

Industrial Symbiosis Mapping in Kosovo

An economic and feasibility analysis



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List of abbreviations

Abbreviation	Full term
AI	Artificial Intelligence
CBAM	Carbon Border Adjustment Mechanism
CSDDD	Corporate Sustainability Due Diligence Directive
CSRD	Corporate Sustainability Reporting Directive
DPP	Digital Product Passport
DRS	Deposit Return System
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
ESPR	Ecodesign for Sustainable Products Regulation
EU	European Union
EUR	Euro
FVA	Food and Veterinary Agency
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRK	Government of the Republic of Kosovo
GVA	Gross Value Added
HDPE	High-density Polyethylene
ICT	Information and Communication Technology
IPPC	Integrated Pollution Prevention and Control
ISO	International Organization for Standardization
KAS	Kosovo Agency of Statistics
KEPA	Kosovo Environmental Protection Agency
KIESA	Kosovo Investment and Enterprise Support Agency
KSA	Kosovo Standardization Agency
LDPE	Low-density Polyethylene
LuxDev	Luxembourg Development Cooperation Agency
MAFRD	Ministry of Agriculture, Forestry and Rural Development
MCA	Multicriteria Analysis
MESP	Ministry of Environment and Spatial Planning
MIETI	Ministry of Industry, Entrepreneurship, Trade and Innovation
NACE Rev. 2	Statistical Classification of Economic Activities in the European Community, Revision 2
OHS	Occupational Health and Safety
PE	Polyethylene
PP	Polypropylene
PPE	Personal Protective Equipment
PPWR	Packaging and Packaging Waste Regulation
PVC	Polyvinyl Chloride
R&D	Research and Development
R&I	Research and Innovation
SME	Small and Medium-sized Enterprise
TA	Technical Assistance
VAT	Value-added Tax

EXECUTIVE SUMMARY

Executive Summary

STRATEGIC CONCLUSION

The Industrial Symbiosis Mapping in Kosovo assignment was undertaken for MIETI with support from LuxDev under Project KSV/023 – Sustainable and Inclusive Growth in Kosovo. It assessed how cooperation among enterprises could improve industrial competitiveness, resource productivity and innovation while reducing avoidable waste and supporting a greener and more circular economy. The analysis focused on manufacturing, while also considering the recyclers, logistics providers, construction companies, agricultural users, utilities and digital-service providers needed to organise viable exchanges. For this study, industrial symbiosis means an organised relationship in which residua, by-products or other underused resources arising from one enterprise or activity are used productively by another enterprise or shared among participating firms. Recycling may form part of industrial symbiosis, but the terms are not interchangeable. Recycling becomes part of an industrial-symbiosis pathway when it contributes to a repeatable exchange linking identifiable generators, collectors or processors and receiving users. The study also considered shared services and digital functions where they directly support resource efficiency or physical exchanges. Kosovo has a credible but uneven foundation for developing such relationships. The strongest opportunities arise where enterprise-generated residua can be separated at source, a processor or preparation route is available, and a defined receiving application can be tested with participating companies. Businesses already undertake some forms of material sale, recovery and inter-company cooperation, providing a practical foundation for more structured and higher-value exchanges.

The principal cross-sector constraint is not technology alone, but the incomplete organisation of the exchange chain. Material quantities, quality, timing and current destinations are not always sufficiently documented; SMEs have limited access to aggregation and testing services; receiving users may lack confidence in secondary materials; regulatory requirements are not consistently translated into practical pathway guidance; and costs and responsibilities are not always clearly allocated among generators, processors and receiving users.

The study therefore supports a focused 24-month Industrial Symbiosis Activation Programme. The programme would organise company partnerships, verify material flows, test products and receiving applications, support compliance and demonstrate repeat transactions. Permanent infrastructure and wider replication should be considered only where regular throughput, receiving demand, regulatory compliance, accountable operation and a viable business case have been demonstrated.

WHAT THE STUDY ASSESSED

The assignment progressed from broad sector screening to company- and pathway-level assessment and, finally, to implementation recommendations. Task 2 identified 34 preliminary material, service and ICT-enabling routes across the mapped domains. Task 3 examined these routes through the 200-company survey, preliminary technical and economic assessment, sector workgroups and stakeholder validation. This process resulted in a final portfolio of ten pathways; the number and composition of the portfolio were

outcomes of the assessment rather than predetermined targets. Task 4 translated the findings into a sequenced implementation framework.

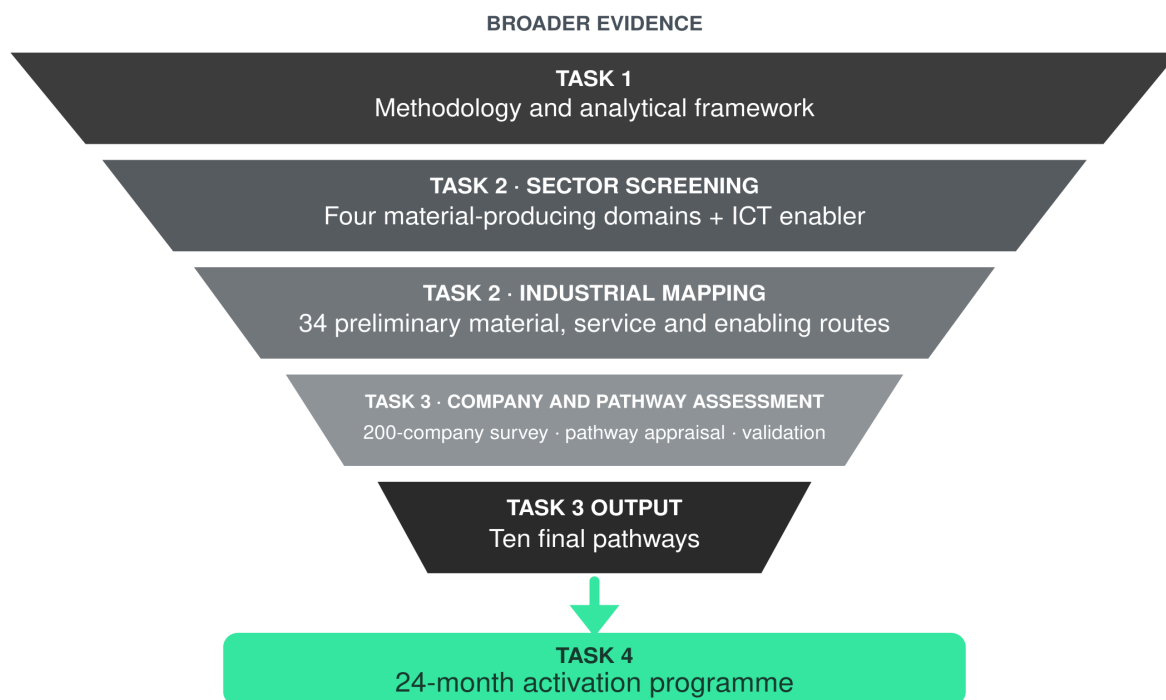


Figure 1. Analytical sequence from sector screening to the proposed activation programme

The analysis focused on Plastics and Rubber; Textile, Apparel and Leather; Agri-food; and Metal Processing. ICT was assessed differently from these material-producing domains: its relevance lies in manufacturing optimisation, information management, resource matching and traceability rather than in generating the principal physical exchanges.

The evidence base combined official statistics and sector studies, industrial system mapping, the 200-company survey, stakeholder engagement, preliminary pathway assessment and review of economic, environmental, regulatory, R&I and inclusion considerations. The evidence supports an implementation portfolio and an appropriate next stage for each pathway; it does not constitute company investment appraisal or confirmation that every pathway is ready for commercial expansion.

RELEVANCE FOR KOSOVO

For Kosovo, the principal drivers of industrial symbiosis are:

- avoidable material-management and disposal costs
- dependence on imported industrial inputs
- opportunities to retain more value from domestically generated materials
- demand for recycling, testing, logistics, engineering and digital services
- opportunities for product and process innovation
- increasing requirements for material information, traceability and compliance in EU-linked supply chains
- the potential to reduce disposal and demand for primary resources where secondary inputs meet the required technical, legal and environmental conditions

These drivers connect industrial symbiosis with the objectives of Kosovo's industrial policy, particularly enterprise competitiveness, innovation, SME development, productive investment and the green and digital transformation of manufacturing.

FINAL PATHWAY PORTFOLIO

Task 3 retained eight material-based pathways and two cross-sector digital enablers. The number and composition of the portfolio were outcomes of the assessment. The pathways are grouped below according to the form of development appropriate to the available evidence.

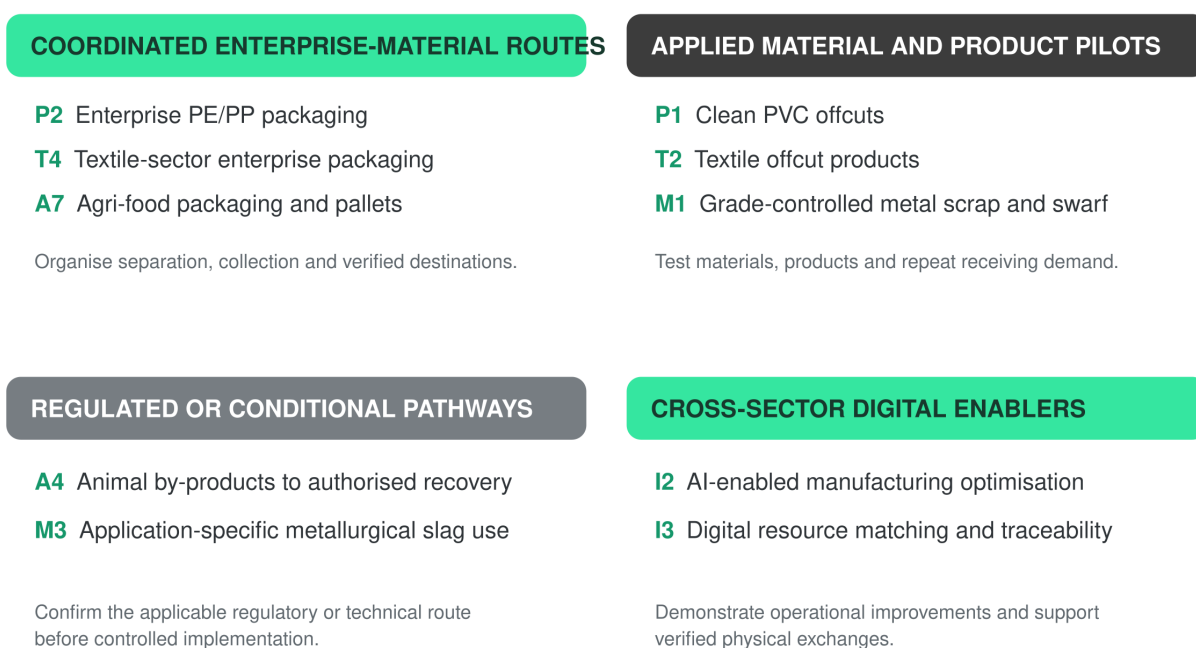


Figure 2. Final Task 3 pathway portfolio by development approach

The three coordinated enterprise-packaging pathways enterprise PE/PP packaging (P2), textile-sector packaging (T4) and agri-food packaging and pallets (A7) provide comparatively accessible starting points because established collection, reuse and recycling processes are available. Their viability nevertheless depends on material-specific source separation, sufficient collection density, suitable storage, reliable collection schedules and verified receiving destinations. These pathways cover packaging generated or controlled by enterprises; household packaging and municipal household-waste collection are outside the assignment scope.

Clean PVC offcuts (P1), textile offcut products (T2) and grade-controlled metal recovery (M1) have identifiable material sources and potential receiving applications but require applied testing, product qualification or process improvement. Animal by-product recovery (A4) depends on official categorisation, authorised collection and treatment arrangements, sufficient treatment capacity and traceability. The productive use of metallurgical slag (M3) is specific to the source material and intended application and therefore requires representative sampling, environmental and engineering testing, applicable conformity evidence and confirmation of receiving demand.

The digital interventions are enabling functions rather than physical material exchanges. AI-enabled manufacturing optimisation (I2) should address defined manufacturing problems and measure changes in downtime, energy use, quality loss or material scrap. Digital resource matching and traceability (I3) should support verified material information, active brokerage, transaction records and repeat exchanges rather than operate as a stand-alone technology platform.

ECONOMIC IMPLICATIONS

The economic assessment used pathway-specific scenarios to illustrate the potential scale and source of value associated with each pathway. Depending on the route, value may arise from material sales, avoided management costs, processing activity, procurement savings, partial substitution of imported inputs or the development of new products and receiving applications.

The estimated values are aggregated across the participating exchange chain, which may include material generators, processors and receiving users. They do not represent revenue or profit accruing to a single company. Because the scenarios use different participation levels, material quantities, yields, prices and benefit boundaries, they should not be ranked solely by their monetary values or added together as a national economic-benefit estimate.

Grade-controlled metal recovery has the clearest near-term commercial basis. Under an illustrative scenario covering approximately 2,500 tonnes across 50 participating firms, M1 produced an estimated annual aggregated gross-value range of EUR 1.50–2.51 million. The M3 scenario, based on approximately 100,000 tonnes generated and 95,000 tonnes accepted in a specified receiving application, produced an indicative annual range of EUR 1.25–3.18 million. This potential could be realised only if representative testing confirms a compliant application and sufficient receiving demand.

Clean PVC offcuts and textile offcut products also show potential for additional value creation. The illustrative annual gross-value ranges were approximately EUR 0.37–0.51 million for P1 and EUR 0.19–0.30 million for T2. These results depend on material compatibility, processing yield, product performance and repeat acceptance by receiving users.

The enterprise-packaging pathways have lower economic value per participating firm. Their viability therefore depends on efficient source separation, sufficient collection density, coordinated logistics and reliable receiving destinations. Animal by-product recovery is driven primarily by compliant management, risk reduction and avoided costs rather than assumed revenue from recovered products.

The two digital pathways were not monetised at portfolio level. The value of I2 would need to be demonstrated through measurable company-level improvements, such as reduced downtime, energy use, material losses or maintenance costs. The value of I3 would depend on completed exchanges, repeat participation, operating costs and documented benefits for participating users.

These results are illustrative gross-value or avoided-cost estimates, not net-profit forecasts, funding requirements or investment decisions. A complete business case would require confirmed capital and operating costs, commercial terms, financing requirements and company-specific material and market evidence. The scenario results are presented in section 5, with detailed assumptions and calculations provided in Technical Annex.

Import substitution is most plausible where a domestic secondary material meets the technical, quality and regulatory requirements of an existing production process or product. Relevant possibilities include qualified recycled polymers, grade-controlled secondary metals and tested mineral inputs. Any import-substitution result should be measured through documented replacement of an imported input in an accepted receiving application, rather than through the quantity of residua collected.

Wider economic effects may include greater domestic value retention and increased demand for collection, preparation, testing, laboratory, logistics, engineering and digital services. These effects depend on the establishment and continuation of viable exchanges and should be measured alongside the direct pathway results.

ENVIRONMENTAL IMPLICATIONS

Environmental benefits must be assessed against the way each material was managed before the intervention. A pathway may produce an additional benefit where it reduces disposal, improves recovery yield, preserves material quality for a higher-value application or replaces a primary material in an accepted production process. Collection alone does not demonstrate an environmental benefit. Where a material was already being reused, recycled or exported for recovery, only the improvement attributable to the intervention should be counted.

The environmental result also depends on how the pathway operates. Processing yield, rejected material, transport distances, energy and water requirements and the final receiving application can significantly affect the overall effect. For example, metallurgical slag used as an aggregate has a different environmental profile from slag used to replace part of a cementitious input. Environmental performance should therefore be assessed separately for each pathway and receiving application.

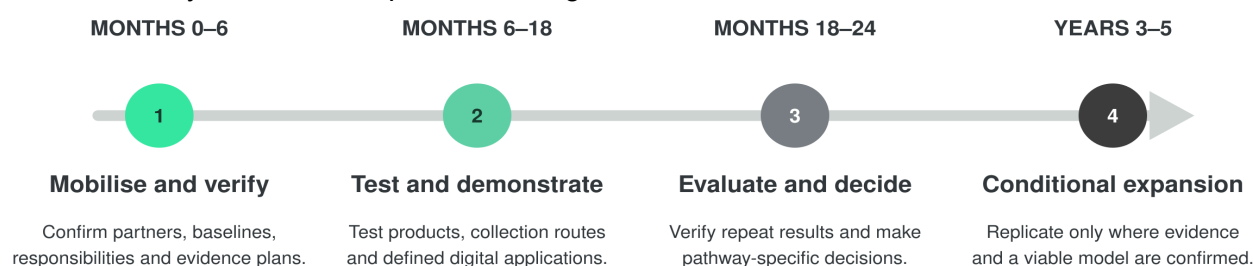
During implementation, the following information should be established and recorded, where relevant:

- the quantity and quality of material generated and its management route before the intervention
- the quantity collected, processed and accepted by the receiving user
- processing yield and the quantity and destination of rejected material
- transport, energy, water and other significant operational inputs
- the type and quantity of primary material or previous management route displaced

These indicators will allow environmental results to be based on verified changes rather than gross quantities collected. Repeat transactions and continued use should be monitored separately to show whether the environmental benefit is sustained over time.

RECOMMENDED IMPLEMENTATION FRAMEWORK

Based on the evidence a 24-month activation period is recommended organised into three overlapping phases, followed by conditional expansion during Years 3-5.



Expansion is a separate decision — not an automatic programme outcome.

Figure 3. Proposed implementation sequence and decision points

The staged structure allows pathways to proceed at different speeds without making the success of the programme dependent on every intervention. Conditional expansion should be limited to pathways that demonstrate regular material throughput, receiving demand, regulatory compliance, accountable operation and a viable financing model.

The programme should also coordinate with Kosovo's emerging eco-industrial park and industrial-zone initiatives. Where firms are geographically concentrated, these initiatives may provide suitable settings for shared collection, logistics, technical services and resource-matching arrangements, subject to site-specific evidence and a viable operating model.

GOVERNANCE, REGULATION AND INSTITUTIONAL RESPONSIBILITIES

The functions required to support industrial symbiosis are distributed across existing institutions. MIETI holds the relevant industrial-policy, enterprise-development, innovation and SME-support functions and is therefore positioned to coordinate the proposed programme. MESP and the relevant environmental authorities retain responsibility for waste classification, environmental authorisation, inspections and environmental oversight. FVA is responsible for official decisions concerning animal by-products, with MAFRD involved where policy or legislative action is required. Standards, accreditation, testing and conformity assessment remain within the mandates of the competent quality-infrastructure bodies.

Participating companies retain responsibility for the accuracy of their material information, compliance with applicable requirements, commercial agreements, private contributions and routine operations. Recyclers, processors, receiving users and service providers are responsible for meeting the technical and legal conditions applicable to their respective activities.

The proposed institutional arrangement therefore assigns programme coordination to MIETI without transferring environmental, veterinary, accreditation or conformity-assessment responsibilities from the competent institutions. This connects industrial symbiosis with the objectives and instruments of industrial policy while maintaining clear regulatory accountability.

A separate industrial-symbiosis law is not considered an immediate requirement. The more immediate need is coordinated application of the existing framework through pathway-specific guidance covering material classification, permits, official controls, documentation, testing and product-conformity requirements. Relevant EU developments concerning packaging, carbon reporting, ecodesign, product information, construction products and supply-chain traceability should also be monitored where they affect Kosovo's alignment process, exporters or customers operating in EU-linked supply chains.

INDICATIVE PROGRAMME COST AND FINANCING

The estimated cost of the initial 24-month programme is approximately EUR 0.94–2.13 million in 2026 prices, excluding VAT and major capital investment. Within this range, the estimated public and technical-assistance contribution is approximately EUR 0.56–1.61 million. The balance would be provided by participating companies through cash or eligible and verifiable in-kind contributions.

These amounts are programme-planning estimates rather than confirmed funding allocations, procurement budgets or commitments by any institution. Detailed programme preparation would need to confirm the scope and cost of each activity, applicable cost-sharing arrangements, funding sources and payment conditions.

Public and technical-assistance resources would principally support functions that individual companies may be unable or unwilling to finance independently, including programme coordination, shared technical evidence, regulatory guidance, applied testing, first demonstrations, SME access and independent evaluation. Participating companies would contribute staff time, materials, equipment use, data, commercial trials and other pathway-specific inputs.

This financing approach reflects the incentives reported by businesses. Participating companies may benefit from material revenue, avoided management costs, lower input costs, improved resource efficiency, stronger compliance or access to new receiving markets. Time-bound public support is appropriate where coordination costs, shared evidence, regulatory complexity or first-application risks constrain otherwise relevant company action. Support should be awarded transparently and linked to private participation, defined outputs and evidence milestones. Longer-term financing should reflect the function being supported. Commercial equipment, working capital and routine operations should be financed primarily by participating companies or financial institutions once a viable business case has been established. User fees, membership contributions or service charges should be tested as possible sources of continuing finance for

the I3 resource-matching service. EPR or DRS financing may support eligible enterprise-packaging activities only where the relevant material falls within the applicable system and the necessary institutional arrangements are operational.

Major aggregation or processing infrastructure should be subject to a separate feasibility study, cost-benefit analysis and investment appraisal. Any proposal should be based on verified material throughput, collection radius, operating responsibility, regulatory requirements, receiving demand, capital and operating costs and a sustainable financing model.

INCLUSION, SKILLS AND SAFE WORK

Implementation may create or strengthen demand for roles in product development, quality assurance, laboratory work, digital services, machine operation, logistics and supervision. This is particularly relevant in Textile and Apparel, where women constitute a substantial share of the workforce. Access to programme support should be based on transparent participation criteria. Where proportionate and reliable, monitoring should distinguish participation, training and employment outcomes by sex and occupational role. Skills support should focus on the technical capabilities required by the pathways, including material separation, machine operation, product testing, quality assurance, digital systems, logistics and supervision. Each pathway should also incorporate occupational health and safety requirements appropriate to the materials, processes, machinery and working environment concerned. Inclusion and employment benefits should be reported only where they are supported by evidence of participation, training, employment quality or progression into skilled roles.

IMMEDIATE PRIORITIES

The following decisions and preparation steps would initiate the proposed 24-month programme:

- 1 Endorse the activation framework and designate the MIETI programme-coordination function.
- 2 Confirm the initial generators, processors, receiving users and institutional partners and establish the material, cost and market baselines for the participating pathways.
- 3 Prepare applied pilots for clean PVC offcuts (P1), textile offcut products (T2) and grade-controlled metal recovery (M1); coordinated enterprise-material routes for enterprise PE/PP packaging (P2), textile-sector packaging (T4) and agri-food packaging and pallets (A7); defined company-level pilots for AI-enabled manufacturing optimisation (I2); and an initial facilitated digital resource-matching and traceability service (I3).
- 4 Obtain a determination from the competent authorities on the applicable regulatory route for animal by-product recovery (A4). For metallurgical slag applications (M3), complete representative and application-specific technical, environmental, conformity and market assessment before controlled implementation or investment.
- 5 Establish the regulatory, standards, testing and product-qualification arrangements required for each initial pathway.
- 6 Convert the indicative programme estimates into detailed scopes, eligible costs, public and private contributions and market-tested budgets. Any proposal for permanent aggregation or processing infrastructure should be supported by a separate material- and location-specific feasibility study, cost-benefit analysis and business case.
- 7 At the end of the 24-month period, assess each pathway separately and decide whether it should continue, be modified, be incorporated into an existing support instrument or be discontinued.

Kosovo can begin by organising and testing the materials, company relationships, receiving applications and institutional arrangements identified through the assignment. The proposed activation programme provides a proportionate route from mapped opportunities to verified exchanges, while generating the technical, commercial, regulatory and financial evidence required for selective expansion.

1

INTRODUCTION AND METHODOLOGY

1. Introduction and Methodology

1.1. Assignment background and objectives

The Industrial Symbiosis Mapping in Kosovo assignment was implemented for MIETI with support from LuxDev under Project KSV/023 - Sustainable and Inclusive Growth in Kosovo. The assignment responds to the need to strengthen industrial competitiveness while improving resource productivity, reducing avoidable waste and supporting Kosovo's transition towards a greener and more circular economy. Its primary focus is manufacturing, although the identified exchanges also involve logistics, recycling, construction, agriculture, utilities, digital services and other receiving applications.

The assignment was designed to move from broad sector screening to implementation-oriented industrial symbiosis opportunities. It therefore combined four successive tasks: preparation of the methodology and research framework; sectoral and industrial mapping; business survey, pathway assessment and stakeholder validation; and final recommendations and actions. The resulting analysis identifies priority sectors and material streams, assesses the feasibility of selected pathways, documents barriers and enabling conditions, and proposes a sequenced implementation framework for MIETI and partner institutions. The assignment complements MIETI's 2026 study *Utilization of Natural Resources and Minimally Processed Goods in Kosovo: Manufacturing Value Added, Import Substitution and Export Competitiveness*. That study examined opportunities to increase domestic processing, manufacturing value added, import substitution and export competitiveness through product upgrading, supplier–processor networks, innovation, skills and quality infrastructure. The present assignment addresses a related but distinct question: how enterprise-generated residua, secondary materials and shared services can contribute to industrial upgrading through organised inter-company exchanges. The specific objectives were to identify industries of sufficient economic and material relevance; map value chains, inputs, outputs, by-products and residua streams; assess potential exchanges across production tiers and sectors; test the findings with companies and stakeholders; estimate the economic, environmental and social implications where evidence permitted; and define practical policy, R&I, regulatory, coordination and financing actions.

This document consolidates the analytical process undertaken during the assignment, progressing from the development of the methodology and research framework through sector screening, industrial and value-chain mapping, the company survey, pathway identification and preliminary assessment, stakeholder consultation and validation, and the formulation of policy recommendations and an implementation framework. It synthesises the evidence, principal findings and final recommendations. The accompanying Technical Annexes provide the supporting methodological and technical detail, including the mapping and survey evidence, pathway assessments, consultation findings and action-costing framework. The resulting portfolio comprises eight material-based pathways and two digital enablers, supported by a sequenced implementation programme for MIETI and its partners.

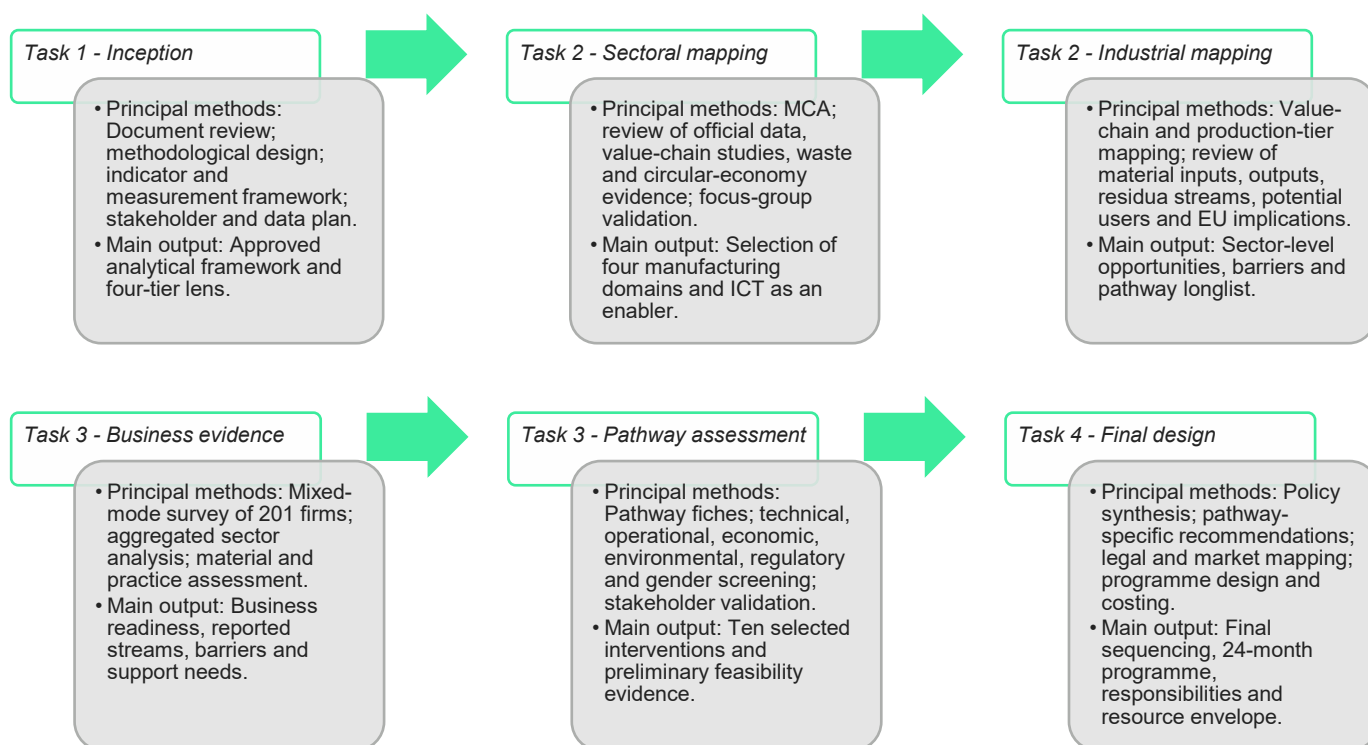
1.2. Definition and relevance of industrial symbiosis in Kosovo

Industrial symbiosis refers to structured cooperation between enterprises through which industrial residua including by-products and other underutilised material streams such as surplus energy, water, services, infrastructure or productive capacity are used productively by another. It relies on organised relationships among generators, intermediaries or processors, and receiving users. Industrial symbiosis extends beyond conventional waste management because its purpose is not simply to collect or manage residua, but to retain or increase their productive value through suitable receiving applications. It may also include the sharing of utilities, infrastructure, logistics and technical services.

For Kosovo, industrial symbiosis is relevant to four closely connected policy objectives. First, it can strengthen industrial competitiveness by reducing material and handling costs, generating revenue from residua and improving access to alternative or more stable inputs. Second, it can support import substitution in selected applications where qualified domestic secondary resources can replace a portion of imported polymers, metals, fibres or mineral inputs. Third, it can stimulate markets for recycling, testing, logistics, engineering, digital solutions and product-development services. Fourth, it can reduce disposal and inappropriate management of residua, as well as demand for primary resources, where secondary inputs meet the necessary technical, environmental and legal requirements. Not all residua are suitable for productive exchange. A viable industrial symbiosis pathway depends on a sufficient and reasonably consistent supply, technical compatibility, an identified receiving application, manageable logistics, clear legal status, appropriate environmental safeguards and either a credible commercial case or a clear public-interest justification. Larger infrastructure investments should therefore follow verification of material availability, product performance, regulatory compliance and repeat market demand through appropriately designed pilots.

1.3. Analytical approach and evidence base

The analysis progressed in four stages, moving from broad screening to focused implementation design. The *first stage – Task 1* established the measurement framework, four-tier value-chain perspective, data-collection approach and feasibility dimensions. The *second stage – Task 2* used multicriteria analysis as an initial sector-screening tool, triangulated with value-chain evidence and stakeholder input, to identify priority industries for more detailed mapping. The selected value chains were then examined in terms of their inputs, outputs, residua, potential receiving applications, cross-sector linkages, barriers and regulatory implications. It produced a broader set of 34 preliminary material, service and ICT-enabling routes. The findings were reviewed through the Focus Group Discussion and Stakeholder Workshop.



The *third stage – Task 3* introduced company-level evidence through the business survey and stakeholder engagement. It examined current material-management practices, business interest, perceived barriers and

enabling conditions, and informed the development and preliminary assessment of potential industrial symbiosis pathways. Illustrative economic scenarios were also developed to explore the possible scale of value creation under defined assumptions. Stakeholder engagement was used to test the practical relevance of the findings and refine the proposed pathways; it did not constitute independent confirmation of material quantities or commercial feasibility. The *final stage – Task 4* translated the accumulated evidence into recommendations, implementation concepts, institutional responsibilities, legal and market actions, and an indicative programme cost.

Pathways assessment considered four linked questions. First, whether a relevant resource stream, likely generators and a plausible receiving application could be identified. Second, what the company and stakeholder evidence indicated about availability, current practices, barriers and business interest. Third, what technical, operational, commercial, environmental, legal and inclusion conditions affected the complete generator–processor–receiving-user chain. Fourth, what form of further development was appropriate and what evidence would be required before continuation or expansion. Inclusion in the final portfolio therefore indicates a justified next stage of coordinated action, verification, testing or demonstration; it does not constitute confirmation of commercial feasibility or investment readiness.

The evidence base combined official statistics and Kosovo-specific sector information, company survey responses, stakeholder observations and external technical benchmarks. Official and sector-specific sources informed the initial screening and industrial context, while the survey provided self-reported evidence on company practices and constraints. Stakeholder input helped interpret the findings and assess their practical relevance. Where local evidence was insufficient, external coefficients and benchmark factors were used for screening or illustrative scenario development and treated as indicative assumptions. Company-level responses were analysed in aggregate, and no commercially sensitive information is disclosed.

1.4. Feasibility and impact-assessment framework

Each shortlisted pathway was examined through an integrated framework that considered whether a technically plausible exchange could operate at a relevant scale, secure a receiving market, comply with applicable requirements and produce an incremental environmental and economic benefit. The framework also considered gender, inclusion and decent-work implications, the uncertainty requiring R&I support, and the justification for time-bound public intervention. Technical maturity alone was therefore insufficient to establish pathway feasibility.

Table 1. Feasibility and impact-assessment framework

Dimension	Core questions
<i>Technical</i>	Can the material be prepared and processed into a product or input that meets application-specific requirements?
<i>Operational</i>	Are sufficient quantities, continuity, source separation, logistics and responsible operators available?
<i>Commercial</i>	Is there a committed receiving use, acceptable cost structure and prospect of repeat demand or measurable avoided cost?
<i>Environmental</i>	Does the pathway create an incremental improvement compared with the actual baseline, after processing and transport are considered?
<i>Legal and institutional</i>	Can the material, process and product be managed under clear classification, permits, official controls and conformity routes?
<i>Gender, inclusion and decent work</i>	Can participation and skilled employment be broadened without reinforcing low-paid or unsafe work?
<i>R&I additionality</i>	What specific uncertainty must be resolved through characterisation, testing, demonstration, data or business-model validation?
<i>Public-policy case</i>	Is time-bound public support justified by coordination failure, shared evidence, SME access, regulatory complexity or wider public value?

This framework informed the type and sequencing of the recommendations. No pathway was treated as automatically ready for wider implementation. Where the available evidence supported a defined material and receiving route, the recommendations focus on coordinated collection or applied pilots. Where legal, technical or application-specific conditions remain, the recommended next stage consists of competent-authority assessment, testing or controlled demonstration. Wider implementation would follow only where material supply, regulatory compliance, product or receiving-user acceptance and repeat demand have been sufficiently demonstrated.

1.5. Evidence boundaries and treatment of assumptions

The study combined primary research including the company survey, face-to-face interviews, focus-group and workgroup discussions and stakeholder workshops with official statistics, Kosovo-specific sector evidence and external technical benchmarks. This primary research provided substantial evidence on company practices, relevant material categories, current destinations, business interest and implementation barriers.

The survey covered approximately 200 enterprises across the four priority manufacturing domains and provided a structured primary evidence base for descriptive sector comparison and pathway assessment. The percentages reported in this document describe the participating enterprises and valid responses to the relevant survey questions. The survey results were interpreted together with the industrial mapping and stakeholder evidence and were not used on their own to derive national material-flow totals.

The study was not designed as an audit of company production and material balances. Available company records and survey responses did not provide uniformly verified quantities, periods, material classifications and destinations across all respondents. Market prices, transport costs, processing yields and product specifications were also unavailable for some pathways. These evidence boundaries were addressed through triangulation, clearly defined scenario assumptions and cautious interpretation.

Environmental estimates are similarly dependent on the baseline destination, processing route and receiving application. For example, slag used as aggregate cannot be assigned the same avoided-emissions factor as slag used to substitute a cementitious constituent. Likewise, upstream water-footprint estimates for textile production do not represent direct water savings in Kosovo factories. Environmental benefits must therefore be verified against a pathway-specific baseline and the actual collection, transport, processing and end-use conditions.

The indicative programme costs are order-of-magnitude design ranges expressed in 2026 euros and excluding VAT. They are intended to support programme preparation, prioritisation and financing discussions rather than procurement. Each programme component will require a detailed scope, unit-cost breakdown, current supplier or service-provider quotations and confirmation of the proposed co-financing arrangements. The available evidence is sufficient to support pathway prioritisation and the design of verification activities and pilots. Procurement, infrastructure financing or company-level investment decisions will require verified material balances, product acceptance, actual operating and capital costs, confirmed regulatory requirements, and measured before-and-after results.

INTERPRETATION OF ESTIMATES: Quantitative pathway results and programme cost ranges are decision-support estimates. They should not be aggregated into national totals or used directly for procurement or investment decisions without further verification.

2

SECTORAL AND INDUSTRIAL MAPPING FINDINGS

2. Sectoral and Industrial Mapping Findings

This section presents the work and findings of Task 2, covering sector screening, the selection of priority industries, detailed industrial system mapping and stakeholder validation. It outlines the broader range of industrial symbiosis opportunities identified through this process, together with the principal constraints and enabling conditions. These findings provided the analytical basis for the subsequent company-level assessment and further prioritisation undertaken under Task 3.

2.1. Purpose and analytical sequence of task 2

Task 2 established the analytical base for the later company-level assessment. Its purpose was first to determine which industries offered the strongest combination of economic relevance and resource-efficiency potential, and then to map how inputs, products, residual materials, energy and possible receiving uses were organised within those industries. The task therefore moved from broad sector screening to a more detailed industrial and value-chain view.

The Task 2 industrial mapping was exploratory and evidence-led. It identified plausible opportunity routes, their likely generators and users, and the barriers that would need to be examined further. It did not constitute a full feasibility assessment and did not, by itself, establish the final set of interventions.

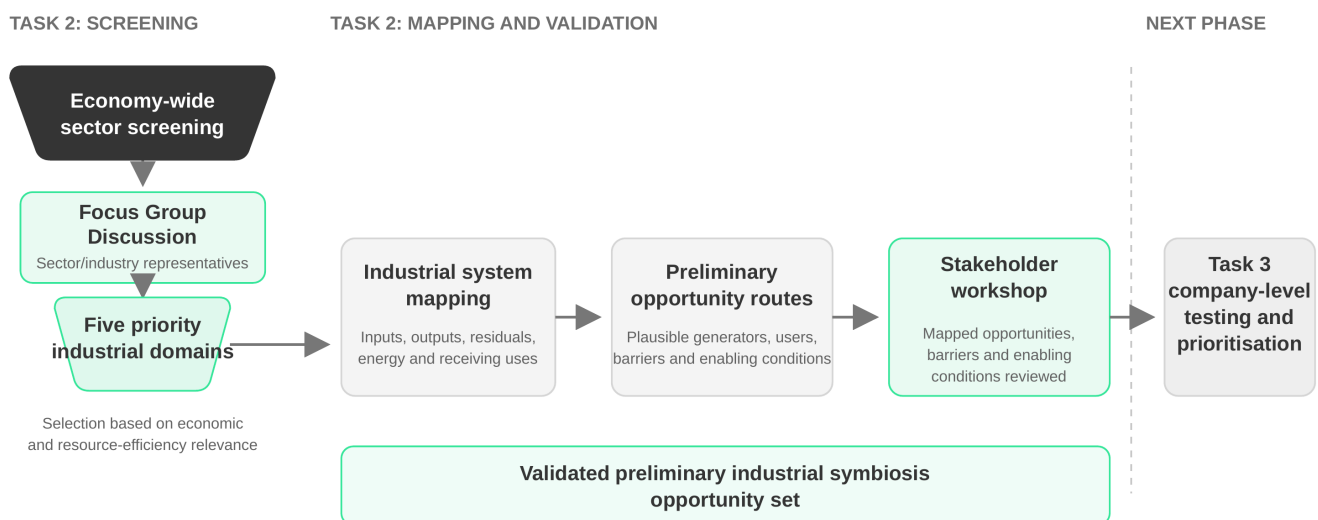


Figure 4. Analytical sequence from sector screening to the validated preliminary industrial symbiosis opportunity set

2.2. Sectoral screening and selection of priority industries

The sectoral screening sought to identify industries that met two related conditions: sufficient economic relevance for industrial symbiosis to contribute meaningfully to competitiveness and growth, and a material, energy or productive-capacity base capable of supporting realistic exchanges. The analysis focused principally on manufacturing, while considering agriculture, mining, construction, energy and waste management where these activities formed part of a relevant value chain or could supply or receive materials, residual or energy.

The multicriteria analysis (MCA) assessed economic performance and resource potential as separate dimensions. Within each dimension, the available indicators were converted into relative sector positions and combined using an equal-weight rank-sum approach. Lower numerical positions therefore indicate stronger relative performance within the relevant screening dimension.

The economic screening considered turnover, employment, exports, imports and changes over time using data available on a sufficiently consistent basis. Enterprise numbers were used to interpret sector scale and structure but were not added to the aggregate economic score, as this could have duplicated the influence of sector size. The resource screening considered recorded waste generation and treatment including recycling, landfilling, incineration and transfer, and energy use where comparable data were available.

The MCA informed the initial screening but did not determine sector selection automatically. Economic data were generally available at a more detailed industry level than waste and resource data, which were often reported for broader sector groupings. The rankings were therefore triangulated with sector and value-chain studies, circular-economy and waste-management evidence, industrial-policy relevance and stakeholder input. This review considered whether relevant residua arose within the value chain, their existing destinations, dependence on imported inputs, and the presence of domestic processors or potential receiving users.

The preliminary sector-screening results were first reviewed through a Focus Group Discussion with sector and industry representatives. The discussion tested the relevance of the candidate industries against sector realities and provided additional insight into value-chain structures, material flows, existing recovery practices and constraints. The feedback confirmed the industries to be taken forward for detailed industrial mapping.

Following completion of the industrial mapping, the findings were presented at a broader stakeholder workshop held in April 2026. The workshop reviewed the selected industrial domains, value-chain and system maps, principal residua streams, possible receiving uses, preliminary industrial symbiosis opportunities, and the associated barriers and enabling conditions. Stakeholder feedback was used to validate and refine the Task 2 findings before proceeding to the company-level assessment.

Together, these consultations provided sector-level and stakeholder validation of the selection and mapping results. They did not independently verify company-level quantities, confirm receiving-user commitments or establish the technical and commercial feasibility of individual exchanges. These aspects were examined subsequently through the Task 3 survey, consultations and pathway assessment.

Table 2. Sector-screening evidence and prioritisation outcome

Industry grouping	Economic screening	Resource screening	Triangulation and interpretation	Prioritisation outcome
<i>Agri-food</i>	Food products: 7; beverages: 5	Food, beverages and tobacco grouping: 6	Large and diverse enterprise base; recurring biological and packaging streams; strong links with agriculture, retail and municipalities.	Selected for detailed mapping.
<i>Textile, Apparel and Leather</i>	Textiles: 13; apparel: 8	Grouped textile, apparel and leather: 7	Employment-intensive and export-oriented converting sector with visible production offcuts and packaging streams. High female employment makes inclusion, skills and job quality particularly relevant.	Selected for detailed mapping.
<i>Plastics and Rubber</i>	Rubber and plastics: 6; other non-metallic mineral products: 2	Grouped rubber, plastics and non-metallic mineral products: 1	Strong combined resource signal, dependence on imported inputs, and an existing domestic conversion and recycling base linked to packaging and construction. The resource ranking represents a broader statistical grouping and is not a plastics-only quantity.	Plastics and rubber selected for detailed mapping; non-metallic mineral products were not mapped as a separate priority domain.
<i>Metal Processing</i>	Basic metals: 11; fabricated	Grouped metals: 11; mining and quarrying: 4 as	Valuable scrap and swarf, dependence on imported metal inputs, established collection and export routes, and high-	Selected for detailed mapping.

Industry grouping	Economic screening	Resource screening	Triangulation and interpretation	Prioritisation outcome
	metal products: 1	<i>relevant upstream context</i>	volume mineral residua associated with heavy industry.	
<i>Wood and Furniture</i>	Wood products: 21; furniture: 3	Grouped wood and paper products: 3	Furniture showed strong economic performance, but available evidence indicated that a substantial share of wood residua was already used internally for heat. Other higher-value uses may remain possible but were not prioritised within the assignment scope.	Not selected as a priority domain for detailed mapping.
<i>ICT</i>	Not directly comparable	Not directly comparable	Does not generate the principal physical residua considered in the mapping but provides capabilities for process optimisation, traceability, information exchange and resource matching.	Retained as a cross-cutting enabling domain.

Source: Assignment MCA and sector and value-chain analysis, based primarily on Kosovo Agency of Statistics data made available for the assignment. Lower positions indicate stronger relative performance within the relevant screening dimension. Economic and resource rankings use different sector classifications and should not be interpreted as a single composite ranking.

The combined evidence supported four material-producing domains for detailed industrial mapping: Agri-food; Textile, Apparel and Leather; Plastics and Rubber; and Metal Processing, including relevant upstream mining linkages. Non-metallic mineral products contributed to the broader resource-screening evidence but were not mapped as a separate priority domain.

Wood and furniture was considered during the screening and performed strongly on some indicators, particularly furniture within the economic dimension and the broader wood and paper grouping within the resource dimension. However, the available evidence indicated that a substantial share of wood residua was already used internally for heat. Although other, potentially higher-value uses may remain possible, the sector was not prioritised for detailed mapping within the assignment. This decision therefore reflects the relative prioritisation of additional industrial-symbiosis opportunities, rather than an absence of circularity potential in the wood sector.

ICT was retained on a different basis. It was not directly comparable with the material-producing industries and was not assigned equivalent economic and resource rankings. Instead, it was included as a cross-sector enabling domain because digital services can support industrial production and resource exchanges through process optimisation, monitoring, traceability, information exchange and resource matching.

Selection for detailed mapping indicated that a domain warranted further investigation; it did not mean that every potential exchange had already been demonstrated or was ready for investment. The subsequent industrial mapping examined the selected domains in greater detail and developed the broader industrial-symbiosis opportunity set that was later tested and prioritised through the company-level work undertaken under Task 3.

2.3. Industrial mapping approach and outputs

The industrial mapping examined each priority domain in greater detail. For each domain, the analysis described the relevant sub-industries and value-chain tiers, principal inputs and outputs, residua materials and energy streams, current recovery practices, possible receiving uses, and the main technical, regulatory, market and coordination conditions influencing potential exchanges.

Evidence was triangulated from official statistics, existing sector and value-chain studies, waste and residua analyses, and feedback gathered through the Focus Group Discussion and stakeholder workshop. As complete company-level mass balances were not available at this stage, the mapping identified where

exchanges appeared plausible and where further verification was required. Indicative quantities and process coefficients used in the sectoral and industrial mapping analyses were treated as screening evidence rather than audited national flow estimates.

The principal output was a broad set of preliminary industrial symbiosis opportunity routes. These included material exchanges, recovery and recycling loops, shared utility and treatment options, and digital coordination functions. The system maps presented in sections below illustrate the relevant value chains, residua flows and potential receiving uses. Together with the stakeholder validation findings, these outputs provided the analytical basis for the subsequent company-level testing and prioritisation undertaken under Task 3.

2.4. Plastics and Rubber

Kosovo's plastics industry operates primarily as a conversion-based system using imported virgin polymers, imported recycled polymers and compounds, and domestically produced recyclate. Figure 2 presents the mapped plastics system, tracing these inputs through production and markets to post-industrial, post-consumer and installation residua, collection and reprocessing, and potential receiving uses. The mapped relationships illustrate existing and potential recovery loops; they do not imply that all flows are currently organised or commercially established. The industrial mapping therefore examined how suitable plastics residua could be returned to plastics manufacturing or used in technically appropriate cross-sector applications, particularly in construction products, boards and pallets. The arrows in Figure 2 represent mapped system relationships and potential recovery loops and should not be interpreted as evidence that all flows are currently organised or commercially established.

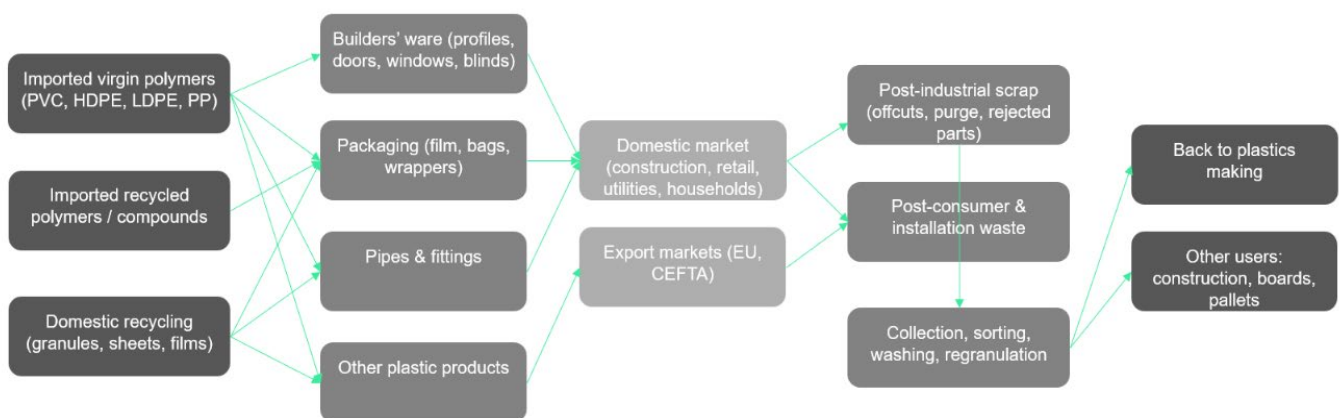


Figure 5. Kosovo-relevant plastics system and the main industrial-symbiosis loop

Source: Industrial Mapping Analysis author's synthesis based on the Kosovo Plastics Industry Value Chain, Manufacturing/Processing Industry Report¹ and evidence reviewed

Preliminary opportunity routes identified through the industrial mapping analysis included:

- Return of clean, segregated production offcuts as feedstock for profile, pipe or other plastics production, subject to polymer compatibility and product requirements.
- Improved collection, sorting, washing and regranulation of packaging plastics for use in secondary film, bags, crates, pallets and other suitable products.
- Recovery of suitable pipe offcuts and installation residua for non-pressure pipe, conduit or other applications where technical requirements can be met.

¹ Reçica, F. and Meier zu Köcker, G. (2019). Kosovo Plastics Industry Value Chain. Ministry of Trade and Industry / GIZ; Ministry of Industry, Entrepreneurship and Trade (2023). Manufacturing / Processing Industry Report.

- Open-loop use of mixed or mineral-filled plastic fractions in composite products, subject to feedstock quality and product-performance testing.
- A lower-priority, conditional route for managing non-recyclable residua as refuse-derived fuel or through co-processing, subject to applicable legal, technical and emissions requirements.

The mapping identified recurring constraints, including contamination and weak source separation, variable recycle quality, fragmented collection, limited traceability and uncertainty regarding consistent receiving demand. During the stakeholder workshop, participants confirmed the importance of packaging residua and highlighted the absence of sufficiently structured reuse and recycling routes. The discussion identified improved source separation and stronger coordination among producers, collectors, recyclers and potential receiving users as key enabling conditions.

2.5. Textile, Apparel and Leather

The textile, apparel and leather domain was mapped as three connected sub-industries: textile manufacturing, apparel and cut-make-trim production, and leather goods and footwear. Imported fabrics, yarns, fibres, accessories, processed hides and components dominate upstream inputs, while the principal residua arise during cutting, sewing, finishing and packaging. Figure 3 presents these relationships and the cross-cutting recovery tier connecting the three sub-industries with construction, furniture, recycling and wastewater-treatment applications. The arrows represent mapped system relationships and potential recovery routes and should not be interpreted as evidence that all collection, recovery or receiving arrangements are currently established.

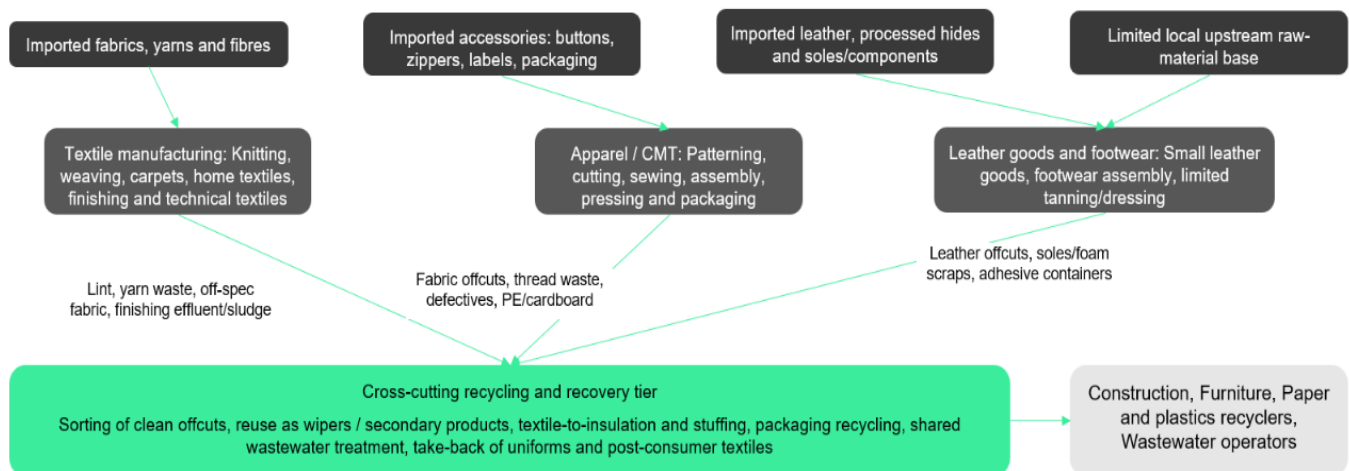


Figure 6. Kosovo textile, apparel and leather system and cross-cutting recovery tier

Source: Industrial Mapping Analysis author's synthesis based on Value Chain Study for the Textile, Clothing and Leather Sectors², and other publicly available information

Preliminary opportunity routes identified through the industrial mapping included:

- Sorting clean fabric offcuts for use as wiping cloths, filling, nonwoven materials or other secondary products.
- Use of technically suitable textile fractions in insulation and acoustic applications, subject to fire, emissions and product-performance requirements.
- Niche reuse of leather offcuts and footwear-component residua in small leather goods or other secondary products.

² D&D Business Support Center. Value Chain Study for the Textile, Clothing and Leather Sectors. Prepared for MIET, Kosovo.

- Recovery of plastic film, cardboard, reels and other packaging materials through coordinated collection.
- Shared wastewater treatment, chemical-management support and water-reuse options where firms are geographically and technically compatible.
- Uniform take-back, repair, reuse and post-consumer textile collection as longer-term options requiring appropriate collection and sorting capacity.

The mapping also considered the sector's employment profile, particularly the strong participation of women in apparel production. Sorting, repair, take-back and secondary processing could support additional formal value-chain roles, although any employment benefits would depend on viable receiving demand, safe working conditions and appropriate skills. During the stakeholder workshop, participants highlighted the significance of textile residua while also emphasising the challenges created by mixed material composition and insufficiently structured collection and recovery routes. Separation by material type, quality protocols, aggregation and stronger coordination with potential receiving users were identified as important enabling conditions.

2.6. Agri-food

The agri-food domain was mapped as five connected processing chains rather than as a single material flow: fruit and vegetable processing, dairy, meat processing, cereals and bakery, and wine and beverages. Each chain generates residua with different composition, seasonality, handling, safety and market requirements. Figure 4 traces the principal inputs, processing activities and residua across these chains and connects them to a cross-cutting recovery tier involving agriculture, energy operators, recyclers, packaging users and ingredient users. The arrows represent mapped system relationships and potential recovery routes; they do not imply that all collection, treatment or receiving arrangements are currently established. Because some biological residua are subject to regulatory controls, each proposed route requires appropriate categorisation and route-specific verification.

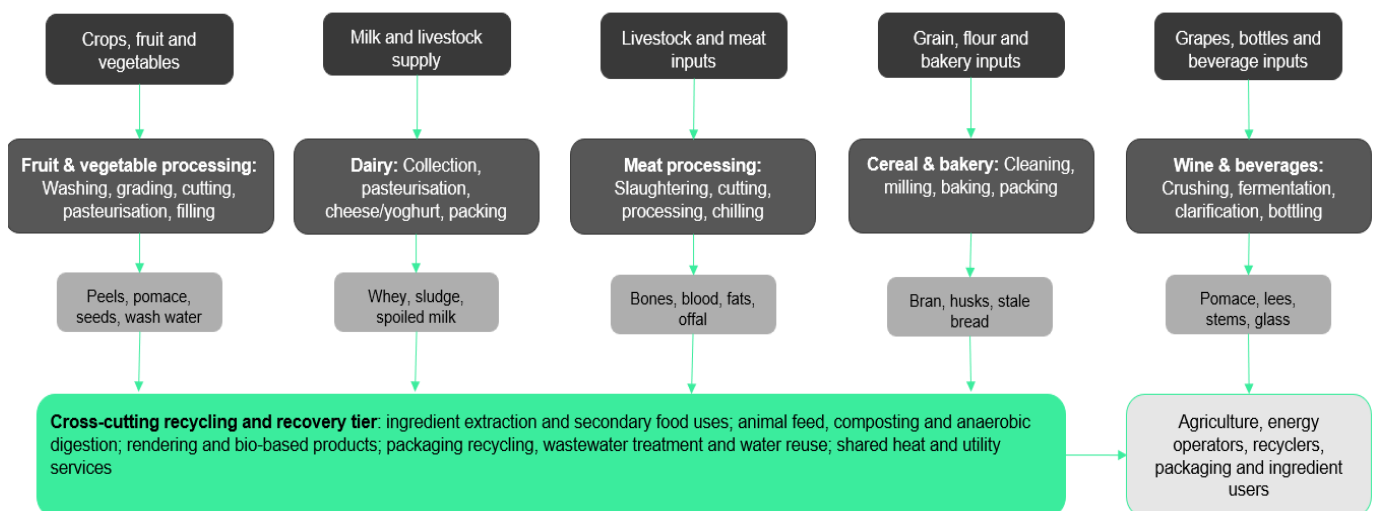


Figure 7. Kosovo agri-food system: priority processing chains and cross-cutting recovery tier

Source: Author's synthesis based on the Kosovo Food and Beverages Processing Value Chain Study³, the fruit and vegetable processor survey and the industrial mapping analysis.

Preliminary opportunity routes identified through the industrial mapping included:

³ Meier zu Köcker, G. and Dermastia, M. (2023). Kosovo Food and Beverages Processing Value Chain Study. MIET.

- Recovery of suitable fruit and vegetable peels, pomace, seeds and other fractions for ingredient extraction, secondary food uses, animal feed, composting, anaerobic digestion or bio-based products, depending on their composition, quality and regulatory classification.
- Collection and processing of whey and other suitable dairy residua for food, feed or other verified uses, with a potential associated reduction in wastewater loads.
- Compliant collection, aggregation and treatment of category-controlled animal by-products through authorised routes.
- Use of bran, husks, screening fines and suitable bakery residua in animal feed, ingredients, composting or other verified applications.
- Valorisation of grape pomace and other suitable winery residua, together with the recovery of glass and other packaging materials.
- Shared heat, water and wastewater-treatment systems, collection arrangements and packaging services where scale, proximity and technical compatibility make cooperation practical.

The mapping identified several conditions affecting these routes, including seasonality, variation in the composition and quality of residua, contamination risks, food and feed safety requirements, cold-chain and storage needs, fragmented supply, limited aggregation and inconsistent records of volumes and quality. The opportunity areas were considered through the broader stakeholder-validation process, but firm-level quantities, regulatory routes, receiving users and commercial arrangements still required further verification. They therefore represented preliminary opportunities for subsequent company-level assessment rather than confirmed investments.

2.7. Metal Processing

The metal-industry mapping connected three distinct but related tiers: mining and mineral concentration; basic metals, smelting and casting; and fabricated-metal manufacturing. These tiers differ considerably in the scale, characteristics and recoverability of their residua. Clean fabrication offcuts, chips and swarf are generally more accessible and retain an established material value, whereas slag, flue dust, foundry materials, tailings and recoverable heat require more extensive characterisation, infrastructure or site-specific assessment. Figure 2-4 presents these tiers and their principal residua, together with the cross-cutting collection, sorting and recovery tier linking generators with recyclers, re-melters, construction-material producers and other industrial users. The arrows represent mapped system relationships and potential recovery routes; they do not imply that all flows are currently organised or commercially established.

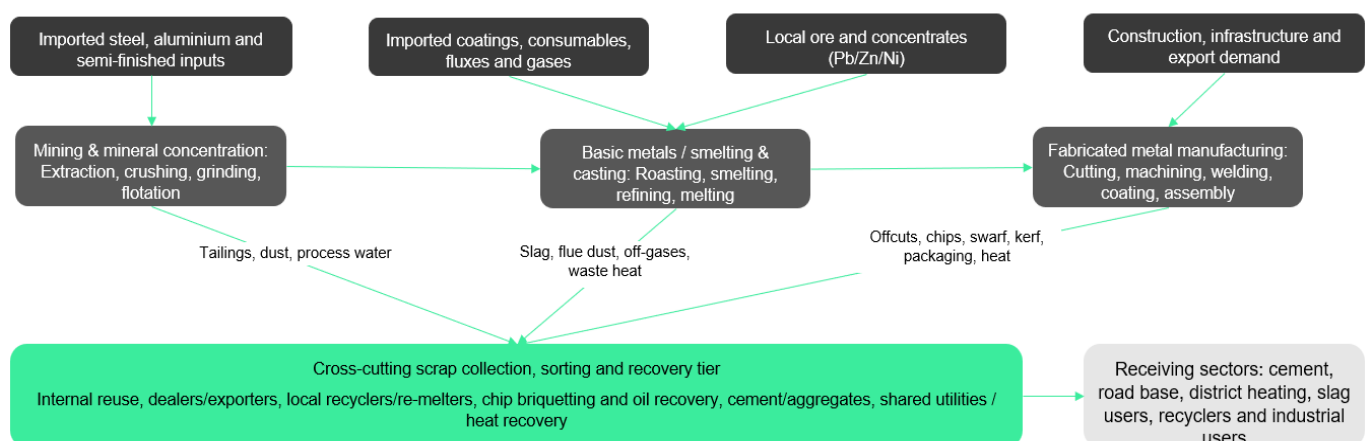


Figure 8. Kosovo metal-industry system: principal tiers and cross-cutting recovery tier

Source: Author's synthesis based on the metal-processing value-chain study⁴, sectoral mapping analysis and metal-industry residua analysis

⁴ Kosovo Metal Processing Value Chain Study (2023). Prepared for MIET and GIZ.

Preliminary opportunity routes identified through the industrial mapping included:

- Grade-controlled segregation, collection and return of clean offcuts and other metallic residua to recyclers, re-melters or other suitable receiving users.
- Briquetting of compatible machining chips and recovery of cutting fluids where volumes, grade separation and contamination controls make these routes technically and commercially viable.
- Use of tested slag or other suitable mineral fractions in cement, aggregates or road-base products where classification, environmental-safety and product-performance requirements are met.
- Recovery and productive use of process or compressor heat where a sufficiently close and stable demand exists and a technically viable connection can be established.
- Recovery or reuse of suitable foundry sand and packaging materials, subject to material characterisation and receiving-user specifications.
- Longer-term assessment of metal-bearing mining residua and tailings through site-specific technical and environmental investigation.

The evidence indicated that clean, grade-controlled fabrication residua were generally more readily recoverable than mineral and heat streams. Constraints across the system included fragmented collection, insufficient sorting and grading, contamination, limited traceability, restricted domestic recycling and re-melting capacity, and uncertainty regarding consistent receiving demand. Mineral applications additionally required material testing and regulatory clarification, while heat-recovery opportunities depended heavily on proximity, infrastructure and stable demand.

Workshop participants indicated that metal residua with reuse potential were being generated but noted that the relevant flows were not sufficiently structured or integrated. They also identified gaps in coordination and supply-demand matching. The mapping therefore presented clean fabrication residua as comparatively actionable opportunities, while mineral, energy and mining-related routes remained conditional on further technical, environmental and commercial verification.

2.8. ICT as a cross-cutting enabler

Industrial Mapping Analysis included ICT among the domains selected for detailed mapping because of its economic relevance and its potential to support productivity, resource efficiency and coordination across other industries. The mapping reviewed Kosovo's principal ICT activities, including software development and IT services, software products and platforms, ICT-enabled business services, infrastructure and support services, and cross-cutting data-integration capabilities. Unlike the four material-producing domains, however, ICT was not assessed principally as a generator or receiving user of physical residua. Drawing on the *Kosovo ICT Value Chain Study*, the

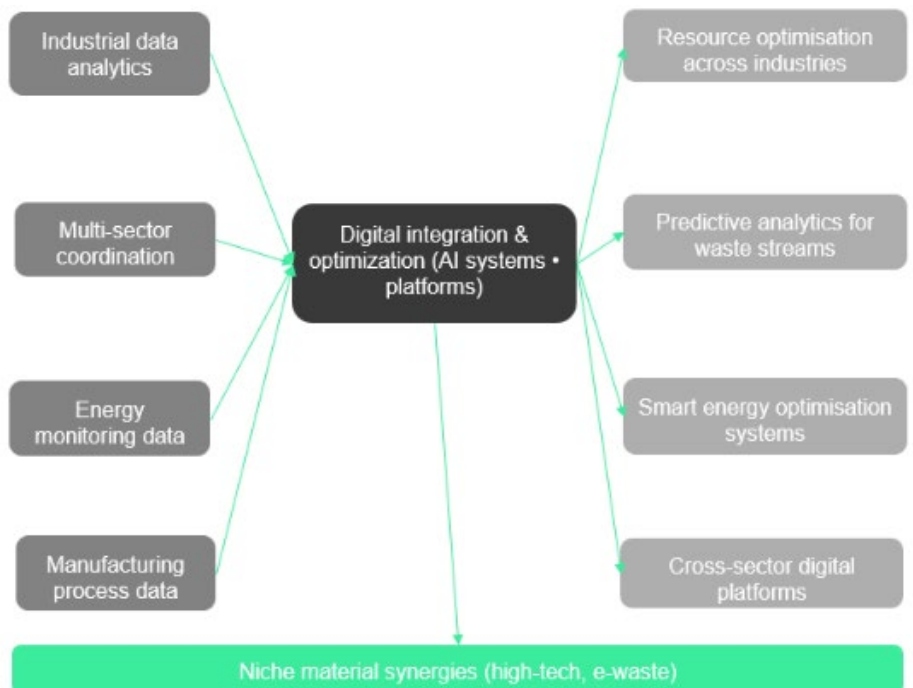


Figure 9. ICT-enabled digital integration and optimisation functions supporting industrial symbiosis. Author's synthesis

mapping characterised Kosovo's ICT sector as predominantly service-based and export-oriented, supported by skilled labour and dependent on imported hardware, cloud services and other digital infrastructure.⁵ Its export performance was considered evidence of an established domestic capability base in software development, data management and systems integration. The export of ICT services was not itself treated as an industrial-symbiosis pathway. The relevant opportunity was the potential application of these capabilities within Kosovo's manufacturing, recycling, utility and resource-management systems.

This differentiated treatment was supported during the Focus Group Discussion, where stakeholders validated the inclusion of ICT as an enabling sector rather than as a direct source of material residua. The same framing was subsequently presented and discussed during the stakeholder workshop, with ICT positioned as supporting data integration, monitoring, coordination and optimisation across the material-producing domains.

Figure 9 illustrates this enabling role by connecting industrial, energy and manufacturing-process data with digital integration and optimisation functions and their potential applications across industries. The arrows represent information and coordination relationships rather than physical material flows. They do not imply that the corresponding platforms, data systems or applications are already operational. The niche reference to high-technology and e-waste applications represents a secondary possibility and was not the principal basis for including ICT in the mapping.

Preliminary enabling functions identified through the industrial mapping included:

- Collection and structuring of information on available and required materials, including quantities, quality characteristics, location, timing and relevant technical specifications.
- Matching and coordination tools connecting material-generating firms with collectors, recyclers, utilities and potential receiving users.
- Support for material aggregation and logistics planning, particularly where individual company volumes are small or geographically dispersed.
- Traceability and documentation functions covering material specifications, testing information, transaction records and the movement of materials between participating actors.
- Energy, water and production-process monitoring to identify inefficiencies and support measurement of resource-efficiency results.
- Integration of industrial datasets and the use of analytics, automation or predictive tools where firms have reliable data, appropriate systems and sufficient technical capacity.

The industrial mapping also considered internal ICT-efficiency issues, including fragmented data, limited interoperability and underused digital or computing capacity. These were treated as productivity and optimisation considerations rather than as physical material exchanges.

Digital tools and platforms can facilitate industrial-symbiosis exchanges but cannot establish them independently of verified material flows, defined receiving uses and participation by the relevant actors. Their effective application requires reliable and interoperable data, clear ownership and governance, appropriate material-quality protocols, and sustained institutional responsibility for operating and maintaining the service. Accordingly, the mapping treated ICT as a cross-sector enabling domain supporting the identification, organisation and monitoring of physical exchanges in the material-producing sectors.

⁵ Krasniqi, B., Meier zu Köcker, G. and Dermastia, M. (2023). Kosovo ICT Value Chain Study. MIET and GIZ.

2.9. EU regulatory and standards implications for the mapped opportunity routes

The Task 2 industrial mapping considered the EU regulatory and standards framework because it increasingly influences the conditions under which secondary materials, recovered products and industrial information are exchanged, processed and accepted in EU-linked value chains. Its relevance varies according to the material, receiving application, production process and destination market. EU instruments are not automatically applicable to every Kosovo enterprise; their practical influence depends on applicable national legislation, the products and activities concerned, and firms' exposure to EU customers and supply chains.

Across the mapped domains discussed in this section, the EU framework influences industrial-symbiosis opportunities through four principal channels. First, it provides reference points for distinguishing waste, by-products and secondary materials. Second, it establishes or informs technical, safety and performance requirements for products containing recovered materials. Third, it shapes requirements concerning controlled biological materials, industrial emissions and resource efficiency. Fourth, it increases expectations regarding traceability, recycled content, product information, sustainability data and supply-chain transparency.

Table 3. EU instruments and standards relevant to the preliminary industrial symbiosis opportunity routes

EU instrument or standard	Principal mapped pathways affected	Main implication identified through Task 2
<i>Waste Framework Directive</i>	Plastics, textile residua, food waste and side-streams, scrap metal, slag and other recovered materials	Provides the principal EU reference for the waste hierarchy and for distinguishing waste, by-products and materials that may cease to be waste. It also reinforces waste prevention, separate collection, traceability and producer-responsibility arrangements.
<i>Packaging and Packaging Waste Regulation</i>	Packaging plastics, glass, cardboard and packaging associated with agri-food, textile and other manufacturing activities	Strengthens the direction towards packaging recyclability, separate collection, recycled content and supporting documentation, increasing the importance of clean and traceable packaging streams.
<i>Ecodesign for Sustainable Products Regulation</i>	Plastics products, textiles and other manufactured goods supplied to EU-linked markets	Establishes a framework for progressively stronger requirements concerning product circularity, durability and product information, including digital product passports for relevant product groups as detailed requirements are adopted.
<i>Construction Products Regulation</i>	Recovered plastics used in builders' ware or composites, textile insulation, and slag or mineral fractions used in cement, aggregates or road applications	Increases the importance of material characterisation, product testing, declared performance, fitness for purpose and conformity evidence for construction applications.
<i>EU animal by-products framework</i>	Blood, bones, fats, offal and other category-controlled materials from livestock and meat processing	Determines how animal by-products are categorised, handled, treated and used. Permitted receiving applications depend on the relevant risk category and authorised treatment route.
<i>Industrial Emissions Directive</i>	Larger metal-processing and agri-food installations and other emissions-intensive activities	Reinforces the importance of emissions control, waste prevention, resource efficiency and environmental performance, particularly in smelting, casting, treatment, wastewater and utility-intensive processes.
<i>Carbon Border Adjustment Mechanism</i>	EU-linked iron, steel and aluminium value chains	Does not create industrial-symbiosis exchanges directly, but increases the strategic relevance of material efficiency, credible secondary inputs,

EU instrument or standard	Principal mapped pathways affected	Main implication identified through Task 2
		process decarbonisation and recoverable heat in affected value chains.
<i>Data Act and Artificial Intelligence Act</i>	Digital resource matching, industrial data integration, process monitoring, predictive analytics and automated optimisation	Increase the importance of data access, interoperability, governance, accountability and trustworthy use of digital and AI-enabled systems.
<i>Corporate sustainability reporting and due-diligence requirements</i>	Export-oriented textile, metal, plastics and other firms supplying EU-linked value chains	May influence Kosovo suppliers indirectly through buyer requests for improved sustainability, traceability and supply-chain information.
<i>ISO 59040:2025 on product circularity data sheets</i>	Cross-sector material documentation, traceability and circularity-information exchange	Provides a voluntary methodology for structuring and exchanging product-level circularity information. It supports consistent documentation but does not replace legal classification, testing, permitting or product-conformity requirements.

Source: Synthesis of the sector-specific EU Regulations and Standards Implications analysis performed during industrial mapping

The implications differ across the mapped domains. In plastics, the regulatory direction favours clean, polymer-specific and traceable feedstock, particularly for packaging, profiles and technically appropriate pipe or construction applications. Mixed-plastics and composite routes remain more dependent on evidence of material quality and product performance. In textiles, separate collection, producer responsibility, product information and buyer expectations increase the relevance of segregated pre-consumer offcuts, documented take-back arrangements and improved management of finishing-related wastewater.

In agri-food, the framework distinguishes relatively flexible plant-based residua from more tightly controlled dairy and animal-processing streams. Fruit and vegetable residua, cereal by-products and winery side-streams may have several possible uses where their quality and classification permit, whereas animal by-products are governed by dedicated risk categories and authorised routes. Packaging requirements also affect the recovery of plastics, glass and cardboard generated across agri-food value chains.

For metals, clean and well-graded fabrication scrap is comparatively straightforward, while slag, foundry sand and other mineral fractions depend more strongly on classification, environmental testing and evidence of suitability for the intended application. EU carbon and industrial-emissions requirements also increase the strategic relevance of material efficiency, secondary inputs and heat recovery in energy-intensive and export-linked production. For ICT-enabled functions, the principal implications concern data quality, interoperability, governance and responsible use of analytics and automation.

ISO 59040:2025 should be understood as an information-exchange standard rather than as a standard prescribing industrial processes or classifying waste streams. Applied illustratively to the mapped pathways, a product circularity data sheet could support the exchange of relevant information on the composition, source and circular attributes of a secondary polymer, recovered textile fraction, secondary metal or product containing recovered material. It does not determine whether a stream is legally classified as waste, a by-product or a material that has ceased to be waste, and it does not replace applicable safety, testing or product-conformity requirements.

Overall, the industrial mapping analysis found that the direction of EU regulation and standards reinforces the relevance of clean, segregated, traceable and well-documented material routes. More complex routes including mixed post-use materials, category-controlled animal by-products and recovered materials intended for construction products are associated with more extensive handling, testing and documentation conditions. The analysis identified these implications as characteristics of the mapped opportunity routes; it did not constitute a legal-compliance determination for individual firms, materials or products.

2.10. Cross-sector synthesis of the Stage 2 - Task 2 findings

Drawing together the sector screening, industrial system maps and regulatory and standards implications presented above, Task 2 identified several structural conditions that recurred across the four material-producing domains, while ICT was considered separately as a cross-sector enabling domain. The domains were prioritised through the Task 2 multicriteria screening, value-chain review and resource analysis. Their relevance was subsequently supported through the Focus Group Discussion, while the industrial mapping and stakeholder workshop provided further evidence on material flows, receiving applications and cross-sector linkages.

Across the four material-producing domains, the mapping identified residua with plausible recovery, reuse or recycling applications. It also showed that material availability alone does not create an industrial-symbiosis relationship. Stable exchanges depend on the alignment of quantity, quality, timing, location, legal status, logistics and receiving demand. These conditions explain why apparently similar materials may have different recovery prospects depending on their source, composition and intended application.

Kosovo's production and recovery chains are frequently incomplete. In this context, "incomplete" means that one or more relevant stages are located outside Kosovo or are not available domestically at sufficient scale. Plastics converters depend largely on imported polymers; textile and apparel manufacturers import most fabrics, fibres and accessories; agri-food processors combine domestic agricultural supply with imported processing inputs and packaging; and metal manufacturers rely substantially on imported metals and semi-finished products. At the other end of the chain, some collected materials are exported because suitable domestic processing, recycling or re-melting capacity is limited.

Import dependence creates potential interest in domestic secondary inputs, but it does not automatically establish a viable import-substitution opportunity. Recovered materials must still meet the technical, safety, quality and commercial requirements of the intended application. Similarly, the export of collected residua is not necessarily evidence of system failure: in some cases, it constitutes an existing recovery route where domestic processing is unavailable or uneconomic.

The mapping also showed that some residua already have established destinations. Depending on the material and sector, these include internal reuse, sale to collectors, domestic recycling, use for heat or export. The industrial-symbiosis opportunity may therefore concern improved source separation, better grade retention, more reliable aggregation, domestic processing or movement towards a higher-value application rather than the creation of an entirely new route.

For interpretation, the material streams considered through the mapping can be understood through three broad routing situations:

1. *Potential domestic industrial-symbiosis route:* A technically plausible domestic processor, recovery option or receiving application was identified. This category includes both comparatively established routes and conditional routes requiring further characterisation, regulatory confirmation, testing or commercial validation.
2. *Existing recovery or export route:* The material was already being reused internally, sold, recycled, recovered or exported through an existing arrangement. These activities form part of the baseline. The industrial-symbiosis opportunity may lie in improving source separation, grade retention, reliability, domestic processing or value addition rather than creating an entirely new route.
3. *No verified productive-use route:* The available evidence did not identify a technically, legally and commercially acceptable productive use. The material therefore remained subject to applicable storage, treatment or disposal requirements, although its routing could be reconsidered if processing capacity, technology, regulation or receiving demand changed.

These are analytical routing situations rather than legal waste classifications or permanent characteristics of the materials. The appropriate route depends on the material's source, composition, legal status, preparation requirements and intended application.

A further recurring finding was the importance of the complete generator–processor–receiving-user relationship. Across the mapped domains, recurring gaps concerned source separation, material aggregation, processing capacity, technical documentation, testing and conformity evidence, traceability, logistics and connections with receiving users. The industrial mapping therefore examined not only where residua arose, but also the processing and receiving functions associated with returning them to productive use.

The regulatory and standards analysis added a consistent cross-sector conclusion. Routes based on clean, segregated and traceable materials with documented characteristics aligned more readily with the direction of EU requirements and buyer expectations. Routes involving mixed materials, category-controlled biological streams or recovered materials intended for construction applications were more dependent on classification, controlled handling, technical testing and conformity evidence. These conditions varied by material and intended application; they did not constitute a single regulatory pathway applicable to all industrial-symbiosis exchanges. The Task 2 evidence also identified several recurring enabling conditions. These included the presence of domestic converters and recyclers in selected value chains, existing collection and trading networks, the intrinsic market value of some residua, established receiving sectors such as construction and agriculture, increasing attention to resource efficiency and circularity, and Kosovo's ICT capabilities in data management and coordination. Their influence differed by pathway and did not remove the structural constraints identified through the mapping.

Table 4. Cross-sector structural findings emerging from Task 2

Task 2 finding	Cross-sector interpretation
<i>Dispersed and variable material flows</i>	Many SMEs generate relatively small or irregular quantities, while biological residua may also be seasonal and geographically dispersed. Aggregation and logistics are therefore central features of several mapped routes.
<i>Variation in quality and composition</i>	Polymer type, fibre composition, alloy grade, biological condition and contamination levels determine whether residua are compatible with particular receiving applications.
<i>Incomplete production and recovery chains</i>	Several industries depend on imported inputs, while some domestic recycling, reprocessing, re-melting or specialised treatment functions remain limited or absent.
<i>Existing recovery and export routes</i>	Some residua are already reused internally, collected, recycled, used for heat or exported. The mapped opportunity may therefore lie in improving the value, reliability or domestic processing of an existing flow.
<i>Importance of receiving-user requirements</i>	Technically plausible uses depend on the specifications, safety requirements, product standards and commercial conditions of the receiving application.
<i>Logistics and proximity</i>	Transport distance, storage and handling requirements influence low-value or dispersed material flows, while heat, wastewater and shared-utility opportunities depend particularly on geographic proximity.
<i>Pathway-specific regulatory and conformity conditions</i>	As detailed in Section 2.9, applicable requirements depend on the legal status of the material and its intended receiving use. Waste classification, environmental authorisations, food and feed safety, veterinary controls, packaging arrangements and construction-product requirements affect different routes in different ways.
<i>Information and coordination gaps</i>	Data on quantities, quality, location and current destinations remain fragmented, while linkages among generators, processors and receiving users are not consistently organised.
<i>Technical and institutional capacity</i>	The mapping identified relevant capability areas in source separation, material identification and grading, sampling and testing, quality control, safe handling, process

Task 2 finding	Cross-sector interpretation
	optimisation and digital resource accounting. It did not constitute a quantified workforce-needs assessment.

Source: Synthesis of the Task 2 Sectoral Mapping Report, Task 2 Industrial Mapping Report, Focus Group Discussion findings and stakeholder workshop evidence.

The industrial system mapping, stakeholder validation and regulatory and standards review defined the broader industrial-symbiosis opportunity landscape established under Task 2. They identified where material, energy and information linkages were present or appeared plausible, distinguished existing recovery practices from emerging opportunities, and clarified the technical, market, organisational and regulatory conditions shaping the different routes. This evidence provided the analytical foundation for the company survey and pathway assessment undertaken under Task 3.

3

BUSINESS SURVEY, PATHWAY ASSESSMENT AND STAKEHOLDER VALIDATION

3. Business Survey, Pathway Assessment and Stakeholder Validation

This section presents the work and findings of Stage 3 - Task 3, which assessed and refined the broader industrial symbiosis opportunity set identified through Task 2. It describes the company mapping and business survey, the analysis of reported residua, current management practices and inter-company cooperation, the preliminary assessment of candidate pathways, and their review through sector workgroups and the stakeholder validation workshop. Together, these activities informed the selection of the final Task 3 portfolio of ten priority industrial symbiosis pathways. The subsequent sections present the detailed pathway assessments and resulting implementation recommendations.

3.1. Purpose and analytical sequence of Task 3

Task 3 moved the analysis from broad sectoral and industrial mapping to evidence at company and pathway level. Task 2 had identified 34 possible routes across four material-producing domains and a cross-sector enabling domain. Task 3 examined these opportunities through the business survey, preliminary technical and economic assessment, sector workgroups and stakeholder validation. Its purpose was to test their relevance, understand the conditions affecting their development and strengthen the evidence base. Following this assessment and the stakeholder workshop, ten pathways were retained in the final Task 3 portfolio. The number and composition of the final portfolio were therefore outcomes of the process.

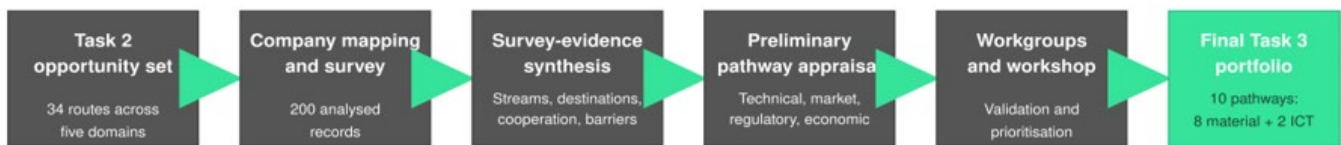


Figure 10. Analytical sequence from the Task 2 opportunity set to the final Task 3 pathway portfolio

For this assessment, industrial symbiosis was understood as an organised relationship in which a resource arising from one enterprise or activity is used productively by another enterprise or shared among participating firms. Recycling can form part of industrial symbiosis, but the two are not the same. Recycling refers to the processing of discarded materials. It becomes part of an industrial symbiosis pathway when it connects companies generating residua with collectors or processors and with companies that can use the recovered material.

The opportunities assessed under Task 3 involved different types of activity. Some concerned the use of a suitable secondary material in an existing production process; others required sorting or reprocessing by an intermediary; and some involved developing a new product or receiving use. Shared collection, logistics and digital coordination were also considered as enabling functions. These differences were reflected in the pathway assessments.

3.2. Company mapping, survey design and respondent profile

The company survey was conducted to test the sectoral and industrial mapping findings against enterprise experience and to gather evidence on material streams, current management practices, inter-company cooperation, barriers, business interest and support needs. It principally targeted enterprises associated with Food and Beverages; Textile, Apparel and Leather; Plastics and Rubber; and Metal Processing.

Companies were identified using active-business information from the Tax Administration of Kosovo, supplemented by available business databases and sectoral registries. The survey focused on active

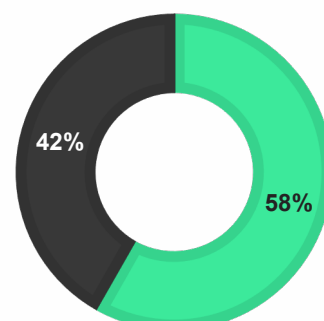
enterprises operating within the four priority manufacturing domains. The survey design sought coverage across relevant NACE Rev. 2 subsectors, enterprise sizes, geographical areas, employment and ownership characteristics, and domestic and export-oriented firms.

Data were collected between 5 May and 5 June 2026 through online questionnaires and face-to-face interviews. A total of 200 enterprises provided valid survey responses. Responses were cleaned, coded and analysed in aggregate, with commercially sensitive company information excluded from reporting.

The approach was designed to provide structured coverage of the four priority manufacturing domains rather than to reproduce their respective shares within Kosovo's entire manufacturing population. This structure supported comparison across the priority domains and triangulation of the survey results with the industrial mapping and stakeholder evidence. Survey percentages are reported for the participating enterprises, while reported material quantities are used as indicative company-level evidence rather than extrapolated national estimates.

COMPOSITION OF THE COMPANY SURVEY

■ Online ■ Face to face



3.3. Survey findings relevant to pathway assessment

3.3.1. Business context and operational readiness

Survey responses indicated generally positive turnover and employment trends, although business performance, scale and investment capacity varied considerably within and across sectors. Metal-processing and food and beverage respondents reported comparatively strong turnover growth, while plastics and rubber included a relatively large share of higher-turnover enterprises. Textile and apparel respondents also reported business growth, but the sector remained characterised by smaller firms and uneven financial and operational capacity.

Capacity utilisation varied considerably among the surveyed enterprises. Almost 44% of respondents reported using less than half of their installed production capacity, while approximately 5% reported operating above 90%. Underutilisation was reported across all four domains and was most pronounced among Textile and Apparel respondents, 48.7% of whom reported operating below 50% capacity.

This finding is relevant because production levels affect the quantity and regularity of the residua generated by firms. The reported material flows reflect current production conditions and may change as capacity utilisation increases or decreases. Capacity utilisation was therefore treated as contextual evidence about current production activity, the possible development of material flows and, where processes are compatible, the ability to absorb secondary inputs.

Table 5. Business evidence relevant to implementation readiness

Evidence area	Survey result	Relevance to the Task 3 assessment
Turnover and employment	Turnover increased by more than 5% among 52.1% of Plastics and Rubber respondents, 67.9% of Metal Processing respondents, 64.1% of Textile and Apparel respondents, and 67.2% of Food and Beverage respondents. The share reporting workforce growth ranged from 33.3% to 43.4%.	Provided evidence on the level and direction of business activity. Growth indicated that production and related material flows could change, but did not by itself demonstrate readiness for a specific pathway.

Evidence area	Survey result	Relevance to the Task 3 assessment
<i>Enterprise scale</i>	The share of respondents reporting annual sales above EUR 500,000 was 51.2% in Plastics and Rubber, 43.4% in Metal Processing, 29.6% in Textile and Apparel, and 25.0% in Food and Beverages.	Showed differences in company scale and potential financial and organisational capacity. These differences were considered at company level rather than attributed uniformly to an entire domain.
<i>Capacity utilisation</i>	Almost 44% of respondents reported operating below 50% of installed capacity, while approximately 5% operated above 90%. The share operating below 50% was highest in Textile and Apparel, at 48.7%.	Helped interpret current production and residua generation. It did not demonstrate that existing equipment could process or use secondary materials.
<i>Investment and financing</i>	Investment in resource efficiency varied across the surveyed firms. Between 81.3% and 95.2% of respondents across the four domains reported using their own financial resources, while reported use of public or donor programmes ranged from 3.4% to 16.7%.	Provided context on firms' ability to finance resource-efficiency measures and informed the subsequent assessment of financial barriers and support needs.
<i>Existing resource-efficiency practices</i>	Reported material-efficiency measures ranged from 21% to 51% across the four domains, while reported waste-reduction measures ranged from 25% to 40%.	Confirmed that relevant practices were already present, although their prevalence differed across domains and firms. These practices were considered alongside material, market and technical evidence in assessing pathways.

3.3.2. Imported inputs and perceived substitution potential

The survey reinforced the industrial mapping finding that Kosovo's manufacturing industries depend substantially on imported raw materials and intermediate inputs. Metal-processing enterprises import metals, sheets and profiles; plastics manufacturers depend on polymer resins and compounds; textile and apparel firms rely on imported fabrics, fibres and accessories; and food and beverage companies import selected agricultural, processing and packaging inputs.

Table 6. Reported import dependency and perceived substitution potential

Domain	Respondents importing critical inputs	Main imported inputs reported	Respondents perceiving potential to replace imported inputs with local secondary materials
<i>Food and Beverages</i>	21%	Selected agricultural and processing inputs and packaging materials	36.1%
<i>Plastics and Rubber</i>	35%	HDPE, LDPE, PE, PVC and rubber compounds	20.8%
<i>Metal Processing</i>	39%	Steel, aluminium, copper, zinc, sheets and metal profiles	26.4%
<i>Textile, Apparel and Leather</i>	30%	Fabrics, fibres, accessories and leather materials	20.5%

Respondents also identified opportunities to replace a portion of imported inputs with domestic secondary materials. Food and beverage enterprises expressed particularly strong perceived potential, followed by metal processing, plastics and rubber, and textiles and apparel. These responses demonstrate business interest but do not establish technical substitutability or commercial viability.

Import substitution is possible only where the secondary input meets application-specific requirements for quality, safety, consistency, performance, traceability and price. Substitution claims must therefore be demonstrated through product testing, buyer acceptance and repeat use.

References to packaging in Task 3 concern packaging residua generated or controlled at enterprise level. These include packaging scrap from production, packaging associated with incoming raw materials, unused or off-spec packaging, and segregated transport and logistics packaging generated by participating firms. They do not include packaging discarded by households and do not extend the assignment into municipal household-waste collection.

3.3.3. Reported residua and their current destinations

Among companies included in the survey, selected as described in Section 3.2, respondents reported material streams consistent with the main categories identified through the Task 2 industrial mapping. Plastics and Rubber respondents reported production scrap, PVC offcuts, plastic films and enterprise packaging residua. Metal-processing firms reported steel, aluminium, copper and other metal offcuts, chips and swarf. Textile and apparel firms reported fabric and fibre offcuts, packaging and smaller leather-related streams. Food and beverage enterprises reported organic residua, animal by-products, enterprise packaging and other processing streams, including wastewater and sludge.

In this section, a material's current destination means the route reported at the time of the survey: internal reuse; sale or transfer to another company; collection by a recycler or waste operator; export; storage; or disposal with general waste or at a landfill. These destinations describe how respondents were managing their materials at the time of data collection; they do not indicate that all reported streams were unmanaged or available for a new exchange.

Table 7. Principal reported residua and current destinations

Domain	Principal residua reported by respondents	Current destinations reported
<i>Plastics and Rubber</i>	PVC and other polymer offcuts, production scrap, films and enterprise packaging residua	Internal reuse, sale or transfer to recyclers and other companies, third-party collection and disposal
<i>Metal Processing</i>	Metal offcuts, chips, swarf, defective parts and enterprise packaging residua	Sale to collectors or recyclers, internal reuse, transfer to other companies, export and disposal
<i>Textile, Apparel and Leather</i>	Fabric and fibre offcuts, cardboard, plastic film, pallets and selected leather-related residua	Internal reuse, sale or transfer, donation in some cases, collection and mixed disposal
<i>Food and Beverages</i>	Biological residua, animal by-products, enterprise packaging, pallets, wastewater and sludge	Internal reuse, sale or transfer, collection, regulated handling where applicable, and disposal

The quantity data provided an indicative picture of the scale of material streams among the surveyed enterprises. They were used to inform the pathway assessments but not to estimate national material volumes.

The survey also asked companies about existing material exchanges, barriers to improved recovery, preferred partners and measures that could facilitate cooperation. Respondents referred to better access to recyclers and receiving users, improved information and matching, financial support, clearer requirements, feasibility studies and public-institution support. These responses provide evidence of business interest and preferred enabling conditions. Existing cooperation and stated readiness are examined further in Section 3.3.4.

Existing recovery was treated as part of the baseline. Materials already reused, sold, transferred or recycled were not considered new industrial-symbiosis results solely because they were associated with a selected pathway. The Task 3 assessment instead considered whether the mapped arrangements could support additional recovery, improved material quality, more reliable exchanges, higher-value uses or greater domestic value retention.

3.3.4. Existing circular practices and inter-company cooperation

The survey confirmed that material exchange and other forms of resource cooperation already occur among the participating enterprises. Companies reported selling by-products and residua, using materials generated by other firms as production inputs, sharing collection and recycling services, coordinating logistics and exchanging technical knowledge.

The most frequently reported form of cooperation was the sale of by-products and residua. This was reported by 56.6% of Metal Processing respondents, 39.6% of Plastics and Rubber respondents, 25.6% of Textile and Apparel respondents and 24.6% of Food and Beverage respondents. Use of another company's residua as a production input was less common, reported by 37.7%, 29.2%, 20.5% and 14.8% of respondents in the same domains respectively.

Shared collection and recycling services were reported by between 21.3% and 39.6% of respondents across the four domains. Shared logistics, joint investment and technical knowledge exchange were also reported, although less consistently. Overall, Metal Processing showed the strongest cooperation profile, followed by Plastics and Rubber. Cooperation was less frequent among Food and Beverage and Textile and Apparel respondents.

These findings show that the opportunities assessed under Task 3 did not all require entirely new business relationships. Some pathways could build on existing exchanges by improving material separation, consistency, documentation or coordination. Other pathways required new links between material generators, processors and receiving users.

Table 8. Share of respondents reporting existing forms of inter-company resource cooperation, by manufacturing domain

Type of cooperation	Plastics and Rubber	Metal Processing	Textile and Apparel	Food and Beverages
<i>Sale of by-products and residua</i>	39.6%	56.6%	25.6%	24.6%
<i>Use of another company's residua as an input</i>	29.2%	37.7%	20.5%	14.8%
<i>Shared collection and recycling services</i>	25.0%	39.6%	23.1%	21.3%
<i>Shared logistics and transport</i>	18.8%	32.1%	23.1%	11.5%
<i>Joint investment</i>	12.5%	17.0%	23.1%	8.2%
<i>Technical knowledge exchange</i>	20.8%	32.1%	25.6%	18.0%

Note: Percentages represent the share of respondents within each domain reporting each type of cooperation. Multiple responses were permitted; percentages therefore do not sum to 100%.

3.3.5. Barriers and support needs reported by businesses

The most frequently reported barriers were limited recycling or processing options, difficulty identifying buyers and market connections, inadequate processing infrastructure and high investment costs. Respondents also identified insufficient information, weak collaboration mechanisms and uncertainty about practical regulatory requirements.

Businesses were most concerned with three questions: where their residua could be processed, who could use or purchase the recovered material, and how the required equipment or services would be financed.

Uncertainty regarding waste and by-product classification and the lack of practical guidance were also identified, although businesses generally gave greater prominence to market, infrastructure and financial constraints.

The reported barriers were closely connected. A company may be unable to find a buyer because its material is not separated consistently, because the available quantity is too small or irregular, or because information about potential users is unavailable. Similarly, investment in equipment would not establish a viable exchange unless there were sufficient material supply and a receiving user for the resulting product.

Businesses gave the highest priority to grants and investment subsidies. Tax incentives, fee reductions, blended finance and low-interest loans were also rated highly. Training, technical assistance, business matching and collaboration platforms were reported as useful supporting measures.

Table 9. Main barriers and regulatory concerns reported by surveyed enterprises

Reported barrier or issue	Assessment in the Business Survey Report
Limited recycling opportunities	High
Lack of buyers and market connections	High
Limited processing infrastructure	High
High investment costs	Medium–high
Limited information and awareness	Medium
Weak collaboration mechanisms	Medium
Uncertainty over waste and by-product classification	High regulatory concern
Lack of practical regulatory guidance	High regulatory concern

3.4. Relationship between the Task 2 opportunity set and the Task 3 portfolio

Task 2 identified 34 possible material, service and ICT-enabling routes across the mapped domains. Task 3 did not seek to reduce this opportunity set to a predetermined number. The business survey, pathway assessment, sector workgroups and stakeholder validation provided additional evidence on the relevance of the mapped routes and the conditions affecting their development. This process resulted in ten pathways being retained in the final Task 3 portfolio.

Table below shows the relationship between the broader Task 2 opportunity set and the outcome of the Task 3 assessment and validation.

Table 10. Relationship between the Task 2 opportunity set and the final Task 3 portfolio

Domain	Broader Task 2 opportunity set	Pathways retained following Task 3 assessment and validation
<i>Plastics and Rubber</i>	PVC offcuts into profile and duct products; packaging residua into recycled film and bags; pipe residua into conduits and corrugated pipes; mixed plastics with mineral fillers into composites; non-recyclable residua into cement co-processing as a lower-priority route; digital scrap exchange and traceability.	P1: PVC Offcuts into Profile and Duct Products; P2: Packaging Waste into Recycled Film and Bags.
<i>Textile, Apparel and Leather</i>	Textile-to-insulation and filling; wipers, packing fill and secondary nonwovens; leather offcuts to small goods and bonded products; packaging loop closure; shared wastewater treatment and water reuse; take-back schemes for uniforms and hotel textiles; shared energy services.	T2: Textile Offcuts into Industrial Wipers, Packing Fill and Secondary Nonwovens; T4: Textile-sector Packaging Loop Closure.
<i>Agri-food</i>	Fruit and vegetable residua to ingredients; lower-grade plant residua to composting or anaerobic digestion; whey to feed, ingredients or anaerobic digestion; meat by-products to rendering and bio-based products; bran, husks and stale-bread loops; winery residua to extracts,	A4: Animal By-products to Authorised Rendering and Bio-based Uses; A7: Agri-food Packaging Loop Closure.

Domain	Broader Task 2 opportunity set	Pathways retained following Task 3 assessment and validation
	bioethanol or materials; packaging loop closure; shared utilities.	
<i>Metal Processing</i>	Closed-loop scrap recycling; chip briquetting and coolant recovery; slag to cement and construction materials; waste-heat recovery; foundry sand and dross recovery; transport-packaging loops; tailings re-mining or other secondary-raw-material uses.	M1: Grade-controlled Recovery and Higher-value Recycling of Metal Scrap and Swarf; M3: Slag to Cement and Construction Materials.
<i>ICT as a cross-sector enabler</i>	Data integration for process optimisation; AI analytics for predictive optimisation; digital platforms for resource matching; smart energy systems; cross-sector digitalisation; use of fragmented or underused data.	I2: AI Analytics to Predictive Optimisation; I3: Digital Resource-Matching and Traceability Service.

Routes not included in the final portfolio were not rejected. Some were covered by broader retained pathways, while others depended on factors such as location, material volumes, receiving demand or longer-term infrastructure development. They remain part of the Task 2 opportunity set and can be considered again as conditions develop.

3.5. Pathway assessment approach

The Task 3 assessment drew on the industrial mapping, company survey, sector workgroups, stakeholder validation and available technical and economic evidence. The assessment considered:

The source and characteristics of the material
The likely generators and receiving users
The continuity and quality of material supply
The proposed receiving use
Existing market activity
Technical, organisational and logistical requirements
Applicable regulatory and environmental conditions
Indicative costs and benefits at company, industry and wider-economy levels

The final portfolio was based on a qualitative comparison of this evidence and stakeholder input rather than a second numerical multicriteria assessment. The pathway categories describe the nature of each opportunity and the basis for its further development; they do not represent a uniform level of technical or commercial readiness.

The ten retained pathways are documented through a consistent fiche structure in the Technical Annexes. The fiches describe the proposed exchange or enabling function, principal actors, technical and commercial evidence, economic rationale, barriers, development conditions, digitalisation opportunities and indicative economic effects. The detailed economic and environmental assessment is presented in the Technical Annexes.

As explained in Section 3.1, recycling-based routes were considered industrial symbiosis pathways where they connected material generators, collectors or processors and receiving users through an organised exchange. Recycling undertaken by an individual company without such an inter-company relationship was not treated as a separate industrial symbiosis pathway.

3.6. Stakeholder validation findings

The Task 3 assessment built on the Task 2 stakeholder engagement described in Section 2 and added sector workgroups and a validation workshop focused on the pathways, barriers and enabling conditions. Participants included representatives of businesses, sector associations, public institutions and other relevant actors. Their input was used to assess the practical relevance of the pathways, clarify how existing exchanges were organised and compare priorities across the mapped domains.

Five messages recurred across the stakeholder discussions:

Participants emphasised the importance of reliable information on material quantities, quality and how the materials were currently managed.

Repeat exchanges were considered more likely where participating companies had clear roles, commercial interest and confidence in the arrangement.

Collection, aggregation and quality-control arrangements needed to reflect the characteristics of the material and the requirements of its intended user.

Testing, standards and conformity evidence were considered particularly important where recovered materials would be used in manufactured products.

Digital tools were considered useful when connected to actual material flows, participating companies and active coordination.

Stakeholder feedback also helped distinguish comparatively established material routes from more conditional applications. Clean PVC offcuts, segregated metal scrap and enterprise-controlled packaging residua received support as comparatively practical routes where source separation and receiving arrangements could be organised. Textile offcuts were retained for product-focused assessment because their composition and possible receiving uses vary.

Animal by-products were retained as a strategically relevant but regulated pathway to authorised recovery. Stakeholder support confirmed the relevance of the pathway but did not remove the applicable veterinary, environmental and treatment requirements. Slag was retained as an application-specific pathway whose use depends on the characteristics of the material and the requirements of the proposed application. ICT functions were retained as cross-sector enablers supporting production optimisation, material information and inter-company coordination rather than as standalone physical exchanges.

Table 11. Final Task 3 pathway portfolio and principal qualifications

Code	Final Task 3 pathway	Positioning and principal qualification
P1	PVC Offcuts into Profile and Duct Products	Priority pilot: strongest fit where offcuts are clean, segregated and compatible with the receiving formulation and product specifications.
P2	Packaging Waste into Recycled Film and Bags	Priority/quick win: applied to source-separated packaging residua generated or controlled by enterprises, with suitable polymer composition and quality. It does not include household packaging collection.
T2	Textile Offcuts into Industrial Wipers, Packing Fill and Secondary Nonwovens	Priority pilot: receiving products and demand depend on fibre composition, cleanliness and product-performance requirements.
T4	Textile-sector Packaging Loop Closure	Priority/quick win: applied to segregated cardboard, film and transport packaging generated or controlled by Textile and Apparel firms.
A4	Animal By-products to Authorised Rendering and Bio-based Uses	Strategic/regulated: relevant within the applicable veterinary, environmental and authorised-treatment system.
A7	Agri-food Packaging Loop Closure	Priority/quick win: applied to enterprise-controlled glass, cardboard, plastics and transport packaging in the agri-food sector. It excludes household and municipal packaging collection.

Code	Final Task 3 pathway	Positioning and principal qualification
M1	Grade-controlled Recovery and Higher-value Recycling of Metal Scrap and Swarf	Priority pilot: builds on established scrap markets, with potential to improve material grading, preparation and domestic value addition.
M3	Slag to Cement and Construction Materials	Priority/conditional: each proposed application depends on the material characteristics and applicable environmental and product-performance requirements.
I2	AI Analytics to Predictive Optimisation	Enabling pathway: supports measurable production and resource-efficiency applications rather than constituting a material exchange.
I3	Digital Resource-Matching and Traceability Service	Enabling pathway: supports physical exchanges through structured information, resource matching, traceability and coordination.

Stakeholder validation informed the relevance and relative priority of the pathways. Technical, economic and regulatory readiness remained pathway-specific, as reflected in Table 12 and the detailed assessments provided in Annexes 4 and 5.

3.7. Stage 3 – Task 3 outcome

The Task 3 process resulted in a final portfolio of ten pathways: eight related to material flows and two cross-sector ICT enablers. The portfolio reflected the combined evidence from the industrial mapping, business survey, pathway assessment, sector workgroups and stakeholder validation. The number and composition of the final portfolio were outcomes of this process rather than a predetermined target.

The final portfolio provides the basis for the recommendations presented in the following sections. Full pathway fiches are provided in Annex 4 of the Technical Annexes, with the detailed economic and environmental assessment presented in Annex 5. The other routes identified through Task 2 remain part of the broader industrial symbiosis opportunity set and are not excluded from future consideration.

4

INDUSTRIAL SYMBIOSIS PATHWAY PORTFOLIO

4. Industrial Symbiosis Pathway Portfolio

4.1. Scope and interpretation of the portfolio

This section presents the final portfolio and the preliminary assessment of the ten retained pathways. It builds on the broader opportunity set described in section 2 and the company-level assessment and stakeholder validation reported in section 3. The section explains how each retained pathway would connect enterprise generators, collectors or processors and receiving users, and records the technical, commercial, environmental and institutional considerations that informed its final pathway positioning.

The portfolio contains eight material-based pathways and two ICT-related enabling pathways. The material pathways cover direct use of a qualified secondary input, recovery through an intermediary processor, development of a new receiving application, and regulated recovery. The ICT pathways support production optimisation and the organisation and traceability of physical exchanges; they are not material exchanges in their own right.

PATHWAY CHAIN: For each pathway, the enterprise source identifies where the residua arise; the intermediary function covers collection, aggregation, preparation, recycling, treatment or testing where required; and the receiving use identifies the product, process or authorised destination able to use the recovered resource. Public institutions and support organisations have an enabling role through regulatory clarity, testing access, time-bound pilot support and monitoring. They are not presented as substitutes for generators, processors or commercial receiving users.

IMPORT-SUBSTITUTION POTENTIAL: Several pathways could reduce reliance on primary or imported inputs where a domestic secondary material meets the receiving application's quality, safety, performance, traceability and price requirements. This potential is pathway-specific and is not treated as demonstrated until the material has been accepted and used repeatedly by a receiving company.

PACKAGING BOUNDARY: References to packaging concern segregated packaging residua generated or controlled by enterprises, including packaging associated with incoming materials, production, warehousing, transport and commercial operations. The pathways do not cover household packaging and do not extend the assignment to municipal household-waste collection.

RESEARCH AND INNOVATION: The R&I requirements differ across the portfolio. P1, T2 and M3 involve applied material characterisation, product development and performance testing. P2, T4 and A7 primarily involve organisational and process innovation in source separation, collection and traceability. M1 focuses on improved material identification and preparation, while A4 requires regulated traceability and route verification. I2 and I3 involve applied digital innovation supporting production optimisation and the organisation of physical exchanges. R&I should therefore not be interpreted as requiring major technology development in every pathway.

ECONOMIC INTERPRETATION: The monetary figures used in this section are preliminary scenarios drawn from the Stage 3 - Task 3 assessment. Depending on the pathway, they represent aggregated gross material value, possible sales and avoided handling or compliant-disposal costs. They are not forecasts, net profit estimates or complete cost-benefit analyses. Detailed assumptions are provided in Technical Annex 5; investment decisions require company- and route-specific capital costs, operating costs, financing, contractual terms, accepted output yields and baseline destinations.

Detailed pathway fiches are provided in Technical Annex 4 and the corresponding economic and environmental assessment is provided in Technical Annex 5. The categories used below describe the

appropriate next stage under the Task 3 evidence; they do not rank the sectors or certify investment readiness.

4.2. Portfolio overview and cross-industry chain

The final portfolio of pathways involve different enterprise sources and receiving arrangements, but they share a common structure: residua must be identified and separated at the generating enterprise, organised through a direct exchange or an appropriate intermediary, and accepted in a defined receiving process or product. Figure below summarises this structure. It shows the roles assessed under Task 3 and does not imply that every relationship is already organised or commercially established.

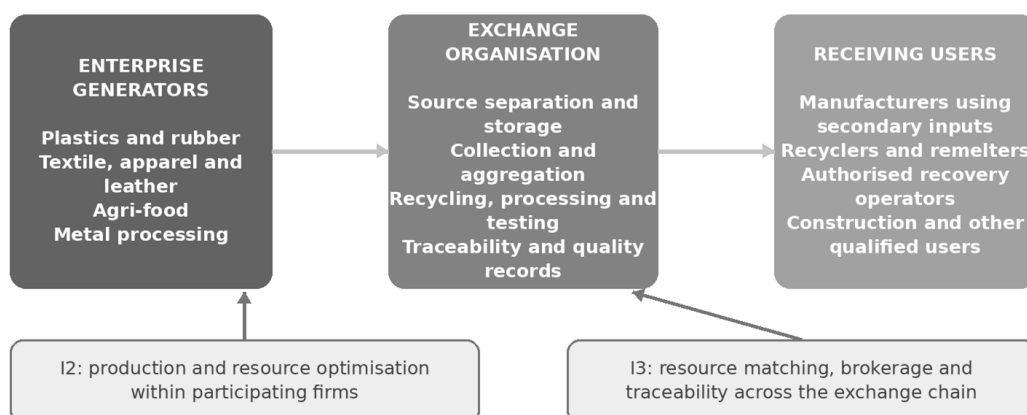


Figure 11. Enterprise and supporting actors across the final pathway portfolio. Source: Author's own synthesis.

Table 12. Final pathway portfolio

Code	Enterprise source	Intermediary and receiving chain	Task 3 positioning
P1	Clean PVC production offcuts from profile, window, door and pipe production	Collectors/recyclers or compounders; manufacturers of selected profile, duct, conduit or other qualified products	Priority applied pilot
P2	Enterprise-controlled PE/PP films, wrap, bags, trimmings and compatible commercial packaging	Collectors and recyclers; converters producing specified non-food film, bags or other products	Near-term coordinated route
T2	Clean textile production offcuts from garment and textile manufacturing	Sorting and secondary-textile processors; buyers of wipers, filling materials and selected nonwoven products	Priority applied pilot
T4	Cardboard, PE/PP film, pallets and protective packaging from textile production and logistics	Collectors, paper and plastics recyclers, pallet repairers and verified receiving users	Near-term coordinated route
A4	Officially categorised animal by-products from slaughter and meat processing	Licensed collection and authorised rendering or other permitted recovery operators	Strategic and regulated
A7	Enterprise-controlled glass, cardboard, plastics, metals and transport packaging from agri-food operations	Material-specific collectors and recyclers; approved container reuse and pallet repair routes	Near-term coordinated route
M1	Alloy- or grade-specific metal offcuts, chips and	Scrap processors, recyclers and remelters; domestic or export receiving users	Priority applied pilot

Code	Enterprise source	Intermediary and receiving chain	Task 3 positioning
	swarf from fabrication and machining		
M3	Metallurgical slag from a defined production source or stockpile	Testing and preparation functions; cement, aggregate, road-base or other application-specific users	Conditional
I2	Operational manufacturing data linked to a defined production problem	Kosovo ICT providers working with participating manufacturers	Cross-sector digital enabler
I3	Verified information on material availability, demand, quality, location and transactions	Governed matching and brokerage service connecting generators, processors and receiving users	Cross-sector digital enabler

4.3. Plastics pathways

P1: PVC Offcuts into Profile and Duct Products

P1 links manufacturers of PVC profiles, windows, doors and pipes with collectors, recyclers or compounders and manufacturers of selected profile, duct, conduit or other non-sensitive products. The source material is clean pre-consumer production offcut arising at enterprise premises. Its composition can generally be identified more readily than mixed post-use PVC, which makes source-controlled offcuts the appropriate starting point for the pathway.

<i>Technical and commercial assessment</i>	Mechanical recycling is technically established. Local applicability depends on segregation by formulation and colour, contamination control, covered storage, efficient aggregation, shredding and regranulation or compounding, stable blend development and product qualification. Existing internal reuse and sales show that some outlets already exist, but do not demonstrate a repeat market for a specified recycled compound or product. Commercial viability therefore rests on a committed processor and receiving manufacturers willing to test and repeatedly purchase qualified output.
<i>Economic perspective</i>	The scenario in Table 12 indicates potential value across a multi-company chain, not net profit for an individual participant. Value depends on the previous destination of the offcuts, collection and processing costs, preparation yield, product acceptance and transaction prices. Import substitution is relevant only where qualified recycled PVC replaces part of the primary or imported polymer input in the accepted receiving product.
<i>Environmental and social implications</i>	Potential benefits arise from additional recovery of clean PVC offcuts and verified displacement of virgin PVC. Results need to exclude offcuts already reused or recycled and account for processing losses and energy use. Product development, laboratory, quality-assurance, equipment-operation and monitoring functions provide more skilled participation opportunities than manual sorting alone; machinery, fire, chemical and handling risks remain relevant
<i>Testing and compliance</i>	The pathway requires representative material characterisation, stable recycled blends and testing against the chemical, dimensional, mechanical, fire and other requirements applicable to the selected product. Testing can be undertaken through an accredited laboratory or another competent testing body appropriate to the intended conformity route. Relevant material status, collection and processing authorisations, restrictions on additives and product-conformity requirements also apply.

Task 3 positioning: P1 is retained as a priority applied pilot connecting generators, a recycler or compounder and receiving manufacturers. Formulation, testing and buyer acceptance precede any decision on permanent aggregation or processing upgrades.

P2: Enterprise PE/PP Packaging Residua into Recycled Film and Bags

P2 concerns clean PE and PP film, stretch wrap, bags, trimmings and compatible commercial packaging generated or controlled by manufacturing enterprises through incoming supplies, production, warehousing and dispatch. It connects enterprise generators with collectors, recyclers undertaking sorting, washing or pelletising and converters producing specified non-food film, bags or other products. It excludes household packaging and municipal collection.

<i>Technical and commercial assessment</i>	Clean mono-material streams can be processed using established recycling technologies. Performance depends on polymer separation, contamination control, dry and secure storage, collection density, preparation and washing yield and the formulation required by the receiving product. Mixed, multilayer or food-contaminated fractions require separate assessment or exclusion. The pathway is therefore principally a coordinated enterprise collection and recovery route rather than a new recycling technology.
<i>Economic perspective</i>	The indicative value is modest at the scenario scale shown in Table 12. Viability is sensitive to route density, sorting and washing costs, rejected fractions and receiving-product prices. Coordination across participating enterprises is more important than the value of the stream generated by any one SME.
<i>Environmental and social implications</i>	Potential benefits include additional recycling of clean enterprise PE/PP packaging and reduced use of virgin polymer in accepted non-food products. Monitoring distinguishes material already recycled from additional collection and records accepted output, rejects and washing residua. Quality control, route planning, logistics and data management are relevant employment functions alongside operations.
<i>Testing and compliance</i>	The main development work concerns practical sorting categories, contamination thresholds, collection routes, washing yields and qualification of specified non-food products. Waste documentation and licensing, applicable packaging requirements and any relevant producer-responsibility or deposit-return arrangements are addressed for the streams they cover. The pathway does not include unauthorised food-contact applications.

Task 3 positioning: P2 is retained as a near-term coordinated route for source-separated enterprise PE/PP packaging. Its first stage establishes common categories, collection arrangements, processing yields and verified non-food receiving destinations.

4.4. Textile pathways

T2: Textile Offcuts into Industrial Wipers, Packing Fill and Secondary Nonwovens

T2 connects garment and textile manufacturers generating clean production offcuts with sorting or secondary-textile processors and buyers of industrial wipers, filling materials and selected nonwoven products. Industrial wipers and filling materials are the most accessible initial uses. Nonwoven, insulation or acoustic applications are separate product-development routes because their technical and conformity requirements differ.

<i>Technical and commercial assessment</i>	Source classification by fibre composition, colour and finish is central. Processing may include contaminant removal, cutting, opening or shredding, blending, prototype production and product testing. Mixed fibres, coatings, chemical finishes and moisture restrict some uses. Commercial performance depends on sufficient aggregation, preparation yield, product performance and repeat demand from identified buyers.
<i>Economic perspective</i>	The illustrative scenario in Table 12 represents aggregated gross value across the proposed chain. Actual value varies materially by fibre composition, product route, processing cost and accepted yield. Equipment needs cannot be inferred from unused capacity in garment

T2: Textile Offcuts into Industrial Wipers, Packing Fill and Secondary Nonwovens

	production; they depend on the chosen secondary product and the processor's technical requirements.
<i>Environmental and social implications</i>	Benefits arise where clean offcuts avoid mixed disposal and replace virgin filling or fibre in an accepted product. Upstream water-footprint benefits are reported separately and are not presented as direct water savings in Kosovo factories. Given the sector's employment profile, the pathway can support women's access to product development, machine operation, quality assurance and supervisory roles, subject to viable demand and safe working conditions.
<i>Testing and compliance</i>	A practical fibre-classification method, representative prototypes, processing yields, production costs and buyer acceptance provide the core evidence. Product-safety and chemical requirements apply to all selected uses. Construction-related applications additionally require appropriate fire, performance and conformity evidence through a competent testing route.
Task 3 positioning: T2 is retained as a priority applied pilot. Initial work focuses on industrial wipers and filling materials, while selected nonwoven, insulation or acoustic applications proceed only as separately tested product routes with identified receiving users.	

T4: Textile-sector Enterprise Packaging Loop Closure

T4 covers cardboard, PE/PP wrapping and stretch film, pallets and protective packaging generated or controlled through textile production, warehousing and enterprise logistics. The materials arise at participating companies and are collected from their premises. The pathway does not include packaging discarded by households or municipal mixed-waste collection.	
<i>Technical and commercial assessment</i>	The required recovery and reuse processes are established. Dry source separation, suitable storage, flattening or baling where justified, scheduled collection and verified receiving destinations are the principal conditions. Paper remains dry; film is separated by polymer and contamination level where practicable; reusable pallets are directed to repair or return routes. Commercial viability depends mainly on collection density because the value generated by individual firms is limited.
<i>Economic perspective</i>	The Table 12 scenario indicates a relatively small aggregated gross value. The business case is consequently based on combined routes, reliable service and reduced handling or disposal rather than on high unit values.
<i>Environmental and social implications</i>	Potential benefits comprise additional recovery of bulky enterprise packaging and extended pallet use where safe. Existing recycling or reuse forms part of the baseline and is not counted again. Collection, logistics, quality control and data management are the principal employment functions.
<i>Testing and compliance</i>	No major technology development is required. The relevant organisational innovations are common material descriptions, collection schedules, transaction records and service arrangements. Waste documentation, packaging requirements and interaction with applicable producer-responsibility systems are confirmed for each material route.
Task 3 positioning: T4 is retained as a near-term organisational pathway using shared packaging principles and material-specific receiving routes. Continuation depends on repeat collection, verified destinations and demonstrated route economics.	

4.5. Agri-food pathways

A4: Animal By-products to Authorised Rendering and Bio-based Uses

A4 concerns bones, fats, offal, blood and other animal by-products, where generated by slaughterhouses and meat processors and categorised under the applicable veterinary framework. It connects these enterprise generators with licensed collection and specialised transport and an authorised rendering or other permitted recovery operator. The potential outputs depend on the official category and may include technical fats, meat and bone meal where permitted, fertiliser inputs or other authorised bio-based uses.

<i>Technical and commercial assessment</i>	Rendering technology is established, but feasibility in Kosovo depends on official categorisation, segregated handling, hygienic containment, temperature control where required, authorised transport, traceability, treatment capacity and permitted outputs. Stakeholders reported an existing long-term arrangement with a private operator for processing certain animal by-products. The assignment did not independently verify its current capacity, the quantities available by category or the complete collection chain. A4 is therefore not presented as an immediately investment-ready exchange.
<i>Economic perspective</i>	For generators, the main value may be avoided compliant-disposal costs and reduced environmental and regulatory liability rather than revenue from material sales. The benchmark in Table 12 is an avoided-cost illustration for a medium generator, not a national benefit estimate. Commercial viability also depends on route density, specialised logistics, operator charges and the value and legal destination of treatment outputs.
<i>Environmental and social implications</i>	A compliant route can reduce risks associated with uncontrolled disposal, odour, pathogens and decomposition. The benefit depends on the material category and baseline practice. Traceability, laboratory and technical roles are relevant, while biological hazards, hygiene, storage, transport and manual handling require strict operating controls. These requirements increase implementation complexity but do not, by themselves, determine feasibility.
<i>Regulatory and institutional position</i>	A4 operates within existing veterinary, animal-health and environmental requirements and does not imply a need for a separate industrial-symbiosis law. The decisive evidence is an officially confirmed chain covering generators, categories and quantities, authorised collection and transport, available treatment capacity, traceability and permitted outputs. MAFRD and the Food and Veterinary Agency are the relevant competent-authority anchors identified for this pathway.

Task 3 positioning: A4 is retained as a strategic, regulated pathway. The Task 3 next stage is competent-authority confirmation of the complete authorised chain, followed by a controlled traceability and rendering trial only where capacity and compliance are confirmed.

A7: Agri-food Enterprise Packaging Loop Closure

A7 covers glass, cardboard, plastic films and containers, metal packaging and pallets generated or controlled by food and beverage processors and their enterprise logistics operations. Materials are separated and collected from participating business premises. The pathway excludes packaging discarded by households and does not extend to municipal household-waste collection.

A7: Agri-food Enterprise Packaging Loop Closure

<i>Technical and commercial assessment</i>	Each material has a separate acceptance rule and receiving destination: glass recycling or approved container reuse, recovered paper fibre, non-food polymer feedstock, metal recycling and pallet repair or reuse. Hygiene and food-contact considerations require clear separation between packaging return or reuse and recycling into non-food applications. Commercial performance depends on material quality, combined collection density and verified receiving routes rather than on treating all packaging as one mixed stream.
<i>Economic perspective</i>	The scenario in Table 12 combines several enterprise packaging fractions. Its indicative gross value is sensitive to material composition, route density, storage and handling costs and the share already recovered. Existing recycling is separated from additional programme-supported recovery.
<i>Environmental and social implications</i>	Potential benefits include reduced mixed disposal, higher material-specific recovery and longer pallet or container use where safe and authorised. Monitoring records the starting destination and accepted output for each material. Quality control, logistics, traceability and data functions offer skilled participation opportunities beyond manual collection.
<i>Testing and compliance</i>	Initial evidence covers packaging composition, quantities, current enterprise destinations, acceptance requirements, collection arrangements and transaction records. Food-contact, hygiene, waste and packaging requirements apply separately to each route. Producer-responsibility or deposit-return coordination is relevant only for the packaging and actors covered by the applicable arrangements.

Task 3 positioning: A7 is retained as a near-term coordinated route within the cross-sector packaging package. It applies material-specific rules to enterprise-controlled cardboard, glass, metals, plastics and reusable transport packaging.

4.6. Metal pathways

M1: Grade-controlled Recovery and Higher-value Recycling of Metal Scrap and Swarf

M1 connects metal fabricators and machining firms generating clean steel, aluminium, copper and other offcuts, chips and swarf with scrap processors, recyclers, remelters and manufacturing users. The pathway builds on existing collection and commodity markets. Its added value lies in grade retention, preparation, recovery of machining fluids where appropriate and improved access to the receiving route that provides the strongest overall value.

<i>Technical and commercial assessment</i>	Metal- and grade-specific segregation, alloy identification, safe management of cutting fluids, suitable storage, cutting, baling or briquetting and grade-specific offtake are technically established practices. Domestic remelting or further processing requires route-specific evaluation and is not assumed to provide greater value than export in every case. The baseline destination and buyer specifications therefore remain central to the business case.
<i>Economic perspective</i>	M1 has the strongest established material value in the portfolio. Table 12 includes both an individual-generator and a network scenario. The estimates depend on metal grade, preparation cost, accepted yield and buyer price. Material already sold or exported is not counted as new recovery; the measurable gain is additional recovery, improved grade retention, more efficient preparation or higher domestic value where demonstrated.
<i>Environmental and social implications</i>	Environmental benefits arise where better preparation enables verified substitution of primary-metal inputs in the receiving process. Domestic value retention is recorded as an economic effect, not automatically as an environmental benefit. Technical apprenticeships and

M1: Grade-controlled Recovery and Higher-value Recycling of Metal Scrap and Swarf

	laboratory, digital, engineering and supervisory roles are relevant, alongside controls for sharp materials, heavy handling, machinery and machining fluids.
<i>Testing and compliance</i>	Applied work covers portable alloy identification, grade-specific source segregation, swarf preparation or briquetting where justified and comparison of domestic and export offtake. Waste classification and movement, hazardous-fluid management, occupational safety and any applicable emissions or product requirements are addressed for the selected route.
Task 3 positioning: M1 is retained as a priority applied pilot focused on grade retention, preparation and buyer trials. Any proposal for additional remelting capacity remains a separate investment decision requiring confirmed supply, environmental performance and repeat demand.	

M3: Slag to Cement and Construction Materials

M3 connects metallurgical slag from a defined production source or stockpile with a specified cementitious, aggregate, road-base or other construction application. International processing routes are established, but suitability is specific to the production process, composition, stockpile condition and intended receiving use. Cementitious and aggregate applications are therefore treated as separate routes rather than as interchangeable uses.

<i>Technical and commercial assessment</i>	Stakeholders reported previous or existing cooperation between a Kosovo metallurgical producer and a cement producer involving slag. This demonstrates relevant local experience but does not establish the present quantities, specifications, environmental performance or replicability of the arrangement. Representative sampling, processing requirements, transport distance, product route, conformity evidence and committed offtake determine feasibility.
<i>Economic perspective</i>	The Table 12 scenario produces one of the larger indicative gross-value ranges because of the assumed volume. It is also one of the most conditional estimates: the value cannot be interpreted without confirming acceptable output yield, processing and transport costs, commercial terms and buyer demand. Available evidence did not support a robust company-level net-benefit calculation.
<i>Environmental and social implications</i>	Potential benefits include reduced stockpile pressure and displacement of selected virgin mineral inputs. Leaching behaviour, dust, processing energy, transport and engineering performance are included in the pathway baseline. Laboratory, engineering, environmental-monitoring and plant-control roles are relevant, alongside safeguards for dust, heavy metals, traffic, machinery and stockpile stability.
<i>Testing and compliance</i>	The evidence package comprises a representative sampling plan, application-specific chemical, mineralogical, leaching and engineering characterisation, demonstration batches and a technical and environmental conformity dossier. Environmental authorisations, material status, construction-product requirements and receiving specifications are confirmed for each intended use. A competent laboratory or testing consortium is required for the relevant test suite.

Task 3 positioning: M3 is retained as a conditional, application-specific pathway. Separate demonstrations for cementitious and aggregate uses proceed only where representative technical, environmental, commercial and conformity evidence supports the proposed application.

4.7. ICT enabling pathways

The two ICT pathways use Kosovo's software, data and digital-services capabilities to support manufacturing efficiency and the organisation of physical resource exchanges. Their inclusion does not suggest that exported IT services are themselves an industrial-symbiosis material flow. ICT is retained as a cross-sector enabling domain, consistent with the ICT value-chain study, industrial mapping and stakeholder validation.

I2: AI Analytics for Predictive Optimisation

I2 connects Kosovo ICT providers with manufacturing firms that have a defined operational problem and usable data. Potential use cases include reduced downtime, energy use, material loss, reject rates or quality variation. The pathway concerns applied production optimisation within participating firms and is not a physical exchange of residual.

<i>Technical and commercial assessment</i>	Each use case requires a data-readiness review, secure integration, documented baseline, model development, operator testing, training and before-and-after evaluation. Data quality, ownership, process integration and user adoption are more decisive than the availability of analytical models. Commercial value and payback must be demonstrated for each firm and operational problem.
<i>Economic and environmental perspective</i>	No credible portfolio-level monetary value can be estimated before participating firms, integration costs and use cases are defined. Each pilot records implementation cost and measurable changes in downtime, energy or material use, rejects and operating cost. Environmental benefits are attributed only where measured resource or waste reductions are demonstrated against the baseline.
<i>Data and compliance</i>	The relevant requirements include data protection, confidentiality, cybersecurity, intellectual property, contractual responsibility and the implications of automated decision support for workers and process owners. Public support is relevant to applied integration and demonstration; routine commercial deployment remains a company decision based on demonstrated value.

Task 3 positioning: I2 is retained as a cross-sector applied digital enabler. The proposed Task 3 scale is four to six manufacturing-ICT use cases with usable data, a responsible process owner and measurable operational results.

I3: Digital Resource-Matching and Traceability Service

I3 addresses fragmented information on enterprise material availability, demand, quality, location, timing and transaction status. It connects verified generators, collectors or processors and receiving users through a governed matching and brokerage service linked to the priority physical pathways. The service supports exchanges; it does not create material supply, product suitability or buyer demand on its own.

<i>Technical and commercial assessment</i>	The initial service requires a common material taxonomy, verified organisations and listings, confidentiality controls, assisted matching, transaction records and performance monitoring. Core software functionality is comparatively straightforward. Governance, facilitation, reliable data and user trust are more demanding. A sustainable operating model can be assessed only after completed exchanges, repeat use and willingness to pay are observed.
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I3: Digital Resource-Matching and Traceability Service

<i>Economic and environmental perspective</i>	No credible aggregate benefit is assigned before transactions occur. Performance is measured through verified users, completed and repeat matches, tonnes accepted by receiving users, transaction value, matching time and operating cost. Environmental effects remain attributed to the relevant physical pathway to avoid double counting.
<i>Data and compliance</i>	Initial implementation tests the taxonomy, verification, assisted-brokerage workflow and transaction records, drawing where useful on the information fields in ISO 59040:2025. Data governance, cybersecurity, confidentiality, terms of use, liability for listings and the regulatory status of the physical materials remain pathway-specific requirements.
Task 3 positioning: I3 is retained as a cross-sector enabling service beginning with a governed, facilitated minimum viable service linked to the priority physical pathways. A permanent national platform is a later decision based on repeated use, completed exchanges, credible governance and a sustainable operating model.	

4.8. Portfolio synthesis and development approaches

The final pathways were retained on different evidentiary and practical grounds and do not have the same form of readiness. Some build on established recovery processes and primarily require coordinated collection; others require product development, competent-authority confirmation, application-specific testing or company-level digital pilots. Table 12 summarises the evidence supporting each pathway, the appropriate development approach and the basis for implementation or further development.

Table 13. Evidence supporting the final pathways and appropriate development approach

Pathway	Evidence supporting inclusion in the portfolio	Appropriate development approach	Basis for implementation or further development
<i>P1 – Clean PVC offcuts into profile and duct products</i>	Source-controlled PVC offcuts were identified, mechanical recycling is established, and potential receiving applications exist.	Applied company pilot linking generators, recyclers and receiving manufacturers.	Confirm polymer formulation, preparation yield, product performance, receiving-user specifications and repeat demand.
<i>P2 – Enterprise PE/PP packaging into recycled film and bags</i>	Clean enterprise PE/PP packaging can be processed through established sorting, washing and mechanical-recycling operations.	Coordinated collection and recycling route.	Establish source separation, efficient collection routes, acceptable washing yield and verified non-food receiving applications.
<i>T2 – Textile offcuts into wipers, packing fill and secondary nonwovens</i>	Clean production offcuts are available, and several comparatively accessible secondary products were identified.	Applied product-development pilot.	Classify offcuts by fibre composition, test preparation and processing yields, assess product performance and involve identified receiving users.
<i>T4 – Textile-sector enterprise packaging recovery</i>	Textile and apparel firms generate cardboard, plastic film, pallets and other enterprise-controlled packaging for which recovery routes already exist.	Coordinated material-specific collection and recovery route.	Separate materials at source, organise collection schedules and confirm appropriate recyclers or receiving users for each material.
<i>A4 – Animal by-products to authorised recovery</i>	Animal by-products arise within the meat-processing chain, and established recovery technologies exist internationally.	Competent-authority-led development of a regulated recovery route.	Confirm official categorisation, authorised operators, treatment capacity, transport and traceability requirements, and permitted output uses.
<i>A7 – Agri-food enterprise packaging and pallet recovery</i>	Food and beverage processors generate segregable enterprise packaging and pallets for which material-	Coordinated material-specific recovery and reuse routes.	Record enterprise-level quantities, maintain hygiene and source separation, and confirm operators and destinations for cardboard,

Pathway	Evidence supporting inclusion in the portfolio	Appropriate development approach	Basis for implementation or further development
	specific recovery and reuse routes are available.		plastics, glass, metals and pallets. Household packaging is outside the pathway.
<i>M1 – Grade-controlled recovery of metal scrap and swarf</i>	Metal scrap has established commercial value and active collection and recycling markets. Improved segregation and preparation could retain material grade and increase value.	Applied process-improvement pilot within existing commercial markets.	Demonstrate grade separation, appropriate management of cutting fluids, preparation economics and additional value compared with current domestic or export routes.
<i>M3 – Metallurgical slag in cement and construction applications</i>	Potential volumes and possible receiving applications were identified, and comparable applications are established internationally.	Application-specific testing and controlled demonstration.	Undertake representative sampling and verify environmental performance, engineering properties, conformity requirements, processing needs and receiving-market acceptance.
<i>I2 – AI-enabled manufacturing optimisation</i>	Kosovo has relevant ICT capabilities, and manufacturing use cases were identified for reducing downtime, energy use, scrap and quality losses.	Company-level digital pilots linked to defined manufacturing problems.	Establish a company baseline, confirm data availability and system integration, and measure the resulting operational improvement.
<i>I3 – Digital resource matching and traceability</i>	Companies and stakeholders identified information, coordination and traceability gaps affecting potential exchanges.	Facilitated minimum viable matching and traceability service.	Begin with verified material flows and active brokerage; record completed exchanges, establish data governance and test a sustainable operating model.

The portfolio comprises three coordinated material-specific recovery routes (P2, T4 and A7), three applied material or process pilots (P1, T2 and M1), two regulated or conditional pathways (A4 and M3), and two digital enabling pathways (I2 and I3). This differentiation allows each pathway to be developed in a manner proportionate to its evidence base, technical characteristics and regulatory context. The economic and wider impact implications of the portfolio are assessed in Section 5.

5

FEASIBILITY AND IMPACT ASSESSMENT

5. Feasibility and Impact Assessment

This section assesses the economic, environmental, institutional, regulatory and inclusion implications of the final Task 3 portfolio. Section 4 presented the individual pathways, the evidence supporting their inclusion and the appropriate development approach for each. This section focuses on the potential value and wider effects of the portfolio and on the considerations relevant to implementation and scale-up.

The assessment covers the preliminary economic scenarios, import-substitution potential, research and innovation requirements, environmental implications, legal and institutional feasibility, and gender and inclusive green-growth considerations. Because the pathways differ in their materials, technologies, actors and intended results, they are assessed individually rather than through a single portfolio score.

The analysis is a preliminary feasibility assessment rather than an investment appraisal. The scenarios indicate the possible scale and sources of economic value but do not demonstrate company-level profitability or provide a complete cost-benefit analysis. Investment decisions would require verified material quantities, operating and investment costs, commercial terms, receiving demand and environmental performance.

5.1. Economic viability at company and pathway level

At company level, an industrial-symbiosis pathway is financially viable only where the additional revenues or avoided costs are sufficient to cover separation, storage, collection, transport, preparation, processing, testing, compliance and coordination, while providing commercially acceptable terms for the participating firms. The distribution of costs and benefits across the generator–processor–receiving-user chain is therefore important. A pathway may create value overall but remain commercially unattractive if one participant bears costs that are not reflected in the agreed prices or contractual arrangements. The scenario calculations do not establish company-level profitability. They provide indicative estimates of the annual gross value that could arise across the participating actors under the assumptions used in the supporting calculation workbook. Depending on the pathway, this value may include revenue received by generators from the sale of segregated material, avoided handling or compliant-management costs, processor conversion value calculated as output turnover less the purchase of feedstock, and estimated procurement savings for receiving users. Where generator revenue from material sales is included, the corresponding feedstock payment is deducted from processor turnover so that the same transaction is not counted twice. The resulting figures are not funding requirements, revenue accruing to a single company, EBITDA, free cash flow or net profit. They are also not the results of a full economic cost-benefit analysis. The scenarios use illustrative assumptions concerning participation, material quantities, recovery yields and prices to indicate the possible scale and economic profile of each pathway. They do not represent confirmed participation by the stated number of firms and do not deduct all capital expenditure, labour, energy, financing, taxation, depreciation, compliance or programme-administration costs. For A4, the estimated value is expressed principally as avoided compliant-management cost rather than product revenue. I2 and I3 remain unmonetised because sufficiently reliable company-level information on implementation costs and resulting savings was not available. These pathways would require use-case-specific baselines and measurement during implementation.

Table 14. Illustrative pathway-level economic scenarios

Pathway	Illustrative scenario boundary	Indicative annual gross value	Interpretation and principal qualification
P1 – Clean PVC Offcuts	50 participating firms and approximately 365 tonnes of material	Approximately EUR 0.37–0.51 million in	Gross value across generators, processor and receiving users; dependent on formulation control,

Pathway	Illustrative scenario boundary	Indicative annual gross value	Interpretation and principal qualification
		aggregated gross value	recovery yield, product qualification and receiving-user acceptance.
<i>P2 – Enterprise PE/PP Packaging Recovery</i>	50 participating firms and approximately 25 tonnes of material	Approximately EUR 24,000–37,000 in aggregated gross value	Gross value across the pathway. The modest value per firm makes collection density, source separation and collection efficiency decisive.
<i>T2 – Textile Offcut Product Development</i>	50 participating firms and approximately 150 tonnes of material	Approximately EUR 0.19–0.30 million in aggregated gross value	Gross value across the pathway; dependent on fibre classification, preparation and processing yield, product performance and buyer acceptance.
<i>T4 – Textile-sector Packaging Recovery</i>	50 participating firms and approximately 15 tonnes of material	Approximately EUR 17,000–26,000 in aggregated gross value	Gross value across material-specific recovery routes; dependent on coordinated collection and reliable receiving destinations.
<i>A4 – Animal By-products to Authorised Recovery</i>	Illustrative medium-sized generator producing approximately 50–100 tonnes	Approximately EUR 2,500–10,000 in avoided compliant-management costs	Potential avoided compliant-management cost rather than assumed product revenue. An authorised and traceable route is a precondition.
<i>A7 – Agri-food Packaging and Pallet Recovery</i>	50 participating firms and approximately 50 tonnes of material	Approximately EUR 35,000–69,000 in aggregated gross value	Gross value across separate enterprise-controlled packaging and pallet routes. Household and municipal packaging remain outside the pathway
<i>M1 – Grade-controlled Recovery and Higher-value Recycling of Metal Scrap and Swarf</i>	50 participating firms and approximately 2,500 tonnes of material	Approximately EUR 1.5–2.5 million in aggregated gross value	Gross value across the pathway; sensitive to alloy grade, preparation yield, commodity prices, current destinations and buyer terms.
<i>M3 – Application-specific Testing and Demonstration of Metallurgical Slag</i>	Approximately 100,000 tonnes generated and 95,000 tonnes accepted	Approximately EUR 1.25–3.18 million in gross value and avoided-cost potential	Potential gross value and avoided costs only if representative testing confirms a compliant receiving application, acceptable processing yield and sufficient market demand.
<i>I2 – AI-enabled Manufacturing Optimisation</i>	Four to six applied manufacturer–ICT pilots	No defensible aggregate monetary estimate at this stage	Benefits require company-specific baselines and verified changes in downtime, energy use, scrap generation, quality losses or maintenance costs.
<i>I3 – Digital Resource-matching and Traceability Service</i>	Minimum viable cross-sector service	No defensible aggregate monetary estimate at this stage	Value depends on completed and repeated exchanges, verified participant savings, service operating costs and a sustainable delivery model.

Note: The scenarios use different numbers of companies, material quantities, boundaries and types of benefit. They are not additive and must not be combined into a national economic-benefit total. Detailed assumptions are provided in the Technical Annexes.

The scenarios indicate different economic profiles. P2, T4 and A7 use established recovery or reuse processes but depend on efficient aggregation because the potential value per participating firm is modest. P1 and T2 may create additional value through material preparation and product development, although they require testing, qualification and market development. M1 has the clearest near-term commercial basis because metal scrap already has established market value. M3 presents potentially significant scale but remains conditional on application-specific technical, environmental, conformity and market evidence. A4 is primarily driven by compliant management, risk reduction and avoided cost.

I2 and I3 cannot be compared directly with the material pathways on the basis of the current monetary estimates. Their economic value would need to be demonstrated through company-level operational improvements for I2 and completed, repeated material exchanges and participant savings for I3. Before investment or expansion, each pathway would require a more detailed business case based on confirmed participants, quantities, costs, receiving demand and commercial arrangements.

5.2. Network and sector-level economic effects

Industrial symbiosis can create benefits beyond the immediate value of the exchanged material. Regular exchanges can improve supply reliability, reduce exposure to imported-input prices, create demand for collection and preparation services, support testing and engineering providers, and strengthen relationships among manufacturers, processors and receiving users. Shared services can also make compliance, traceability and product qualification more accessible to SMEs.

These wider effects should nevertheless be interpreted cautiously. No national multiplier, GDP or economy-wide employment effect has been estimated because the evidence does not provide a sufficiently robust basis for doing so. The principal measurable effects during implementation should be participating enterprises, accepted material quantities, completed and repeated exchanges, verified avoided costs, value retained through preparation or processing, and skilled roles created or improved.

5.3. Import-substitution and wider economic potential

Import substitution is most plausible where a verified domestic secondary material can replace part of an imported input without compromising product performance or compliance. Potential examples include recycled polymer compounds, secondary textile materials, prepared metals and qualified mineral inputs. The relevant measure is the quantity and value of imported material demonstrably displaced in an accepted application, rather than the total quantity of residua collected.

The potential is not uniform across the portfolio. P1 and T2 may substitute selected imported inputs if qualified products are accepted. M1 can support domestic value retention where better segregation and preparation result in a viable local receiving route. M3 could reduce demand for selected primary mineral inputs if testing and conformity are successful. P2, T4 and A7 mainly improve recovery and material management and should not automatically be presented as import-substitution measures.

The import-substitution rationale is consistent with MIETI's 2026 analysis of natural resources and minimally processed goods, which identified continued dependence on imported semi-finished and processed industrial inputs alongside opportunities for greater domestic value capture through processing, product development, testing and stronger supplier linkages. In the present assessment, however, import substitution is attributed only where a qualified secondary material can be accepted in a defined receiving process or product.

Wider economic claims should therefore be based on verified transactions and receiving applications. Material collected, software deployed or firms registered does not in itself demonstrate import substitution, value added or productivity improvement.

5.4. Research and innovation implications

Research and innovation requirements differ across the final pathway portfolio. In the Kosovo context, they primarily concern the application, adaptation and validation of existing technologies, production processes and organisational solutions rather than the development of entirely new technologies. The purpose is to

determine whether identified industrial residues can be recovered, prepared and used in products or processes that meet defined technical, commercial and regulatory requirements.

P1, T2 and M3 require applied material characterisation, process or product development, performance testing and receiving-user qualification. M1 involves process improvement through better material identification, grade separation and preparation of scrap and swarf. P2, T4 and A7 involve organisational and process innovation through source separation, coordinated collection, traceability and material-specific receiving arrangements. A4 principally requires the organisation and verification of a compliant recovery chain. I2 and I3 involve applied digital innovation supporting manufacturing optimisation, resource matching and traceability.

Applied R&I can occur at several points in the industrial-symbiosis chain. Material-generating companies may improve source separation, material identification and production practices. Collectors, processors and laboratories may characterise materials, adapt preparation or processing methods and develop prototypes. Receiving companies may test material compatibility, product performance and conformity and confirm whether the recovered input can be used repeatedly. Research organisations, laboratories, universities and ICT providers may support these activities, while participating companies remain responsible for the relevant production and commercial decisions.

Public support is most appropriate where testing or demonstration generates evidence that can be used by several SMEs, reduces uncertainty affecting the development of a pathway or supports market acceptance of a secondary material for a defined application. Standard commercial equipment and routine improvements that principally benefit one company retain a stronger private-financing rationale. Limited public co-financing may nevertheless be appropriate for first applications where the resulting evidence can support wider replication.

5.5. Environmental impacts and benefits

Environmental benefit depends on the actual baseline and the use that the recovered material displaces. Diverting material from disposal may be beneficial, but the result can be reduced or reversed by inefficient processing, long transport distances, high energy or water use, contamination, rejects or displacement of an already effective recovery route.

Environmental claims should therefore be pathway-specific. The relevant comparison is between the verified baseline and the demonstrated receiving application, including preparation, processing, transport and rejects.

Table 15. Pathway-level environmental interpretation

Pathway	Principal potential benefit	Main environmental qualification
P1	Reduced disposal and partial displacement of virgin polymer inputs	Processing yield, formulation, additives, energy use and rejected material must be recorded
P2	Improved recovery of clean industrial film and packaging	Benefits depend on avoiding contamination, unnecessary transport and displacement of existing recycling
T2	Diversion of clean offcuts and possible displacement of selected primary materials	Product lifetime, fire performance, processing inputs and rejects must be assessed
T4	Improved recovery of cardboard, films, pallets and transport packaging	Each material requires a separate baseline and verified destination
A4	Reduced risk from uncontrolled management and recovery through authorised routes	Hygiene, storage, transport, treatment emissions and permitted output use are decisive
A7	Increased recovery and reuse of packaging materials	Separate treatment is required for cardboard, glass, metals, plastics, pallets and reusable packaging

Pathway	Principal potential benefit	Main environmental qualification
M1	Improved recovery and potential displacement of primary metal production	Cutting-fluid management, preparation energy, transport and the actual receiving route must be documented
M3	Potential displacement of primary aggregates or cementitious inputs and reduced stockpiling	Benefits are application-specific and depend on leaching, processing, transport and conformity
I2	Reduced downtime, energy intensity, scrap or quality losses	No environmental benefit should be attributed to software without verified operational improvement
I3	Improved traceability and increased completion of viable exchanges	Registrations and listings are not environmental outcomes; accepted and repeated exchanges must be recorded

Environmental monitoring should use a common minimum structure while allowing pathway-specific indicators. At minimum, implementation should establish the quantity generated, baseline destination, quantity collected, quantity accepted by the receiving user, processing yield, rejected quantity, transport distance, energy and water use where material, and the primary input or management route displaced.

Table 16. Environmental verification requirements during pilot implementation

Verification area	Minimum evidence
<i>Baseline</i>	Documented pre-intervention destination, handling practice and cost
<i>Material balance</i>	Quantity generated, collected, processed, accepted and rejected
<i>Receiving application</i>	Named user, product or process, acceptance specification and accepted batches
<i>Displacement</i>	Evidence of the primary input or previous management route displaced
<i>Processing</i>	Energy, water, additives and principal emissions where material to the result
<i>Logistics</i>	Collection and transport distances, frequency and load efficiency
<i>Compliance</i>	Relevant classification, permits, testing, official controls and conformity evidence
<i>Result</i>	Net improvement assessed against the verified baseline

These requirements provide the minimum evidence needed to substantiate pathway-level environmental claims and to guide decisions on continuation, modification or scale-up.

5.6. Institutional and regulatory feasibility

Industrial symbiosis operates through existing legal and institutional systems rather than through a single dedicated regulatory framework. Depending on the pathway, relevant requirements may include waste classification, permits, environmental authorisations, veterinary controls, packaging obligations, product standards, testing, accreditation, construction-product conformity and occupational safety.

The applicable legal route must be confirmed for each intervention before material is transferred or placed on the market. Kosovo legislation and implementing acts determine domestic obligations. EU legislation may additionally influence regulatory alignment, exports and information requested by EU customers, but should not be presented as directly applicable to every Kosovo enterprise unless incorporated into domestic law or relevant to a particular market transaction.

Table 17. Principal legal and market implications

Regulatory area	Relevance to the portfolio	Main implementation requirement
<i>Waste classification and permitting</i>	Relevant to all material pathways	Confirm whether the material is waste, a by-product or a product and identify applicable collection, transport, treatment and storage requirements
<i>Animal by-products and veterinary controls</i>	Central to A4	Confirm categorisation, authorised operators, containment, traceability, transport, processing and permitted output uses with the competent authority
<i>Packaging and producer responsibility</i>	Relevant to P2, T4 and A7	Coordinate with applicable packaging, extended producer-responsibility and deposit-return arrangements; avoid parallel or conflicting collection systems

Regulatory area	Relevance to the portfolio	Main implementation requirement
<i>Product standards and conformity</i>	Relevant to P1, T2 and M3	Define the intended application, applicable specifications, testing method and conformity route before demonstration
<i>Construction products</i>	Particularly relevant to T2 and M3 applications in construction	Confirm applicable Kosovo requirements and, where relevant, EU-market requirements under the current construction-products framework
<i>Chemical and material restrictions</i>	Relevant to polymers, textiles and construction applications	Review additives, coatings and restricted substances for the intended receiving use
<i>Environmental authorisation</i>	Relevant to processing, animal by-products and slag	Confirm permitting, emissions, water, storage, transport and monitoring requirements
<i>Data governance and cybersecurity</i>	Central to I2 and I3	Establish data ownership, confidentiality, access rights, retention, cybersecurity and responsibility for data accuracy
<i>Occupational health and safety</i>	Relevant across all interventions	Address machinery, dust, cutting fluids, biological exposure, manual handling, traffic and storage risks
<i>EU market and supply-chain requirements</i>	Relevant where products or customers are linked to the EU market	Assess pathway-specific implications of packaging, carbon, ecodesign, due-diligence and reporting requirements without assuming universal direct applicability

Where relevant, the Corporate Sustainability Reporting Directive (CSRD) and the Corporate Sustainability Due Diligence Directive (CSDDD) may lead EU-linked customers to request sustainability, traceability and due-diligence information from Kosovo suppliers. These implications should be assessed by value chain and contractual relationship and should not be interpreted as universally or directly applicable to all Kosovo enterprises. The EU Packaging and Packaging Waste Regulation is particularly relevant to packaging-intensive pathways because it introduces requirements affecting packaging design, recyclability, recycled content and reuse. CBAM may affect iron, steel, aluminium and cement-related value chains supplying the EU market. ESPR may introduce product-specific ecodesign and digital product-passport requirements through subsequent measures. These developments strengthen the case for reliable material data and traceability, but they do not remove the need for pathway-specific legal analysis.

5.7. Gender and inclusive green-growth implications

Gender and inclusion implications differ across the priority pathways. The Textile, Apparel and Leather sector is particularly relevant because women constitute a substantial share of its workforce. The proposed interventions could support progression from routine production and sorting activities into product design, machine operation, quality assurance and supervisory roles. Agri-food pathways provide related opportunities in quality control, traceability, packaging logistics and management, while the digital interventions can broaden participation in skilled ICT and manufacturing-support functions.

The assessment also identified potential risks. Collection, sorting and material-preparation activities could reinforce low-paid or insecure manual work unless training and progression are incorporated into implementation. Male-dominated sectors such as metal processing and construction-related activities may present barriers to women's participation in technical roles. Several pathways also involve biological, chemical, dust, machinery, traffic and manual-handling hazards that require pathway-specific occupational health and safety measures.

Table 18. Gender, inclusion and decent-work considerations

Pathway group	Opportunity	Risk	Required measure
P1/P2	Roles in quality assurance, laboratory testing, collection coordination and SME recycling services	Concentration in low-value sorting and barriers to technical or capital-intensive activities	Transparent participant selection, targeted outreach, technical training

Pathway group	Opportunity	Risk	Required measure
			and mandatory OHS provisions
T2/T4	Progression from production and sorting into product design, machine operation, quality control and supervision	Reinforcement of low-paid manual roles without corresponding skills development	Skills training, progression pathways, appropriate machinery safeguards and participation in pilot decisions
A4/A7	Roles in quality assurance, traceability, packaging logistics, hygiene control and management	Biological exposure, informal work arrangements and concentration in lower-paid activities	Strict hygiene and OHS procedures, formal working arrangements and access to technical training
M1/M3	Skilled roles in laboratory testing, engineering, environmental monitoring and digital traceability	Male-dominated recruitment and significant machinery, dust, chemical and traffic risks	Inclusive recruitment and apprenticeships, appropriately fitted PPE, technical training and safety audits
I2/I3	Skilled digital roles and improved access to services for firms of different sizes and locations	Digital-skills gaps, unequal access and participation concentrated among established firms	Inclusive calls, accessible onboarding, skills support and participation data disaggregated by sex and role

Programme calls and pilot agreements should include transparent participation criteria, targeted outreach, sex-disaggregated participation and employment data where appropriate, skills development linked to progression into technical roles, and mandatory OHS requirements. Inclusion should be assessed through the quality of participation, access to training and representation in technical and decision-making roles, not only through the total number of workers engaged.

5.8. Overall feasibility interpretation

The assessment does not produce a single readiness ranking for all ten pathways. It shows a differentiated portfolio. P2, T4 and A7 are primarily coordination and collection pathways using established recovery processes. P1 and T2 require material and product qualification. M1 builds on an existing commodity market but seeks improved grade retention and domestic value addition. M3 is conditional on application-specific technical, environmental and conformity evidence. A4 is governed by legal categorisation and authorised recovery capacity. I2 and I3 are enabling pathways whose value depends on measurable operational results or completed physical exchanges.

These qualifications reflect the difference between a preliminary feasibility assessment and the company-specific engineering, permitting, product testing, contracting and investment appraisal required before implementation or scale-up. The assignment established the rationale, pathway structure, principal actors, indicative economic potential and decision conditions for the next stage.

The evidence supports differentiated forms of time-bound public assistance. Organisational pathways with established technologies may require facilitation and limited start-up support. Product-development, testing and regulated demonstration pathways may justify stronger co-financing where shared evidence, coordination failures or first-application risks would otherwise prevent action. Infrastructure support would require verified throughput, a clear operator, a compliant receiving route and demonstrated demand. Detailed instrument design is addressed in the recommendations section.

6

CONCLUSIONS, RECOMMENDATIONS AND IMPLEMENTATION FRAMEWORK

6. Conclusions, Recommendations and Implementation Framework

Kosovo has a credible but uneven foundation for industrial symbiosis. The strongest opportunities arise where clean industrial residua are generated within active value chains, a processor or preparation route can be identified, and a defined receiving application can be tested with participating companies. The findings do not indicate that all mapped residua are immediately recoverable or that a single national infrastructure solution would be appropriate. They support a focused programme that develops the retained pathways into verified, repeat commercial relationships.

The principal constraint is not the absence of suitable technology, but the incomplete organisation of the exchange chain. Material quantities, quality, timing and current destinations are not always sufficiently documented; SMEs have limited access to aggregation and testing services; receiving users may lack confidence in secondary materials; regulatory requirements are not consistently translated into practical pathway guidance; and financing is not always structured around the evidence required for market entry. Because these constraints are interconnected, they require coordinated technical, commercial, regulatory and financial responses.

Industrial symbiosis should therefore be treated primarily as an industrial competitiveness and innovation agenda that also delivers environmental benefits. MIETI is well positioned to coordinate the programme through its responsibilities for enterprise development, applied R&I, market organisation and industrial support. Environmental, veterinary, municipal and quality-infrastructure institutions should retain their respective regulatory and technical responsibilities.

On this basis, this section presents the portfolio rationale, proposed activation programme, pathway-specific and cross-cutting recommendations, institutional arrangements, indicative costs, financing considerations and immediate decisions required for implementation. Skills, inclusion, occupational safety and environmental safeguards are addressed as cross-cutting implementation considerations.

Figure 12 synthesises the study's main conclusion by showing how industrial inputs and manufacturing activities connect to the retained industrial-symbiosis pathways, receiving applications and enabling conditions.

Kosovo industrial symbiosis ecosystem

CENTRAL STUDY CONCLUSION
Organise complete exchange chains
before permanent infrastructure

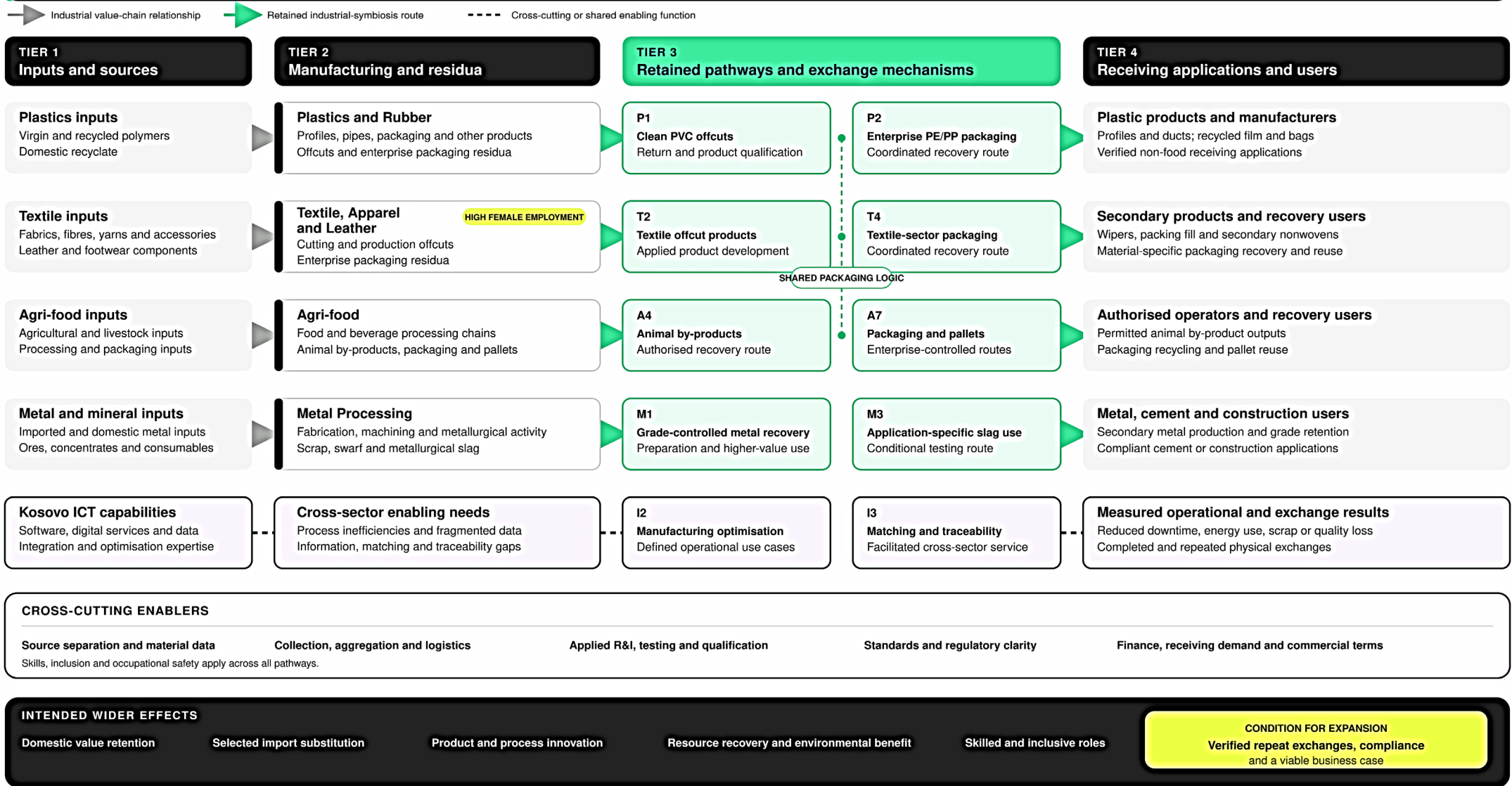


Figure 12. Kosovo industrial-symbiosis ecosystem: from manufacturing inputs to retained pathways and receiving applications

6.1. Main conclusions and portfolio rationale

The assessment identifies a portfolio of industrial-symbiosis opportunities in Kosovo that differ in their technical characteristics, commercial maturity and implementation requirements. The strongest basis for action exists where enterprise-generated residua can be separated at source, a processor or preparation route is available, and a defined receiving application can be tested with participating businesses. The evidence does not support treating all industrial residua as equally suitable for exchange or establishing a general multi-material infrastructure solution at the outset. The principal challenge is the organisation of the complete exchange chain. Technology is available for many of the identified pathways, but implementation also depends on material quantity and quality, collection and logistics, receiving-user specifications, regulatory compliance, workable commercial arrangements and repeat demand. These factors explain why the final pathways require different forms of development and support.

Industrial symbiosis should therefore be approached primarily as an industrial competitiveness, innovation and resource-efficiency agenda. MIET should coordinate the relevant industrial-policy and enterprise-support measures, while environmental, veterinary, quality-infrastructure and other competent institutions would retain their statutory responsibilities.

Table 19. Main drivers, enabling conditions, potential wider effects and economic interpretation

Dimension	Assessment finding	Programme implication
<i>Principal drivers</i>	Avoidable material-management costs; dependence on imported inputs; potential substitution of selected imported inputs; domestic value retention; regulatory compliance; and demand for more traceable industrial supply chains.	Focus on pathways with identifiable generators and receiving applications and with a clear economic, environmental or compliance rationale.
<i>Market enablers</i>	Receiving-user participation, material specifications, source separation, aggregation, reliable logistics and repeat commercial relationships.	Test the complete generator–processor–receiving-user chain rather than supporting isolated technologies or equipment.
<i>Technical and R&I enablers</i>	Material characterisation, product and process development, application-specific testing, conformity evidence and digital optimisation.	Use applied pilots, testing support and product qualification linked to defined receiving applications.
<i>Institutional enablers</i>	Practical regulatory guidance, competent-authority involvement, clear responsibilities and coordinated decisions.	Maintain statutory responsibilities within a coordinated MIET-led programme.
<i>Financial enablers</i>	Time-bound support for shared evidence, initial testing and first applications, together with private contributions to commercially oriented activities.	Use milestone-based grants, testing or innovation vouchers and technical assistance rather than permanent operating subsidies.
<i>Potential spillover and wider effects</i>	Reduced material losses and disposal; domestic value retention and possible import substitution; demand for collection, testing, design, logistics and digital services; new or improved products; better industrial data; skilled employment; and stronger compliance capacity.	Measure verified additional recovery, accepted products, input substitution, value retained, operational and environmental performance, and employment outcomes.
<i>Economic interpretation</i>	Benefits and costs are distributed among generators, processors, receiving users and the programme. The pathway scenarios provide indicative gross values for selected pathways rather than net-profit estimates or a portfolio benefit-cost ratio.	Prepare pathway- or investment-specific business cases before financing permanent equipment or infrastructure. Major publicly financed infrastructure should also be subject to a proportionate economic cost-benefit analysis.

Source: Assignment synthesis based on the industrial mapping, business survey, pathway assessment, economic analysis and stakeholder validation.

The pathways generate value through different mechanisms, including revenues from segregated materials, avoided handling or compliant-management costs, procurement savings, operational improvements and possible domestic substitution of selected imported inputs. Section 5 presents illustrative gross annual

values where the evidence allowed quantification, while Section 6.6 presents the indicative cost of the proposed activation programme. These figures cannot be compared directly or combined into a portfolio benefit-cost ratio because they use different boundaries and do not include all investment and operating costs. Pathway-specific business cases and, for major publicly financed infrastructure, proportionate cost-benefit analysis would therefore be required before investment.

6.1.1. Routing interpretation of mapped residua

Building on the Task 2 mapping and the subsequent pathway assessment, the residua considered in this study can be interpreted through three routing situations. These situations reflect the available evidence and current material destinations; they are not legal waste classifications or permanent judgements about whether a material can be used.

POTENTIAL DOMESTIC INDUSTRIAL-SYMBIOSIS ROUTE: A plausible domestic processor, recovery option or receiving application has been identified. Readiness differs within this category: some routes can proceed through coordinated collection or applied pilots, while others including animal by-product recovery and metallurgical slag applications require regulatory confirmation or application-specific evidence before implementation.

EXISTING RECOVERY OR EXPORT ROUTE: The material is already reused, sold, recycled, recovered or exported and therefore forms part of the baseline. Programme support would be justified where it produces an additional benefit, such as improved recovery, better grade retention, greater domestic value addition or a more reliable receiving arrangement.

NO VERIFIED PRODUCTIVE-USE ROUTE: The study did not identify a technically, legally and commercially acceptable productive use based on the available evidence. The material should therefore continue to follow the applicable storage, treatment or disposal route unless a suitable application is subsequently demonstrated.

These situations may change as processing capacity, regulatory conditions, technology and receiving markets develop. Export is a current destination rather than a material characteristic, while the absence of a verified productive use does not mean that no future use can be developed.

6.2. Recommended implementation framework

The recommended implementation framework is a proposed 24-month Industrial Symbiosis Activation Programme led by MIETI. The programme would provide a common structure for developing the final pathway portfolio, while allowing each pathway to follow an approach suited to its technical, commercial and regulatory characteristics.

6.2.1. Proposed industrial symbiosis activation programme

The programme would move the final pathway portfolio from preliminary assessment towards implementation by organising participating firms and receiving users, testing materials and products, confirming compliant routes, demonstrating selected digital applications and generating evidence for decisions on continuation or expansion. It would be a targeted industrial-policy, innovation and resource-efficiency programme rather than a general waste-management programme.

Applied R&I forms an integral component of the Activation Programme rather than a separate programme. The requirements identified in Section 5.4 would be implemented through applied material and process pilots, coordinated recovery routes, regulated and conditional evidence work, digital interventions, and shared testing and qualification support. Industry would lead the adaptation, application and commercial validation of solutions, supported where relevant by laboratories, universities, research organisations, technical specialists and ICT providers.

Figure 13 summarises the proposed programme structure, showing the main action groups, their timing, indicative cost ranges and the principal evidence or outputs expected during the initial implementation cycle.

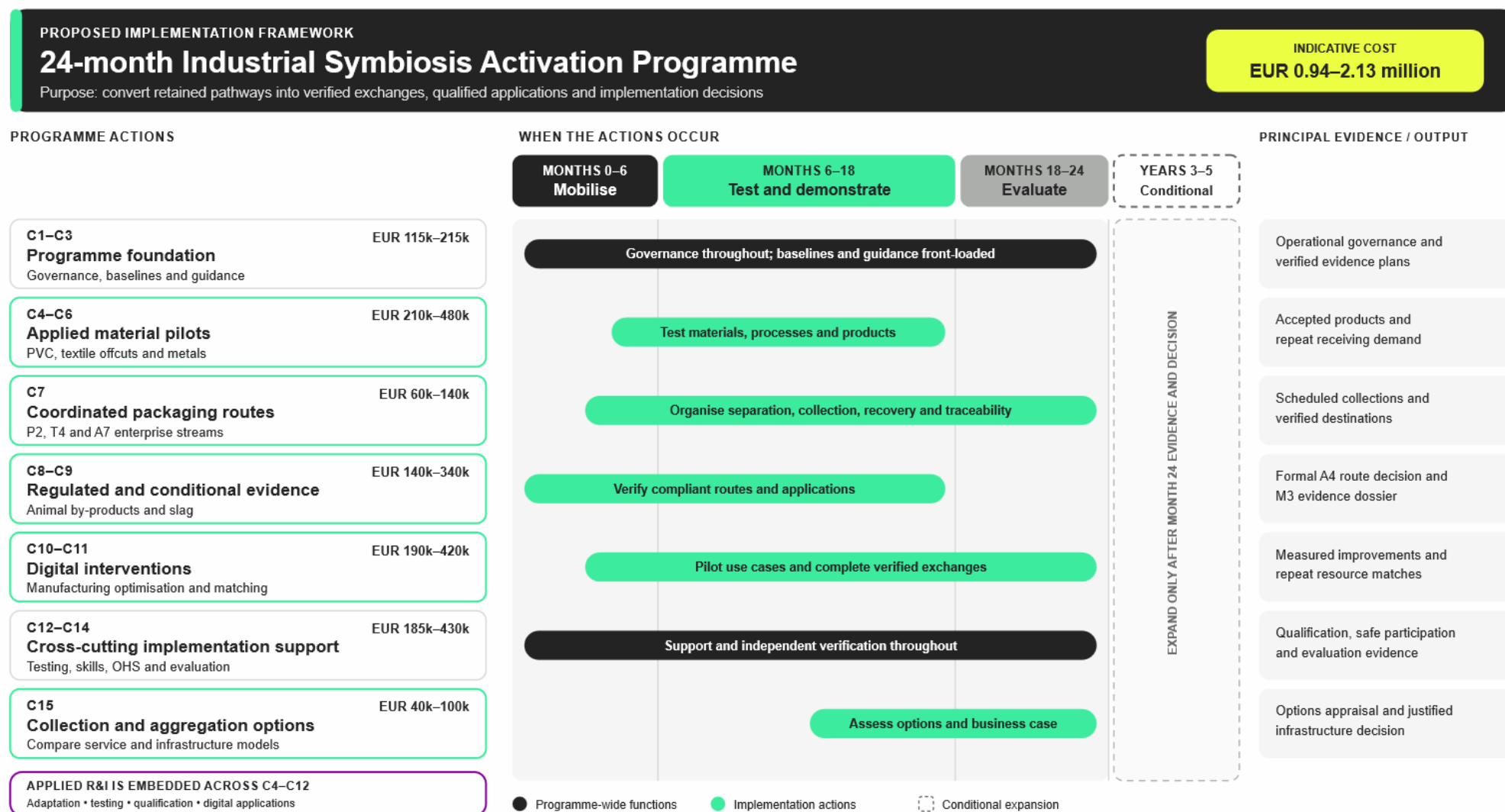


Figure 13. Industrial Symbiosis Activation Programme at a glance

Note: C1–C15 are cross-reference codes for the costed programme actions presented in Section 6.6 and detailed in Technical Annex 7. Cost ranges are indicative 2026 prices, exclude VAT and major capital investment, and are intended for programme planning rather than procurement.

During the initial 24-month cycle, the programme should concentrate on verifying material, cost and market baselines; undertaking applied testing and controlled demonstrations; organising supply, collection and receiving arrangements; and confirming the requirements for regulated pathways. Permanent infrastructure should be considered only where sufficient and regular material throughput, clear ownership and operating responsibility, regulatory compliance, receiving demand and a viable business case have been demonstrated.

The Activation Programme should be coordinated with Kosovo's emerging eco-industrial park and industrial-zone initiatives. Industrial parks and zones may provide practical settings for pathways that benefit from geographical proximity, coordinated source separation, shared collection and logistics, common technical services, resource-efficiency measures and digital resource matching. Participation in the programme should not, however, be limited to firms located within designated parks, as viable exchanges may connect generators, processors and receiving users across different locations. Any park-based shared infrastructure should be considered only where site-specific mapping confirms compatible material flows, sufficient throughput, receiving demand, a responsible operator and a viable business case.

Implementation should follow five principles: address a defined industrial challenge; assess the complete generator–processor–receiving-user chain; use existing facilities and market relationships where suitable; provide time-bound public support linked to evidence milestones and appropriate private contributions; and base continuation or expansion on verified technical, commercial and environmental results rather than participation numbers or collected tonnage alone.

6.2.2. Pathway-specific development actions and evidence for continuation

The ten pathways require four different development approaches. Applied material and process pilots are proposed for clean PVC offcuts (P1), textile offcut products (T2), and grade-controlled metal recovery (M1). Coordinated recovery arrangements are proposed for enterprise PE/PP packaging (P2), textile-sector packaging (T4), and agri-food packaging and pallets (A7). Animal by-product recovery (A4) and metallurgical slag applications (M3) require regulatory confirmation or application-specific technical evidence before controlled implementation or wider development. The two digital pathways AI-enabled manufacturing optimisation (I2) and digital matching and traceability (I3) must demonstrate their value through measured operational improvements or completed physical exchanges. Table below translates the common programme framework into a recommended development action for each pathway and identifies the evidence required before continuation, replication or infrastructure investment is considered.

Table 20. Pathway-specific development actions and evidence required for continuation

Pathway	Recommended development action	Evidence required for continuation or expansion
<i>P1 – Clean PVC offcuts</i>	Establish a generator–recycler–manufacturer partnership; confirm polymer formulations and current destinations; and test recycled blends in specified profile, duct or other suitable products.	Accepted product batches, verified recovery yield, compliance with receiving-user specifications, repeat demand and workable commercial terms.
<i>P2 – Enterprise PE/PP packaging</i>	Define material categories and recycler acceptance requirements; establish source separation and coordinated collection; and assess contamination, preparation yield and specified non-food receiving applications.	Repeat deliveries, acceptable contamination and recovery yield, documented collection and processing costs, and receiving-user acceptance.
<i>T2 – Textile offcut products</i>	Classify offcuts by fibre composition, cleanliness and buyer requirements; aggregate compatible materials; and develop and test wipers, packing fill and selected nonwoven products.	Verified material composition and processing yield, compliant product performance, accepted prototypes and evidence of repeat demand.

Pathway	Recommended development action	Evidence required for continuation or expansion
<i>T4 – Textile-sector packaging</i>	Apply common source-separation and storage practices and operate scheduled, material-specific collection for cardboard, plastic film, pallets and transport packaging.	Repeat collections, accepted quantities, verified material-specific destinations and workable service economics.
<i>A4 – Animal by-products</i>	Complete a competent-authority-led assessment of generators, official categories, quantities, authorised capacity and compliance requirements. Undertake a controlled trial only if a compliant route is confirmed.	Written competent-authority confirmation, an authorised handling and treatment chain, sufficient capacity, verified traceability and confirmation of permitted output uses.
<i>A7 – Agri-food packaging and pallets</i>	Map enterprise-controlled packaging and pallets by material and current destination; establish separate collection, reuse and recovery routes; and coordinate with applicable EPR or DRS arrangements where relevant.	Material-specific quantities, appropriate hygiene and segregation controls, repeat collections, and verified operators and receiving destinations. Household and municipal packaging remain outside the pathway.
<i>M1 – Metal scrap and swarf</i>	Map materials by alloy, grade and current destination; test source segregation, grade identification, swarf preparation and safe fluid management; assess domestic buyer acceptance; and compare domestic and export value.	Repeat grade-specific transactions, safe management of cutting fluids, preparation economics and demonstrable additional value compared with the baseline route.
<i>M3 – Metallurgical slag</i>	Verify material quantity, production source and current destination; undertake representative sampling and characterisation; and assess cementitious and aggregate applications separately.	Application-specific technical, environmental, conformity and market evidence based on representative material, together with confirmation of receiving-user acceptance.
<i>I2 – AI-enabled manufacturing optimisation</i>	Select four to six manufacturers with suitable data and test defined maintenance, energy, quality or material-efficiency applications against verified company baselines.	Measured operational improvement, clear process ownership, documented integration and operating costs, and a viable commercial-delivery model.
<i>I3 – Digital matching and traceability</i>	Launch an initial facilitated matching and traceability service using common material descriptions, verified participating organisations, assisted brokerage and transaction records.	Completed and repeated exchanges, accepted quantities, reliable data, workable governance, documented operating costs and demonstrated value for participating users.

The evidence requirements define the results to be generated during the initial programme cycle. Inclusion in the programme does not imply that every pathway should proceed automatically to expansion or infrastructure investment. Continuation decisions should be made separately for each pathway on the basis of its demonstrated technical performance, compliance, receiving demand, commercial arrangements and wider economic or environmental value.

6.3. Cross-cutting implementation measures

The following measures apply across several pathways and provide the common market, technical, financial, digital and workforce conditions needed for implementation. They complement the pathway-specific actions in Table 20 and should be applied in proportion to the characteristics and requirements of each pathway.

6.3.1. Organise collection and aggregation before investing in permanent infrastructure

The initial programme should improve source separation and test whether sufficient and consistent collection volumes can be organised through common material-handling procedures, shared schedules and aggregation arrangements using existing authorised facilities wherever technically suitable. For enterprise-controlled packaging and clean production offcuts, initial arrangements may use suitable containers,

covered storage, baling or compacting, scheduled collection and documented delivery to verified operators or receiving users.

The assessment of collection and aggregation options should include existing industrial zones and emerging eco-industrial park initiatives as possible locations for shared services. These options should be compared with the use of existing authorised facilities, scheduled or mobile collection services and sector-based arrangements. Inclusion in the assessment should not be interpreted as prior justification for constructing a permanent aggregation centre.

A permanent aggregation facility should not be the starting assumption. The proposed collection and aggregation assessment should compare the use of existing facilities, scheduled or mobile collection services, shared sector arrangements and dedicated aggregation facilities. The assessment should be material- and location-specific and examine:

The types, quantities, quality and seasonality of the relevant material streams
Their current destinations and the additional value expected from a new arrangement
The collection radius, logistics requirements and achievable throughput
Capital and operating costs, potential material revenue and avoided costs
Contamination, preparation losses and materials requiring alternative management
Applicable permits and environmental requirements
Confirmed receiving demand and commercial terms
Ownership, financing and operating responsibility

The assessment should determine whether a permanent facility is justified and, if so, its appropriate location, scale, operating model and material coverage. A full business case should be required before any capital investment is considered. Major infrastructure involving substantial public financing should also be subject to a proportionate economic cost-benefit analysis. The pathway-level gross-value scenarios presented in section 5 use different calculation boundaries and cannot be added together or used on their own to justify an aggregation centre or processing facility.

6.3.2. Strengthen application-specific research, innovation, testing and qualification

MIETI should support initial material characterisation, product and process testing and qualification where the resulting evidence benefits several SMEs or contributes to the development of a secondary-material market. Support should be linked to defined materials, products and receiving applications rather than offered as general laboratory assistance.

A quality-infrastructure gap assessment should distinguish:

- Testing and certification services already available in Kosovo
- Initial tests that may require competent external laboratories, including accredited laboratories where required
- Recurring testing demand that may justify expanding the scope of accredited services available domestically
- Standards, technical specifications or guidance needed to strengthen receiving-user and buyer confidence

Where appropriate, publicly supported non-confidential test methods, material specifications and results should be made available for replication. Regulatory, accreditation and conformity-assessment bodies should retain their independent responsibilities, and programme support should not influence regulatory or certification decisions.

6.3.3. Use targeted and time-bound financial instruments

The recommended instrument mix comprises pilot grants, research, innovation and testing vouchers, limited co-financing for minor shared equipment, and technical assistance. The level of public contribution should reflect the shared value of the evidence generated, the number of SMEs benefiting, the regulatory or technical complexity of the pathway and any wider public benefits. Support should be awarded through transparent selection, limited in duration and linked to evidence milestones and appropriate private contributions. Commercial production equipment, working capital and routine operating costs should normally remain the responsibility of participating firms. Major processing or aggregation facilities should be considered only after completion of the technical, environmental and financial appraisal described in Section 6.3.1.

6.3.4. Develop digital services around verified material flows and operational needs

The I3 service should support common material descriptions, verified participating organisations and listings, facilitated matching, transaction records and basic analytics. Its information structure may draw selectively on ISO 59040:2025, *Circular economy — Product circularity data sheet*, which provides a general methodology for the interoperable exchange of circularity-related information about products. Its application would need to be adapted because the mapped residua may have the legal status of waste or by-products rather than products.

ISO 59040:2025 does not determine whether a material is classified as waste, a by-product or a product and does not replace pathway-specific legal, technical or conformity assessment. It should therefore be used, where relevant, as a reference for structuring and exchanging information rather than as a standard for deciding whether an industrial-symbiosis exchange is legally or technically acceptable.

I3 Digital Resource-Matching and Traceability Service - performance should be measured through completed exchanges, accepted quantities, repeat participation, transaction value, operating costs and documented benefits for participating users rather than through registrations or listings alone.

I2 AI Analytics for Predictive Optimisation - support should be limited to manufacturers with usable data and a defined operational problem. Each application should establish a company baseline and measure changes in the relevant indicator, such as downtime, energy use, material losses, product quality or maintenance performance. Data protection, confidentiality, cybersecurity, intellectual property, worker implications and responsibility for automated recommendations should be addressed for each use case.

6.3.5. Integrate skills, inclusion and occupational health and safety

Programme calls should use transparent participation criteria and ensure that smaller firms, women-owned or women-led enterprises and firms outside the main industrial centres are not disadvantaged in accessing support. Reporting should track participation and employment by sex, region and occupational role where the information is reliable and proportionate to the scale of the intervention.

Training should respond to the needs of the supported pathways. Relevant areas include material identification and source separation, safe sorting and handling, product design, laboratory work, quality assurance, machine operation, digital functions, logistics and supervision. Where new roles are created or existing roles are expanded, the programme should support progression into skilled technical and supervisory functions and promote safe and decent working conditions.

All interventions should include pathway-specific occupational health and safety provisions covering the relevant machinery, fire risks, chemicals, dust, heavy metals, biological hazards, hygiene, manual handling, vehicles and workplace traffic. The costs of safe implementation form part of pathway feasibility and should be reflected in programme budgets, company contributions and commercial decisions.

6.4. Legal and regulatory recommendations

A separate industrial symbiosis law is not considered an immediate requirement. The priority is coordinated and practical application of the existing legal and institutional framework. MIETI should convene the relevant authorities, including MESP, MAFRD, FVA, quality-infrastructure bodies, municipalities and industry representatives, to prepare pathway-specific implementation guidance.

The guidance should distinguish requirements arising directly from Kosovo legislation, requirements associated with particular products or markets, and EU-alignment considerations that may influence future regulation or access to EU supply chains.

Table 21. Legal and regulatory action package

Recommendation	Content
<i>Clarify classification and documentation</i>	Prepare practical checklists covering waste, by-product and product status; required records; storage and transport; processing requirements; and authorised destinations.
<i>Map permits and official controls</i>	Identify the environmental, waste, veterinary and facility requirements applicable to each intervention before contracting or material transfer.
<i>Define testing and conformity routes</i>	Specify representative sampling, test methods, accredited evidence, product-performance requirements, certification and market-placement procedures.
<i>Coordinate packaging implementation</i>	Align industrial packaging routes with applicable EPR arrangements and with DRS requirements only where the relevant packaging stream falls within their scope. Household and municipal packaging collection remains outside the programme.
<i>Support EU-market information</i>	Provide periodically updated information on relevant PPWR, CBAM, ESPR, construction-product and supply-chain requirements affecting Kosovo exporters or their customers.
<i>Reconfirm requirements when the pathway changes</i>	Require renewed legal and technical review where the material classification, processing method, facility, receiving use or intended market is modified.

Before an intervention is contracted or implemented, the competent authorities should confirm the applicable classification, permits, official controls, testing and conformity route. This confirmation should be revisited if the process, facility or intended product changes.

6.5. Institutional responsibilities and coordination

Implementation requires a coordinated but distributed institutional model. MIETI should provide overall programme ownership and connect industrial-policy and enterprise-support instruments with the regulatory, technical and market functions required by each pathway. Environmental, veterinary, standards, accreditation and conformity decisions should remain with the institutions holding the relevant statutory mandates. The allocation of responsibilities below distinguishes programme coordination from regulatory oversight and commercial delivery. It is intended to clarify accountability, avoid duplication and ensure that each intervention has an identified institutional route from preparation and authorisation through implementation and evaluation.

Table 22. Core institutional responsibilities

Programme function	Primary institution	Main responsibility
<i>Programme ownership and coordination</i>	MIETI	Programme design, competitive calls, contracting, industrial and SME support, financing coordination and performance oversight.
<i>Waste and environmental regulation</i>	MESP and relevant environmental authorities, including KEPA where applicable	Waste classification, licensing, environmental permits, EPR and DRS coordination, inspections and environmental monitoring.

<i>Animal by-products and veterinary control</i>	FVA, with MAFRD where policy or legislative action is required	A4 categorisation, approval of operators and establishments, transport and processing requirements, traceability and official controls.
<i>Standards, accreditation and testing</i>	Kosovo Standardization Agency, Kosovo Accreditation Directorate, and competent testing, inspection and certification bodies	Standards and technical information; accreditation of conformity-assessment bodies; testing, inspection and certification; and provision of product-conformity evidence within their respective mandates.
<i>Local and market implementation</i>	Participating firms, business associations and municipalities where relevant	Company mobilisation, route organisation, aggregation and logistics, commercial agreements, private contributions and routine operation.
<i>Research and technical support</i>	Universities, research organisations, laboratories and technical specialists	Material characterisation, product development, process testing and independent technical evidence.

To operationalise these responsibilities, MIETI should chair a steering group comprising the institutions required for pathway decisions. The steering group should meet at defined implementation and decision points to confirm sequencing, resolve cross-institutional issues, review evidence and document whether interventions should proceed, be modified or be discontinued. It should not assume or duplicate the statutory functions of its members.

Temporary technical working arrangements may be established where specialised coordination is required, particularly for A4 and M3. Participating companies should retain responsibility for the accuracy of material information, commercial agreements, private contributions and routine operations. Business associations and municipalities may facilitate company mobilisation and local route organisation, while development-partner support should remain subject to separately agreed financing arrangements and respective institutional mandates.

6.6. Roadmap, indicative cost and financing

The implementation framework is organised around an initial 24-month activation period followed by conditional expansion during years 3-5. The phases may overlap across interventions because the pathways differ in maturity and complexity. Packaging measures may become operational relatively early, whereas A4 and M3 require additional regulatory or technical verification. The roadmap therefore establishes a common programme sequence while allowing pathway-specific timing and decision gates.

Table 23. Implementation roadmap

Phase	Timing	Core purpose	Principal decision output
<i>1. Mobilise and verify</i>	Months 0–6	Establish programme governance; confirm participating companies and partners; verify material, cost and market baselines; complete initial legal and standards screening; and prepare implementation agreements.	Confirmed intervention package, assigned responsibilities, verified baselines and agreed evidence plans.
<i>2. Test and demonstrate</i>	Months 6–18	Implement applied R&I, collection routes, product testing and controlled demonstrations; launch the minimum viable resource-matching service and selected manufacturing-optimisation pilots.	Tested products, accepted batches, completed exchanges and documented operational results.
<i>3. Evaluate and prepare decisions</i>	Months 18–24	Assess repeat transactions, compliance, commercial performance and environmental results; undertake independent evaluation; and prepare commercial and financing cases where justified.	Decision to continue, modify or discontinue each intervention, together with a costed expansion case where appropriate.
<i>Conditional expansion</i>	Years 3–5	Expand successful routes and finance justified processing or aggregation infrastructure through appropriate public, private or blended instruments.	Sustained operation and selective replication based on verified evidence.

Months 18–24 constitute an evaluation and decision phase rather than an automatic transition to scale-up. Each intervention should receive a documented proceed, modify or discontinue recommendation. Scale-up proposals should specify the verified material base, receiving market, commercial model, investment requirement, financing structure, institutional responsibilities and environmental safeguards.

6.6.1. Indicative programme cost

The indicative cost of the initial 24-month programme is EUR 0.94–2.13 million in 2026 prices, excluding VAT and major capital investment. This range is derived from the 15 costed programme actions C1 to C15 presented in Technical Annex 7. The C-codes identify programme actions and are separate from the pathway codes used elsewhere in the report.

The estimates are programme-planning ranges rather than procurement estimates or budget commitments. They cover programme coordination, baseline verification, technical assistance, regulatory guidance, applied pilots, testing, limited equipment, digital interventions, skills development, occupational health and safety support and independent evaluation. They exclude land, major civil works, full-scale processing facilities, working capital and routine private operating costs.

Table 24. Summary of indicative 24-month programme costs

Programme component	Cost reference	Indicative range
<i>Governance, baseline verification and regulatory guidance</i>	C1–C3	EUR 115,000–215,000
<i>Physical pilots and coordinated packaging measures</i>	C4–C9	EUR 410,000–960,000
<i>Digital R&I and resource matching</i>	C10–C11	EUR 190,000–420,000
<i>Testing, skills, OHS and independent evaluation</i>	C12–C14	EUR 185,000–430,000
<i>Collection and aggregation feasibility and design</i>	C15	EUR 40,000–100,000
Total	C1–C15	EUR 940,000–2,125,000

Cross-programme activities, including baseline verification, regulatory guidance, testing support, skills, OHS and independent evaluation, are costed separately from pathway-specific implementation. Any subsequent capital investment in permanent processing or aggregation facilities would require a separate feasibility and financing process.

6.6.2. Potential financing sources

Applying the indicative public and technical-assistance shares to the programme cost ranges gives an estimated public and technical-assistance contribution of approximately EUR 0.56–1.61 million. This is a planning assumption rather than a confirmed allocation. The remaining contribution would come from participating firms through cash or eligible and verifiable in-kind inputs.

The appropriate financing structure will differ by action. A higher public contribution may be justified where an intervention produces shared evidence, benefits several SMEs, addresses significant regulatory complexity or supports wider public objectives. Commercial equipment, working capital, routine logistics and continuing operations have a stronger private-financing rationale.

Table 25. Potential financing sources and delivery mechanisms

Source or mechanism	Suitable uses	Conditions
<i>MIETI industrial and SME support resources</i>	Programme coordination, competitive calls, testing and innovation vouchers and limited shared equipment.	Budget availability, transparent selection, eligible-cost rules, milestone payments and evidence requirements.
<i>Development-partner technical assistance</i>	Programme preparation, specialist support, baseline verification, regulated-pathway assessment, testing access and evaluation.	Alignment with partner mandates, separate financing agreements and avoidance of duplicate support.
<i>Private contributions</i>	Commercial trials, productive equipment, staff, routine logistics, software licences, working capital and scale-up.	Signed commitments and verifiable cash or eligible in-kind contributions.

Source or mechanism	Suitable uses	Conditions
<i>Financial institutions and blended finance</i>	Equipment and processing upgrades after successful demonstration of a viable business case.	Creditworthy sponsors, confirmed material supply and buyers, and satisfactory technical and environmental due diligence.
<i>EPR and DRS financing</i>	Packaging collection, sorting, reporting and recovery where the relevant stream is covered by an operational system.	Applicable legal and institutional arrangements and material-specific eligibility.
<i>Tax or depreciation incentives</i>	Eligible resource-efficiency or circular-manufacturing investments under wider industrial policy.	Fiscal assessment, clear eligibility criteria and verification of qualifying investment.

Before implementation, each cost range should be converted into a detailed scope and unit-cost basis and tested against market conditions. Financing agreements should specify eligible costs, public and private shares, payment milestones, evidence requirements and the ownership and subsequent use of supported assets. Public financing should not create permanent operating dependence for commercially viable services. The detailed action-costing, indicative financing shares and consolidated implementation matrix are presented in Technical Annex 7.

6.7. Immediate decisions and next steps

The proposed programme does not require all ten pathways to be implemented simultaneously or at full scale. The immediate priority is to establish the coordination arrangements, confirm participating companies and receiving users, prepare the necessary regulatory and technical guidance, and develop detailed scopes for the first implementation cycle.

Table 26. Decisions required to initiate and evaluate the proposed programme

Decision area	Proposed decision	Timing
<i>Programme mandate and coordination</i>	Endorse the proposed 24-month activation framework and designate the MIETI programme-coordination function.	Before programme launch
<i>Initial implementation package</i>	Prepare applied pilots for P1, T2 and M1; coordinated enterprise-material routes for P2, T4 and A7; defined I2 company pilots; and an initial facilitated I3 resource-matching service.	Months 0–6
<i>Regulated and conditional pathways</i>	Obtain competent-authority confirmation of the applicable route for A4 and complete representative, application-specific technical and environmental assessment for M3 before controlled implementation.	Before the respective trials
<i>Detailed budget preparation</i>	Convert the C1–C15 planning ranges into detailed scopes, eligible costs, public and private contributions, procurement requirements and market-tested budgets.	During programme preparation
<i>Permanent infrastructure</i>	Complete the material- and location-specific appraisal under C15 before considering investment in a permanent aggregation centre or processing facility.	Months 12–24
<i>Continuation and expansion</i>	Assess each pathway separately and decide whether it should continue, be modified, be incorporated into an existing support instrument or be discontinued. Any expansion should be supported by verified technical, commercial, regulatory and environmental evidence.	By Month 24

The available evidence supports moving from analytical preparation to a targeted first implementation cycle. It does not support an immediate full-scale rollout of all pathways or investment in a general multi-material facility. The proposed 24-month programme would provide the operational evidence needed to verify material flows, qualify products and receiving applications, demonstrate repeat exchanges and determine which pathways have a sufficient basis for continued or expanded implementation.

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Selected sector and value-chain sources

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Selected legal and technical references

- Kosovo Strategy for Industrial Development and Business Support 2030.
- Kosovo Law on Waste and relevant implementing acts.
- Kosovo environmental protection and permitting legislation, veterinary and food-safety framework, construction-product requirements, and standardisation and accreditation framework reviewed under the assignment.
- Regulation (EU) 2023/956 establishing a Carbon Border Adjustment Mechanism, as amended.
- Directive (EU) 2022/2464 on corporate sustainability reporting, as subsequently amended.
- Directive (EU) 2024/1760 on corporate sustainability due diligence, as subsequently amended.
- Regulation (EU) 2024/1781 establishing a framework for ecodesign requirements for sustainable products.
- Regulation (EU) 2025/40 on packaging and packaging waste.
- Directive 2008/98/EC on waste, as amended and consolidated.
- Regulation (EC) No 1069/2009 on animal by-products and derived products not intended for human consumption.
- Regulation (EU) 2024/3110 laying down harmonised rules for the marketing of construction products.
- ISO 59040:2025, Circular economy - Product circularity data sheet, where relevant to resource-information fields.