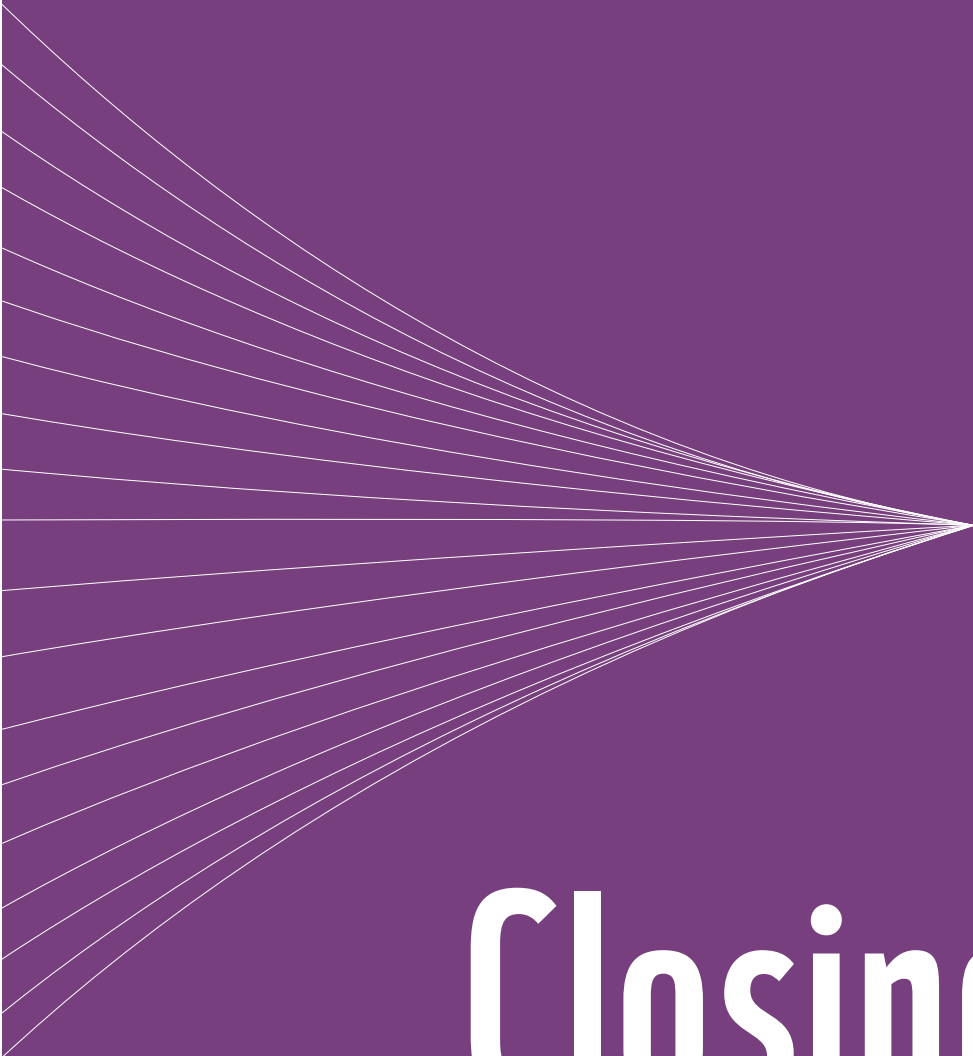




Quantis
A BCG COMPANY



Closing the Valuation Gap

A BUSINESS CASE
FRAMEWORK FOR CIRCULAR
ECONOMY INVESTMENTS

Publication details

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Testimonials

Dr Johannes Kirchhoff

Chairman of the BDI Circular Economy Initiative Executive Board
Chairman of the KIRCHHOFF Ecotec SE supervisory board

“Circular business models are increasingly central to Germany's industrial competitiveness. This report makes a valuable contribution by showing how the financial case for circular investment can be built more completely by capturing value that conventional appraisal tools routinely leave on the table.”

Dr Matthias Ballweg

Co-Founder Circular Republic

“What this report gets right is the focus on making circular value legible to the people who control investment decisions. The framework does not ask companies to change how they evaluate investments but gives them better inputs to work with.”

Delphine Garin

Manager, Global Circularity Protocol, Circular Finance, World Business Council for Sustainable Development (WBCSD)

“The transition to a circular economy will only accelerate if a credible financial case can be made. This report advances that agenda by providing a structured, evidence-based approach to quantifying circular value that speaks the language of CFOs and investment committees without oversimplifying the complexity involved.”

Dr Markus Steilemann

Member of the BDI Circular Economy Initiative Executive Board
Chairman of the Management Board of Covestro AG

“The German industry has the capability to lead the circular transition, but investment decisions require a stronger analytical foundation. This report addresses that need: a credible framework connecting circular value creation to the financial metrics that actually drive corporate investment decisions.”

Arne von Hofe

Senior Expert, CSCP – Collaborating Centre on Sustainable Consumption and Production

“This is a genuinely useful report that makes overlooked value drivers quantifiable within the logic companies already use. What now decides its impact is its application, by the people driving circular business models in companies and by everyone helping them get there. That work can start, and we are keen to be part of it.”

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Executive Summary

Circular economy (CE) is a central lever for reducing resource consumption, creating opportunities for new revenue and improved profitability, stabilising supply chains and securing long-term competitiveness.

Numerous CE initiatives – such as projects for reuse, refurbishment, recycling, product-as-a-service models or circular design – now exist in many companies. However, a recurring pattern is emerging: these projects function from a technological perspective and are considered strategically relevant, but they predominantly remain at the pilot or demonstration level and do not develop into core business models.

The central bottleneck is not a lack of innovation or willingness to transform, but rather the way in which economic viability is calculated and evaluated within a company. A circular business case is often stronger than it looks on paper. The problem is usually not the underlying economics, it is that the tools used to evaluate these business cases were never built to show the full picture.

The problem: A systematic valuation gap

CFOs and investment committees use a range of tools to inform investment decisions, such as EBITDA to assess period profitability as well as payback, NPV and IRR. While these are well suited for linear, single-cycle investments, they miss the additional value a circular model creates: value that compounds across multiple product cycles, through mechanisms with no line on a standard P&L. These include a take-back programme that hedges commodity risk; a remanufacturing line that becomes cheaper with every cycle; a repair relationship that keeps a customer for a decade instead of one purchase.

Every company and expert consulted for this report recognised this value. Almost none had a method to put a number on it.

10 quantifiable circular value drivers

This report supplies that method and illustrates the value of circular innovation. It sets out 10 circular value drivers, grouped into three areas – Risk & Resilience, Strategy & Competitiveness and Organisation & Ecosystem – each with a formula, supporting evidence, known limitations and a worked example. They are designed to sit inside the investment case a company is already building, adding the missing inputs to the metrics the finance team already trusts.

10 circular value drivers, grouped into three areas.



DIMENSION 01

Risk & Resilience

- ① Input Price Volatility & Commodity Hedging
- ② Supply Chain Disruption Risk
- ③ Regulatory Transition Risk



DIMENSION 02

Strategy & Competitiveness

- ④ Customer Lifetime Value Extension
- ⑤ Brand Equity & Access to New Customers
- ⑥ First-Mover Advantage in Emerging Circular Markets



DIMENSION 03

Organisation & Ecosystem

- ⑦ Operational Scale-Up & Learning Effects
- ⑧ Reverse Logistics Cost Efficiency
- ⑨ Ecosystem Leverage & Shared Infrastructure
- ⑩ Data Infrastructure & Material Traceability

A clear framework to integrate value drivers into usual financial metrics

Applying these value drivers is a three-step process.

- STEPS
- ① **Diagnose** the investment's specifics: the business model, the industry, where the company sits in the value chain.
 - ② **Identify** and prioritise which of the 10 drivers actually apply, using a shortlist and an impact-versus-feasibility matrix to cut the list down fast.
 - ③ **Integrate** the strongest drivers into the existing appraisal, inviting finance to collaborate at an early stage to avoid being challenged in the room during investment decision making.

The report goes through the entire process using a fictional compressor manufacturer, Hartmann Machine, to evaluate a remanufacturing programme and by doing so shows how including the full picture of circular value moves its NPV, payback and IRR from marginal to clearly viable.

A call to action to unlock the financial impact of circularity

For companies, the framework's primary use is in applying it together with the finance and controlling functions to ensure that circular investments are assessed on a more complete basis. While it is not a tool that builds a business case on a company's behalf, it ensures that genuine existing value is not excluded from the process by default.

For investors, the same logic applies from a different perspective: circular assets can carry an unfamiliarity premium that reflects novelty rather than rigorous risk assessment, when functioning circular models can reduce commodity, supply-chain and regulatory exposure. Incorporating Risk & Resilience drivers into lending

criteria and credit assessments can therefore provide a more accurate risk-adjusted view.

For policymakers, regulatory consistency is not background context but a financial variable. Several of the value drivers in this framework depend on the credibility and persistence of the regulatory signals behind them, while delays or dilution can undermine investments made in anticipation of future requirements. Two priorities follow: supporting market-led initiatives in developing a standardised circular business case methodology, following the precedent set by the TCFD and the GHG Protocol; and incorporating circular value into public funding and procurement criteria to ensure a direct reward through signals on the demand side.

Technical experts and change makers are tasked with challenging the framework, testing its assumptions, sharing evidence and contributing to its further development. The aim is to build an expert community that can strengthen the methodology over time and help establish a robust, tried-and-tested reference for integrating circular value into mainstream investment appraisal.

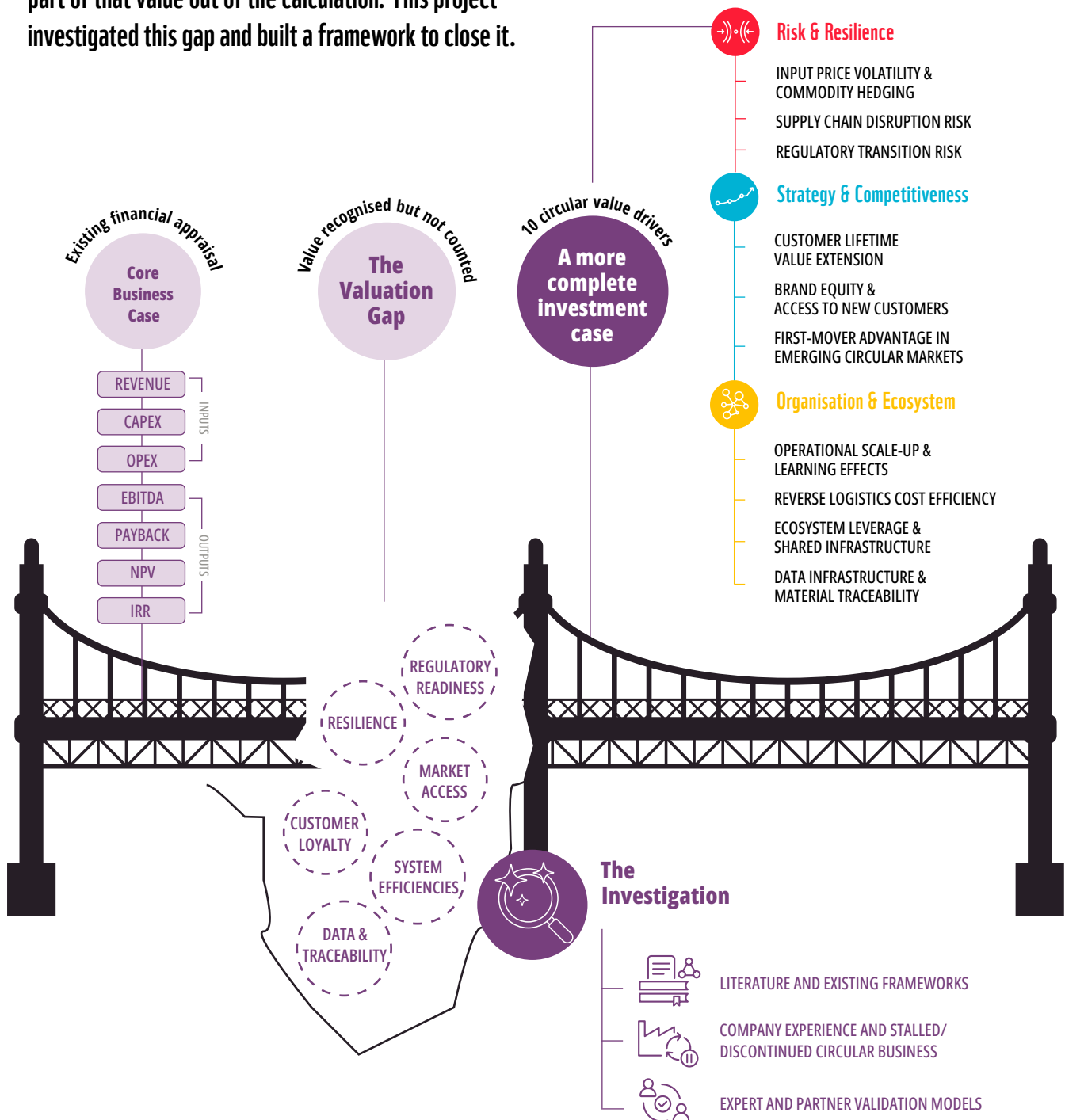
Outlook: From framework to practice

This report is a contribution to a more systematic approach to valuing circular investments. The next step is practical application: testing the framework in real investment decisions across sectors and business models and assessing where circular value drivers materially change financial metrics, risk assessments and investment outcomes.

The report aims to make circular value a normal part of mainstream investment appraisal. Ultimately, success will be measured by whether the framework contributes to more informed capital allocation decisions and helps viable circular economy projects move from pilot to scale. The partners welcome feedback, challenges and engagement from companies and experts who wish to apply the framework, test its assumptions and help develop it further.

Closing the Valuation Gap

Circular business models create economic and strategic value — but conventional financial appraisal often leaves part of that value out of the calculation. This project investigated this gap and built a framework to close it.



Introduction and Context

Introduction and Context

1.1 Project background and partners

Circular business models (CBMs) hold significant economic value and business opportunities and at the same time are a key lever for reducing environmental impact. On a microeconomic level, circularity can provide companies with a competitive advantage, resource independence, risk reduction, and organisational and ecosystem improvements. From a macroeconomic perspective, CBMs increase the gross value added and reduce overall import dependency. In Germany alone, the gross value added of the circular economy could more than double from €60 billion today to up to €125 billion by 2045 – and realising this potential requires significant investment.¹ That investment depends heavily on companies being able to build a credible financial case for circular business models and to win internal approval for them.

Over the last years, circular economy pilot projects have become widespread, and many organisations have attempted to implement circularity initiatives and incorporate them into their core business model. While these pilots regularly demonstrate technical feasibility and strategic relevance, they often fail to scale into a core business model and remain a small part of a company's revenue, stay at the pilot stage or are abandoned completely. While there are significant exceptions such as Lorenz or Hilti, where companies have successfully integrated CBMs into their core business and demonstrate that scale is achievable, these remain outliers rather than the norm. This highlights a variety of well-documented barriers that CBMs face: high upfront costs, ecosystem and organisational complexity, acceptability by customers, robustness of emerging players and the difficulty of building an investment case that survives internal financial scrutiny.²

Circular business models (CBMs) hold significant economic value and business opportunities and at the same time are a key lever for reducing environmental impact.

¹ BCG & BDI (2026)

² Gonçalves, Carvalho & Fiorini (2022); Saarinen & Aarikka-Stenroos (2023)

Of these barriers, the business case is among the most consequential: many scholars and practitioners alike have emphasised that conventional financial valuation methodologies were designed for linear, single-cycle investment logic and are therefore structurally ill-suited to CBMs because they omit the full value.³ Unlike linear investments, which generate value primarily through a single production and sales cycle, circular investments realise value across multiple material or product use cycles, dimensions and time horizons. The result is a persistent gap between sustainability teams, which can see the strategic case for circular investments, and finance functions working with tools and frameworks that structurally undervalue it.

Circularity is best understood as an investment in innovation capacity that is realised over multiple dimensions and timeframes. It must be treated on its own terms, with a business case logic that reflects how CBMs actually create value. Creating a framework that demonstrates this logic and closes the valuation gap is the purpose of this report.

The content of this report is designed to support practitioners – CFOs, CSOs, strategy teams, investment committees and project managers – in building business cases that reflect the full value of circular models, ensuring circular investments are evaluated thoroughly when being compared to the linear alternatives they compete against. It provides a concrete methodology for quantifying and integrating circular value drivers into existing appraisal processes, which aims to give decision-makers more confidence to drive the transition towards a circular economy while enabling organisations to capture and capitalise on the projected economic value of circularity.

This report is a joint initiative led by WWF Germany and Quantis, with the advisory partnership of the Bertelsmann Stiftung and the BDI Circular Economy Initiative. The four partners welcome feedback and dialogue from companies who would like to take this work further.



³ Gigli, Landi & Germani (2019); Rodrigo-González, Grau-Grau & Bel-Oms (2021); Saarinen & Aarikka-Stenroos (2023)

1.2 Methodology and scope

1.2.1 PROJECT STRUCTURE

This report was developed across **three steps**.

STEP ①

The first step comprised a systematic literature review of academic sources, industry reports and white papers that cover circularity, CBMs, financial valuation and investment decision-making as well as an analysis of existing valuation frameworks and tools that quantify/measure circularity and CBM performance and financially evaluate CBMs. The goal was to establish what is already known about how circularity creates value and how – or whether – this is currently captured in financial models as well as to identify the most significant gaps in existing approaches. The reference list provides a complete overview of the literature used, while Appendix D contains a list of existing frameworks for evaluating CBMs.

STEP ②

The second step comprised a series of expert interviews with companies across multiple sectors and circular business model types. The interviews included companies and experts who were able to provide input on experiences in scaling circular models and with models currently at pilot stage as well as where companies have stepped back from circular investments after initial trials. The interviews were designed to ground the framework in real decision-making practice by creating an understanding for how companies actually build and evaluate CBMs today, which metrics and tools are used, where conventional approaches fall short and what specifically has determined the success or failure of an investment decision in practice. In addition, the interviews focussed specifically on the value circularity brings to companies and whether the organisation has developed innovative approaches to financially quantify this value. Appendix E provides a full list of interviewees.

STEP ③

The third step comprised the development, testing and validation of the framework itself. The framework was developed iteratively, drawing on the findings of both preceding phases, and refined through engagement with project partners and validation with experts and external stakeholders. The goal throughout was to produce something applicable in practice through a framework that integrates seamlessly into existing corporate investment processes and financial valuation rather than a parallel tool or metric.

1.2.2 CIRCULAR BUSINESS MODELS, GEOGRAPHIC & INDUSTRY SCOPE

This report focuses on circular business models that extend the functional life of products or components across multiple use cycles or by prolonging individual use cycles. The circular business model types covered are: product-as-a-service, reuse, repair, and remanufacturing/refurbishment (Appendix B). Given that recycling focuses on material rather than on product life optimisation, it has been excluded from the scope of this report, which focuses on business models that drive product-level longevity.

The industry scope covers a variety of industries with industrial, automotive, fashion, electronics, retail and consumer packaged goods (CPG). It was selected to reflect a diversity of circular business model archetypes and to find similarities and differences across sectors. However, the developed framework is not solely applicable to these industries and can be applied to an even broader variety of sectors. Appendix I provides a full overview of our industry typology. As a partnership between four organisations located in Germany, the company interviews primarily focus on Germany; however, the report also includes a number of international examples, and the methodology and conclusions can be applied to other geographies.

The Valuation Gap

The Valuation Gap

2.1 How investment decisions are made today and why they fall short for circular business models

Based on our literature review and expert interviews, this section examines how companies currently evaluate circular investments and where conventional appraisals fall short.

When companies evaluate whether to invest in a CBM, they do so using the same tools they apply to every other investment decision: they model the revenues generated by circular activities, subtract the associated operating costs and capital expenditure required to establish the model, and assess whether the return justifies the capital required. In practice, the metrics that dominate this assessment are EBITDA, profit margin⁴ and payback period as well as Net Present Value (NPV) and Internal Rate of Return (IRR).⁵

These tools are well-suited to what they are designed to capture: directly attributable revenues and costs within a defined accounting period. However, the value that CBMs generate often falls outside the chosen boundary of these tools. What cannot be clearly assigned to a specific activity in a given period is excluded by default or acknowledged as qualitative context alongside the numbers without influencing them.

This limitation has structural roots. Conventional appraisal tools were built for linear, single-cycle investments where value is generated once, over a defined period, through a direct transaction.⁶ They have narrow system and time boundaries, lack risk and scenario assumptions, and treat strategic effects qualitatively. CBMs operate differently: they generate value across multiple cycles, over longer time horizons and through mechanisms that cannot be cleanly mapped onto a revenue or cost line. They are either excluded entirely or added as a qualitative narrative.

Perhaps the clearest illustration of these limitations is how conventional appraisal treats risk. A linear business model is not risk-free but carries exposure to commodity price volatility, supply chain concentration and regulatory tightening. Yet conventional appraisal treats the linear status quo as a zero-cost baseline, making any financial benefit from risk reduction structurally invisible. A circular model that reduces commodity price exposure, maintains supply continuity during disruption or positions a company ahead of regulatory change generates real financial value; however, a standard appraisal framework currently does not recognise this.

⁴ For this report, EBITDA margin was selected to be used as a placeholder for all types of profit margins.

⁵ Graham (2022) and WWF/Quantis analysis

⁶ Gigli, Landi & Germani (2019); Rodrigo-González, Grau-Grau & Bel-Oms (2021); Saarinen & Aarikka-Stenroos (2023)

This played out consistently in the expert interviews conducted. Business cases were built around directly attributable financial flows. The broader value of circularity was universally recognised, however it was treated as qualitative context rather than a financial input. One interviewee described a long internal list of value upsides explicitly acknowledged as real but left out of the business case entirely. Another noted that the financial case was understood by essentially one person in the organisation, making approval dependent on individual conviction rather than analytical robustness. A third described the business case as necessarily built on storytelling rather than quantification, because the model could not be made analytically defensible within conventional frameworks. The pattern is consistent: the value is recognised as existent, yet it is not counted in financial terms.

Attempts to address this gap by modelling the economic value of circular business models and potentially including this omitted value exist in academic literature as well as in practitioner toolkits and frameworks (see Appendix D for an overview of frameworks). The approaches identified tend to fall into one of two

categories. The first group tries to quantify a broader range of value drivers but relies on extensive previous methodological efforts and a quantification approach that lacks the rigor required for credibility with finance functions. The second category explores the financial modelling in depth and details individual revenue and cost lines within the logic of linear models, but is selective and incomplete by lacking quantification approaches for central ways in which circularity creates value. Therefore neither category successfully bridges the gap between identifying circular value and translating it into investment-grade financial inputs that can survive internal scrutiny. Additionally, the overall awareness and adoption of these tools among companies is limited, which emphasises the need for a commonly used, generalisable framework.

The result is a systematic gap: circular business models generate value that conventional appraisal excludes, and the tools available to address this remain either insufficiently rigorous or insufficiently comprehensive. What that missing value consists of is the subject of the next section.

Circular business models generate value that conventional appraisal excludes, and the tools available to address this remain either insufficiently rigorous or insufficiently comprehensive.

2.2 The missing layer: Circular value drivers

Drawing on both our literature and the expert interviews conducted for this report, we have identified **10 circular value drivers** that conventional appraisal excludes and for which this framework proposes quantification approaches. These value drivers fall across three dimensions that are summarised below.

DIMENSION

Risk & Resilience



VALUE DRIVER

DESCRIPTION

① **Input Price Volatility & Commodity Hedging**

Take-back and material recovery reduce dependence on virgin commodity markets, functioning as a structural hedge against input cost shocks and cost increases.

② **Supply Chain Disruption Risk**

Circular material flows reduce dependencies and provide operational continuity when supply chains are disrupted, including by physical climate and nature risks.

③ **Regulatory Transition Risk**

Proactive circular investment satisfies the compliance requirements as regulations become more ambitious (e.g. ESPR, WFD, ELV, Battery Regulation, CSRD), thus reducing risks.

Strategy & Competitiveness



④ **Customer Lifetime Value Extension**

Circular touchpoints (repair, resale, rental) create repeated customer interactions, increasing retention and total spend per customer over the relationship lifetime.

⑤ **Brand Equity & Access to New Customers**

Circular models generate positive brand associations, unlocking new customer segments, reducing customer acquisition costs and strengthening the long-term market position.

⑥ **First-Mover Advantage in Emerging Circular Markets**

Building operating capability in circular business at an early stage creates a first-mover advantage; being able to fulfill new procurement guidelines and a temporary price premium can apply during the early compliance window when regulations create mandatory demand for circular products and services.

Organisation & Ecosystem



⑦ **Operational Scale-Up & Learning Effects**

Circular operations build proprietary know-how, product data and circular design capabilities that compound over time and are difficult for competitors to replicate.

⑧ **Reverse Logistics Cost Efficiency**

Per-unit reverse logistics costs decline as return volumes grow and collection routes become denser, showing an improvement obscured by flat cost assumptions in the core model.

⑨ **Ecosystem Leverage & Shared Infrastructure**

Distributing shareable infrastructure costs across partners reduces per-company upfront investments and time to market while shortening payback.

⑩ **Data Infrastructure & Material Traceability**

Component-level tracking improves recovery rates and reduces inventory write-offs.

Risk & Resilience

Circular business models structurally alter a company's risk profile by reducing exposure to several financial risk categories that are inherent to linear operations. By creating internal material supply streams through take-back and remanufacturing, they reduce dependency on external commodity markets and single-source suppliers. By building a circular infrastructure ahead of regulatory requirements, they convert future compliance obligations into competitive advantages.

The interview evidence on this dimension was particularly consistent and specific.

Lorenz Messtechnik described how their take-back and remanufacturing programme provided supply continuity during the Covid-19 pandemic and the Suez Canal crisis, creating resilience throughout geopolitical supply chain disruptions and an economic benefit compared to their competitors. The resilience value was real and decisive, yet it had never been modelled, neither before nor after the fact, and did not appear in the investment case.

Wilhelm Mauß, CEO of Lorenz Messtechnik

“During COVID and the Suez Canal crisis, our competitors could not deliver. Due to our circular business model, we could.”

Circularity.fm reframed a take-back system explicitly in treasury language.

Patrick Hypscher, Circularity.fm

“The cost of maintaining a circular supply stream is directly comparable to the cost of financial hedging against commodity price volatility and in several scenarios is cheaper.”

Björn Knoop from CEMUNE described applying shadow carbon pricing derived from the EU ETS and German CO₂ tax as internal scenario inputs, converting an anticipated regulatory cost into a quantified financial variable rather than a qualitative risk narrative.⁷

Screwfix identified supply chain resilience as a direct value driver.

John Fretwell, Head of Quality of Screwfix

“Our sourcing recovers copper from a local recycler instead of from Chilean open-cast mining, with lower carbon, lower biodiversity risk and significantly lower supply concentration risk.”

The Risk & Resilience dimension therefore captures three value drivers: Input Price Volatility and Commodity Hedging; Supply Chain Disruption Risk; and Regulatory Transition Risk.

⁷ CEMUNE works across global sustainability negotiations, such as the Global Plastic Treaty



Strategy & Competitiveness

CBMs generate commercial value that extends well beyond the direct revenues of the circular activity itself, but conventional appraisal rarely adopts a mechanism to capture this. Effects on customer relationships, brand positioning, competitive differentiation and access to new markets are real and, in a number of cases, measurable, yet they are systematically excluded from investment cases because they cannot be mapped onto a standard revenue or cost line.

Across our interviews, companies described circular programmes that demonstrably deepened customer relationships, attracted new customer segments at lower acquisition cost and built competitive capabilities that were difficult for others to replicate. These effects were either excluded from the business case at the insistence of finance functions or again only presented as a qualitative narrative.

One interviewee stated that, while they had come to the strategic conclusion that circular models are the only viable long-term growth path available to their company, this had never been formally modelled. Another described the value of early regulatory positioning as a future competitive advantage that was real but had no place in the current investment case.

The Strategy & Competitiveness dimension therefore captures three value drivers: Customer Lifetime Value Extension; Brand Equity and Access to New Customers;

and First-Mover Advantage in Emerging Circular Markets. It is worth noting that the value drivers described above do not assume that circular models replace linear ones. For the business models in scope, the more realistic and financially significant scenario is that circular and linear models operate alongside and complement each other, mutually reinforcing the overall business value. A remanufactured product line can reach customer segments that the primary linear offering cannot access at its price point without necessarily cannibalising core revenue. A repair programme can deepen relationships with existing customers while a new product line continues to serve others. In the best case, these models interact in a positive manner: circular touchpoints generate data, loyalty and margin that strengthen the linear business, while the linear business provides the volume and asset base that makes circular recovery economically viable, especially during the early stages of the new models.



Organisation & Ecosystem

A third dimension of circular value is rooted in the operational and ecosystem conditions that determine whether a circular model can actually deliver the financial results its business case projects. Logistics networks, partner relationships, data infrastructure and internal staff engagement are not just background conditions but financial variables, as return rates, product condition at intake and per-unit recovery costs are all directly determined by how well these foundations function. Where these foundations are well-designed and actively managed, they generate direct financial value. Where they are underdeveloped, they erode the economics the business case assumes.

Across our interviews, companies described operational capabilities that improved materially as circular volumes scaled, partner arrangements that made circular models viable at significantly lower capital investment, and a data infrastructure whose value accrued across future cycles rather than the current one – none of which was visible in the financial model. **John Fretwell** explicitly flagged this as a critical gap.

John Fretwell, Head of Quality of Screwfix
“Where logistics, partner relationships and staff engagement function well, they directly improve the return rates and recovery volumes the model depends on.”

The framework we propose is designed to address that gap – not by replacing the appraisal processes that companies already use, but by correcting and expanding the inputs that flow into them. **EBITDA, EBITDA**

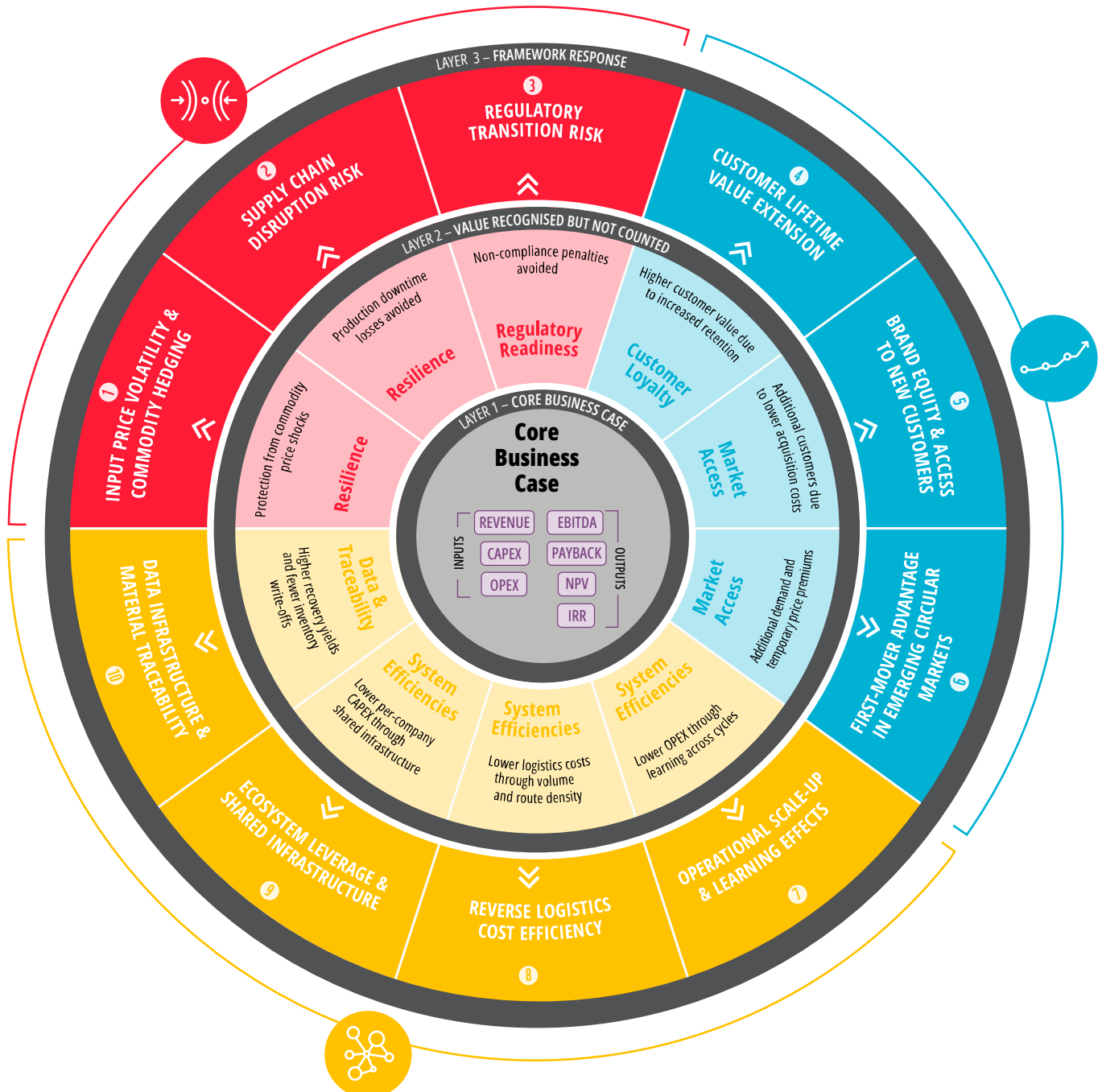
margin, payback period, NPV and IRR remain the primary output metrics; what changes is the completeness of what is incorporated in the individual calculations. In the following part we therefore take a closer look at the ways in which CBMs can create value across three dimensions, while suggesting and explaining quantification approaches for each individual value driver.

The Organisation & Ecosystem dimension therefore captures four value drivers: Operational Scale Up & Learning Effects; Reverse Logistics Cost Efficiency; Ecosystem Leverage and Shared Infrastructure; and Data Infrastructure and Material Traceability.

The value drivers above represent the full scope of circular value that this framework aims to quantify. We describe the proposed methodology in Section 3.

The missing value layer

Same financial model.
Better inputs.



VALUE DRIVER DIMENSIONS

- Risk & Resilience
3 drivers
- Strategy & Competitiveness
3 drivers
- Organisation & Ecosystem
4 drivers

Layer 1: CORE BUSINESS CASE

What the existing financial model captures.

Layer 2: VALUE RECOGNISED BUT NOT COUNTED

Business value that companies recognise, followed by the specific financial effect omitted from the Core Business Case.

Layer 3: FRAMEWORK RESPONSE

The Circular Value Driver that makes the missing value visible and quantifiable.

2.2.4 LIMITATIONS

However, there are boundaries to what is included in these financial calculations. Some of the value that circular models generate, most notably environmental and social benefits such as carbon savings, biodiversity impact and avoided waste, is inherently difficult to quantify in a way that produces figures robust enough to function as direct financial input in an investment appraisal context. This is not a statement about the importance or reality of that value, nor does it reflect on the growing body of work on the financial quantification of environmental impacts. It is a practical boundary condition: for the purposes of this framework, which is designed to produce outputs that can survive scrutiny from finance functions in standard investment processes, we have only included value drivers when the financial impact is direct, traceable and defensible without having to rely on contested valuation conventions. While this report does not aim to quantify the environmental benefit of circular business models, the purpose of enabling the creation and scaling of CBMs through this framework is to create positive environmental and social impacts, which have already been proved in existing studies.⁸

8 WWF-Modell Germany Circular Economy Study and BCG-BDI Circular Economy Opportunities for German Industry May 2026



Some of the value that **circular models** generate is inherently difficult to quantify in a way that produces figures robust enough to function as direct financial input in an investment appraisal context.

1 Diagnose**2 Identify & Prioritise****3 Integrate**

Applying the Framework

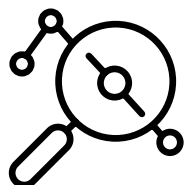
Applying the Framework

The following section takes a closer look at the three steps required to select and integrate circular value drivers into an existing investment appraisal: Diagnose; Identify & Prioritise; and Integrate.

Each step builds on the previous one. The process is designed to be completed before or while building the financial model, though it can also be applied retrospectively to identify value drivers that may have been excluded from an existing business case.

STEP	ELEMENT	DESCRIPTION
1 Diagnose 	Circularity Case Basics	Define the contextual parameters of the investment to determine which value drivers are structurally relevant and which can credibly be quantified
	Internal Process	Map how investment decisions are actually made in the organisation to determine how value driver outputs need to be presented and defended
	Core Business Model	Build the financial baseline using the relevant CBM formula against which value driver uplifts will be measured
2 Identify and Prioritise 	CBM-Type Shortlist	Use the shortlist to identify the most financially material value drivers for the specific CBM type
	Impact Potential x Implementation Feasibility Matrix	Rank candidates across two dimensions to identify which drivers are both significant and applicable in practice
	Final Confirmation	Run a three-criteria check to confirm selected drivers are ready for integration
3 Integrate 	-	Embed the selected value drivers into the existing appraisal using the methodology pages in Section 4, present outputs in the metrics the investment committee already uses and involve the finance function at an early stage to stress-test assumptions and secure internal acceptance

Diagnose



Before considering any value drivers, the diagnostic step establishes three things: the investment context by identifying the business model basics; an analysis of internal processes and potential appraisal constraints; and construction of the core financial baseline. All three are necessary inputs to Step 2.

3.1.1 CIRCULARITY CASE BASICS

Before any value drivers can be selected or applied in any meaningful way, the specific context of the CBM and circular investment must be established. The financial materiality of each value driver depends heavily on seven parameters, which should be worked through before deciding which circular value drivers to integrate.

PARAMETER	EXAMPLE	HOW IT SHAPES THE ASSESSMENT
CBM type	Repair, Reuse/Resell, Remanufacturing/ Refurb., PaaS/Leasing	Provides a starting point for structuring the core revenue and cost model and for screening potentially relevant value drivers
Industry and product category	Automotive, industrial machinery, fashion, CPG, etc.	Shapes material and asset intensity, product lifetime, recovery economics, demand patterns and exposure to industry-specific risks
Position in the value chain	OEM, retailer, logistics provider, etc.	Defines which costs, risks and benefits the company incurs or captures, which levers it controls and what data it can access
Business model stage	Concept/early pilot, scaling pilot, fully scaled/core business	Shapes data availability, ramp-up and volume assumptions, the appropriate estimation method and the level of confidence in the results
Geographic market	Local, country level, regional level (EU, US, Asia), global	Shapes market conditions, infrastructure, input prices, customer demand and the broader regulatory and incentive environment
Relevant regulations	ELV Regulation, Battery Regulation, EPR schemes, CSRD, Right to Repair, etc.	Defines the compliance baseline, timing and potential cash-flow effects, including costs, avoided costs, incentives and market-access implications
Time horizon	3 years, 5 years, 10 years, etc.	Determines how many use cycles, scale-up effects, risks and residual values are captured and must be aligned with the product life cycle and investment
Reference case and assessment boundary	Linear status quo at full input cost, incumbent supplier relationships and existing disposal obligations	Defines which cash flows and risks are incremental, which actors and activities are included and how costs and benefits are attributed
Environmental integrity	Carbon savings from avoided virgin material production, potential rebound effect if circular model grows, total market volume	Confirms whether the circular model is expected to deliver a net environmental benefit compared to the reference case and identifies potential trade-offs or rebound effects



3.1.2 DECISION PROCESS, GOVERNANCE & EVIDENCE REQUIREMENTS

The second component of the diagnostic step maps the organisation-specific decision process within which the circular investment will be assessed. The purpose is not to change the underlying financial relevance of circular value drivers or to lower methodological standards, but to understand the applicable decision gates, metrics, evidence requirements, responsibilities and data ownership. This shapes how results should be validated, translated into existing decision formats and presented to the relevant decision-makers.

The following questions help structure this mapping:

• **What type of** investment decision is being made, and which metrics, thresholds and decision gates apply?

• **Who owns the** decision at each stage, and who is responsible for reviewing or validating the business case?

• **Which functions** own the financial and operational assumptions and will be accountable for delivering the expected costs and benefits?

• **Who holds the** required data, and what level of evidence or assurance is required?

• **How does the** organisation currently treat uncertainty, longer time horizons and strategic or risk-related effects?

The organisational context should not determine whether a financially material value driver is considered. It does, however, affect the evidence available, the confidence of the estimate, the probability that the value can be realised and how the result needs to be presented and received. Where evidence is insufficient, the driver should be addressed through scenarios, ranges or a data improvement plan rather than being automatically excluded. Beyond the value drivers themselves, the organisational context also determines how to engage internal stakeholders in this process from the start.

The second component of the diagnostic step maps the organisation-specific decision process within which the **circular investment** will be assessed.



3.1.3 CORE BUSINESS MODEL

The third component of the diagnostic step is the core business model, which constitutes the financial baseline of a circular investment. It captures the economics of establishing and operating the circular offering and describes how it is expected to generate financial returns under the baseline assumptions.

The core business model captures three financial input categories: revenue lines, which include income from circular activities such as revenue from reuse business models, remanufactured product sales and service or subscription fees; operating cost lines (OPEX), which include labour, logistics, take-back and processing costs, quality assurance and sales costs associated with the circular model; and capital expenditure (CAPEX), which covers upfront investments in equipment, infrastructure, technology systems and setup of the take-back programme. These inputs are combined to produce the primary output metrics used in investment appraisal.

Defining this baseline is necessary in order to be able to expand it and integrate the CVDs, as we first need to establish what the appraisal includes if we are to identify what is missing. The core business model captures the direct economics of creating and operating the circular offering, while Circular Value Drivers capture additional financial effects created by circularity. As a practical distinction, if an effect is necessary to explain how the offering operates and generates revenue, it belongs in the core business model. If the model can operate without the effect, but circularity creates an additional financial advantage that is not yet reflected in the baseline assumptions, it may be assessed as a Circular Value Driver. Each Value Driver selected can then be mapped onto the core business model.⁹

The primary output metrics selected for this framework are EBITDA, EBITDA margin, payback period, NPV and IRR (for definitions, see Appendix F). Based on our interviews, EBITDA, EBITDA margin and payback period dominate in practice and are the most central decision-making KPIs. Both NPV and IRR are the most dominant formal investment appraisal tools and have therefore been included in the formula blocks for the sake of completeness and specifically for investor audiences.

To make this core model concrete and replicable, we have provided a template for the EBITDA calculations and the necessary revenue, OPEX and CAPEX inputs by CBM type in Appendix G. Additionally, Appendix F contains general formulas (not by CBM type) for EBITDA margin, payback period, NPV and IRR, since these are replicable across all business model types and inputs do not differ. These formulas serve as the analytical baseline onto which the value drivers in Section 3.3 can be mapped.

⁹ It is important to mention that this distinction aims to help practitioners to expand and integrate circular value into their financial cases. Sometimes individual CVDs might have already been taken into account when applying the framework and be considered core. This is not an academic exercise to provide the perfect distinction, but rather a practical guide.

Identify and Prioritise



Not all 10 CVDs are equally relevant to every business model type. With the investment context, internal process and financial baseline established, Step 2 proposes two selection tools to arrive at a prioritised shortlist of value drivers.

3.2.1 CBM-TYPE SHORTLIST

To support prioritisation, the framework provides an initial, structured shortlist which has been derived from the literature review and expert interviews and identifies which drivers are most likely to be financially material for a given CBM type. This is provided as an orientation tool and a suggested starting point. Many companies might have already quantified some of the value drivers or will want to include a different/larger selection of CVDs.

The shortlist below maps the most relevant probable CVDs against the four CBM types covered in this report. For each CBM type, three value drivers have been identified across the three axes and are presented without internal prioritisation. The order within each CBM type reflects the framework's axis structure and is not a ranking of financial importance. The basis for the shortlist is indicative rather than definitive. The allocations reflect the combined weight of interview mentions, validation framework feedback and the analytical judgement of the project team and does not come from a statistical sample large enough to support a generalisation.

We therefore encourage companies to go beyond this indicative Top 3 list to map all the value drivers that are most relevant on a case-by-case basis.

BUSINESS MODEL TYPE	MOST RELEVANT CIRCULAR VALUE DRIVER
Repair	- Regulatory Transition Risk - Customer Lifetime Value Extension - Operational Scale-Up & Learning Effects
Reuse/Resell	- Customer Lifetime Value Extension - Brand Equity & Access to New Customers - Reverse Logistics Cost Efficiency
Remanufacturing/ Refurbishment	- Input Price Volatility & Commodity Hedging - Supply Chain Disruption Risk - Customer Lifetime Value Extension
PaaS/Leasing	- Input Price Volatility & Commodity Hedging - Customer Lifetime Value Extension - Data Infrastructure & Material Traceability

Reading across the four CBM types, there are several patterns worth noting. Customer Lifetime Value Extension appears as a relevant driver across three of the four model types, which reflects the consistent finding across interviews that circular touchpoints deepen customer relationships in ways that extend total spend and reduce churn regardless of the specific model structure. Remanufacturing and Refurbishment is the only CBM type where both Input Price Volatility and Supply Chain Disruption Risk appear together, which reflects the often high material intensity of these models, specifically in German industrial sectors, while highlighting the degree to which a functioning take-back system restructures commodity exposure. Repair stands apart in having Regulatory Transition Risk as a leading driver, reflecting the growing regulatory environment around right to repair and extended producer responsibility that is making repair capability a compliance asset as well as a commercial one. The regulatory context might become a core driver for other models at any point.

3.2.2 IMPACT POTENTIAL X IMPLEMENTATION FEASIBILITY MATRIX

The CBM-type shortlist in Section 3.2.1 helps to identify which value drivers are most relevant by business model type. The matrix in the next page adds a second dimension: how these value drivers compare across two criteria that matter when deciding which ones to prioritise in a specific business case – their potential financial impact, and how feasible their implementation is in practice.

The vertical axis details the “Impact Potential”, reflecting a perception-based, indicative assessment of how significantly each value driver could influence the financial business case for a circular investment. This assessment is based on the combined weight of our expert interviews and the frequency of mentions as well as validation rounds and the internal analytical judgement of the project team regarding the overall potential of each driver to materially shift key financial metrics.

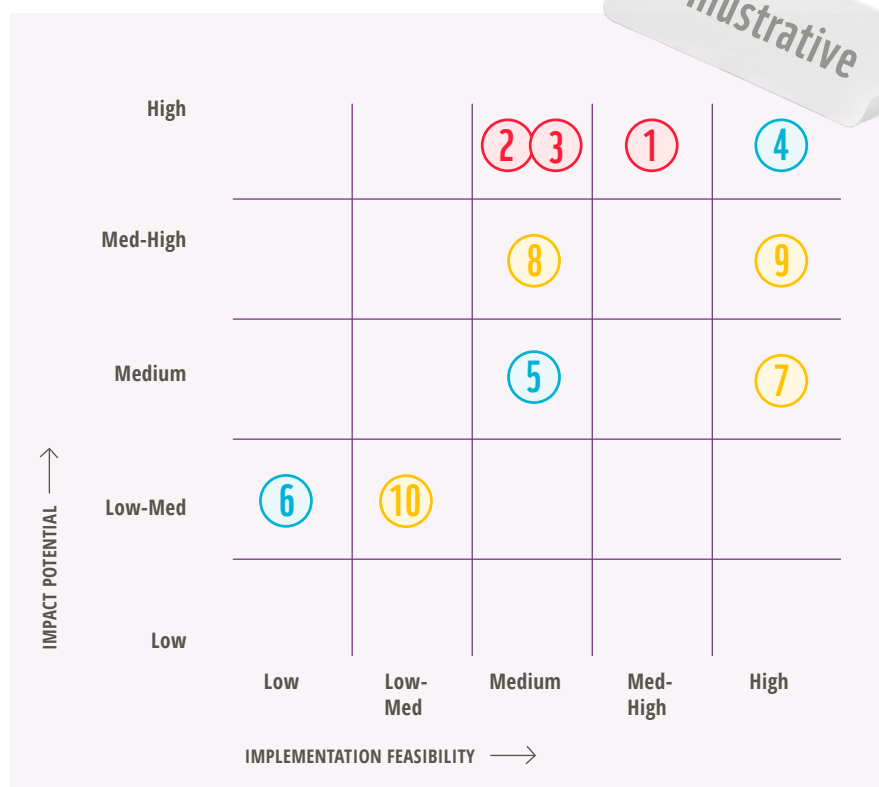
The horizontal axis, “Implementation Feasibility”, reflects how difficult or simple it is for a company building a business case to integrate the value driver in practice. This was assessed across two central dimensions: calculation complexity based on the analytical steps required and the degree of judgement involved in key assumptions; and data requirements based on the type and volume of data typically needed to apply the methodology. CVDs that can be calculated with data most companies already have and have straightforward analytical steps score higher on feasibility, while CVDs that depend on data that is difficult to obtain or require complex modelling score lower.

To ensure that this shortlist is as meaningful as possible, it will need to be adapted and finetuned on a case-by-case basis, with a cross-functional core team being put together to arrive at a common analysis.

Illustrative

VALUE DRIVER

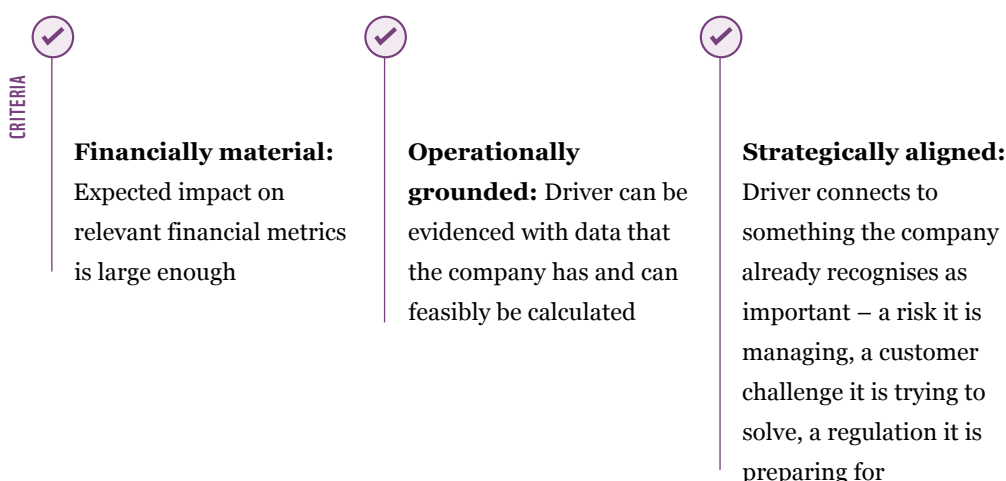
- ① Input Price Volatility & Commodity Hedging
- ② Supply Chain Disruption Risk
- ③ Regulatory Transition Risk
- ④ Customer Lifetime Value Extension
- ⑤ Brand Equity & Access to New Customers
- ⑥ First-Mover Advantage in Emerging Circular Markets
- ⑦ Operational Scale-Up & Learning Effects
- ⑧ Reverse Logistics Cost Efficiency
- ⑨ Ecosystem Leverage & Shared Infrastructure
- ⑩ Data Infrastructure & Material Traceability



This graphic demonstrates how the methodology works and does not represent a standardised assessment. The impact potential and implementation feasibility of each value driver may vary depending on the specific business case.

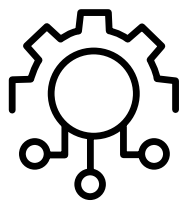
3.2.3 FINAL CONFIRMATION

Before carrying the selected drivers into Step 3, run a final check against the following three criteria to confirm they are ready to be integrated into the business case.



If the selected value drivers meet all criteria, continue to Step 3.

Integrate



Once the CVDs have been selected, integrate them into the existing investment appraisal using the quantification methodology provided in the relevant CVD pages in Section 4.

Each page provides a step-by-step calculation, data requirements and an illustrative example that can be adapted to a specific investment context. The output should be presented as additional inputs to the existing business case in metrics the investment committee already uses – i.e. EBITDA, payback, contribution margin – so that the CVDs and the core model speak the same financial language.

Introducing new value drivers into an established appraisal process requires more than a correct calculation; it requires internal alignment. The finance function should be involved at an early stage both to stress-test the assumptions behind each selected driver and to ensure the methodology is accepted before the business case reaches the investment committee. A value driver that is analytically sound but unfamiliar to the approving function is unlikely to survive scrutiny. Involving the CFO or controlling team during the integration process rather than presenting a finished model is therefore a practical prerequisite for the business case to be taken seriously. Where possible, frame value drivers as corrections to inputs the existing model already contains, since an additive framing is consistently more likely to gain internal approval than one that requires the finance function to accept an entirely new logic.

Each page provides a **step-by-step calculation**, data requirements and an illustrative example that can be adapted to a specific investment context.

Circular Value Drivers: Quantification Approaches

Circular Value Drivers: Quantification Approaches



This section provides the technical foundation for integrating the 10 CVDs detailed in Section 2 into a financial business case and traditional appraisal approaches.

In the following, we present each of the CVDs in a format that remains consistent across all pages, namely: a description of the driver and how CBMs generate it; the CBM type, industry and value chain position for which the value driver is most relevant; a step-by-step quantification methodology; evidence drawn from the companies consulted for this report; limitations & caveats on the methodology; ratings for impact potential and implementation feasibility, each with a score of Low, Medium or High; and an illustrative example calculation with accompanying commentary.

CORE BUSINESS MODEL: KEY ASSUMPTIONS

4.0 Worked Example: Hartmann Machine (Fictional)

All figures are illustrative. Hartmann Machine is a fictional company created for explanatory purposes only.

BUSINESS CONTEXT

Hartmann Machine is a fictional industrial compressor manufacturer based in Germany. The company sells new industrial compressors at €20,000 per unit to a B2B customer base spanning manufacturing, processing and infrastructure operators. The company is evaluating a remanufacturing programme for returned end-of-use units, under which compressors are collected from customers at the end of their first operational life, disassembled, assessed, refurbished or component-replaced to certified as-new standard, and resold as remanufactured units at €16,000, a 20% discount compared to new, reflecting the price sensitivity of the secondary market segment while maintaining full OEM warranty and quality certification. Components that are recovered during disassembly and are not suitable for reuse in refurbishment, such as valves, pistons, control units and sub-assemblies, are sold separately to third-party maintenance and repair workshops at €1,000 per unit in aggregate recovered component revenue.

The programme is evaluated over a 10-year horizon since a shorter horizon would only capture the ramp-up phase and systematically understate the long-term financial case. All figures are constructed assumptions and do not reflect real-world data.

VOLUME AND CUSTOMER ASSUMPTIONS

- Programme grows slowly as logistics are established, then accelerates as the take-back network matures
- Total 10-year volume: 770 units (annual unit volume in example of calculation below)
- Product has a useful life of approximately 10 years (repeat purchases outside of 10-year horizon)
- 770 units are assumed to be purchased by 770 unique customers

REVENUE ASSUMPTIONS

- Remanufactured unit price: **€16,000** per unit (held flat, no price escalation modelled, price structure includes quality & longevity premium)
- Recovered component sales: **€1,000** per unit (assumed for 100% of returned units for simplification)
- Cannibalisation adjustment: 25% of remanufactured unit buyers are estimated to displace new unit purchases
 - » New unit (linear model) contribution margin:
 $€20,000 \times 35\% = €7,000$
 - » Remanufactured unit EBITDA per unit: €5,400
 - » Foregone margin per cannibalised unit:
 $€7,000 - €5,400 = €1,600$
 - » Cannibalisation cost per unit:
 $€1,600 \times 25\% = €400.00 \approx \textbf{€400}$

CAPEX ASSUMPTIONS

- Remanufacturing equipment: €1,400k
- Take-back programme setup: €350k
- Traceability and certification system: €250k
- Working capital: €400k (inventory held across the remanufacturing cycle)
- **Total CAPEX: €2,400k (all incurred in Year 0)**
- Straight-line depreciation over 10 years: €240k per year

OPEX ASSUMPTIONS

- Labour: **€4,500** (disassembly, testing, refurbishment, handling)
- Materials: **€3,500** (new component procurement for the ~40% of components not recoverable from returned units; utility cost savings consolidated here)
- Process cost: **€500** (tooling, overhead, certification)
- QA, sales, other: **€1,500** (warranty provision, customer management, administration, certification costs)
- Logistics: **€1,200** (inbound take-back collection and outbound delivery)
- No learning curve, inflation or scaling efficiencies modelled in baseline

OTHER ASSUMPTIONS

- WACC: 8%
- Horizon: 10 years
- NPV and IRR calculated on annual EBITDA cash flows discounted at 8% ¹⁰
- NPV and IRR are calculated on EBITDA cash flows, excluding tax, ongoing capex and working capital changes – a simplification for illustrative comparability, not a full free-cash-flow valuation.
- Payback: cumulative EBITDA basis (year in which cumulative EBITDA first exceeds €2,400k)

10 EBITDA-based NPV/IRR (excludes tax, recurring capex, working-capital changes) – illustrative, not a full free cash flow valuation

CORE BUSINESS MODEL: CALCULATIONS

Worked Example: Hartmann Machine (Fictional)

All figures are illustrative. Hartmann Machine is a fictional company created for explanatory purposes only.

PER-UNIT ECONOMICS

REVENUE LINE	PER UNIT	OPEX LINE	PER UNIT
Remanufactured unit revenue	€16,000	Labour	€4,500
Recovered component sales	€1,000	Materials	€3,500
Cannibalisation adjustment	-€400	Process cost	€500
Net revenue	€16,600	QA, sales, other	€1,500
		Logistics	€1,200
Net revenue per unit	€ 16,600	Total OPEX	€11,200
- Total OPEX per unit	-€11,200		
EBITDA per unit	€5,400		

ANNUAL EBITDA, PAYBACK PERIOD & NPV

YEAR	UNITS	ANNUAL EBITDA	CUMULATIVE EBITDA	VS CAPEX (€2,400K)	DISCOUNT FACTOR (8%)	PV OF EBITDA
1	20	€108.0k	€108.0k	-€2,292.0k	0.9259	€100.0k
2	30	€162.0k	€270.0k	-€2,130.0k	0.8573	€138.9k
3	40	€216.0k	€486.0k	-€1,914.0k	0.7938	€171.5k
4	50	€270.0k	€756.0k	-€1,644.0k	0.7350	€198.5k
5	60	€324.0k	€1,080.0k	-€1,320.0k	0.6806	€220.5k
6	75	€405.0k	€1,485.0k	-€915.0k	0.6302	€255.2k
7	95	€513.0k	€1,998.0k	-€402.0k	0.5835	€299.3k
8	115	€621.0k	€2,619.0k	+€219.0k	0.5403	€335.5k
9	135	€729.0k	€3,348.0k	+€948.0k	0.5002	€364.6k
10	150	€810.0k	€4,158.0k	+€1,758.0k	0.4632	€375.2k
TOTAL	770					€2,459.2k

SUMMARY: BASELINE BUSINESS CASE

METRIC ¹¹	VALUE
Total CAPEX	€2,400k
EBITDA per unit	€5,400
EBITDA margin per unit	32.5%
EBITDA Year 1 (20 units)	€108.0k
EBITDA Year 5 (60 units)	€324.0k
EBITDA Year 10 (150 units)	€810.0k
Payback period	7.6 years
NPV (8% WACC, 10 years)	+€59.2k
IRR ¹²	~8.4%

11 Formulas for all metrics can be found in Appendix E.

12 For the sake of simplicity, the IRR formula and calculation have not been detailed.

01

Dimension

Risk &
Resilience





4.1 Input Price Volatility & Commodity Hedging

All figures are illustrative. Hartmann Machine is a fictional company created for explanatory purposes only.

DESCRIPTION

Every manufacturer that procures components from external suppliers carries commodity price exposure as a structural feature of its cost base. A remanufacturing programme reduces this exposure by replacing a share of new component procurement with components recovered internally at a stable, fixed cost. When commodity prices rise, a linear competitor absorbs the shock across 100% of its material costs; the remanufacturing model only absorbs that cost across the remaining new procurement share.

The hedge value of this driver is therefore not a saving within the remanufacturing model but the reduction in material costs from component substitution already reflected in the core business model. What this value driver captures is the differential in commodity exposure between linear and circular operations: the additional financial protection against future price volatility that the remanufacturing programme provides and which a standard investment model built on flat commodity price assumptions does not see.

FORMULA

$$\text{EBITDA uplift} = (\text{linear model material costs per unit} - \text{remanufacturing model material costs per unit}) \times \text{P-weighted price shock} \times \text{volume}$$

SHOWCASE INDUSTRIES

- Industrial
- Automotive
- Manufacturing

SHOWCASE CBM TYPES

- Reuse/Resell
- Refurb/Reman

SHOWCASE VALUE CHAIN POSITIONS

- Suppliers
- Producers (OEM)
- Recovery managers

CALCULATION STEPS

1	Material costs differential Linear model material costs per unit – CBM material costs per unit	Establish the differential in commodity-exposed procurement between the linear and circular model per unit. This is the new component procurement that the circular model has structurally eliminated and is therefore shielded from commodity price shocks.
2	Probability-weighted price shock $\Sigma (\Delta \text{ price} \times \text{P-weight})$ applied to the differential	Model mild, moderate and severe commodity price shock scenarios weighted by probability. Apply the P-weighted price shock to the material costs differential to calculate the expected per-unit hedge value across realistic market conditions.
3	Annual EBITDA uplift P-weighted hedge value per unit $\times$ annual volume	Translate the per-unit hedge value into an annual EBITDA uplift by multiplying by the number of units processed in that year. Grows as volume scales across the ramp-up.
4	Hedge cost comparison Reframe take-back cost as procurement risk management	Reframe the take-back programme as a physical commodity hedge since it reduces new procurement exposure while simultaneously generating remanufacturing revenue and operational capability. Benchmark its cost against existing procurement risk management alternatives to shift the CFO conversation from circular cost to risk management value.

COMPANY SUPPORT

“Risk departments systematically underestimate the impact by not pricing in future resource scarcity, with rare earth materials being the obvious example.”
- Axel Berger, Franz Haniel & Cie.

DATA REQUIREMENTS

- Full material costs per unit under linear production (100% new procurement)
- Material costs per unit under remanufacturing model (new procurement only)
- Component substitution rate by material type
- Historical commodity price volatility data for key materials

LIMITATIONS & CAVEATS

- The hedge value is a differential between linear and circular models and not a direct saving within the circular model. This value driver only captures the additional protection against future price volatility.
- The full hedge value is only realised at steady-state recovery volume. During the ramp-up phase, fewer units are processed and the per-year uplift is proportionally smaller. Present the uplift as a growing annual figure rather than a flat assumption.
- Probability weights for price shock scenarios are evaluative. Calibrate against historical commodity price volatility data for the specific materials in the product rather than setting them arbitrarily.
- The hedge cost comparison in Step 4 is directional. Financial futures costs vary by commodity, contract duration and market conditions. Use it as a framing tool for CFO conversations rather than a precise financial input.



Input Price Volatility & Commodity Hedging

All figures are illustrative. Hartmann Machine is a fictional company created for explanatory purposes only.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann's remanufacturing programme recovers approximately 60% of components from returned units, reducing new component procurement from 100% to 40% of the original linear cost base. This means that when commodity prices for steel and copper rise, Hartmann only absorbs the shock on the 40% of new components it still procures, while a linear competitor absorbs that shock across 100%. The questions this value driver addresses are: what is that differential exposure worth in financial terms, and how does it change the investment case?

ASSUMPTIONS

- Linear model material costs per unit:** €8,750 - derived as €3,500 / 0.40, reflecting 100% new component procurement.
- Price shock scenarios:** Three scenarios are evaluative and should be calibrated against historical commodity price volatility data for steel and copper in practice. This driver assumes a price shock of the estimated magnitude occurs every year of the horizon; it is not weighted by the probability that a shock occurs in a given year, unlike the Supply Chain Disruption driver. Treat the resulting EBITDA uplift as an upper-bound estimate rather than a probability-adjusted expected value.

SCENARIO OVERVIEW

SCENARIO	PRICE CHANGE	PROBABILITY WEIGHT
Baseline (no shock)	0%	-
Mild shock	+10%	50%
Moderate shock	+30%	35%
Severe shock	+60%	15%

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
① Material cost differential Linear model: €8,750 per unit CBM: €3,500 per unit (40% new) Differential = €8,750 - €3,500	€5,250 / unit shielded from commodity exposure	These are the material costs per unit that Hartmann has structurally removed from commodity market exposure through the remanufacturing programme. The linear competitor absorbs commodity shocks across €8,750 per unit; Hartmann only absorbs them across €3,500. The €5,250 differential is the hedge.
② P-weighted price shock Mild (+10%) × 50% + Moderate (+30%) × 35% + Severe (+60%) × 15% = weighted average shock of +24.5% applied to €5,250 differential	€1,286 / unit expected price shock value	Across the three commodity shock scenarios, the P-weighted average price increase is approximately 24.5%. Applied to the €5,250 material cost differential, this produces an expected per-unit value of €1,286, which is the average annual benefit of the circular model's reduced commodity exposure across realistic market conditions.
③ Annual EBITDA uplift €1,286 per unit × annual volume (grows with ramp-up)	Year 1: +€25.7k Year 5: +€77.2k Year 10: +€192.9k	The annual hedge value grows with programme volume. At 20 units in Year 1, the uplift is €25.7k. At 60 units by Year 5, it reaches €77.2k. At 150 units by Year 10, it reaches €192.9k. This compounding effect, which grows with both volume and commodity market conditions, is invisible in a standard flat-cost investment model.
④ Hedge cost comparison Reframe the take-back system as procurement risk management	-	Hartmann has no formal hedging strategy for steel and copper price risk. The remanufacturing programme effectively fills that role by eliminating €5,250 of per-unit commodity exposure at no additional cost beyond the take-back infrastructure already justified by remanufacturing revenue.

EFFECT ON THE BUSINESS CASE

EBITDA per unit	+€1,286 = €6,686
EBITDA margin per unit	+7.7% = 40.2%
Payback	-1.5 yrs = 6.1 years
NPV	+€838k = €897.2k
IRR	+4.6% = 13.0%

CONCLUSION

The Input Price Volatility and Commodity Hedging value driver makes a financial benefit visible that was always there but never counted. By structurally removing €5,250 per unit from commodity market exposure, the remanufacturing programme functions as a physical hedge that compounds in value as both commodity prices and recovery volumes grow. The take-back programme stops being a cost of circularity and becomes visible procurement risk management.



4.2 Supply Chain Disruption Risk

Circular material flows as operational continuity insurance against supply chain failure.

DESCRIPTION

Every manufacturer that depends on external suppliers for critical components carries supply chain disruption risk as a structural feature of its operations. When a supplier fails, a logistics route closes or a geopolitical event restricts material flows, a purely linear operation potentially faces significant delays with often expensive alternatives. A company with a functioning remanufacturing programme has an internal component supply stream that operates independently of those external pressures.

This driver also captures physical climate risk: extreme weather events that disrupt supplier operations or close logistics corridors follow the same financial mechanism as any other disruption, and the circular model's internal supply stream provides the same structural protection regardless of the source.

The financial case is straightforward. Each day of production downtime has a calculable EBITDA cost. The circular model reduces the probability and duration of that downtime by eliminating a portion of single-source supply dependency, and that reduction has a quantifiable annual value that belongs in the investment case.

FORMULA

$$\text{EBITDA uplift} = P(\text{disruption}) \times \text{severity-weighted days down} \times \text{daily linear EBITDA} \times \% \text{ substitutable components}$$

SHOWCASE INDUSTRIES

- Industrial
- Automotive
- Manufacturing

SHOWCASE CBM TYPES

- Reuse/Resell
- Refurb/Reman
- PaaS/Leasing

SHOWCASE VALUE CHAIN POSITIONS

- Suppliers
- Producers (OEM)
- Logistics providers

CALCULATION STEPS

- Daily linear EBITDA**
Linear model material cost per unit – CBM material cost per unit
Calculate the daily EBITDA of the existing linear business: the amount lost for each day production stops. This is the financial cost of disruption per day and the baseline for all further steps.
- Severity analysis**
 Σ (severity probability $\times$ days down)
Model three disruption severity scenarios (mild, moderate, severe) and weight them by how likely each is when a disruption occurs. This produces a single expected number of days lost per disruption event that reflects the realistic range of outcomes.
- Annual resilience value**
 $P(\text{disruption}) \times \text{severity-weighted days} \times \text{daily linear EBITDA} \times \% \text{ components substitutable through CBM}$
Apply annual disruption probability to severity-weighted days and daily linear EBITDA to produce the expected annual EBITDA loss under a linear model. Multiply by the proportion of exposure the circular programme eliminates to produce the annual resilience value.
- Make-or-buy**
Take-back OPEX vs insurance premium or buffer stock carrying cost
Reframe the take-back programme as a supply chain risk management instrument. Benchmark its annualised cost against the alternatives a CFO would otherwise consider, e.g. insurance premiums or buffer stock carrying costs, to contextualise the circular investment in treasury language rather than sustainability language.

COMPANY SUPPORT

“During COVID and the Suez Canal crisis, our competitors could not deliver. Due to our circular business model – we could.”

– Wilhelm Mauß, Lorenz

DATA REQUIREMENTS

- Annual linear EBITDA and working days
- Historical disruption frequency for your sector
- Estimated disruption duration by severity
- Single-source exposure by component
- Insurance premium or buffer stock cost as comparator

LIMITATIONS & CAVEATS

- Annual disruption probability and severity scenario weights are evaluative. Use sector-specific historical data and your own supply chain concentration as a starting point and present the result across a range of probability assumptions rather than a single figure.
- The portion of components substitutable through the circular programme does not directly translate to the same portion of protected EBITDA, and the financial impact depends on the criticality of the specific components recovered. Validate the component substitution assumption against the bill of materials and prioritise recovery of those components with the highest criticality.
- Formula captures production downtime costs only. Many disruptions do not halt production entirely but still generate significant additional costs which circular models may also help mitigate. These are not quantified here but should be acknowledged qualitatively when presenting this driver internally.
- Do not double-count revenue continuity lines already in the circular model's core EBITDA.

Supply Chain Disruption Risk

Circular material flows as operational continuity insurance against supply chain failure.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

The value of supply chain resilience is almost always recognised in hindsight. Hartmann's opportunity is to model that value in advance and include it in the investment case. The question here is not whether industrial machinery supply chains will regularly face occurrences of disruption, but what this costs the linear business on average each year, how much of that exposure the remanufacturing programme protects, and whether the take-back system is the most cost-effective way of providing that protection.

ASSUMPTIONS

- Buffer stock comparator:** €420k component inventory at 10% carrying cost = €42k per year – illustrative
- Take-back annualised cost:** infrastructure cost only; does not include logistics OPEX already in core model
- Resilience value held flat across the horizon –conservative; grows in practice with remanufacturing volume

SCENARIO OVERVIEW

SEVERITY	DAYS DOWN	PROBABILITY
Mild	5 days	50%
Moderate	12 days	35%
Severe	25 days	15%
Expected	10.45 days	

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 Daily linear EBITDA 600 units × €7,000 contribution margin = €4,200k / 244 working days	€17,213 / day	Hartmann's linear business generates €4,200k in annual EBITDA from 600 units at a contribution margin of €7,000 each. Divided by 244 working days results in the daily EBITDA at risk when production is disrupted.
2 Severity analysis (5 days × 50%) + (12 days × 35%) + (25 days × 15%)	10.45 days per disruption event	Three severity scenarios reflect the range of disruption outcomes when a disruption occurs that can be found in the scenario overview above. Weighted by their respective probabilities, the expected number of days of downtime per disruption event is 10.45 days.
3 Annual resilience value 15% × 10.45 days × €17,213 / day × 60% components substitutable	+€16.2k / year	An annual disruption probability of 15% is applied, calibrated against industrial machinery sector data. The expected annual EBITDA loss under a linear model is 15% × 10.45 × €17,213 = €27.0k. The remanufacturing programme eliminates 60% of Hartmann's dependency on recovered components which protects €16.2k of that exposure annually through internal supply continuity.
4 Make-or-buy Take-back: €350k / 10 yrs = €35k / yr. Buffer stock: €420k inventory × 10% carrying cost = €42k / yr	Take-back €35k / yr vs buffer stock €42k / yr: take-back is cheaper	The annualised cost of Hartmann's take-back programme setup (€35k / yr) is lower than the cost of maintaining an equivalent buffer stock to protect against the same supply disruption risk (€42k / yr). The take-back system is therefore the more cost-effective supply chain risk management instrument on a pure cost basis, and unlike a buffer stock, it simultaneously generates remanufacturing revenue, deepens customer relationships and contributes to regulatory positioning.

EFFECT ON THE BUSINESS CASE

EBITDA per unit	+€210 = €5,610
EBITDA margin per unit	+1.3% = 33.8%
Payback	-0.3 yrs = 7.3 years
NPV	+€109k = €168.2k
IRR	+0.6% = 9%

CONCLUSION

The Supply Chain Disruption Risk driver adds €16.2k of protected EBITDA per year which is modest in isolation, but has a reframing value that exceeds the number itself. Once the cost of inaction is visible, the take-back programme stops looking like a circularity cost and starts to look like supply chain insurance that also generates revenue.



4.3 Regulatory Transition Risk

Circular investment as proactive compliance and revenue protection against tightening product lifecycle regulations.

DESCRIPTION

Regulatory requirements for product lifecycles are tightening across major markets. EPR schemes, the ELV Regulation, the Battery Regulation, ESPR and CSRD are dated, sequenced obligations with defined penalties and thresholds. Companies that have not built circular capabilities by the time these regulations take effect will face regulatory penalties. Companies that have invested proactively will not.

This value driver converts regulatory risk into a quantifiable expected annual cost by treating compliance failure the same way a CFO would treat any other insurable risk. The circular model reduces that exposure by directly satisfying a portion of the compliance requirements the regulation imposes. The difference between the expected annual cost under a linear model and under a circular model is the financial value of proactive circular investment.

This approach applies to any regulation that carries a financial penalty for non-compliance such as the ones described above. Identify the applicable obligations, estimate the exposure, and calculate by how much the circular model reduces it.

FORMULA

$$\text{EBITDA uplift} = \text{max penalty} \times P(\text{non-compliance of linear model}) \times \% \text{ reduction from circular model}$$

SHOWCASE INDUSTRIES

- Automotive
- Electronics
- CPG

SHOWCASE CBM TYPES

- Refurb/Reman
- PaaS/Leasing

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Retailers (and wholesalers)
- Recovery managers

CALCULATION STEPS

1	Expected fine under linear model Max penalty × P (non-compliance under linear model)	Establish the full expected annual cost of regulatory non-compliance under a linear model – the do-nothing baseline. This is the financial exposure the company carries each year by not investing in circular capabilities. Run separately for each applicable regulation and sum.
2	Fine reduction from CBM % of compliance requirements directly satisfied by the circular model	Estimate by how much the circular model reduces non-compliance probability. This depends on which specific regulatory requirements the circular model directly addresses, such as take-back infrastructure, design for disassembly, lifecycle data, material recovery rates. The higher the coverage, the greater the fine reduction.
3	Annual EBITDA uplift Step 1 × Step 2	Multiply the expected annual fine by the reduction percentage to produce the annual EBITDA uplift – the regulatory cost the circular model eliminates. Add EBITDA to the core model as a recurring annual saving.

COMPANY SUPPORT

“Regulation is the most consistent source of transition risk. Companies that wait until the last moment forfeit the ability to make proactive investments and arrive at compliance with higher costs and no strategic advantage.”

– Head of Sustainability of Electronics Manufacturer

DATA REQUIREMENTS

- Applicable regulations with penalty frameworks and compliance deadlines
- Estimated probability of non-compliance under linear continuation
- Assessment of which compliance requirements the circular model directly satisfies
- Legal input on enforcement probability and actual penalty exposure

LIMITATIONS & CAVEATS

- Always name a specific regulation. A generic regulatory risk argument without a named obligation and penalty framework is not defensible before an investment committee.
- Regulatory timing is uncertain. Present early, on-time and delayed implementation scenarios rather than a single point estimate.
- Penalty quantification and enforcement probability require legal input. Maximum penalty figures are publicly available but actual exposure in a specific company context requires legal judgement.
- The reduction in non-compliance probability depends on which specific requirements the circular model satisfies. Validate against the regulation's compliance criteria before including.





Regulatory Transition Risk

Circular investment as proactive compliance and revenue protection against tightening product lifecycle regulations.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann operates in industrial machinery where the Ecodesign for Sustainable Products Regulation could create concrete and dated compliance obligations around reparability, durability and circular design. The questions here are: what is the expected cost of non-compliance under a linear model, how does it affect Hartmann's business, and how much of that cost does the remanufacturing programme eliminate.

ASSUMPTIONS

- **Applicable regulation:** ESPR – same methodology applies to any regulation with a defined penalty framework
- **Maximum ESPR penalty:** €280k – actual penalty requires legal judgement
- **Fine reduced to zero** for covered requirements – assumes full satisfaction of each requirement; partial satisfaction would produce a proportionate fine reduction
- **Regulatory timing:** assumed on-schedule; present early, on-time and delayed scenarios in practice

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
① Expected fine under linear model €280k max ESPR penalty / 10 years	€28k / year	The maximum applicable penalty is €280k, producing an expected annual regulatory cost of €28k. This is the financial exposure Hartmann carries each year by not investing in circular capabilities. Spreading the maximum penalty evenly across the 10-year horizon is used here as a simplifying proxy for an estimated annual non-compliance probability of 10%.
② Fine reduction from CBM	Fine reduced to 0 for covered requirements	The remanufacturing programme satisfies the ESPR requirements most likely to carry financial penalties for Hartmann's product category and therefore reduces the fine in its entirety.
③ Annual EBITDA uplift Step 1 × Step 2	+€28k / year	Because the circular model fully satisfies the requirements that would otherwise trigger a fine, the full expected annual penalty of €28k is eliminated. This is added to the core model EBITDA as a recurring annual saving for as long as these regulatory requirements remain in force.

EFFECT ON THE BUSINESS CASE

EBITDA per unit	+€364 = €5,764
EBITDA margin per unit	+2.2% = 34.7%
Payback	-0.3 yrs = 7.3 years
NPV	+€188k = €247.2k
IRR	+1.1% = 9.5%

CONCLUSION

The Regulatory Transition Risk value driver converts a risk that most companies acknowledge qualitatively into a quantified annual saving of €28k that belongs in the financial model. The remanufacturing programme eliminates a growing regulatory liability at no additional cost beyond the investment already justified by remanufacturing revenue. As ESPR delegated acts for industrial equipment are finalised and enforcement intensifies, the probability and magnitude of that saving increases.

02

Dimension

Strategy & Competitiveness





4.4 Customer Lifetime Value Extension

Circular touchpoints as a mechanism for deepening customer relationships and increasing total revenue per customer.

DESCRIPTION

Circular business models create structured, repeated interactions with customers that a one-time linear sale does not. A take-back moment, a repair visit or a subscription renewal each deepens the customer relationship, increasing the likelihood that the customer will return, stay longer and spend more over time. The financial consequence is straightforward: a customer who stays longer is worth more than one who buys once and leaves.

This value driver captures the difference in total customer value between a circular and a linear model driven by the higher retention rate that circular touchpoints create. The per-unit margin of a circular transaction may be lower than a new product sale, but the relationship it creates is more durable.

FORMULA

$$\text{CLV} = (\text{margin per period} \times \text{retention rate}) / (1 + \text{discount rate})^{\text{product's useful life}}$$

$$\text{EBITDA uplift} = (\text{CLV circular} - \text{CLV linear}) \times \text{circular customers in that year}$$

SHOWCASE INDUSTRIES

- Fashion
- Electronics
- Retail

SHOWCASE CBM TYPES

- Repair
- PaaS/Leasing

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Retailers (and wholesalers)
- Repair providers

CALCULATION STEPS

- 1 CLV linear model**
 $\text{CLV linear} = (\text{linear margin} \times \text{linear retention rate}) / (1 + \text{discount rate})^{\text{product life}}$
 Calculate the present value of a future repurchase under the linear model. The two key inputs are the unit margin and the probability that the customer will return at end of product life. Discount back to today using the company's WACC and the product's useful life.
- 2 CLV circular**
 $\text{CLV circular} = (\text{circular margin} \times \text{circular retention rate}) / (1 + \text{discount rate})^{\text{product life}}$
 Calculate the present value of a future repurchase under the circular model. The margin per unit may be lower, but the repurchase probability is higher because circular touchpoints deepen the relationship and create switching costs.
- 3 Annual CLV uplift**
 $(\text{CLV circular} - \text{CLV linear}) \times \text{circular customers in that year}$
 Translate per-customer CLV improvement into an annual uplift by multiplying the delta by the number of customers engaging through the circular channel each year. Apply year by year across the ramp-up to reflect how benefit grows as the CBM scales.

COMPANY SUPPORT

“Refurbishment customers stay longer and buy new products. We directly reactivate lapsed customers through the refurbishment channel.”
 - John Fretwell, Screwfix

DATA REQUIREMENTS

- Margin per transaction for linear and circular customers
- Estimated retention rate for linear and circular customers
- Product's useful life
- Number of customers engaged through the circular channel per year

LIMITATIONS & CAVEATS

- Retention rate is the single most sensitive assumption. Small changes produce large changes in CLV, therefore always present the result alongside a sensitivity range across two or three plausible retention scenarios.
- The product's useful life must be aligned with the discount period. For long-lived capital equipment, the future repurchase is heavily discounted, producing a smaller CLV uplift than shorter-cycle products.
- Circular customers may self-report a higher degree of brand loyalty. If customers who choose circular products are already more loyal than average, the CLV uplift may reflect this trait rather than what the circular model does. Validate using real customer data where available.





Customer Lifetime Value Extension

Circular touchpoints as a mechanism for deepening customer relationships and increasing total revenue per customer.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann's remanufacturing programme creates a sustained service relationship with customers whose compressors are collected, assessed and returned as remanufactured units. Each collection and return is a structured touchpoint and an opportunity to demonstrate quality, deepen trust and position Hartmann as a long-term operational partner. The 770 units processed across the 10-year programme represent 770 unique customers, each with a useful product life of approximately 10 years. The question here is what the deeper relationship created by the circular model is worth financially, applied to each year's circular customers as the programme grows.

ASSUMPTIONS

- **Linear retention rate:** 45% – illustrative; reflects probability of returning for servicing, parts or earlier replacement; validate against actual customer data
- **Circular retention rate:** 65% – illustrative; 20pp uplift based on interview evidence from comparable service models; validate once programme is operational
- Retention rate reflects probability of returning for servicing, maintenance or earlier replacement – not annual unit repurchase

ANNUAL UPLIFT OVERVIEW

YEAR (EXCERPT)	UNITS	ANNUAL UPLIFT
1	20	€3.3k
5	60	€10k
10	150	€25.1k

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 CLV linear model $€7,000 \times 45\% / (1.08)^{10} = €3,150 / 2.159$	€1,459 per customer	Hartmann's linear customers generate a margin of €7,000 per unit with a 45% probability of returning for their next compressor purchase at end of product life – approximately 10 years from now. Discounted back at 8% WACC, the present value of that future repurchase is €1,459 per customer. This is what the average linear customer relationship is worth today.
2 CLV circular $€7,400 \times 65\% / (1.08)^{10} = €3,510 / 2.159$	€1,626 per customer	Remanufacturing customers generate a lower per-unit margin of €5,400 – but the take-back relationship increases their repurchase probability from 45% to 65%, reflecting the stronger relationship and switching costs the circular model creates. Despite the lower margin, the higher repurchase probability produces a present value of €1,626 per customer – materially higher than the linear model.
3 Annual CLV uplift $(€1,626 - €1,459) = €167 \text{ delta} \times \text{circular customers in that year}$	See table above	The delta of €167 per-customer is applied to all customers in the CBM each year. Every customer who returns a unit has experienced a circular touchpoint that increases their repurchase probability. The uplift grows as the programme scales, from €3.3k in Year 1 to €25.1k in Year 10.

EFFECT ON THE BUSINESS CASE

EBITDA per unit	+€167 = €5,567
EBITDA margin per unit	+1.0% = 33.5%
Payback	-0.1 yrs = 7.5 years
NPV	+€76k = €135.2k
IRR	+0.4% = 8.8%

CONCLUSION

The CLV Extension driver adds €76k to the NPV of Hartmann's investment case, driven entirely by the higher probability that circular customers will return to Hartmann for their next compressor purchase. Every take-back moment is a structured interaction that a one-time sale does not produce, and that interaction increases repurchase probability from 45% to 65%. With a 10-year product life cycle, the present value of that additional loyalty is €167 per customer, which is modest per transaction, but meaningful across 770 customers as the programme scales.



4.5 Brand Equity & Access to New Customers

Circular programmes as drivers of organic brand growth and lower-cost customer acquisition

DESCRIPTION

Circular business models generate brand value that reduces the cost of acquiring new customers. A remanufacturing story, a take-back programme or a repair service creates organic awareness and word-of-mouth referrals that a purely linear business does not produce and which mean that the same marketing spend reaches more customers, or that the same number of customers can be reached with less spend. The mechanism is measured by the Net Promoter Score (NPS). CBM customers are more satisfied, more likely to recommend the brand and more likely to bring new customers into the funnel without paid acquisitions. This translates into a lower effective cost per customer acquired and thus more reachable customers within the same marketing budget. The financial value is the additional customers the circular model provides access to at no additional marketing cost.

FORMULA

Effective CAC reduction = marketing budget per customer × (NPS uplift × revenue-per-NPS-point / marketing budget)
Additional customers reachable = marketing budget / effective CAC – marketing budget / conventional CAC
EBITDA uplift = additional customers × EBITDA per unit

SHOWCASE INDUSTRIES

- Fashion
- Retail
- CPG

SHOWCASE CBM TYPES

- Repair
- Reuse/Resell

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Retailers (and wholesalers)
- Intermediaries

CALCULATION STEPS

1	NPS differential NPS circular customers – NPS linear customers	Establish the NPS differential between circular and linear customers. A higher NPS means more organic referral and word-of-mouth – the starting point for quantifying the improvement in marketing efficiency the circular model generates.
2	Marketing cost saving per customer NPS uplift × revenue-per-NPS-point benchmark	Convert the NPS differential into marketing cost savings per customer. A higher NPS reduces the effective cost of acquiring each new customer because a portion of the acquisition happens organically rather than through paid channels.
3	Additional customers reachable Marketing budget / effective CAC – marketing budget / conventional CAC	Use the marketing cost saving to calculate how many additional customers become reachable within the same annual marketing budget. Multiply by EBITDA per unit to determine the annual EBITDA uplift from those additional customers.

COMPANY SUPPORT

“The engagement that our repair programme and initiatives like our repair truck bring is enormous and generates significant brand and marketing value.”
 - Willem Swager, Patagonia

DATA REQUIREMENTS

- NPS scores for circular vs standard customers
- Revenue-per-NPS-point benchmark for the relevant sector
- Annual marketing budget

LIMITATIONS & CAVEATS

- NPS-to-revenue conversion benchmarks vary significantly by sector. The relationship between NPS and revenue growth is validated at macro level but is less reliable at product or programme level. Use sector-specific benchmarks and present as a directional range.
- The marketing budget assumption is an addition to the core model and should be validated against actual company marketing spend. The calculation is sensitive to this input.
- This driver is most credible for consumer-facing brands with high media exposure. For industrial B2B companies, NPS-driven referral is less material and estimates should be weighted conservatively.
- Attribution is difficult. Not all new customers who arrive through organic channels can be attributed directly to the circular programme. Use conservative assumptions and flag the attribution explicitly.





Brand Equity & Access to New Customers

Circular programmes as drivers of organic brand growth and lower-cost customer acquisition.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann operates in the industrial B2B sector where NPS-driven referral is less prominent than in consumer markets but not absent. Word-of-mouth referrals among procurement managers and industry networks is a real acquisition channel. By creating a distinctive and documentable circular capability, the remanufacturing programme generates stronger customer advocacy than the primary linear business, meaning Hartmann's existing marketing spend reaches more prospective customers than it would without the circular programme.

ASSUMPTIONS

- NPS circular customers: 58 – illustrative; requires customer survey data to validate
- NPS standard customers: 34 – illustrative; requires customer survey data to validate
- Revenue per NPS point: €180 per year – based on B2B industrial sector benchmarks; varies significantly by sector
- Annual marketing budget: €30k – estimated at 3% of Year 5 revenue of €996k; validate against actual company marketing spend
- Marketing budget held constant – efficiency gain attributed entirely to NPS improvement
- Additional customers treated as incremental to core model volume – not already captured in the 770-unit ramp-up

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 NPS differential NPS circular: 58 NPS standard: 34 Delta: 24 points	+24 NPS points	CBM customers report an NPS of 58 vs 34 for standard customers, which creates a 24-point differential driven by the quality assurance, warranty and service relationship of the remanufacturing model. This stronger advocacy means circular customers are materially more likely to recommend Hartmann to peers in their industry network, generating organic awareness that reduces the need for paid acquisition.
2 Marketing cost saving per customer Marketing budget per customer: €30k / 77 avg customers = €390 / customer NPS uplift value: 24 points × €180 revenue per NPS point = €4,320 / yr Marketing saving per customer: €4,320 / 77 customers = €56 / customer Effective CAC: €390 – €56 = €334 / customer	Effective marketing cost per customer falls from €390 to €334	Hartmann spends approximately €30k per year on marketing for its CBM. This translates to €390 per customer at current volumes. The NPS uplift from the CBM generates an additional organic reach of €4,320 per year, which reduces the effective marketing cost per customer by €56 to €334.
3 Additional customers reachable At €390 / customer: €30k / €390 = 76.9 customers. At €334 / customer: €30k / €334 = 89.8 customers. Additional customers: 89.8 – 76.9 = 12.9 customers / yr × €5,400 EBITDA per unit	+€69.7k / year	Within the same annual marketing budget of €30k, the NPS-driven efficiency improvement allows Hartmann to reach approximately 12.9 additional customers per year. At the core model EBITDA of €5,400 per unit, these additional customers generate an annual EBITDA uplift of approximately €69.7k – customers the marketing budget could not have reached without the brand advocacy the circular programme creates.

EFFECT ON THE BUSINESS CASE

EBITDA per unit	+12.9 = 89.8 / yr
EBITDA margin per unit	+€69.7k / yr
Payback	-0.7 yrs = 6.9 years
NPV	+€468k = €527.2k
IRR	+2.7% = 11.1%

CONCLUSION

The Brand Equity and Access to New Customers driver adds €69.7k of annual EBITDA driven entirely by the circular programme, making Hartmann's existing marketing budget more productive. The same €30k of marketing spend reaches 12.9 more customers per year because circular customers are stronger advocates and bring new contacts into the funnel organically. The circular model does not require additional marketing investment to grow the customer base and instead makes the existing spend more efficient.



4.6 First-Mover Advantage in Emerging Circular Markets

Early circular capability as a structural competitive position when regulation creates mandatory demand

DESCRIPTION

Regulation does not create circular markets overnight but it does create a window of time. Companies that have built circular capabilities before compliance deadlines arrive enter that window with an infrastructure, experience and cost structures that late movers cannot quickly replicate.

The financial logic can be divided into two phases. Early on in the compliance window, when few suppliers can meet the new standard, early movers can command a price premium driven by a scarcity in the supply of compliant products. As the market normalises, the advantage shifts from pricing power to cost leadership: a circular infrastructure that has already been depreciated, learning curves that have already been traversed and supply chains that have already been optimised.

This value driver is formulated as being conditional on regulation; however, circular markets can emerge due to other reasons such as increased consumer demand or specific public procurement guidelines. Therefore the methodology in this value driver can also be adapted and applied to similar cases.

FORMULA

$$\text{EBITDA uplift} = (\text{additional customers from regulation} \times \text{EBITDA per unit}) + (\text{scarcity price premium \%} \times \text{total compliant volume} \times \text{unit price})$$

SHOWCASE INDUSTRIES

- Industrial
- Automotive
- Electronics

SHOWCASE CBM TYPES

- Refurb/Reman
- PaaS/Leasing

SHOWCASE VALUE CHAIN POSITIONS

- Suppliers
- Producers (OEM)
- Recovery managers

CALCULATION STEPS

- Additional customers from regulation**
 First-mover market share × regulated market size / unit price – core model units in each year across the compliance window
 Establish how many additional customers regulation creates on top of the core model volume. The regulated market pulls in buyers who would not have purchased at all without mandatory compliance requirements; these are new incremental customers that have not been included in the core model.
- Scarcity price premium**
 Price uplift % × total compliant volume × unit price, across the compliance window
 Capture the temporary price premium available when regulation bites and few suppliers are compliant. Apply to the total volume of both existing and additional customers in the scarcity window since all compliant units command the premium during this period. Model as a time-limited uplift only.

COMPANY SUPPORT

“First movers that are building closed loop recycling business models will now have a decisive advantage when the recycled content requirements of the battery and ELV regulations come into force in 2031 and 2032, respectively.”

- Sophie Schmidlin & Jean-Denis Curt, The Future is Neutral & Renault

DATA REQUIREMENTS

- Named regulation with specific compliance deadline
- Total addressable regulated market size and unit price
- Realistic first-mover market share estimate
- Price premium estimates from comparable regulated markets

LIMITATIONS & CAVEATS

- This driver is entirely conditional. Present as a scenario overlay, not a baseline input
- Regulatory timing is uncertain. If ESPR is delayed beyond the model horizon, the conditional uplift is zero and the core model must stand on its own.
- First-mover market share is highly evaluative. Use conservative estimates and sensitivity-test explicitly.
- The scarcity price premium is temporary. Model as a time-limited uplift during the compliance window only (typically 2 to 3 years).
- Regulated market size estimates are sensitive to the defined scope of the delegated act. A narrower product scope produces a smaller regulated market.





First-Mover Advantage in Emerging Circular Markets

Early circular capability as a structural competitive position when regulation creates mandatory demand.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann is building its remanufacturing programme today, before the ESPR obligations that will apply to industrial equipment have fully taken effect. ESPR is assumed to create a mandatory demand for compliant remanufactured industrial compressors from 2027 onwards. By Year 3 of regulation, when the compliance market will have been established but most competitors will still be scrambling to comply, Hartmann will already be operational and positioned to capture both additional customers and a scarcity price premium. All figures below are conditional on ESPR arriving on this timeline.

ASSUMPTIONS

- Regulatory trigger: ESPR compliance deadline for industrial equipment expected in 2030 (Year 3) – all figures conditional on this assumption; if delayed beyond Year 10, conditional uplift is zero
- Regulated market size: €8.5m annually by Year 3 of regulation – illustrative; based on current industrial compressor market data adjusted for projected ESPR compliance penetration
- First-mover market share: 12% – conservative estimate; validate against competitive landscape analysis
- Scarcity premium: 8% in Year 3, declining to 5% in Year 4 and 2% in Year 5 – reflects increasing competitive supply as more players achieve compliance
- Scarcity window: approximately 3 years from compliance deadline – as more competitors achieve compliance, pricing normalises

CONDITIONAL UPLIFT – YEARS 3 TO 5

	YEAR 3	YEAR 4	YEAR 5
Core model units	40	50	60
Regulated market units	61	61	61
Additional units from regulation	21	11	1
Additional EBITDA (× €5,400)	€113.4k	€59.4k	€5.4k
Scarcity premium %	8%	5%	2%
Scarcity premium EBITDA	€81.0k	€50.6k	€20.3k
Total conditional uplift	€194.4k	€110.0k	€25.7k

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 Additional customers from regulation Regulated market units: $12\% \times €8.5m / €16,600 = 61$ units. Year 3-5 calculations in table above.	Decrease from 21 to 1 additional unit across Years 3-5	Hartmann's first-mover share of 12% of the €8.5m regulated market implies an approximate annual demand of 61 units. The core model volume ramps up from 40 units in Year 3 to 60 units in Year 5, meaning the gap between regulated demand and core model volume narrows each year. By Year 6, Hartmann's own programme volume has grown to the full regulated market share and this step contributes zero additional units. Each additional unit generates €5,400 in EBITDA.
2 Scarcity price premium Year 3: $8\% \times 61 \text{ units} \times €16,600 = €81.0k$ Year 4: $5\% \times 61 \text{ units} \times €16,600 = €50.6k$ Year 5: $2\% \times 61 \text{ units} \times €16,600 = €20.3k$	Decline from €81.0k to €20.3k across Years 3-5	The scarcity premium applies to the total compliant volume of both existing and additional customers in each year since all compliant units command the premium while few competitors can supply them. The premium declines from 8% in Year 3 to 5% in Year 4 and 2% in Year 5, reflecting an increasing competitive supply as more players achieve compliance. After Year 5 the premium normalises to zero.

EFFECT ON THE BUSINESS CASE

EBITDA Year 3	+194.4k = €410.4k
EBITDA Year 4	+€110.0k = €380.0k
EBITDA Year 5	+€25.7k = €349.7k
Payback	-0.5 yrs = 7.1 years
NPV	+€253k = €312.2k
IRR	+1.6% = 10.0%

CONCLUSION

The First-Mover Advantage value driver produces its largest uplift in Year 3 when the gap between regulatory demand and Hartmann's core model volume is widest, and the scarcity premium is at its peak. As the core model ramps up and more competitors achieve compliance, the additional volume and the price premium both show a natural decline. By Year 6, Hartmann's own programme volume has grown to the regulated market share and the driver has served its purpose: adding €253k to NPV during the critical early compliance window.

03

Dimension

Organisation & Ecosystem





4.7 Operational Scale-Up & Learning Effects

Circular operations as a source of increasing cost efficiency and proprietary capability that improves across cycles.

DESCRIPTION

Circular operations improve with repetition. The first cycle of a remanufacturing programme is the most expensive, as disassembly procedures are refined, quality thresholds calibrated, logistics routes optimised and failure modes encountered for the first time. By the second cycle, these costs have declined. By the third, the operation has developed proprietary knowledge that competitors starting from scratch cannot quickly or cheaply replicate.

A standard 3-to-5 year business case evaluates the circular model almost entirely in its most expensive phase. Cycle 1 carries the highest unit OPEX, the lowest recovery yields and a learning curve that has barely begun. The economics of Cycles 2 and 3, where unit costs have declined materially and the operational model has been refined through repetition, only become visible when the appraisal horizon is extended far enough to reach them. The result is an investment case built on the worst version of the model's unit economics, which is precisely the version most likely to fail to clear the hurdle rate.

FORMULA

$$\text{Unit OPEX (Cycle N)} = \text{Unit OPEX (Cycle 1)} \times (1 - r)^{(N-1)}$$

where $r = 20\%$ for labour and process OPEX; $r = 15\%$ for logistics OPEX

SHOWCASE INDUSTRIES

- Industrial
- Automotive
- Electronics

SHOWCASE CBM TYPES

- Refurb/Reman
- Repair

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Repair providers
- Recovery managers

CALCULATION STEPS

- OPEX reduction per cycle**
 $\text{Unit OPEX (Cycle N)} = \text{Unit OPEX (Cycle 1)} \times (1 - r)^{(N-1)}$
 where $r = 20\%$ for labour and process OPEX, $r = 15\%$ for logistics OPEX
 Calculate the per-unit OPEX in each cycle by applying a fixed reduction percentage to those OPEX components that improve with repetition. Material costs are held flat, and learning effects only apply to labour, process and logistics. The rates are simplified approximations grounded in manufacturing benchmarks; actual rates should be calibrated against observed operational data once the programme is running.
- Multi-cycle unit economics**
 $\text{Unit revenue} - \text{unit OPEX per cycle, across Cycles 1, 2 and 3}$
 Build a per-unit comparison table showing the unit revenue, unit OPEX and contribution margin for each cycle. Depending on the modelled time horizon, either present as OPEX savings or as a value indicator that goes beyond the time horizon to where the economics improve from a long-term perspective.

COMPANY SUPPORT

"The accumulated learning from our refurbishment programme will accelerate the scaling of all future circular business models."
 - Karoline Reperich, Tchibo

DATA REQUIREMENTS

- Cycle 1 unit OPEX broken down by labour, materials, logistics and process
- Observed cost reduction data from pilot phase where available
- Product useful life to determine cycle duration

LIMITATIONS & CAVEATS

- Learning rates are simplified approximations. The 20% and 15% rates are grounded in manufacturing benchmarks but are applied as cycle-based simplifications rather than strict cumulative output doublings. Calibrate against observed operational data from the pilot phase once available.
- Material costs are held flat. Learning effects only apply to labour, process and logistics. In practice, material recovery yields may also improve with experience.
- For products with a 10-year useful life, Cycle 2 begins approximately in Year 11 and Cycle 3 in Year 21. The full multi-cycle benefit falls entirely beyond the standard 10-year model horizon; the value driver should therefore be presented as a long-term value indicator, not as an NPV or payback input.
- Learning effects require operational continuity and sufficient volume. Programmes that are frequently paused or operated at very low volume will not realise the default improvement rates.



Operational Scale-Up & Learning Effects

Circular operations as a source of compounding cost efficiency and proprietary capability that improves across cycles.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

In the core business model, the unit economics of Hartmann's remanufacturing programme are evaluated during Cycle 1; the calculated business case thus reflects the most expensive version of the operation. Each product cycle spans approximately 10 years, meaning Cycle 2 begins approximately in Year 11 and Cycle 3 in Year 21. The full learning effect therefore falls entirely beyond the 10-year model horizon. The analysis below presents the Cycle 2 and Cycle 3 economics as long-term value indicators and a directional statement of what the investment generates after the model window has closed, and why the circular infrastructure Hartmann is building today will increase in value over time.

ASSUMPTIONS

- Learning rate – labour/process/QA: 20% per cycle – simplified approximation; calibrate against observed data
- Learning rate – logistics: 15% per cycle – simplified approximation
- Cycle duration: approximately 10 years – consistent with useful life of industrial compressors
- Annual EBITDA in Cycles 2 and 3 calculated at 150 units – Year 10 volume carried forward
- Long-term NPV figures are indicative and not included in the core model NPV calculation
- Revenue held constant across cycles – no price escalation modelled

MULTI-CYCLE UNIT ECONOMICS

	CYCLE 1	CYCLE 2	CYCLE 3
Net revenue per unit	€16,600	€16,600	€16,600
Materials OPEX	€3,500	€3,500	€3,500
Logistics OPEX	€1,200	€1,020	€867
Labour/process/QA OPEX	€6,500	€5,200	€4,160
Total OPEX per unit	€11,200	€9,720	€8,527
EBITDA per unit	€5,400	€6,880	€8,073
EBITDA margin	32.5%	41.4%	48.6%
Annual EBITDA at 150 units	€810k	€1,032k	€1,211k
EBITDA uplift vs Cycle 1	-	+€222k (+27%)	+€401k (+50%)

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
① OPEX reduction per cycle Materials: €3,500 flat. Logistics Cycle 2: $€1,200 \times (1 - 15\%) = €1,020$ Logistics Cycle 3: $€1,020 \times (1 - 15\%) = €867$ Labour/process/QA Cycle 2: $€6,500 \times (1 - 20\%) = €5,200$ Labour/process/QA Cycle 3: $€5,200 \times (1 - 20\%) = €4,160$	C1: €11,200 C2: €10,520 C3: €9,167 per unit	Learning rates are applied separately to each OPEX component. Material costs are held flat at €3,500 – no learning effect assumed. Logistics improve to 15% per cycle. Labour, process and QA improve to 20% per cycle, reflecting the accumulated experience in disassembly sequencing, quality assessment and operational efficiency. The reductions reflect repetition and know-how – not additional capital investment.
② Multi-cycle unit economics C1: $€16,600 - €11,200 = €5,400$ (32.5%) C2: $€16,600 - €10,520 = €6,080$ (36.6%) C3: $€16,600 - €9,167 = €7,433$ (44.8%)	Margin improves from 32.5% to 48.6% across three cycles	The per-unit contribution margin improves from €5,400 in Cycle 1 to €6,880 in Cycle 2 and €8,073 in Cycle 3 – a margin improvement of 49.5% from Cycle 1 to Cycle 3 with no increase in revenue and no additional capital investment. At 150 units per year – Year 10 volume carried into subsequent cycles – the annual EBITDA improvement from Cycle 1 to Cycle 2 is €222k; from Cycle 1 to Cycle 3, €401k.

EFFECT ON THE BUSINESS CASE

Cycle 1 annual EBITDA (within model horizon, Year 10 at 150 units)	€810k
Cycle 2 annual EBITDA (beyond model horizon, Year 11 onwards)	+€222k = €1,032k
Cycle 3 annual EBITDA (beyond model horizon, Year 21 onwards)	+€401k = €1,211k

CONCLUSION

The Learning Effects driver does not improve Hartmann's 10-year NPV or payback, and its value falls entirely beyond the model horizon. What it does do is reframe the investment itself. The €2,400k of CAPEX Hartmann commits today does not just generate Cycle 1 remanufacturing revenue for 10 years. It builds an operational capability that generates materially higher returns in Cycles 2 and 3 and an additional €589k of indicative NPV from Cycle 2 alone, before Cycle 3 is even counted.



4.8 Reverse Logistics Cost Efficiency

Take-back and recovery operations as a scalable cost advantage that improves materially with volume.

DESCRIPTION

Reverse logistics (the collection, processing and handling of returned products) is one of the most consequential cost lines in a circular business model. Its economics are volume-dependent: per-unit recovery costs decline as collection routes become denser and return volumes grow, meaning that the cost structure at early programme scale is materially different from the cost structure at operating scale.

This volume sensitivity makes trajectory as important as level. The relevant question is what these logistics cost at the volume the model is designed to operate at. Modelling this trajectory rather than applying a single per-unit cost assumption across the full horizon produces a more accurate picture of the CBM's long-run economics.

FORMULA

$$\text{Logistics cost ratio} = \text{reverse logistics OPEX} / \text{total CBM revenue}$$

$$\text{EBITDA uplift} = \text{returned units} \times (\text{core model logistics cost per unit} - \text{modelled logistics cost per unit in that year})$$

SHOWCASE INDUSTRIES

- Industrial
- Automotive
- Electronics

SHOWCASE CBM TYPES

- Refurb/Reman
- Repair

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Repair providers
- Recovery managers

CALCULATION STEPS

- Logistics cost ratio**
 Reverse logistics OPEX / total CBM revenue
 Establish whether the reverse logistics cost is proportionate to the revenue it enables. Compare against sector-specific benchmarks to identify whether logistics are the binding constraint on EBITDA viability or within a defensible range for the sector.
- Logistics cost trajectory**
 Model a year-specific logistics cost per unit trajectory from current volume to operating scale
 Establish how per-unit logistics cost declines as return volumes grow, driven by fixed-cost dilution, route consolidation, backhauling and volume discounts. The trajectory should reflect the specific logistics network and geography of the programme. The gap between the core model's flat cost assumption and the modelled trajectory in each year is the efficiency improvement available as the programme matures.
- Annual EBITDA uplift**
 Returned units × (core model logistics cost per unit – modelled logistics cost per unit in that year)
 Translate the year-specific per-unit logistics improvement into an annual EBITDA uplift. Apply the improvement to each year's actual volume to produce a growing annual uplift that reflects the actual cost trajectory.

COMPANY SUPPORT

“The return stream is our supply; maximising the return rate is therefore existential for our model.”

- Antonia Giessler, Hilti

DATA REQUIREMENTS

- Product life to determine cycle duration
- Current reverse logistics OPEX broken down by fixed and variable components
- Recovery volume at current stage and projected operating volume
- Route density and collection frequency data
- Sector logistics cost benchmarks for ratio comparison

LIMITATIONS & CAVEATS

- Reverse logistics unit costs at early-programme scale are not representative of costs at operating volume. Model the cost trajectory across volume scenarios rather than applying a single per-unit cost assumption across the full horizon.
- Route optimisation savings depend on volume assumptions that are themselves uncertain. If projected recovery volume is not reached on the expected timeline, the logistics cost reduction will materialise later than the model assumes.
- Reverse logistics cost ratios vary significantly by sector, product type and geography. Use sector-specific benchmarks and validate against comparable programmes in the same industry.
- If Operational Scale-Up & Learning Effects is also selected, ensure the two drivers are not applied to the same cost base. Reverse Logistics Cost Efficiency only captures density and scale effects; Operational Learning captures process efficiency improvements.
- This driver is most financially significant for high-value products where recovery value substantially exceeds logistics costs. For low-value or high-weight consumer products, reverse logistics costs may structurally limit the viability of this driver, regardless of volume.



Reverse Logistics Cost Efficiency

Take-back and recovery operations as a scalable cost advantage that improves materially with volume.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann's remanufacturing programme is evaluated in the core business model using a flat, Cycle-1 logistics cost assumption of €1,200 per unit across the full 10-year horizon. In practice, reverse logistics costs decline as return volumes grow: denser collection routes, consolidated pickups and volume-based carrier discounts reduce the cost per processed unit. The analysis below models this cost trajectory on a year-by-year basis, from €1,200 per unit at low volumes down to €750 per unit at Year-10 scale, and translates the growing gap between the flat core-model assumption and the declining modelled cost into an annual EBITDA uplift that builds progressively within the model horizon.

ASSUMPTIONS

- Modelled logistics cost trajectory: €1,200 by Year 3 declining to €750 by Year 10 – illustrative; reflects fixed-cost dilution, route consolidation, backhauling and volume discounts; validate against logistics provider quotes at projected volumes
- No logistics cost improvement assumed in Years 1–3 – volume too low to generate meaningful density benefits
- Logistics cost reduction here reflects density and scale effects only – the 15% logistics learning rate in the Operational Scale-Up & Learning Effects driver captures process efficiency improvements and should not be combined with this trajectory without adjustment
- Industrial equipment logistics benchmark: 4–6% of revenue – validate against sector-specific data

MULTI-CYCLE UNIT ECONOMICS

YEAR	UNITS	MODELLED LOGISTICS COST	UPLIFT PER UNIT	ANNUAL EBITDA UPLIFT
1	20	€1,200	€0	€0
2	30	€1,200	€0	€0
3	40	€1,200	€0	€0
4	50	€1,150	€50	€2.5k
5	60	€1,100	€100	€6.0k
6	75	€1,050	€150	€11.3k
7	95	€950	€250	€23.8k
8	115	€900	€300	€34.5k
9	135	€820	€380	€51.3k
10	150	€750	€450	€67.5k

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 Logistics cost ratio Year 3 logistics OPEX: $40 \times €1,200 = €48k$ Year 3 revenue: $40 \times €16,600 = €664k$ Ratio: $€48k / €664k$	7.2% – above industrial benchmark of 4–6%	At a Year 3 volume of 40 units, Hartmann's logistics cost ratio sits above the 4–6% benchmark for industrial equipment. This signals that logistics are a binding constraint on EBITDA at current scale and that there is an optimisation opportunity as volume grows.
2 Logistics cost trajectory See table above	Decline from €1,200 to €750 per unit	As Hartmann's return volume grows from 40 to 150 units, per-unit logistics costs decline progressively. In early years, sparse routes and low utilisation keep costs high. As density increases, fixed costs are spread across more units, consolidated pickups reduce per-trip costs and volume discounts become available.
3 Annual EBITDA uplift See table above	Growth from €0 in Year 3 to €67.5k by Year 10	In the early years, logistics costs remain at the core model assumption. As volume grows and route density increases, the gap between the flat core model assumption and the actual modelled cost widens, producing a growing annual EBITDA uplift that reaches €67.5k by Year 10.

EFFECT ON THE BUSINESS CASE

EBITDA per unit (yr 10)	+€450 = €5,850
EBITDA margin per unit	+2.7% = 35.2%
Payback	-0.5 yrs = 7.1 years
NPV	+€102k = €161.2k
IRR	+0.6% = 9.0%

CONCLUSION

The Reverse Logistics Cost Efficiency driver produces a growing EBITDA uplift from zero in Years 1–3 to €67.5k by Year 10, driven entirely by the density and scale benefits that accumulate as the programme grows. The core model's flat logistics assumption obscures this trajectory: a business case evaluated at an early stage of logistics economics systematically understates long-run performance. Making the cost curve explicit gives the investment committee a more accurate picture of what they are approving.



4.9 Ecosystem Leverage & Shared Infrastructure

Partner networks as a mechanism for reducing investment barriers, accelerating market entry and scaling beyond capacity.

DESCRIPTION

Circular business models rarely succeed in isolation. Take-back logistics require a collection infrastructure; remanufacturing requires processing capacities; material traceability requires data systems. Building all of these from scratch, alone, is expensive, slow and creates a fixed cost base that only becomes viable at volumes most companies cannot reach unilaterally. Embedding the circular model within a partner ecosystem that shares an infrastructure and distributes capital requirements transforms the investment calculus: when shareable infrastructure costs are distributed across partners, per-company CAPEX falls, payback shortens and projects that have a negative-NPV on a solo basis can become viable.

Not all CAPEX is shareable. Company-specific investments such as remanufacturing equipment, proprietary systems and working capital remain with the individual company. The financial benefit of the partner ecosystem is therefore not a blanket CAPEX reduction but a targeted one: the components of the circular infrastructure that can genuinely be shared across partners are identified, their cost is distributed and the resulting per-company CAPEX is recalculated. This distinction is essential for a credible argument in favour of a shared infrastructure.

FORMULA

$$\text{Shared-case CAPEX} = \text{non-shareable CAPEX} + (\text{shareable CAPEX} / \text{number of partners}) + \text{integration and governance setup costs}$$

$$\text{Shared payback} = \text{shared-case CAPEX} / \text{annual EBITDA}$$

SHOWCASE INDUSTRIES

- Fashion
- Electronics
- Retail

SHOWCASE CBM TYPES

- Refurb/Reman
- PaaS/Leasing

SHOWCASE VALUE CHAIN POSITIONS

- Logistics providers
- Recovery managers
- Intermediaries

CALCULATION STEPS

- Shareable vs non-shareable CAPEX**
 Identify shareable vs non-shareable CAPEX components
 Divide the total circular infrastructure investment into components that can be shared across partners (collection logistics, processing facilities, traceability systems) and components that must remain with the individual company (remanufacturing equipment, proprietary systems, working capital). Only the shareable portion is distributed across partners.
- Shared-case CAPEX**
 $\text{Shared-case CAPEX} = \text{non-shareable CAPEX} + (\text{shareable CAPEX} / \text{partners}) + \text{governance costs}$
 Calculate the per-company CAPEX under the shared infrastructure arrangement. Add an estimate of integration and governance setup costs, such as contractual arrangements, partner coordination and joint venture management, to avoid understating the true cost of the partnership.

COMPANY SUPPORT

“Strategic partnerships across supply chain partners are essential for a successful Circular Economy business.”

- Kristin von Szadkowski, Volkswagen Group

DATA REQUIREMENTS

- Total circular infrastructure CAPEX broken down by component
- Identification of shareable vs non-shareable components
- Number of confirmed or prospective partners
- Governance and integration setup cost estimate

LIMITATIONS & CAVEATS

- A shared infrastructure requires governance that carries its own cost. Joint ventures, contractual arrangements and partner coordination create transaction costs and management time that must be included in the shared-case CAPEX calculation. Do not present the shared payback figure without a governance cost estimate.
- Not all CAPEX is shareable. An explicit distinction must be made, and defended, between shareable and non-shareable components, since a blanket CAPEX reduction across all partners is not credible.
- Partner dependency creates strategic risk. Where the circular model depends on a single logistics or processing partner, supply chain concentration risk is transferred from material suppliers to infrastructure partners rather than eliminated.
- The NPV improvement from CAPEX reduction is a one-time benefit at $t=0$. It does not affect annual EBITDA or the ongoing economics of the circular model.



Ecosystem Leverage & Shared Infrastructure

Partner networks as a mechanism for reducing investment barriers, accelerating market entry, and scaling beyond capacity.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann is evaluating whether to build a take-back and remanufacturing infrastructure on its own or to share an infrastructure with two other industrial equipment manufacturers (a pump manufacturer and a compressor parts supplier) who operate complementary take-back programmes in the same geographic region. The shared infrastructure would cover collection logistics and traceability systems. The remanufacturing equipment and working capital remain a solo investment. The question here is how sharing components affects Hartmann's CAPEX, payback and NPV.

ASSUMPTIONS

- Shareable CAPEX: take-back programme setup €350k + traceability system €250k = €600k
- Non-shareable CAPEX: remanufacturing equipment €1,400k + working capital €400k = €1,800k
- Number of partners: 3 – Hartmann plus two complementary industrial equipment manufacturers
- Hartmann's allocated share of shareable CAPEX: €600k / 3 = €200k
- Governance and integration setup costs: €50k – illustrative; validate against actual contractual and coordination costs
- Total shared-case CAPEX: €1,800k + €200k + €50k = €2,050k
- EBITDA and annual cash flows unchanged – the benefit is a CAPEX reduction only at t=0
- NPV improvement = solo CAPEX minus shared-case CAPEX = €350k

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 Shareable vs non-shareable CAPEX Shareable: take-back programme setup €350k + traceability system €250k = €600k Non-shareable: remanufacturing equipment €1,400k + working capital €400k = €1,800k	Shareable: €600k Non-shareable: €1,800k	The take-back programme setup and traceability system are the components most naturally shared across a regional collection network with collection routes, partner agreements and a tracking infrastructure that benefits all three partners equally. The remanufacturing equipment and working capital are company-specific and reflect Hartmann's own production capacity and inventory requirements and cannot be shared in any meaningful way.
2 Shared-case CAPEX Non-shareable: €1,800k. Allocated share of shareable: €600k / 3 partners = €200k Governance and integration setup costs: €50k Total: €1,800k + €200k + €50k = €2,050k	€2,050k shared-case CAPEX vs €2,400k solo	Under the shared arrangement, Hartmann's per-company CAPEX is €2,050k as well as a reduction of €350k compared to the solo case. The governance cost of €50k is included to reflect the contractual arrangements, partner coordination and joint management required to make the shared infrastructure work. Excluding this cost would overstate the benefit of the partnership.

EFFECT ON THE BUSINESS CASE

EBITDA per unit (yr 10)	+€0 = €5,400
EBITDA margin per unit	+0% = 32.5%
Payback	-0.6 yrs = 7.0 years
NPV	+€350k = €409.2k
IRR	+2.4% = 10.8%

CONCLUSION

The Ecosystem Leverage and Shared Infrastructure driver produces a meaningful improvement to payback and NPV by reducing the upfront investment required to get the CBM operational. A CAPEX reduction of €350k through a shared infrastructure transforms a marginal NPV of +€60k into a clearly positive +€410k and shortens payback by 0.6 years. The mechanism is straightforward: shareable infrastructure is identified, costs are distributed across partners and the per-company investment falls.

The governance cost is a deliberate inclusion. Partnership arrangements carry real coordination costs that are frequently excluded from shared infrastructure arguments; including them produces a more honest and defensible business case.



4.10 Data Infrastructure & Material Traceability

Digital product tracking as a source of operational efficiency, compliance readiness and proprietary data assets.

DESCRIPTION

Circular business models depend on information in a way that linear models do not. Knowing where a product is in its lifecycle, what condition it is in and which components are recoverable are operational prerequisites for closing the loop. Without them, recovery rates are lower, write-offs are higher and the residual value assumptions that underpin multi-cycle economics cannot be validated or improved.

Digital product passports and material traceability systems convert this operational dependency into a financial asset. As product and material data accumulates, the circular model becomes more efficient: recovery rates improve because fewer items are lost or scrapped through traceability gaps; inventory write-offs decline, as the condition and location of components are known at all times. Both effects feed directly into EBITDA through improved recovery yields and reduced inventory loss, respectively.

FORMULA

$$\text{EBITDA uplift} = (\text{recovery rate improvement} \times \text{material OPEX saved per unit}) + (\text{inventory carrying value} \times \text{write-off rate} \times \% \text{ avoidance from traceability})$$

SHOWCASE INDUSTRIES

- Automotive
- Electronics
- Retail

SHOWCASE CBM TYPES

- PaaS/Leasing
- Refurb/Reman

SHOWCASE VALUE CHAIN POSITIONS

- Producers (OEM)
- Logistics providers
- Intermediaries

CALCULATION STEPS

1	Recovery rate improvement Traceability uplift in recovery rate (%) × annual units × material OPEX saved per unit	Quantify the improvement in recovery yield when components are tracked through their lifecycle. Fewer returned units are scrapped due to uncertainty around their condition, with each additional unit that is successfully recovered generating a material saving equal to the avoided cost of procuring a new component. Apply to every year of the programme as volume grows.
2	Write-off reduction Inventory carrying value × write-off rate × % of write-offs demonstrably avoided through traceability	Convert inventory loss into a quantifiable OPEX saving. Apply the write-off rate to the average component inventory value at risk and apply a conservative avoidance rate to reflect that traceability prevents only a portion of write-offs. Ensure this calculation distinguishes component inventory from the returned units already captured in Step 1. Apply to every year of the programme as inventory value grows with volume.

COMPANY SUPPORT

“We are tracking life-cycle data, for example to ensure the trade-in criteria of our coffee machines are met and to evaluate the profitability of refurbishment.”

- Karoline Reperich, Tchibo

DATA REQUIREMENTS

- Current recovery rate and estimated improvement due to full traceability
- Inventory write-off rate and average component inventory value at risk
- Material costs saved per recovered unit
- Realistic estimate of write-off avoidance rate attributable to traceability

LIMITATIONS & CAVEATS

- An improvement in recovery rates due to traceability is difficult to isolate. Besides better data, improved recovery rates may reflect multiple factors – better logistics, higher staff engagement, improved customer communication. A specific attribution to traceability requires controlled comparison data.
- A reduction in write-offs and improved recovery rates must cover distinct asset pools. If both calculations draw on the same returned units or components, double-counting will overstate the combined uplift. Define asset pools explicitly before combining.
- The write-off avoidance rate should be conservative. Traceability only prevents a portion of write-offs – apply a realistic avoidance rate rather than assuming full elimination.
- DPP implementation costs vary enormously by product category and existing IT infrastructure. Obtain an IT implementation estimate before including CAPEX in the model.



Data Infrastructure & Material Traceability

Digital product tracking as a source of operational efficiency, compliance readiness and proprietary data assets.

WORKED EXAMPLE: HARTMANN MACHINE (FICTIONAL & ILLUSTRATIVE)

Hartmann's remanufacturing programme is evaluated in the core business model without accounting for the operational value of digital product tracking. In practice, component-level data on product history, condition and location improves two things directly: it increases the share of components identified as recoverable rather than written off, and it reduces unnecessary write-offs of components discarded due to incomplete information. The analysis below models both effects, an incremental recovery-rate uplift and an avoidable write-off reduction, and translates them into an annual EBITDA uplift that scales with volume across the model horizon.

ASSUMPTIONS

- Recovery rate uplift: 5pp – illustrative; requires comparison of traced vs untraced recovery outcomes from pilot data where available
- Material saving per recovered unit: €3,500 – consistent with material cost assumption in core model
- Inventory write-off rate: 3% of average component inventory value – illustrative; validate against actual write-off records
- Write-off avoidance rate: 60% – conservative assumption reflecting that traceability prevents only a share of write-offs
- Recovery rate improvement covers returned units only; write-off reduction covers existing component inventory – the two asset pools are distinct and do not overlap

ANNUAL UPLIFT

YEAR	UNITS	RECOVERY UPLIFT	WRITE-OFF UPLIFT	TOTAL UPLIFT
1	20	€3.5k	€1.3k	€4.8k
2	30	€5.3k	€1.9k	€7.2k
3	40	€7.0k	€2.5k	€9.5k
4	50	€8.8k	€3.2k	€12.0k
5	60	€10.5k	€3.8k	€14.3k
6	75	€13.1k	€4.7k	€17.8k
7	95	€16.6k	€6.0k	€22.6k
8	115	€20.1k	€7.2k	€27.3k
9	135	€23.6k	€8.5k	€32.1k
10	150	€26.3k	€9.5k	€35.8k

STEP-BY-STEP WALKTHROUGH

STEP	RESULT	WHAT THIS MEANS
1 Recovery rate improvement 5pp uplift × annual units × €3,500 material saving per unit – applied to each year (see table above)	From +€3.5k in Year 1 to +€26.3k in Year 10	Without component-level traceability, a proportion of returned units cannot be fully recovered due to uncertainty about component condition and provenance. Full traceability improves recovery rates by an estimated 5 percentage points in every year of the programme, recovering additional units that would otherwise be scrapped. At a material saving of €3,500 per recovered unit, this produces a growing annual OPEX saving from the first year of operation. This calculation covers returned units only, while the distinct asset pool for Step 2 comprises the existing inventory of components already in the warehouse.
2 Write-off reduction Annual units × €3,500 × 3% write-off rate × 60% avoidance rate – applied to every year (see table above)	From +€1.3k in Year 1 to +€9.5k in Year 10	Approximately 3% of Hartmann's existing component inventory is written off annually due to traceability gaps caused by items being returned to incorrect storage locations, the condition of components deteriorating before processing, and parts that cannot be matched to their source unit. Full traceability is estimated to prevent 60% of these write-offs. Applied to the average component inventory value at risk in each year, this produces a growing annual saving that is distinct from and does not overlap with the recovery rate improvement above.

EFFECT ON THE BUSINESS CASE

EBITDA per unit (Yr 10)	+€238 = €5,638
EBITDA margin per unit	+1.4% = 34.0%
Payback	-0.2 yrs = 7.4 years
NPV	+€109k = €168.2k
IRR	+0.6% = 9.0%

CONCLUSION

The Data Infrastructure and Material Traceability driver produces a meaningful and growing EBITDA uplift from €4.8k per year in Year 1 to €35.8k per year in Year 10, driven by two distinct effects that the core model does not capture. The recovery rate improvement reflects improved decisions about which returned units and components are worth processing. The write-off reduction reflects fewer losses in existing component inventory. Together they add €109k to NPV and add further justification to the €250k traceability system CAPEX that is already in the core model.

4.11 Additional effects not quantified in the framework

The 10 Circular Value Drivers represent effects for which this report provides a standardised quantification approach. They do not claim to capture every way in which circular business models may create economic value. Further effects can arise at company or portfolio level and either depend strongly on organisational context or enable the realisation of other value drivers. These effects should be kept in mind when developing a circular business case, even if they are not quantified or incorporated into the financial model. The following are selected examples of relevant effects that have not been quantified as standalone value drivers in this framework.

Financial Market & Reputational Effects. Credible circular activities can support sustainability targets and, where eligibility criteria are met, improve access to green/sustainability-linked financing and investor interest. Missed public commitments can damage credibility and trigger remediation costs. Customer-facing brand and retention effects fall under Brand Equity & Access to New Customers and Customer Lifetime Value Extension; operational/regulatory risk falls under the Risk & Resilience drivers. This effect is limited to financing and reputational outcomes beyond direct customer impact.

Talent Attraction & Retention. Visible circular initiatives can improve recruitment and retention, especially for specialist roles, and strengthen broader employer perception. However, pay, leadership, culture, location and labour-market conditions also drive these outcomes, making the isolated contribution of any one initiative hard to measure, although a portfolio of credible initiatives may still create a strategically relevant effect across the organisation.

Staff Activation & Incentive Alignment. Tangible circular initiatives help employees understand and apply circular principles, boosting internal ownership and adoption. Misaligned incentives can suppress return rates and offering uptake. Leadership signals and KPIs help convert understanding into behaviour. The resulting financial outcomes are already reflected in the core business model or the relevant value drivers; staff activation therefore primarily influences whether these expected effects are realised in practice.

Organisational Learning & Proprietary Know-how. Building circular business models generates proprietary knowledge, data and cross-functional capabilities that compound over time and are hard to replicate – for example, insights on product condition and material flows can inform R&D, procurement and supply chain decisions. Cost savings within the model are captured by the Operational Scale-Up & Learning Effects driver, traceability benefits by the Data Infrastructure & Material Traceability driver. The residual effect here is knowledge transferability and a broader innovation capability.

Worked Example: Circular Value Drivers Applied

Worked Example: Circular Value Drivers Applied

The company, figures and assumptions in this example are entirely fictional and constructed for illustrative purposes only. They do not represent a real company or real investment decisions.



5.1 Step 1: Diagnose

5.1.1 CIRCULARITY CASE BASICS

Hartmann Machine is a fictional industrial compressor manufacturer based in Germany. The company sells new industrial compressors at €20,000 per unit to a B2B customer base and is evaluating a remanufacturing programme for returned end-of-use units.

PARAMETER	SELECTED OPTION
CBM type	Remanufacturing/Refurbishment
Industry & product category	Industrial & industrial compressors
Position in the value chain	Producers (OEM)
Business model stage	Early scaling – programme under evaluation, not yet operational
Geographic market	Germany
Relevant regulations	Ecodesign for Sustainable Products Regulation (ESPR)
Time horizon	10 years – necessary to capture ramp-up trajectory and long-run economics
Reference case & assessment boundary	Linear model at full new component procurement cost; existing disposal obligations; and incumbent supplier relationships
Environmental integrity	Net material savings from component recovery and extended product lifetime expected, leading to reduced material use and positive environmental externalities

5.1.2 DECISION PROCESS, GOVERNANCE & EVIDENCE REQUIREMENTS

Internally, investment decisions at Hartmann are governed by EBITDA and payback period. The investment committee requires a credible path to positive EBITDA within the first three years and a payback period that is below eight years. NPV and IRR are calculated for the sake of completeness as well as for any external financing conversations. Risk and strategic benefits are currently acknowledged qualitatively but do not enter the financial model as quantified inputs. The finance function holds the procurement and cost data; the sales team holds the customer relationship and retention data. Both need to be involved in the value driver integration process at an early stage.

5.1.3 CORE BUSINESS MODEL

Before any value drivers are applied, the core financial model establishes what the remanufacturing programme generates and costs on its own terms. The full assumptions, per-unit economics and year-by-year calculations are set out in the core business model on pages 33-34. The key outputs are summarised below.

The programme ramps up from 20 units in Year 1 to 150 units in Year 10, totalling 770 unique customers over the 10-year horizon. Net revenue per unit amounts to €16,600 after applying the cannibalisation adjustment. Total OPEX per unit is €11,200, producing an EBITDA of €5,400 per unit and a margin of 32.5%. Total CAPEX amounts to €2,400k incurred in Year 0.

METRIC	VALUE
Total CAPEX	€2,400k
EBITDA per unit	€5,400
EBITDA margin per unit	32.5%
EBITDA Year 1 (20 units)	€108.0k
EBITDA Year 5 (60 units)	€324.0k
EBITDA Year 10 (150 units)	€810.0k
Payback period	7.6 years
NPV (8% WACC, 10 years)	+€59.2k
IRR	~8.4%

The baseline is viable with a positive NPV, and the IRR clears the 8% hurdle, if narrowly. An NPV of €60k on a €2,400k investment and an IRR that is only 0.4 percentage points above the cost of capital means this business case would struggle to survive a sensitivity test or compete for capital against alternative investments. This is the starting point for value driver integration.

5.2 Step 2: Identify and Prioritise



5.2.1 CBM-TYPE SHORTLIST

After consulting the CBM-type shortlist in Section 3.2.1 for remanufacturing and refurbishment, the most relevant value drivers are:

- Input Price Volatility & Commodity Hedging
- Supply Chain Disruption Risk
- Customer Lifetime Value Extension

All three are currently absent from Hartmann's investment appraisal. While they have been acknowledged qualitatively by the management team, they have not been quantified.

commodity price histories are publicly available. The methodology directly maps the materials OPEX line of the core model, and the differential between linear and circular procurement exposure is straightforward to calculate.

Customer Lifetime Value Extension scores high on impact potential and medium on feasibility as the finance function is familiar with the Customer Lifetime Value formula, and the retention rate differential between linear and circular customers is the primary input. The retention rate assumption is the most sensitive variable and will need validating against actual customer data once the programme is operational.

Supply Chain Disruption Risk scores medium-high on impact potential but lower on feasibility. This driver is potentially material given Hartmann's single-source component dependencies, but the company does not yet hold historical supply disruption data of sufficient quality to produce a defensible quantification.

5.2.2 IMPACT POTENTIAL X IMPLEMENTATION FEASIBILITY MATRIX

Input Price Volatility & Commodity Hedging scores high on both impact potential and implementation feasibility, as Hartmann holds internal material cost data, and

FINAL CONFIRMATION

DRIVER	FINANCIALLY MATERIAL	OPERATIONALLY GROUNDED	STRATEGICALLY ALIGNED	DECISION
Input Price Volatility & Commodity Hedging	Yes – steel and copper are significant and historically volatile	Yes – internal cost data and public commodity histories available	Yes – procurement risk is already an active concern for the finance team	Selected
Customer Lifetime Value Extension	Yes – repurchase probability improvement increases across the 770-unit horizon	Yes – customer data available; CLV formula familiar internally	Yes – customer retention is a recognised strategic priority	Selected
Supply Chain Disruption Risk	Yes – single-source dependencies make this material	Not yet – disruption frequency data unavailable at required quality	Yes - supply chain risk is actively discussed internally	Not selected



5.3 Step 3: Integrate

The two value drivers that have been selected should now be integrated into Hartmann's investment appraisal as additional inputs to the core model.

The full quantification methodology, step-by-step calculations, assumptions and limitations for each driver are set out in the value driver deep dive pages in Section 4. (Input Price Volatility & Commodity Hedging: Section 4.1; Customer Lifetime Value Extension: Section 4.5). What follows is a summary of the key findings from each and the combined effect on the business case.

5.3.1 VALUE DRIVER 1: INPUT PRICE VOLATILITY & COMMODITY HEDGING (SECTION 4.1)

Hartmann's remanufacturing programme recovers approximately 60% of components from returned units, reducing new component procurement from 100% to 40% of the linear cost base. The linear model's full material cost per unit is €8,750, while the remanufacturing model's material cost is €3,500. The differential of €5,250 per unit represents commodity-exposed procurement that the circular model has structurally eliminated.

Applying a probability-weighted commodity price shock across three scenarios produces a P-weighted average shock of approximately 24.5%. Applied to the €5,250 differential, this yields a hedge value of €1,286 per unit, growing with programme volume from +€25.7k in Year 1 to +€192.9k in Year 10.

METRIC	UPLIFT	UPDATED VALUE
EBITDA per unit	+€1,286	€6,686
EBITDA margin per unit	+7.7%	40.2%
Payback period	-1.5 years	6.1 years
NPV (8% WACC, 10 years)	+€838k	+€897.2k
IRR	+4.6%	13.0%

5.3.2 VALUE DRIVER 2: CUSTOMER LIFETIME VALUE EXTENSION (SECTION 4.5)

Hartmann's remanufacturing programme creates a structured service relationship with every customer whose compressor is collected and returned. The 770 units across the 10-year programme represent 770 unique customers, each with a useful life of approximately 10 years. The circular touchpoint increases the probability that these customers will return to Hartmann when their next compressor purchase is due.

Linear customers generate a CLV of €1,459, while circular customers generate a CLV of €1,626, which creates a delta of €167 per customer. Applied year by year to the full programme volume, the uplift grows from €3.3k in Year 1 to €25.1k in Year 10.

METRIC	UPLIFT	UPDATED VALUE
EBITDA per unit	+€167	€5,567
EBITDA margin per unit	+1.0%	33.5%
Payback period	-0.1 years	7.5 years
NPV (8% WACC, 10 years)	+€76k	+€135.2k
IRR	+0.4%	8.8%

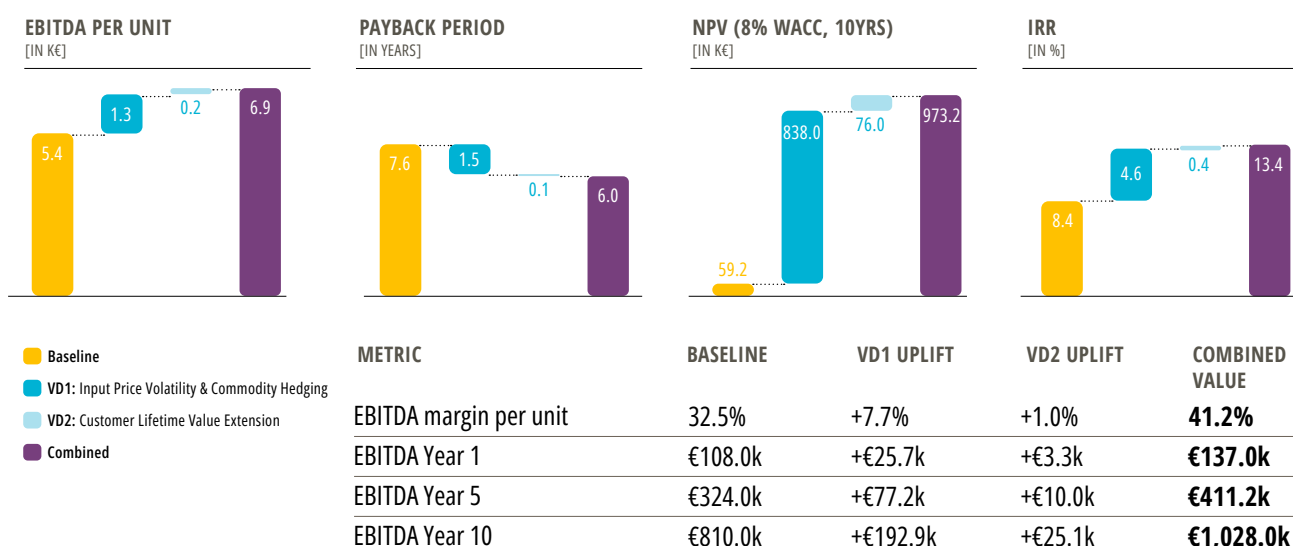
5.3.3 COMBINING THE TWO VALUE DRIVERS

In this case, the two drivers operate through different mechanisms and do not depend on the same underlying assumptions, meaning they can be treated as additive in this example without a risk of double-counting.

It is important to flag that simple additivity is not always appropriate. Where two value drivers depend on the same operational variable – for example, where both CLV extension and reverse logistics efficiency depend on the same return rate assumption – direct addition bears the risk of double-counting. In these cases, a discount should be applied to the combined figure and the sensitivity of the result compared to the shared assumption should be tested explicitly. The worked example here has intentionally been constructed in a way that ensures the two drivers are independent; however, this will not always be the case in practice.

HARTMANN
WORKED
EXAMPLE

IMPACT OF THE SELECTED VALUE DRIVERS ON KEY FINANCIAL METRICS



This example demonstrates that – provided each is applied to the core financial model with transparent assumptions and explicit caveats – two value drivers can transform a business case that would struggle to clear the investment hurdle into one that is compelling. NPV increases from +€60k to +€973.2k; IRR rises from 8.4% to approximately 13.4%; the payback period is reduced from 7.6 to 6 years.

This example does not aim to demonstrate that every remanufacturing business case will improve by this magnitude, as the inputs are illustrative, and results will vary significantly by sector, product and market context. What it does show is the mechanism: two value drivers, each applied to a specific line in the core financial model, with transparent assumptions and explicit caveats, produce a substantially more complete picture of the investment than the baseline alone. A circular model that looks viable in the core model becomes significantly more compelling when the genuine value it creates is made visible. That is the purpose of this framework.

Conclusions & Implications



6.1 For companies

The framework presented in this report can function as a translation tool. Its purpose is to convert the genuine value that CBMs create into the language of traditional financial appraisal by ensuring that the inputs incorporated into existing financial models are more complete. In doing so, it can help companies pursue circularity not only as a means of meeting sustainability objectives, but as part of building more competitive and resilient business models in an industrial landscape increasingly shaped by climate-, nature-, resource- and supply-chain-related risks.

The primary call to action addresses CSOs, strategy leads, sustainability leads and circular economy champions who are preparing to make the financial case for a circular investment within their company. The framework is explicitly designed for this process and for the conversations with finance and controlling that too often fail, not because the circular model lacks merit, but because its merit has not been expressed in terms that financial decision-making processes can act on. While the framework does not construct the business case for you, it helps ensure that the financially relevant circular economy value is not excluded from the assessment by default.

The next step is application. Companies are encouraged to use the framework on real investment decisions, to test which CVDs are financially material in their specific context, and to involve finance functions in validating the underlying assumptions and evidence at an early stage.

The project partners are particularly interested in working with companies willing to apply the framework to an actual circular investment case and develop practical case studies from that experience. These applications can provide companies with a structured way to strengthen individual investment cases while generating practical evidence on where and how the framework creates value.

6.2 For investors

CBMs are routinely treated as riskier than their linear counterparts and attract higher risk premiums, face greater scrutiny in due diligence and encounter more conservative financing terms. In most cases, this treatment is due to unfamiliarity rather than a rigorous assessment of risk.

The Risk & Resilience drivers identified in this framework are directly relevant to investment due diligence. Supply chain resilience, input price hedging through material recovery and proactive regulatory compliance are established risk categories. CBMs address each of them in ways that linear models often cannot for structural reasons. A company with a functioning take-back and remanufacturing programme has a degree of insulation from commodity price shocks that a purely linear competitor does not.

Therefore, incorporating CVDs into lending criteria, credit assessments and investment decisions can produce a more accurate risk-adjusted view of circular assets. For models that are economically robust but often subject to an unfamiliarity premium, this correction could potentially improve access to capital and reduce financing costs.

Public investors specifically play a distinct role in mainstreaming the financial appraisal of circular business models. Unlike commercial lenders, they operate with an explicit mandate to support systemic transition and can tolerate longer payback horizons and higher uncertainty than private investors. By incorporating circular value drivers into their decision making process, public investors can directly address the financing gap that unfamiliarity creates and signal to commercial markets that circular assets are investable.

6.3 For policymakers

Across the interviews and literature reviewed for this report, interviewees and sources consistently described policy as one of the most powerful enablers of circular value, while the absence, delay or dilution of policy is perceived as one of the most significant barriers. Several of the value drivers identified in this framework are directly dependent on credible regulatory signals. The avoidance of regulatory compliance risk only generates financial value if the regulation in question is substantive and implemented as scheduled. A first-mover market access advantage only materialises if the market the regulation promises to create actually arrives. Companies that have invested in circular infrastructure in anticipation of regulatory requirements that were subsequently weakened or delayed have faced real write-down costs. This suggests that policy consistency is not a background condition for circular investment but a financial variable.

For policymakers, this results in two options that are worth considering.

The first could be to support market-led initiatives in developing a standardised circular business case methodology. A common framework for evaluating circular investments, developed jointly by industry, experts and standard setters would improve overall comparability, increase investor confidence, and integrate CVDs into mainstream financial decision-making. There are existing precedents that may serve as instructive examples: the Task Force on Climate-related Financial Disclosures (TCFD) and the Greenhouse Gas Protocol (GHG Protocol) originated as voluntary, market-driven standards before policymakers formally integrated them into regulatory frameworks (such as IFRS S2 or CSRD). A circular business case standard could follow a comparable trajectory, beginning as a voluntary methodology that is subject to market adoption, methodological robustness, auditability and interoperability with existing standards and subsequently informs regulatory requirements.

The second could be to integrate CVDs into public funding and procurement criteria. Evaluation frameworks for public funding schemes, such as the EU Innovation Fund, and public procurement rules could consider moving beyond upfront costs to explicitly reward long-term value creation. Residual asset value, resource resilience, lifecycle revenues and the cost of inaction relative to the linear alternative are all quantifiable and can be assessed alongside conventional financial metrics. Procurement criteria that reward circular value could create signals on the demand side that make the business case for circular investment more straightforward to construct.

6.4 For technical experts and change makers

This framework is intended as a first contribution, not a finished methodology. Its long-term value will depend on how well the proposed CVDs and quantification approaches hold up under expert scrutiny and across different sectors, business models and investment contexts.

The project partners therefore invite finance and circular economy practitioners, researchers, investors, auditors and assurance professionals, consultants and other technical experts to challenge the framework, test its assumptions, share evidence and contribute to its further development. The aim is to build an expert community that can strengthen the methodology over time and help establish a robust, tried-and-tested reference for integrating circular value into mainstream investment appraisal.

Across the interviews and literature reviewed for this report, interviewees and sources consistently described **policy as one of the most powerful enablers of circular value**, while the absence, delay or dilution of policy is perceived as one of the most significant barriers.

Reference List

- Boston Consulting Group [BCG] and the Federation of German Industries [Bundesverband der Deutschen Industrie, BDI]. 2026. "Growth, competitiveness and resilience: the opportunities the circular economy offers German industry." [Wachstum, Wettbewerbsfähigkeit und Resilienz: Chancen der Circular Economy für die deutsche Industrie.] https://bdi.eu/media/pages/specials/industry-spotlight-circular-economy-studie/f9ba7d99d4-1777457891/26-04-28-circular-economy_bcg-bdi_de_langversion-studie.pdf.
- Chen, James. 2026. "Understanding EBITDA Margin: Definition, Formula, and Strategic Use." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/e/ebitda-margin.asp>.
- DEFINITE Consortium Partners. 2025. "DEFINITE-CCRI Project Evaluation Guidebook." 2025. <https://tool.definite-ccri.eu/>.
- Fernando, Jason. 2026a. "Capital Expenditure (CapEx): Definitions, Formulas, and Real-World Examples." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/c/capitalexpenditure.asp>.
- . 2026b. "Internal Rate of Return (IRR): Formula and Examples." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/i/irr.asp>.
- . 2026c. "Net Present Value (NPV): What It Means and How to Calculate It." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/n/npv.asp>.
- Gigli, Silvia, Daniele Landi and Michele Germani. 2019. "Cost-benefit Analysis of a Circular Economy Project: A Study on a Recycling System for End-of-life Tyres." *Journal of Cleaner Production* 229 (April): 680–94. <https://doi.org/10.1016/j.jclepro.2019.03.223>.
- Gonçalves, Beatriz De Souza Mello, Flávio Leonel De Carvalho and Paula De Camargo Fiorini. 2022. "Circular Economy and Financial Aspects: A Systematic Review of the Literature." *Sustainability* 14 (5): 3023. <https://doi.org/10.3390/su14053023>.
- Graham, John R. 2022. "Presidential Address: Corporate Finance and Reality." *The Journal of Finance* 77 (4): 1975–2049. <https://doi.org/10.1111/jofi.13161>.
- Hansen, Erik G., Florian Lüdeke-Freund and Klaus Fichter. 2022. *Circular Business Model Typology: Actor, Circular Strategy, and Service Level*. University Library Linz Repository (Johannes Kepler Universität Linz). <https://doi.org/10.35011/iqd.2020-01>.
- Hayes, Adam. 2025. "Revenue: Definition, Formula, Calculation, and Examples." 2025. Accessed 20 July 2026. <https://www.investopedia.com/terms/r/revenue.asp>.
- . 2026. "EBITDA: Definition, Calculation Formulas, History, and Criticisms." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/e/ebitda.asp>.
- Hoffmann, Niklas and Martin Perau. 2026. "Circular Economy Business Case Calculator." Data set. Zenodo (CERN European Organization for Nuclear Research). <https://doi.org/10.5281/zenodo.20326386>.
- Kagan, Julia. 2026. "Payback Period: Definition, Formula, and Calculation." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/p/paybackperiod.asp>.
- MSCI. 2023. "The Global Industry Classification Standard (GICS®)." 2023. <https://www.msci.com/indexes/index-resources/gics>.
- Paljug, Katharine. 2026. "Operating Costs: Key Types, Formulas, and Examples." 2026. Accessed 20 July 2026. <https://www.investopedia.com/terms/o/operating-cost.asp>.
- Position Green. 2026. "Calculate Your Sustainability ROI and Business Impact." 2 March 2026. <https://www.positiongreen.com/drive-business-value/roi-calculator/>.
- ResCoM. n.d. "The ResCoM platform and tools." <https://www.rescoms.eu/platform-and-tools.html>.
- Rodrigo-González, Amalia, Alfredo Grau-Grau and Inmaculada Bel-Oms. 2021. "Circular Economy and Value Creation: Sustainable Finance With a Real Options Approach." *Sustainability* 13 (14): 7973. <https://doi.org/10.3390/su13147973>.
- Saarinen, Arttu and Leena Aarikka-Stenroos. 2022. "Financing-Related Drivers and Barriers for Circular Economy Business: Developing a Conceptual Model From a Field Study." *Circular Economy and Sustainability* 3 (3): 1187–1211. <https://doi.org/10.1007/s43615-022-00222-5>.
- Sitra, Technology Industries of Finland and accenture. 2018. "Circular Economy Playbook." Teknologiateollisuus Ry. 2018. <https://teknologiateollisuus.fi/circular-economy-playbook/>.
- Sustainability Advantage. 2026. "Project Level Business Case | Sustainability Advantage." Sustainability Advantage | Resources for Sustainability Champions. 12 March 2026. <https://sustainabilityadvantage.com/businesscases/project-level-business-case/>.
- The German Environment Agency [Umweltbundesamt, UBA]. 2025. "UBA Tool to Calculate Life-Cycle and CO2 Costs." [UBA-Tool zur Berechnung von Lebenszyklus- und CO₂-Kosten.] The German Environment Agency. 2025. <https://www.umweltbundesamt.de/themen/neues-uba-tool-zur-berechnung-von-lebenszyklus-co2>.
- VDI Center for Resource Efficiency (VDI ZRE). n.d. "Cost Calculator." <https://www.resource-germany.com/tools/cost-calculator/>.
- VITO, Econocom and Foundation for Future Generations. 2026. "Home - My Website." CEvaluator. 2026. <https://cevaluator.be/en>.
- Vosecky, Vojtech. 2025. "Circular Business Case Calculator." 2025. <https://circularcalculator.lovable.app/>.
- WWF, 2023, "Modell Deutschland Circular Economy". <https://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/Unternehmen/WWF-Modell-Deutschland-Circular-Economy-Broschuere.pdf>

Appendices

Appendix A: Industries, circular business model types and value chain actors for which each circular value driver is probably the most relevant¹³

DIMENSION	CIRCULAR VALUE DRIVER	INDUSTRIES	CBM TYPES	VALUE CHAIN ACTORS ¹⁴
 Risk & Resilience	Input Price Volatility & Commodity Hedging	Industrial, Automotive, Electronics	Reuse/Resell, Refurb/Reman	Suppliers, producers (OEM), recovery managers
	Supply Chain Disruption Risk	Industrial, Automotive, Electronics	Reuse/Resell, Refurb/Reman, PaaS/Leasing	Suppliers, producers (OEM), logistics providers
	Regulatory Transition Risk	Automotive, Electronics, CPG	Refurb/Reman, PaaS/Leasing	Producers (OEM), retailers (and wholesalers), recovery managers
 Strategy & Competitiveness	Customer Lifetime Value Extension	Fashion, Electronics, Retail	Repair, PaaS/Leasing	Producers (OEM), retailers (and wholesalers), repair providers
	Brand Equity & Access to New Customers	Fashion, Retail, CPG	Repair, Reuse/Resell	Producers (OEM), retailers (and wholesalers), intermediaries
	First-Mover Advantage in Emerging Circular Markets	Industrial, Automotive, Electronics	Refurb/Reman, PaaS/Leasing	Suppliers, producers (OEM), recovery managers
 Organisation & Ecosystem	Operational Scale-Up & Learning Effects	Industrial, Automotive, Electronics	Refurb/Reman, Repair	Producers (OEM), repair providers, recovery managers
	Reverse Logistics Cost Efficiency	Fashion, Electronics, Retail	Reuse/Resell, Refurb/Reman, PaaS/Leasing	Logistics providers, recovery managers, retailers (and wholesalers)
	Ecosystem Leverage & Shared Infrastructure	Fashion Electronics, Retail	Refurb/Reman, PaaS/Leasing	Logistics providers, recovery managers, intermediaries
	Data Infrastructure & Material Traceability	Automotive, Electronics, Retail	PaaS/Leasing, Refurb/Reman	Producers (OEM), logistics providers, intermediaries

¹³ Industries, CBM types and value chain actors are indicative rather than empirically exhaustive. While informed by patterns observed across the interview sample, they reflect the WWF/Quantis analysis rather than a direct quantitative finding.

¹⁴ Producers (OEM) appear prominently across nearly all value drivers because the framework development process focused on OEM investment decision-making; this concentration reflects the framework's intended audience rather than the finding that other value chain actors are less relevant to circular value creation.

Appendix B:

Circular business model typology and scope¹⁵

#	TYPE	CBM/ R-STRATEGY	DEFINITION	INCLUDED IN SCOPE?
R0	Use and create products in a smarter way	Refuse	Prevent the use of products and raw materials in the creation of goods, processes and services	No
R1		Rethink	Reconsider the ownership, use and maintenance of products	No
R2		Reduce	Decrease the use of raw materials in products and services	No
R3	Extend the lifespan of products and parts	Reuse/Resell	Secondary use of products by another owner for the same intended purpose	Yes
R4		Repair	Maintain and repair existing products for extended use	Yes
R5		Refurbishment	Restore and improve products to a satisfactory condition for extended use	Yes
R6		Remanufacturing¹⁶	Make more products with the same purpose using discarded products or parts	Yes
-		Product-as-a-Service/ Leasing¹⁷	Provide access to a product's function through leasing, subscriptions or a usage-based fee, with the provider retaining ownership and end-of-life responsibility.	Yes
R7	Practical use of materials	Repurpose	Make new products with a different purpose using discarded products or parts	No
R8		Recycle	Process waste into new products or materials that can be used for new products	No
R9		Recover	Process waste to recover energy	No

¹⁵ Based on Circularise (2023) & Circular Value Institute (2025)

¹⁶ Refurbishment and remanufacturing have been grouped together throughout this report due to the similarities in business case development and financial appraisal methodology.

¹⁷ Product-as-a-Service and leasing are not traditional R-Strategies but describe ownership and revenue models. They have been treated as a distinct business model type due to their empirical relevance and particular financial appraisal methodology.

Appendix C:

Criteria for inclusion as a circular business model¹⁸

#	CONDITION	DESCRIPTION
1	Deliberate recovery	The return of the product or component after initial use must be an intentional, organised part of the business model, not an incidental by-product of operations
2	Productive re-entry	The recovered product, component or material must re-enter productive use (resale, repair, refurbishment, remanufacturing or redeployment in a service model) and retain meaningful product or component value
3	Separable financial footprint	The circular activity must generate its own revenue streams, cost structure, or both, in a distinct enough manner to be evaluated as a standalone business case

¹⁸ Qualifying conditions developed based on the Quantis/WWF analysis.

Appendix D: Existing frameworks for the financial valuation of circularity¹⁹

Existing approaches are either broad but lack methodological value quantification or financially rigorous but incomplete with selective coverage of circular value drivers. Neither bridges the gap between identifying circular value and producing investment-grade financial inputs that withstand internal scrutiny. Also, the adoption of these tools is still limited, underscoring the need for a common, generalisable framework.

FRAMEWORK	DEVELOPED BY	DESCRIPTION
ResCoM Platform and tools	ResCoM (Resource Conservative Manufacturing) – co-funded by EU Commission	11 different tools to support decision-making and implementation of closed-loop product systems (including tools to assess economic performance and profitability)
CEvaluator	Circular Impact Investing project (partnership between VITO, Econocom, Foundation for Future Generations, Circulair Flanders)	Checklist developed for the financial sector that maps out the circularity performance of investment files
Circular Business Case Calculator	The Circular Economists (Vojtech Vosecky)	Tool to calculate the NPV of a circular business model
Circular Economy Business Case Calculator	The Wuppertal Institute (Niklas Hoffmann & Martin Perau)	Excel-based tool to model profitability of circular business models
Circular Economy Playbook	Sitra, Technology Industries of Finland, accenture	Excel-based tool to model profitability of circular business models
Cost Calculator	VDI Centre for Resource Efficiency (Kompetenzzentrum für zirkuläre Wirtschaft und Ressourceneffizienz, VDI ZRE)	4 different calculators to calculate costs in relation to material and energy flows and determine resource efficiency potential
LLC-CO2-Tool (German only)	The German Environment Agency	Excel-based life cycle costing tool including CO2-pricing and costing
ROI Calculator	Position Green	Web-based tool to calculate DCF-adjusted ROIs on sustainability investments
Project-Level Business Case ROI Calculator	Sustainability Advantage	Excel-based tool to model revenue and costs; IRR, Payback Period, NPV
DEFINITE-CCRI Project Evaluation Guidebook	DEFINITE Consortium Partners (ICLEI EURO, Circle Economy, Stad Gent, BwB, NTUA)	Tool to determine readiness of circular venture and provide information on how to move forward

¹⁹ Links to all tools can be found in the references.

Appendix E:

List of interviewed experts

INTERVIEWEE	TITLE	COMPANY
BDI Board & BDI Circularity Working Group		
Björn Knoop	Head of Private Sector Partnerships	CEMUNE
Dr Matthias Ballweg	Co-Founder	Circular Republic
Robert Kapferer	CEO	Circularity Germany
Arne von Hofe	Senior Expert	CSCP
Ella Hedley	Project Manager Strategy & Innovation	Ellen MacArthur Foundation
Axel Berger	Chief Digital & Sustainability Officer	Franz Haniel & Cie. GmbH
Antonia Giessler	Global Tool Services Head of Circularity	Hilti
Rebecca Frank	Project Manager	Hydroplant
Patrick Hypscher	(Former) Head of BlueMovement	Independent – Circularity.fm
Karin Merle	Senior Expert in Circular Economy and Investment	Independent
Linda Salomo	Circular Business Development	Independent
John Fretwell	Head of Quality	Kingfisher/Screwfix
Wilhelm Mauß	CEO	Lorenz
Theresa Bodner	VP Nature & Biodiversity	MSCI
Willem Swager	Director of Finance and Operations EMEA	Patagonia
Jean-Denis Curt	Expert Leader Circular Economy	Renault
Alessandro Taini	CEO	T1 Solutions
Karoline Reperich	Sustainability Manager	Tchibo
Sophie Schmidtlin	Chief Technology Officer	The Future is Neutral
Thomas Rauser	Head of Circular Economy Corporate Sustainability	Trumpf
Robert Klauer	Circular Business Development	Vaude
Kristin von Szadkowski	Sustainability Strategist	Volkswagen Group
Delphine Garin	Manager, Circular Finance and Data	WBCSD

Appendix F: Financial metrics (definitions, formulas & inputs)²⁰

REVENUE	DEFINITION	FORMULA	INPUTS
Revenue	Total income generated by a business in a given period.	Revenue = $\Sigma (\text{volume} \times \text{price per unit})$ (<i>per income stream</i>)	Unit volume – number of products sold, serviced or leased Price per unit – selling price, service fee, subscription rate or usage fee
OPEX Operational Expenditure	All recurring cash costs required to operate a business, excluding capital investments and non-cash charges.	OPEX = COGS + SG&A + other operating costs	COGS – direct costs of producing goods or services (labour, materials) SG&A – sales, general and administrative costs Other operating costs – logistics, overhead, maintenance
CAPEX Capital Expenditure	Upfront investment in physical or intangible assets required to establish or expand operations.	CAPEX = Σ all capital investments	Equipment and machinery; infrastructure and facilities; technology and software
EBITDA Earnings Before Interest, Taxes, Depreciation & Amortisation	Operating earnings before non-cash charges and financing costs. Used as a proxy for cash generation from operations, independent of capital structure and accounting choices.	EBITDA = Net Income + Interest + Taxes + D&A	Net income – residual earnings after all deductions Interest – cost of debt Taxes – corporate income tax D&A – non-cash depreciation and amortisation
EBITDA Margin	EBITDA expressed as a percentage of total revenue. Measures how much of each unit of revenue converts into operating earnings.	EBITDA Margin = $(\text{EBITDA} / \text{Revenue}) \times 100$	EBITDA – as above Revenue – as above
Payback Period	Time for cumulative undiscounted cash flows to recover the initial investment.	Breakeven year = CAPEX / annual EBITDA (for even cashflows)	CAPEX – as above Annual EBITDA – as above
NPV Net Present Value	The value created or destroyed by an investment expressed in today's currency. Sum of all future cash flows discounted to present value, minus the initial investment.	NPV = $\Sigma [Rt / (1 + i)^t] - \text{CAPEX}$ (<i>Rt = net cash flow in year t; i = discount rate; T = project life</i>)	CAPEX – as above Cash flows (Rt) – annual EBITDA less maintenance CAPEX and tax Discount rate (i) – typically WACC ²¹ Project life (T) – typically 3–10 years
IRR Internal Rate of Return	The discount rate at which NPV equals zero, which shows the implied annual return on capital invested.	$0 = \Sigma [Cf_t / (1 + \text{IRR})^t] - \text{CAPEX}$ (<i>solve for IRR iteratively</i>)	CAPEX – as above Cash flows (Cf_t) – annual EBITDA less maintenance CAPEX and tax Project life (T) – typically 3–10 years

²⁰ Based on Chen (2026), Fernando (2026a, 2026b, 2026c), Hayes (2025, 2026), Kagan (2026) & Paljug (2026)

²¹ Weighted Average of Cost of Capital

Appendix G: EBITDA²², revenue, OPEX²³ & CAPEX by CBM type²⁴

Repair	
REVENUE	OPEX
• Service/repair sales • Add-on products & service sales • Service contracts/warranty revenue • Spare parts sales	• Service/labour costs • Sales costs • Spare parts/material costs • Reverse logistics/collection costs • Quality control and testing • Other operating costs
EBITDA = revenue - OPEX	
CAPEX = Σ all capital investments	
• Diagnostic tools & monitoring equipment • Technology (AI, IoT, AR/VR, digital twin) • Reverse logistics infrastructure • Other investments	

Reuse/Resell	
REVENUE	OPEX
• 2nd hand (or 3rd hand) sales	• Sales costs • Product takeback and inspection • Grading, cleaning & cosmetic refurbishment • Digital product passport/certification cost • Other operating costs
EBITDA = revenue - OPEX	
CAPEX = Σ all capital investments	
• Inspection & quality assurance technology • Resale platform • Digital traceability/product passport infrastructure • Other investments	

²² EBITDA formula is simplified in this section but equivalent to the standard definition; OPEX as used here excludes D&A, interest and taxes.

²³ Cost savings through CBMs, such as avoided material costs, avoided disposal costs or utility savings, are not shown as separate line items but have been integrated into lower OPEX numbers. However, these cost savings are conceptually relevant and should be modelled accordingly.

²⁴ Based on Sitra, Technology Industries of Finland & accenture (2018)

Remanufacture/Refurbishment

REVENUE	OPEX
• Resale of remanufactured products • Secondary material/recovered component sales	• Labour costs • Sales costs • Material costs • Disassembly, sorting & cleaning • Quality assurance & testing per batch • Other operating costs
EBITDA = revenue - OPEX	
CAPEX = Σ all capital investments	
• Remanufacturing equipment • Take-back programme setup • Disassembly & end-of-life sorting line	• Material tracking & traceability system • Technology (3D printing, robotics, AI, RFID) • Other investments

Product-as-a-Service/Leasing

REVENUE	OPEX
• Monthly subscription fees (fixed) • Usage-based/overage fees (variable) • End-of-contract asset resale/residual value recovery	• Repair & maintenance costs • Insurance costs • Contract management & customer servicing • End-of-contract remarketing & refurbishment • Other operating costs
EBITDA = revenue - OPEX	
CAPEX = Σ all capital investments	
• Asset acquisition • Diagnostic tools & condition monitoring • IoT/connectivity infrastructure	• End-of-contract asset recovery logistics • Technology (big data, blockchain, digital twin, ML) • Other investments

Appendix H: Value chain actor typology²⁵

VALUE CHAIN ACTOR	DEFINITION
Suppliers (raw materials/machines and equipment)²⁶	Actors providing raw materials and other substances needed for production processes; actors producing components and machines needed by producers
Producers (OEM)	Actors producing proprietary materials, components and products
Retailers (and wholesalers)	Actors selling products
Repair providers	Actors offering repair services
Prosumers	Non-market actors organising DIY and other informal activities
Logistics providers	Actors providing logistics services and spare parts management
Recovery managers	Actors recovering, managing and sorting materials
Intermediaries	Actors operating platforms for coordinating recycling, used products or sharing activities
Emerging actors	Umbrella category containing further actors that support the key actors' business models (e.g. financial service providers), leaving room for entirely new types of actors yet to be identified

²⁵ Taken from: Hansen, Lüdeke-Freund and Fichter (2022)

²⁶ For this report, suppliers of raw materials and suppliers of machines and equipment will not be differentiated and will be referred to as "Suppliers".

Appendix I: Industry typology²⁷

GICS SECTOR	GICS INDUSTRY GROUP	DEFINITION	REPORT LABEL
Industrials	Capital Goods	Manufacturers of aerospace/defense equipment, building products, industrial machinery and electrical equipment, plus construction & engineering and industrial conglomerates	Industrial
	Automobiles & Components	Manufacturers of automobiles, motorcycles and the parts, tires and equipment used in them	Automotive
Consumer Discretionary	Consumer Durables & Apparel	Manufacturers of long-lasting consumer goods, including electronics, appliances, home furnishings, homebuilding, leisure products, apparel and footwear	Fashion/ Electronics ²⁸
	Consumer Discretionary Distribution & Retail	Distributors and retailers selling non-essential consumer goods, including department stores, specialty retailers and online marketplaces	Retail
Consumer Staples	Consumer Staples Distribution & Retail	Distributors and retailers of everyday essential goods, including food, drugstore products, and general staples	Retail
	Food, Beverage & Tobacco	Producers of beverages, food products, agricultural goods and tobacco	CPG
	Household & Personal Products	Manufacturers of non-durable household cleaning products and personal care/beauty products	CPG
Health Care	Health Care Equipment & Services	Manufacturers of medical equipment and supplies, plus providers of health care services, facilities and health care-specific technology	Industrial ²⁹
Information Technology	Technology Hardware & Equipment	Manufacturers of computers, smartphones, communications equipment and other physical technology hardware and components	Electronics
	Semiconductors & Semiconductor Equipment	Manufacturers of semiconductors and the equipment/materials used to produce them	Electronics

²⁷ According to the Global Industry Classification Standard (GICS) by MSCI (MSCI, 2023)

²⁸ Consumer Durables & Apparel spans multiple product types. For the purpose of this report, it is split into Fashion (apparel, footwear, textiles) and Electronics (consumer electronics and household appliances).

²⁹ Although no healthcare equipment company was interviewed for this report, Health Care Equipment & Services is included under Industrial given its strong relevance to circular economy models. It is grouped with the Industrial category due to shared characteristics: high unit value, long asset life, B2B sales structures and established component-level refurbishment markets.

Appendix J: Abbreviations

ABBREVIATION	STANDS FOR
CAPEX	Capital expenditure
CBM	Circular business model
CPG	Consumer packaged goods
CVD	Circular value driver
EBITDA	Earnings before interest, taxes, depreciation & amortisation
IRR	Internal rate of return
NPV	Net present value
OEM	Original equipment manufacturer
OPEX	Operational expenditure
PaaS	Product-as-a-Service (circular business model type)
P&L	Profit and loss statement
Refurb	Refurbishment (circular business model type)
Reman	Remanufacturing (circular business model type)
WACC	Weighted average cost of capital

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