



# Identification of circular processes, products, and solutions

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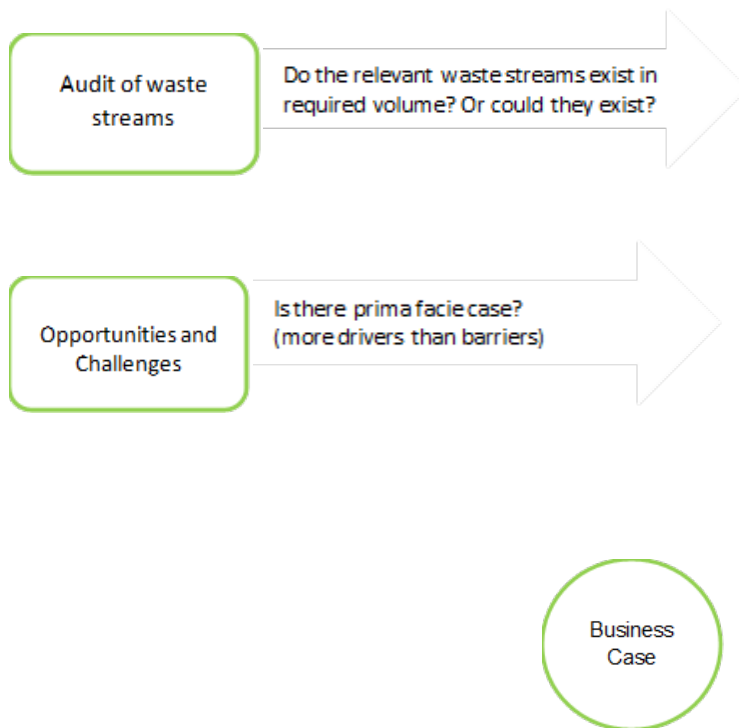
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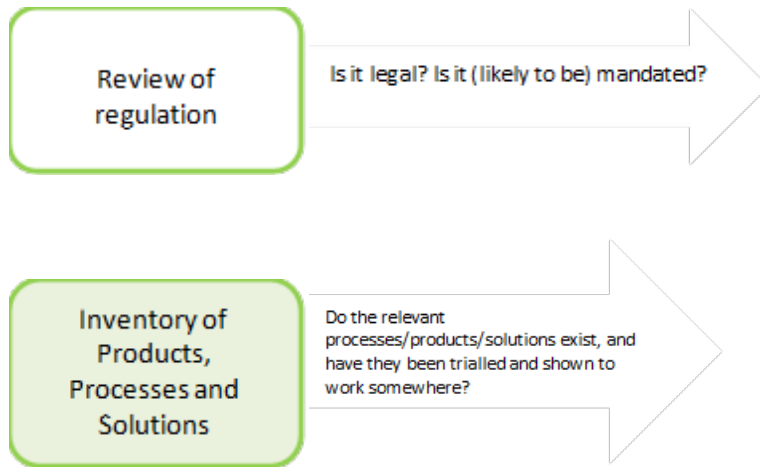


## 1.3.1 Identification of circular processes, products, and solutions

### 1. Objectives

- A broad inventory describing processes, products and solutions that involve the upcycling of business waste streams based on examples and concepts from around Europe (and beyond)
- The aim is to show the great potential and socio-economic benefits of upcycling and the diversity of possible solutions, and to inspire SMEs to rethink their 'waste' and start seeing it as a resource
- The inventory also enables us to create detailed upcycling business cases (D1.3.





If the answer to all four questions is yes, then we put it forward as a candidate for developing the detailed business case.



## 2. Context

The term upcycling refers to the reuse of a material that would otherwise be waste. The material is instead transformed into a new product of greater value than the original material. This value can be technical, economic, and societal, and comes without burdening people and the environment. The new product may have a similar function as it is previous life, or it may be used for something completely new. In comparison to recycling, upcycling is more environmentally friendly. When recycling a product, it is often reduced back to its raw materials to create a new product. Depending on the material, this process may require a lot of energy to undertake. In the last decade or so upcycling has become a key component of waste reduction, coming under the 'Reuse' segment of the waste hierarchy "Reduce, Reuse, and Recycle".

Upcycling is also a component of the advance towards a circular economy. This is in contrast to the linear economy whereby once a product has expired in its useful life it is thrown straight to landfill. The circular economy aims to move economic activity away from the use of finite resources and design a system without waste.

According to The Ellen MacArthur Foundation, the circular economy is based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems



Regarding these principles upcycling is a strategy that directly tackles numbers two and three. Upcycling keeps materials in the loop as they are repurposed as new products, with the advantage of not being broken down back to their raw materials. It also helps to regenerate natural systems, as no virgin materials are required to repurpose the material.

To transition from a linear economy, a systemic shift is required, rather than a mere adjustment to the current system. Therefore, to be successful, the processes must work not only for large corporations but also small and medium-sized enterprises (SMEs).



### 3. Inventory

The main objective of 1.3.1 was to create “a broad inventory describing processes, products and solutions that involve upcycling of business waste streams based on examples and concepts from around Europe (and beyond)”. Subsequently, the second and third objectives can be achieved. Through creating an inventory of upcycling cases “the great potential and socio-economic benefits of upcycling” can be showcased alongside “the diversity of possible solutions, to inspire SMEs to rethink their ‘waste’ and start seeing it as a resource”. This will then allow us to “create detailed upcycling business cases” for future projects.

To construct the inventory, there are three criteria that need to be agreed upon. These are:

- A set of searchable sources
- A clearly defined search protocol
- A set of inclusion/exclusion criteria.

The set of searchable sources refers to databases where studies may be found. All the data for this project was gathered electronically through online databases. In total, five sources were used to gather information. These were:

- The academic database Scopus
- The collection of case studies collected by The Ellen MacArthur Foundation
- CORDIS Europa
- Google Scholar
- Cases sent from European Partners





The search protocol involves creating a replicable sequence of activities. This required searching the first four of these databases using the keywords “upcycling” and “upcycle”. Results from these searches have been placed into a dataset of their own. Due to the large quantity of material available using these keywords, those that were not relevant had to be removed. This leads on to the formulation of a set of inclusion/exclusion criteria. Initial ideas for this were as follows:

- Geographic restrictions, e.g. European countries only
- Restriction to Organisation for Economic Co-operation and Development (OECD) countries only
- If upcycling is the focus of the study
- If the upcycling process of the product studied is described
- The maturity of the project – is it just defined, or has it been made mainstream?
- Is it sustainable or are there any figures to show it is beneficial to the environment?
- Are there any restrictions due to policy/regulation?
- Does it show involvement with SMEs?
- Is information on collection, storage and sorting available?
- Is the process deemed profitable, and if so, are there any figures to back this up?
- Does the case provide any information regarding marketing of the product?
- Any social/public value creation
- Date of publication.





## 4. Identification

Each of the searchable sources were examined using the search protocol and keywords “upcycling” and “upcycle”. This provided a large array of results of varying relevance. Table 1 shows the number of results from each search on each database.

| Database/Source                | Number of results (papers containing the words “upcycling” and “upcycle”) |
|--------------------------------|---|
| Scopus                         | 338   |
| The Ellen MacArthur Foundation | 90  |
| CORDIS Europa                  | 104   |
| Google Scholar                 | 10,900  |

Table 1: A table showing number of results for a search using the keywords “upcycling” and “upcycle” on each database

As shown in Table 1, the search results yielded hundreds – and in the case of Google Scholar, thousands – of results. Some of these results will be irrelevant to the project and therefore must be removed.

### Screening for eligibility

To identify cases that are eligible for inclusion in the inventory, criteria must be set. By identifying what criteria has been met, the case can be ranked, with those ranked highest being most suitable to take forward into the inventory. The criteria used to rank the studies is as follows:

- Upcycling focus of study



- OECD country
- Evidence of economic value creation.

Before undertaking the screening process, the results from the Scopus search were uploaded to a spreadsheet in order to streamline the procedure. The three criteria listed above were added as column headings. From here, the abstract for each study was read and a simple ‘Yes’/‘No’ answer placed under each heading depending on the information available. Based on the met criteria, the studies were ranked into suitability categories, shown in Table 2. There were also a few subjective decisions made here based on the studies' abstracts.

| Rank/Suitability         | Number of criteria met |
|--------------------------|------------------------|
| 1 - Highly suitability   | 3                      |
| 2 - Moderate suitability | 2                      |
| 3 - Low suitability      | 1                      |
| 4 - Not relevant         | 0                      |

Table 2: A table showing the ranking system for suitability of case studies

Case studies that were deemed suitable were put forward to create the framework. Due to time constraints, not all the studies put forward from the search could be screened. Table 3 shows the total number of studies from each source which were ranked as highly suitable.

| Database/Source | Number of highly suitable studies |
|-----------------|-----------------------------------|
|-----------------|-----------------------------------|



|                                |    |
|--------------------------------|----|
| Scopus                         | 10 |
| The Ellen MacArthur Foundation | 13 |
| CORDIS Europa                  | 4  |
| Google Scholar                 | 2  |

Table 3: A table showing the number of cases put forward to the framework from each source



## 5. Framework

To dissect information from each case study a framework was created in which boxes could be filled to identify details of key fields. This contained the criteria used for ranking, as well as several new fields. The framework was filled in with information from each case study put forward as highly suitable. The framework can be seen below in Table 4.

| Field Name  | Detail   | Notes   |
|-------------|--|---|
| Case id     | Number   | Primary key   |
| Title:      | Short title for case   | Emphasises the product, process, or solution          |
| Sources:    | Link to table of sources (many to many – e.g. one case may have many sources and one source may detail many cases) | Main sources of information relating to the case need |
| Contacts    | Any actual contacts for more information (again link to separate contacts table)                                   | E.g. where there is a named or traceable individual   |
| Geography 1 | Drop down: country   | From drop down list of countries                      |



|                             |  |  |
|-----------------------------|--|--|
|                             |  |  |
| Geography 2                 | Text: additional detail if available                               | E.g. city, region, land, or other subnational territory or even a full address |
| Duration<br>(project began) | Drop down: year  | Very rough indication of maturity – see below for documented maturity          |
| Input Material<br>Focus 1   | Drop down: biowaste; paper; plastics; metals; EEEW, Wood; Textiles | High level grouping from a drop-down table and include other                   |
| Input Material<br>Focus 2   | Drop down: detail for focus e.g., type of plastic PET, PVC etc     | Detail grouping: should be from a drop-down table and include other            |
| Key Process(es)             | Text: brief description of the key process(es)                     | What is the key upcycling process  |
| Collection and storage      | Text: how is waste collected and stored and by whom?               |  |



|                                     |  |  |
|-------------------------------------|--|--|
| Sorting/Cleaning                    | Text: how is waste sorted/separated (if required) and by whom?                                       |  |
| Sales and Marketing                 | Text: how is upcycled product marketed and sold?   |  |
| Output market:                      | Text: source(s) of final/intermediate demand for upcycled product                                    | Could be consumer or commercial, local, or international, bespoke or commodity, etc.   |
| Level of documented maturity        | Defined/Initiated,<br>Designed/Planned,<br>Implemented/Executed,<br>Evaluated/Reviewed<br>Mainstream | Some idea of the stage of development of the case uses the PMI stages of a project (Initiation, Planning, execution and control, Closeout) + Mainstreaming |
| Evidence of Economic Value Creation | Text: some indication of 'Economic Value', presence or absence of price/cost data                    |  |





|  |   |  |
|--|---|--|
| Evidence of Social/Public Value Creation | Text: some indication of quantified and measured (rather than modelled) social/public benefit (e.g. net jobs created; social inclusion measures etc.) |  |
| Evidence of Environmental Value Creation | Text: Some indication of quantified and measured (rather than modelled) environmental benefit (e.g., Kgs CO <sub>2</sub> forgone)                     |  |
| SME Involvement                          | Yes/No  |  |
| Regulatory Issues                        | Note any relevant regulatory issues   |  |

Table 4: A table showing the framework

## 6. Refined list

To display the information gathered from the framework in a more simple and readable manner, a new spreadsheet was created to show this refined list. This contained column headings for each of the rows under 'Field Name' from Table 4. From here a 'Yes', 'Partial', or 'No' answer was added to identify if the case study contained the relevant information for that field. The spreadsheet is colour coded to allow for easy comparison of information available between studies. Green identifies



that information is available (or for the country field that it was OECD), yellow identifies partial information (normally for estimations or no quantitative data) and red signifies no data is available for that field. A comment was then added to each cell containing 'Yes' or 'Partial' as an answer. This means that hovering the mouse over a cell will cause a brief piece of information on that field to pop up. A final column was added to provide comments adding insight into why it was or was not potentially suitable for SMEs in Norwich.

## 7. Results and analysis of inventory

Is the country of study a member of the OECD?

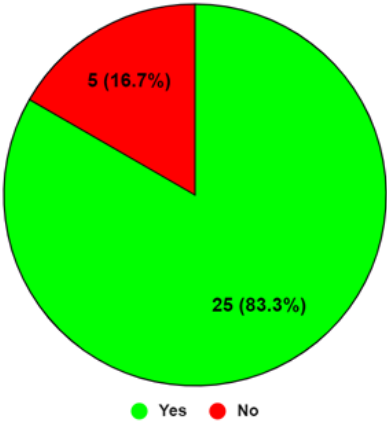


Figure 1: A pie chart showing which studies were undertaken in OECD countries

From Figure 1 we can see that the vast majority (83.3%) of case studies in the inventory were undertaken in countries which are members of the OECD. This is likely due to the fact it was one of the criteria set for the study to be put forward for the framework. OECD countries generally have high income economies as well as a high Human



Development Index (HDI) and include many European countries. This means that cases that are from OECD countries are more suitable for the inventory as they were more likely undertaken within similar market conditions.

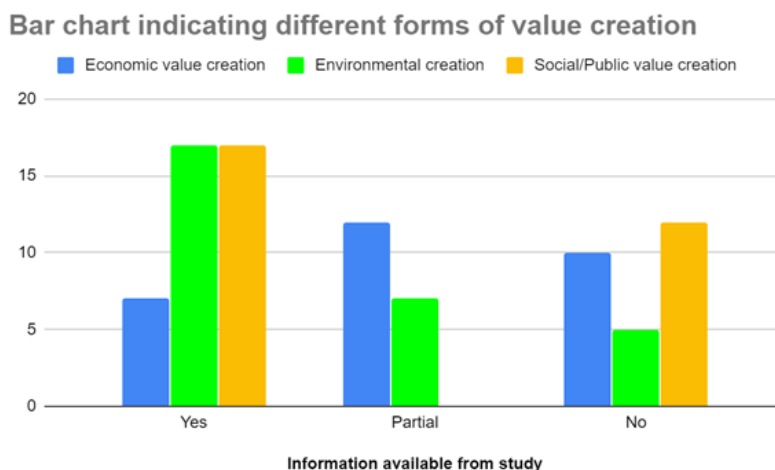


Figure 2: A bar graph comparing information available on the three forms of value creation

| Field Name | Economic Value Creation | Environmental Value Creation | Social/Public Value Creation |
|------------|-------------------------|------------------------------|------------------------------|
| Yes        | 7                       | 17                           | 17                           |
| Partial    | 12                      | 7                            | 0                            |
| No         | 10                      | 5                            | 12                           |

Table 5: A table comparing information available on the three forms of value creation

As shown in Figure 2 and Table 5, we can see that many of the case studies in the inventory are lacking quantitative data on economic value creation. However, many do still have some partial information, likely estimates. This may be due to factors such



as some of the projects not being mainstream. Although the majority have full or partial information on this, there are still a large number that do not. This may be a problem for some of the platform's users, as a method's profitability is more than likely a key factor a business would consider if undertaking an upcycling project.

In terms of environmental value creation, there is more information available. The vast majority have quantitative data and only five cases have no data at all. This is to be expected, as the main incentive behind undertaking upcycling projects is to move further towards a circular economy and create new sustainable business methods. This will be another important factor for users accessing the inventory.

With regards to social/public value creation, most studies contain quantitative data. In most cases this is related to net jobs created, a factor that may be useful for determining the size of a project.

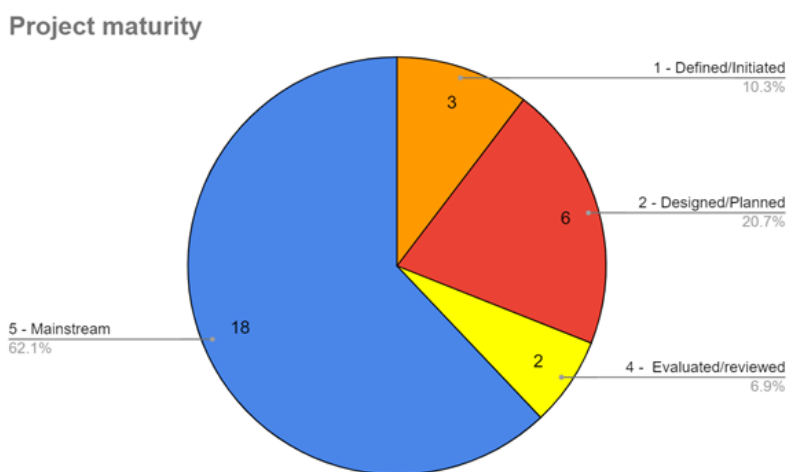


Figure 3: A pie chart comparing the maturity of case studies



Looking at Figure 3, we can see the majority (62.1%) of case studies in the inventory are mainstream. This is the ideal category for any case in the inventory as it shows the method of upcycling can be successful as well as profitable. Many of these

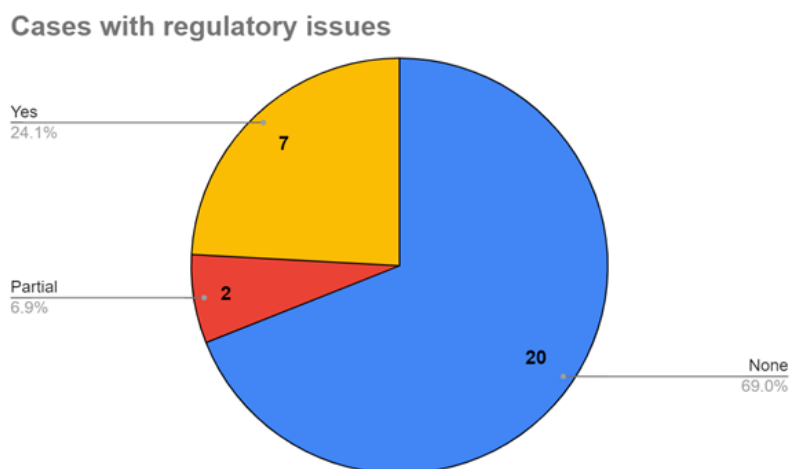


Figure 4: A pie chart comparing the number of cases facing regulatory issues

mainstream cases came from The Ellen MacArthur Foundation's library of circular economy case studies, as well as CORDIS Europa. Alternatively, results from Scopus provided much more variation in project maturity – this is because they are from scientific journal articles, often either specifically focussing on the upcycling process or using available data to estimate the potential of certain methods.

From Figure 4 we can see that the majority (69%) of cases in the inventory contained no information about regulatory issues with the upcycling process. This is important as these kinds of issues can be time and money consuming. Additionally, although most of the studies do not contain information about regulatory issues, there may still be some. These issues occur mainly in the construction field, where the product must meet industry standards, and for fertilizers, where damaging chemicals are present.



Bar graph comparing information on collection/storage and sorting/cleaning availability

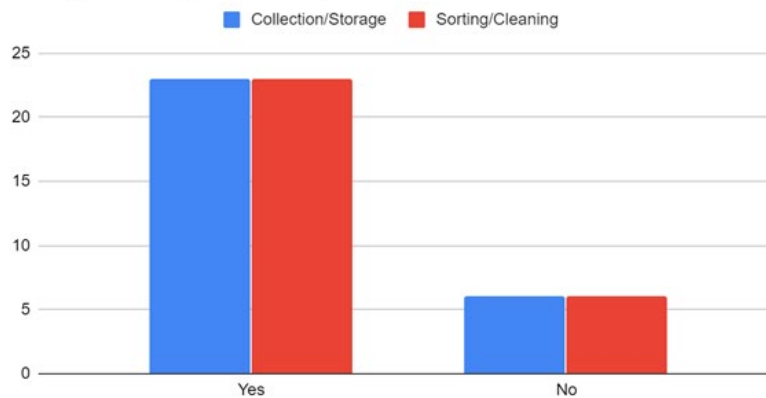


Figure 5: A bar graph comparing information available on collection/storage and storing/cleaning

Figure 5 shows that most of the studies in the inventory contain information on the collection/storage of the material – relating to who does so and how it is done. This is important, as if material is collected/stored by a third party there may be extra costs involved, and the same for sorting/cleaning of the material. In most cases the sorting of the material is carried out at the source.

Bar graph comparing available sales/marketing and output market information

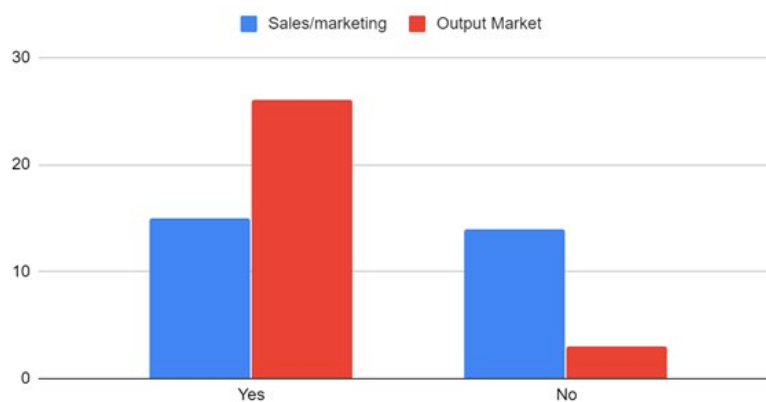
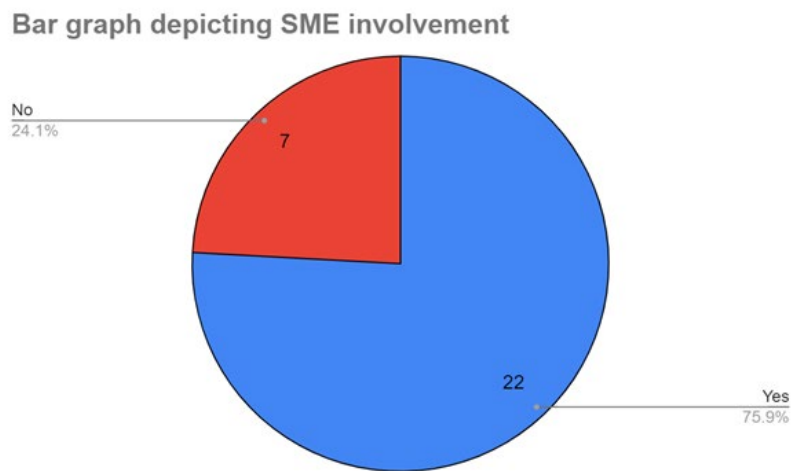


Figure 6: A bar chart comparing information available on sales/marketing and output market



Figure 6 shows that just over half of the cases in the inventory provide information on how the product is marketed and sold. The vast majority specify their output market. This helps show the scope of the project and its target audience, vital for putting forward a business case.



*Figure 7: A pie chart depicting which case studies involve SMEs*

Figure 7 identifies that just over three quarters (75.9%) of cases in the inventory show involvement with SMEs. This however does not necessarily mean that the other 24.1% could not be carried out by SMEs on a smaller scale. It is also a good indicator that the aim of showing the great potential and socio-economic benefits of upcycling and the diversity of possible solutions for SMEs could be achieved through this inventory.



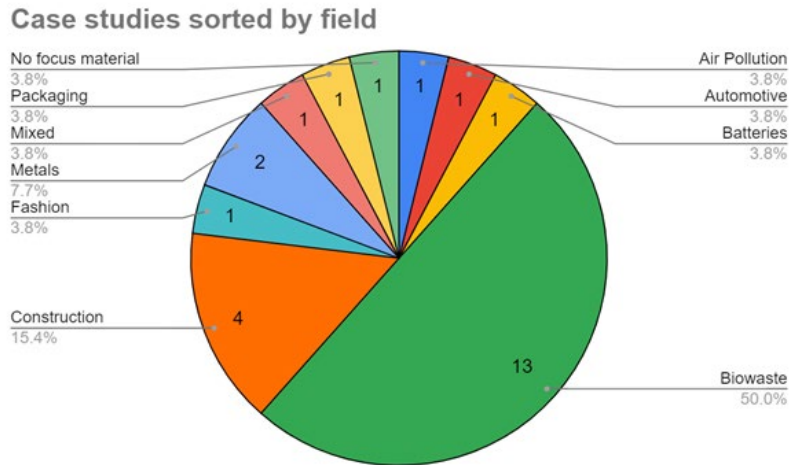


Figure 8: A pie chart sorting case studies by field

By studying Figure 8, we can see that by far the most popular field for upcycling projects in the inventory is biowaste, with 50% of the studies focussing in this field. There are several possible reasons behind this. One is that there may be better information about the science and technology of upcycling biowastes. This would allow for easier and more efficient processing into new products. It may also be due to the high volumes of food waste present in society. This means that large quantities are available for upcycling, solving one of the main issues of sourcing material. It's also important to consider that collection is likely much easier than from other sources. Many homes and businesses already sort their food waste into separate bins, so there are no extra steps required in this regard. The second most popular field is that of construction. One reason for this again may be high volumes of waste created, allowing for a reliable flow of material. Construction is also generally expensive so reusing materials where possible is a great way to cut down on costs. Lastly, it can again be sorted easily on site.





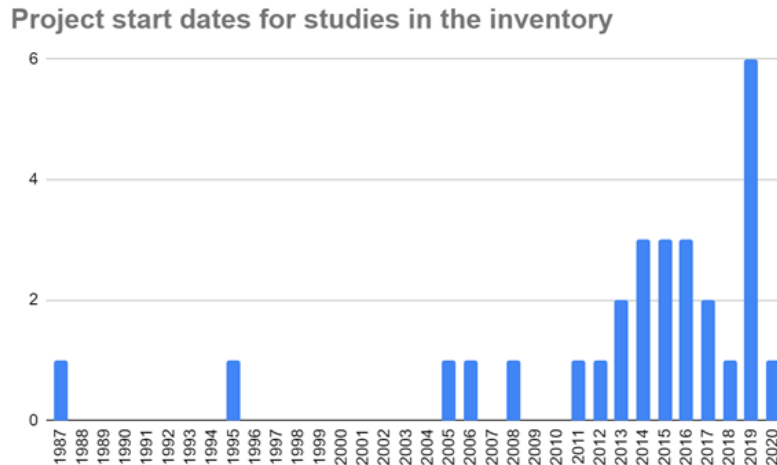


Figure 9: A bar chart showing project start dates

Figure 9 shows the years at which each project in the inventory began. As we can see most cases were implemented within the last decade, with only five cases starting before 2011. This highlights the fact that upcycling is a reasonably new method of tackling waste streams and therefore may have a lot of room for improvement in processes and solutions.

With regards to this data there is, however, some bias. Due to time constrictions not all the studies found from Scopus were screened. The screening process was carried out through studies ordered by date, starting with the most recent. This could explain the spike for cases in the year 2019.



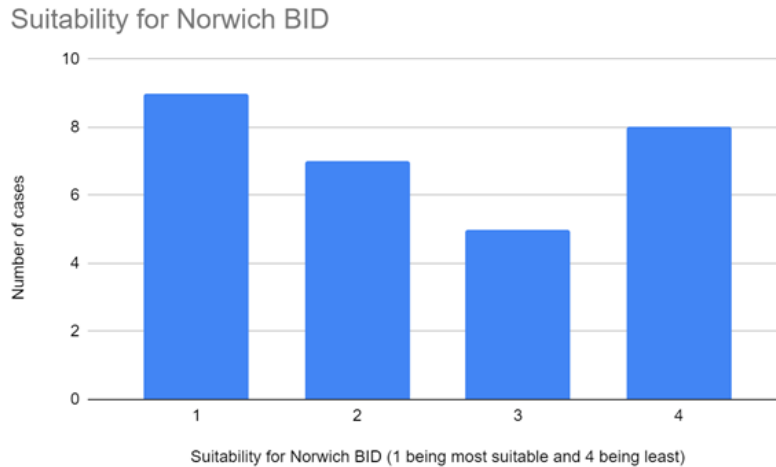


Figure 10: A bar chart showing which cases are most suitable for Norwich BID (ranked 1-4)

Looking at Figure 10 we can see that around half the studies in the inventory were deemed to be either highly or moderately suitable for the Norwich BID. The main factor that led a study to being ranked 4 was a lack of SME involvement. This was a crucial factor, as the main part of the second objective of the project. However, there were also other outside factors that lead to a study being ranked 4, which could not be seen through the spreadsheet alone. For example, one study looking at creating animal feed uses black soldier flies to do so. Although the study seemed very successful, these flies are found in South Africa and would therefore not be suitable for Norwich due to ecological reasons.

## 8. Discussion

Looking at the results, we can see that it is often the sales/marketing information that is the weak point in the chain. From the available data we can see products are mostly sold either through existing markets or online exchanges. Despite many cases being involved in a global supply chain, local markets are also very commonly utilised. In



terms of the collection/storage methods, the results show this was mostly carried out through third party services, likely incurring greater running costs for the project. Regarding the separation of waste, it is much more efficient to be sorted upstream. If the waste provider can sort into separate bins reliably, the project is likely to be more successful. Sorting the waste downstream is an expensive and dirty process, and therefore less efficient.

With reference to key processes, there is a wide variety. However, the majority are relatively simple. This is likely due to the screening process undertaken to access eligibility. Many of the more high-tech projects emphasise the upcycling process and lacked information on areas such as economic value creation. With more time available or a change to the screening criteria, more high-tech options could be added to the inventory. Regarding value creation, the data shows emphasis on environmental and social over economic data. Having more information on environmental value creation was expected due to the nature of upcycling. However, the lack of economic data may be a hindrance for the third objective of 1.3.1, in which we are able to create a detailed upcycling business case. There is also little consideration of regulatory issues. Although the data shows that most cases have no regulatory issues, this is unlikely.

The results also found that more options are provided for big players, rather than creating ideas for entrepreneurship – meaning they are less likely to be suitable for the BID and SMEs elsewhere. From the data on SME involvement, it shows that their main role would be to provide the waste, rather than process it. There is also a focus on upcycling – had a wider range of key terms, such as “remanufacture” been used,



more cases would have been made available, perhaps providing a different pattern. This may also have provided a wider range of sources, in which this project was limited.

In terms of the project, finding case studies and reports with suitable information to fill the criteria required for the framework was much more difficult than anticipated. Although some studies do manage to provide information on each criterion, the majority show gaps. The Ellen MacArthur Foundation proved to be the best source, as its case studies provided projects that were already mainstreamed and had detailed information. Picking information apart from academic journals and articles from Scopus was much more difficult due to their focus on the process of upcycling and not its real world implementation. These difficulties may have come because of upcycling being a relatively new method of mainstream waste processing. Regarding Scopus, if the time had been available some of the older projects found may have been more promising – they would have had more time to become streamlined and mainstreamed. One of the main barriers identified through screening many studies was the reliability and volume of waste streams. To be successful a project needs a steady flow of materials at a suitable volume, otherwise it will fail. This could be the main reason why biowaste and construction were the two most popular fields, as waste from these sectors is readily available.



## 9. Mounting a searchable version

By week 25, the aim was to mount a searchable version of the inventory online, with a comment and self-submission function. Although this has not yet been achieved, the project is ready to handover for the front-end to be created. All the data from the refined list spreadsheet has been transferred to SQL and use cases have been created to allow whoever mounts the inventory a clear objective.



## 10. Use cases

Use cases are used to identify system requirements – in this case the searchable inventory. Each case is a possible set of sequences undertaken by the user of the system. By creating these use cases, the developer of the searchable inventory will have a good idea of the functions required and how best to carry this out. There are four use cases listed below, each describing the actions of a different user. Use Case 1 identifies how someone who has a particular waste material may go about searching for potential upcycling methods for the material. Use Case 2 identifies how someone might use the database to research what materials are commonly upcycled and the processes by which this can occur. Use Case 3 looks at how someone might go about uploading their own case study to the database. Lastly, Use Case 4 looks at how the database will be managed and moderated.

### 10.1 Use Case 1

|                   |  |
|-------------------|--|
| <b>Use Case 1</b> | <b>Business looking for potential in their waste stream.</b>   |
| Actor             | Local bakery.  |
| Use Case Overview | A local business has identified through an audit that they are producing a lot of bread waste. They would like to identify ways in which this waste could be |



|              |  |
|--------------|--|
|              | utilised rather than it simply going to landfill.            |
| Subject Area | Biowaste.  |
| Actor(s)     | Local bakery.  |
| Trigger      | Waste bread collected into bins at the end of each day/week. |
| Precondition | There is bread waste in the bins.                            |

#### Basic Flow

|             |  |
|-------------|--|
| Description | This scenario identifies a successful scenario with minimal criterium.         |
| 1           | Bakery owner registers (?) and gains access to opensource (?) online database. |
| 2           | Initial search for food waste/biowaste.  |
| 3           | All examples of cases where biowaste is listed as field are shown.             |
| 4           | Further option to refine by material, in this case bread.                      |



|                     |   |
|---------------------|---|
| Termination outcome | All cases in the database where bread is the material are shown. Once clicked on information from framework is available. |
|---------------------|---|

Alternative Flow

|             |   |
|-------------|---|
| Description | This is a scenario with more refined criterium.                                   |
| 1           | Bakery owner has identified case studies from the database regarding bread waste. |
| 2           | Search is refined to cases suitable for SMEs.                                     |
| 3           | Search is refined to cases where economic value creation data is available.       |
| 4           | Search is refined to only cases which have been successfully mainstreamed.        |





|                     |  |
|---------------------|--|
| Termination Outcome | All cases in the database where the refined criteria is met are available, with link to the framework. |
|---------------------|--|

## 10.2 Use Case 2

|                   |   |
|-------------------|---|
| <b>Use Case 2</b> | <b>Someone looking to identify what materials are upcycled and their uses.</b>  |
| Actor             | Third party organisation/researcher/student.  |
| Use Case Overview | Someone looking for information about what materials are commonly upcycled and the processes by which this can occur. |
| Subject Area      | Research.   |
| Trigger           | Writing paper on upcycling/material flow.   |
| Precondition      | Register to access the database.  |

Basic Flow



|                     |  |
|---------------------|--|
| Description         | A scenario where all criteria is met.  |
| 1                   | User registers (?) and gains access to opensource (?) online database.   |
| 2                   | User can see all current cases in the database.  |
| 3                   | User can use dropdowns to interact with database and set criteria.   |
| 4                   | Criteria set for example:<br><br>Material – wood<br><br>Economic and environmental value creation information available<br><br>Information of collection/storage and sorting/cleaning available. |
| Termination Outcome | All cases in the database where the criteria is met are available, with link to framework  |

### 10.3 Use Case 3

|                   |  |
|-------------------|--|
| <b>Use Case 3</b> | <b>Somebody looking to publicise their case.</b> |
|-------------------|--|



|                   |  |
|-------------------|--|
| Actor             | Third party<br>organisation/researcher/student.  |
| Use Case Overview | Someone looking to upload a case they have found/created to the database.                  |
| Subject Area      | Research/data.   |
| Trigger           | In possession of a case study.   |
| Precondition      | Case study must provide a reasonable amount of information contained within the framework. |

### Basic Flow

|             |  |
|-------------|--|
| Description | A scenario where a new case study is submitted by a third party.       |
| 1           | User registers (?) and gains access to opensource (?) online database. |
| 2           | User can input data/information into relevant categories.              |
| 3           | Data/information is moderated.   |



|                     |   |
|---------------------|---|
| 4                   | Data/information is uploaded to the database.                                     |
| Termination Outcome | The case study is uploaded to the database for anyone with access to see and use. |

## 10.4 Use Case 4

| Use Case 4        | System management.  |
|-------------------|---|
| Actor             | ?   |
| Use Case Overview | Someone able to make backups, clean and correct errors, moderate etc. |
| Subject Area      | Management.   |
| Trigger           | Error is found, new data needs uploading.                             |
| Precondition      | Error/new data must be identified.                                    |

### Basic Flow

|             |                                      |
|-------------|--------------------------------------|
| Description | Error is identified in the database. |
|-------------|--------------------------------------|



|                     |  |
|---------------------|--|
| 1                   | Error identified – could be flagged by a user? |
| 2                   | Error notification sent to admin user.         |
| 3                   | Error rectified by admin.                      |
| Termination Outcome | Error in data is corrected.                    |

### Basic Flow

|                     |  |
|---------------------|--|
| Description         | Database backup.                               |
| 1                   | New entry/case study is added to the database. |
| 2                   | Database automatically saves back up.          |
| Termination Outcome | A backup is saved.                             |

## 10.5 Use Case 5

|                   |  |
|-------------------|--|
| <b>Use Case 5</b> | <b>Business looking for a particular material.</b> |
|-------------------|--|



|                   |   |
|-------------------|---|
| Actor             | Econyl.   |
| Use Case Overview | A business is looking for potential sources of a particular material. In this case, the material is nylon. This could come from several sources, such as fishing nets or carpet flooring. |
| Subject Area      | Textiles.   |
| Actor(s)          | Econyl.   |
| Trigger           | New sources of Nylon required to continue production.   |
| Precondition      | There is Nylon waste available.   |

### Basic Flow

|             |  |
|-------------|--|
| Description | This scenario identifies a successful scenario with minimal criterium. |
| 1           | User registers (?) and gains access to opensource (?) online database  |
| 2           | Initial search for textile waste.                                      |



|                     |  |
|---------------------|--|
| 3                   | All examples of cases where textiles are listed as field are shown.  |
| 4                   | Further option to refine by material, in this case nylon.  |
| Termination Outcome | All cases in the database where nylon is the material are shown. Once clicked on, information from the framework is available. Potential waste streams identified. |

#### Alternative Flow

|             |   |
|-------------|---|
| Description | This is a scenario with more refined criterium.                             |
| 1           | User has identified case studies from the database regarding nylon waste.   |
| 2           | Search is refined to cases suitable for SMEs.                               |
| 3           | Search is refined to cases where economic value creation data is available. |



|                     |   |
|---------------------|---|
| 4                   | Search is refined to only cases which have been successfully mainstreamed.  |
| Termination Outcome | All cases in the database, where the refined criteria is met, are available, with link to framework. Suitable waste streams identified. |

## 11. Conclusions

In conclusion, all three objectives of the project have been met. The inventory has provided the processes, products, and solutions to 29 methods of upcycling business waste streams. These come from a broad range of 10 different fields, with multiple more material variations within these fields. The studies come from a wide range of 17 different countries, 10 of which are in European and five of which are beyond. The inventory has also helped to show the great potential and socio-economic benefits of upcycling. Browsing through the inventory, there are many different studies showcasing how they provide economic, environmental, and social value creation in a variety of ways. By providing solutions to a broad range of wastes, the inventory can inspire SMEs who have identified a particular waste material with ideas on sustainable solutions, rather than just sending it to landfill. The inventory can also enable us to create detailed upcycling business cases for the future. This can be done by identifying similar projects within the inventory to provide information relevant to the





business case. Due to this project, objectives and outcomes can be proven to successfully work in similar markets, improving the likelihood of funding.



## 12. Appendix database fields

The main database table records cases. Information on each case is collected according to several core constructs. These are captured as blocks of fields as per the description below.

The first block of fields contains an ID, short title, abstract and basic information about time and geography.

The second block of fields is based on a very simple process model of upcycling that involves taking a stream (or streams) of waste **material** and passing it through a simple linear process. We propose to use a version of the EU List of Wastes<sup>1</sup> – although this may not prove to be the most useful classification and a subset may need to be used. The process has five stages: 1) **collection and storage**, 2) **sorting and cleaning**, 3) a focal **key process**, 4) **sales and marketing** of the resulting upcycled product and 5) the final **market or consumers** of the upcycled product. For stages 1-2 and 4-5 in the process, there is a simple ‘Yes’/‘No’ field to indicate the availability of information on these aspects of the case, as well as more detailed information about that aspect of the case in a separate field. For the key process, there is only the detailed information as there would be little point in adding a case to the database without a key process.

A third block indicates an assessment of the **maturity** of the case, ranging from one (least mature) to five (most mature). The stages of maturity are as follows:

- Paper plan
- Pilot study/lab based proof of concept



- Funded demonstration project
- Economically viable operation
- Economically viable operation with evaluation evidence of wider sustainability/impact.

Because maturity is a judgement, some evidence to substantiate this allocation is required, and is provided for in a subsequent field.

A fourth block is based on the concept of triple bottom line accounting. It records the presence of evidence of each of the three value domains – economic value, environmental value, and social value – and provides fields to substantiate the allocation.

A fifth block records whether there is evidence of SME involvement and whether there are significant regulatory issues noted in the case. Again, these 'Yes'/'No' answers can be substantiated in accompanying note fields.

A sixth block notes and justified the relevance to Norwich BID.

A final block records the date of creation of the case record and the original author as well as the date the record was last amended and the author of that amendment.

| Name | Type | Size | Description |
|------|------|------|-------------|
|------|------|------|-------------|



|            |                 |     |  |
|------------|-----------------|-----|--|
| ID         | Long<br>Integer | 4   | Unique ID number   |
| Title      | Short<br>Text   | 255 | Short title for identification   |
| Abstract   | Long<br>Text    | -   | Short summary or abstract of the case  |
| StartDate  | Short<br>Text   | 255 | Date(s) project commenced or ran (e.g., 2015-; 2010-2015)                                    |
| Sources    | Anchor          | -   | Primary Source Hyperlink – e.g., DOI or URL  |
| Contacts   | Short<br>Text   | 255 | Contact details if available   |
| Geography1 | Short<br>Text   | 255 | Country drawn from standard list or EU   |
| Geography2 | Short<br>Text   | 255 | Further geographical detail e.g., other countries involved or city or region                 |
| Materials1 | Short<br>Text   | 255 | High level description of material from EU Wastes Listing e.g., 20 01 01 paper and cardboard |



|                         |               |     |   |
|-------------------------|---------------|-----|---|
| Materials2              | Long<br>Text  | -   | Full detailed listing of Wastes   |
| Key process(es)         | Long<br>Text  | -   | Description of key physical, mechanical, biological or other process involved |
| Collection and Storage1 | Short<br>Text | 255 | Availability of Information on how waste is collected and stored              |
| Collection and Storage2 | Long<br>Text  | -   | Detailed Information on how waste is collected and stored                     |
| Sorting and Cleaning1   | Short<br>Text | 255 | Availability of information about how waste is sorted and cleaned             |
| Sorting and Cleaning2   | Long<br>Text  | -   | Detailed Information about how waste is sorted and cleaned                    |
| Sales and Marketing1    | Short<br>Text | 255 | Availability of Information on how upcycled product is marketed and sold      |
| Sales and Marketing2    | Long<br>Text  | -   | Detailed Information on how upcycled product is marketed and sold             |



|                    |                 |     |  |
|--------------------|-----------------|-----|--|
| Market Consumer1   | Short<br>Text   | 255 | Availability of Information on markets/consumers of upcycled waste |
| Market Consumer2   | Long<br>Text    | -   | Detailed Information on markets/consumers of upcycled waste        |
| Maturity           | Long<br>Integer | 4   | Maturity of the case on a Scale of 1-5                             |
| MaturityNote       | Long<br>Text    | -   | Justification for Maturity   |
| EconomicValue      | Short<br>Text   | 255 | Availability of Evidence of Economic Value                         |
| EconomicValueNote  | Long<br>Text    | -   | Detail Evidence of Economic Value                                  |
| SocialValue        | Short<br>Text   | 255 | Availability of Evidence of Social Value                           |
| SocialValueNote    | Long<br>Text    | -   | Detail Evidence of Social Value                                    |
| EnvironmentalValue | Short<br>Text   | 255 | Availability of Evidence of Environmental Value                    |



|                        |               |     |  |
|------------------------|---------------|-----|--|
| EnvironmentalValueNote | Long<br>Text  | -   | Detail Evidence of Environmental Value     |
| SMEinvolvement         | Short<br>Text | 255 | Evidence of SME involvement                |
| SMEinvolvementNote     | Long<br>Text  | -   | Detail of Evidence of SME involvement      |
| RegulatoryIssues       | Short<br>Text | 255 | Regulatory Issues addressed                |
| RegulatoryIssuesNote   | Long<br>Text  | -   | Detail of regulatory issues addressed      |
| BID                    | Short<br>Text | 255 | Relevance to Norwich BID                   |
| BIDNote                | Long<br>Text  | -   | Evidence of Relevance to Norwich BID       |
| Date first added       | Date          | -   | The date the original record was created   |
| First added by         | Short<br>Text | 255 | The person who created the original record |
| Date last amended      | Date          | -   | The date record was last amended           |



|                 |               |     |   |
|-----------------|---------------|-----|---|
| Last amended by | Short<br>Text | 255 | The person who last amended the<br>record |
|-----------------|---------------|-----|---|

