European Union Network for the Implementation and Enforcement of Environmental Law

IMPEL WASTE MANAGEMENT & CIRCULAR ECONOMY PROJECT
A guidance book for By-products

Promoting a common understanding of By-products to promote circular economy and the prevention of waste

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Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the European Union (EU) Member States, and of other European authorities, namely from acceding and candidate countries of the EU and European Economic Area (EEA). The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 8th Environment Action Programme that guide European environmental policy until 2030, the EU Action Plan: "Towards a Zero Pollution for Air, Water and Soil" on Flagship 5 and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

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Executive Summary

This guidance document from the IMPEL network provides offers guidance on the definition and application of by-products under the Waste Framework Directive. By-products are production residues that, when meeting four cumulative conditions, are not classified as waste. The document emphasizes the importance of certain and lawful use of such production residues. The report addresses challenges in assessing by-product status as well as various national practices within IMPEL member states. It also discusses cross-border transport of by-products highlighting the relevance of the Waste Shipment Regulation. The role of industrial symbiosis, where by-products serve as resources in other processes, is presented. Some innovative examples of industrial symbiosis are showcased from countries like Denmark and Spain. In the annex of the guidance a practical tool to help ensure compliance, is presented.

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1. Introduction

1.1. Subject and purpose of the Guidance

Environmental permitting and inspection authorities in Europe ('regulators') play an important role in supporting the circular economy. They are expected to encourage businesses to implement circular innovations. Circular innovations aim at improving and increasing:

1. resource efficiency: using less primary raw materials;
2. prevention of waste: reducing the production of waste;
3. reducing the use and the phasing out of hazardous substances and achieving a non-toxic environment;
4. the use of production residues as secondary raw materials or products (by-products);
5. the recovery of materials from waste (recycling) and the use of these materials as secondary raw materials or products (end-of-waste).

Regulators have the important task to consider whether these innovations are in accordance with the relevant legislation.

In 2019 IMPEL published the guidance *Making the Circular Economy work*[1] , which aims at supporting regulators in assessing circular innovations, within the framework of the relevant EU environmental legislation (e.g. the Waste Framework Directive (WFD) and the Industrial Emissions Directive (IED)).

In subsequent discussions with IMPEL members it was pointed out that there was a need to provide additional guidance regarding topic 4: the use of by-products. The present guidance document provides further details on that particular topic, building on the *Making the Circular Economy work* Guidance. For the development of the present guidance document in particular the following two documents were used:

- Commission guidance on the interpretation of the WFD[2];
- Study conducted on behalf of the Commission regarding Member State practices regarding by-products and end-of-waste[3].

[1] Guidance for regulators on enabling innovations for the circular economy (prevention and recycling of waste)
[2] Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste
[3] Study on Member States practices on by-products and end-of-waste

Further information regarding by-product practices in the IMPEL Member Countries was collected using a questionnaire open to all IMPEL Member countries. See for the outcomes Section 2.2.

1.2. Content of the Guidance

This document addresses the following topics:

- The EU policy- and legal framework for by-products and practices in the IMPEL member countries > chapter 2
- Assessing by-product status > chapter 3
- Cross border shipments of by-products > chapter 4
- The use of by-products and industrial symbiosis > chapter 5
- Practical tool for assessing by-product status > Annex I

2. The EU policy- and legal framework for by-products and practices in the IMPEL member countries

2.1. The EU policy- and legal framework

The transition to a circular economy, where the value of materials is maintained in the economy for as long as possible and the generation of waste is minimised, is an essential contribution to the EU's efforts to develop a sustainable economy. A first step to achieving this is to encourage the use of good quality and safe production residues as valuable secondary (raw) materials that can replace their primary (raw) material counterparts. A production residue is a substance or object resulting from a production process whose primary aim is not the production of that substance or object.

The figure below provides a schematic overview of the various material flows in a circular economy that circulate between the production phase (left) and consumption phase (right). In the production phase (consumption) products are produced (no. 1 in the figure) alongside various production residues (2). Some of these production residues can be directly reintroduced into the production process as raw materials (3) or be marketed as final (consumption) products (4). Other production residues are discarded as waste (5). These waste materials can however undergo a recycling or other recovery operation after which they may serve as a raw material (6) or be marketed as a final (consumption) product (7). An increase in the use of these secondary (raw) materials will lead to reduced disposal (incineration (8), landfilling (9)) and reduced use of primary raw materials (10).

The production residues that can be used without further treatment and do not become waste are referred to as by-products in the WFD, if they fulfil the conditions set out in Article 5 of the WFD. The production residues that become waste and must undergo treatment before they can be used, can then reach the end-of-waste status also defined in the WFD. Article 6 of the WFD sets out the conditions for the end-of-waste status.

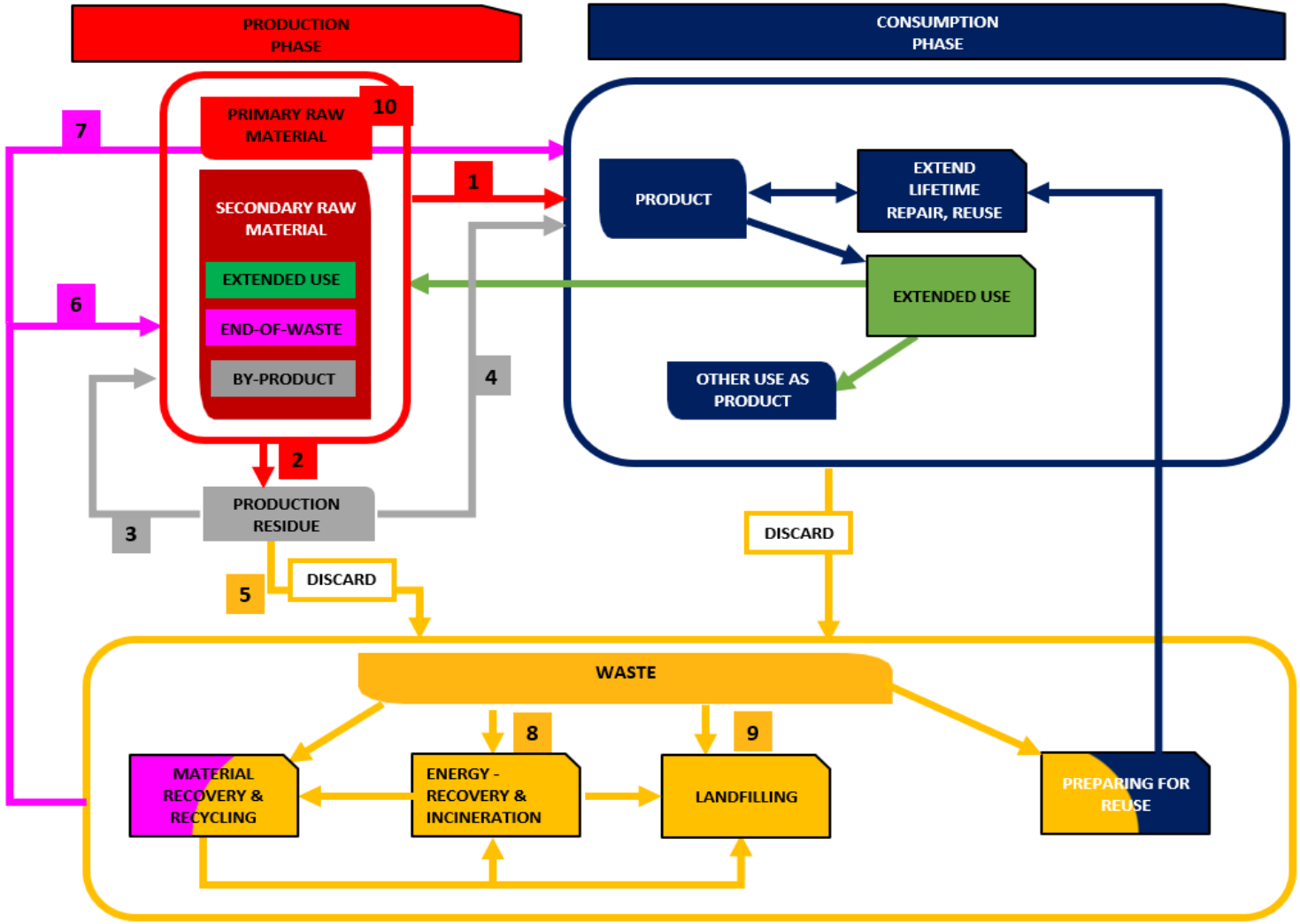

Figure 1: Schematic overview of the material flows in a circular economy

This guidance is about by-products. The main focus is on the WFD. In addition attention is given to the Waste Shipment Regulation (WSR) and the IED.

The WSR, regulating cross-border movements of waste, is of interest as by-products are sometimes traded and shipped across borders. It may be unclear whether a certain production residue is in fact a by-product or a waste. In the latter case the WSR would be applicable.

The IED provides the framework for regulating the environmental impacts of production processes, where by-products are produced or used. The IED is addressed in the discussion of the topic of industrial symbiosis and the use of by-products.

The use of by-products, and in particular the establishment of stable markets for the supply and demand of those products, is often hindered in practice by various practical, organisational, financial, and legal obstacles. Only through good cooperation between businesses, policymakers and regulators can these obstacles be removed. See for further details the above mentioned *Making the Circular Economy work* Guidance.

The key provision for the use of by-products is article 5 WFD. The article reads as follows:

> ***Art 5 (1)*** *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the following conditions are met:*
>
> *(a) further use of the substance or object is certain;*
>
> *(b) the substance or object can be used directly without any further processing other than normal industrial practice;*
>
> *(c) the substance or object is produced as an integral part of a production process; and*
>
> *(d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.*
>
> ***Art 5 (2)*** *The Commission may adopt implementing acts in order to establish detailed criteria on the uniform application of the conditions laid down in paragraph 1 to specific substances or objects.*
>
> *Those detailed criteria shall ensure a high level of protection of the environment and human health and facilitate the prudent and rational utilisation of natural resources.*
>
> *Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 39(2). When adopting those implementing acts, the Commission shall take as a starting point the most stringent and environmentally protective of any criteria adopted by Member States in accordance with*

paragraph 3 of this Article and shall prioritise replicable practices of industrial symbiosis in the development of the detailed criteria.

***Art 5 (3)** Where criteria have not been set at Union level under paragraph 2, Member States may establish detailed criteria on the application of the conditions laid down in paragraph 1 to specific substances or objects.*

'Production process' in paragraph 1 includes both industrial and other processes. It does not include waste treatment facilities.

Paragraph 1 instructs the EU Member States to assure that production residues that meet the conditions set out in that paragraph are treated as by-products. Recital 16 of the WFD states:

"In order to promote sustainable use of resources and industrial symbiosis, Member States should take appropriate measures to facilitate the recognition as a by-product of a substance or an object resulting from a production process the primary aim of which is not the production of that substance or object if the harmonised conditions established at Union level are respected."

The obligation to take appropriate measures in general means that the regulators in the Member States (the competent environmental authorities) will need to assess on a case to case basis whether a production residue meets the four conditions set out in article 5, paragraph 1, and can therefore be regarded as a by-product.

The form of the case by case assessment is not specified in the WFD and can take different forms, depending on the MS legislation. For instance it can be:

1. a prior authorisation, either as part of a waste permit or IED-permit or as a separate decision. In this case the producer/owner provides the necessary information that the production residue complies with article 5 WFD through the application for the permit;

2. a (prior) non binding legal opinion acknowledging the by-product status of a production residue. In this case the producer/owner provides the necessary information that the production residue complies with article 5 WFD through the request for the opinion;

3. a verification of compliance with article 5 WFD as part of inspection and enforcement of the national legislation through which article 5 WFD was transposed. In this case the producer/owner would have first assessed compliance with article 5 WFD himself

(self-assessment). The information which was gathered as part of this self-assessment can be handed over to the inspecting authority who performs the verification.

In all cases it is the responsibility of the producer/owner to check prior to the actual use whether the production residue concerned meets all the conditions of article 5 WFD. Producers, owners and users should at all times be able to provide sufficient information that the conditions for the by-product status are complied with. The burden of proof lies with the producer/owner. Certain information, for instance on how the residue was produced and its composition would have to be provided by the producer. See also chapter 6, practical tool.

The WFD does not require a notification of case-by-case decisions to the European Commission but gives the MS the opportunity to make information about case-by-case decisions and about the results of verification by competent authorities publicly available by electronic means.

Paragraphs 2 and 3, give the Commission respectively the Member States the competence to establish (EU- resp. nationwide) criteria on the uniform application of the four conditions listed in paragraph 1 for certain types of production residue. These criteria make case-by-case decisions unnecessary; one only needs to test against the EU- or nationwide criteria. In some countries where prior authorisation /permits are required the (national) criteria are incorporated in the authorisation/ permit or in the authorisation/permit reference is made to these criteria. At the present moment no EU-wide criteria have been established yet and only few national criteria.

The use of by-products has long been common practice in some traditional industry sectors, like steel industry and wood treatment. With the definition of by-products in the WFD the perspective has changed, so that it can initially be assumed that all residual materials from a manufacturing process are waste. If a residue meets the conditions for by-product status, on the other hand, it is exempted and has never been a waste. As a result, material flows in industry and business that have been used as resources for a long time, must now be assessed against the conditions of article 5 WFD.

In the table here below some examples of production residues are given which can have the by-product status when they fulfil the conditions for by-products and depending on country practices.

INDUSTRY	BY-PRODUCT	APPLICATION
Wood treatment	Wood residues (chips, cuttings), sawdust	Fuel
Furniture production	Wood cuttings	Fuel
Ferrous and non-ferrous smelting processes	Slags	Aggregate in road Construction
Coal-fired power plants	Fly ash	Supplementary cementitious material
Combustion plants	Flue gas desulfurization gypsum	Plasterboard production
Agriculture (biological)	Tomato leaves and stems	Paper industry
Plastic product manufacturing	Mix plastic (pvc/pp)	Plastic product manufacturing
Ceramic industry	Ceramic residues	Manufacturing of ceramic paste Manufacturing of construction materials (cement, concrete, mortars, aggregate) Earthworks and road construction Paving of sports areas
Food industry	Sunflower husk	Fuel (pellets, briquettes)
Construction material production	Residues from mineral wool production	Lightweight aggregates in concrete

INDUSTRY	BY-PRODUCT	APPLICATION
Production of foam products (such as mattresses, cushions, insulation materials, etc.)	Polyurethane foam4	Manufacture of composite foams Cushion filling Foam agglomerate production Acoustic insulation panel manufacturing
Polymeric material production	Residues of production of polymeric material	Agricultural silage film[5]
Biodiesel production	Crude glycerine	Optimizing biogas production in digestion installations
Asphalt industry	Pulverized coal fly ash	Asphalt aggregates
Aluminium extrusion industry	Sodium hydroxide solutions saturated with sodium aluminate	Manufacturing of sodium aluminate and zeolites
Boilers from pulp production processes	Fluidized bed biomass (sand)	Paving and manufacturing of construction materials (cement, mortars)
Aeronautical industry	Aluminium leftovers	Production and processing of metals
Soil from construction work	Excavated soil and rocks[6]	Construction and building
Various processes (Agricultural, livestock, and forestry activities etc.)	Leftover biomass[6]	Energy production

[4] Order APM/397/2018 (Spain)
[5] Order APM/852/2019 (Spain)
[6] A By-product National Decree has been issued in Italy on this residue

INDUSTRY	BY-PRODUCT	APPLICATION
Livestock effluents	Digestate[6]	Agronomic use
Agriculture	Apricot kernels[7]	Combustion and biogas production plants, food, cosmetics, and pharmaceutical industries
Poultry farm	Poultry litter[7]	Fertilisers production
Plastic industry	Plastic residues[7]	Plastic industry
Meat industry	Salt derived from meat salting[7]	Road de-icer

[7] By-product included in the By-products regional register of Emilia Romagna in Italy (https://ambiente.regione.emilia-romagna.it/it/rifiuti/rifiuti/economia-circolare/sottoprodotti)

2.2. Practices in the IMPEL Member countries

The IMPEL questionnaire regarding by-product practices in the IMPEL Member Countries was answered by 34 respondents from 21 IMPEL countries, namely: Albania, Austria, Croatia, Cyprus, Czech Republic, England, Estonia, Finland, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Serbia, Slovakia, Spain, Sweden, and Wales.

On the basis of the answers received, follow up interviews were held with experts from regulators in Finland, Portugal, Ireland and Cyprus. The team responsible for drafting this guidance is grateful for their input.

The full overview of questions and answers, as well as references to cases and documents, is included in an Excel sheet which will be published as a separate document on the IMPEL website. A short summary of the main outcomes is given below.

The questionnaire contained mainly questions about how regulators in IMPEL Member countries assess the by-product status of a production residue.

In Europe a variety of procedures for case-by-case decisions exists.
Respondents were asked by whom and by what procedure a production residue is assessed?

- 45% of the respondents answered: The operator assesses this and the competent authority verifies the assessment carried out by the operator as part of inspections
- 31% of the respondents answered: The operator assesses this and the competent authority assesses this as part of a prior permit/authorisation procedure (a production residue can only be used as a by-product after such authorisation is issued).
- 17% of the respondents mentioned another procedure
- 6% of the respondents mentioned only self-assessment by the producer

There are relatively still few national or regional guidelines or national/regional criteria for by-products.

Respondents were asked whether their country has guidelines on how to assess/verify that a production residue meets the conditions for by-products. Only the following countries answered yes: England, Estonia, Ireland, Italy, Lithuania, Netherlands, Portugal, Serbia, Sweden, and Wales.

Respondents were also asked whether their country has a guideline or checklist for verifying compliance with the conditions for by-products during environmental inspections? Only the

following countries answered yes: England, Estonia, Ireland, Lithuania, Netherlands and Wales.

Respondents were also asked about the use in their country of detailed criteria on the uniform application of the conditions for by-products for certain, specific materials (article 5, paragraph 3, WFD). They were asked whether their country or region has such criteria in legislation or in other documents (for example guidance).
Only the following countries answered yes: England, Ireland, Italy, Netherlands, Portugal, Slovakia, Spain.

Some other outcomes of the questionnaire will be mentioned when addressing specific topics in the following chapters.

Many respondents indicated that they would welcome further guidance on assessing by-product status of production residues, confirming earlier expressed needs for such guidance after the *Making the Circular Economy work* Guidance was launched. This guidance document aims at providing such guidance.

3. Assessing By-Product Status

3.1. Introduction

In this chapter we will discuss the various aspects that need to be considered when assessing the by-product status of a material in accordance with article 5, paragraph 1 WFD. The following topics will be addressed:

- the term production residue > section 3.2
- the four conditions for by-products > sections 3.3 to 3.8
- when a material ceases to be a by-product > section 3.9

In the diagram below the successive steps for considering the aspects relevant to by-products are shown.

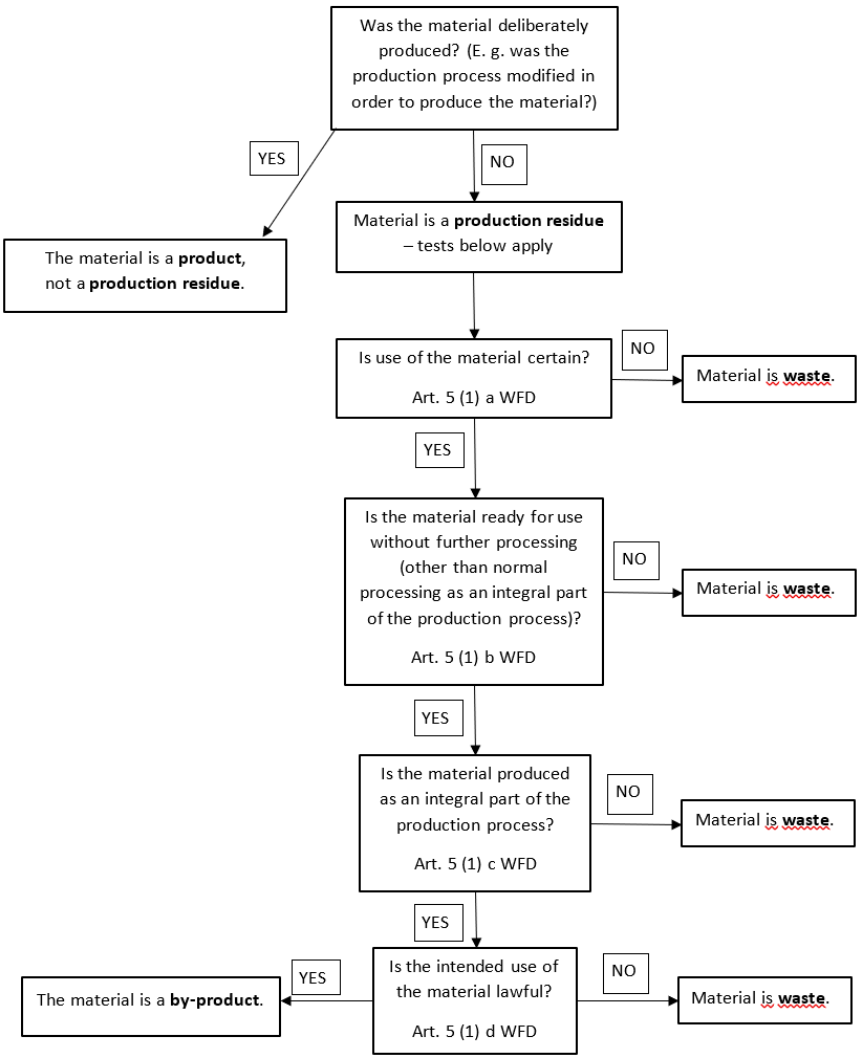

Figure 2: Successive steps for considering the aspects relevant to by-products

When assessing the by-product status as a general approach the producer and the competent authority can make a comparison between the production residue and the primary (raw) material it is meant to substitute. The comparison should ideally cover all relevant aspects regarding delivery, storage and usage as regulated under the various applicable sectoral legislation. This includes possible necessary pre-treatment, special regulation for handling it with respect to e.g. industrial safety as well as special regulation for the usage of the newly produced substance or object. If the comparison yields distinct differences, the substance or object is more likely to be a waste. The guiding question can be "*Is there anything authorities need to control via waste law, which is not being controlled under any of the other legislations*?"

3.2. The term production residue

Art 5 (1) Member States shall take appropriate measures to ensure that ***a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste****, but to be a by-product if the following conditions are met:*

(a) further use of the substance or object is certain;

(b) the substance or object can be used directly without any further processing other than normal industrial practice;

(c) the substance or object is produced as an integral part of a production process; and

(d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

Paragraph 1 defines production residues as substances or objects resulting from a production process whose primary aim is not the production of that substance or object.

Production processes include industrial and other processes such as metal industry, production of goods, production of chemicals, agriculture and excavation of soil as part of construction works. It does not include waste treatment facilities nor waste or products after consumption. Mining is in some countries also regarded as a production process[8].

[8] Waste from mining activities is excluded from the scope of the Waste Framework Directive (Article 2-2-d) **insofar as** the Mining Waste Directive provides regulations. The provision on by-products in Article 5 of the WFD has no equivalent provision in the Mining Waste Directive and therefore applies in full. By-products in the extractive industry may arise from materials such as overburden (soil or rock with no mineral value) and waste rock (rocks with insufficient economically recoverable minerals).

In Italy some services (for example rental and industrial washing of textiles) can also be seen as production processes. A by-product can therefore originate from any process that "produces" results, meaning it transforms production inputs into outputs and, consequently, potentially even from activities that provide services.

Here are some examples of materials which at least according to decisions or court rulings in some IMPEL Member countries do not comply with the term production process.

Example: Asphalt from road renewal (Poland)

An example of waste for which a by-product case-by-case decision led to the refusal of an application as a by-product is broken asphalt which then had to be considered as waste (waste code 17 03 02). The reason for the refusal was the fact that the product was not generated by a production process.

Example: Asphalt from road renewal (Slovakia)

An example of waste for which by-product case-by-case decision led to the refusal of the relevant application is asphalt removed from the road surface by special equipment. The question here is, whether the material is a result of a production process (the primary aim of which is not the production of that material) and whether the material is produced as an integral part of a production process or not.

Example: Material from demolition (various countries)

Materials resulting from the demolition of a building must be classified as waste, as such activity does not constitute a "production process" from which "by-products" can originate. This clarification comes from the Italian Court of Cassation with Judgment No. 18020 of May 8, 2024.
To benefit from the preferential regime of by-products rather than being subject to waste regulations, the residues must result from a production process. In the specific case, the demolition of a building, which can occur for various reasons, is not aimed at producing any goods but rather at eliminating the building itself, which cannot be considered a "product" of the demolition activity.
Demolition is not a prerequisite for construction, as construction can occur independently of prior demolition. The legislation stipulates that by-products must "originate from," meaning they must directly derive from a "production process," clearly aimed at creating something obtained through the processing or transformation of other materials

Example: Used clothing (Italy)

According to the Judgment No. 35000 of September 19, 2024, by the Italian Court of Cassation, the idea that used clothing could be defined as a "by-product" is difficult to reconcile with the requirement that a by-product must originate from a production process. Instead, used clothing is more accurately classified as an

item discarded by its holder, and therefore as waste.
To cease being classified as waste, textile waste not originating from a production process must therefore undergo authorized recovery activities.

Example: Maintenance of Green areas (Italy)

In Italy, questions from different authorities and companies have arisen about classifying materials from mowing and pruning during green area maintenance as by-products. The Italian Ministry of the Environment sought clarification from the European Commission on:

- *Whether waste regulations exclude residues from public and private maintaining green areas.*
- *Conditions for classifying these residues as by-products.*
- *Whether these residues used for biogas or composting can bypass certification requirements for by-product classification.*

In its April 26, 2024 response, the Commission stated that residues from green area maintenance are considered waste, not by-products. Since green maintenance does not aim to manufacture a product, such residues cannot be classified as by-products, even if used for composting or biogas production.

Here is an example of materials which do comply with the term production process.

Example: The case of soil (Porr Bau, Austria, ECJ preliminary ruling)[9]

In the Porr judgement the ECJ acknowledged that excavated soil can be a by-product and therefore can be regarded as the result of a production process where it stated that it would be necessary to examine whether the excavated materials at issue in the main proceedings must be classified as a 'by-product' within the meaning of Article 5(1) of Directive 2008/98 and that it is for the referring court to ascertain whether all the conditions laid down in that provision (...) are fulfilled.

Unlike a production residue, a product is deliberately created in a production process. In many cases it is possible to identify one (or more) 'primary' products, this or these being the principal material(s) produced. In *Palin Granit,* the ECJ stated that a production residue is something that is not the end product that the manufacturing process directly seeks to produce.

[9] Case C-238/21

Example: The case of leftover stone Palin Granit[10].

In Case C-9/00 the central issue was whether the leftover stone from quarrying should be considered waste, as this determination would impact the authority responsible for issuing environmental licences.
The court ruled that material which is stored for an indefinite period of time, until a further use may be found for it, may be classified as a waste. It ruled that leftover stone, which was not a material primarily sought by the operator of a quarry, was in fact a production residue. Factors such as the place of storage, composition, and lack of harm to human health or the environment were deemed irrelevant in determining whether the leftover stone constituted waste.
The CJEU found that by-products, which were defined as those substances resulting from a process whose aim was not to produce that product, may be viewed as distinct from production residues. By-products which require no further processing, prior to their reuse in another subsequent process, should not be regarded as waste within the meaning of the Directive.

As also specified in the Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste (2012), where the production of the material concerned is 'the result of a technical choice', it cannot be a production residue and is considered a primary product. If the manufacturer could have produced the primary product without producing the material concerned but chose not to do so, this can be evidence that the material concerned is a primary product and not a production residue. Other evidence that the production of the material concerned was a technical choice could include a modification of the production process in order to give the material concerned specific technical characteristics.

Example: The case of petroleum coke (Saetti C-235/02)[11]

In the case of Saetti and Frediani, the ECJ was asked to give an opinion on whether petroleum coke, a carbon based material produced in the refining of crude oil, was a waste or not. The court held that petroleum coke could not be classified as a production residue as the production of coke is the result of a technical choice, specifically intended for use as a fuel. They also held that even if petroleum coke was an automatic result of the refining process, if it was certain that the coke production in its entirety would be used, mainly for the same purposes as other substances (produced in the refining process), then petroleum coke was also a petroleum product, manufactured as such, and not a production residue but product. The court appears to indicate that it is common ground that the petroleum coke is certain to be fully used as fuel in the production process and that all the resulting surplus electricity is sold.

[10] Case C-9/00 Palin Granit Oy (2002), para 32.

[11] CURIA - List of results

3.3. The four conditions for by-products

> ***Art 5 (1)*** *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the following conditions are met:*
>
> *(a) further use of the substance or object is certain;*
>
> *(b) the substance or object can be used directly without any further processing other than normal industrial practice;*
>
> *(c) the substance or object is produced as an integral part of a production process; and*
>
> *(d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.*

The conditions for by-products listed in article 5, paragraph 1, WFD must be fulfilled cumulatively. This means that a substance or object remains subject to waste legislation if there is for example no market for it or individual demand for it or if its further use is not certain.

Some of the conditions for by-products in article 5, paragraph 1 WFD are very similar to those for end-of-waste. See the table below.

End-of-Waste (Art. 6 (1) WFD)	**By-product (Art. 5 (1) WFD)**
a) the substance or object is to be used for specific purposes	a) further use of the substance or object is certain
b) a market or demand exists for such a substance or object	
c) the substance or object fulfils the technical requirements for the specific purpose and meets the existing legislation and standards applicable to products	d) further use is lawful, i.e. all relevant product, environmental and health protection requirements for the specific use are fulfilled and the use will not lead to overall adverse environmental or human health impacts.
d) the use of the substance or object will not lead to overall adverse environmental or human	

There is however a major difference: an end-of-waste material was considered as a waste before it underwent a recycling or other recovery operation, whereas a by-product directly results from a production process and never was a waste. It should be noted, however, that some IMPEL members emphasise that a production residue must initially always be considered as waste and only after, if it is proven that such a substance meets the conditions for by-products, it can be considered as a by-product.

3.3.1 Condition a - Further use is certain

> ***Art 5 (1)*** *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the following conditions are met:*
>
> *(a) further use of the substance or object is certain;*

This condition means that the usage of the material has to be guaranteed and should not be a mere possibility but a certainty. This condition helps to assure that situations are avoided where the usage is not certain and there is a risk of the material being disposed of as waste.

The possibility of indefinite storage of materials in view of their possible future use must certainly be excluded (see the Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste, par. 1.2.3).

The adequacy of the storage time must be assessed with regard to various other factors, such as the characteristics of the residue, the way in which it is stored, and the characteristics it must have for subsequent use. It therefore seems appropriate for the operator - especially in cases where he organises a storage time for the residue that is not short - to prepare further evidence capable of supporting the existence of the condition in question.

In the Palin Granit (see section 3.2), the ECJ rules that 'the holder of leftover stone resulting from stone quarrying which is stored for an indefinite length of time to await possible use discards or intends to discard that leftover stone, which is accordingly to be classified as waste'. Thus, if the holder of the material in question is storing it for an indefinite time period, further use is not certain.

Example: The case of leftover stone (Avesta Polarit Case, Finland)[12]

Avesta Polarit applied for an environmental permit to continue its mining operations. The mine extracted chromium and other minerals through drilling, blasting, and processing. Permit conditions considered addressed leftover rock and ore-dressing sand as waste. The ruling stated that if the holder of leftover rock and sand from mining operations intends to discard these substances, they must be classified as we could be classified as a by-product where the holder used it for the necessary backfilling of the mine and provided guarantees in relation to the identification and actual use of the leftover rock for that purpose.

Between the time of the by-product's production and its actual use, there may be a gap; however, it is necessary that the qualities and quantities provided to the user are predetermined in advance.

In some cases, there may be the potential for a certain proportion of the material to be used, with the rest needing to be disposed of. If a certain use cannot be guaranteed for all the material concerned then this is an indication the material could be regarded as a waste. However, the existence of long term contracts between the material holder and its subsequent users can be an indication that the material covered by the contract will be used and therefore that certainty of use is present.
Portugal and Italy explicitly take the position that even if only a portion of the produced materials is used, that portion can be considered a by-product. In Portugal, there is a registration system that tracks which part is used as a by-product and which part remains waste. See further section 3.9.
Estonia on the other hand has a Supreme Court decision 3-3-1-61-16[13] of leftover stone from oil shale mining, stating that the further use is not certain in case only a small part of the material is used and the remaining part is disposed of. The court states: *"However, the lack of certainty of further use is indicated by the lack of a market, the partial use of the material and the disposal of the remaining part (...) and the fact that the financial income for the waste owner is only symbolic compared to the costs of waste treatment (...)*".

To demonstrate certainty of use for a residue, it must be shown that, from the time of its production, the activity or facility where the residue will be used is either already identified or can be identified based on the material's specific characteristics. These characteristics must make the residue suitable for use in certain production processes.

[12] C-114/01

[13] Case 3-3-1-61-16 https://www.riigikohus.ee/et/lahendid/?asjaNr=3-3-1-61-16

The certainty of use is demonstrated by analysing the production cycle, the characteristics of the activities from which the material originate, and the process of destination, assessing, in particular, the congruence between the type, quantity, and quality of the residues to be used and the intended use.

The holder of the material must prove that it is certain that actual use will take place and that the material is fit for that purpose. Examples of relevant evidence or indications are:

- the existence of acceptance contracts
- a solid market for the material
- evidence of fulfilling the same quality criteria as for primary products
- purchase agreements
- a financial gain for the producer

Purchase agreements should be as long-term as possible. In the case of seasonal substances (e.g. potato pulp), the purchase contracts should cover several seasons, otherwise the question of by-product status or end-of-waste status would arise again in the following season at the latest.

In Italy, in the absence of contractual documentation, the requirement for certainty of use and the intention not to discard the residue are demonstrated by preparing a technical sheet containing the information outlined in a National Decree. This information is necessary to enable the identification of the by-products intended for use, as well as the determination of their technical characteristics and the sector of activity or type of facilities suitable for their utilization.

It might be difficult to verify the existence of a market for a particular substance or object. For this purpose, contact could be made with relevant bodies who have knowledge on these issues. As an example, industrial associations can be consulted. It is important to verify the answer with other authorities such as waste or economic authorities.

On the other hand, the following are examples of indications that future use may be uncertain:

- there is no obvious market for the material;
- only part of the material is to be used, with the rest is to be disposed of;
- the financial gain for the holder of the material is nominal compared to the cost of waste treatment;

- the material is going to be stored for an undefined amount of time, prior to a potential but not certain use; it should normally have to be considered as a waste while it is being stored. The condition of the storage gives also an indication of the real value given by the producer and of his real intention (discard or not).

From the answers to the IMPEL questionnaire it became apparent that regulators can find it challenging to assess the certainty of use. For example, if there is a need to temporarily store the substance due to market fluctuations or the substance is sent to intermediaries.

When a material is sent to a trader rather than to an end user, it does not influence the by-product status according to the Italian Council of State.

Nevertheless, forwarding the substance/object to an intermediary does not in itself guarantee that it will actually be used by an end user. In these situations, the intermediary's declaration of interest should not be enough, but the intermediary must also certify that it undertakes to send to an authorised final destination.

It must be contractually determined with the intermediaries that taking the substance or object to an intermediate site before it is actually used must not jeopardise the quality of the material for that purpose. It should also be stipulated that the substance or object cannot be stored indefinitely on the premises of the intermediaries.

When storage is prolonged and it is unclear when the material will be used, this may mean that the condition a is no longer met. It is conceivable, by the way, that the regulator may impose a maximum storage period as a further specification of condition a. If this period is exceeded, the material is no longer considered a by-product but becomes waste. In the Italian By-product national decree on rock and stones, a maximum storage time of one year is set.

The producer of the substance/object can struggle with guaranteeing the certainty of use. However it is the producer's duty to provide evidence. If the producer cannot reassure the authority that the substance/object is used, it has to be considered a waste.

Further questions may arise in the context of (waste) shipments. IMPEL Member countries report that materials are being sent to dealers or brokers, who then ship these materials outside the EU. As in the cases mentioned above authorities can ask for proof of use, which the producer of the substance/object has to submit. The producer may cooperate with the dealer/broker to submit the required information, e.g. a Letter of Intent from the end user.

3.3.2 Condition b - Further use is possible without further processing

> ***Art 5 (1)*** *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the* ***following conditions are met****:*
>
> ***(b) the substance or object can be used directly without any further processing other than normal industrial practice;***

Condition b means that no further pre-treatment of the material, other than normal industrial practice, should be necessary in order to use the material. If a production residue has to be treated before it can be used, this may indicate a waste treatment operation. Therefore, the CJEU stressed in its rulings on the definition of waste that a production residue can only be regarded as a by-product if its further use is certain without prior processing[14]. Those treatment techniques that address typical waste-related characteristics of the production residue, such as its contamination with components which are hazardous or not useful, would prevent classification as non-waste. This is to ensure that such operations, which might pose risks to the environment or human health, are monitored under waste management law in accordance with the precautionary principle.

On the other hand, it has to be considered that primary raw materials usually also require some processing before they can be used in production processes. If a pre-treatment of a production residue is necessary, it has to be similar to that of primary materials in the same operational area e.g. modification of size or shape by mechanical treatment. In meeting the condition b the crucial point is to determine what 'normal industrial practice' is. Normal industrial practice can include all steps which a producer would take for a material or substance, such as:

- the material being filtered, washed, or dried
- adding materials necessary for further use
- carrying out quality control
- conditioning to a specific size
- sorting by size
- drying in order to reduce the volume

[14] Case C-194/05 Commission v Italy (2007), para 39

Further treatment operations, which are normal industrial practice, can take place on the site of the producer of the material, on the site of the industrial facility using the material or on an intermediate site.

If the pre-treatment is similar to that of primary materials, it can be considered as a by-product. If the further treatment of the production residue specifically addresses waste-related characteristics, it is more likely considered to be a waste.

The purpose of the condition is to avoid that an activity can be considered as "normal industrial practice", if it aims at reducing the concentration of polluting or dangerous substances. In that case the provisions on waste management and the relative necessary precautions and authorisations were to be circumvented.

On one hand, the most rational interpretation is that 'normal' should be understood as that which is ordinarily used in the facility where the by-product will be utilized. Others, on the other hand, consider as "normal industrial practice" limited treatments, such as sorting, selection, crushing, washing, drying, homogenization, refining, and quality control, which do not affect the commercial and environmental quality characteristics that the by-product already possesses at the source.

In 2017, the Italian Court clarified that normal industrial practice activities are "limited to marginal interventions carried out on by-products that do not require complex operational infrastructures, nor do they result in the subsequent production of substantial quantities of additional residues which need to be disposed".

The answers to the IMPEL questionnaire confirmed that in practice it can be difficult to determine what normal industry practice is and what not. Whether a certain treatment can be considered as normal industrial practice will have to be assessed case-by-case. The relevant BREF might help to answer this question.

Example: blast furnace slag in road construction (Germany)

In iron production blast furnace slag accrues. It is not the actual aim of the production to obtain the slag, but the process might be adopted due to affecting the characteristics of the slag on purpose. Even if the process is not adopted, the blast furnace slag can often be used to replace primary material for example in road construction. A possible pre-treatment such as crushing to get the appropriate particle size is not a bar to the by-product status of blast furnace slag.

Example: digestate from anaerobic digestion (various countries)

Anaerobic digestion of waste is considered to be a waste treatment. In that case the digestate can not be considered as a by-product.

If the input material is non-waste (for example for that special purpose produced material), the digestate will also be non-waste and can be considered a by-product. The main product from that process is mostly biogas.

Example: metal dust from steel production (Germany)

Dust is captured in filters via an extraction process. These filters are then cleaned. The resulting metallic content can be returned to the economic cycle after a recycling operation. Both the dust and the metals should therefore need to be treated and cannot be regarded as by-products. These waste streams can be considered as end-of-waste in case the conditions are met.

Example of treatment: washing, selection and crushing

According to the Italian Court of Cassation ruling no. 40109/2015, washing, selection, and crushing (of industrial plastic residues) are operations that fall within the notion of "normal industrial practice" for the purpose of classifying a residue as a by-product (and therefore not as waste). These operations and other operations like drying, sorting, screening, and grinding, "do not cause the material to lose its identity or its commercial and environmental quality characteristics that it already possesses." Instead, they are useful or functional for its further use, which may take place either at the producer's site or with other users.

Example: treatment of excavated soil and stone (Italy)

According to the Italian Soil & Stone by-product national Decree, among the most commonly performed operations that fall within the scope of normal industrial practice are the following:

- *Granulometric selection of excavated soil and stone, with the possible removal of anthropogenic elements/materials;*
- *Volume reduction through grinding;*
- *Spreading on the ground to allow the drying and maturation of excavated soil and rocks, aimed at improving handling characteristics, achieving optimal moisture levels, and promoting the natural biodegradation of additives used to facilitate excavation operations.*

Excavated soil and rocks maintain their status as by-products even when they contain heterogeneous non-polluting anthropogenic fragments, provided they meet the technical/performance requirements for the use of soil in construction.

3.3.3 Condition c - Produced as integral part of a production process

Art 5 (1) *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the* ***following conditions are met****:*

(c) the substance or object is produced as an integral part of a production process;

Sometimes industries discover the value of production residues which they initially did not intend to put on the market. They then may invest in further treatment or preparation.

Condition c means that the process where the by-product is generated has to be an integral part of the main production process. Besides the main production process there can be other processes implemented in a plant, which especially serve the emission control, e.g. waste water or exhaust air treatment. Those processes then are not to be seen as the main production process and substances/objects resulting from them cannot be a by-product due to not fulfilling condition c. But in case the process is modified and controlled to produce FGD gypsum of the required characteristics and is used for example in the production of pasteboard it can still be considered as a by-product.

If the material leaves the site or factory where it has been produced in order to undergo further processing then this may be evidence that such actions are no longer a part of the same production process. However, with the increasing specialisation of industrial processes, this cannot be taken as definitive evidence. Next users and intermediated companies may be involved in preparing the material for further use, through carrying out the type of activities described above in Section 3.5 (i.e the material being filtered, washed, or dried, adding materials necessary for further use, carrying out quality control, conditioning to a specific size, sorting by size, drying in order to reduce the volume).

The Commission guidance on the interpretation of the WFD points out that competent authorities when determining in a particular case if a substance or object is 'produced as an integral part of a production process' may consider:

- What is the nature and extent of the tasks needed to prepare the material for direct further use? How integrated are these tasks in the main production process?

- Are the tasks that are undertaken as part of 'normal industrial practice' also 'an integral part of a production process'? The relevant Reference document - BREF might be taken into consideration.

Example: raw glycerine from biodiesel production (Germany, Netherlands)

During the chemical production process of biodiesel raw glycerine accrues as a residual substance. The owner of the plant wants to sell the raw glycerine and therefore invests in a further purification facility. As the raw glycerine does not accrue in a necessary process of emission control but is rather the product of a side process of the biodiesel production, it can be referred to as a by-product under the WFD.

Example: flue gas desulphurisation (FGD) gypsum (various countries)

Flue gas desulphurisation facilities remove sulphur from the flue gases that are produced when sulphurous fossil fuels are burnt in power plants, in order to prevent these emissions contributing to air pollution and acid rain. The resulting material, flue gas desulphurisation (FGD) gypsum, has the same range of uses as natural gypsum, notably in the production of plasterboard. The process is modified and controlled to produce FGD gypsum with the required characteristics. The generation of gypsum from the residues from flue gas cleaning on the site of the power plant can be regarded as an integral part of a production process (energy generation), and FGD gypsum a by-product.

3.3.4 Condition d - Further use is lawful and will not lead to environmental or human health impacts

Art 5 (1) *Member States shall take appropriate measures to ensure that a substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste, but to be a by-product if the* ***following conditions are met****:*

(d) further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

Respondents to the IMPEL questionnaire were asked to indicate what conditions for by-products pose problems in practice. From the answers it was clear that condition d poses most of the problems.

Condition d has two elements: further use is lawful and further use will not lead to overall adverse environmental or human health impacts.

Further use is lawful implies that the producer of the material has to make sure that the further use complies with the relevant legislation and with (public or private, national or EU-wide) product standards, quality standards, etc. Therefore, it is necessary to distinguish between the case where there is legislation defining the requirements for a specific use, and the case where there is no legislation. In the first case, when the specific regulations for the intended use of the material are not fulfilled, then it has to be classified as waste. In the second case, when there are no particular regulation for the use of the material, there is the need to demonstrate the compliance with the product standards and the technical standards of the sector (as stated in the Italian Court of Cassation, sentence no. 17453/2012 for foundry fumes). For example, the production residue must fulfil the regulation of fertilising products (2019/1009/EC) or the requirements of chemical and product legislation, i.e. to have a REACH registration and possibly an authorisation. REACH Regulation is applied to by-products. By-products are not considered waste if they meet the criteria set with the WFD and will fall under the full scope of REACH if placed on the market themselves. All forms of recovery, including mechanical processing, are considered as a manufacturing process under REACH whenever they result in the generation of one or several substances as such or in a mixture or in an article that have ceased to be waste. More information can be found in the Guidance "REACH Regulation and Circular Economy" (IMPEL, 2023).

According to the Commission guidance on the interpretation of the WFD compliance with relevant product, environmental and health protection requirements can be relatively easily assessed when such requirements already exist for the primary material which is substituted by the by-product. If there are no relevant technical specifications for the material, it can still be lawful to use it, when its use is not specifically forbidden. If the material has the same characteristics as the naturally occurring material, this constitutes a strong indication that its use will be lawful, assuming that the relevant requirements for the primary material are also complied with when using the by-product.

The following can indicate that further use is unlawful: the material does not meet the technical specifications, or an object does not meet the product specifications required for it to be usable. An example is stone or gravel that does not meet the technical specifications (e.g. bursting strength) associated with the use of such material for road construction. Further use may also be unlawful when the material is banned from use or the material must be disposed of or recovered as waste by certain obligatory methods.

Examples are transformers containing PCBs in oil at levels greater than 50 ppm or wastes containing persistent organic pollutants which have to be treated according to Article 7 of the POP Regulation (EC) No 850/2004.

Further use will not lead to overall adverse environmental or human health impacts implies assessing the impact on the environment or human health which is not (yet) described and regulated by legislation. The regulator could look for relevant information on possible risks gathered by universities and research institutes.

This part of condition d should be applied from the standpoint that the use of primary raw materials might also result in certain environmental or health risks. An indication might be gained from an assessment as to whether using and treating the production residue under the provisions of waste legislation would prevent adverse effects on the environment and human health compared to using the corresponding primary product under chemical and product legislation

In daily inspection routines it is often challenging to assess against condition d. While product and chemical legislation usually contain quite clear provisions, environmental law is often less specific and instructs in more general terms to assess potential negative environmental impacts that should be prevented. Also the additional wording "and will not lead to overall adverse environmental or human health impacts" is unspecific and not necessarily covered by legislation.

Example: Residues of industrial wood processing (bark, sawdust, shavings, wood chips)

Non-treated wood, by definition, does not contain hazardous substances, thus does not lead to overall adverse environmental or human health impacts.

Condition d may also include compliance with the waste hierarchy as prescribed in the WFD and further specified in national legislation. As an example: in Portugal currently the use of production residues for incineration and energy recovery is regarded as a lower value application and therefore does not comply with the waste hierarchy. This is the case for for instance contaminated wood waste coming from the wood processing industry. The incineration and energy recovery of that material is regarded as a waste recovery operation (R1 operation: use principally as a fuel or other means to generate energy, Annex 2 WFD). As a side note: such materials must be distinguished from untreated, uncontaminated wood that is generated, for example, during the maintenance of parks

and other green spaces and forestry activities. This latter wood waste will normally fall under Article 2 WFD, Exclusions from the scope, section 1f (faecal matter, if not covered by paragraph 2(b), straw and other natural non-hazardous agricultural or forestry material used in farming, forestry or for the production of energy from such biomass through processes or methods which do not harm the environment or endanger human health).

3.4. Testing of by-products

In Portugal the possibility exists to apply for an authorisation to test whether a certain residue (waste) may be used as a by-product. The testing covers both the production and subsequent usage of the substance. The test period is a maximum of six months, with the possibility of a one-time extension. In particular, the test provides the opportunity to determine whether the potential future by-product can meet condition d of Article 5.1 WFD. During the test period, the obligations that would normally apply to waste processing do not apply. During the testing period there is involvement of the relevant CTI (Technology and Innovation Centre), which also plays a role in the procedure for (final) authorisation of a substance as a by-product.

3.5. Monitoring of the production and usage of by-products

In countries where a prior authorization is required for the use of by-products a record of these materials is often kept. In the case of Portugal, a more comprehensive data registration system has been set up, obligating both by-product producers and intermediaries to submit annual data on various aspects related to the production, storage, and use of by-products. If only part of the production residues is used as a by-product, the quantity must be specified, along with the amounts that remain as waste. The table below summarises the information that must be reported. Such a system enables the competent authorities to better track the different by-product flows, which can facilitate enforcement.

Producer	Intermediate
REACH Regulation (Yes or No)	Amount transacted
Quantity produced (t)	Stored quantity (end of year) (t)
Stored quantity (end of the year) (t)	Forwarded to (second) intermediate or final destination
Forwarded to intermediate or final destination	Identification of the final destination (Name of end user)
Identification of the final destination (Name of end user))	Destination (PT/EU/Other)
Destination (PT/EU/Other)	Future use
Future use	Quantity sent as by-product (t)
Quantity sent as by-product (t)	Quantity sent as waste (t)
Quantity sent as waste (t)	

In Italy, to facilitate the exchange and transfer of by-products, the Chambers of Commerce establish a dedicated register in which producers and users of by-products can enrol. The register specifies the general information and contact details of the enrolled entities, as well as the type of by-products involved in their activities. Furthermore, an online help desk Portal for Technical Assistance on By-products has been activated.

3.6. Storage and handling

By-products must be managed and handled carefully to maintain their characteristics (necessary to allow its use) and to avoid risks to health or the environment.

Operators or permit holders need to set clear rules for storage and handling, ensuring that the material stays suitable for its intended use. Timing and management must be planned so the material is used at the right time without losing its functionality.

In the case of self assessment and prior authorization it is recommended that the operator provides information about the maximum storage time. If the material isn't used before this time runs out, it will no longer qualify as a by-product and must be treated as waste. However, if the material still meets the criteria for a by-product, a new assessment/authorization needs to be done.

3.7. When a material ceases to be a by-product

In practice, it can happen that production residues are not used as by-products as planned. The reasons for this vary. The most common reason is insolvency of the user. In case a material no longer fulfils all the conditions for by-products it should be regarded as waste.

The storage of this material is regulated under waste legislation. The storage of waste is distinguished between “temporary storage of waste” and “storage of waste”. The legal basis is the Landfilling Directive Art. 2 1999/31/EC, where temporary storage is defined as storage of waste prior to disposal for a period less than one year and prior to recovery for a period of three years or less. Depending on the storage period, the amount of waste and its hazard potential (hazardous or non-hazardous waste), different authorities can be responsible for carrying out any licensing procedures (building permit, emission control permit). The requirements of the IED must also be observed.

If the waste is located on a company's property, it is the responsibility of the company's competent supervisory authority to convert this waste storage facility into a legally compliant state. This can be both the disposal of the waste to landfill and the approval of a corresponding waste storage facility. In individual cases, it must be clarified with the waste owner which path should be taken.

Example: Zinc containing residue from Lead production (Germany)

A company produces lead. During processing in the electrochemical plating, by-products containing zinc are produced. Until recently, this could be given to another company, which in turn produces zinc. Due to the insolvency of the zinc-producing company, it is no longer guaranteed that the zinc-containing by-product will continue to be used. Nor can it be safely assumed that another buyer will be found quickly. This means that no longer all the conditions of Art. 5 WFD are met and the substance is to be regarded as waste and no longer as a by-product. Storage would thus fall under waste legislation according to national law.

4. Cross border shipments of by-products

4.1. Introduction

Trans-frontier shipments of waste and goods between EU Member States and between EU Member States and third countries play an important role in the European economy. If materials should be regarded as waste their shipment must follow the WSR. If a production residue can be regarded as a by-product, its shipment does not fall under the WSR.

The WSR follows the definition of waste as outlined in the WFD, including the exceptions like the one in article 5 WFD for production residues that meet the conditions for by-products. By following the WFD's definition, the WSR ensures that the regulatory framework for the transboundary movements of waste is aligned with the EU's overall waste management policies. The WSR establishes procedures and control regimes for the shipment of waste both within the European Union and between EU countries and non-EU countries.

In very general terms the following differences exist depending on whether the waste is being shipped within the EU or exported outside the EU.

1. Within the EU: Waste shipments within EU countries are subject to a system of notification and consent, which means that the shipment must be pre-approved by the relevant authorities in the country of dispatch, transit, and destination. This involves submitting detailed documentation regarding the type of waste, quantity, destination, and disposal or recovery method. The shipment must comply with the EU's environmental standards.
2. Outside the EU: For shipments to non-EU countries, the rules are more stringent. The EU applies different regulatory frameworks depending on the destination country's status under the Basel Convention (the UNCE treaty designed to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries).
    - To OECD countries: Shipments must adhere to both EU regulations and the rules of the Organisation for Economic Co-operation and Development (OECD), which generally allow for the shipment of certain types of waste for recovery operations under specific conditions.
    - To non-OECD countries: The EU generally prohibits the export of hazardous waste for recovery and all waste for disposal outside the OECD. There are stricter controls and consent procedures in place, requiring not only the approval from EU authorities but also clear consent from the importing country.

- Import into the EU: Imports of waste into the EU from non-EU countries are also heavily regulated, with requirements for prior written notification and consent from the relevant EU authorities, ensuring that the waste can be managed in an environmentally sound manner.

Overall, the WSR aims to ensure that waste is treated in an environmentally friendly manner, whether it is dealt with inside or outside the EU, and that hazardous waste is not exported to countries that cannot manage it safely.

Regulators in the MS that are competent for the WSR (issuing permits and performing inspections) may need to assess or verify whether a material shipped across borders, is waste or a by-product (or end-of-waste).
One IMPEL-member is of the opinion that it has to be certain that the competent authorities in country of destination accepts the material as by-product. Due to more stringent rules for export ton non-OECD countries, more examples occur of companies who claim to export a by-product (or end-of-waste). Which information should the exporter deliver before he may export the material as by-product? The authority should demand also confirmation of the competent authority in the country of destination.
Another IMPEL-member is actively informing producers/exporters that they must check this understanding with the destination authorities before starting the shipment procedures. Once the producer/exporter receives an affirmative response from the destination competent authority, the shipment procedure can be carried out as a by-product. Proof of contact and feedback must be provided to the inspection entities if necessary.

Transfer countries have to accept the decision of the import and export country, especially if the latter decides to process the material as by-product or end of waste.

4.2. Shipment of by-products within the EU

Authorities of different MS (country of dispatch versus destination country) might disagree on the waste status of a shipment. Article 28, paragraph 1, WSR stipulates that if the responsible authorities in both the originating and destination countries cannot reach a consensus on whether the material in question should be classified as waste or non-waste (by-product), it will be treated as waste.
However, this classification does not restrict the destination country from managing the material as per its own laws after it has been received, provided that these national laws comply with relevant EU or international regulations.

In particular in case of disagreement, it is key that information is provided that the production residue meets the conditions of article 5 WFD. This information may be contained in a by-product status case by case decision, in national criteria regarding the by-product concerned or self-assessment documents drawn up by the producer/owner.

The existence of different views regarding the by-product status across the EU can lead to market distortions. Depending on the opinion of the competent authorities of dispatch and reception, the same material might be shipped with or without the administrative burdens of a notification (amber list) or with or without a contract and an identification form (green list for recovery).

Producers/owners are often not sure if the procedures of the WSR should be followed or not. The operator has to take into account that multiple procedures may have to be followed when shipping a certain material: material can be shipped as a product to one Member State, but when shipped to another Member State the WSR might apply. This may cause unequal competition between different countries and companies. Furthermore, these discrepancies lead to shipments being stopped (e.g. at borders), sometimes for longer periods, before eventually being accepted or refused. This has been often reported as a barrier to trade and free movement of materials that could be recycled. It has been mentioned that there is no clear process of how national or case-by-case decisions of by-products could be mutually recognised/accepted by other EU or non-EU MS.

Differences of opinion concerning the by-product status of a production residue sometimes occur in case of specific waste streams (e.g. filter dust from exhaust gas cleaning of thermal processes; mill scales).

Some examples:

*In **Portugal** mill scale is considered a by-product. In **Spain** it is classified as waste. Once the operator sends a mill scale from Portugal to Spain, it has to be shipped as waste in accordance with the WSR.*

*Lecithin was assessed by one of the **Dutch** regional environmental agencies as a by-product in a non-binding decision but was not accepted by the Belgium competent authorities.*

*Usage of stainless steel slags for road construction: the slags were to be imported from **Belgium** to **Germany**. The incorporation as aggregate in asphalt layers is only permissible in Lower Saxony if certain limit values are complied with. The question of whether the slags could be classified as a by-product was superfluous, as the concentration limits for permissible recovery as waste were already not met, while even lower values applied for classification as non-waste. The petitioner was no longer interested after the legal situation had been explained, so that the question of by-product status was superfluous.*

A filter dust from the steel industry (10 02 07, AA010) was shipped to **Austria** as a "by-product", although*

the lead content was too high for use as a raw material in cement production according to national law and contamination with PCDD/PCDF could not be excluded (was not tested by the producer). Administrative penal proceedings were initiated against the importing company.

4.3. Shipment of by-products between EU member states and other countries

The concept of by-products does not seem to be well defined outside the EU. Therefore businesses exporting by-products to countries outside the EU need to be aware that the material in question may be considered a waste in the country of destination.

Article 28 of the WSR is applicable to all waste shipments covered by the regulation, including shipments to and from countries outside the EU. This is because the WSR governs the shipment of waste both within the borders of the European Union and between EU member states and non-EU countries.

Example of importing outside from the EU

*In **Estonia**, a large combustion plant operator was planning to import biomass (sunflower seeds, olive cake) from third countries (Ukraine, Tunisia) for combustion. The competent authority had a question whether it was waste or a by-product or product. The operator was unable to provide documents to prove compliance to all by-product conditions. The producer of sunflower seeds and olive cake was not willing to provide data and assumed that it was a biomass or product. Since no evidence was provided regarding the compliance of the by-product with the conditions, and the facility did not meet the requirements of a waste incineration and co-incineration plant, the operator ceased operations.*

5. The use of by-products and industrial symbiosis

5.1. Introduction

The commonly used definition for Industrial Symbiosis is:

"engaging traditionally separate entities in a collective approach to competitive advantage involving physical exchange of materials, energy, water, and by-products. The keys to Industrial Symbiosis are collaboration and the synergistic possibilities offered by geographic proximity" [15]

So, Industrial symbiosis is a system which connects facilities where by-product from one facility is a valuable input resource in the other facility.

Example of the exchange of material, water and energy flows between sites, at Kalundborg, Denmark[16]:

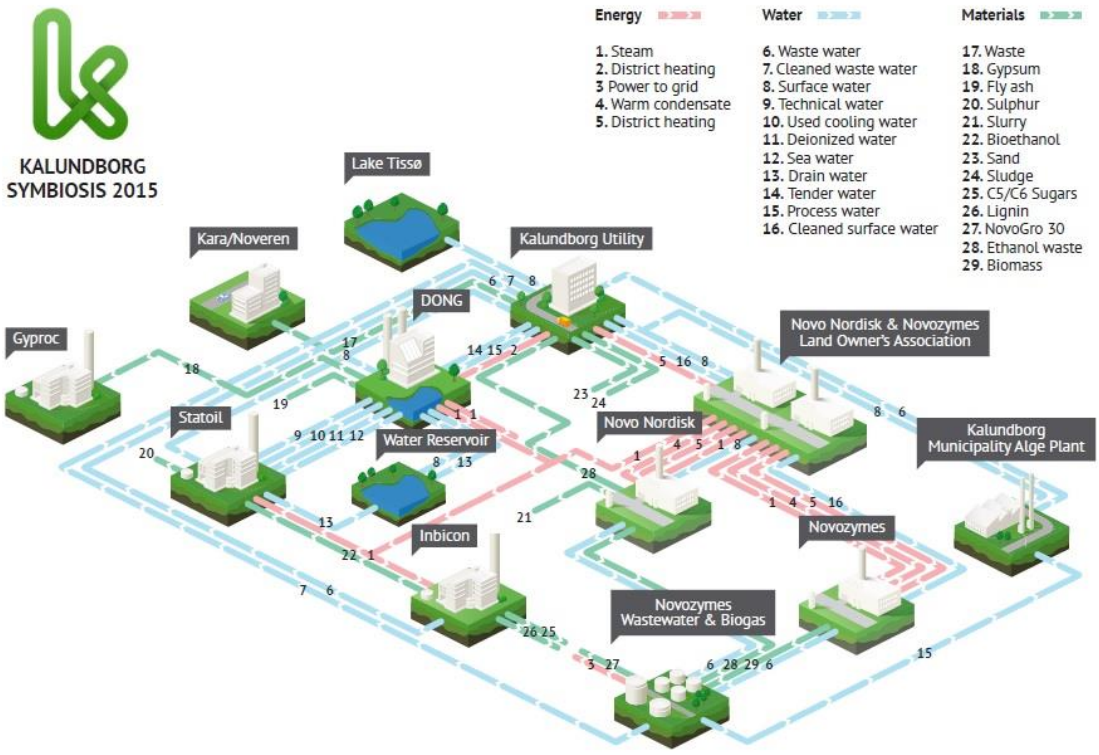

Figure 3: Kalundborg

[15] Chertow, M.R. INDUSTRIAL SYMBIOSIS: Literature and Taxonomy. Annu. Rev. Energy Environ. 2000, 25, 313–337.Industrial symbiosis is the use by one company or sector of underutilised resources broadly defined, which include waste, by-products, residues, energy, water, logistics, capacity, expertise, equipment and materials from another, with the result of keeping resources in productive use for longer

[16] Source: https://www.symbiosis.dk/en/

Key Aspects and Benefits of Industrial Symbiosis

1. **Collaboration and Synergies**: Encourages cooperation among entities to share resources, identify opportunities, and create mutual benefits, maximizing combined outputs.

2. **Resource Efficiency and Waste Reduction**: Promotes efficient use of materials, energy, and water by turning waste into inputs, reducing landfill use, and aligning with circular economy principles.

3. **Economic Advantages**: Offers cost savings through shared infrastructure, transportation, and utilities while contributing to regional economic growth and fostering job creation.

4. **Innovation**: Drives the development of sustainable processes, new products, and efficient resource utilization through collaboration.

5. **Geographic Proximity**: Enhances feasibility and reduces transportation costs and logistics challenges, supporting local resource exchange.

6. **Environmental Sustainability**: Minimizes environmental impact by reducing waste, optimizing resource use, and supporting sustainable practices.

7. **Regulatory Compliance**: Helps companies meet environmental regulations through responsible waste management and resource utilization.

8. **Supply Chain Resilience**: Reduces vulnerability to disruptions by diversifying inputs and sharing resources.

9. **Community Engagement and Reputation**: Demonstrates commitment to sustainability, fostering positive relationships with stakeholders and communities.

10. **Long-Term Planning and Sustainability**: Encourages industries to adopt forward-thinking strategies for enduring environmental, economic, and social benefits.

These aspects and benefits highlight the potential of industrial symbiosis as a strategy for sustainable development and efficient resource management, tailored to the specifics of each case.

5.2. Examples of Industrial Symbiosis

Industrial Symbiosis is currently not yet widely implemented or policy, nonetheless there are examples from mid-twentieth century and onward. The oldest industrial symbiosis found is in Denmark: Kalundborg industrial symbiosis that bonds 12 private and public facilities since 1961. This network was spontaneously developed with the goal to reduce waste by finding alternative ways of using it to generate profit. The five core partners are coal power stations, an oil refinery, a plasterboard factory, a pharmaceutical manufacturer and the Kalundborg municipal authorities, which supply water and heating; excess energy from the power plant is used for fish farming; the refinery supplies excess gas to the plasterboard factory; fly ash from the power station is used by the cement firm; sludge from pharmaceutical production and from the fish farm's water treatment plant is used as fertiliser.

Based on information from the IMPEL questionnaire regarding by-products the following cases of Industrial Symbiosis can be mentioned.

In Cyprus, slaughterhouses with anaerobic digestion are an example of industrial symbiosis, but the key problem is that these kinds of facilities have not prescribed criteria. So some by-products of one installation are unsuitable for use as material at the other installation. Still they keep using them to reduce cost, even if it leads to operational problems, due to lack of know-how.

Furthermore, in Finland there is the example of Motiva Ltd. – a Finnish Sustainable Development Company that coordinates the practices. The core of the action is to bring together regional actors in a network. Regional organisers take care of the symbiosis promotion in practice. Their tasks include business activation and commitment, exchange of resource information and networking. FISS-workshops are a focal tool in business activation, resource data collection and the identification of synergies. The resource information and identified opportunities for synergies are collected in a common SYNERGie® database. The database is used to monitor the progress of the synergies and achieved benefits

There is also the example of the pulp and paper industry supplying its own energy for pulp and paper production. The stated papermill will produce energy through a gasification process that transforms unused tree bark into biogas that can be used to replace fossil fuels. Also, opinion is that by-products that are easy to transport can be used as a raw material in different industrial areas. From Finland we also received the information that the subject industrial symbiosis is a part of the governmental development policy.

Another example of industrial symbiosis can be found in Iceland. The project revolves around the country's third largest geothermal plant, Reykjanes, which was created by HS Orka. The Resource Park operates under the motto 'Society without waste'. The companies involved in the park must ensure that all resource streams that flow to and from their

operations are utilised to their full potential, in a responsible manner and to the benefit of society. In practice this means the park contains for example:

- An expansive spa that uses electricity, hot water, geothermal brine, steam and CO2 from the geothermal operations to create a facility that attracts 1.3 million visitors a year. It also uses the silica and minerals geothermal by-products for skin care products.
- A biotech company that grows barley in a high-tech greenhouse to develop a plant-based growth factor for cosmetics and cell-cultured meat. The company uses crushed volcanic rock, electricity and water from Reykjanes.
- A fish farm which uses warm, lava-filtered sea water to raise the farmed sole fish, which it sells to restaurants in North America and Europe.
- Two fish processing companies that use thermal energy and steam from the power plant to dry fish offcuts to turn into a protein source for African markets.
- And a recycling company, which uses the power plant's carbon dioxide, electricity and water to make methanol from geothermal by-products.

The Resource Park was created to raise awareness of the valuable resources entrusted to the Company and the importance of ensuring the sustainability of energy resources for future generations.

In Valencia, Spain, the ceramic industry, in collaboration with technical institute ITC, provides a notable example of industrial symbiosis through innovative approaches to resource efficiency and waste management. Centred around the ceramic cluster in Castellón, near Valencia, companies have implemented systems that recover waste heat from kilns. This recovered heat is reused in production processes, such as preheating raw materials or drying ceramic tiles, significantly reducing energy consumption and operational costs. Additionally, by-products like ceramic sludge and waste materials are repurposed. Crushed ceramic waste is reused as raw material for new tiles, and other waste streams find applications in the production of concrete and construction materials. To further enhance resource efficiency, glaze overspray and residual powders from production are recycled into new glaze batches, minimizing raw material waste. Energy synergies within the cluster have been achieved by sharing natural gas pipelines and energy infrastructure, which reduces duplication and enhances efficiency. Water management is another critical aspect, with water used in production being treated and recycled within facilities. Some factories also share water treatment plants, optimizing water usage across the cluster. The ceramic industry collaborates with neighbouring industries to utilize their by-products. For example, slag from steel plants and ash from power plants are used as additives in ceramic production. These collaborative efforts reduce waste sent to landfills, lower emissions, and contribute to a circular economy. This integrated approach delivers significant economic

benefits through cost savings and increased competitiveness while promoting environmental sustainability. The symbiotic relationships among companies in Valencia's ceramic cluster demonstrate the potential of industrial symbiosis to drive innovation, reduce resource dependency, and foster sustainable industrial development.

Finally, in Poland industrial symbiosis is applied in the Smilowo Eco-Park, located in the Notec valley region. The industrial symbiosis in this Eco-park promotes a business model which covers the whole life cycle of the products starting from the plant growing by animal feed preparation, livestock breeding, meat preparations, meat-bone meal production from animal waste and the use of pig slurry as a fertiliser. The solutions used include the prevention of environmental pollution through the modernization of existing processes, implementation of new technologies, reduction of waste and its reuse, recycling, and recovery of materials and energy, the substitution of raw materials with waste, and thermal treatment of waste and its use as biofuel.

However, the majority of the IMPEL member countries who filled in the questionnaire are not familiar with the topic or in these countries there are not yet established examples of Industrial symbiosis.

The answers to the questionnaire show that the use of by-products in IMPEL member countries varies as do the procedures in these countries for assessing the by-product status of a material. When Industrial Symbiosis is concerned, things may get even more complicated because different businesses, facilities, regulators and policy makers need to work together.

5.3. The policy and legislative framework for Industrial Symbiosis

The European Union places Industrial Symbiosis at the core of resource efficiency strategies and the transition to Circular Economy, as stated in the Circular Economy Action Plan (2020), which proposes facilitating and enabling industrial symbiosis as a means of transforming consumption and production patterns for greater circularity in Industry. The CE Action Plan 2020 addresses Industrial Symbiosis and recommends:

facilitating industrial symbiosis by developing an industry-led reporting and certification system, and enabling the implementation of industrial symbiosis.[17]

But a concrete and practical European wide Industrial Symbiosis policy with more specific goals is lacking. The development of a European Industrial Symbiosis policy could be

[17] COM (2020) 98 final, p.6

considered. But such policies could also be developed at Member State or even at regional or local level. The EU emphasis is promoting local or regional actions.

One example is the EU4Environment Action, which targets the Eastern Partnership (EaP) countries of the EU, is centred around resource efficiency promoted through several intervention levels essential for application of industrial symbiosis. The Action's focus on Circular Economy and new growth opportunities includes work on initiating symbiotic activities like providing information and common training, developing (overarching) environmental management activities, promoting cooperation, exchanging materials, energy and common actions (such as energy supply or waste water treatment) among the manufacturing enterprises of the EaP countries.

The EU-funded "EU4Environment" Programme, launched in 2019, helps six Eastern Partnership (EaP) countries: Armenia, Azerbaijan, Belarus, Georgia, the Republic of Moldova and Ukraine, preserve their natural capital and increase people's environmental well-being. It supports environment-related actions, demonstrating and unlocking opportunities for greener growth, and setting mechanisms to better manage environmental risks and impacts.

Besides this action, is the promotion of waste prevention and material efficiency by the member states set in the European directives.

The usage "by-product" within the current policy frameworks supports reutilization of materials. So the development of Industrial Symbiosis is the task of local or regional government.

IED and WFD

Both the IED and the WFD are key pieces of European legislation that address different aspects of environmental protection. While they focus on distinct areas, there are aspects within each directive that align with some of the key principles of industrial symbiosis.

A regulator or a proactive operator could, ideally, explore opportunities for Industrial Symbiosis and discuss these with the different possible partners. In doing this, a frontrunner will not only have to understand the material flows in relation to IED, WFD, etc., but also needs to explore new opportunities for materials that are not yet used as a by-product in another activity.

Articles in IED relevant to Circular Economy and symbiosis

A regulator's role, ideally is, to comprehend material flows in relation to directives like the IED, Water Framework Directive (WFD), and Waste Framework Directive (WFD). This understanding aids in identifying opportunities to use materials currently not exploited as by-products.understand the symbiosis and discuss the relationships with the different

operators. Effective use of regulation supports circular economy principles, emphasizing waste prevention, reuse, recycling, recovery, and minimizing environmental impacts.

Article 11: General principles governing the basic obligations of the operator

Article 11 of the IED contains several paragraphs which align with several aspects of circular economy:

(d) the generation of waste is prevented in accordance with Directive 2008/98/EC;

(e) where waste is generated, it is, in order of priority and in accordance with Directive 2008/98/EC, prepared for re-use, recycled, recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;

(g) the necessary measures are taken to prevent accidents and limit their consequences;

(h) the necessary measures are taken upon definitive cessation of activities to avoid any risk of pollution and return the site of operation to the satisfactory state defined in accordance with Article 22.

Article 12: Permit application

Also article 12, paragraph 1, describes what the permit application should include:

(b) the raw and auxiliary materials, other substances, the energy and the water used in or generated by the installation;

(h) measures for the prevention, preparation for re-use, recycling and recovery of waste generated by the installation;

(i) further measures planned to comply with the general principles of the basic obligations of the operator as provided for in Article 11;

Article 14: Permit conditions

Article 14 requires that a permit includes all measures necessary for compliance with articles 11 and 18 of the IED and under paragraph b:

(b) appropriate requirements ensuring protection of the soil and groundwater and measures concerning the monitoring and management of waste generated by the installation;

In making regulatory decisions, it is important to consider and utilize the flexibility with regard to industrial symbiosis. While it in principle requires individual installations to operate according to BAT, the decision on what BAT is, may be taken at the level of a group of installations connected through industrial symbiosis. Including as much as possible within the scope of a permit may be desirable, but there may be constraints on this:

- neighbouring facilities, installations or activities within a symbiosis may have different operators and be different legal entities;
- combining activities may capture non-IED activities and operators may consider this undesirable;
- with multiple operators, it might be difficult to assign responsibility for non-compliance;
- a 'dome' permit or umbrella permit is a possibility in some regulatory regimes, though their adoption depends on national regulatory contexts.

WFD

Certain provisions of the WFD have a clear link with industrial symbiosis. Production residues which are used within symbiosis can be regarded as a by-product if they meet the conditions for by-products. If the production residue is a by-product under the WFD, it is not a waste and will have the same classification under IED, as IED defines waste simply by reference to the WFD.

Article 9 WFD is also relevant. It obliges member states to take measures to prevent waste generation. Of these measures several have a connection with the circular economy.

The following measures mentioned in article 9 WFD indicate a more obligatory role of the competent authorities:

(f) reduce waste generation in processes related to industrial production, extraction of minerals, manufacturing, construction and demolition, taking into account best available techniques;

(g) reduce the generation of food waste in primary production, in processing and manufacturing, in retail and other distribution of food, in restaurants and food services as well as in households as a contribution to the United Nations Sustainable Development Goal to reduce by 50 % the per capita global food waste at the retail and consumer levels and to reduce food losses along production and supply chains by 2030;

(j) reduce the generation of waste, in particular waste that is not suitable for preparing for reuse or recycling.

In general terms the following observations can be made regarding the WFD in relation to industrial symbiosis:

1. Material Exchange and Circular Economy Principles: The WFD is instrumental in promoting a circular economy by setting out waste management hierarchy principles, prioritising prevention, reusing, recycling, and other recovery methods over disposal. These

principles resonate with the idea of material exchange and resource optimization, which are key aspects of industrial symbiosis.

2. Collaboration: The emphasis on waste prevention and the promotion of cooperation between economic operators to encourage efficient use of resources aligns with the collaborative nature of industrial symbiosis.

3. Economic Benefits: Efficient waste management, as promoted by the WFD in articles 8, 8a and 14, can result in economic benefits for industries through cost savings, resource recovery, and the creation of new business opportunities.

4. Innovation: The WFD encourages innovation in waste management practices, fostering the development and adoption of technologies that contribute to more sustainable waste handling. This can align with the innovative aspects of industrial symbiosis. The latest approved version of the IED gives more leeway to set up innovative projects where also IS can be researched. Article 27b IED in conjunction with article 11 IED give operator the maximum derogation period of "30 months, provided that after the period specified, either the technique is stopped or the activity achieves at least the emission levels associated with the best available technique"

It's important to note that while these directives provide a regulatory framework, the specific implementation and the extent to which industrial symbiosis principles are embraced can vary across different regions and industries. Compliance in the spirit of a circular economy can, however, drive industries toward practices that align with the key aspects of industrial symbiosis.

5.4. Recommendations

From examples provided by member states and the EU4Environment project several roles and strategies recommendations for facilitating industrial symbiosis can be initiated by the competent authorities:

At the single company level: Promoting the organisation of cross-sector working groups to promote industrial symbiosis by policy officers like the Resource Efficient and Cleaner Production Clubs (RECP). These multi-stakeholder working groups with representatives from industry, government, NGOs, and the community participating in joint coaching workshops to receive guidance on mapping their inputs and outputs, this helps enterprises to assess material and energy efficiency and their organisation. The member companies develop strategies to minimise non-product output, and increase energy efficiency and recycling. By doing so, they exchange opinions, transfer knowledge and replicate feasible solutions while

working on a low level environmental management system and support them in identifying appropriate measures, and facilitate cooperation and knowledge sharing.

Using local government support and incentives to help identify compatible industries and set up networks for resource sharing.

When the waste and material information is collected and the opportunities are identified the competent authority should:

- set a practical uniform procedure that operator can by self-assessment declare material as by-product; local authority can check this in the online database, and the inspection than control amounts of the by-products on year level, storage of the by-products and conditions of the storage, analysis of the by-product, and
- if the procedure is guided by the local authorities in a permitting procedure, the permits should have to contain a part that considers by-products and prescribes criteria on which by-products will be treated as by-products, such as storage time, conditions on the storage and conditions on which by-product become waste again(for example if the market is not available for long time for this kind of by-product etc.)
- European or national criteria for assigning by-products classifications for some specific materials, such as wood, glass, plastic, clear soil, etc. so the operators can classify production residues as a by-product instead of as waste. European criteria are preferred for a level playing field.
- make a short check-list for the inspection of the operators that work with the by-products to facilitate inspections procedure.

At the sub-regional level: Industrial Waste Mapping (IWM) activities can be organised by policy makers to focus on waste inventory in municipalities (collecting data in a consistent way, promoting transport optimization, and looking into recycling options). With the waste mapping activities, information on waste flows is collected, and identified for opportunities for recycling and reusing materials and resources in collaboration with regional administrations and enterprises. Options are to intensify interaction between the regional authorities and the companies is as competent authority, to facilitate the exchange of waste; promote networking and share available information on which wastes of one company can be used as input materials in another; facilitate measures to recycle paper, cardboard, plastic, wood waste, and ceramics through matchmaking; and test the application of identified measures while continuously looking for models of cooperation.

At the industrial (or special/free economic zones) parks level: Here, exploring the competitive advantage for activities focused on the park management using An

International Framework for Eco-Industrial Parks (Version2)[18] to identify starting points for cooperation and exchange among enterprises (including policy advice at the park/zone level). The Eco Industrial Park concept provides a framework for the management of an industrial zone or industrial park to surface synergies among the tenants and promote a common use of resources and utilities to advance its development towards the goal of low carbon, circular, and green economy. In another example, the competent authority of the Port of Amsterdam has a directing role as a land lessor. This gives it a unique position to actively guide and organically promote the circular economy. By strategically allocating and managing leasehold and ground lease, companies can be attracted that fit within the circular ecosystem and promote sustainability. These companies are allowed based on the knowledge of the existing industry and it needs or available materials/waste, energy or waste water.

Together, the cross-sector working groups, industrial waste maps, and the Industrial parks encapsulate a set of methods for the systematic analysis of clusters of industries. They help identify options for developing industrial symbiosis measures, contributing to the elaboration of sustainable business strategy for enterprises in which more business models with circular elements and low-carbon solutions are introduced. So there are proven tools to start symbiotic activities in industries and support them to upscale a mentality of improved use of resources, both locally and regionally.

5.5. Barriers for Industrial Symbiosis

On the basis of the available research by Sodergren[19] and literature seven generic barrier categories can be identified. These are referred to as specific barriers. In each of these categories environmental and other governmental agencies can come across these barriers when working towards IS between two or multiple operators. Most of those barriers are not within the scope of the work of permit writers or inspectors but are key parts to take in mind for making IS a success. This summary provides a concise overview of the key barriers to Industrial Symbiosis:

1. Governmental Barriers: Government actions, policies, and regulations influence Industrial Symbiosis. Inconsistent policies, insufficient consideration of circularity in

[18] https://www.unido.org/sites/default/files/files/2021-04/An%20international%20framework%20for%20eco-industrial%20parks%20v2.0.pdf

[19] https://www.sciencedirect.com/science/article/pii/S2666789421000064#abs0015

innovation policies, and neglect of structural industry changes in policy documents hinder Industrial Symbiosis development.

2. Economic Barriers: The pricing mechanism for waste products, economic risks in waste exchange, high costs associated with transporting waste, and significant investments in Industrial Symbiosis technologies can act as economic barriers to Industrial Symbiosis. The absence of a reliable market and clear benefits may discourage companies.

3. Technological Barriers: Technical feasibility concerns, such as the availability of reliable recovery technologies, hinder Industrial Symbiosis. The lack of local technical know-how and evaluation techniques for Industrial Symbiosis opportunities pose additional technological barriers.

4. Organisational Barriers: Corporate organisational structures, especially within subsidiaries of national or international corporations, may limit autonomy for waste exchanges due to limited decision-making powers. Organisational cultures with low interfirm cooperation can create reluctance to engage in Industrial Symbiosis.

5. Informational Barriers: Insufficient information in time, poor market and supply information, and difficulties in exchanging information between companies act as informational barriers to Industrial Symbiosis. Lack of communication platforms and resistance to information sharing further hinder Industrial Symbiosis.

6. Cognitive and motivational barriers: Negative perceptions of waste, historical neglect of waste in strategic processes, and limited understanding of Industrial Symbiosis concepts and benefits hinder its integration into company operations. Stakeholder cooperation is crucial, but a lack of trust often acts as a barrier. In larger regions, distrust toward government entities further complicates the implementation of Industrial Symbiosis.

7. Safety Barriers: Concerns about the environmental and health implications of using industrial by-products, especially in agriculture, require careful examination. Safety concerns, particularly in marine transport of hazardous materials, can hinder Industrial Symbiosis.

Annex

Annex I. PRACTICAL TOOL ON PROVIDING INFORMATION TO DEMONSTRATE BY-PRODUCT STATUS

Residues are by-products and not waste when the producer demonstrates that, since they have not been produced voluntarily and as the primary purpose of the production cycle, they are intended to be used in the same or a subsequent process, either by the producer itself or by a third party. For this purpose, at each stage of the management of the residue, proof must be provided that all of the conditions set in the WFD are met.

The following checklist indicates the main elements that are deemed appropriate to analyse during an inspection to check compliance with the by-product conditions, as well as the key contents of a by-product assessment in a permitting process. It can serve as the information basis for the development of a dossier that, in cases of self-assessment, the operator must keep available for the inspection authority to verify the by-product requirements. It can also form the basis for identifying the content of an authorization application for a by-product status.

The annex also includes the content of a voluntary **By-product Data Sheet,** aimed at demonstrating the requirement of certainty of use and the intention not to discard the residue; this “technical” data sheet contains the necessary information to allow the identification of the by-products whose use is envisaged and the identification of their technical characteristics, as well as the sector of activity or type of plant suitable for their use. The By-product data sheet shall also indicate appropriate times and methods for the storage and handling of the by-products, from the production of the residue, up to its use in the process of destination. In the event of substantial changes in the production process or destination of the by-product, , a new data sheet must be prepared.

In summary: the checklist can be used by the inspector or permit writer or other competent authority to assess compliance with byproduct conditions. The technical data sheet is a document to be provided by the operator to the authority to demonstrate compliance with some byproduct conditions. It is a kind of self-declaration.

CHECKLIST

General data

Company name:
Address
Authorization and release date
Main product(s):
Production process:
Evaluated by-product(s):
Permit / self-assessment:
Place of the production process:
Date of the inspection/assessment

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
A	A substance or object resulting from a production process the primary aim of which is not the production of that substance or object is considered not to be waste	Production process	The term 'production process' is not defined in the WFD. However, in the light of the case-law, the term 'production process' should not be construed restrictively, for example, to industrial production processes only. A 'production process' can be said to include mineral extraction, manufacturing, chemical industry, agriculture, animal husbandry and forestry (services in some countries). Production processes are processes aimed at producing one or more products (non-waste). In any case, no production processes are: ▪ transport, commerce, hotels and restaurants and health care, private households, office work; ▪ activities involving the recovery of waste (e.g. recycling or preparation for re-use).	In order to verify this condition, the production process that originated the substance or object must be described by the operator. Specifically, the following information are required: 1. Description and characteristics of the production process: explain why the substance or object originates from a "production process" and why is a "production residue"; 2. Indication of the materials exiting the production process (by-product, waste, products); 3. Quantity produced and maximum of storage space (t or kg) 4. Type and characteristics of the by-product 5. Indicate the BAT conclusions used in the production process	Process flow diagram indicating input and output
B1	Further use of the substance or object is	Certainty of use	There should be a document which describes: ▪ It must be established that the customer has the intention and is	The requirement for the material and its certainty of use at the end use location(s) must be documented and supported by the necessary evidence;	▪ List of Multiple/regular

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
	certain		able (given available production or processing capacity) to use the material for the intended application. ▪ This must be evidenced by and recorded in written agreements (contracts, invoices, etc.) between the holder and the customer. ▪ Suitability of the material - It must be clear that the material is also suitable for the intended application. ▪ Quantity sent as byproduct. ▪ Quantity sent as waste.	the following information are required: 1. Provide information on the destination facility (or activity) of the by-product, the timing and method of storage and handling. Describe how the by-product is used by the customer for the intended application. 2. Ask for a description of the existent or potential market for the by-product 3. Describe the financial gain for the producer (prove the existence of a consistent interest in the substance or object through invoices and/or sales receipts) 4. Declaration of interest from the future user, preferably with the quantities to be purchased each year 5. Evidence that the by-product fulfils the same specification as other products on the market. 6. Check the existence of contracts between the producer and	customers and intermediaries ▪ Long term contracts with the end users ▪ Letters of intents, agreements ▪ Sales evidence (Quantity sent as by-product and/or waste). ▪ Documents of transport

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
				subsequent user (also intermediaries), from which information on the technical characteristics of the by-products, how they are to be used, and the conditions of their transfer, shall be evidence. 7. Check is all or only part of the residue is to be used, with the rest disposed of as waste. 8. In case of border crossing: check if the point of view of the competent authority in the country of destination is added	
B2		Storage	When assessing whether the condition of certainty of use is met, the quantity of material that is stored and/or delivered is important, as is the duration of storage. In the case of long-term storage of the material, the certainty of use will usually be more difficult to demonstrate. Storage for an indefinite period of time does not constitute a certain use and is therefore waste.	9. Check the storage of the residue and the timeframe (quantity and storage time). 10. Method of collection and storage of the by-product. 11. Indication of the place and characteristics of all the (intermediate) storages. 12. Maximum time expected for storage from production to	▪ Layout indicating by-products storage area

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
				definitive use. 13. Mode of transport between facilities and storages.	
C	The substance or object can be used directly without any further processing other than normal industrial practice	Normal industrial practice	It has to be assessed that no further processing of the by-product is required prior to its use. Therefore, the nature of any processing of the production residue must be adequately documented to demonstrate that it is 'normal industrial practice' for such materials. For example, this may include demonstrating that the same processing steps are undertaken in the production of equivalent (virgin) material(s). By-products must be able to be used without any further treatment (than usual). The main production process is the starting point here. Treatments such as mixing, drying, wetting and hygienizing are recognized as usual actions. Any treatment should be described but also compared to common practices.	Check the following: 14. Description of the by-product required treatment and if it corresponds to those ordinarily carried out in the production process in which the material is used 15. Check if the treatment causes the material to lose its identity or environmental quality, and does not bring about a structural change in the chemical-physical component.	▪ Layout of the by-product final user production process: preliminary treatments should be included.

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
D	Further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts	Lawful use and Environmental standards	The use of the material complies with all applicable legislation and any product standards and the application is desirable from the point of view of resource efficiency. Ask to provide information on the characteristics of the by-product and its conformity with the intended use, both from a technical point of view and in terms of compliance with the requirements and parameters established by sector standards, where they exist (e.g. EN-ISO-EPA Standards ecc).	16. Check compliance with environmental standards if set in the permit (e.g. leachate test, ecotoxic tests), or check criteria used by the operator to reassure on the absence of environmental impacts. 17. Check applicable product legislation or standards that apply to the material in question or to the manufacturing process; 18. Check agreement on the quality of the material between the producer and the future user (if there are no regulations) 19. Check REACH applicability verification (if applicable ask for the assessment); 20. Check any applicable certification procedure. 21. Check presence in the material of SVHCs (that are not regulated under the substances legislation or the product legislation);	▪ Lab analysis to check compliance with environmental criteria if set ▪ Documents proving lawfulness: evidence that the specified further use of the material is provided within some form of authorisation/licence/certification

N.	WFD provisions	Topic	Context	What to check	Documents to be presented
				22. Check if the future utilisation of the material is BAT in the sector	

BY-PRODUCT DATA SHEET

	Manufacturer's Details
1	▪ Company name – VAT Number
2	▪ Address of the registered office and operational site
	Production Facility
3	▪ Address
4	▪ Authorization / Issuing Authority
5	▪ Date of issue
6	▪ Description and characteristics of the production process
7	▪ Specification of materials exiting the production process (products, residues, and waste)
	Information on the By-product
8	▪ Type and characteristics of the by-product and production method
9	▪ Conformity of the by-product with its intended use
	Destination of the By-product
10	▪ Type of activities or facilities suitable for using the residue
11	▪ Destination facility or activity
12	▪ References to any intermediaries

	Storage and Handling Times and Methods
13	▪ Methods of collection and storage of the by-product
14	▪ Specification of the location and characteristics of the storage site and any intermediate deposits
15	▪ Maximum period allowed for storage from production to final use
16	▪ Transportation methods
	Organization and Continuity of the Management System
17	▪ Description of the timing and management methods aimed at ensuring the identification and effective use of the by-product