

Module 4: Regulatory Challenges and Economic Considerations in I-US

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Module Overview

In this module, local and regional authorities can get a comprehensive guide to navigating the regulatory, economic, and financial landscape of I-US. This module equips readers with tools to understand and overcome legal and bureaucratic barriers, and it also explores economic considerations and structured financing strategies for municipalities, while introducing viable business models and governance approaches I-US hubs, and highlights the strategic use of Green Public Procurement (GPP) and complementary policy instruments to stimulate market demand and industrial collaboration.

- [Chapter 4.1: Navigating Regulatory Barriers in I-US](#)
- [Chapter 4.2: Economic Considerations for Local Governments](#)
- [Chapter 4.3: Financing I-US and Business Models](#)
- [Chapter 4.4: Green Public Procurement and Policy Tools for I-US](#)





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Chapter 4.1: Navigating Regulatory Barriers in I-US

This chapter examines key legal and bureaucratic obstacles such as end-of-waste regulations, and it delves into permitting and compliance processes, which can create administrative bottlenecks for industries seeking to exchange resources. Sector-specific regulations, including those governing waste management, energy-sharing agreements, and water reuse, further complicate the landscape. Additionally, the chapter highlights the issue of regulatory uncertainty, where unclear or evolving policies discourage business investment in I-US projects.

- Target audience: Local Authorities and Municipalities
- Estimated time: 15 minutes
- Includes: Explanations





Navigating Regulatory Barriers in I-US

Industrial-Urban Symbiosis (I-US) initiatives depend on collaboration between industries, urban infrastructures, and public authorities to exchange resources such as energy, water, materials, and by-products. While the technical and economic potential of such exchanges is often significant, their implementation frequently encounters regulatory and administrative barriers. These barriers arise because most regulatory frameworks governing environmental protection, energy systems, waste management, and urban planning were developed for **linear production and consumption systems**, where materials move in a single direction from extraction to disposal.

In contrast, I-US projects operate through **networked and circular flows of resources**, often involving multiple actors, shared infrastructures, and innovative uses of materials that do not easily fit within traditional regulatory categories.





Navigating Regulatory Barriers in I-US

As a result, circular initiatives can face administrative delays, legal uncertainty, or regulatory constraints that limit their feasibility even when they offer clear environmental and economic benefits.

For local and regional authorities seeking to facilitate I-US initiatives, understanding these barriers is essential. Regulatory challenges are not simply obstacles to be overcome; they are also opportunities to identify where governance systems may need to evolve to better support circular economy practices. By anticipating regulatory issues early in the planning process, municipalities can reduce risks for participating companies, streamline project development, and foster an enabling environment for circular industrial collaboration.





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Navigating Regulatory Barriers in I-US

Several categories of regulatory barriers commonly affect I-US projects:

- Regulatory complexity and fragmentation
- Waste classification and end-of-waste criteria
- Permitting and compliance procedures
- Sector-specific regulations (waste, energy, water)
- Ownership and liability in shared systems
- Regulatory uncertainty and evolving policy frameworks
- Governance continuity and institutional coordination

Each of these barriers is examined below, along with potential strategies that local authorities can use to address them.





Regulatory Complexity and Fragmentation

One of the most significant challenges for I-US initiatives is the need to navigate a **complex and fragmented regulatory landscape**. Resource exchanges within a circular hub often intersect with multiple regulatory domains simultaneously. For example, a project that captures waste heat from an industrial facility and supplies it to nearby residential buildings may involve:

- Environmental permitting requirements
- Energy market regulations
- Building and infrastructure permits
- Urban planning and zoning rules
- Safety and environmental monitoring requirements

Each of these areas is typically governed by **different regulatory frameworks and administrative bodies**. Environmental agencies, energy regulators, planning departments, and municipal authorities may all have jurisdiction over different aspects of a single project.





Regulatory Complexity and Fragmentation

Because these frameworks were not originally designed to support integrated industrial-urban resource exchanges, they may operate in isolation from one another. In practice, this can create overlapping responsibilities, inconsistent interpretations of rules, or procedural delays.

For I-US initiatives, regulatory fragmentation can have several consequences:

- Companies may struggle to identify the relevant regulatory requirements during the early stages of project development.
- Administrative procedures may need to be completed sequentially, extending project timelines.
- Conflicting interpretations of legislation can increase legal uncertainty.

The complexity of regulatory procedures may discourage participation by companies, particularly small and medium-sized enterprises (SMEs).





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Regulatory Complexity and Fragmentation

SMEs are especially affected because they often lack the internal legal or regulatory expertise required to navigate complex legislation. Without external support, potentially beneficial exchanges may not progress beyond the conceptual stage.

Local authorities can play an important role in reducing these barriers by acting as **facilitators and coordinators** between companies and regulatory bodies. In some regions, public agencies have developed practical tools to simplify regulatory navigation.





Regulatory Complexity and Fragmentation

Mitigation Strategies

Local authorities and hub facilitators can adopt several measures to reduce the impact of regulatory complexity:

1. Assign dedicated regulatory facilitation

Circular hubs should designate a **facilitator or coordinating entity** responsible for regulatory navigation. This role may include:

- Collecting regulatory questions from participating companies
- Liaising with competent authorities and regulatory agencies
- Translating legal requirements into operational guidance
- Coordinating permitting processes across stakeholders

This intermediary function helps companies avoid navigating regulatory systems individually and reduces duplication of effort.





Regulatory Complexity and Fragmentation

Mitigation Strategies

2. Creating regulatory guidance tools

Municipalities and regional authorities can develop practical guidance documents explaining regulatory procedures for common I-US activities. These may include:

- Regulatory roadmaps outlining the approval steps required for typical exchanges
- Decision trees helping companies determine whether materials qualify as by-products or waste
- Checklists summarizing compliance requirements for infrastructure projects

For example, the **OVAM** has developed digital “legislation wizards” that guide companies through waste regulation requirements step by step.





Regulatory Complexity and Fragmentation

Mitigation Strategies

3. Facilitating cross-departmental cooperation

Within municipalities, regulatory responsibilities are often distributed across different departments. Establishing **internal coordination mechanisms** can significantly streamline decision-making. Examples include:

- Interdepartmental working groups on circular economy initiatives
- Shared project review processes
- Joint permitting discussions involving planning, environmental, and infrastructure departments

Such coordination allows local authorities to provide clearer guidance to companies and reduce administrative delays.





Regulatory Complexity and Fragmentation

Mitigation Strategies

4. Supporting SMEs through regulatory assistance

Small and medium-sized enterprises often lack dedicated regulatory expertise. Municipalities can support them by:

- Offering advisory services or regulatory helpdesks
- Providing access to legal or technical experts.
- Facilitating workshops on regulatory compliance in circular economy projects

These actors can assist with regulatory interpretation, feasibility assessments, and compliance strategies:

- Environmental law specialists
- Universities and research institutions
- Industrial symbiosis consultancies
- Public innovation agencies





Regulatory Complexity and Fragmentation

Mitigation Strategies

3. Engage specialized expertise

When regulatory questions become highly technical, collaboration with external experts can be valuable. Relevant expertise may come from:

- Environmental law specialists
- Universities and research institutions
- Industrial symbiosis consultancies
- Public innovation agencies

These actors can assist with regulatory interpretation, feasibility assessments, and compliance strategies.





Waste Classification and End-of-Waste Criteria

Another major regulatory barrier for I-US projects relates to **waste classification**, particularly the application of **end-of-waste criteria** under European waste legislation.

The **European Commission** Waste Framework Directive establishes strict rules governing materials that are classified as waste. These rules regulate how waste must be handled, transported, treated, and documented in order to prevent environmental or public health risks.

However, many industrial symbiosis exchanges involve materials that originate from waste streams but could be **safely reused as secondary raw materials**. Examples include:

- Industrial by-products used as inputs for other manufacturing processes
- Construction and demolition materials reused in infrastructure projects
- Organic residues converted into energy or fertilizers
- Process water reused within industrial or urban systems





Waste Classification and End-of-Waste Criteria

Once a material is legally classified as waste, however, its reuse becomes subject to strict regulatory requirements. This can limit flexibility and increase the administrative burden associated with circular resource exchanges.

Understanding End-of-Waste Criteria

End-of-waste criteria determine when a material that was previously classified as waste can **cease to be waste** and instead be treated as a product or secondary raw material. According to EU legislation, this transition is possible when specific conditions are met:

- The material is commonly used for specific purposes.
- A market or demand exists for the material.
- The material meets technical standards and quality requirements.
- Its use does not result in adverse environmental or health impacts.





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Waste Classification and End-of-Waste Criteria

While this mechanism is designed to support circular economy practices, in practice it can be difficult to apply. Many materials do not yet have standardized end-of-waste criteria at the EU level, meaning that decisions must be made at national or regional levels. This can lead to inconsistent interpretations and administrative complexity.

Why This Creates Barriers for I-US

For industrial symbiosis initiatives, the end-of-waste process can create several obstacles:

- Companies may need to provide extensive documentation proving that materials meet regulatory requirements.
- Approval processes can be time-consuming and resource-intensive.
- Regulatory authorities may adopt cautious interpretations due to environmental liability concerns.
- Companies may avoid using secondary materials if their legal status remains uncertain.





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SYMSITES Training Materials on
Industrial-Urban Symbiosis

← [Module 4: Regulatory Challenges and Economic Considerations in I-US](#)

Waste Classification and End-of-Waste Criteria

These challenges illustrate a broader issue: environmental regulations often assess compliance **at the level of individual firms**, while I-US initiatives generate benefits **at the system level**. Even if a resource exchange reduces overall waste generation or emissions across a network of companies, regulatory constraints may still prevent it because legislation does not always account for system-wide impacts.

Organizations such as the Ellen MacArthur Foundation have highlighted the need for regulatory frameworks that better recognize the role of secondary materials in circular industrial systems.

Local authorities can help address these barriers by facilitating dialogue between companies and regulatory bodies, supporting pilot projects, and promoting the development of regional guidelines for secondary material use. Below we explore some of these mitigation strategies.



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Waste Classification and End-of-Waste Criteria

Mitigation Strategies

1. Early engagement with waste authorities

Local authorities can facilitate early discussions between companies and waste regulators to clarify whether a material may qualify as a by-product or achieve end-of-waste status. Early engagement helps identify documentation requirements and avoid delays later in the process.

2. Developing regional guidelines

Where EU-level criteria are not available, regional authorities can develop **guidelines or standard procedures** for evaluating secondary materials. These guidelines help create greater consistency in regulatory decisions.





Waste Classification and End-of-Waste Criteria

Mitigation Strategies

3. Supporting material characterization

Demonstrating that a material is safe and suitable for reuse often requires technical testing. Local authorities can support companies by:

- Facilitating partnerships with research institutions
- Providing access to testing facilities
- Supporting pilot projects that demonstrate material reuse

4. Documenting blocked exchanges

If regulatory barriers prevent certain exchanges, it is important to systematically document these cases. Evidence on the environmental benefits that could not be realized can inform future policy discussions and contribute to regulatory reform.





Permitting and Compliance Processes

Complex **permitting and compliance procedures** represent another important barrier for I-US initiatives. Many industrial symbiosis projects require new infrastructure or operational changes that trigger regulatory approval processes.

Examples of permits that may be required include:

- Environmental permits for industrial operations
- Construction permits for pipelines, storage facilities, or energy infrastructure
- Water discharge permits
- Air emissions permits
- Waste treatment or storage authorizations

Because symbiotic exchanges often involve multiple actors, each participating facility may need to modify its existing permits to accommodate new resource flows. This can significantly increase administrative complexity.





Permitting and Compliance Processes

Permitting procedures may involve several steps:

- Technical feasibility assessments
- Environmental impact assessments
- Public consultations
- Review by regulatory authorities
- Issuance of operational permits

These procedures can take months or even years to complete, particularly when projects involve innovative technologies or new forms of collaboration.

Local authorities can support project implementation by improving coordination between regulatory bodies and streamlining administrative procedures.





Permitting and Compliance Processes

Mitigation Strategies

1. Establishing one-stop-shop administrative services

Local authorities can create centralized contact points where companies receive guidance on regulatory requirements. These services help coordinate communication between companies and regulatory bodies and reduce administrative complexity.

2. Coordinating permitting processes

Municipalities can encourage **parallel permit reviews**, allowing different authorities to assess project components simultaneously rather than sequentially.





Permitting and Compliance Processes

Mitigation Strategies

3. Providing early regulatory screening

Before companies invest heavily in project development, local authorities can facilitate preliminary regulatory assessments to identify potential barriers and permitting requirements.

4. Developing fast-track procedures for circular projects

Some regions are introducing accelerated permitting procedures for projects that contribute to environmental or climate objectives. Circular economy initiatives may qualify for such mechanisms.

5. Supporting environmental impact assessments

Environmental impact assessments can be complex and costly. Municipalities can assist companies by providing guidance, coordinating consultations, or supporting data collection efforts.





Sector-Specific Regulatory Constraints

In addition to general regulatory challenges, I-US initiatives must also comply with **sector-specific regulations** governing particular resource flows. These regulations can impose additional constraints depending on the type of exchange involved.

Waste Management Regulations

Waste management legislation remains one of the most influential regulatory frameworks affecting industrial symbiosis. These regulations are essential for protecting the environment and public health, but they can also limit the flexibility needed to facilitate material exchanges between companies.

Waste regulations typically govern:

- Waste classification and labelling
- Transport and storage conditions



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Sector-Specific Regulatory Constraints

- Treatment and recovery operations
- Reporting and traceability requirements

Companies must ensure that any reuse or recovery activity complies with these rules, which can create administrative burdens for symbiotic exchanges.

Mitigation Strategies

Local authorities can support waste-based symbiosis initiatives by:

- Facilitating dialogue between companies and waste regulators
- Supporting pilot projects that demonstrate safe material reuse
- Promoting standardized documentation for waste exchanges
- Encouraging industrial clusters to develop shared waste management infrastructure





Sector-Specific Regulatory Constraints

Energy Sharing Regulations

Energy exchanges are a key component of many I-US initiatives, particularly those involving waste heat recovery or district heating systems. However, energy markets are often tightly regulated.

Potential regulatory barriers include:

- Licensing requirements for energy suppliers
- Grid access rules and tariffs
- Restrictions on direct energy sharing between companies
- Regulatory frameworks governing district heating systems

In some jurisdictions, companies that share energy with other entities may legally be classified as **energy suppliers**, requiring them to comply with additional regulatory obligations.





Sector-Specific Regulatory Constraints

Mitigation Strategies

To address these challenges, local authorities can:

- Facilitate partnerships between industries and district heating operators
- Clarify regulatory obligations related to energy sharing
- Support feasibility studies for waste heat recovery networks
- Promote integration of industrial heat into municipal energy planning





Sector-Specific Regulatory Constraints

Water Reuse Regulations

Water reuse represents another promising opportunity for industrial symbiosis, particularly in regions facing increasing water scarcity. Industrial facilities may treat wastewater that could potentially be reused by other industries, municipal infrastructures, or agricultural activities.

However, water reuse is often strictly regulated due to public health and environmental concerns. Regulatory requirements may include:

- Water quality standards for specific uses
- Permits for wastewater treatment and reuse
- Monitoring and reporting obligations
- Infrastructure safety requirements

While these regulations are necessary, they can make it difficult to implement innovative water symbiosis systems.





Sector-Specific Regulatory Constraints

Mitigation Strategies

Authorities can promote safe water reuse by:

- Supporting advanced water treatment technologies
- Developing regional guidelines for industrial water reuse
- Facilitating collaboration between industries and municipal water utilities
- Promoting pilot projects to demonstrate safe water recycling systems





Ownership and Liability in Shared Systems

Many I-US initiatives rely on shared infrastructure and collaborative resource flows, such as pipelines, treatment facilities, or energy networks. These arrangements can complicate traditional legal concepts of ownership and responsibility. Uncertainty regarding ownership and liability can create hesitation among companies and delay project approvals.

Examples include:

- Shared pipelines transporting steam or waste heat
- Jointly used water treatment systems
- Shared storage facilities for secondary materials
- Multi-stage processing of by-products across several companies

In these situations, materials may:

- Move between multiple companies
- Change legal status during processing
- Be temporarily stored by another partner
- Be jointly owned or managed



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Ownership and Liability in Shared Systems

If ownership and responsibility are not clearly defined several problems may arise:

- Uncertainty regarding **who must obtain permits**
- Ambiguity about **compliance responsibilities**
- Disputes over **liability in case of environmental incidents**
- Delays in regulatory approval due to unclear governance structures

Such uncertainty can discourage companies from participating in symbiotic exchanges.





Ownership and Liability in Shared Systems

Mitigation Strategies

To prevent these issues, local and regional authorities should support the **legal clarity from the outset**. Key actions include:

1. Explicitly defining ownership transitions

- Specify when ownership of materials changes during exchanges
- Identify the entity responsible for handling, storage, and processing at each stage
- Clarify responsibility for regulatory compliance and monitoring

2. Clarifying infrastructure governance

- Determine who owns shared infrastructure such as pipelines or storage facilities
- Establish maintenance responsibilities and operational procedures





Ownership and Liability in Shared Systems

3. Formalizing agreements

Although informal collaboration may work during early experimentation, long-term hub stability requires **formal contracts and agreements**. These should outline:

- Ownership arrangements
- Compliance obligations
- Liability allocation
- Monitoring and reporting procedures

Formalization reduces legal uncertainty and strengthens trust between partners.





Regulatory Uncertainty and Evolving Policy Frameworks

Regulatory environments are not static. Policies related to the circular economy, waste management, and climate action are evolving rapidly across Europe. While these developments often aim to support sustainability transitions, they can also create **short-term uncertainty for businesses and municipalities**.

Examples of regulatory uncertainty include:

- Upcoming revisions of waste classification rules
- Changes to environmental standards or emissions limits
- New requirements for waste tracking or reporting
- Future restrictions on hazardous materials

For circular hubs, such uncertainty can influence long-term investment decisions. Companies may hesitate to invest in infrastructure if future regulatory changes could alter the viability of resource exchanges.





Regulatory Uncertainty and Evolving Policy Frameworks

Mitigation Strategies

Strategies for Managing Regulatory Uncertainty

Local authorities can help mitigate these risks by:

- Monitoring policy developments at EU, national, and regional levels
- Participating in circular economy networks and policy consultations
- Maintaining regular communication with regulatory agencies
- Designing flexible infrastructure that can adapt to regulatory changes

Proactive monitoring allows I-US initiatives to anticipate regulatory changes and adapt accordingly. The OECD has emphasized the importance of embedding circular economy initiatives into long-term governance frameworks to ensure institutional stability.

Want to learn more?

- Read this: [Final Report on Industrial Symbiosis and Circular Economy in Industries: Insights from the Thematic Working Group of the Circular Cities and Regions Initiative](#)





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Chapter 4.2: Economic Considerations for Local Governments

This chapter examines the financial rationale and strategic approaches that municipalities can adopt when engaging in I-US. It highlights both direct and indirect benefits, including enhanced regional competitiveness, citizen well-being, and industrial resilience. The chapter introduces the “black box” model for analysing municipal resource systems, and it outlines structured financing strategies, including the selection of appropriate instruments (grants, loans, equity, or blended finance), mapping funding opportunities, sequencing investments according to project stage, and leveraging advisory support.

- Target audience: Local Authorities and Municipalities
- Estimated time: 15 minutes
- Includes: Explanations Tools





Economic Considerations for Local Governments

Industrial-Urban Symbiosis (I-US) is often discussed primarily in terms of environmental benefits and circular resource flows. However, for local and regional authorities, the **economic dimension is equally important**. Municipalities operate within constrained public budgets and must carefully assess whether new initiatives create financial value, reduce costs, or generate long-term economic benefits for the region.

Circular hubs and I-US networks can provide **direct financial returns as well as broader socio-economic benefits**. Direct benefits may include reduced waste treatment costs, new energy revenues, or improved efficiency in municipal infrastructure systems. Indirect benefits include enhanced industrial competitiveness, job creation, increased regional attractiveness for investment, and improved quality of life for citizens.

Understanding these economic implications is therefore critical when municipalities consider whether to support or actively participate in I-US initiatives.



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Direct and Indirect Economic Benefits of I-US

Municipal governments typically manage or regulate key urban systems such as **municipal solid waste (MSW)**, **wastewater (WW)**, **energy infrastructure**, and **land-use planning**. These systems represent both costs and opportunities within the municipal budget.

I-US initiatives can transform these systems from cost centres into resource-generating infrastructures.

Direct Economic Benefits

Direct economic gains for municipalities may include:

- **Reduced waste management costs** through waste valorisation or industrial reuse of municipal waste streams
- **Lower wastewater treatment costs** when industrial symbiosis enables water reuse or reduces treatment volumes
- **Energy generation from waste streams**, such as biogas production through anaerobic digestion



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Direct and Indirect Economic Benefits of I-US

- **Reduced energy expenditures** for municipal buildings and services through waste heat recovery
- **Revenue streams from recovered materials**, such as compost, recycled materials, or bio-based products

For example, municipal wastewater treatment plants can produce **biogas**, **recovered nutrients**, or **reclaimed water**, creating additional value streams that offset operational costs.

Indirect Economic Benefits

Beyond direct financial returns, I-US initiatives generate broader economic advantages for local economies. These include:

- **Increased industrial competitiveness** due to lower resource costs
- **Job creation in circular economy sectors**, including recycling, bio-based materials, and energy services
- **Regional innovation ecosystems** centred around circular technologies



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Direct and Indirect Economic Benefits of I-US

- **Improved energy and resource security** through local resource loops
- **Enhanced attractiveness for investors and businesses seeking sustainable locations**

Such indirect benefits are particularly important for regional development strategies. Cities and regions that successfully implement circular economy initiatives often become **innovation hubs**, attracting companies and research institutions focused on sustainable technologies.

These broader impacts contribute to the **long-term economic resilience of local economies**.



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The “Black Box” Model for Municipal Resource Systems

To assess the economic potential of I-US initiatives, municipalities must understand the **material and energy flows within their infrastructure systems**. One useful analytical approach is the “**black box**” model.

In this model, municipal facilities (such as waste treatment plants or wastewater treatment systems) are treated as **integrated systems with defined inputs and outputs**.

Inputs - Typical inputs include:

- Municipal solid waste (MSW)
- Wastewater (WW)
- Organic waste streams
- Industrial residues
- Energy inputs (electricity or heat)



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The “Black Box” Model for Municipal Resource Systems

Outputs - Outputs generated by these systems may include:

- Biogas or renewable energy
- Recovered heat
- Recycled water
- Compost or soil amendments
- Secondary raw materials
- Low-carbon products

By analysing these flows, municipalities can evaluate both the **material balance** and the **economic balance** of their systems. This analysis helps identify where additional value can be generated through symbiotic exchanges with nearby industries.



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The “Black Box” Model for Municipal Resource Systems

For example:

- Wastewater treatment plants may produce **biogas that can supply nearby industries**.
- Organic municipal waste may be converted into **fertilizers for local agriculture**.
- Waste heat from industrial processes may supply **district heating networks for residential areas**.

The black box approach helps municipalities shift their perspective from **waste disposal systems to resource production systems**, enabling more strategic decision-making regarding circular investments.



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Expanding Circular Resource Opportunities

Although energy and water exchanges are often the most visible aspects of I-US, circular hubs can also create economic value through **diverse material loops**.

Examples include:

- **Cardboard and paper recycling loops** supporting local packaging industries
- **Wood waste reuse** in construction or bio-energy production
- **Agricultural residues** used for bio-based materials or bioenergy
- **Organic waste streams** converted into compost or biogas
- **Construction and demolition materials** reused in local infrastructure projects



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Expanding Circular Resource Opportunities

Such loops can create **localized circular markets** reducing transportation costs while supporting regional supply chains.

For municipalities, these loops offer opportunities to integrate circular resources into public services such as:

- Municipal landscaping and green infrastructure using compost
- Public building construction using recycled materials
- District heating systems powered by industrial waste heat
- Urban agriculture using recovered nutrients

In this way, I-US initiatives contribute to **both economic efficiency and sustainable urban development**.



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Developing a Structured Financing Strategy

While the economic potential of I-US can be significant, implementing circular hubs requires careful financial planning. Infrastructure investments, coordination activities, and research efforts all require funding.

A structured financing strategy helps municipalities identify appropriate financial instruments and sequence investments effectively.

1. Align Funding with Organizational Profile and Use of Funds

Different project phases require different types of funding. Municipalities should first identify **what the funding will be used for**, and **which organizations are involved**.



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Developing a Structured Financing Strategy

Typical categories include:

- **Research and development (R&D):** feasibility studies, pilot projects, innovation development
- **Capital expenditures (CAPEX):** infrastructure investments such as pipelines, treatment facilities, or energy systems
- **Operational expenditures (OPEX):** ongoing operational and maintenance costs
- **Coordination and networking activities:** stakeholder engagement, project management, and hub facilitation

Each category may require different financing instruments.



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Developing a Structured Financing Strategy

2. Select Appropriate Financial Instruments

Several financial instruments are commonly used to support circular economy projects.

Grants

Grants are non-repayable funding sources often provided by public institutions.

Advantages include:

- Lower financial risk for municipalities
- Support for early-stage innovation and experimentation
- Ability to fund feasibility studies and pilot projects

However, grants are usually **competitive and time-limited**.



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Developing a Structured Financing Strategy

Debt Financing

Debt financing includes loans or bonds used to finance infrastructure investments.

This option is suitable for **mature projects with predictable revenue streams**, such as district heating networks or waste treatment facilities.

Advantages include:

- Large capital availability
- Long repayment periods
- Compatibility with municipal infrastructure investments

However, debt requires stable revenue streams to ensure repayment.



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Developing a Structured Financing Strategy

Equity and Quasi-Equity

Equity financing involves investors providing capital in exchange for ownership shares or future returns.

This approach is typically used for **innovative or high-growth circular technologies** where risks are higher but potential returns are significant.

Blended Finance

Blended finance combines multiple funding sources, such as grants, loans, and private investments.

This approach is particularly useful for circular hubs because it allows municipalities to:

- Reduce financial risks for private investors
- Support early-stage innovation while preparing projects for commercial scale



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Developing a Structured Financing Strategy

3. Mapping the Financing Landscape

Municipalities should actively explore funding opportunities at multiple governance levels.

These include:

- EU funding programs
- National funding schemes
- Regional development funds
- Promotional or development banks
- Private investment funds

Institutions such as **European Investment Bank** provide financing for large-scale sustainable infrastructure projects. Advisory initiatives such as [JASPERS](#) help municipalities prepare complex infrastructure projects for financing. Mapping the available financing landscape helps authorities identify **complementary funding sources**.



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Developing a Structured Financing Strategy

4. Assess Costs, Trade-offs, and Financing Sequencing

Different financing instruments are appropriate at different stages of project development. Typical financing sequences include:

- **Early-stage projects:** grants and public funding support feasibility studies and pilot projects
- **Intermediate stages:** equity investments help scale promising technologies
- **Mature projects:** debt financing supports large-scale infrastructure investments

Municipalities should carefully assess:

- expected revenues
- operational costs
- investment timelines
- financial risks



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Developing a Structured Financing Strategy

5. Leveraging Advisory Support

Many municipalities face **capacity constraints**, particularly when managing complex circular economy projects involving multiple stakeholders and financing mechanisms.

External advisory support can therefore play a crucial role.

Possible sources of support include:

- engineering consultancies
- universities and research institutions
- regional development agencies
- international advisory programs

Working with experienced partners can improve **project bankability**, meaning the project becomes more attractive to investors and financial institutions.



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SYMSITES Training Materials on
Industrial-Urban Symbiosis

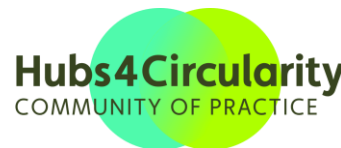
← [Module 4: Regulatory Challenges and Economic Considerations in I-US](#)

A practical Tool: H4C Guidance on I-US Funding

The publication produced by the EU project Hubs for Circularity (H4C ECoP) “Your way through funding I-US in the EU” aims to provide direction into the financial aspects of implementing industrial symbiosis projects, laying out an overview of available funding mechanisms, opportunities and financial strategies.

Access the full resource on the [H4C Knowledge Platform](#).

Hubs4Circularity
COMMUNITY OF PRACTICE



DELIVERABLE 6.1

Your way through funding I-US in the EU

joint with H4C Europe

WPG – Exploitation: Planning for H4C and ECoP Continuity
T6.1 – Assessment of funding schemes relevant to the H4C ECoP and to future
H4Cs

Date: 30/08/2024
Dissemination level: Public



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Chapter 4.3: Financing I-US and Business Models

This chapter explores the financial and operational frameworks necessary to ensure the long-term viability of I-US projects. It focuses on how municipalities can establish viable business models that balance public and private interests while stabilizing supply and demand for reclaimed water, energy, and materials. The chapter also addresses financing barriers and presents mitigation strategies. It further describes different hub governance models (operational, managerial, and hybrid) and revenue streams.

- Target audience: Local Authorities and Municipalities
- Estimated time: 15 minutes
- Includes: Explanations Exercises





Financing I-US and Business Models

While the economic benefits of Industrial-Urban Symbiosis can be substantial, the success of these initiatives ultimately depends on **viable financial and operational frameworks**. Circular resource exchanges must be supported by business models that balance public interests, private incentives, and operational feasibility.

For municipalities, this means moving beyond conceptual symbiosis opportunities and establishing **sustainable financing structures, stable revenue streams, and clear governance models**.

Across Europe and other regions, successful I-US initiatives demonstrate that combining **innovative financing mechanisms with collaborative business models** can significantly reduce risks and accelerate implementation.



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The Importance of Viable Business Models

A business model describes **how value is created, delivered, and captured** within an economic activity. For I-US projects, business models must address several challenges simultaneously:

- Ensuring reliable supply of secondary resources
- Creating stable demand for reclaimed materials or energy
- Distributing costs and benefits among participating actors
- Managing shared infrastructure and operational responsibilities

Without viable business models, even technically feasible resource exchanges may fail because **economic incentives are insufficient or poorly distributed**.

Successful I-US initiatives often rely on **collaborative business structures**, where industries, municipalities, and service providers share investments, infrastructure, and operational responsibilities.



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Mechanisms for Stabilizing and De-Risking I-US Projects

Several financial and contractual mechanisms can help reduce uncertainty and increase investor confidence in circular hub projects.

Long-Term Offtake Agreements

Offtake agreements guarantee that a buyer will purchase a specific quantity of a product or resource over a defined period.

These agreements are particularly important for:

- reclaimed water
- industrial waste heat
- recycled materials
- bio-based products

Long-term contracts ensure **predictable revenue streams**, making projects more attractive to investors.



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Mechanisms for Stabilizing and De-Risking I-US Projects

Subsidies and Public Incentives

Public subsidies can help overcome market barriers during early stages of adoption.

Examples include:

- incentives for using recycled materials in construction
- subsidies for reclaimed water use in agriculture or industry
- feed-in tariffs for renewable energy produced from waste streams

These incentives can make circular solutions economically competitive with conventional alternatives.



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Mechanisms for Stabilizing and De-Risking I-US Projects

In-Situ Usage and Local Symbiosis

Locating resource exchanges close to their point of origin significantly reduces transportation costs and environmental impacts.

Local symbiosis also helps build **trust between participating actors**, which is particularly important during early project stages.

Municipalities can support this approach through **spatial planning and industrial zoning policies** that encourage clustering of complementary industries.



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Mechanisms for Stabilizing and De-Risking I-US Projects

Pre-Design and Co-Design Approaches

Designing industrial processes with circular exchanges in mind can significantly improve the quality and usability of by-products.

Pre-design or co-design strategies involve:

- coordinating industrial processes during project development
- optimizing material characteristics for reuse
- aligning production schedules between companies

These approaches help reduce technical and logistical barriers.



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Mechanisms for Stabilizing and De-Risking I-US Projects

Shared Investment Models

Infrastructure for circular hubs (such as pipelines, treatment plants, or energy networks) can require significant capital investment.

Shared investment models allow costs to be distributed among multiple actors, including:

- industrial companies
- municipalities
- utility providers
- private investors

Shared investments reduce financial risk and make infrastructure projects more feasible.



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Mechanisms for Stabilizing and De-Risking I-US Projects

Carbon Credits and Green Finance

Environmental benefits generated by I-US projects may qualify for carbon credit mechanisms or green financing instruments.

Such mechanisms can provide additional revenue streams while supporting climate objectives.

Institutions such as the **European Investment Bank** increasingly provide financing for sustainable infrastructure projects aligned with climate goals.



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Financing Barriers

Despite growing interest in circular economy initiatives, several barriers still limit access to financing for I-US projects.

Common challenges include:

- Information gaps regarding financial opportunities
- Limited administrative capacity within municipalities
- Perceived technological or market risks
- Weak business cases due to uncertain resource markets

These barriers can discourage both public and private investors.

Mitigation Strategies

To address financing barriers, municipalities and project developers can adopt several strategies.





Financing Barriers

Engaging Advisory Services

Advisory services can help municipalities prepare investment proposals, conduct financial analyses, and identify suitable funding mechanisms. For example, [JASPERS](#) provides technical and financial advisory services for large infrastructure projects.

Building Strategic Partnerships

Collaboration with regional authorities, development banks, and research institutions can strengthen project credibility and improve access to financing.

Partnerships can also help municipalities access specialized expertise in project development and financial structuring.



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Financing Barriers

Aligning Financing with Technology Readiness Levels

Different financing instruments are appropriate for different stages of technological development.

Typical financing pathways include:

- **Early-stage technologies:** supported primarily by research grants and innovation funding
- **Intermediate stages:** attract venture capital or equity investment
- **Mature technologies:** financed through loans or infrastructure financing mechanisms

Aligning financing instruments with technology maturity improves project viability.



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Business Models for I-US Hubs

I-US projects and Circular hubs can adopt several governance and operational models depending on their objectives and level of involvement.

Operational Hubs

Operational hubs own or manage physical infrastructure such as treatment plants, energy systems, or logistics networks.

Two types of operational models often emerge:

- **Defensive models**, focusing primarily on regulatory compliance and waste management obligations
- **Accommodative models**, aiming to achieve broader environmental and social objectives





Business Models for I-US Hubs

Managerial Hubs

Managerial hubs do not necessarily own infrastructure but instead focus on **facilitating collaboration between companies**.

Their activities may include:

- identifying symbiosis opportunities
- coordinating partnerships
- supporting circular innovation
- redesigning waste value chains

Hybrid Hubs

Hybrid models combine operational and managerial functions. These hubs both **operate infrastructure and coordinate symbiotic networks**, offering greater flexibility in managing resource flows.



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Business Models for I-US Hubs

Revenue Streams for I-US and Circular Hubs

To remain financially sustainable, circular hubs typically rely on **multiple revenue streams**.

Examples include:

- membership fees from participating companies
- service fees for resource exchange coordination
- commissions on successful symbiotic exchanges
- infrastructure usage fees
- energy management contracts
- sales of recovered materials or energy

A diversified revenue model improves resilience and reduces dependence on a single funding source.



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Business Models for I-US Hubs

Strategic Alignment Between Governance and Financing

The financial structure of a circular hub should align with its governance model and operational ambitions. Public funding can play a critical role in early phases by:

- reducing financial risks
- supporting pilot projects
- demonstrating technical and economic feasibility

Once projects become commercially viable, private investments and market-based revenue streams can support long-term operations.

Over time, combining public funding, private investment, and operational revenues creates a **resilient financing structure that supports scaling and replication of circular hubs**.



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SYMSITES Training Materials on
Industrial-Urban Symbiosis

← [Module 4: Regulatory Challenges and Economic Considerations in I-US](#)

H4C Training – Financial Mechanisms

Click on the image to watch the video from the H4C Training on Financial Mechanisms for I-US

Presented by:

James Woodcock
*Senior Project Manager at
International Synergies Limited*

Financial Instruments for Funding Industrial Symbiosis

04 February 2026

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Exercise – Reflection: Choosing your I-US Business Model

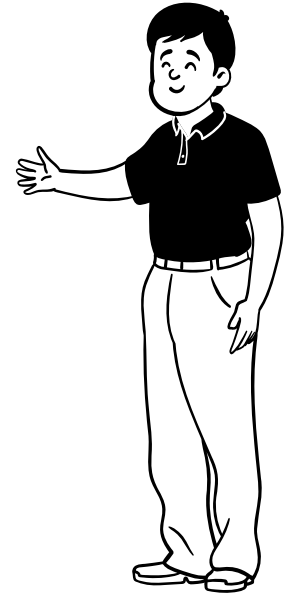
Help your municipality identify which business model (operational, managerial, or hybrid) best fits your local context and resources.

Instructions:

1. Assess Local Context

Consider:

- Existing municipal or industrial infrastructure
- Available technical and administrative capacity
- Level of stakeholder engagement and collaboration
- Financial resources and access to funding





Exercise – Reflection: Choosing your I-US Business Model

Help your municipality identify which business model (operational, managerial, or hybrid) best fits your local context and resources.

Instructions:

2. Score Each Model

On a scale of 1–5, rate each model for:

- Feasibility in your municipality
- Alignment with local sustainability and circular economy goals
- Financial and administrative manageability
- Potential to engage local industries and communities





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Exercise – Reflection: Choosing your I-US Business Model

Help your municipality identify which business model (operational, managerial, or hybrid) best fits your local context and resources.

Instructions:

3. Reflect and Decide

- Identify which model scores highest overall.
- Note strengths and challenges for that model in your context.
- Consider whether a hybrid approach might be advantageous to balance operational control and collaborative facilitation.

4. Action Step

Write a brief paragraph summarizing your reflection and next steps for exploring or piloting the selected model in your municipality.





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Chapter 4.4: Green Public Procurement and Policy Tools for I-US

This chapter demonstrates how municipalities can use Green Public Procurement (GPP) and complementary policy tools to drive I-US. By embedding circular economy and environmental criteria into public tenders, GPP is applied across sectors such as construction, utilities, materials, food services, and ICT, and can be supported with subsidies, regulatory alignment, and knowledge platforms for procurement officers.

- Target audience: Local Authorities and Municipalities
- Estimated time: 10 minutes
- Includes: Explanations Tools





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Green Public Procurement and Policy Tools for I-US

Municipalities have a unique opportunity to **leverage their purchasing power to drive sustainability and circularity**. Public procurement accounts for roughly **14% of the EU's GDP**, making it a powerful instrument to influence markets, guide industrial practices, and stimulate collaboration across sectors. By integrating environmental and circular economy criteria into procurement decisions, commonly referred to as **Green Public Procurement (GPP)**, local and regional authorities can create predictable demand for circular products, encourage supplier innovation, and promote Industrial-Urban Symbiosis (I-US) at the regional scale.

Beyond GPP, municipalities can also deploy complementary **policy tools** to remove barriers, incentivize participation, and embed circular principles into urban infrastructure, utilities, and service delivery. Together, these levers can accelerate the development of **local circular economies** while aligning municipal investments with broader sustainability objectives.



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The Role of Green Public Procurement in I-US

GPP is more than a tool to reduce environmental impacts; it is a **strategic lever for shaping local industrial ecosystems**. When municipalities explicitly include circularity and industrial symbiosis principles in their tenders, they can:

- **Create predictable demand** for secondary raw materials, recycled products, and modular or adaptable infrastructure components.
- **Stimulate local circular markets**, facilitating resource recovery, energy reuse, and material upcycling.
- **Encourage supplier innovation**, prompting companies to redesign processes, reduce waste, and develop new circular products or services.
- **Align municipal investments with long-term sustainability goals**, integrating I-US principles into energy, water, waste, construction, and ICT infrastructure.



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The Role of Green Public Procurement in I-US

For example, specifying that construction contracts must use a minimum percentage of **recycled aggregates** or mandating **energy recovery from industrial waste streams** in district heating projects can significantly influence supplier behaviour and drive symbiotic exchanges across municipal and industrial actors.



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Sectors Relevant to I-US for GPP Implementation

Green Public Procurement can be applied across multiple sectors that are particularly relevant to Industrial-Urban Symbiosis:

Construction and Infrastructure

- Use of recycled or secondary materials in public buildings, roads, and utilities
- Modular and easily upgradable designs that facilitate resource recovery
- Integration of industrial waste streams into building materials

Utilities and Energy Systems

- Procurement of low-carbon energy sources or waste heat recovery systems
- Water reuse and treatment infrastructure that allows for industrial symbiosis
- Smart grids that integrate energy flows between industrial and municipal actors



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Sectors Relevant to I-US for GPP Implementation

Materials and Supplies

- Circular office materials, packaging, and municipal consumables
- Biodegradable or recyclable alternatives in municipal operations

Food Services and Catering

- Sustainable sourcing from local circular supply chains
- Integration of food waste into composting or biogas programs

Information and Communication Technology (ICT)

- Energy-efficient devices and servers
- Reuse and refurbishment of electronics
- Platforms to manage industrial symbiosis data and resource tracking

By embedding GPP requirements in these sectors, municipalities can **create systemic demand for circular products and services**, which directly supports industrial collaboration and the implementation of I-US initiatives.



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Approaches for Implementing GPP in I-US

Approaches for Implementing GPP in I-US

Municipalities have several practical approaches for integrating GPP into their procurement processes:

1. Specifying Environmental and Circular Criteria in Tenders

Procurement officers can include **quantitative and qualitative criteria** for circularity, such as:

- Minimum recycled content in construction materials
- Energy efficiency thresholds for industrial or municipal equipment
- Requirements for modular or reusable infrastructure components
- Reuse or upcycling of by-products in service delivery

These criteria should be clearly measurable and enforceable to ensure compliance and maximize impact.



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Approaches for Implementing GPP in I-US

2. Using Subsidies and Incentives to Offset Initial Costs

Circular solutions, particularly in early adoption phases, may have higher upfront costs than conventional alternatives. Municipalities can:

- Combine GPP with **subsidies** or grants to bridge cost gaps
- Offer long-term service contracts to reduce perceived investment risk for suppliers
- Support pilot projects that demonstrate technical and economic viability
- Such measures encourage suppliers and local industries to participate in symbiotic networks and adopt circular practices.



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Approaches for Implementing GPP in I-US

3. Ensuring Regulatory Alignment

GPP initiatives must align with existing regulatory frameworks, including:

- EU and national **waste and material management laws**
- Energy sharing and water reuse regulations
- Standards for industrial symbiosis and circular economy

Regulatory alignment ensures that procurement actions **do not conflict with other legal requirements** and provides suppliers with clarity on compliance.



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Approaches for Implementing GPP in I-US

4. Leveraging Knowledge Platforms and Training for Procurement Officers

Effective GPP implementation requires **capacity building**:

- Training procurement officers in circular economy principles
- Sharing best practices and case studies from other municipalities
- Providing access to digital platforms and decision-support tools to assess environmental and economic impacts

Platforms such as the **EU GPP Training Toolkit** offer guidance for municipal officers to integrate circularity criteria across sectors.



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Measurable Outcomes from GPP in I-US

European case studies demonstrate that well-designed GPP initiatives can **directly support I-US outcomes**:

- **Increased use of recycled construction materials** in public infrastructure projects, reducing demand for virgin resources
- **Energy exchange agreements** between municipal and industrial facilities, creating predictable demand for waste heat recovery
- **Local industrial partnerships** for water reuse, composting, and material upcycling
- Demonstrated **cost savings and lifecycle benefits** over the long term, reinforcing the financial case for circular infrastructure

These examples illustrate that **public procurement is not just an operational tool** but a strategic mechanism to shape regional markets and stimulate symbiotic industrial networks.



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Complementary Policy Tools

In addition to GPP, municipalities can use **supportive policy instruments** to promote I-US:

- **Subsidy schemes** for collaborative infrastructure or circular technology adoption
- **Tax incentives** for companies participating in symbiotic exchanges
- **Zoning and land-use policies** to cluster industrial actors and enable resource sharing
- **Innovation sandboxes** for testing new circular technologies under controlled regulatory conditions
- **Awareness and communication campaigns** to encourage local businesses and citizens to participate in circular programs

Together, these tools **reinforce the effect of GPP**, reducing market and operational barriers and facilitating the long-term implementation of industrial-urban symbiosis.



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A practical Tool: EU Buying Green Handbook

Within the European Union, GPP is grounded in EU law and guidance that encourages public buyers to consider sustainability across procurement processes.

The **Commission's "Buying Green!" handbook** provides structured guidance on planning and implementing GPP, including the use of life-cycle costing and sustainable production criteria. GPP is particularly relevant for advancing I-US because public procurement represents a substantial share of economic activity (around 14 % of EU GDP) and can influence market demand for circular products, services and infrastructure such as recycled materials, modular construction, secondary raw materials, and services that prolong product life or enable reuse. By embedding circularity into procurement processes, municipalities can stimulate local markets for resource-efficient solutions, create predictable demand for inputs that would otherwise be wasted, and encourage suppliers to innovate in ways that align with symbiotic resource exchanges.



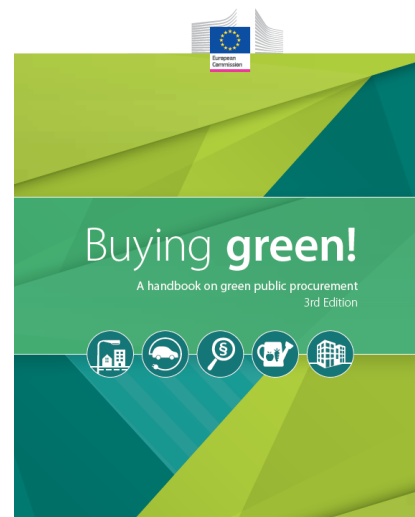


A practical Tool: EU Buying Green Handbook

Specific GPP criteria have been developed for a wide range of sectors including electricity, ICT equipment, food catering, furniture, cleaning services, and building design & maintenance. These can be incorporated into procurement documentation depending on the contract category.

In sum, GPP is a **practical, policy-aligned lever** that can be incorporated into I-US strategies to stimulate demand for circular products and services, strengthen local circular markets, and align public investment with broader resource efficiency and industrial symbiosis objectives. By formalising environmental and circular criteria in tender processes, municipalities and other contracting authorities can help connect procurement decisions to systemic resource flows and symbiotic reuse opportunities.

Click [here](#) to download the handbook.





A practical Tool: ProCirc Procurement toolbox

The circular procurement toolbox is based on existing tools and methodologies aimed at supporting procurers. The toolbox contains the original tools and methods as compiled over the life of the project, and is being improved based on practical experience with their application in practice.

When choosing a tool, it is important to consider the context of your organisation, the circular maturity, the product category and - most importantly - the goal you want to achieve.

The toolbox contains a list of tools that can be filtered based on the product category, the stage of the procurement, and other specific parameters in order to arrive at a selection of the most appropriate tools for your procurement.

You can download the toolbox [here](#) (Excel document).

Tool Name	Category	Stage	Goal	Other Parameters
EMU Super Example	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain	Procurement Tool, The Netherlands, Dutch, Free
Transform Together	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain, CO2 Reduction, Waste Reduction	Information Resource, The Netherlands, English, Free
Guidelines for circular economy (CE) transition in urban, lower and medium	EU	Initial requirements, Evaluation & award	Waste Reduction, Virgin Materials Reduction, Social Responsibility	Information Resource, The Netherlands, English, Free
Guidelines	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain, CO2 Reduction, Waste Reduction	Information Resource, The Netherlands, English, Free
Tool Certified	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain, CO2 Reduction, Waste Reduction	Procurement Tool, Certification, The Netherlands, English, Paid
CO2 Performance Indicator	EU	Initial requirements, Evaluation & award	CO2 Reduction	Information Resource, The Netherlands, English, Paid
UPB Indicator	EU	Initial requirements, Evaluation & award	CO2 Reduction, Waste Reduction, Virgin Materials Reduction	Information Resource, The Netherlands, Dutch, Paid
Circular Procurement platform	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain	Information Resource, The Netherlands, English, Free
PROFAMIN	EU	Initial requirements, Evaluation & award	CO2 Reduction, Waste Reduction, Virgin Materials Reduction	Information Resource, The Netherlands, Dutch, Paid
PROFAMIN	EU	Initial requirements, Evaluation & award	Waste Reduction, Virgin Materials Reduction	Information Resource, Belgium, Dutch, Free
Impulsion - ICE CIRCULAR BUSINESS STRATEGY 2	EU	Initial requirements, Evaluation & award	Cost, Total Supply Chain, Virgin Materials Reduction	Information Resource, Belgium, Dutch, Free
Building Circularly	EU	Initial requirements, Evaluation & award	CO2 Reduction, Waste Reduction, Virgin Materials Reduction	Design Tool, The Netherlands, English, Dutch, Paid
Circularity Calculator	EU	Initial requirements, Evaluation & award	CO2 Reduction, Waste Reduction, Virgin Materials Reduction	Design Tool, CE Business M, The Netherlands, English, Paid
UNEP SPP United Nations service systems in circular procurement	EU	Initial requirements, Evaluation & award	Waste Reduction, Virgin Materials Reduction	Procurement Tool, The Netherlands, English, Free



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CONSORTIUM MAP

