure that must recover asset depreciation and high logistical overheads. The primary day-rate fee (€/day), frequently combined with a kilowatt-hour-delivered charge, must absorb physical degradation plus the continuous mobilisation, demobilisation and safety-recertification costs incurred between deployments. The defining commercial risk is low asset utilisation. Pricing must therefore impose minimum utilisation thresholds (a minimum billable period regardless of actual discharge) and, because temporary-power demand is seasonal, use dynamic season-adjusted rate cards with peak-season surcharges to maximise yield when fleet utilisation is high.

### 7.4.2 Secondary mechanism – retained-availability subscription

For multi-month projects the operator pivots to a retained-availability subscription: a flat monthly fee priced below the aggregate day-rate that removes idle risk from the operator's balance sheet by transferring utilisation risk to the client in exchange for budget predictability. This alternative secures baseline revenue stability for long-duration construction or event sites that want to guarantee availability without tracking daily usage.

### 7.4.3 Calibration baseline, risk mitigation and bankability

Day-rate pricing is calibrated on asset depreciation and logistical overhead and mitigated through minimum billable-utilisation thresholds; performance is governed by logistical service-level agreements (a rapid-redeployment SLA mandating delivery of a replacement unit within a specified window), while SoH management is handled via physical recertification at the central depot. Bankability of a centrally managed, service-based fleet is evidenced by Zenobē (UK), which raised approximately £600 million from KKR and a further approximately £270 million from Infracapital in 2023, and has secured over £1 billion of green debt since 2019 from a syndicate of banks including Aviva, Lloyds, NatWest and Santander against long-term battery-management service contracts (Zenobe, 2023, 2024), providing indicative evidence of investor and lender interest in service-based battery models.



## 7.5 Business Model Canvas

Figure 17 synthesises the BMC for Pathway C integrating the problem–solution fit, customer segments, relationship and channel strategies, pricing logic, key operational requirements, partner network, cost structure and revenue streams.

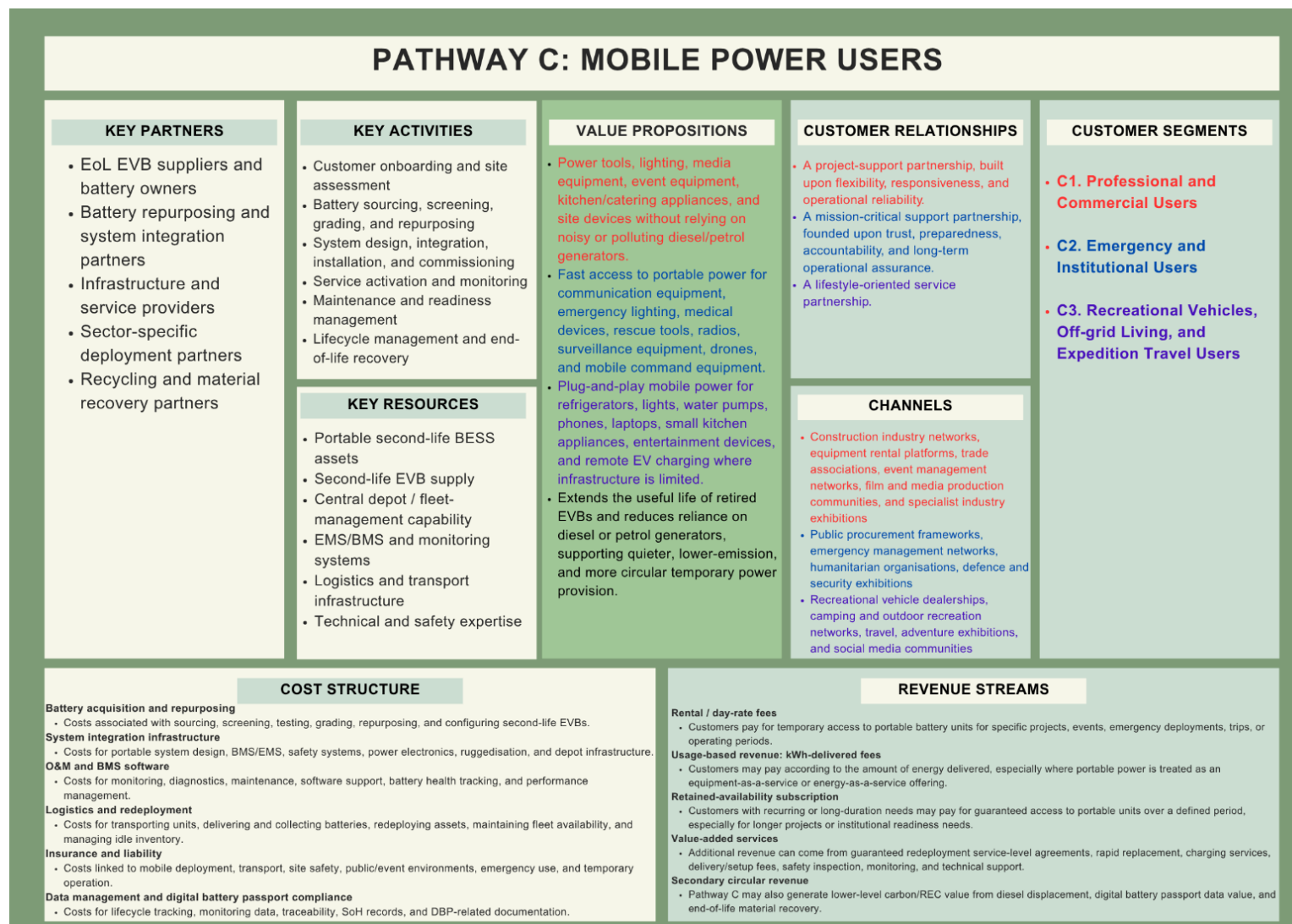


Figure 17. Pathway C – Business Model Canvas

## 8 Pathway D – Consumer & Light Mobility

**Pathway D: Consumer & Light Mobility** refers to a **distributed, customer-facing** deployment pathway in which retired EVBs are downscaled for smaller mobility and light-energy applications. Unlike Pathways A, B and C, which mainly involve stationary or portable BESS, Pathway D focuses on compact applications such as e-bikes, e-scooters, delivery drones, and other forms of urban electromobility.

In this pathway, second-life EVBs are not normally reused as complete vehicle packs because full EV packs are too large, heavy, and technically unsuitable for small mobility devices. Instead, the relevant reuse opportunity is at the module level, where selected battery modules can be tested, reconfigured, and integrated into lower-power mobility applications. Value is therefore created by extending the useful life of EVB components in applications with lower energy demand, while supporting urban mobility, last-mile transport, inclusive mobility, and reduced demand for virgin battery materials.

However, Pathway D also requires clearer boundaries than the other pathways. Module-level reuse for urban electromobility can represent a valid second-life pathway, but micro-battery applications for phones, laptops, or small consumer electronics are better understood as remanufacturing or recycling pathways rather than direct second-life reuse. In these cases, cells must be dismantled, tested, reprocessed, and rebuilt into entirely new battery formats, creating economic and safety challenges. Therefore, the BaaS relevance of Pathway D is strongest where providers can manage battery supply, replacement, subscription, swapping, or fleet-level battery services for light mobility systems, rather than where individual cells are remanufactured into consumer electronics.

### 8.1 Problem definition and unique selling proposition (USP)

This section develops the problem–solution fit and USP for Pathway D. Building on the pathway overview above, the analysis distinguishes between D1 Urban Electromobility, which represents a potential module-level second-life reuse pathway, and D2 Micro Batteries/Consumer Electronics, which is treated as a boundary case rather than a standard second-life BaaS pathway.

#### 8.1.1 Sub-pathway Value Proposition Canvas and Problem–USP fit

Unlike Pathways B and C, Pathway D requires a more cautious interpretation because not all downscaled battery applications represent viable second-life deployment. Therefore, D1 Urban Electromobility is presented as a standard VPC, while D2 Micro Batteries/Consumer Electronics is presented as a boundary assessment to clarify the limits of direct second-life reuse.

As shown in Figure 18, **D1 Urban Electromobility** is to power compact urban mobility devices and small electric vehicles with lighter, smaller battery modules rather than full EVB packs. The resulting USP is selective module-level second-life battery solutions for compact urban mobility and inclusive transport applications.

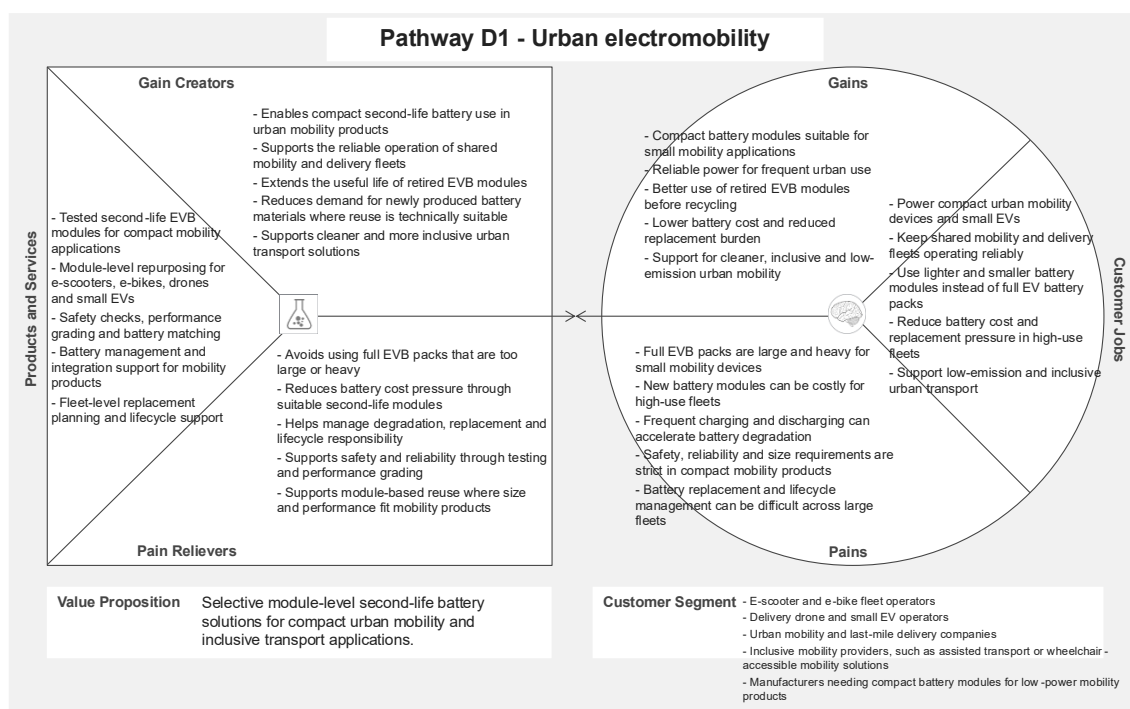


Figure 18. VPC for D1 Urban electromobility

In contrast to D1, D2 Micro Batteries/Consumer Electronics is not presented as a standard VPC because it does not represent a viable direct second-life BaaS pathway. Although consumer electronics require compact, safe and reliable batteries, the direct reuse of EVB cells in these applications is constrained by the combination of extensive disassembly, testing, sorting, product redesign, new battery management systems and safety and quality requirements. The limitation, thus, arises not solely from cell-level processing, but from the high transformation intensity and the difficulty of retaining battery traceability and lifecycle control once the battery becomes an embedded component of a new consumer product. D2 is therefore treated as a boundary case whose circular value is better captured through remanufacturing, recycling or material recovery rather than direct second-life BaaS.

Table 12. Boundary assessment for D2 Micro Batteries/Consumer Electronics

| VPC element         | Explanation                                                                                                                                           | Implication for Pathway D                                                                |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Customer segment    | Consumer electronics manufacturers, power bank producers, and users of smartphones, laptops and small devices require compact and reliable batteries. | There is a real market need, but the application is highly demanding and standardised.   |
| Customer jobs       | Customers need small, lightweight, safe and standardised batteries for highly integrated electronic products.                                         | These jobs require precise battery design rather than flexible second-life module reuse. |
| Pains               | Used EVB cells vary in health, performance and remaining life; they also require full disassembly, testing, repackaging and new safety checks.        | Cell-level reuse creates high technical and safety complexity.                           |
| Expected gains      | Customers seek low-cost, compact, safe and consistent batteries with reliable performance.                                                            | Used EV cells may struggle to meet mass market consumer electronics requirements.        |
| Product/service fit | Direct second-life BaaS is not suitable because consumer electronics batteries are embedded product components, not standalone service assets.        | BaaS relevance is limited in this pathway.                                               |

|            |                                              |                                                                                             |
|------------|----------------------------------------------|---------------------------------------------------------------------------------------------|
| Conclusion | D2 is not a direct second-life BaaS pathway. | Circular value is better captured through remanufacturing, recycling and material recovery. |
|------------|----------------------------------------------|---------------------------------------------------------------------------------------------|

### 8.1.2 Sustainable USP of Pathway D

The analysis of Pathway D shows that this pathway requires a more selective interpretation than Pathways B and C. While Pathway D is built around the idea of downscaling retired EVBs into smaller applications, not all small-scale uses represent viable second-life battery deployment. Table 13 shows the USP of each sub-pathway when addressing their core problems.

*Table 13. Problem–USP summary for Pathway D sub-pathways*

| Sub-pathway                             | Core problem                                                                                                                          | Resulting USP                                                                                                                        |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| D1 Urban Electromobility                | Low-power urban mobility applications need compact, lower-cost and circular energy solutions, but full EVB packs are large and heavy. | Selective module-level second-life battery solutions for compact urban mobility and inclusive transport applications.                |
| D2 Micro Batteries/Consumer Electronics | Consumer electronics require compact, highly standardised and critical batteries that do not fit well with directly reused EVB cells. | Not a viable direct second-life pathway; circular value is better captured through remanufacturing, recycling, or material recovery. |

Across Pathway D, the sustainable USP is therefore not broad reuse in any small-scale battery application. Instead, it lies in selective module-level repurposing of retired EVBs for compact, low-energy mobility applications where size, weight, performance and safety requirements remain compatible with second-life use. Customers are not simply receiving cheaper batteries; they are accessing circular energy solutions that can reduce demand for newly produced battery materials, lower battery replacement pressure in suitable mobility applications, and support cleaner and more inclusive urban transport.

Interpreted through the B2B value hierarchy, D1 meets table-stakes expectations of safety, compatibility and product compliance; creates functional value through compact battery solutions for low-power mobility; eases doing business via testing, grading, matching and replacement planning; builds confidence in module suitability; and delivers inspirational value through circular reuse and cleaner, more inclusive urban mobility. However, D2 highlights an important boundary condition where applications require highly customised, compact and standardised battery cells, direct second-life reuse becomes less viable. In such cases, circular value is more appropriately created through remanufacturing, recycling or material recovery rather than through a direct second-life value proposition.

This USP creates economic, environmental and social value in a more selective way than Pathways B and C. Economically, D1 can support lower-cost energy solutions for suitable low-power mobility applications. Environmentally, it extends the useful life of EVB modules and can reduce reliance on newly produced batteries where reuse is technically appropriate. Socially, it can support accessible, inclusive and lower-emission urban mobility applications. However, the sustainability value depends strongly on correct pathway classification: module-level reuse can con-

tribute to second-life value creation, while cell-level consumer electronics applications should be redirected toward recycling, material recovery or remanufacturing.

## 8.2 Marketing Approaches: Segmentation, Targeting, Positioning

### 8.2.1 Segmentation and targeting

The market segmentation for Pathway D is based on the primary purpose of the target customer: utilising smaller-scale energy solutions derived from second-life EVBs for low-energy mobility and electronic applications. This pathway adopts a selective and critically differentiated marketing strategy, as not all downscaled battery applications constitute viable second-life use cases (Table 14).

Unlike Pathways B and C, where the BaaS–BESS model is clearly applicable, Pathway D includes both technically feasible second-life applications (module-level reuse) and non-viable applications that fall outside the second-life boundary (cell-level reuse). This distinction is essential, as it determines whether value is created through reuse or through recycling and remanufacturing. BaaS may not be applicable in this pathway. Consumer electronics rely on embedded batteries as product components, and there is no service-based deployment or lifecycle management model comparable to BESS applications. These sub-pathways are supported by the following real-world case studies:

The relevance of **D1 – Urban electromobility** is demonstrated by several emerging industry practices. The collaboration between Stellantis and Avathor illustrates how second-life EVB can be disassembled and reconfigured into smaller modules (1.4 kWh to 2.8 kWh) for compact vehicles such as the Avathor One, **a wheelchair-accessible electric vehicle** designed for short-range urban mobility<sup>16</sup>. The system enables up to 50 km of range and integrates modern safety and control features, demonstrating how second-life batteries can support inclusive and specialised transport solutions. Similarly, Re/cell in the United States repurposes used EVB cells into modular lithium-ion blocks designed for heavy-duty drones and UAV applications across sectors such as agriculture, surveying, logistics, and security<sup>17</sup>. These modules, ranging from 12 to 48 amp-hours, demonstrate the flexibility of second-life batteries when reconfigured into smaller, application-specific energy units. These cases show that D1 represents a functionally valid second-life pathway, if repurposing occurs at the module level, where size, weight, and performance characteristics align with the requirements of low-power mobility applications.

For **D2 – Micro Batteries: Consumer Electronics (Non-Viable Second-Life Pathway)**, the Lime collaboration with Gouach and Innov8 illustrates the limitations of this pathway<sup>18</sup>. While used e-scooter and e-bike batteries are repurposed into portable consumer battery packs, the process involves sorting, testing, reprocessing, and reassembling cells into new products, effectively constituting remanufacturing rather than direct second-life reuse. Even in this case, significant processing is required to ensure safety, standardisation, and performance. This case reinforces that D2 does not represent a pure second-life pathway but rather a transition toward circular material use, where value is retained through processing rather than direct reuse.

<sup>16</sup> [Stellantis Innovates with Second-Life EV Batteries for Accessible Mobility Solutions - Giga Gears](#)

<sup>17</sup> [US firm recycles waste Tesla EV batteries to power drones](#)

<sup>18</sup> [Lime Gives A Second Life To EV Batteries With... | Lime Micromobility](#)

Table 14. Pathway D Segmentation and Targeting

| Segment                          | Description                                                                                                                                                                                                                                                                                                                                                                                  | Use Case Example                                                                                                                           | Key Characteristics                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  |                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                            | Energy Role                                                                                                                                                                                                                                                                                                                                                                 | Customer Profile                                                                                                                                                                                                                                                         | Operating Context                                                                                                                                                                                                                        | Key Value and Economic Focus                                                                                                                                                                                                                                                                                                                                | Procurement Complexity                                                                                                                                                                                                                                                                                                                                                       |
| <b>D1. Urban electromobility</b> | The application of second-life EVB in this case is similar to first-life EVB, as the battery is used to energise mobility. However, second-life EVB should be disassembled to the module level and repurposed for lower-energy-demand applications such as e-scooters, e-bikes, delivery drones, wheelchairs, or compact mobility vehicles.                                                  | The Avathor One, a wheelchair-accessible electric vehicle developed through the collaboration between Stellantis and Avathor.              | <b>Energy role:</b> Embedded traction power or auxiliary power for small electric mobility devices.<br><b>Coverage:</b> Powers individual light electric vehicles or provides backup energy for low-power mobility applications. Usage is intensive and high-frequency, with frequent charge-discharge cycles in shared mobility, delivery, or short-range urban transport. | <b>Customer profile:</b> Private-sector mobility operators and manufacturers, including e-scooter/e-bike fleet operators, delivery drone operators, and compact EV developers.<br><b>Scale:</b> SMEs to large enterprises; startup, scale-up, or enterprise-level users. | Mainly urban and metropolitan areas, especially cities with high demand for last-mile mobility, delivery services, congestion reduction, low-emission transport, and inclusive mobility solutions.                                       | <b>Key value:</b> Low-demand electromobility and module-level circular reuse.<br><b>Economic focus:</b> Extending EVB life by reusing suitable modules in smaller mobility applications, reducing demand for virgin battery materials, supporting lower-emission transport, improving convenience, and enabling inclusive mobility.                         | <b>Procurement complexity:</b> Medium to high due to module testing, safety certification, integration with mobility products, and battery management requirements. Industrial and commercial customers with short replacement cycles due to intensive use. Customers are price-sensitive but value lower battery costs, fleet uptime, and predictable replacement services. |
| <b>D2. Micro Batteries</b>       | The proposed application of second-life EVB in this case is similar to first-life batteries used to energise electronic devices. However, EVB would need to be disassembled into individual cells, tested, reconditioned, and remanufactured for lower-power consumer electronics applications. This makes the pathway closer to remanufacturing or recycling than direct second-life reuse. | Used e-scooter and e-bike batteries repurposed into portable consumer battery packs through the Lime collaboration with Gouach and Innov8. | <b>Energy role:</b> Small-device power or portable backup energy.<br><b>Coverage:</b> Powers small electronic devices such as phones, laptops, or power banks. However, the application requires cell-level extraction and reassembly into new battery formats, rather than direct module-level reuse.                                                                      | <b>Customer profile:</b> Consumer electronics manufacturers, portable battery pack producers, and users of small electronic devices. <b>Scale:</b> SMEs to large organisations; potentially mass-market consumer electronics producers.                                  | Markets where customers prefer green products, repairable electronics, or more affordable portable energy options. However, application feasibility depends heavily on safety standards, product design, and remanufacturing capability. | <b>Key value:</b> Material efficiency rather than direct second-life reuse.<br><b>Economic focus:</b> reducing virgin material demand through remanufacturing, recycling or material recovery rather than direct second-life reuse. However, the circularity logic is weaker than D1 because significant reprocessing is required before reuse is possible. | <b>Procurement complexity:</b> Very high due to cell-level dismantling, testing, sorting, safety assurance, new BMS integration, and product certification. Price-sensitive market, but direct second-life reuse is commercially weak. This pathway is better classified as remanufacturing or recycling rather than a core BaaS pathway.                                    |

### 8.2.2 Positioning and customer relationship

- **D1 – Urban Electromobility**

Customers operating within this segment are likely to focus on questions such as: “*How can reliable battery performance be achieved while reducing costs and improving the sustainability of urban mobility systems?*” Consequently, a value positioning strategy is particularly appropriate, as it emphasises the combination of economic efficiency, resource circularity, and practical mobility performance delivered through repurposed battery modules.

Customers within this segment are likely to value long-term battery availability, predictable performance, lifecycle transparency, and technical support related to battery replacement and optimisation. As a result, customers may appreciate regular performance monitoring, replacement planning, and technical consultation regarding fleet electrification strategies. Accordingly, the most suitable customer relationship approach for this segment can be characterised as a lifecycle optimisation partnership.

- **D2 – Micro Batteries**

Unlike the previous segment, this pathway does not represent a commercially viable second-life battery application. Rather than positioning second-life EVBs as a suitable solution for consumer electronics, the primary objective is to communicate the limitations and risks associated with attempting to reuse EVB cells in highly compact consumer products. Consequently, a de-positioning strategy is most appropriate. A central question for organisations considering this pathway is therefore likely to be: “*Does this application genuinely create second-life value, or does it require a level of processing that effectively constitutes battery remanufacturing?*”

Customer relationships within this context are therefore less concerned with market development and more focused on technical education, standards guidance, and evidence-based decision-making. Accordingly, the most suitable relationship approach for this segment can be characterised as a technical advisory relationship.

## 8.3 Channels

- **D1 – Urban Electromobility**

For this segment, appropriate channels are likely to include urban mobility networks, electric vehicle industry associations, sustainable transport initiatives, and mobility-focused innovation programmes. Collaboration with vehicle manufacturers, fleet operators, battery integrators, and smart-city initiatives can further strengthen customer engagement and market credibility.

- **D2 – Micro Batteries**

To align with the technical advisory relationship approach, the channels selected for this segment should reinforce evidence-based decision-making and accurate classification of circular economy activities. Appropriate channels are therefore likely to include battery research conferences, technical standards organisations, regulatory forums, academic publications, industry white papers, and circular economy policy discussions.

## 8.4 Pricing strategy

**In Quadrant: distributed x customer-facing** (Table 1) Pathway D targets highly distributed light-mobility applications, such as e-bikes, e-scooters, delivery drones

and comparable urban electromobility (sub-pathway D1) within closed-loop, operator-owned service ecosystems. The deliverable D1.4 flags micro-batteries for consumer electronics (D2) as a non-viable second-life pathway, so the strategy below concerns the urban-electromobility segment only. Pathway D may support several service architectures, including battery or module leasing, managed replacement services and, for standardised high-utilisation fleets, battery swapping. Where a distributed swap network is used, the operator must reconcile substantial infrastructure investment with the relatively low value of each transaction.

#### 8.4.1 Primary mechanism – tiered subscription pricing

Fixed monthly subscription pricing is the primary mechanism, because predictable recurring cash flow is required to service the infrastructure debt of the swap network. The handbook's analysis is that calibration relies on cohort analysis balancing customer-acquisition cost against projected lifetime value, and that tiered structures (basic and premium access) should be used for churn management – capture high-frequency commercial couriers at premium margins while retaining casual users to sustain base utilisation. Subscription pricing must be sufficient to fund module testing, grading, reconfiguration, safety assurance, and replacement planning.

#### 8.4.2 Secondary mechanism – pay-per-swap and usage overage

Pay-per-swap pricing acts strictly as an overage mechanism to monetise usage outside the contracted subscription, rather than as a stand-alone primary stream. Operator-controlled swap stations confine charging within the network, enabling enforcement of low-rate charging algorithms and hard-capped depth-of-discharge limits that protect the cells.

#### 8.4.3 Calibration baseline, policy support and an evidential limit

Subscription pricing is calibrated on infrastructure-debt servicing and user lifetime value. EU-level grant funding is materially relevant: the EU Innovation Fund, financed by EU Emissions Trading System revenues, supports energy-storage and net-zero-mobility deployment and can subsidise upfront swap-network capital, allowing lower subscription tiers (European Commission, 2025). An evidential limit must be stated. The reference operator for subscription-and-swap economics, Gogoro (Taiwan, Nasdaq: GGR), reported full-year 2024 total revenue of USD 310.5 million (down 11.2%) and full-year adjusted EBITDA of USD 46.5 million, with its battery-swapping subscriber base reaching approximately 640,000 and the energy business overtaking vehicle sales for the first time; the company recorded a full-year net loss of USD 123.2 million after impairments and targets non-IFRS profitability for the swapping business in 2026, and is repurposing its batteries for second-life applications (Gogoro, 2025). Gogoro operates with first-life cells under Taiwan's specific subsidy and urban-density conditions, and there is no directly comparable second-life precedent at European scale. Pathway D pricing assumptions carry the widest uncertainty band of the four pathways and should be treated as provisional.

### 8.5 Business Model Canvas

Figure 19 synthesises the BMC for Pathway D, integrating the problem–solution fit, customer segments, relationship and channel strategies, pricing logic, key operational requirements, partner network, cost structure and revenue streams.

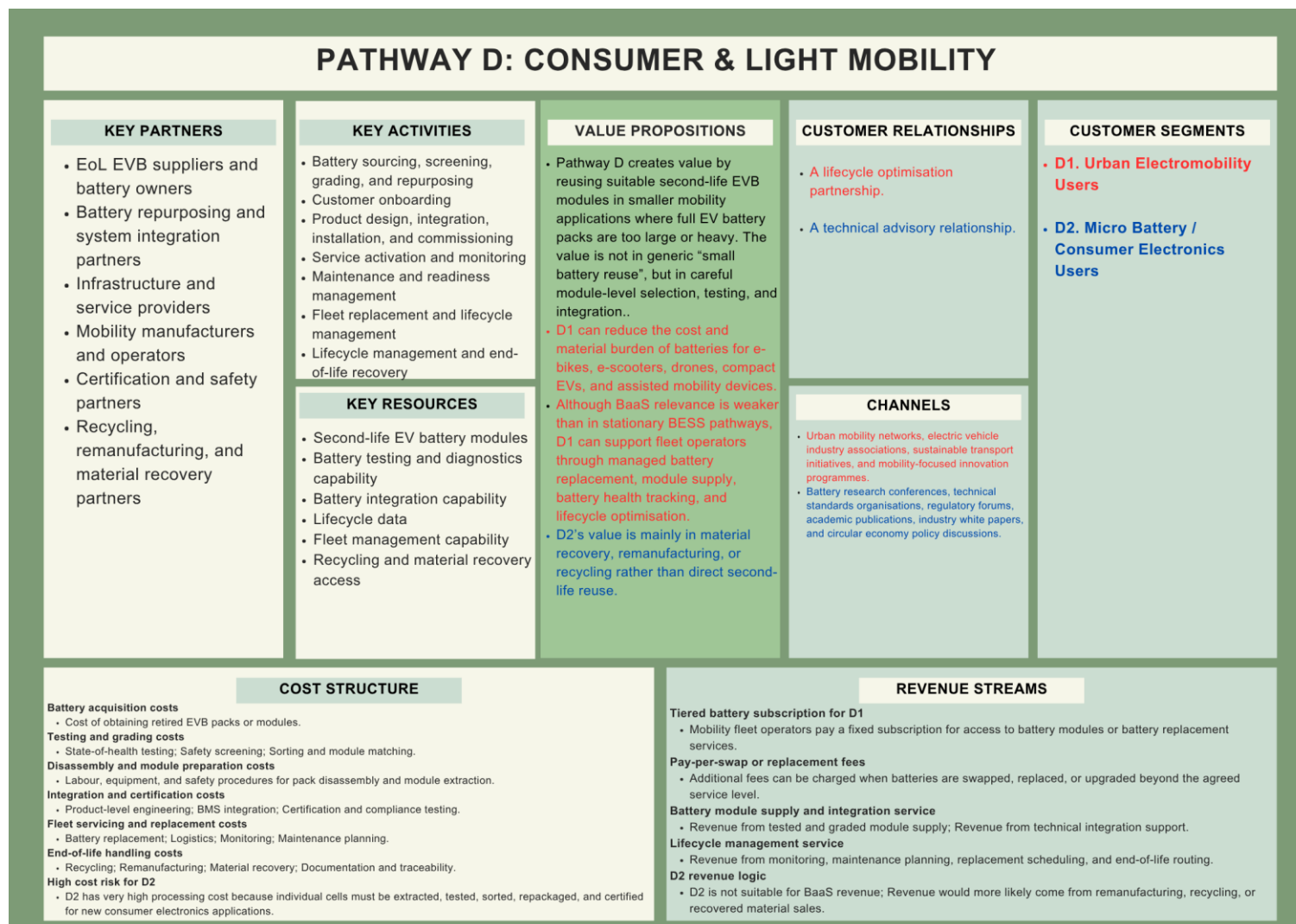


Figure 19. Pathway D – Business Model Canvas

## 9 Conclusions

This handbook shows that second-life EVB deployment requires differentiated business model design. The four pathways do not represent variations of the same model; they reflect different service logics, customer problems, operating conditions and revenue mechanisms.

Pathway A is centred on energy optimisation and grid-related value. Pathway B is centred on resilience, uptime and continuity. Pathway C is centred on flexible access to portable power. Pathway D is more selective, highlighting module-level opportunities in light mobility while clarifying that some applications are better classified as remanufacturing or recycling. Table 15 consolidates the pricing logic across the four pathways, aligned to the two-dimension framework.

*Table 15. Pricing logic summary*

| Dimension                           | A – Grid Optimisers                                    | B – Grid Independents                                    | C – Mobile Power Users                     | D – Consumer & Light Mobility                               |
|-------------------------------------|--------------------------------------------------------|----------------------------------------------------------|--------------------------------------------|-------------------------------------------------------------|
| <b>Framework quadrant</b>           | Centralised × market-facing                            | Distributed × customer-facing                            | Centralised × customer-facing              | Distributed × customer-facing                               |
| <b>Primary pricing model</b>        | Fixed capacity fee + outcome-based ESCo management fee | Shared-savings agreement (% of verified cost reductions) | Day-rate + kWh-delivery charge             | Tiered monthly subscription / managed fleet battery service |
| <b>Secondary pricing mechanism</b>  | Tolling agreements (profit splitting)                  | Fixed-fee equipment leases (HaaS)                        | Retained-availability subscription         | Pay-per-swap or replacement overage                         |
| <b>Indicative contract duration</b> | Multi-year (long)                                      | Multi-year (medium)                                      | Days to months                             | Monthly rolling or annual                                   |
| <b>Calibration baseline</b>         | Projected residual life and ancillary-market forecasts | Pre-installation M&V energy audits                       | Asset depreciation and logistical overhead | Infrastructure-debt servicing and user lifetime value       |
| <b>Financial risk mitigation</b>    | Inflation indexation and SoH floor clauses             | Dynamic tariff pass-through clauses                      | Minimum billable-utilisation thresholds    | Tiered structures to manage churn and capacity              |

*Contract-duration ranges are indicative and qualitative. Mechanism logic draws on established energy performance contracting practice (IEA, 2018; U.S. Department of Energy, 2024)*

A common insight across the pathways is that BaaS is valuable where customers face uncertainty around battery ownership, performance, maintenance, degradation and recovery. By retaining ownership and managing the battery lifecycle, providers can offer customers access to battery-enabled outcomes while maintaining control over monitoring, replacement, redeployment and EoL routing.

The analysis also shows that each pathway requires different commercial and business model logics. Pricing mechanisms vary across pathways, including capacity-based fees, availability payments, shared savings, rental fees, subscriptions and pay-per-swap payments. These mechanisms are integrated with customer segments, value propositions, customer relationships, channels, key activities, key resources, key partners, cost structures and sustainability contributions through the pathway BMCs.

As an interim output, this handbook provides a practical basis for the next stage of CIRCUBATT work. Further validation will focus on testing assumptions with stakeholders, refining cost and revenue parameters, and identifying pilot opportunities that can demonstrate the feasibility of the proposed BaaS models.

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