

# JRC SCIENCE FOR POLICY REPORT

## Scoping possible further EU-wide end-of-waste and by-product criteria

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## **Abstract**

This study supports the implementation of both the Circular Economy Action Plan and the Waste Framework Directive by identifying a list of priority waste or by-product streams (scoping) and deriving the most suitable candidate streams for which to develop further EU-wide end-of-waste or by-product criteria.



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Spain	Andy Wolf	The European Recycling Industries' Confederation (EuRIC)	The European Construction Industry Federation (FIEC)
France	Associazione nazionale riciclatori e rigeneratori di materie plastiche (ASSORIMAP)	The European insulation Manufacturers Association (EURIMA)	Fédération Internationale du Recyclage (FIR)
The Netherlands	AZTI scientific and technological centre	The Association of European ferro-Alloy producers (EUROALLIAGES)	Hazardous Waste Europe (HWE)
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## Executive summary

This study was carried out by the Joint Research Centre and the Directorate-General for the Environment and aimed to support the Commission in the implementation of both the Circular Economy Action Plan and the Waste Framework Directive by:

- **1)** identifying a list of priority waste or by-product streams for which to develop further EU-wide end-of-waste or by-product criteria (scoping); and
- **2)** deriving a shortlist of top-candidate streams for which to develop further EU-wide end-of-waste or by-product criteria.

To appraise the potential of candidate streams, data and information was collected from stakeholders via a **web-based survey** organised from November 2020 to January 2021, and a **structured written consultation**, organised from July 2021 to October 2021. Stakeholders were composed of industry, environmental Non-Governmental Organisations (NGOs) and Member States' representatives.

The potential of candidate streams was appraised using **12 ranking criteria**:

- level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria;
- current collection and material re-use/recycling rates;
- identified uses, types of uses (recycling versus other recovery operations) and impacted economic sectors;
- estimated EU market value;
- intra-EU shipments;
- extra-EU shipments;
- purity/composition of recovered materials;
- possibility to recover critical raw materials;
- evidence of demand;
- existence of relevant international or national product standards;
- existence of national or regional end-of-waste or by-product criteria; and
- expected environmental and human health impacts.

For each ranking criterion, a three-level scoring (or traffic light) system was used to appraise the potential of candidate streams:

- higher potential streams were given a score of 3;
- average potential streams were given a score of 2; and
- lower potential streams were given a score of 1.

The overall potential took into consideration the scores obtained for each ranking criterion and the relative importance given to each criterion for the objectives of this study.

Based on the methodology developed for this purpose, and the data and information provided by stakeholders, the candidate streams were ranked based on their overall potential for the further development of EU-wide end-of-waste or by-product criteria. The streams with a higher overall potential (top tercile) were identified as **priority streams (objective 1)**. The identified priority list includes the following waste/by-product categories and streams in the top tercile:

### **1 – Plastics:**

- polyethylene terephthalate recovered/recycled from plastic waste;
- low- and high-density polyethylene recovered/recycled from plastic waste;
- mixed plastics waste recovered/recycled from plastic waste;
- polystyrene and expanded polystyrene recovered/recycled from plastic waste; and
- polypropylene plastic recovered/recycled from plastic waste.

## **2 – Textiles:**

- separately collected clothes and other textiles prepared for re-use;
- cellulosic fibres recovered/recycled from textile waste; and
- mixed fibres recovered/recycled from textile waste.

## **3 – Rubber:**

- rubber recovered/recycled from end-of-life tyres.

## **4 – Mineral fractions of construction and demolition wastes:**

- aggregates recovered/recycled from construction and demolition waste; and
- mineral wool recovered/recycled from demolition waste.

## **5 – Paper and cardboard:**

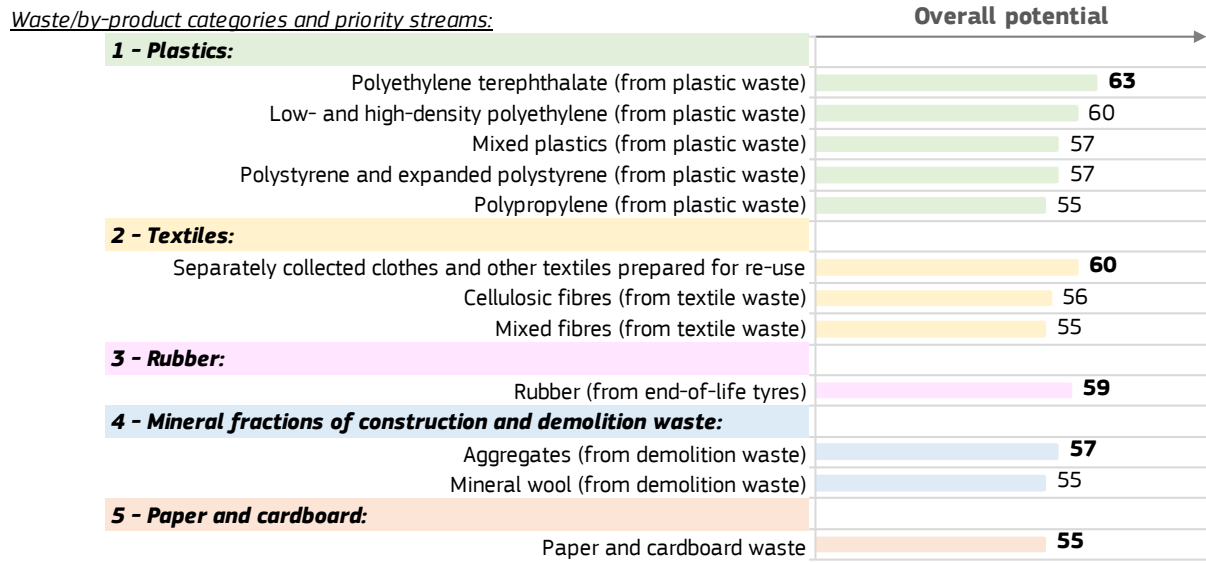
- paper and cardboard waste.

Finally, considering the priority streams, the waste/by-product categories and the ranking, a shortlist of **top-candidate streams** for which to develop further EU-wide end-of-waste or by-product criteria (**objective 2**) was derived. Based on the applied methodology and data and information provided by stakeholders, the **plastic waste category** was identified as having the highest overall potential. On the one hand, 5 out of 12 priority streams belong to the plastic waste category. On the other hand, polyethylene terephthalate recovered/recycled from plastic waste obtained the highest overall score for potential from all waste/by-product streams, followed by low- and high-density polyethylene recovered/recycled from plastic waste with the second highest overall score for potential. Therefore, the **plastic waste category with its 5 top-candidate streams** is proposed for the further development of EU-wide end-of-waste or by-products:

- **polyethylene terephthalate** recovered/recycled from plastic waste;
- low- and high-density **polyethylene** recovered/recycled from plastic waste;
- **mixed plastics** recovered/recycled from plastic waste;
- **polystyrene** and **expanded polystyrene** recovered/recycled from plastic waste; and
- **polypropylene** recovered/recycled from plastic waste.

The list of priority streams grouped per category, and ranked based on their overall potential is presented in **Figure A**.

**Figure A:** List of priority streams grouped per category, and ranked based on their overall potential, according to the scoring system and data used for the present study



# 1 Introduction

## 1.1 Policy context and legal framework

The Commission, in its Communication on the implementation of the circular economy package<sup>1</sup>, indicated EU rules on end-of-waste as one of *'the four most critical issues identified in the way the legislation on chemicals, products and waste work together and how these are hampering a circular economy development'*. One of the issues reported by the Communication was that these rules are *'not fully harmonised, making it uncertain how waste becomes a new material and product'*. Therefore, the Commission decided to *'launch a study to gain a better understanding of Member States' practices as regards implementation and verification of provisions on end-of-waste as a basis for possible guidelines'*.

As a result of this study, in 2020 the Commission published a study on Member States' practices<sup>2</sup> providing an overview of the different existing practices, and the issues raised by the lack of EU harmonisation on end-of-waste or by-product criteria amongst Member States.

Finally, in its new Circular Economy Action Plan for a cleaner and more competitive Europe<sup>3</sup>, in order to promote the use and the uptake of secondary raw materials in a *'well-functioning'* internal market, the Commission planned to *'assess the scope to develop further EU-wide end-of-waste criteria for certain waste streams based on monitoring Member States' application of the revised rules on end-of-waste status and by-products, and support cross-border initiatives for cooperation to harmonise national end-of-waste and by-product criteria (by 2021)'*.

In addition, the Waste Framework Directive (2008/98/EC) as last amended by Directive (EU) 2018/851 sets a legal basis for the monitoring and the possible development of EU-wide end-of-waste or by-product criteria as it stipulates that:

- *'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'* Article 5(2) on by-products; and
- *'the Commission shall monitor the development of national end-of-waste criteria in Member States, and assess the need to develop Union-wide criteria on this basis. To that end, and where appropriate, the Commission shall adopt implementing acts in order to establish detailed criteria on the uniform application of the conditions laid down in paragraph 1 to certain types of waste'* Article 6(2) on end-of-waste status.

## 1.2 Study objectives

In line with the policy context and legal framework, and in order to support the Commission in the implementation of both the Circular Economy Action Plan and the Waste Framework Directive, this study, carried out by the Joint Research Centre and the Directorate-General for the Environment, had two main objectives:

- **1)** to identify a list of priority waste or by-product streams for which to develop further EU-wide end-of-waste or by-product criteria (scoping); and
- **2)** to derive a shortlist of top-candidate streams for which to develop further EU-wide end-of-waste or by-product criteria.

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<sup>1</sup> COM(2018) 32 final

<sup>2</sup> Study to assess Member States' (MS) practices on by-product (BP) and end-of waste (EoW), 2020, doi:10.2779/279259

<sup>3</sup> COM(2020) 98 final

## 2 Methodology

### 2.1 Data and information used for the appraisal

#### 2.1.1 Web-based survey

From November 2020 to January 2021, the Directorate-General for Environment of the European Commission carried out a **web-based survey** to collect data and information to help the Commission to fully understand the potential behind the waste and by-product streams shortlisted as candidates for which to develop further EU-wide end-of-waste or by-product criteria.

The shortlist as well as the survey were developed taking into account the information already available from the study on Member States' practices on by-products and end-of waste<sup>4</sup>. In addition, data and information collected in the targeted stakeholder consultation and the open public consultation, carried out in association with the drafting and publication of the Communication on the implementation of the circular economy package and in particular on options to address the interface between chemical, product and waste legislation<sup>5</sup>, were also taken into account.

#### 2.1.2 Written consultation

To supplement the data and information collected via the web-based survey, and to give the stakeholders an additional opportunity to provide data and information in a **structured** way in order to enable the Commission to appraise the potential of each candidate stream for which to develop further EU-wide end-of-waste or by-product criteria, an additional consultation, the **written consultation**, was organised jointly by the Joint Research Centre and the Directorate-General for Environment of the European Commission from July 2021 to October 2021.

Stakeholders were composed of industry, environmental NGOs and Member States' representatives.

The earlier organised web-based survey helped the Commission to produce a structured overview of the candidate streams and the level of data and information available, using **12 ranking criteria**, which on the one hand covered the conditions set in Articles 5 and 6 of the Waste Framework Directive<sup>6</sup> on by-products and end-of-waste respectively, and on the other hand provided a broader set of data and information to best appraise the potential of candidate streams:

- level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria;
- current collection and material re-use/recycling rates;
- identified uses, types of uses (recycling vs other recovery operations) and impacted economic sectors;
- estimated EU market value;
- intra-EU shipments;
- extra-EU shipments;
- purity/composition of recovered materials;
- possibility to recover critical raw materials;
- evidence of demand;
- existence of relevant international or national product standards;
- existence of national or regional end-of-waste or by-product criteria; and
- expected environmental and human health impacts.

Finally, both sets of data and information, the one collected during the web-based survey and the additional one collected during the written consultation, were used to appraise the potential of candidate streams for

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<sup>4</sup> Study to assess Member States' (MS) practices on by-product (BP) and end-of waste (EoW), 2020, doi:10.2779/279259

<sup>5</sup> COM(2018) 32 final

<sup>6</sup> Directive 2008/98/EC as last amended by Directive (EU) 2018/851

which to develop further EU-wide end-of-waste or by-product criteria. In addition, stakeholders were given the possibility to propose further candidate streams during the written consultation and to provide data for these.

Where data and information provided by stakeholders were incomplete, data were supplemented by internal expert knowledge or publicly available data<sup>7</sup>, if possible, in order to appraise the potential of each candidate stream. In addition, where possible, a quality check was performed with publicly available data.

## 2.2 Candidate streams

Following both consultations, a number of the specific waste and by-product streams suggested by stakeholders were considered as candidates for which to develop further EU-wide end-of-waste or by-product criteria.

The list of candidate streams is presented in **Table 1** (last column). These streams were grouped into broader categories presented in the first column.

**Table 1:** Specific waste or by-product candidate streams proposed by stakeholders

<b>Waste/By-product category</b>	<b>Specific waste/by-product stream</b>
Bauxite residues	Red mud residue from alumina refining Bayer process
Bio-materials not covered by the Fertilising Products Regulation <sup>8</sup>	<p>Materials recovered or produced from waste water and sewage sludge:</p> <ul style="list-style-type: none"> <li>— Ammonium salts</li> <li>— Bio-plastics and bio-polymers (e.g. PHA, PHBV, PLA)</li> <li>— Cellulose</li> <li>— Phosphorus</li> <li>— Potassium chloride</li> </ul> <p>Sludge from urban waste water treatment and the food industry</p> <p>Spent coffee ground</p> <p>Other bio-materials not covered by the Fertilising Products Regulation<sup>8</sup></p>
Synthetic gypsum	Gypsum from flue-gas desulphurisation in coal-fired power plants
	Phosphogypsum residue from the production of mineral fertilisers from phosphate rock
Mill scale	The oxidised surface of steel produced during steel processing (reheating, conditioning, hot rolling, and/or hot forming operations)

<sup>7</sup> Supplementary data were necessary for the appraisal and are clearly indicated and referenced in the report.

<sup>8</sup> Regulation (EU) 2019/1009

Waste/By-product category	Specific waste/by-product stream
Mineral fractions of construction and demolition waste	Recovered materials from construction and demolition waste: <ul style="list-style-type: none"> <li>— Aggregates</li> <li>— Gypsum (plasterboard)</li> <li>— Mineral wool (man-made vitreous fibre)</li> </ul>
Paper and cardboard	Waste paper and cardboard
Plastics	Recovered/recycled plastics: <ul style="list-style-type: none"> <li>— Acrylonitrile butadiene styrene</li> <li>— Cellulose acetate</li> <li>— Low- and high-density polyethylene</li> <li>— Polycarbonate</li> <li>— Polyethylene terephthalate</li> <li>— Polypropylene</li> <li>— Polystyrene and Expanded polystyrene</li> <li>— Polyurethane</li> <li>— Polyvinyl chloride</li> <li>— Other plastics recovered from waste</li> <li>— Mixed plastics</li> </ul>
Rubber	Rubber recovered/recycled from end-of-life tyres
Slags (ferrous and non-ferrous)	Slags produced during ferrous and non-ferrous metals processing: <ul style="list-style-type: none"> <li>— Iron silicate slags from copper processing</li> <li>— Ferro-alloys and silicon slags</li> <li>— Iron and steel slags</li> </ul>
Textiles	Waste carpets Separately collected clothes and other textiles prepared for re-use Materials recovered/recycled from waste clothes / waste textiles: <ul style="list-style-type: none"> <li>— Cellulosic fibres</li> <li>— Cotton fibres</li> <li>— Polyester</li> <li>— Cotton-polyester blends</li> <li>— Mixed fibres</li> </ul>

Waste/By-product category	Specific waste/by-product stream
Waste electrical and electronic equipment	<p>Separately collected waste electrical and electronic equipment prepared for re-use</p> <p>Other waste not prepared for re-use:</p> <ul style="list-style-type: none"> <li>— waste electrical and electronic equipment and materials recovered/recycled from waste electrical and electronic equipment: <ul style="list-style-type: none"> <li>▪ Plastics</li> <li>▪ Glass, ceramics</li> <li>▪ Metals</li> </ul> </li> </ul>

### 2.3 Appraisal of potential

The following methodology was used to appraise the potential of the specific waste or by-product streams, suggested by stakeholders as candidates for which to develop further EU-wide end-of-waste or by-product criteria:

- the 12 ranking criteria described in Section 2.1.2 were used to appraise the potential of each candidate stream;
- for each ranking criterion, a three-level scoring rule (or traffic light) was used to appraise the potential of candidate stream:
  - higher potential streams were given a score of 3;
  - average potential streams were given a score of 2; and
  - lower potential streams were given a score of 1.

The ranking criteria, along with the scoring rule used to appraise the potential of each candidate stream, are presented in **Table 2**. The appraisal was based on the data and information collected (see Section 2.1 on Data and information used for the appraisal). A more detailed description of each ranking criterion and its scoring rule, as well as the results of the appraisal based on each criterion, are provided in Section 3.

**Table 2:** Ranking criteria and scoring rules developed and used for the appraisal of candidate streams for which to develop further EU-wide end-of-waste or by-product criteria

Ranking criteria	Scoring rules		
	Higher potential = 3	Average potential = 2	Lower potential = 1
Level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria	Consensus amongst stakeholders	Industry consensus but environmental associations' opposition or stream indicated as not a priority by one or more Member States	No industry consensus
Current collection and material re-use/recycling rates	Higher potential to increase the current re-use and recycling rates <sup>a</sup>	Average potential to increase the current re-use and recycling rates <sup>a</sup>	Lower potential to increase the current re-use and recycling rates <sup>a</sup>



	<b>Scoring rules</b>		
<b>Ranking criteria</b>	<b>Higher potential = 3</b>	<b>Average potential = 2</b>	<b>Lower potential = 1</b>
Identified uses, types of uses (recycling versus other recovery operations) and impacted economic sectors	Higher impact on the economy based on the number of impacted economic sectors and uses promoting recycling over other recovery operations <sup>a</sup>	Average lower impact on the economy based on the number of impacted economic sectors and uses promoting recycling over other recovery operations <sup>a</sup>	Lower impact on the economy based on the number of impacted economic sectors and uses promoting recycling over other recovery operations <sup>a</sup>
Total EU market value	Higher value <sup>a</sup>	Average value <sup>a</sup>	Lower value <sup>a</sup>
Intra-EU shipments	Reported intra-EU shipments	Limited intra-EU shipments	No intra-EU shipments
Extra-EU shipments	Reported extra-EU shipments	Limited extra-EU shipments	No extra-EU shipments
Purity/composition of recovered materials	High purity or stable composition	Variable composition	Unknown composition
Possibility to recover critical raw materials	-	Possible recovery from waste/by-product stream	No recovery or not relevant
Evidence of demand	Quantified evidence provided	Qualitative evidence provided	No evidence provided
Existence of relevant international or national product standards	International (EN/ISO) or equivalent standards reported	No international (EN/ISO) or equivalent standards reported but national guidance or industry standards reported	No standards identified
Existence of national or regional end-of-waste or by-product criteria	National or regional end-of-waste or by-product criteria identified in two or more Member States	National or regional end-of-waste or by-product criteria identified in only one Member State or case-by-case decisions identified	No criteria identified
Expected environmental and human health impacts	Mostly benefits reported (and quantified) compared to possible risks	Mostly benefits reported (but not quantified) compared to possible risks OR balanced risks and benefits reported	Mostly possible risks reported compared to benefits

<sup>a</sup> Relative ranking between the candidate streams based on the distribution of the collected values, i.e. collection and recycling rates, number of impacted economic sectors or estimated EU market values.

In addition, a weighting factor was attributed to each ranking criterion to differentiate between ranking criteria considered more important, of average importance or less important when it comes to developing further EU-wide end-of-waste or by-product criteria. As for the scoring rules, a three-level (or traffic light) system was used to differentiate between the three groups of ranking criteria:

- criteria considered more important were given a weight of 3;
- criteria considered of average importance were given a weight of 2; and

- criteria considered less important were given a weight of 1.

The weighting factor attributed to each ranking criteria is presented in **Table 3**.

**Table 3:** Weighting factors attributed to each ranking criterion

Higher weight = 3	Medium weight = 2	Lower weight = 1
Level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria	Current collection and material re-use/recycling rates	Intra-EU shipments
Estimated EU market value	Identified uses, types of uses (recycling vs other recovery operations) and impacted economic sectors	Extra-EU shipments
Evidence of demand	Existence of relevant international or national product standards	Purity of recovered materials
Expected environmental and human health impacts	Existence of national or regional end-of-waste or by-product criteria	Possibility to recover critical raw materials (CRMs)

The overall potential of each candidate stream was then appraised using the weighted sum ( $WS_j^i$ ) of the scores ( $S_j^i$ ) obtained by each candidate stream ( $i$ ) for each ranking criterion ( $j$ ).

The overall potential was calculated as follows:

$$WS_j^i = \sum_{j=1}^{12} w_j \cdot S_j^i \quad (\text{Equation 1})$$

where  $w_j$  represents the weighting factor attributed to a ranking criterion  $j$  (see **Table 3** for the weighting factors); and

$S_j^i$  the score of a candidate stream  $i$  for a given ranking criterion  $j$ .

## 2.4 Ranking

The candidate streams were then ranked from the one with the lowest potential to the one with the highest, based on their calculated overall potential, i.e. the weighted sum ( $WS_j^i$ ) of the scores ( $S_j^i$ ) obtained after appraisal of their potential.

## 2.5 Priority list and top candidate

For the purpose of identifying a priority list of waste or by-product streams for which to develop further EU-wide end-of-waste or by-product criteria, the 33<sup>rd</sup> and 66<sup>th</sup> percentiles (also known as first and second terciles) of the distribution of the overall potentials (weighted sums of scores) were used.

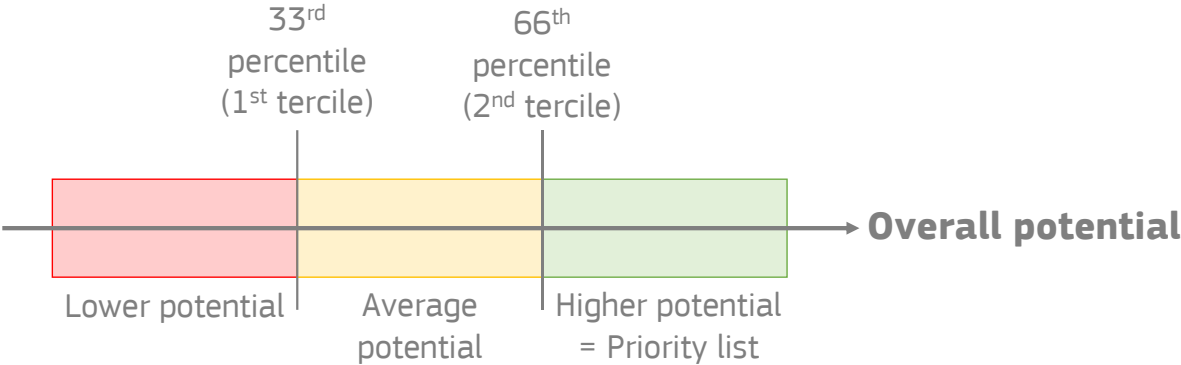
The candidate streams with an overall potential greater than the 66<sup>th</sup> percentile (second tercile) were considered as having a higher potential and therefore priority streams.

The candidate streams with an overall potential lower than the 66<sup>th</sup> percentile (second tercile) were considered as having either an average potential (overall potential lower than the 66<sup>th</sup> percentile but higher than the 33<sup>rd</sup> percentile), or a low potential (overall potential lower than the 33<sup>rd</sup> percentile).

The candidate stream with the highest overall potential was considered the top candidate for which to develop further EU-wide end-of-waste or by-product criteria.

A schematic representation of the methodology applied to determine the priority list and the top candidate is provided in **Figure 1**.

**Figure 1:** Schematic view of the ranking and the determination of the priority list



### 3 Scoring and ranking

#### 3.1 Level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria

The result of the appraisal of the potential of each candidate stream based on the level of support from stakeholders is presented in **Table 4**.

The **objective** of this criterion was to differentiate between candidate streams for which all the stakeholders would support the development of further EU-wide end-of-waste or by-product criteria, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams for which there is, or might be, a certain level of disagreement amongst stakeholders, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams for which there is a high level of support as the process of developing further EU-wide end-of-waste or by-product criteria will require a high level of support from stakeholders.

The **scoring rule** was the following:

- candidate material streams supported by all the stakeholders, or supported by industry without the opposition of either environmental NGOs or Member States' representatives (i.e. answer indicating that the stream is not suitable for either EU-wide end-of-waste or by-product criteria<sup>9</sup>), were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams supported by industry representatives but not supported by either environmental NGOs or Member States' representatives (this includes an opposition or a non-priority indication<sup>10</sup>) were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams either not unanimously<sup>11</sup> supported by industry representatives or without information provided on the level of support were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, the red mud stream (or bauxite residue) was supported by industry representatives as a candidate for which to develop further EU-wide end-of-waste or by-product criteria, but was indicated as '*not a priority stream*' by one or more Member States' representatives. Therefore, this stream was given a score of 2.

Based on the level of support from stakeholders, the streams appraised to have a **higher potential** are:

- mineral fractions of construction and demolition wastes:
  - aggregates recycled/recovered from construction and demolition waste;
  - gypsum recycled/recovered from construction and demolition waste;
  - mineral wool recycled/recovered from construction and demolition waste;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene;
  - cellulose acetate;
  - low- and high-density polyethylene;
  - polyethylene terephthalate;
  - polypropylene;

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<sup>9</sup> If no answer was provided by stakeholders, this was considered as 'no opposition'. Answers supporting EU-wide end-of-waste or by-product criteria '*under certain conditions*' were also considered as 'no opposition'.

<sup>10</sup> This means that one or more representatives indicated a given stream as either '*not suitable for the development of further EU-wide end-of-waste or by-product criteria*' or '*not a priority stream*'.

<sup>11</sup> This means that, for a given stream, one or more industry representatives indicated that EU-wide end-of-waste or by-product criteria are '*not necessary*'.

- mixed plastics;
  - other plastics; and
- a number of textile waste streams: all textile streams except the carpet waste stream.

Conversely, the streams appraised to have a **lower potential** are:

- paper and cardboard waste;
- iron and steel slags; and
- other waste electrical and electronic equipment (not prepared for re-use).

All the other streams were appraised to have an average potential.

**Table 4:** Appraisal of potential based on the level of support from stakeholders for the further development of EU-wide end-of-waste or by-products

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
	Bio-plastics and bio-polymers		2
	Cellulose		2
	Other bio-materials		2
	Phosphorus		2
	Potassium chloride		2
	Sludge from urban waste water treatment and the food industry		2
	Spent coffee ground		2
Synthetic gypsum	Flue-gas desulphurisation gypsum	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
	Phosphogypsum	Suggested by industry representatives as an alternative to flue-gas desulphurisation gypsum.	2
Mill scale	Mill scale from steel processing	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
Mineral fractions of	Aggregates	Supported by all the stakeholders.	3

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
construction and demolition waste	Gypsum		3
	Mineral wool		3
Paper and cardboard	Paper and cardboard	Not unanimously supported by industry representatives.	1
Plastics	Acrylonitrile butadiene styrene	Supported by industry without the opposition of environmental NGOs or Member States' representatives.	3
	Cellulose acetate		3
	Low- and high-density polyethylene	Supported by industry and environmental NGOs representatives without the opposition of Member States' representatives.	3
	Mixed	Supported by industry and Member States' representatives without the opposition of environmental NGOs representatives.	3
	Other	Supported by industry without the opposition of environmental NGOs or Member States' representatives.	3
	Polycarbonate	Supported by industry representatives, but opposed by environmental NGOs representatives.	2
	Polyethylene terephthalate	Supported by all the stakeholders.	3
	Polypropylene	Supported by industry and environmental NGOs representatives without the opposition of Member States' representatives.	3
	Polystyrene (and expanded polystyrene)	Supported by industry representatives, but opposed by environmental NGOs representatives.	2
	Polyurethane		2
Polyvinyl chloride	2		

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Rubber	Rubber recovered/recycled from end-of-life tyres	Supported by industry representatives, but opposed by environmental NGOs representatives and reported as not a priority stream by one or more Member States' representatives.	2
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
	Ferro-alloys and silicon slags	Supported by industry representatives, but reported as not a priority stream by one or more Member States' representatives.	2
	Iron and steel slags	Not unanimously supported by industry representatives.	1
Textiles	Carpets	Supported by industry representatives, but opposed by environmental NGOs representatives.	2
	Cellulosic fibres	Supported by industry and Member States' representatives without the opposition of environmental NGOs representatives.	3
	Separately collected clothes and other textiles prepared for re-use		3
	Cotton		3
	Mixed fibres		3
	Polyester		3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use		Supported by industry and Member States' representatives without the opposition of environmental NGOs representatives.
	Other waste not prepared for re-use	Not unanimously supported by industry representatives.	1



## 3.2 Current collection and material re-use/recycling rates

The result of the appraisal of the potential of each candidate stream based on the current collection and material re-use/recycling rates is presented in **Table 5**.

The **objective** of this criterion was to differentiate between candidate streams with a higher potential to increase their current re-use and recycling rates, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams with a lower potential to increase their current re-use and recycling rates, which would then be considered as having a lower potential for the development of further EU-wide criteria. For that purpose both the collection and the material re-use/recycling rates were considered. More importance was given to streams with a high potential to increase their re-use and recycling rates as one of the objectives of developing further EU-wide end-of-waste or by-product criteria is to support a more circular economy.

The **scoring rule** was the following:

- candidate material streams for which lower<sup>12</sup> material re-use/recycling rates were reported by stakeholders were considered as having a higher potential to increase their re-use/recycling rate, and therefore a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which higher<sup>12</sup> material re-use/recycling rates and lower<sup>12</sup> collection rates were reported by stakeholders were considered as having an average potential to increase their re-use/recycling rate, and therefore an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which higher<sup>12</sup> material re-use/recycling rates and higher<sup>12</sup> collection rates were reported, or for which no re-use/recycling rates and collection rates were reported by stakeholders<sup>13</sup>, were considered as having a lower potential to increase their re-use/recycling rate, and therefore a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for the polystyrene and expanded polystyrene stream, stakeholders reported higher recycling rates (a midrange recycling rate of 40% for polystyrene and expanded polystyrene versus a median re-use/recycling rate of 35% for all the candidate streams) and lower collection rates (a midrange collection rate of 50% for polystyrene and expanded polystyrene versus a median collection rate of 55% for all the candidate streams). Therefore, this stream was given a score of 2.

Where partial data were provided, i.e. re-use/recycling rates were reported but not the collection rates, expert knowledge was used to qualitatively assess the collection rate in comparison with the other streams, in order to assess the potential of a given stream for which to develop further EU-wide end-of-waste or by-product criteria, in which case this is indicated in **Table 5**.

Based on the collection and material re-use/recycling rates, the streams appraised to have a **higher potential** are:

- red mud / bauxite residue;
- spent coffee ground;
- mineral wool recovered/recycled from construction and demolition waste;
- a couple of plastic waste streams:
  - polyvinyl chloride;
  - mixed plastics;

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<sup>12</sup> Lower re-use/recycling or collection rates means that, for a given stream, the reported mid-range re-use/recycling rates or collection rates are lower than the calculated median value for all the streams: <35% for re-use/recycling rates, and <55% for collection rates.

Higher re-use/recycling or collection rates means that, for a given stream, the reported mid-range re-use/recycling rates or collection rates are higher than the calculated median value for all the streams: ≥35% for re-use/recycling rates, and ≥55% for collection rates.

<sup>13</sup> This means that neither re-use/recycling rates nor collection rates were reported.

- a number of textile waste streams:
  - carpet waste;
  - cellulosic and cotton fibres;
  - polyester fibres;
  - mixed fibres; and
- separately collected waste electrical and electronic equipment prepared for re-use.

Conversely, the streams appraised to have a **lower potential** are:

- bio-materials and materials recovered/produced from bio-materials (all streams except the spent coffee ground, mostly due to a lack of data);
- flue-gas desulphurisation gypsum;
- phosphogypsum (due to a lack of data);
- mill scale;
- aggregates recovered/recycled from construction and demolition waste;
- gypsum recovered/recycled from construction and demolition waste (due to a lack of data);
- paper and cardboard waste;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene (due to a lack of data);
  - cellulose acetate (due to a lack of data);
  - low- and high-density polyethylene;
  - polycarbonate (due to a lack of data);
  - polyethylene terephthalate;
  - polypropylene;
  - polyurethane (due to a lack of data);
  - other plastics (due to a lack of data);
- rubber recovered/recycled from end-of-life tyres;
- copper slags; and
- ferro-alloys and silicon slags (due to a lack of data).

All the other streams were appraised to have an average potential.

**Table 5:** Appraisal of potential based on the material re-use/recycling and collection rates

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Material re-use/recycling rates: ~3%.	3
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	No data.	1
	Bio-plastics and bio-polymers	No data.	1
	Cellulose	No data.	1
	Other bio-materials	No data.	1
	Phosphorus	No data.	1
	Potassium chloride	No data.	1
	Sludge from urban waste water treatment and the food industry	Material recycling rates: 30-40%. Collection rates: higher <sup>a</sup> .	1
	Spent coffee ground	Material recycling rates: 0%.	3
Synthetic gypsum	Flue-gas desulphurisation gypsum	No data.	1
	Phosphogypsum	No data.	1
Mill scale	Mill scale from steel processing	Re-use/recycling rates: >90%. Collection rates: higher <sup>a</sup> .	1
Mineral fractions of construction and demolition waste	Aggregates	Material recycling rates: 60-80%. Collection rates: higher <sup>a</sup> .	1
	Gypsum	No data.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	Lower material recycling rates (~5%).	3
Paper and cardboard	Paper and cardboard	Material recycling rates: 55-90%. Collection rates: up to 90%.	1
Plastics	Acrylonitrile butadiene styrene	No data.	1
	Cellulose acetate	No data.	1
	Low- and high-density polyethylene	Material recycling rates: 10-60%, EU average 30-40%. Collection rates: 40-80%.	1
	Mixed	Recycling rates: ~30%. Collection rates: lower <sup>a</sup> .	3
	Other	No data.	1
	Polycarbonate	No data.	1
	Polyethylene terephthalate	Material recycling rates: 30-50%, EU average ~40%. Collection rates: ~60%.	1
	Polypropylene	Material recycling rates: 10-60%, EU average ~40%. Collection rates: 40-70%.	1
	Polystyrene (and expanded polystyrene)	Material recycling rates: 20-60%. Collection rates: 35-65%.	2
	Polyurethane	No data.	1
	Polyvinyl chloride	Material recycling rates: 30-35%. Collection rates: lower <sup>a</sup> .	3
Rubber	Rubber recovered/recycled from end-of-life tyres	Material recycling rates: 50-60%. Collection rates: ~90%.	1
Slags (from ferrous and	Copper slags (iron silicate)	No data.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	No data.	1
	Iron and steel slags	Material re-use/recycling rates: >90%. Collection rates: higher <sup>a</sup> .	1
Textiles	Carpets	Material recycling rates: ~3%. Collection rates: lower <sup>a</sup> .	3
	Cellulosic fibres	Material recycling rates: ~1%. Collection rates: lower <sup>a</sup> .	3
	Separately collected clothes and other textiles prepared for re-use	Material re-use rates: 30-50%. Collection rates: ~10%.	2
	Cotton	Material recycling rates: ~1%. Collection rates: lower <sup>a</sup> .	3
	Mixed fibres	Material recycling rates: lower <sup>a</sup> (reported disposal rate ~70%). Collection rates: ~40%.	3
	Polyester	Material recycling rates: ~15%. Collection rates: lower <sup>a</sup> .	3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	Material re-use rates: 0.1%. Collection rates: lower <sup>a</sup> .	3
	Other waste not prepared for re-use	Material recycling rates: 45-75%. Collection rates: ~45%.	2

<sup>a</sup> No data provided by stakeholders; qualitative estimate based on expert judgement in comparison with the other waste/by-product streams suggested by stakeholders.

### 3.3 Identified uses, types of uses (material recycling versus other recovery operations) and impacted economic sectors

The result of the appraisal of the potential of each candidate stream based on the identified uses, types of uses and impacted economic sectors is presented in **Table 6**.

The **objective** of this criterion was to differentiate between candidate streams with a higher impact on the economy, promoting recycling over other recovery operations, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams with a lower impact on the economy, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with a high impact on the economy as one of the conditions of EU-wide end-of-waste or by-product criteria refers to the use of the substance or object<sup>14</sup>. In addition, recycling operations were considered more important than other recovery operations to reflect the waste hierarchy principles. Finally, energy recovery operations were not considered for the purpose of this appraisal.

The **scoring rule** was the following:

- candidate material streams for which the reported uses promoted material re-use or recycling over other recovery operations<sup>15</sup> impacting a higher<sup>16</sup> number of economic sectors were considered as having a higher impact on the economy, and therefore a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which the reported uses promoted material re-use or recycling over other recovery operations<sup>15</sup> impacting an average<sup>16</sup> number of economic sectors were considered as having an average impact on the economy, and therefore an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which the reported uses promoted material re-use or recycling over other recovery operations<sup>15</sup> impacting a lower<sup>16</sup> number of economic sectors were considered as having a lower impact on the economy and therefore a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for ammonium salts recovered or produced from waste water and sewage sludge, stakeholders reported a number of uses promoting recycling over other recovery operations. In total, three economic sectors were impacted based on the reported uses: the agricultural sector, the chemical industry and the food/feed/pharmaceuticals industry. This represented an average number compared to the first tercile of 2 and the second tercile of 4 calculated for all the streams. Therefore, this stream was given a score of 2.

Based on the identified uses, the types of uses (material recycling vs other recovery operations) and the impacted economic sectors, the streams appraised to have a **higher potential** are:

- red mud / bauxite residue;
- bio-polymers and bio-plastics recovered or produced from waste water and sewage sludge;
- mill scale;
- gypsum recovered/recycled from construction and demolition waste;
- a number of plastic waste streams:
  - low- and high-density polyethylene;

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<sup>14</sup> Articles 5(1)(a) and 6(1)(a) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>15</sup> The waste hierarchy principles were followed by giving more importance to preparing for re-use and material recycling over material recovery. Reported energy recovery uses were reported but not considered for the assessment and the scoring.

<sup>16</sup> Lower means that, for a given stream, the reported uses promoting material recycling over other recovery operations cover less than 2 economic sectors (calculated 33<sup>rd</sup> percentile value for all streams).

Average means that, for a given stream, the reported uses promoting material recycling over other recovery operations cover between 2 and 4 economic sectors (calculated 33<sup>rd</sup> percentile and 66<sup>th</sup> percentile values for all streams, respectively).

Higher means that, for a given stream, the reported uses promoting material recycling over other recovery operations cover 4 or more economic sectors (calculated 66<sup>th</sup> percentile value for all streams).

- polyethylene terephthalate;
  - polypropylene;
  - polystyrene and expanded polystyrene;
  - mixed plastics;
- separately collected clothes and other textiles prepared for re-use; and
- other waste electrical and electronic equipment (not prepared for re-use).

Conversely, the streams appraised to have a **lower potential** are:

- cellulose recovered or produced from waste water and sewage sludge;
- other bio-materials recovered or produced from waste water and sewage sludge;
- sludge from urban waste water treatment and the food industry;
- phosphogypsum (due to a lack of data);
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene (due to a lack of data);
  - cellulose acetate;
  - polycarbonate (due to a lack of data),
  - polyurethane;
  - other plastics (due to a lack of data);
- a number of textile waste streams:
  - carpets (due to a lack of data);
  - cellulosic and cotton fibres;
  - polyester fibres; and
  - mixed fibres.

All the other streams were appraised to have an average potential.

**Table 6:** Appraisal of potential based on identified uses, types of uses and impacted economic sectors

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Cement industry: clinker, cement, concrete production. Chemical industry: catalysis. Construction: road, dyke construction, tiles, bricks, insulation mineral wool production. Metal industry: iron, titanium, aluminium, rare earth elements recovery. Soil remediation: phosphate trapping, acid-rock/mine drainage treatment.	3
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	Agriculture: fertilisers production. Chemical industry: cleansing agent, surfactants, antistatic agent, disinfectants. Food/Feed/Pharmaceuticals: additives, diuretics production.	2
	Bio-plastics and bio-polymers	Agriculture: bio-stimulants production, fertilisers controlled release, seed coating, composting, geotextiles, mulch films, plant fixing clips, tree shelters, floral foam, plant plugs. Chemical industry: flocculant aid. Construction. Consumer goods: bristles for sweeping brushes, furniture. Food/Feed/Pharmaceuticals. Packaging and Containers: bags.	3
	Cellulose	Construction: asphalt binder, insulation, composite materials.	1
	Other bio-materials	Agriculture: compost production.	1
	Phosphorus	Agriculture: fertilisers production. Food/Feed/Pharmaceuticals: additives to or raw animal feed.	2



<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Potassium chloride	Agriculture: fertilisers production. Chemical: feedstock. Food/Feed/Pharmaceuticals.	2
	Sludge from urban waste water treatment and the food industry	Agriculture: compost production, growing media.	1
	Spent coffee ground	Agriculture: growing media (for mushrooms). Energy <sup>a</sup> : bioethanol production, fuel pellets. Food/Feed/Pharmaceuticals: Ingredient for animal feed, coffee oils.	2
Synthetic gypsum	Flue-gas desulphurisation gypsum	Agriculture. Cement industry: clinker, cement, concrete production. Construction: new plasterboard. Food/Feed/Pharmaceuticals.	2
	Phosphogypsum	No information.	1
Mill scale	Mill scale from steel processing	Metal industry: iron. Cement industry: clinker, cement, concrete production. Construction: limestone. Chemical industry: pigments, additives.	3
Mineral fractions of construction and demolition waste	Aggregates	Cement industry: clinker, cement, concrete production. Construction: aggregates, road construction, drainage, asphalt, fillers, backfilling of quarries, building material, foundations, embankments.	2

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Gypsum	Agriculture. Cement industry: clinker, cement, concrete production. Construction: plasterboard, gypsum product. Food/Feed/Pharmaceuticals.	3
	Mineral wool	Agriculture: growing media. Construction: insulation, fire prevention.	2
Paper and cardboard	Paper and cardboard	Paper industry. Consumer goods. Packaging.	2
Plastics	Acrylonitrile butadiene styrene	No information.	1
	Cellulose acetate	Consumer goods: eyewear.	1
	Low- and high-density polyethylene	Agriculture: silage, mulch, stretch films, nets. Construction: building films, pipes, plastic lumber, floor tiles, armour spacers, cable trays. Consumer goods: bins, moulded products, furniture, plasticware/houseware, flower pots, ropes, toys. Electrical and electronic equipment. Packaging and Containers: food and non-food contact. Textile industry: synthetic fibres. Transport industry: internal parts.	3
	Mixed	Construction: windows, pipes. Consumer goods: furniture.	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
		Electrical and electronic equipment. Packaging and Containers: food and non-food contact. Transport industry: internal parts	
	Other	No information.	1
	Polycarbonate	No information.	1
	Polyethylene terephthalate	Construction: reinforced concrete. Consumer goods: moulded products. Packaging and Containers: food and non-food contact. Textile industry: synthetic fibres.	3
	Polypropylene	Agriculture. Construction: pipes. Consumer goods: furniture, garden furniture, crates, stationary, ropes, housewares. Electrical and electronic equipment. Packaging and Containers: non-food contact. Textile: carpet fibres, underwear. Transport industry: internal parts.	3
	Polystyrene (and expanded polystyrene)	Agriculture: substrate for plants. Construction: insulation, drainage, concrete fill, roadway, road bank stabilisation. Consumer goods: moulded and extruded products, surfboards. Electrical and electronic equipment. Energy <sup>a</sup> : pyrolysis oil, gas, char.	3

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
		Packaging and Containers: food and non-food contact. Textile industry. Transport industry: internal parts.	
	Polyurethane	Consumer goods: mats, foams, pillow filling.	1
	Polyvinyl chloride	EEE (cable insulation). Construction (frames, profiles, floor and wall covering, pipes), profiles and pipes). Consumer goods (garden hoses, inflatable pools).	2
Rubber	Rubber recovered/recycled from end-of-life tyres	Chemical industry: plastic production, carbon black. Construction: asphalt, road paving, safety barriers, vibration absorption, filling material, playgrounds, synthetic turf, roofing systems, backfilling, drainage materials. Consumer goods: moulded products. Energy <sup>a</sup> : refuse-derived fuels, e.g. for cement production.	2
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	Construction: aggregates, building materials, road construction, hydraulic engineering. Ceramic industry: abrasives production. Cement industry.	2
	Ferro-alloys and silicon slags	Cement industry: clinker, cement, concrete production. Construction: road construction, asphalt, drainage, embankment fills, insulation, building materials, blocks, refractory materials, aggregates. Metal industry: briquettes for cast iron, manganese recovery, alloying additives.	2
	Iron and steel slags	Agriculture: fertilisers production. Construction: aggregates, road construction, railway construction, waterway, hydraulic engineering, insulation mineral wool production.	2

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
		Cement industry: clinker, cement, concrete production.	
Textiles	Carpets	No information.	1
	Cellulosic fibres	Textile industry: fibres.	1
	Separately collected clothes and other textiles prepared for re-use	Construction: insulation, padding. Energy <sup>a</sup> : refuse-derived fuels. Textile industry: second-hand clothes, fibres, rags, carpets, wiping clothes. Transport industry: seat fillings.	3
	Cotton	Textile industry: fibres.	1
	Mixed fibres	Textile industry: fibres.	1
	Polyester	Textile industry: fibres.	1
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	Second-hand electrical and electronic equipment.	2
	Other waste not prepared for re-use	Ceramic industry. Construction: landfill building materials. Glass: funnels and cullet. Metal industry: metals recovery. Chemical industry: plastic production.	3

a Energy recovery uses reported by stakeholders but not considered for the assessment and the scoring.

### 3.4 Total EU market value

The result of the appraisal of the potential of each candidate stream based on the total EU market value is presented in **Table 7**.

The **objective** of this criterion was to differentiate between candidate streams with a higher existing or potential internal market value, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams with a lower existing or potential internal market value, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with a high internal market value as one of the conditions of EU-wide end-of-waste criteria refers to the existence of a market for the substance or object<sup>17</sup>.

The **scoring rule** was the following:

- candidate material streams with higher<sup>18</sup> total EU market value were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams with average<sup>18</sup> total EU market value were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams with lower<sup>18</sup> total EU market value, or no estimated EU market value, were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

The total EU market value of each stream as reported by stakeholders is presented in **Table 7**. Data provided by stakeholders are indicated in **Table 7** as 'reported' data. Where partial data were provided by stakeholders, i.e. only data on EU volumes (generated volumes in the EU in million tonnes per year – Mt/y) or market prices were provided (in EUR or USD per tonne) but no data on total EU market value (in million euros per year), the partial data were supplemented, where possible, with publicly available data in order to calculate an estimated total EU market value. The estimated total EU market value was calculated as the product of the EU volume and the market price. Supplementary data is indicated in **Table 7** as 'estimated' data, along with the references used for that purpose. Where no publicly available data were found to supplement the partial data, this is indicated in **Table 7** as 'No data on total EU market value, market prices or EU volumes'.

For **example**, for phosphorous recovered or produced from waste water and sewage sludge, stakeholders reported a total EU market value of EUR 200 000 000 per year. This represented an average value compared to the first tercile of EUR 77 000 000 per year and the second tercile of EUR 888 000 000 per year calculated for all the candidate streams. Therefore, this stream was given a score of 2.

Based on the estimated EU market value, the streams appraised to have a **higher potential** are:

- aggregates recovered/recycled from construction and demolition waste;
- mineral wool recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- a couple of plastic waste streams:
  - polyethylene terephthalate;
  - polystyrene and expanded polystyrene;
- rubber recovered/recycled from end-of-life tyres; and

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<sup>17</sup> Article 6(1)(b) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>18</sup> Lower means that, for a given stream, the estimated or reported mid-range EU market value is lower than MEUR 77 per year (calculated 33<sup>rd</sup> percentile value for all streams).

Average means that, for a given stream, the estimated or reported mid-range EU market value is between MEUR 77 per year and MEUR 888 per year (calculated 33<sup>rd</sup> percentile and 66<sup>th</sup> percentile values for all streams, respectively).

Higher means that, for a given stream, the estimated or reported mid-range EU market value is equal to or higher than MEUR 888 per year (calculated 66<sup>th</sup> percentile values for all streams).

— iron and steel slags.

Conversely, the streams appraised to have a **lower potential** are:

— red mud / bauxite residue;

— a number of bio-materials and materials recovered/produced from bio-materials:

- ammonium salts recovered or produced from waste water treatment and sewage sludge (due to a lack of data);
- cellulose recovered or produced from waste water treatment and sewage sludge (due to a lack of data);
- potassium chloride recovered or produced from waste water treatment and sewage sludge;
- other bio-materials recovered or produced from waste water treatment and sewage sludge (due to a lack of data);
- sludge from urban waste water treatment and the food industry;
- spent ground coffee (due to a lack of data);

— phosphogypsum (due to a lack of data);

— mill scale;

— gypsum recovered/recycled from construction and demolition waste (due to a lack of data);

— a number of plastic waste streams:

- acrylonitrile butadiene styrene;
- cellulose acetate;
- polycarbonate;
- polypropylene;
- polyurethane (due to a lack of data);
- mixed plastics (due to a lack of data);
- other plastics (due to a lack of data);

— ferro-alloys and silicon slags (due to a lack of data);

— a number of textile waste streams:

- carpets;
- cellulosic and cotton fibres;
- polyester fibres (due to a lack of data);
- mixed fibres; and

— waste electrical and electronic equipment prepared to re-use (due to a lack of data).

All the other streams were appraised to have an average potential.

**Table 7:** Appraisal of potential based on the estimated EU market value

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
Bauxite residue	Red mud	<p>Reported EU volumes: ~0.2 Mt/y.</p> <p>Estimated market price: USD 4-12 per tonne<sup>a, b, c</sup>.</p> <p>Estimated total EU market value: MEUR 0.7-2.0 per year.</p>	1
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	No data on total EU market value, market prices or EU volumes.	1
	Bio-plastics and bio-polymers	<p>Reported market price of polyhydroxyalkanoates (PHA): EUR 4-6 per kilogram.</p> <p>Estimated EU volumes: 0.01 Mt/y<sup>d</sup>.</p> <p>Reported market price of polylactic acid (PLA): EUR 1.60-2.00 per kilogram.</p> <p>Estimated EU volumes: 0.1 Mt/y<sup>d</sup>.</p> <p>Reported market price of bio-plastics for medical purposes: EUR 10-15 per kilogram.</p> <p>No data on EU volumes.</p> <p>Reported market price of other proprietary bio-polymers produced from sewage sludge: EUR 2-5 per kilogram.</p> <p>No data on EU volumes.</p> <p>Estimated total EU market value for bio-polymers: MEUR 40-200 per year.</p>	2
	Cellulose	<p>Reported market price of recovered cellulose (crude, fluff, pellets): EUR 75-3 500 per tonne.</p> <p>No data on total EU market value or EU volumes</p>	1



<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Other bio-materials	No data on total EU market value, market prices or EU volumes.	1
	Phosphorus	Reported total EU market value of recovered phosphorus: MEUR 200 per year.	2
	Potassium chloride	Reported total EU market value of recovered potassium chloride: MEUR 23-34 per year.	1
	Sludge from urban waste water treatment and the food industry	Reported market price of sludge from urban waste water treatment and the food industry: EUR 3 per tonne. Estimated EU volumes MEUR 2-5 per year <sup>e</sup> . Estimated total EU market value: MEUR 6-15 per year.	1
	Spent coffee ground	Reported market price of spent coffee ground: EUR 500-600 per tonne. No data on total EU market value or EU volumes.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	Reported EU volumes: 12-14 Mt/y. Estimated gypsum market price: EUR 7 per tonne <sup>f</sup> . Estimated total EU market value: MEUR 84-98 per year.	2
	Phosphogypsum	No data on total EU market value, market prices or EU volumes.	1
Mill scale	Mill scale from steel processing	Reported global market value: MUSD ~400 per year. Estimated global volumes ~13.5 Mt/y <sup>g</sup> . Estimated EU volumes: ≤1 Mt/y <sup>h</sup> . Estimated total EU market value: MEUR ≤30 per year.	1
Mineral fractions of construction and demolition waste	Aggregates	Reported total EU market value for recycled aggregates: MEUR 1 800-4 400 per year.	3
	Gypsum	No data on total EU market value, market prices or EU volumes.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	Reported market price of recycled mineral wool: EUR 50-130 per tonne. Estimated total EU market value: MEUR ~14 per year <sup>i</sup> .	3
Paper and cardboard	Paper and cardboard	Reported market price of recycled paper: EUR 140 per tonne. Reported EU volumes ~50 Mt/y. Estimated total EU market value: MEUR 7 000 per year.	3
Plastics	Acrylonitrile butadiene styrene	Reported total EU market value: MEUR 0 per year (only disposal costs reported).	1
	Cellulose acetate	Reported total EU market value of recycled cellulose acetate: MEUR 0.2 per year.	1
	Low- and high-density polyethylene	Reported market price of recycled low- and high-density polyethylene: EUR 300-1 400 per tonne. Estimated EU volumes: 0.4-0.8 Mt/y <sup>i</sup> . Estimated total EU market value: MEUR 113-1 050 per year.	2
	Mixed	No data on total EU market value, market prices or EU volumes.	1
	Other	No data on total EU market value, market prices or EU volumes.	1
	Polycarbonate	Reported total EU market value: MEUR 0 per year (only disposal costs reported).	1
	Polyethylene terephthalate	Reported market price of recycled polyethylene terephthalate: EUR 300-1 400 per tonne. Reported total EU market value: MEUR 1 000-2 000 per year.	3
	Polypropylene	Reported total EU market value: MEUR 0 per year (only disposal costs reported).	1
	Polystyrene (and expanded polystyrene)	Reported market price of recycled polystyrene and expanded polystyrene: EUR <1 500 per tonne. Reported total EU market value: MEUR 1 000-2 500 per year.	3

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Polyurethane	Reported market price of recycled polyurethane: EUR 50-800 per tonne. No data on total EU market value or EU volumes.	1
	Polyvinyl chloride	Reported market price of recycled polyvinyl chloride: EUR 250-475 per tonne. Estimated EU volumes: ~0.25 Mt/y <sup>k</sup> . Estimated total EU market value: MEUR 44-166 per year.	2
Rubber	Rubber recovered/recycled from end-of-life tyres	Reported market price of rubber recovered/recycled from end-of-life tyres: EUR 120-900 per tonne. Reported EU volumes: ~1-2 Mt/y. Estimated total EU market value: MEUR 120-1 800 per year.	3
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	Reported market price of copper slags (iron silicate): EUR 10-100 per tonne. Estimated EU volumes: 4 Mt/y <sup>l</sup> . Estimated total EU market value: MEUR 40-400 per year.	2
	Ferro-alloys and silicon slags	Reported EEA volumes of ferro-alloys and silicon slags: from 0.25 to 0.7 Mt/y (depending on the type of slag). No data on total EU market value or market prices.	1
	Iron and steel slags	Reported EU volumes of iron and steel slags: ~40-50 Mt/y. Estimated market price of iron and steel slags: EUR ~23 per tonne <sup>m</sup> . Estimated total EU market value: MEUR 940-1 170 per year.	3
Textiles	Carpets	Reported EU volumes of collected carpet waste: 1.6 Mt/y. No data on total EU market value or market prices.	1

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
	Cellulosic fibres	No data on total EU market value, market prices or EU volumes.	1
	Separately collected clothes and other textiles prepared for re-use	Reported market price of rags: EUR 100-300 per tonne. Reported EU volumes of collected textile waste: 2-5 Mt. Estimated total EU market value: MEUR 200-1 500 per year.	2
	Cotton	Reported total EU market value of recycled cotton fibre: MEUR ~6 per year.	1
	Mixed fibres	Reported total EU market value of recycled mixed fibres: MEUR 40-60 per year.	1
	Polyester	No data on total EU market value, market prices or EU volumes.	1
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	No data on total EU market value, market prices or EU volumes.	1
	Other waste not prepared for re-use	Reported market price of waste electrical and electronic equipment: EUR 40-200 per tonne. Estimated EU volumes: ~3 Mt/y <sup>a</sup> . Estimated total EU market value: MEUR 120-600 per year.	2

- a Bauxite residue market value estimated at 2% of the alumina market price based on Ujaczki, E. et al., Re-using bauxite residues: benefits beyond (critical raw) material recovery, Journal of Chemical Technology and Biotechnology, Volume 93, Issue 9 (2018) 2498-2510, <https://doi.org/10.1002/jctb.5687>
- b Alumina market price estimated at USD 200-600 per tonne based on London Metal Exchange data, <https://www.lme.com/Metals/Non-ferrous/LME-Alumina#Price+graph>, and SandP Global Platts data <https://www.spglobal.com/platts/en/market-insights/latest-news/metals/041420-alumina-prices-dive-to-4-year-low-after-strong-start-to-2020>
- c Considering EUR 1 = USD 1.18 based on a yearly average for the last 12 months, [https://www.ecb.europa.eu/stats/policy\\_and\\_exchange\\_rates/euro\\_reference\\_exchange\\_rates/html/eurofxref-graph-usd.en.html](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html)
- d Estimate based on European Bio-plastics data <https://www.european-bio-plastics.org/market/>
- e Estimate based on C. Whalley et al., Sewage sludge and the circular economy, Final Report, 2021, pp.6-7, <https://forum.eionet.europa.eu/nrc-eionet-freshwater/library/urban-waste-water-treatment/sewage-sludge-and-circular-economy> taking into account agricultural and compost use data.
- f Estimate based on "European Commission, Study on the EU's list of Critical Raw Materials (2020), Factsheets on Non-critical Raw Materials", 2020, p.174, [https://ec.europa.eu/growth/sectors/raw-materials/areas-specific-interest/critical-raw-materials\\_en](https://ec.europa.eu/growth/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en)
- g Estimate based on Varvara et al., Assessment of Recycling Potential of the Steel Mill Scale in the Composition of Mortars for Sustainable Manufacturing, Procedia Manufacturing, Volume 46 (2020) 131-135, <https://doi.org/10.1016/j.promfg.2020.03.020>
- h Estimate based on REACH data: <https://echa.europa.eu/fr/substance-information/-/substanceinfo/100.059.988>
- i Estimate based on Pavel, C. C. and Blagoeva, D. T., Competitive landscape of the EU's insulation materials industry for energy-efficient buildings, EUR 28816 EN, Publications Office of the European

Union, Luxembourg, 2018, ISBN 978-92-79-96383-4, doi:10.2760/750646, <https://publications.jrc.ec.europa.eu/repository/handle/JRC108692>, and assuming a specific weight of ~100kg/m<sup>3</sup>

Estimate based on data from <https://www.recyclingtoday.com/article/plastic-recycling-pet-pp-hdpe-material-shortage-2021-europe/>

Estimate based on data from <https://pvc.org/>

Estimate based on data from <https://copperalliance.eu/uploads/2021/03/eci-position-paper-on-iron-silicate-for-by-product-survey.pdf>

Estimate based on data from USGS: <https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-iron-steel-slag.pdf> and considering EUR 1 = USD 1.18 based on a yearly average for the last 12 months, [https://www.ecb.europa.eu/stats/policy\\_and\\_exchange\\_rates/euro\\_reference\\_exchange\\_rates/html/eurofxref-graph-usd.en.html](https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html)

A market price for second-hand clothes: up to EUR 1 400 per tonne was reported by stakeholders but no data on EU market volumes were available to estimate the EU market value for second-hand clothes. Therefore, the estimated value is based on the reported market price for rags.

Estimate based on Eurostat data: env\_waselee, total waste sent for recycling and preparing for re-use operations: <https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do>

### 3.5 Intra-EU shipments

The result of the appraisal of the potential of each candidate stream based on intra-EU shipments is presented in **Table 8**.

The **objective** of this criterion was to differentiate between candidate streams being traded and shipped across the EU, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams not being traded and shipped across the EU, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams being traded and shipped across the EU as one of the objectives of developing further EU-wide end-of-waste or by-product criteria is to improve the internal market for secondary raw materials.

The **scoring rule** was the following:

- candidate material streams for which intra-EU shipments were reported by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which limited<sup>19</sup> intra-EU shipments were reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which no intra-EU shipments were reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for sludge from urban waste water treatment and the food industry, stakeholders reported limited intra-EU shipments. Therefore, this stream was given a score of 2.

Based on intra-EU shipments, the streams appraised to have a **higher potential** are:

- phosphorus recovered or produced from waste water treatment and sewage sludge;
- mille scale;
- aggregates recovered/recycled from construction and demolition waste;
- gypsum recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene;
  - cellulose acetate;
  - low- and high-density polyethylene;
  - polycarbonate;
  - polyethylene terephthalate;
  - polyurethane;
  - mixed plastics;
- rubber recovered/recycled from end-of-life tyres;
- iron and steel slags;
- a number of textile waste streams:
  - cellulosic fibres;
  - mixed fibres;

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<sup>19</sup> Limited means stakeholders reported limited/rare intra-EU shipments, or mostly local/national shipments, or relatively small shipments compared to the reported or estimated EU volumes (see **Table 7** in Section 3.4).

- separately collected clothes and other textiles prepared for re-use; and
- other waste electrical and electronic equipment (not prepared for re-use).

Conversely, the streams appraised to have a **lower potential** are:

- ammonium salts recovered or produced from waste water treatment and sewage sludge;
- bio-polymers and bio-plastics recovered or produced from waste water treatment and sewage;
- cellulose recovered or produced from waste water treatment and sewage sludge;
- potassium chloride recovered or produced from waste water treatment and sewage sludge;
- other bio-materials recovered or produced from waste water treatment and sewage sludge;
- spent coffee ground
- flue-gas desulphurisation gypsum;
- phosphogypsum;
- other plastic waste streams;
- a number of textile waste streams:
  - carpet waste;
  - cotton fibres;
  - polyester fibres; and
- separately collected waste electrical and electronic equipment prepared for re-use.

All the other streams were appraised to have an average potential.

**Table 8:** Appraisal of potential based on intra-EU shipments

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Limited intra-EU shipments between Greece and Cyprus: ~0.2 Mt/y.	2
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	No information.	1
	Bio-plastics and bio-polymers	No information.	1
	Cellulose	No information.	1
	Other bio-materials	No information.	1
	Phosphorus	Intra-EU shipments reported but no data provided on volumes.	3
	Potassium chloride	No information.	1
	Sludge from urban waste water treatment and the food industry	Limited intra-EU shipments reported but no data provided on volumes.	2
	Spent coffee ground	No information.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	No information.	1
	Phosphogypsum	No information.	1
Mill scale	Mill scale from steel processing	Intra-EU shipments: ~1 Mt/y.	3
Mineral fractions of construction and demolition waste	Aggregates	Intra-EU shipments: ~1 Mt/y.	3
	Gypsum	Intra-EU shipments reported but no data provided on volumes.	3



<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	Limited intra-EU shipments reported but no data provided on volumes.	2
Paper and cardboard	Paper and cardboard	Intra-EU shipments: ~10 Mt/y	3
Plastics	Acrylonitrile butadiene styrene	Intra-EU shipments reported but no data provided on volumes.	3
	Cellulose acetate	Intra-EU shipments: ~1 Mt/y	3
	Low- and high-density polyethylene	Intra-EU shipments: ~1 Mt/y	3
	Mixed	Intra-EU shipments reported but no data provided on volumes.	3
	Other	No information.	1
	Polycarbonate	Intra-EU shipments reported but no data provided on volumes.	3
	Polyethylene terephthalate	Intra-EU shipments: 1-2 Mt/y	3
	Polypropylene	Limited intra-EU shipments: ~0.2 Mt/y	2
	Polystyrene (and expanded polystyrene)	Limited intra-EU shipments: 0.01-0.02 Mt/y	2
	Polyurethane	Intra-EU shipments reported but no data provided on volumes.	3
	Polyvinyl chloride	Limited intra-EU shipments: ~0.01 Mt/y	2
Rubber	Rubber recovered/recycled from end-of-life tyres	Intra-EU shipments: ~0.3 Mt/y	3
Slags (from ferrous and	Copper slags (iron silicate)	Limited intra-EU shipments reported but no data provided on volumes.	2

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	Limited intra-EU shipments reported but no data provided on volumes.	2
	Iron and steel slags	Intra-EU shipments ~5 Mt/y	3
Textiles	Carpets	No information.	1
	Cellulosic fibres	Intra-EU shipments reported but no data provided on volumes.	3
	Separately collected clothes and other textiles prepared for re-use	Intra-EU shipments reported but no data provided on volumes.	3
	Cotton	No information.	1
	Mixed fibres	Intra-EU shipments reported but no data provided on volumes.	3
	Polyester	No information.	1
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	No information.	1
	Other waste not prepared for re-use	Intra-EU shipments reported but no data provided on volumes.	3

### 3.6 Extra-EU shipments

The result of the appraisal of the potential of each candidate stream based on extra-EU shipments is presented in **Table 9**.

The **objective** of this criterion was to differentiate between candidate streams being traded and shipped outside the EU, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams not being traded and shipped outside the EU, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams being traded and shipped outside the EU as one of the objectives of developing further EU-wide end-of-waste or by-product criteria is to prevent (secondary) raw materials leakage, while EU-wide end-of-waste or by-product criteria can be considered to stimulate the internal market and therefore lower the dissipation of valuable secondary raw materials out of the EU.

The **scoring rule** was the following:

- candidate material streams for which extra-EU shipments were reported by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which limited<sup>20</sup> extra-EU shipments were reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which no extra-EU shipments were reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for sludge from urban waste water treatment and the food industry, stakeholders reported limited extra-EU shipments. Therefore, this stream was given a score of 2.

Based on extra-EU shipments, the streams appraised to have a **higher potential** are:

- bio-polymers and bioplastics recovered or produced from waste water treatment and sewage sludge;
- flue-gas desulphurisation gypsum;
- mille scale;
- paper and cardboard wastes;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene;
  - cellulose acetate;
  - low- and high-density polyethylene;
  - polycarbonate;
  - polyethylene terephthalate;
  - mixed plastics;
- rubber recovered/recycled from end-of-life tyres;
- a number of textile waste streams:
  - cellulosic and cotton fibres;
  - polyester fibres; and
  - mixed fibres;

Conversely, the streams appraised to have a **lower potential** are:

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<sup>20</sup> Limited means stakeholders reported either limited/rare extra-EU shipments or relatively small shipments compared to the reported or estimated EU volumes (see **Table 7** in Section 3.4).

- red mud / bauxite residue;
- cellulose recovered or produced from waste water treatment and sewage sludge;
- phosphorus recovered or produced from waste water treatment and sewage sludge;
- potassium chloride recovered or produced from waste water treatment and sewage sludge;
- other bio-materials recovered or produced from waste water treatment and sewage sludge;
- spent coffee ground;
- phosphogypsum;
- gypsum recovered/recycled from construction and demolition waste;
- other plastic waste streams;
- rubber recovered/recycled from end-of-life tyres;
- copper slags;
- ferro-alloys and silicon slags;
- carpet waste;
- separately collected waste electrical and electronic equipment prepared for re-use; and
- other waste electrical and electronic equipment (not prepared for re-use).

All the other streams were appraised to have an average potential.

**Table 9:** Appraisal of potential based on extra-EU shipments

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	No information.	1
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	Limited extra-EU shipments reported but no data provided on volumes.	2
	Bio-plastics and bio-polymers	Extra-EU shipments reported but no data provided on volumes.	3
	Cellulose	No information.	1
	Other bio-materials	No information.	1
	Phosphorus	No information.	1
	Potassium chloride	No information.	1
	Sludge from urban waste water treatment and the food industry	Limited extra-EU shipments reported but no data provided on volumes.	2
	Spent coffee ground	No information.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	Extra-EU shipments reported but no data provided on volumes.	3
	Phosphogypsum	No information.	1
Mill scale	Mill scale from steel processing	Extra-EU shipments: ~0.3 Mt/y	3
Mineral fractions of construction and demolition waste	Aggregates	Limited extra-EU shipments reported but no data provided on volumes.	2
	Gypsum	No information.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	Limited extra-EU shipments reported but no data provided on volumes.	2
Paper and cardboard	Paper and cardboard	Extra-EU shipments: 7-10 Mt/y	3
Plastics	Acrylonitrile butadiene styrene	Extra-EU shipments reported but no data provided on volumes.	3
	Cellulose acetate	Extra-EU shipments: ~0.1 Mt/y	3
	Low- and high-density polyethylene	Extra-EU shipments: 0.3-1 Mt/y	3
	Mixed	Extra-EU shipments reported but no data provided on volumes.	3
	Other	No information.	1
	Polycarbonate	Extra-EU shipments reported but no data provided on volumes.	3
	Polyethylene terephthalate	Extra-EU shipments: 0.2-0.8 Mt/y	3
	Polypropylene	Limited extra-EU shipments: ~0.1 Mt/y	2
	Polystyrene (and expanded polystyrene)	Limited extra-EU shipments: <0.01-0.1 Mt/y	2
	Polyurethane	Limited extra-EU shipments: ~0.1 Mt/y	2
	Polyvinyl chloride	Limited extra-EU shipments: ~0.02 Mt/y	2
Rubber	Rubber recovered/recycled from end-of-life tyres	Extra-EU shipments reported but no data provided on volumes.	3
Slags (from ferrous and	Copper slags (iron silicate)	No information.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	No information.	1
	Iron and steel slags	Limited extra-EU shipments reported but no data provided on volumes.	2
Textiles	Carpets	No information.	1
	Cellulosic fibres	Extra-EU shipments (2% of total market)	3
	Separately collected clothes and other textiles prepared for re-use	Limited extra-EU shipments: ~0.04 Mt/y	2
	Cotton	Extra-EU shipments reported but no data provided on volumes.	3
	Mixed fibres	Extra-EU shipments reported but no data provided on volumes.	3
	Polyester	Extra-EU shipments reported but no data provided on volumes.	3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	No information.	1
	Other waste not prepared for re-use	No information.	1

### 3.7 Purity/composition of recovered materials

The result of the appraisal of the potential of each candidate stream based on the purity/composition of recovered materials is presented in **Table 10**.

The **objective** of this criterion was to differentiate between candidate streams with a higher purity and potentially low level of contaminants, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams with a lower purity and potentially higher level of contaminants, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with a higher purity as one of the requirements of EU-wide end-of-waste or by-product criteria may include a criterion on the composition and the level of contaminants.

The **scoring rule** was the following:

- candidate material streams for which the composition of the recovered stream was reported as highly pure or with a low level of contaminants by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which the composition of the recovered stream was reported as variable by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which the composition of the recovered stream is unknown were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

Where no data were provided, expert knowledge was used to qualitatively assess the purity/composition in order to appraise the potential of a given stream for EU-wide end-of-waste or by-product criteria, in which case this is indicated in **Table 10**.

For **example**, for copper slags (iron silicate), stakeholders reported iron silicate and silicates of aluminium and calcium as the main constituents. Traces of other non-ferrous metals were also reported. Therefore, this stream was considered of variable composition and given a score of 2.

Based on the purity/composition of recovered materials, the streams appraised to have a **higher potential** are:

- ammonium salts recovered or produced from waste water treatment and sewage sludge;
- bio-polymers and bioplastics recovered or produced from waste water treatment and sewage sludge;
- cellulose recovered or produced from waste water treatment and sewage sludge;
- phosphorus recovered or produced from waste water treatment and sewage sludge;
- potassium chloride recovered or produced from waste water treatment and sewage sludge;
- flue-gas desulphurisation gypsum;
- phosphogypsum;
- aggregates recovered/recycled from construction and demolition waste;
- gypsum recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene;
  - cellulose acetate;
  - low- and high-density polyethylene;
  - polycarbonate;
  - polyethylene terephthalate;



- polypropylene;
- polystyrene and expanded polystyrene
- polyurethane;
- polyvinyl chloride;
- rubber recovered/recycled from end-of-life tyres;
- a number of textile waste streams:
  - cellulosic and cotton fibres;
  - polyester fibres;
  - separately collected clothes and other textiles prepared for re-use; and
- separately collected waste electrical and electronic equipment prepared for re-use.

Conversely, the streams appraised to have a **lower potential** are:

- other bio-materials recovered or produced from waste water treatment and sewage sludge; and
- other plastic waste streams.

All the other streams were appraised to have an average potential.

**Table 10:** Appraisal of potential based on recovered material purity

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Variable composition <sup>a</sup>	2
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	High purity ( $\geq 99\%$ )	3
	Bio-plastics and bio-polymers	High purity ( $\geq 98\%$ )	3
	Cellulose	High purity <sup>a</sup>	3
	Other bio-materials	Unknown	1
	Phosphorus	High purity	3
	Potassium chloride	High purity ( $\geq 98\%$ )	3
	Sludge from urban waste water treatment and the food industry	Variable composition <sup>a</sup>	2
	Spent coffee ground	Variable composition <sup>a</sup>	2
Synthetic gypsum	Flue-gas desulphurisation gypsum	High purity ( $\geq 95\%$ )	3
	Phosphogypsum	High purity <sup>a</sup>	3
Mill scale	Mill scale from steel processing	Variable composition	2
Mineral fractions of construction and demolition waste	Aggregates	High purity	3
	Gypsum	High purity ( $\geq 85\%$ )	3

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	Variable composition <sup>a</sup>	2
Paper and cardboard	Paper and cardboard	High purity <sup>a</sup>	3
Plastics	Acrylonitrile butadiene styrene	High purity (≥95%)	3
	Cellulose acetate	High purity (≥99%)	3
	Low- and high-density polyethylene	High purity	3
	Mixed	Variable composition	2
	Other	Unknown	1
	Polycarbonate	High purity (≥95%)	3
	Polyethylene terephthalate	High purity (≥95%)	3
	Polypropylene	High purity (≥95%)	3
	Polystyrene (and expanded polystyrene)	High purity (≥95%)	3
	Polyurethane	High purity <sup>a</sup>	3
Polyvinyl chloride	High purity <sup>a</sup>	3	
Rubber	Rubber recovered/recycled from end-of-life tyres	High purity	3
Slags (from ferrous and	Copper slags (iron silicate)	Variable composition	2

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	Variable composition <sup>a</sup>	2
	Iron and steel slags	Variable composition <sup>a</sup>	2
Textiles	Carpets	Variable composition <sup>a</sup>	2
	Cellulosic fibres	High purity	3
	Separately collected clothes and other textiles prepared for re-use	Low level of contaminants	3
	Cotton	High purity	3
	Mixed fibres	Variable composition <sup>a</sup>	2
	Polyester	High purity	3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	Low level of contaminants	3
	Other waste not prepared for re-use	Variable composition <sup>a</sup>	2

<sup>a</sup> No data provided by stakeholders; qualitative estimate based on expert judgement.

### 3.8 Possibility to recover critical raw materials

The result of the appraisal of the potential of each candidate stream based on the possibility to recover critical raw materials is presented in **Table 11**.

The **objective** of this criterion was to differentiate between candidate streams for which recovery of critical raw materials is possible, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams for which no recovery of critical raw materials is possible, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams for which recovery of critical raw materials is possible as one of the objectives of developing further EU-wide end-of-waste or by-product criteria is to prevent critical raw materials losses.

The **scoring rule** was the following:

- candidate material streams for which a possibility to recover critical raw materials was reported by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and
- candidate material streams for which no possibility to recover critical raw materials was reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for the red mud stream (or bauxite residue), stakeholders reported the possibility to recover rare earth elements that are listed as critical raw materials. Therefore, this stream was given a score of 2.

Based on the possibility to recover critical raw materials, the streams appraised to have an **average potential** are:

- red mud / bauxite residue;
- phosphorus recovered or produced from waste water treatment and sewage sludge;
- rubber recovered/recycled from end-of-life tyres;
- ferro-alloys and silicon slags; and
- other waste electrical and electronic equipment (not prepared for re-use).

Conversely, all the other streams were appraised to have a **lower potential** (no high potential for this criteria).

**Table 11:** Appraisal of potential based on the possibility to recover critical raw materials

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Yes	2
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	No answer provided.	1
	Bio-plastics and bio-polymers	No	1
	Cellulose	No answer provided.	1
	Other bio-materials	No answer provided.	1
	Phosphorus	Yes	2
	Potassium chloride	No	1
	Sludge from urban waste water treatment and the food industry	No answer provided.	1
	Spent coffee ground	No answer provided.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	No	1
	Phosphogypsum	No answer provided.	1
Mill scale	Mill scale from steel processing	No	1
Mineral fractions of construction and demolition waste	Aggregates	No answer provided.	1
	Gypsum	No answer provided.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mineral wool	No answer provided.	1
Paper and cardboard	Paper and cardboard	No	1
Plastics	Acrylonitrile butadiene styrene	No answer provided.	1
	Cellulose acetate	No answer provided.	1
	Low- and high-density polyethylene	No answer provided.	1
	Mixed	No answer provided.	1
	Other	No answer provided.	1
	Polycarbonate	No answer provided.	1
	Polyethylene terephthalate	No answer provided.	1
	Polypropylene	No answer provided.	1
	Polystyrene (and expanded polystyrene)	No answer provided.	1
	Polyurethane	No answer provided.	1
Polyvinyl chloride	No answer provided.	1	
Rubber	Rubber recovered/recycled from end-of-life tyres	Yes	2
Slags (from ferrous and	Copper slags (iron silicate)	No answer provided.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	Yes	2
	Iron and steel slags	No	1
Textiles	Carpets	No answer provided.	1
	Cellulosic fibres	No answer provided.	1
	Separately collected clothes and other textiles prepared for re-use	No answer provided.	1
	Cotton	No answer provided.	1
	Mixed fibres	No answer provided.	1
	Polyester	No answer provided.	1
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	No answer provided.	1
	Other waste not prepared for re-use	Yes	2



### 3.9 Evidence of demand

The result of the appraisal of the potential of each candidate stream based on the evidence of demand is presented in **Table 12**.

The **objective** of this criterion was to differentiate between candidate streams with an evidence of demand, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams without an evidence of demand potential, which would then be considered as having a lower potential for the development of further EU-wide criteria. For that purpose the re-use rate or the virgin material replacement rate were (for example) considered as an evidence of demand. More importance was given to streams with an evidence of demand as one of the conditions of EU-wide by-product criteria refers to the certainty of the further use of the substance or object<sup>21</sup>, and one of the conditions of the EU-wide end-of-waste criteria refers to the existence of a demand for the substance or object<sup>22</sup>.

The **scoring rule** was the following:

- candidate material streams for which quantified evidence of demand was reported by stakeholders<sup>23</sup> were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which qualitative evidence of demand was reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which no evidence of demand was reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for flue-gas desulphurisation gypsum, stakeholders reported a demand, but did not provide data to quantify it. Therefore, this stream was given a score of 2.

Based on the evidence of demand, the streams appraised to have a **higher potential** are:

- red mud / bauxite residue;
- bio-polymers and bioplastics recovered or produced from waste water treatment and sewage sludge;
- cellulose recovered or produced from waste water treatment and sewage sludge;
- sludge from urban waste water treatment and the food industry;
- spent coffee ground;
- mille scale;
- aggregates recovered/recycled from construction and demolition waste;
- mineral wool recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- a number of plastic waste streams:
  - low- and high-density polyethylene;
  - polyethylene terephthalate;
  - polypropylene;
- rubber recovered/recycled from end-of-life tyres;
- iron and steel slags;
- a number of textile waste streams:

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<sup>21</sup> Article 5(1)(a) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>22</sup> Article 6(1)(b) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>23</sup> Where provided, the current virgin material replacement rate was considered as quantitative evidence of demand.

- cellulosic and cotton fibres;
  - polyester fibres;
  - mixed fibres;
  - separately collected clothes and other textiles prepared for re-use; and
- separately collected waste electrical and electronic equipment prepared for re-use.

Conversely, the streams appraised to have a **lower potential** are:

- other bio-materials recovered or produced from waste water treatment and sewage sludge;
- phosphogypsum;
- other plastic waste streams; and
- carpet waste.

All the other streams were appraised to have an average potential.

**Table 12:** Appraisal of potential based on evidence of demand

<b>Waste/by-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	3% input rate in cement industry	3
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	Qualitative evidence	2
	Bio-plastics and bio-polymers	Virgin material replacement: 5-20%	3
	Cellulose	Virgin material replacement: ~2%	3
	Other bio-materials	No answer provided.	1
	Phosphorus	Qualitative evidence	2
	Potassium chloride	Qualitative evidence	2
	Sludge from urban waste water treatment and the food industry	Compost replacement: ~20%	3
	Spent coffee ground	Animal feed substitution: ~10%	3
Synthetic gypsum	Flue-gas desulphurisation gypsum	Qualitative evidence	2
	Phosphogypsum	No answer provided.	1
Mill scale	Mill scale from steel processing	≥90% re-used	3
Mineral fractions of construction and demolition waste	Aggregates	~40% input rate in construction works	3
	Gypsum	Qualitative evidence	2

Waste/by-product stream category	Specific material stream	Summary of the data and information collected	Score
	Mineral wool	2-3% buildings renovation per year	3
Paper and cardboard	Paper and cardboard	40-50 Mt/y	3
Plastics	Acrylonitrile butadiene styrene	Qualitative evidence	2
	Cellulose acetate	Qualitative evidence	2
	Low- and high-density polyethylene	Virgin material replacement: ~20%	3
	Mixed	Qualitative evidence	2
	Other	No answer provided.	1
	Polycarbonate	Qualitative evidence	2
	Polyethylene terephthalate	Virgin material replacement: ~10%	3
	Polypropylene	Virgin material replacement: ~10%	3
	Polystyrene (and expanded polystyrene)	Qualitative evidence	2
	Polyurethane	Qualitative evidence	2
	Polyvinyl chloride	Qualitative evidence	2
Rubber	Rubber recovered/recycled from end-of-life tyres	Stable market over last decade, ~50% recycled into playgrounds, ~30% into moulded objects and ~20% into bitumen	3
Slags (from ferrous and	Copper slags (iron silicate)	Qualitative evidence	2

<b>Waste/by-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
non-ferrous metal processing)	Ferro-alloys and silicon slags	Qualitative evidence	2
	Iron and steel slags	Up to 50% recycled into cement and 30-50% road construction	3
Textiles	Carpets	No answer provided.	1
	Cellulosic fibres	Virgin material replacement: ~0.5%	3
	Separately collected clothes and other textiles prepared for re-use	Second hand clothes growing market	3
	Cotton	Virgin material replacement: 0.5-1%	3
	Mixed fibres	Virgin material replacement: ~0.5%	3
	Polyester	Virgin material replacement: ~5%	3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	Refurbished appliances growing market	3
	Other waste not prepared for re-use	Qualitative evidence	2

### 3.10 Existence of relevant international or national product standards

The result of the appraisal of the potential of each candidate based on the existence of relevant international or national product standards criteria is presented in **Table 13**.

The **objective** of this criterion was to differentiate between candidate streams with relevant product standards, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams without relevant product standards, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with relevant product standards as one of the conditions of EU-wide by-product criteria refers to relevant product requirements<sup>24</sup>, and one of the conditions of the EU-wide end-of-waste criteria refers to standards applicable to products<sup>25</sup>.

The **scoring rule** was the following:

- candidate material streams for which one or more EN, ISO or other equivalent international product standards were reported by stakeholders<sup>26</sup> were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which one or more national or industry product standards were reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which no product standards were reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for separately collected clothes and other textiles prepared for re-use, stakeholders reported industry standards in place, but did not provide any references to an international standard. Therefore, this stream was given a score of 2.

Based on the existence of relevant international or national product standards criteria, the streams appraised to have a **higher potential** are:

- red mud / bauxite residue;
- aggregates recovered/recycled from construction and demolition waste;
- mineral wool recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- a number of plastic waste streams:
  - cellulose acetate;
  - low- and high-density polyethylene;
  - polyethylene terephthalate;
  - polypropylene;
  - polystyrene and expanded polystyrene
  - polyvinyl chloride;
  - mixed plastics;
- rubber recovered/recycled from end-of-life tyres; and
- slags:
  - copper slags;

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<sup>24</sup> Article 5(1)(d) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>25</sup> Article 6(1)(c) of Directive 2008/98/EC as last amended by Directive 2018/851

<sup>26</sup> Withdrawn EN/ISO standards reported by stakeholders are not reported in **Table 13**, and were not considered for the appraisal of the potential.

- ferro-alloys and silicon slags;
- iron and steel slags.

Conversely, the streams appraised to have a **lower potential** are:

- bio-materials and materials recovered/produced from bio-materials (all the streams);
- phosphogypsum;
- mille scale;
- a number of plastic waste streams:
  - acrylonitrile butadiene styrene;
  - polycarbonate;
  - polyurethane;
  - other plastics;
- carpet waste; and
- other waste electrical and electronic equipment (not prepared for re-use).

All the other streams were appraised to have an average potential.

**Table 13:** Appraisal of potential based on the existence of relevant international product standards

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	EN 197-1:2011: Cement - Part 1: Composition, specifications and conformity criteria for common cements EN 413-1:2011: Masonry cement - Part 1: Composition, specifications and conformity criteria	3
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	No answer provided.	1
	Bio-plastics and bio-polymers	No answer provided.	1
	Cellulose	No answer provided.	1
	Other bio-materials	No answer provided.	1
	Phosphorus	No answer provided.	1
	Potassium chloride	No answer provided.	1
	Sludge from urban waste water treatment and the food industry	No answer provided.	1
	Spent coffee ground	No answer provided.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	Industry standards	2
	Phosphogypsum	No answer provided.	1
Mill scale	Mill scale from steel processing	No answer provided.	1



Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
Mineral fractions of construction and demolition waste	Aggregates	<p>EN 12620:2002+A1:2008: Aggregates for concrete</p> <p>EN 13043:2002: Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas</p> <p>EN 13055:2016: Lightweight aggregates</p> <p>EN 13139:2002: Aggregates for mortar</p> <p>EN 13242:2002+A1:2007: Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction</p> <p>EN 13285:2018: Unbound mixtures - Specifications</p> <p>EN 13383-1:2002/AC:2004: Armourstone - Part 1: Specification</p> <p>EN 13450:2002/AC:2004: Aggregates for railway ballast</p>	3
	Gypsum	Industry standards	2
	Mineral wool	<p>EN 13162:2012+A1:2015: Thermal insulation products for buildings - Factory made mineral wool (MW) products - Specification</p> <p>EN 14064-1:2018: Thermal insulation products for buildings - In-situ formed loose-fill mineral wool (MW) products - Part 1: Specification for the loose-fill products before installation</p> <p>EN 14064-2:2010: Thermal insulation products for buildings - In-situ formed loose-fill mineral wool (MW) products - Part 2: Specification for the installed products</p> <p>EN 14303: Thermal insulation products for building equipment and industrial installations - Factory made mineral wool (MW) products - Specification</p>	3
Paper and cardboard	Paper and cardboard	EN 643:2014: Paper and board - European list of standard grades of paper and board for recycling	3
Plastics	Acrylonitrile butadiene styrene	No answer provided.	1
	Cellulose acetate	ISO 12311:2013: Personal protective equipment — test methods for sunglasses and related	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
		eyewear ISO 12312: Eye and face protection ISO 12870:2016: Ophthalmic optics — spectacle frames — requirements and test methods	
	Low- and high-density polyethylene	EN 15344:2021: Plastics - Recycled plastics - Characterization of Polyethylene (PE) recyclates	3
	Mixed	EN 15342:2007: Plastics - Recycled Plastics - Characterization of polystyrene (PS) recyclates EN 15344:2021: Plastics - Recycled plastics - Characterization of Polyethylene (PE) recyclates EN 15345:2007: Plastics - Recycled Plastics - Characterisation of polypropylene (PP) recyclates EN 15346:2014: Plastics - Recycled plastics - Characterization of poly(vinyl chloride) (PVC) recyclates EN 15347:2007: Plastics - Recycled Plastics - Characterisation of plastics wastes EN 15348:2014: Plastics - Recycled plastics - Characterization of poly(ethylene terephthalate) (PET) recyclates CEN/TS 16010:2020: Plastics - Recycled plastics - Sampling procedures for testing plastics waste and recyclates	3
	Other	No answer provided.	1
	Polycarbonate	No answer provided.	1
	Polyethylene terephthalate	EN 15347:2007: Plastics - Recycled Plastics - Characterisation of plastics wastes EN 15348:2014: Plastics - Recycled plastics - Characterization of poly(ethylene terephthalate) (PET) recyclates CEN/TS 16861:2015: Plastics - Recycled plastics - Determination of selected marker compounds in food grade recycled polyethylene terephthalate (PET)	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
	Polypropylene	EN 15343:2007: Plastics - Recycled Plastics - Plastics recycling traceability and assessment of conformity and recycled content EN 15345:2007: Plastics - Recycled Plastics - Characterisation of polypropylene (PP) recyclates	3
	Polystyrene (and expanded polystyrene)	EN 15342:2007: Plastics - Recycled Plastics - Characterization of polystyrene (PS) recyclates	3
	Polyurethane	No answer provided.	1
	Polyvinyl chloride	EN 1566-1:1998: Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure - Chlorinated poly(vinyl chloride) (PVC-C) - Part 1: Specifications for pipes, fittings and the system EN 15346:2014: Plastics - Recycled plastics - Characterization of poly(vinyl chloride) (PVC) recyclates CEN/TS 14541:2013: Plastics pipes and fittings - Characteristics for utilisation of non-virgin PVC-U, PP and PE materials	3
Rubber	Rubber recovered/recycled from end-of-life tyres	EN 14243-1:2019: Materials obtained from end of life tyres - Part 1: General definitions related to the methods for determining their dimension(s) and impurities EN 14243-2:2019: Materials obtained from end of life tyres - Part 2: Granulates and powders - Methods for determining the particle size distribution and impurities, including free steel and free textile content EN 14243-3:2019: Materials obtained from end of life tyres - Part 3: Shreds, cuts and chips - Methods for determining their dimension(s) including protruding filaments dimensions EN 14836:2018: Surfaces for sports areas - Synthetic surfaces for outdoor sports areas - Test method for artificial weathering EN 14955:2005: Surfaces for sports areas - Determination of composition and particle shape of unbound mineral surfaces for outdoor sports areas EN 15330-1:2013: Surfaces for sports areas - Synthetic turf and needle-punched surfaces primarily designed for outdoor use - Part 1: Specification for synthetic turf surfaces for football,	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
		<p>hockey, rugby union training, tennis and multi-sports use</p> <p>CEN/TR 17511:2020: Materials obtained from End-of-Life Tyres - Odour of ELT granulates - Origin and remediation possibilities</p> <p>CEN/TS 16916:2016: Materials obtained from End-of-Life Tyres - Odour of ELT granulates - Origin and remediation possibilities</p> <p>CEN/TS 17045:2020: Materials obtained from end-of-life tyres - Quality criteria for the selection of whole tyres, for recovery and recycling processes</p> <p>CEN/TS 17188:2018: Materials obtained from end of life tyres (ELT) - Sampling method for granulates and powders stored in big-bags</p> <p>CEN/TS 17189:2018: Materials obtained from end of life tyres (ELT) - Determination of the true density of granulates - Method based on water pycnometry</p> <p>CEN/TS 17307:2019: Material derived from End-of-Life tyres - Granulates and powders - Elastomers identification: Gas-chromatography and mass-spectrometric detection of pyrolysis products in solution</p> <p>CEN/TS 17308:2019: Materials produced from end of life tyres - Steel wire - Determination of the non-metallic content</p> <p>CEN/TS 17510:2020: Materials obtained from end-of-life tyres - Determination of the specific surface area of powders - Method based on krypton adsorption</p> <p>CEN/TR 17511:2020: Materials obtained from End-of-Life Tyres - Odour of ELT granulates - Origin and remediation possibilities</p>	
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	<p>EN 206:2013+A2:2021: Concrete - Specification, performance, production and conformity</p> <p>EN 12620:2002+A1:2008: Aggregates for concrete</p> <p>EN 13383-1:2002/AC:2004: Armourstone - Part 1: Specification</p> <p>EN 13242:2002+A1:2007: Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction</p> <p>EN 13043:2002/AC:2004: Aggregates for bituminous mixtures and surface treatments for</p>	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
		roads, airfields and other trafficked areas EN 13285:2018: Unbound mixtures - Specifications EN 13139:2002: Aggregates for mortar EN 14227-2:2013: Hydraulically bound mixtures - Specifications - Part 2: Slag bound granular mixtures EN ISO 11126-3:2018: Preparation of steel substrates before application of paints and related products - Specifications for non-metallic blast-cleaning abrasives - Part 3: Copper refinery slag	
	Ferro-alloys and silicon slags	EN 197-1:2011: Cement - Part 1: Composition, specifications and conformity criteria for common cements EN 206:2013+A2:2021: Concrete - Specification, performance, production and conformity EN 12620:2002+A1:2008: Aggregates for concrete EN 13139:2002: Aggregates for mortar EN 13242:2002+A1:2007: Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction EN 13285:2018: Unbound mixtures - Specifications EN 13383-1:2002/AC:2004: Armourstone - Part 1: Specification EN 13450:2002/AC:2004: Aggregates for railway ballast EN 14227-2:2013: Hydraulically bound mixtures - Specifications - Part 2: Slag bound granular mixtures	3
	Iron and steel slags	EN 197-1:2011: Cement - Part 1: Composition, specifications and conformity criteria for common cements EN 206:2013+A2:2021: Concrete - Specification, performance, production and conformity EN 1744-1:2009+A1:2012: Tests for chemical properties of aggregates - Part 1: Chemical analysis	3

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
		<p>EN 1744-3:2002: Tests for chemical properties of aggregates - Part 3: Preparation of eluates by leaching of aggregates</p> <p>EN 12620:2002+A1:2008: Aggregates for concrete</p> <p>EN 12945:2014+A1:2016: Liming materials - Determination of neutralizing value - Titrimetric methods</p> <p>EN 13043:2002/AC:2004: Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas</p> <p>EN 13139:2002: Aggregates for mortar</p> <p>EN 13242:2002+A1:2007: Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction</p> <p>EN 13282-1:2013: Hydraulic road binders - Part 1: Rapid hardening hydraulic road binders - Composition, specifications and conformity criteria</p> <p>EN 13282-2:2015: Hydraulic road binders - Part 2: Normal hardening hydraulic road binders - Composition, specifications and conformity criteria</p> <p>EN 13282-3:2015: Hydraulic road binders - Part 3: Conformity evaluation</p> <p>EN 13285:2018: Unbound mixtures - Specifications</p> <p>EN 13383-1:2002/AC:2004: Armourstone - Part 1: Specification</p> <p>EN 13383-2:2009: Armourstone, Part 2: Test methods</p> <p>EN 13450:2002/AC:2004: Aggregates for railway ballast</p> <p>EN 14227-2:2013: Hydraulically bound mixtures - Specifications - Part 2: Slag bound granular mixtures</p> <p>EN 15167-1:2006: Ground granulated blast furnace slag for use in concrete, mortar and grout - Part 1: Definitions, specifications and conformity criteria</p>	
Textiles	Carpets	No answer provided.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Cellulosic fibres	Industry standards	2
	Separately collected clothes and other textiles prepared for re-use	Industry standards	2
	Cotton	Industry standards	2
	Mixed fibres	Industry standards	2
	Polyester	Industry standards	2
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	Industry standards	2
	Other waste not prepared for re-use	No answer provided.	1

### 3.11 Existence of national or regional end-of-waste or by-product criteria

The result of the appraisal of the potential of each candidate stream based on the existence of national or regional end-of-waste or by-product criteria is presented in **Table 14**.

The **objective** of this criterion was to differentiate between candidate streams with national or regional end-of-waste or by-product criteria already in place, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams without national or regional end-of-waste or by-product criteria, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with national or regional end-of-waste or by-product criteria as on the one hand, the existence of such national or regional criteria may ease the development of further EU-wide criteria, and on the other hand, the further development of EU-wide end-of-waste or by-product criteria may help a more harmonised and uniform application of end-of-waste or by-product criteria across the EU.

The **scoring rule** was the following:

- candidate material streams for which more than one national or regional end-of-waste or by-product criteria were reported by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which one national or regional end-of-waste or by-product criterion or one or more case-by-case decisions were reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which for which no national or regional end-of-waste or by-product criteria or case-by-case decisions were reported by stakeholders were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for gypsum recovered/recycled from construction and demolition waste, stakeholders reported one national end-of-waste criteria in the United Kingdom only. Therefore, this stream was given a score of 2.

Based on the existence of national or regional end-of-waste or by-product criteria, the streams appraised to have a **higher potential** are:

- aggregates recovered/recycled from construction and demolition waste;
- paper and cardboard wastes;
- plastics (all the waste streams);
- rubber recovered/recycled from end-of-life tyres;
- iron and steel slags; and
- separately collected waste electrical and electronic equipment prepared for re-use.

Conversely, the streams appraised to have a **lower potential** are:

- red mud / bauxite residue;
- bio-materials and materials recovered/produced from bio-materials (all the streams);
- phosphogypsum;
- mineral wool recovered/recycled from construction and demolition waste;
- copper slags;
- ferro-alloys and silicon slags;
- carpet waste; and
- other waste electrical and electronic equipment (not prepared for re-use).

All the other streams were appraised to have an average potential.



**Table 14:** Appraisal of potential based on the existence of national or regional end-of-waste or by-product criteria

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	No answer provided.	1
Bio-materials and materials recovered/produced from bio-materials <sup>a</sup>	Ammonium salts	No answer provided.	1
	Bio-plastics and bio-polymers	No answer provided.	1
	Cellulose	No answer provided.	1
	Other bio-materials	No answer provided.	1
	Phosphorus	No answer provided.	1
	Potassium chloride	No answer provided.	1
	Sludge from urban waste water treatment and the food industry	No answer provided.	1
	Spent coffee ground	No answer provided.	1
Synthetic gypsum	Flue-gas desulphurisation gypsum	Reported as a by-product in some Member States (list of Member States not provided, and type of criteria unknown, i.e. case-by-case decision or a by-product criterion).	2
	Phosphogypsum	No answer provided.	1

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Mill scale	Mill scale from steel processing	By-product on a case-by-case basis in Germany. May be classified as a by-product in Sweden. Mostly classified as waste in Italy. By-product or end-of-waste on a case-by-case basis. Classified as waste in Spain.	2
Mineral fractions of construction and demolition waste	Aggregates	End-of-waste status on a case-by-case basis in Italy and Ireland. National end-of-waste criteria in preparation in Spain for 17 01 01 concrete waste and 17 03 02 bituminous mixtures other than those mentioned in 17 03 01. National or regional end-of-waste criteria in Austria, Flanders and the Netherlands. National end-of-waste criteria in France for sediments and excavated soils, inert (and non-hazardous) mineral wastes. National end-of-waste criteria in Poland for reclaimed asphalt.	3
	Gypsum	National end-of-waste criteria in the United Kingdom. Industry criteria.	2
	Mineral wool	No answer provided.	1
Paper and cardboard	Paper and cardboard	National or regional end-of-waste criteria in Bavaria, North Rhine-Westphalia, Spain, France and Italy.	3
Plastics	Acrylonitrile butadiene styrene	No answer provided.	3 <sup>b</sup>
	Cellulose acetate	National by-product criteria in Italy.	3 <sup>b</sup>
	Low- and high-density polyethylene	No answer provided.	3 <sup>b</sup>

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Mixed	National end-of-waste criteria in preparation in Spain for mechanical recycling of plastics. National or regional end-of-waste criteria in Flanders and the United Kingdom.	3
	Other	No answer provided.	3 <sup>b</sup>
	Polycarbonate	No answer provided.	3 <sup>b</sup>
	Polyethylene terephthalate	Single case decision in Ireland for PET recyclate flakes	3 <sup>b</sup>
	Polypropylene	National end-of-waste criteria in the Netherlands.	3 <sup>b</sup>
	Polystyrene (and expanded polystyrene)	No answer provided.	3 <sup>b</sup>
	Polyurethane	National by-product criteria in Spain for trim foam. End-of-waste status on a case-by-case basis in the Netherlands.	3 <sup>b</sup>
	Polyvinyl chloride	Non-binding advice decision on a single case.	3 <sup>b</sup>
Rubber	Rubber recovered/recycled from end-of-life tyres	National end-of-waste criteria in Estonia and France. National end-of-waste criteria in Portugal and the United Kingdom for recycled tyres, National end-of-waste criteria in the Czech Republic, Denmark, Italy Portugal, Slovakia and the United Kingdom for granulates derived from end-of-life tyres, and in the Netherlands for granulates used in infill applications. National end-of-waste criteria in preparation in Greece, Spain, Estonia and Latvia.	3
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	No answer provided.	1
	Ferro-alloys and silicon slags	No answer provided.	1

Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
	Iron and steel slags	National or regional end-of-waste or by-product criteria in North Rhine-Westphalia, Belgium, France, Finland, Austria and the United Kingdom.	3
Textiles	Carpets	No answer provided.	1
	Cellulosic fibres	National end-of-waste in France for cut wiping cloths made from used textiles to be used as rags.	2
	Separately collected clothes and other textiles prepared for re-use	End-of-waste status on a case-by-case basis in Italy. National end-of-waste criteria in Austria for second-hand textiles.	2
	Cotton	No answer provided.	2 <sup>c</sup>
	Mixed fibres	National end-of-waste in France for cut wiping cloths made from used textiles to be used as rags.	2
	Polyester	No answer provided.	2 <sup>c</sup>
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	National end-of-waste criteria in Austria and France for refurbished/repared waste electrical and electronic equipment.	3
	Other waste not prepared for re-use	No answer provided.	1

a Estonia, France and Italy provided a reference to national legislation on sewage sludge, soil improvers or agricultural law, but no clear reference to national or regional end-of-waste or by-product criteria was provided.

b Based on the assessment that the end-of-waste criteria reported by stakeholders for mixed plastics may also be relevant for this specific stream.

c Based on the assessment that the end-of-waste criteria reported by stakeholders for cut wiping cloths made from used textiles to be used as rags may also be relevant for this specific stream.

### 3.12 Expected environmental and human health impacts

The result of the appraisal of the potential of each candidate stream based on the expected environmental and human health impacts<sup>27</sup> is presented in **Table 15**.

The **objective** of this criterion was to differentiate between candidate streams with potentially higher benefits and lower risks for the environment and human health, which would then be considered as having a higher potential for the development of further EU-wide criteria; and the candidate streams with potentially lower benefits and possible risks for the environment and human health, which would then be considered as having a lower potential for the development of further EU-wide criteria. More importance was given to streams with potentially higher benefits and lower risks for the environment and human health as one of the conditions of EU-wide end-of-waste or by-product criteria refers to overall adverse environmental or human health impacts<sup>28</sup>.

The **scoring rule** was the following:

- candidate material streams for which mostly quantified benefits without possible risks were reported by stakeholders were considered as having a higher potential for EU-wide end-of-waste or by-product criteria, and were given a score of 3 (green);
- candidate material streams for which either mostly not quantified benefits without possible risks or balanced risks and benefits were reported by stakeholders were considered as having an average potential for EU-wide end-of-waste or by-product criteria, and were given a score of 2 (yellow); and finally
- candidate material streams for which for which mostly risks were reported, or no answer was provided by stakeholders, were considered as having a lower potential for EU-wide end-of-waste or by-product criteria, and were given a score of 1 (red).

For **example**, for potassium chloride recovered or produced from waste water and sewage sludge, stakeholders reported possible CO<sub>2</sub> savings, but did not provide any value for these (not quantified). Therefore, this stream was given a score of 2.

Based on the expected environmental and human health impacts, the streams appraised to have a **higher potential** are:

- spent coffee ground;
- cellulose acetate; and
- textile waste (all the streams except carpet waste).

Conversely, the streams appraised to have a **lower potential** are:

- red mud / bauxite residue;
- cellulose recovered or produced from waste water treatment and sewage sludge (no answer provided);
- other bio-materials recovered or produced from waste water treatment and sewage sludge;
- sludge from urban waste water treatment and the food industry;
- phosphogypsum (no answer provided);
- mineral fractions of construction and demolition waste (all the streams);
- polyvinyl chloride;
- rubber recovered/recycled from end-of-life tyres;
- ferro-alloys and silicon slags (no answer provided);
- carpet waste; and

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<sup>27</sup> This appraisal aims to estimate the potential of each stream for EU-wide end-of-waste or by-product criteria and does not in any way represent a risk assessment or an environmental risk assessment.

<sup>28</sup> Articles 5(1)(d) and 6(1)(d) of Directive 2008/98/EC as last amended by Directive 2018/851

— separately collected waste electrical and electronic equipment prepared for re-use (no answer provided).  
All the other streams were appraised to have an average potential.

**Table 15:** Appraisal potential based on the expected environmental and human health impact

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Bauxite residue	Red mud	Possible risk of metal leaching.	1
Bio-materials and materials recovered/produced from bio-materials <sup>a</sup>	Ammonium salts	Possible benefits of energy savings, greenhouse gas emissions reduction and chemicals use reduction (not quantified).	2
	Bio-plastics and bio-polymers	Possible benefits of greenhouse gas emissions reduction and land use reduction (not quantified).	2
	Cellulose	No answer provided.	1
	Other bio-materials	Possible risk of contamination with pathogens, heavy metals, pharmaceutical and micro plastics.	1
	Phosphorus	Possible benefit of greenhouse gas emissions reduction (not quantified).	2
	Potassium chloride	Possible benefit of greenhouse gas emissions reduction (not quantified).	2
	Sludge from urban waste water treatment and the food industry	Possible risks of contamination with and mobilisation of persistent organic pollutants.	1
	Spent coffee ground	Possible benefits of greenhouse gas emissions reduction and land use reduction: 591 406 t CO <sub>2</sub> /year, 2 542 t SO <sub>2</sub> /year, 1 641 t NO <sub>3</sub> /year, and land occupation 295 312 ha/year.	3
Synthetic gypsum	Flue-gas desulphurisation gypsum	Low environmental risks based on toxicity assessment (not specified).	2
	Phosphogypsum	No answer provided.	1
Mill scale	Mill scale from steel processing	REACH registered, assessed as not hazardous (based on chemicals labelling and packaging requirements). Possible risk of oil contamination.	2

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
Mineral fractions of construction and demolition waste	Aggregates	Possible risks of metal leaching (e.g. antimony, cadmium, copper, chromium, lead, vanadium), sulphates leaching, and contamination with asbestos, phthalates, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons.	1
	Gypsum	Possible risks of contamination with substances of very high concern (not specified).	1
	Mineral wool	Possible risk of contamination with legacy substances (not specified).	1
Paper and cardboard	Paper and cardboard	Low environmental risk, but possible risk of contamination with polychlorinated biphenyls and per- and poly-fluoroalkyl substances.	2
Plastics	Acrylonitrile butadiene styrene	Possible benefits of energy savings and greenhouse gas emissions reduction (not quantified). Possible risk of contamination with fire retardants, per- and poly-fluoroalkyl substances and other additives contamination (not specified).	2
	Cellulose acetate	Possible benefit of greenhouse gas emissions reduction: 22%.	3
	Low- and high-density polyethylene	Possible benefits of energy savings and greenhouse gas emissions reduction (not quantified apart from for recycled polystyrene, for which an 80% greenhouse gas emissions reduction was reported).  Possible risk of contamination with fire retardants, per- and poly-fluoroalkyl substances and other additives (not specified).	2
	Mixed		2
	Other		2
	Polycarbonate		2
	Polyethylene terephthalate		2
	Polypropylene		2
	Polystyrene (and expanded polystyrene)		2



Waste/By-product stream category	Specific material stream	Summary of the data and information collected	Score
	Polyurethane	Low environmental risk, but possible risk of contamination with fire retardants (not specified).	2
	Polyvinyl chloride	Possible risk of contamination with heat stabilisers, plasticisers, per- and poly-fluoroalkyl substances and other hazardous substances (e.g. chlorine, mercury, fluorinated substances, cadmium, lead, phthalates, bromine).	1
Rubber	Rubber recovered/recycled from end-of-life tyres	<p>Possible benefit of greenhouse gas emissions reduction: ~1 t of CO<sub>2</sub> per tonne of end-of-life tyres or rubber granulates.</p> <p>Possible positive impact for road construction: based on a life cycle assessment, modified bitumen with recycled end-of-life tyres has a positive impact in all the impact categories (not specified which ones) compared to conventional pavement (+30%).</p> <p>Possible risk of contamination with and leaching of polycyclic aromatic hydrocarbons, heavy metals (not specified), and micro plastics.</p> <p>Possible concern over benzene formation during chemical recycling.</p>	2
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	REACH registered, assessed as not hazardous (based on chemicals labelling and packaging requirements). Possible risk of copper leaching.	2
	Ferro-alloys and silicon slags	No answer provided.	1
	Iron and steel slags	REACH registered, assessed as not hazardous (based on chemicals labelling and packaging requirements).	2
Textiles	Carpets	Possible risk of contamination and leaching of metals (not specified) and substances of very high concern (e.g. phthalates, polycyclic aromatic hydrocarbons, per- and poly-fluoroalkyl substances).	1
	Cellulosic fibres	Possible benefits of:	3
	Separately collected clothes and other textiles prepared for re-use	<ul style="list-style-type: none"> <li>— water savings: up to 99%, e.g. 765 t of water saved for 1 t of cotton mechanically recycled;</li> <li>— energy savings: e.g. 85% for recycled cotton; and</li> </ul>	3

<b>Waste/By-product stream category</b>	<b>Specific material stream</b>	<b>Summary of the data and information collected</b>	<b>Score</b>
	Cotton	— greenhouse gas emissions reduction: from 27% to 98% for mechanical recycling, e.g. ~90% for recycled cotton, 66% for mechanically recycled polyester, and 5-27% for chemical recycling, or a reduction of 3 kg CO <sub>2</sub> per kilogram of recycled textiles thanks to landfill diversion.	3
	Mixed fibres		3
	Polyester	Possible risk of contamination with legacy substances (not specified), fire retardants, per- and poly-fluoroalkyl substances and other additives (not specified).	3
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	No answer provided.	1
	Other waste not prepared for re-use	Possible benefits of removal of luminescent coating. Possible risk of contamination with persistent organic pollutants, phthalates, fire retardants and heavy metals (e.g. lead, barium, strontium).	2

### 3.13 Overall potential and final ranking

The overall potential and the final ranking are based on both the methodology developed and presented in Section 2 and the data and information provided by stakeholders, and supplemented with publicly available information or expert judgement where necessary and possible, and summarised in the previous sections (Section 3.1 to Section 3.12).

As detailed in Section 2.3, the overall potential for each candidate stream was calculated as the weighted sum ( $WS_j^i$ ) of the scores ( $S_j^i$ ) obtained by each candidate stream ( $i$ ) for each ranking criterion ( $j$ ) using Equation 1:

$$WS_j^i = \sum_{j=1}^{12} w_j \cdot S_j^i \quad (\text{Equation 1})$$

where  $w_j$  represents the weighting factor attributed to a ranking criterion  $j$ ; and

$S_j^i$  the score of a candidate stream  $i$  for a given ranking criterion  $j$ , presented in the previous sections for each ranking criteria (Section 3.1 to Section 3.12).

An overview table showing the scores and overall potential of each candidate stream calculated following Equation 1 is provided in the Annex (see Section 5.1).

The candidate streams were then ranked from the one with the lowest to the one with the highest potential, based on their calculated overall potential, i.e. the weighted sum ( $WS_j^i$ ) of the scores ( $S_j^i$ ) obtained after appraisal of their potential.

The final ranking is plotted in **Figure 2**. As visible on this graph, the candidate stream with the highest overall potential to develop further EU-wide end-of-waste or by-product criteria was the polyethylene terephthalate plastic waste stream.

Conversely, other bio-materials not covered by the Fertilising Products Regulation<sup>8</sup> (other than ammonium salts, bio-plastics and bio-polymers, cellulose, phosphorus and potassium chloride recovered or produced from waste water treatment and sewage sludge, sludge from urban waste water treatment and the food industry, or spent coffee ground) were appraised to have the lowest potential.

Based on the ranking of the overall potential values (weighted sums of scores), the following waste or by-product streams had an overall potential greater than the 66<sup>th</sup> percentile of the distribution<sup>29</sup> (top tercile) and are indicated in green on the graph:

- polyethylene terephthalate recovered/recycled from plastic waste;
- low- and high-density polyethylene recovered/recycled from plastic waste;
- separately collected clothes and other textiles prepared for re-use;
- rubber recovered/recycled from end-of-life tyres;
- aggregates recovered/recycled from construction and demolition waste;
- mixed plastics recovered/recycled from plastic waste;
- polystyrene and expanded polystyrene recovered/recycled from plastic waste;
- cellulosic fibres recovered/recycled from textile waste;
- mineral wool recovered/recycled from demolition waste;
- paper and cardboard waste;
- polypropylene plastic recovered/recycled from plastic waste; and
- mixed fibres recovered/recycled from textile waste.

The top tercile covered 5 waste/by-product categories and 12 streams in total. The plastics, with 5 candidate streams, were the most represented group in the top tercile. The textiles, with 3 candidate streams, were the

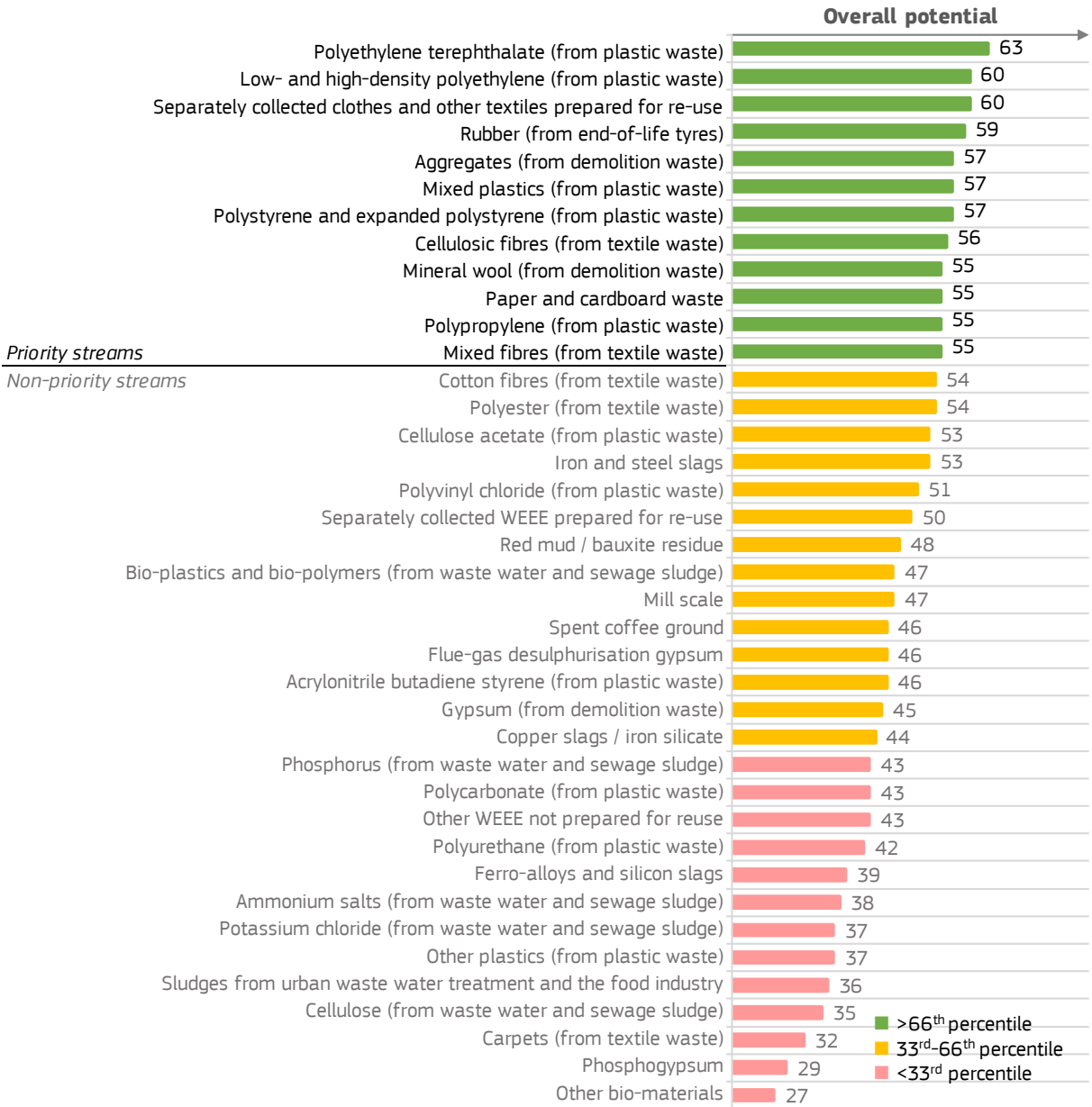
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<sup>29</sup> The 33<sup>rd</sup> and 66<sup>th</sup> percentiles of the overall potential values' (weighted sums of scores) distribution were 43.3 and 54.0 respectively.

second most represented group in the top tercile. The mineral fractions of construction and demolition waste were represented with 2 candidate streams in the top tercile. Finally, rubber recovered/recycled from end-of-life tyres and paper and cardboard waste were also in the top tercile, each with a candidate stream.

Other waste or by-product streams with an average or low overall potential are indicated in yellow and red respectively.

**Figure 2:** Final ranking of the candidate streams for which to develop further EU-wide end-of-waste or by-product criteria based on their overall potential



## 4 Conclusion

Based on the methodology developed in Section 2 and the data and information provided by stakeholders summarised in Section 3, the candidate streams were ranked based on their overall potential for the further development of EU-wide end-of-waste or by-product criteria. The streams with a higher overall potential (top tercile) were identified as **priority streams (objective 1)**. The identified priority list includes the following waste/by-product categories and streams in the top tercile:

### 1 – Plastics:

- polyethylene terephthalate recovered/recycled from plastic waste;
- low- and high-density polyethylene recovered/recycled from plastic waste;
- mixed plastics waste recovered/recycled from plastic waste;
- polystyrene and expanded polystyrene recovered/recycled from plastic waste; and
- polypropylene plastic recovered/recycled from plastic waste.

### 2 – Textiles:

- separately collected clothes and other textiles prepared for re-use;
- cellulosic fibres recovered/recycled from textile waste; and
- mixed fibres recovered/recycled from textile waste.

### 3 – Rubber:

- rubber recovered/recycled from end-of-life tyres.

### 4 – Mineral fractions of construction and demolition wastes:

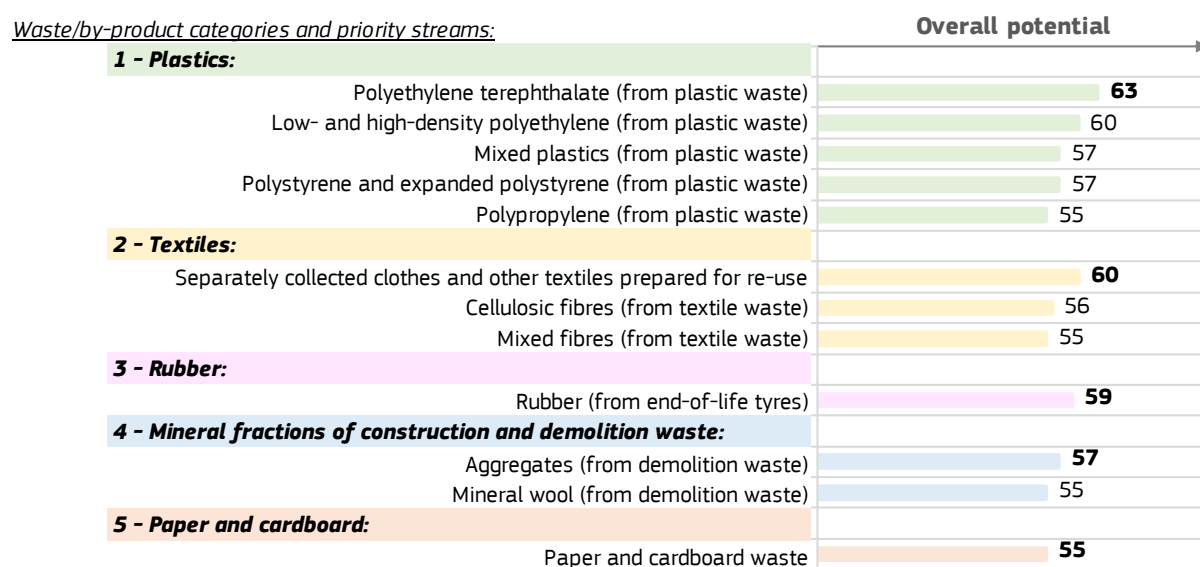
- aggregates recovered/recycled from construction and demolition waste; and
- mineral wool recovered/recycled from demolition waste.

### 5 – Paper and cardboard:

- paper and cardboard waste.

The list of priority streams, grouped per waste/by-product category and ranked based on the overall potential of each stream as presented in Section 3.13, is plotted in **Figure 3**.

**Figure 3:** List of priority streams grouped per category, and ranked based on their overall potential



Finally, considering the priority streams, the waste/by-product categories and the ranking, a shortlist of **top-candidate streams** for which to develop further EU-wide end-of-waste or by-product criteria (**objective 2**) was derived. Based on the applied methodology and data and information provided by stakeholders, the **plastic waste category** was identified as having the highest overall potential. On the one hand, 5 out of 12 priority streams belong to the plastic waste category. On the other hand, polyethylene terephthalate recovered/recycled from plastic waste obtained the highest overall score for potential from all waste/by-product streams, followed by low- and high-density polyethylene recovered/recycled from plastic waste with the second highest overall score for potential. Therefore, the **plastic waste category with its 5 top-candidate streams** is proposed for the further development of EU-wide end-of-waste or by-products:

- **polyethylene terephthalate** recovered/recycled from plastic waste;
- low- and high-density **polyethylene** recovered/recycled from plastic waste;
- **mixed plastics** recovered/recycled from plastic waste;
- **polystyrene** and **expanded polystyrene** recovered/recycled from plastic waste; and
- **polypropylene** recovered/recycled from plastic waste.

## 5 Annex

### 5.1 Overview table

The detailed results of the appraisal of the potential of each ranking criterion are presented in the following sections:

- 3.1 Level of support from stakeholders to develop further EU-wide end-of-waste or by-product criteria
- 3.2 Current collection and material re-use/recycling rates
- 3.3 Identified uses, types of uses (material recycling versus other recovery operations) and impacted economic sectors
- 3.4 Total EU market value
- 3.5 Intra-EU shipments
- 3.6 Extra-EU shipments
- 3.7 Purity/composition of recovered materials
- 3.8 Possibility to recover critical raw materials
- 3.9 Evidence of demand
- 3.10 Existence of relevant international or national product standards
- 3.11 Existence of national or regional end-of-waste or by-product criteria
- 3.12 Expected environmental and human health impacts

**Table 13** presents a summary of this appraisal exercise. It provides an overview of the scores ( $S_j^i$ ) obtained by each candidate stream ( $i$ ) – rows – for each ranking criterion ( $j$ ) – columns. The last column corresponds to the overall potential, calculated as the weighted sum ( $WS_j^i$ ) of the scores ( $S_j^i$ ) using Equation 1 presented in Section 2.3:

$$WS_j^i = \sum_{j=1}^{12} w_j \cdot S_j^i \quad (\text{Equation 1})$$

where  $w_j$  represents the weighting factor attributed to a ranking criterion  $j$  (see **Table 3** for the weighting factors); and

$S_j^i$  the score of a candidate stream  $i$  for a given ranking criterion  $j$ .

**Table 16:** Overview table of scores and overall potential used for the ranking of candidate streams (weighting factor indicated in brackets)

<b>Waste/by-product stream category</b>	<b>Specific material stream</b>	<b>Level of support (w=3)</b>	<b>Collection and recycling (w=2)</b>	<b>Uses (w=2)</b>	<b>EU market value (w=3)</b>	<b>Intra-EU shipments (w=1)</b>	<b>Extra-EU shipments (w=1)</b>	<b>Purity (w=1)</b>	<b>Critical raw materials (w=1)</b>	<b>Evidence of demand (w=3)</b>	<b>Existing standards (w=2)</b>	<b>Existing criteria (w=2)</b>	<b>Expected impacts (w=3)</b>	<b>WEIGHTED SUM (WS)</b>
Bauxite residue	Red mud	2	3	3	1	2	1	2	2	3	3	1	1	<b>48</b>
Bio-materials and materials recovered/produced from bio-materials	Ammonium salts	2	1	2	1	1	2	3	1	2	1	1	2	<b>38</b>
	Bio-plastics and bio-polymers	2	1	3	2	1	3	3	1	3	1	1	2	<b>47</b>
	Cellulose	2	1	1	1	1	1	3	1	3	1	1	1	<b>35</b>
	Other bio-materials	2	1	1	1	1	1	1	1	1	1	1	1	<b>27</b>
	Phosphorus	2	1	2	2	3	1	3	2	2	1	1	2	<b>43</b>
	Potassium chloride	2	1	2	1	1	1	3	1	2	1	1	2	<b>37</b>
	Sludge from urban waste water treatment and the food industry	2	1	1	1	2	2	2	1	3	1	1	1	<b>36</b>
	Spent coffee ground	2	3	2	1	1	1	2	1	3	1	1	3	<b>46</b>
Synthetic gypsum	Flue-gas desulphurisation gypsum	2	1	2	2	1	3	3	1	2	2	2	2	<b>46</b>
	Phosphogypsum	2	1	1	1	1	1	3	1	1	1	1	1	<b>29</b>



Waste/by-product stream category	Specific material stream	Level of support (w=3)	Collection and recycling (w=2)	Uses (w=2)	EU market value (w=3)	Intra-EU shipments (w=1)	Extra-EU shipments (w=1)	Purity (w=1)	Critical raw materials (w=1)	Evidence of demand (w=3)	Existing standards (w=2)	Existing criteria (w=2)	Expected impacts (w=3)	WEIGHTED SUM (WS)	
Mill scale	Mill scale from steel processing	2	1	3	1	3	3	2	1	3	1	2	2	47	
Mineral fractions of construction and demolition waste	Aggregates	3	1	2	3	3	2	3	1	3	3	3	1	57	
	Gypsum	3	1	3	1	3	1	3	1	2	2	2	1	45	
	Mineral wool	3	3	2	3	2	2	2	1	3	3	1	1	55	
Paper and cardboard	Paper and cardboard	1	1	2	3	3	3	3	1	3	3	3	2	55	
Plastics	Acrylonitrile butadiene styrene	3	1	1	1	3	3	3	1	2	1	3	2	46	
	Cellulose acetate	3	1	1	1	3	3	3	1	2	3	3	3	53	
	Low- and high-density polyethylene	3	1	3	2	3	3	3	1	3	3	3	2	60	
	Mixed	3	3	3	1	3	3	2	1	2	3	3	2	57	
	Other	3	1	1	1	1	1	1	1	1	1	3	2	37	
	Polycarbonate	2	1	1	1	3	3	3	3	1	2	1	3	2	43
	Polyethylene terephthalate	3	1	3	3	3	3	3	1	3	3	3	2	63	
	Polypropylene	3	1	3	1	2	2	2	3	1	3	3	3	2	55

Waste/by-product stream category	Specific material stream	Level of support (w=3)	Collection and recycling (w=2)	Uses (w=2)	EU market value (w=3)	Intra-EU shipments (w=1)	Extra-EU shipments (w=1)	Purity (w=1)	Critical raw materials (w=1)	Evidence of demand (w=3)	Existing standards (w=2)	Existing criteria (w=2)	Expected impacts (w=3)	WEIGHTED SUM (WS)
	Polystyrene (and expanded polystyrene)	2	2	3	3	2	2	3	1	2	3	3	2	57
	Polyurethane	2	1	1	1	3	2	3	1	2	1	3	2	42
	Polyvinyl chloride	2	3	2	2	2	2	3	1	2	3	3	1	51
Rubber	Rubber recovered/recycled from end-of-life tyres	2	1	2	3	3	3	3	2	3	3	3	2	59
Slags (from ferrous and non-ferrous metal processing)	Copper slags (iron silicate)	2	1	2	2	2	1	2	1	2	3	1	2	44
	Ferro-alloys and silicon slags	2	1	2	1	2	1	2	2	2	3	1	1	39
	Iron and steel slags	1	1	2	3	3	2	2	1	3	3	3	2	53
Textiles	Carpets	2	3	1	1	1	1	2	1	1	1	1	1	32
	Cellulosic fibres	3	3	1	1	3	3	3	1	3	2	2	3	56
	Separately collected clothes and other textiles prepared for re-use	3	2	3	2	3	2	3	1	3	2	2	3	60
	Cotton	3	3	1	1	1	3	3	1	3	2	2	3	54
	Mixed fibres	3	3	1	1	3	3	2	1	3	2	2	3	55

Waste/by-product stream category	Specific material stream	Level of support (w=3)	Collection and recycling (w=2)	Uses (w=2)	EU market value (w=3)	Intra-EU shipments (w=1)	Extra-EU shipments (w=1)	Purity (w=1)	Critical raw materials (w=1)	Evidence of demand (w=3)	Existing standards (w=2)	Existing criteria (w=2)	Expected impacts (w=3)	WEIGHTED SUM (WS)
	Polyester	3	3	1	1	1	3	3	1	3	2	2	3	<b>54</b>
Waste electrical and electronic equipment	Separately collected waste electrical and electronic equipment prepared for re-use	3	3	2	1	1	1	3	1	3	2	3	1	<b>50</b>
	Other waste not prepared for re-use	1	2	3	2	3	1	2	2	2	1	1	2	<b>43</b>



## 6 List of abbreviations and definitions

CO <sub>2</sub>	Carbon dioxide
EC	European Commission
EEE	Electrical and electronic equipment
EU	European Union
EUR	Euro
MEUR	Million euros: EUR 1 000 000
Mt	Million tonnes: 1 000 000 t
MUSD	Million United States dollars: USD 1 000 000
NGO	Non-Governmental Organisation
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
USD	United States Dollar
WEEE	Waste electrical and electronic equipment
y	year



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