

# CIRCE2020

## DT1.3.4 M-SCALE ANALYSIS OF THE PHYSICAL FLOWS AT LOCAL INDUSTRIAL SYSTEM LEVEL

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# 1. Introduction

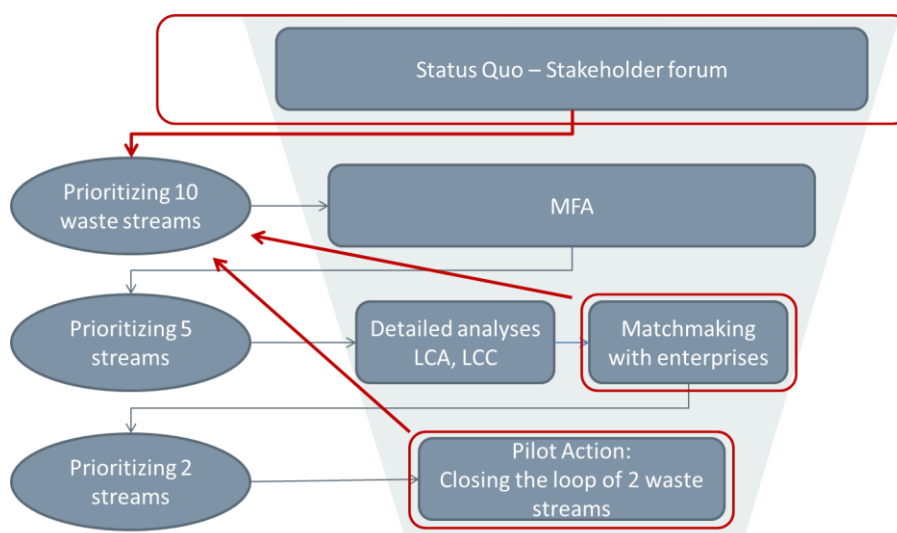
## 1.1. Data collection and quality

As explained in detail in the report DT1.3.2 (*Report of the quantity of industrial waste in the Circe2020 Pilot areas*), available data are from various sources and are not always consistent.

The data sources depend on the specific waste stream: some are company data, and others are from general research and are regional averages or estimates.

## 1.2. Selection of waste flows

For the MFA analyses, 10 waste streams were selected based on the feedback of 27 stakeholder interviews (see Figure 1). The stakeholders represented regional administration, private companies, business support associations and universities. The interviews were carried out on one-to-one basis, between December 2017 and May 2018. In addition to this feedback, the willingness of companies to cooperate and potential ideas for a circular solution were relevant criteria for the selection of these 10 waste streams. To gather this information, some parts of the steps ‘Matchmaking with enterprises’ and ‘Closing the loop’ were done earlier than scheduled.



**Figure 1: Work flow of the project steps. Indicated in red are the steps which were considered for the selection of the 10 waste streams.**

## 2. MFA Tool results

In total, 10 waste streams were selected for the material flow analysis (Table 1).



**Table 1: Selected waste streams for material flow analysis.**

	Waste streams	Waste producing enterprises	Economic sector	Circular solution idea
1	Waste wood	Several companies	Several	Wood gas power plant
2	Sheep wool, minor quality	Sheep Breeding Association	Primary production	Fertilizing pellets
3	Non-saleable vegetables (rejects)	Farmers	Primary production	Rejects retail / convenience food
4	Old bread	Bakery	Food production	Animal feed
5	Organic waste	Supermarkets, restaurants, hotels	Food production, gastronomy, tourism, retail	Production of regional soil
6	Grease trap waste	Restaurants, hotels	Gastronomy and tourism	Biogas/Biodiesel
7	Sewage sludge	Wastewater treatment plants	Sewerage	Phosphate recycling
8	Filter cake	Paint producer	Chemical industry	
9	Sifted limestone (0-25mm)	Chemical producer	Chemical industry	Soil-pH neutralizer
10	Calcium carbide production residue	Chemical producer	Chemical industry	

## 2.1. Indicators

The Directive 2008/98/EC defines a waste hierarchy as a priority for waste management legislation and policies, as follows:

(a) prevention; (b) preparing for re-use; (c) recycling; (d) other recovery, e.g. energy recovery; and (e) disposal.

The waste hierarchy was selected as an indicator for the assessment of the CE solutions for the 10 selected waste streams to compare the current situation and the expected outcomes after implementation.

In the CIRCE2020 project framework, this indicator can be measured as summation of the weighted different waste management options for a specific waste stream ( $x_i$ ), as illustrated in the following formula:

$$\sum x_i * Wh$$

Where:

$x_i$  = quantity of waste  $i$  -expressed as %- sent to a specific waste management option

$Wh$  = waste hierarchy score: equal to 5 for prevention; 4 for preparing for re-use ; 3 for recycling ; 2 for other recovery; 1 for disposal

For the 10 selected waste streams, the following waste hierarchy indicators were calculated:



**Table 2: Calculated waste hierarchy indicators for selected waste streams.**

Waste stream	Situation	Prevention [%]	Re-use [%]	Recycling [%]	Recovery [%]	Disposal [%]	Waste hierarchy indicator
Waste wood	current situation	0	0	0.13	0.87	0	2.13
	expected outcome	0	0	0.22	0.78	0	2.22
Sheep wool, minor quality	current situation	0	0	0.16	0	0.84	1.32
	expected outcome	0	0	1	0	0	3
Non-saleable vegetables (rejects)	current situation	0	0	0	0	1	1
	expected outcome	0.5	0	0	0.5	0	3.5
Old bread	current situation	0	0		1	0	2
	expected outcome	0	0	1	0	0	3
Organic waste	current situation	0	0	0.6	0.4	0	2.6
	expected outcome	0	0	1	0	0	3
Grease trap waste	current situation	0	0	0	1	0	2
	expected outcome	0	0	0.5	0.5	0	2.5
Sewage sludge	current situation	0	0	0.48	0	0.52	1.96
	expected outcome	0	0	0.05	0.95	0	2.05
Filter cake	current situation	0	0	0	0	1	1
	expected outcome	0	0	0.5	0	0.5	2
Sifted limestone (0-25mm)	current situation	0	0	0.1	0	0.9	1.2
	expected outcome	0	0	1	0	0	3
Calcium carbide production residue	current situation	0	0	0.42	0	0.58	1.84
	expected outcome	0	0	0.25	0	0.75	1.5

## 2.2. Other criteria

In addition to the calculated indicators, softer and rather semi-objective criteria were defined, complementing the selection process in order to define the most promising waste stream.

- **Social/Moral**
  - Is the newly created circular solution product of moral and ethical relevance?
  - Does the process of valorisation create jobs?
- **Economic/Companies**
  - Is a partner structure existing / established across the entire process chain (producer, collector / processor, distributor / consumer)?
  - Is there a market/demand for the new output product, preferably regional?
- **Technical**
  - Is the concept/idea technically feasible within the project duration?

For the evaluation, 9 regional waste management experts were asked to value each of the above listed criteria for each of the 10 waste streams. The evaluation referred to the pilot region Tyrol

and was limited to the duration of the project. Each criterion could be valued on a scale from 0 - 5 (for exact details of the scale see Annex 1).

The waste hierarchy indicator (chapter 2.1) was considered as the criteria category “environment”, in addition to the above listed categories social/moral, economic and technical. All four criteria categories are weighted equally, i.e. each category equals 25%.

The (sub)criteria themselves are weighted according to their relevance for the circular solution.

For the filled in evaluation matrix please see Annex 1.

### 3. Conclusion

The combined results of the calculated waste hierarchy indicator and the additionally defined softer criteria resulted in the selection of the following 5 waste streams:

1. Non-saleable vegetables (rejects)
2. Sheep wool of minor quality
3. Organic wastes
4. Old bread
5. Waste wood

In a next step, the product environmental footprint (PEF), life cycle costs (LCC) and technology readiness rating (TRR) for these 5 waste streams will be analysed.

In the case of the waste stream “old bread”, the potential company partner did not show a strong interest or willingness to cooperate in the project. ATM will try to find another company partner who is keen to participate in order to gather the necessary data and information for the PEF, LCC and TRR. If this is not possible, the waste stream “old bread” will be excluded and the following best evaluated waste stream will be selected: grease trap waste.

### 4. Annex

**Annex 1: Criteria matrix for the selection of the five most promising waste streams for further analyses.**

Waste stream	Category	Social		Environmental	Economic		Technical	Sum	Rank
	Weight	5%	20%	25%	10%	15%	25%		
	Description	ethical / moral	jobs	waste hierarchy indicator	partner structure	market demand	feasibility		
<b>Waste wood</b> <b>Sheep wool, minor quality</b> <b>Non-saleable vegetables (rejects)</b> <b>Old bread</b> <b>Organic waste</b> <b>Grease trap waste</b> <b>Sewage sludge</b> <b>Filter cake</b> <b>Sifted limestone (0-25mm)</b> <b>Calcium carbide production residue</b>		2.00	2.11	2	4	3.22	2.78	2.63	5
		3.22	2.00	4	5	3.44	4.33	3.86	2
		4.67	3.00	5	4	3.11	4.11	4.19	1
		3.67	1.22	4	1	2.22	2.78	2.74	4
		3.00	2.11	4	4	2.89	3.56	3.44	3
		2.56	1.56	3	2	3.44	2.22	2.49	6
		2.33	1.67	2	1	2.44	1.00	1.66	8
		0.56	0.33	2	1	0.44	0.67	0.98	10
		1.56	1.00	4	1	2.22	2.67	2.37	7
		0.78	0.78	1	1	1.33	1.33	1.06	9
		0 = 0 1 = very low 2 = low 3 = medium 4 = high 5 = very high	0 = 0 1 = 1 jobs 2 = 2 -5 jobs 3 = 6 - 10 jobs 4 = 11 -20 jobs 5 = > 20 jobs	0 = 1 - 1,49 1 = 1,5 - 1,99 2 = 2,0 - 2,49 3 = 2,5 - 2,99 4 = 3,0 - 3,49 5 = 3,5 - 4,0	0 = 0 1 = 1 partner per 1 chain link 2 = 1 partner per 2 chain links 3 = 1 partner per 3 chain links 4 = > 1 partner per chain link 5 = multi-firm	0 = 0 1 = very low 2 = low 3 = medium 4 = high 5 = very high	0 = no 1 = 10 - 20 % probability 2 = 30 - 40 % 3 = 50 - 60 % 4 = 70 - 80 % 5 = 90 - 100 %		
Scope of evaluation: the new final product which will be produced as part of the circular solution, e.g. in case of waste wood --> active charcoal to be used to purify landfill leachate Region to be referred to for evaluation: Tyrol Time scale to be referred to for evaluation: project duration (2017-2020)									