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# Plant food waste valorisation: Part of the wider food systems policy solution?

**Centre for  
Food Policy**

Shaping an effective food system

Plant Food Waste Valorisation – Opportunities and Challenges  
Hybrid Event hosted at the  
Newlyn Building, University of Leeds, UK  
11th-12th September 2023  
13:35-14:00

Dr Christian Reynolds  
*Centre for Food Policy, City, University of London*  
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Today is a work in progress and part of wider research on FLW policy solutions.

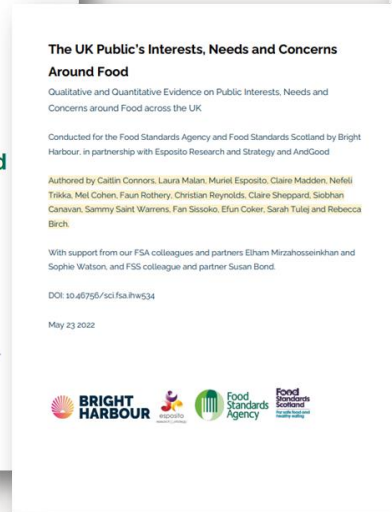
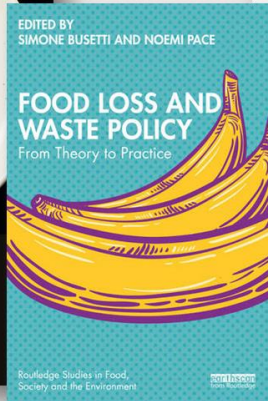
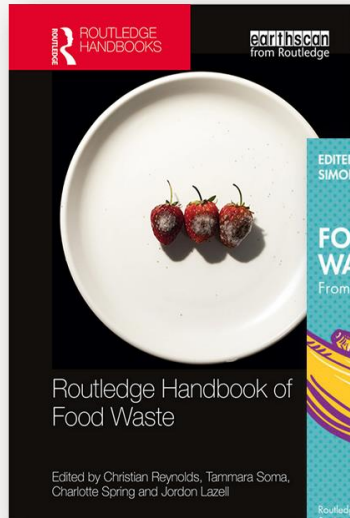
- All input warmly received.  
(Feedback, questions, your thoughts.)
- Who should I be talking to?

Dr Christian Reynolds  
*Centre for Food Policy, City, University of London*  
@sartorialfoodie @FoodPolicyCity  
[christian.reynolds@city.ac.uk](mailto:christian.reynolds@city.ac.uk)

# Who am I?

## Reader at the Centre for Food Policy.

- Focus on sustainable food systems and food waste.
- Supporting the FSA/Defra through research projects. Scottish food systems research (ZW Scotland). Household Simulation modelling (WRAP). Local food strategy development.
- Nutrition Society Food Systems theme lead. IFST Sustainability working group.
- Recent publications



# To me, food loss and waste is a climate issue.

- Responses to FLW need to think about climate change

## 6% of global greenhouse gas emissions come from food losses and waste

Our World in Data

Emissions from food that is never eaten accounts for 6% of total emissions



Food production is responsible for 26% of global greenhouse gas emissions

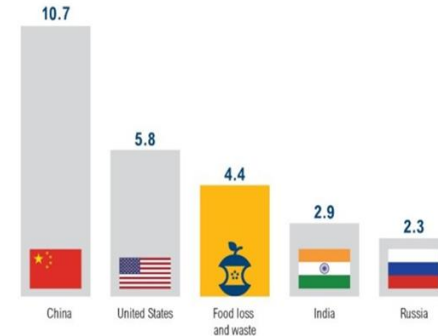
Note: One-quarter of food emissions comes from food that is never eaten: 15% of food emissions from food lost in supply chains; and 9% from consumer waste.

Data source: Joseph Poore & Thomas Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*.

[OurWorldinData.org](https://ourworldindata.org) - Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Hannah Ritchie.

If Food Loss and Waste Were its own Country, it Would Be the Third-Largest Greenhouse Gas Emitter



GT CO<sub>2</sub>e (2011/12)\*

\* Figures reflect all six anthropogenic greenhouse gas emissions, including those from land use, land-use change, and forestry (LULUCF). Country data is for 2012 while the food loss and waste data is for 2011 (the most recent data available). To avoid double counting, the food loss and waste emissions figure should not be added to the country figures.

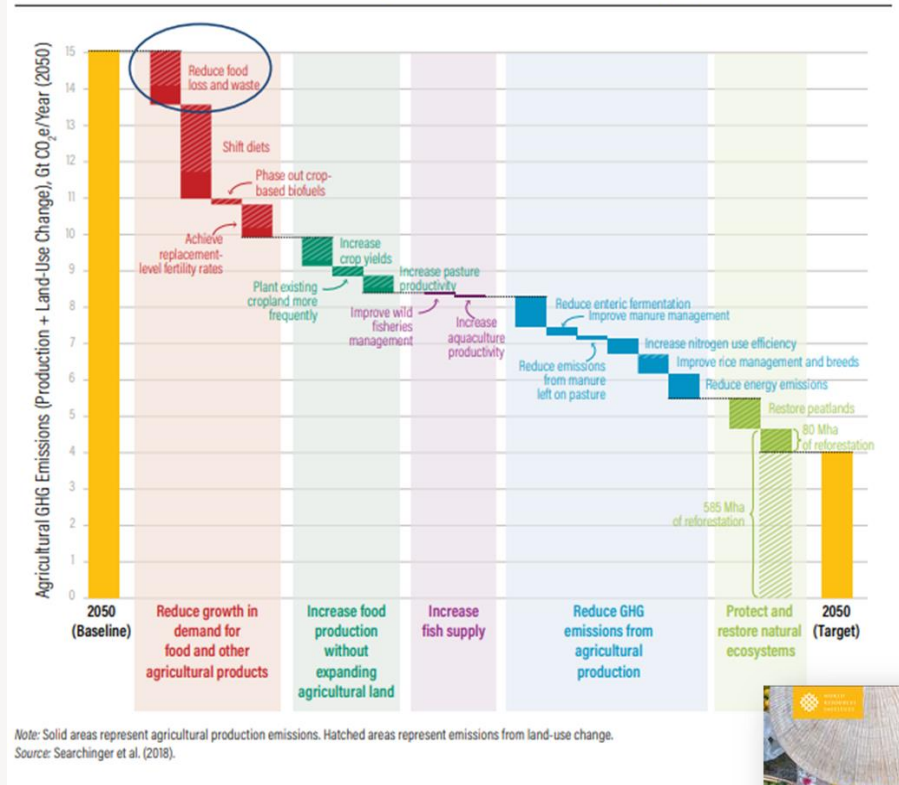
Source: CAIT, 2015; FAO, 2016. Food waste footprint & climate change. Rome: FAO.



# FLW reduction is one of the biggest actions we can take to reduce global GHGE

- The two biggest reductions we can make to agricultural GHGE to achieve a **2° C** warming target (4 Gt/year) or **1.5° C** warming target (0 Gt/year) are through:
  1. Shifting to sustainable diets
  2. Reducing Food Loss and Waste

Figure I.2 | Reducing Food Loss and Waste Can Play an Important Role in Eliminating the Projected 15 Gt of Greenhouse Gas Emissions from Agriculture and Land-Use in 2050 (CO<sub>2</sub> equivalent)



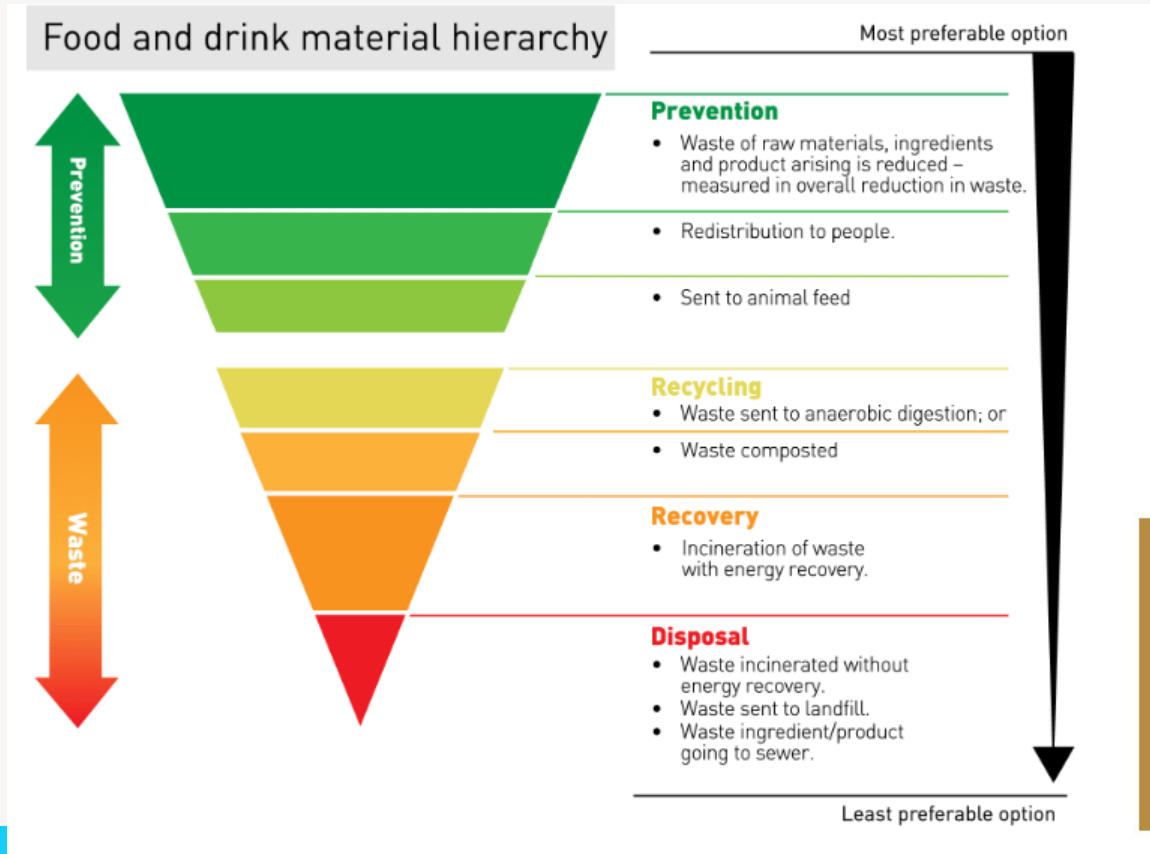
# Is plant food waste valorisation part of this wider climate change narrative?

Today I want to ask

- How is valorisation currently regarded in UK FLW policy?
- How can valorisation become regarded as part of a wider food systems solution?



# Food loss and waste solutions are within a hierarchy



All interventions and policy solutions prevent, divert (recover or recycle), or reduce food loss and waste.

**We need a combination of solutions** to achieve Sustainable Development Goal 12.3.

TARGET 12-3

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

50%

HALVE GLOBAL PER CAPITA FOOD WASTE

# Valorisation has "competition" from other solutions

**Table 1** Summary of food surplus, waste and related material arisings in the UK, and their respective treatment and disposal routes  
(See notes on subsequent page for further detail)

	Household	HaFS*	Retail & Wholesale	Manufacturing	Farm	Total <sup>1</sup>
<b>Total food waste</b>	<b>6.6 Mt</b>	<b>1.1 Mt</b>	<b>0.3 Mt<sup>8</sup></b>	<b>1.5 Mt</b>	<b>[0.9 – 3.5 Mt]</b>	<b>&gt;9.5 Mt</b>
<b>Food (excl. inedible parts)</b>	<b>4.5 Mt</b> <b>(£13.8 bn)</b>	<b>0.8 Mt</b> <b>(£3.2 bn)</b>	<b>0.3 Mt</b> <b>(£0.9 bn)</b>	<b>0.8 Mt</b> <b>(£1.1 bn)</b>	<b>nk</b>	<b>&gt; 6.4 Mt</b> <b>(&gt;£19 bn)</b>
<b>Preventing food becoming waste</b> (Green arrow)						
<b>Redistribution &amp; animal feed</b>	<b>0.3 Mt</b> [n/a humans 0.3 Mt pets/ other animals]	<b>&gt;0.005 Mt</b> [>4kt to people n/a to animals]	<b>0.07 Mt</b> [38kt to people] [27kt to animals]	<b>0.67 Mt</b> [35kt to people] [635kt to animals]	<b>nk<sup>9</sup></b> [7kt to people]	<b>&gt; 1.0 Mt</b>
<b>Waste management</b> (Red arrow)						
<b>Recycling (AD/composting)</b>	<b>1.3 Mt<sup>2</sup></b>	<b>0.04 Mt</b>	<b>0.15 Mt<sup>3</sup></b>	<b>0.44 Mt<sup>4</sup></b>	<b>nk</b>	<b>&gt; 1.9 Mt</b>
<b>Recovery (thermal, landspreading)</b>	<b>3.0 Mt<sup>5</sup></b>	<b>0.84 Mt<sup>6</sup></b>	<b>0.15 Mt<sup>3</sup></b>	<b>1.1 Mt<sup>4</sup></b>	<b>nk</b>	<b>&gt; 5.1 Mt</b>
<b>Disposal (sewer, landfill)</b>	<b>2.3 Mt<sup>5</sup></b> [1.5 Mt sewer 0.8 Mt landfill]	<b>0.21 Mt<sup>6</sup></b> [nk sewer 0.20 Mt landfill]	<b>nk<sup>3,10</sup></b>	<b>0.002 Mt<sup>4</sup></b> [nk sewer 0.002 Mt landfill]	<b>nk</b>	<b>&gt; 2.5 Mt</b>
<b>In addition:</b>						
<b>Rendering of animal by-products</b>				<b>0.6 Mt</b>	<b>nk</b>	<b>0.6 Mt</b>
<b>Other food by-products<sup>7</sup></b>				<b>2.2 Mt</b>		<b>2.2 Mt</b>
* HaFS = hospitality and food service; nk = not known; n/a = not applicable						

Other FLW solutions are embedded in the UK.

- Landfill (decline)
- Redistribution and AD (ascendent)

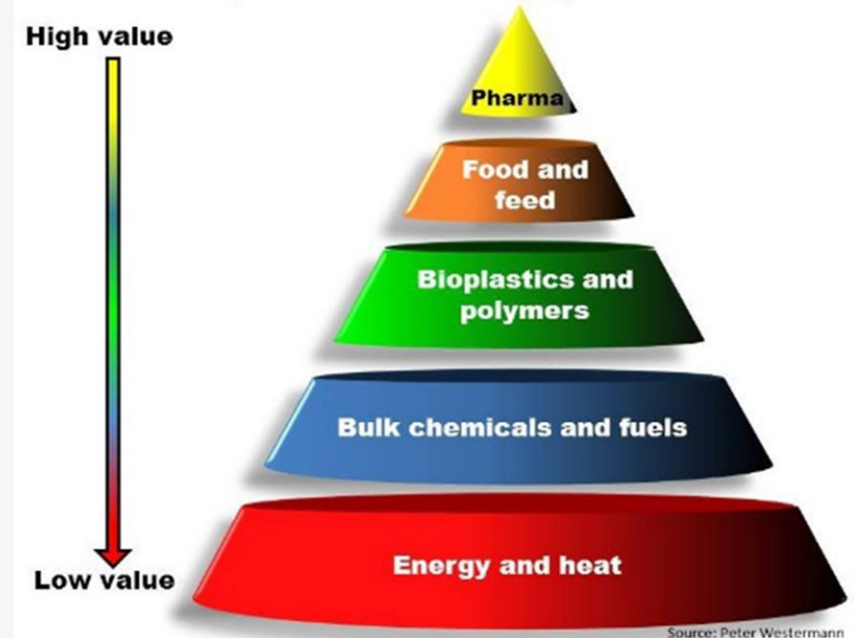


# Valorisation has positive system impacts

- but is currently "too small" for the previous table. Why?

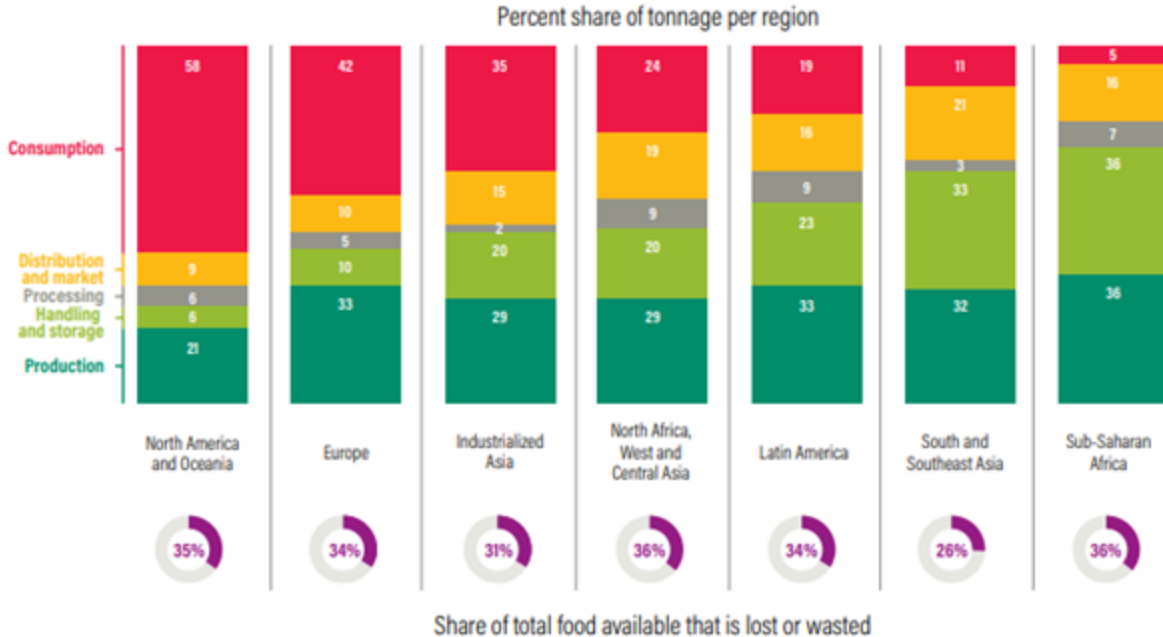
- Policy Focus is on **avoidable** waste - what we should be doing with the unavoidable 40% of food waste ?
- Policy focus is on **Energy** and **Heat**. Less focus on converting food waste materials into higher value products including:
  - Chemicals, materials, and fuels that could displace fossil derived products
  - Higher value food, pet food and animal feed products

Valorisation is many solutions and so has many places in the net-zero and FLW policy landscape.



# FLW Spread across the globe and supply chain

Figure ES-1 | Distribution of Food Loss and Waste by Region and Stage in the Food Supply Chain, 2007



Notes: Values displayed are of food loss and waste as a percent of food supply, defined here as the sum of the "Food" and "Processing" columns of the FAO Food Balance Sheet. Numbers may not sum to 100 due to rounding.  
Source: WRI analysis based on FAO (2011).

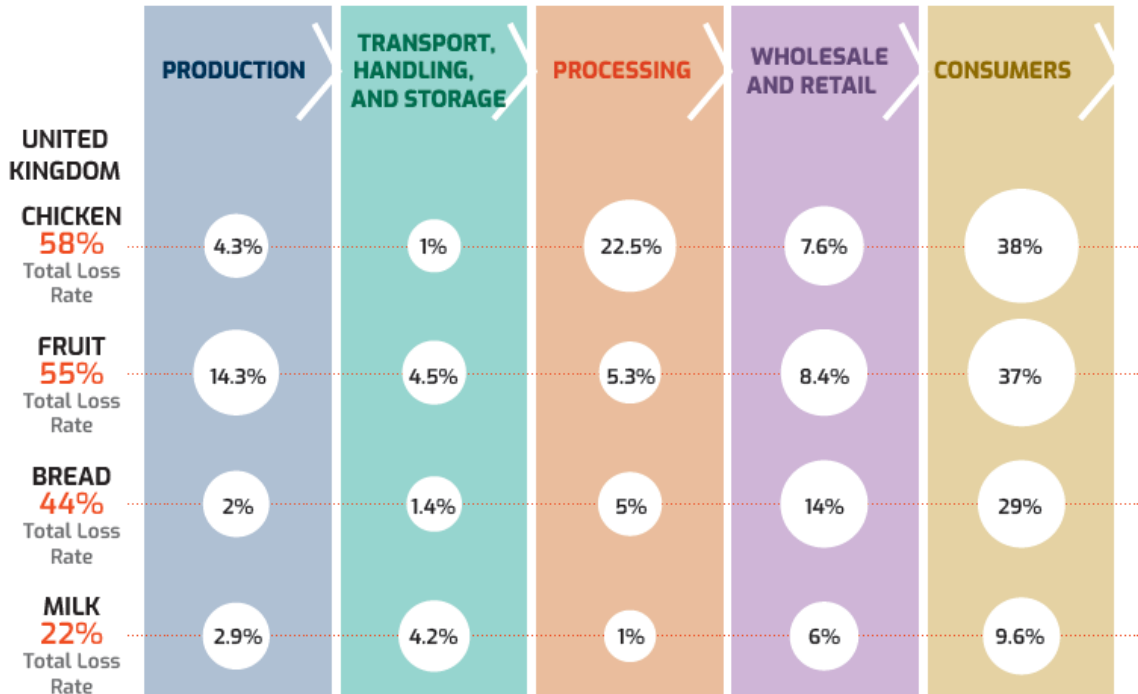
Only a certain % will ever be suitable for valorisation.

*This is due to the challenges of mixed vs separate waste streams*

But there are many types of valorisation...

# Action needed at different points in the supply chain, for diff. products/countries...

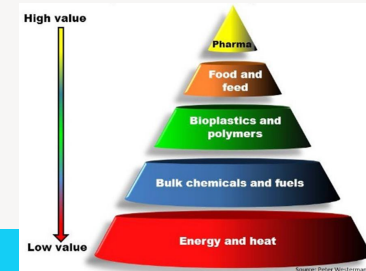
FIGURE 14: Rates of loss and waste at each stage of the supply chain – UK, Rwanda, Vietnam



Only a certain % will ever be suitable for valorisation.

*This is due to the challenges of mixed vs separate waste streams*

But there are many types of valorisation...



# Many types of valorisation solution

	Waste reduction potential	Savings per tonne of waste reduced		
		Climate	Water	Costs
<b>Products, processing and food waste solutions</b>				
Animal feed from insects	■	●	●	●
Processed food waste to chicken feed	■	●	●	●
Dairy waste to animal feed	■	●	●	●
Processing technology to improve shelf life	■	◆	■	◆
Standardised date labelling	◆	■	■	■
Better information for longer shelf life	◆	■	■	■
Fibre products from food waste	◆	●	◆	●
New food products from processing waste	●	●	●	●
Nutrient extraction from processing waste	●	●	●	●
Packaging size and design adjustments	●	■	■	■
Relax produce specifications at retail	●	●	●	◆
<b>Efficient business operations and supply chain solutions</b>				
Waste tracking and analytics	■	◆	■	■
Improved cold chain management	■	◆	◆	■
Whole crop purchase contracts	◆	●	●	●
Centralised and 'dark' commercial kitchens	◆	◆	■	■
Manufacturing line optimisation	●	●	●	●

	Waste reduction potential	Savings per tonne of waste reduced		
		Climate	Water	Costs
<b>Education and behaviour change solutions</b>				
Household behaviour change programs	■	■	■	■
Hospitality and food service solutions	◆	■	■	■
Waste audits at hospitality and institutions	◆	■	■	■
<b>Food rescue, recovery and redistribution solutions</b>				
Business-to-consumer platforms	■	◆	■	■
Increase food rescue across supply chain	■	◆	■	◆
Secondary resellers	◆	◆	●	◆
Legislating food rescue at retail	◆	■	●	■
Sustainable catering guidelines and procurement	●	■	■	■
Online platform for surplus products	●	◆	●	◆

■ High impact ◆ Medium impact ● Low impact



**The Path to Half** (Victoria, Au) 25 solutions

**ReFED** (USA) 73 solutions

**Australian food waste strategy** 41 solutions

**Recommendations for Action in Food Waste Prevention** (EU Platform on Food Losses and Food Waste) 47 solutions

# Some possible issues with valorisation as a "new" FLW solution

- Internal competition (Animal Feed and Biofuel vs other higher value valorisation types)
- Providers work in specific areas, and may lack the ability to scale.
- Valorised products may be more costly than conventional products, which can limit the customer base. (Until a market shock – Ukraine war?, Climate change?)
- End products vary greatly by the feedstocks used, so the economics and diversion potential vary depending on location (England vs Scotland vs Wales vs NI)
- Businesses selling their feedstock (waste) may not have the capacity to store product for extended periods of time.

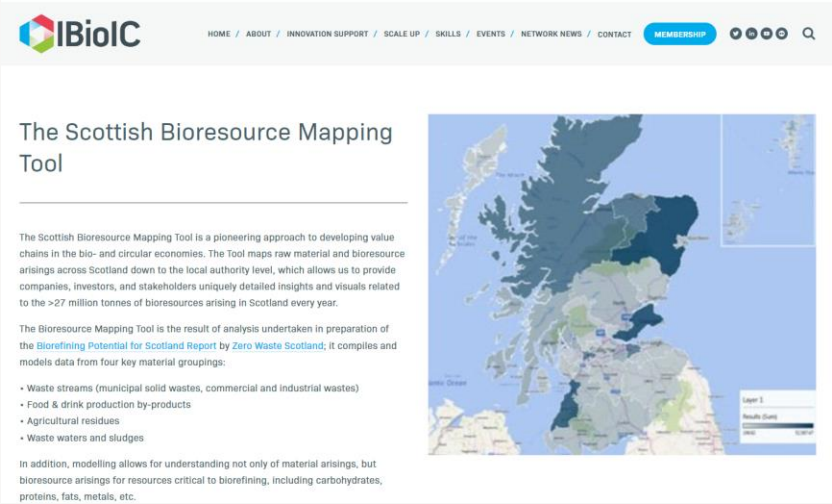




# Do we know the UK's current or maximum capacity?

## ■ Scotland

<https://www.ibioic.com/scottish-bioresource-mapping-tool>



The screenshot shows the IBioIC website header with navigation links: HOME / ABOUT / INNOVATION SUPPORT / SCALE UP / SKILLS / EVENTS / NETWORK NEWS / CONTACT. A blue MEMBERSHIP button and social media icons are also visible.

### The Scottish Bioresource Mapping Tool

The Scottish Bioresource Mapping Tool is a pioneering approach to developing value chains in the bio- and circular economies. The Tool maps raw material and bioresource arisings across Scotland down to the local authority level, which allows us to provide companies, investors, and stakeholders uniquely detailed insights and visuals related to the >27 million tonnes of bioresources arising in Scotland every year.

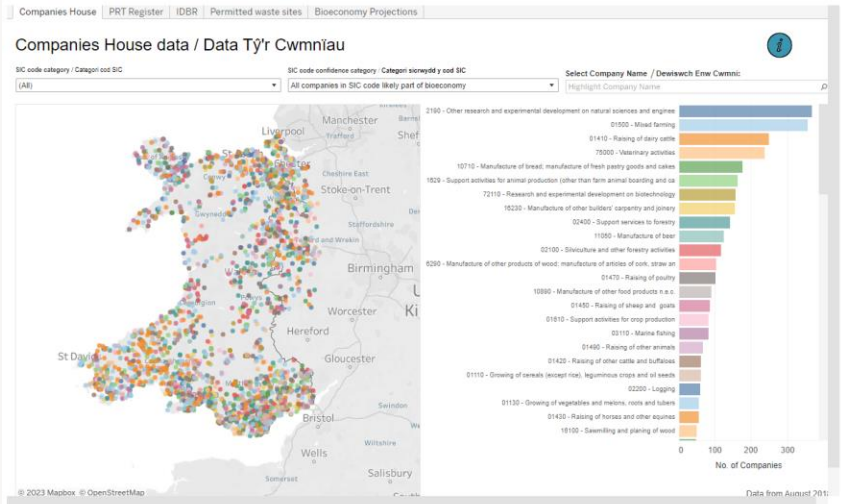
The Bioresource Mapping Tool is the result of analysis undertaken in preparation of the *Biorefining Potential for Scotland Report* by *Zero Waste Scotland*; it compiles and models data from four key material groupings:

- Waste streams (municipal solid wastes, commercial and industrial wastes)
- Food & drink production by-products
- Agricultural residues
- Waste waters and sludges

In addition, modelling allows for understanding not only of material arisings, but bioresource arisings for resources critical to biorefining, including carbohydrates, proteins, fats, metals, etc.

## 10 Wales

<https://w.rapcymru.org.uk/resources/tool/valorisation-tools>



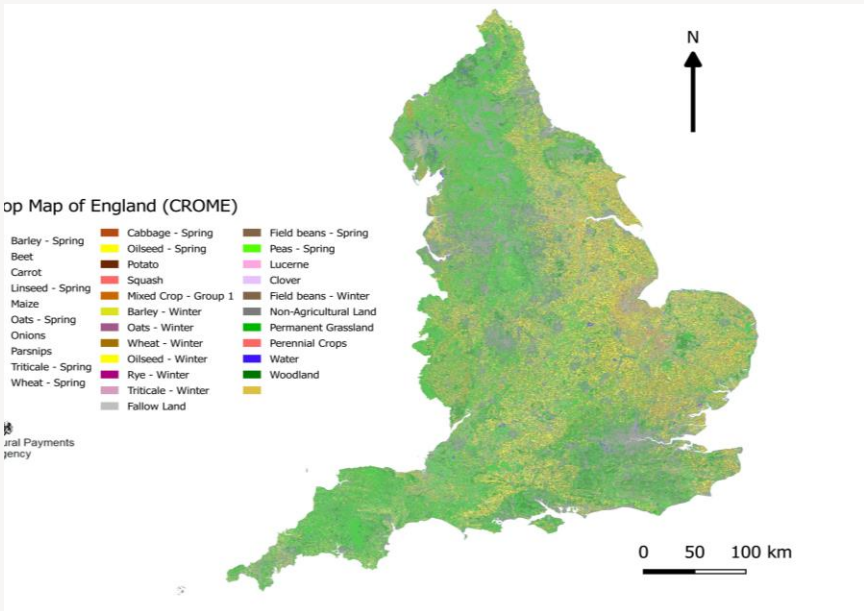
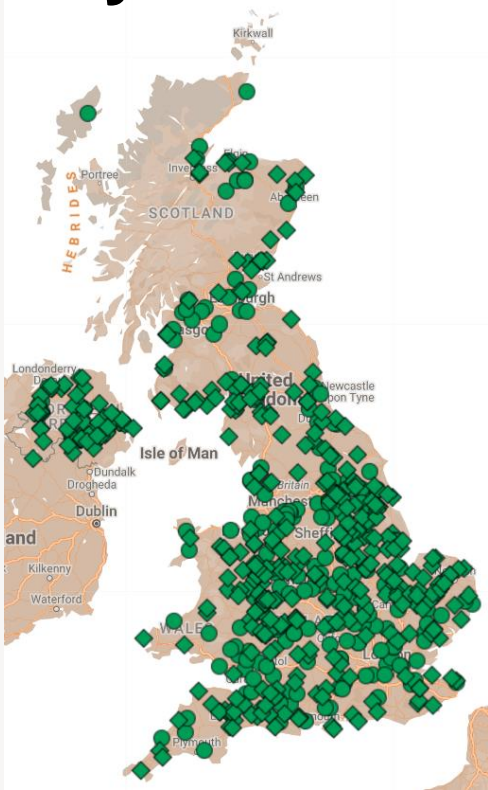
The screenshot shows the 'Companies House data / Data Tŷr Cwmni' tool interface. It includes filters for SIC code category and company name. A map of Wales displays numerous colored dots representing company locations. A bar chart on the right lists various SIC code categories and their corresponding number of companies.

SIC code category / Categori cod SIC	No. of Companies
2100 - Other research and experimental development on natural sciences and engine...	~300
0100 - Mixed farming	~250
0140 - Raising of dairy cattle	~200
7500 - Veterinary activities	~180
1070 - Manufacture of bread, manufacture of fresh pastry goods and cakes	~150
1020 - Support activities for animal production (other than farm animal boarding and ca...	~140
7210 - Research and experimental development on biotechnology	~130
1023 - Manufacture of other builders' carpentry and joinery	~120
0240 - Support services to forestry	~110
1100 - Manufacture of beer	~100
0290 - Silviculture and other forestry activities	~90
0200 - Manufacture of other products of wood; manufacture of articles of cork, straw an...	~80
0147 - Raising of poultry	~70
1090 - Manufacture of other food products n.e.c.	~60
0140 - Raising of sheep and goats	~50
0180 - Support activities for crop production	~40
0210 - Value adding	~30
0140 - Raising of other animals	~20
0142 - Raising of other cattle and buffaloes	~15
0110 - Growing of cereals (except rice), leguminous crops and oil seeds	~10
0220 - Logging	~5
0130 - Drying of vegetables and melons, roots and tubers	~5
0143 - Raising of horses and other equines	~5
1010 - Sawmilling and planing of wood	~5

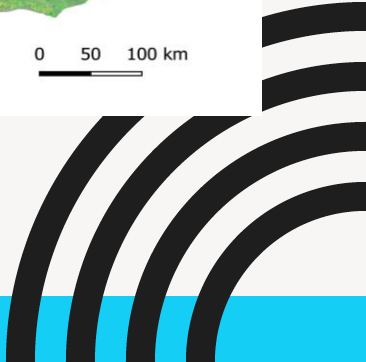


# Geographic tension: AD is where the feedstocks are. AD has already been invested in.

All operational anaerobic digestion plants in the UK (excluding water treatment facilities). April 2023



Crop Map of England (CROME) 2020



## **In 2017, valorisation was on the UK agenda**

**"A key area of focus for WRAP's Courtauld Commitment 2025 is to identify the best ways to recover products from food waste with the remaining wastes still being recycled in the most appropriate way." WRAP 2017**

<https://www.wrap.org.uk/resources/case-study/getting-more-value-waste-and-surplus-food-drink>

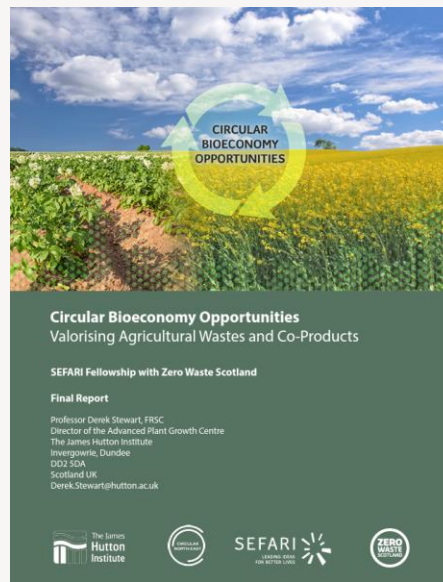
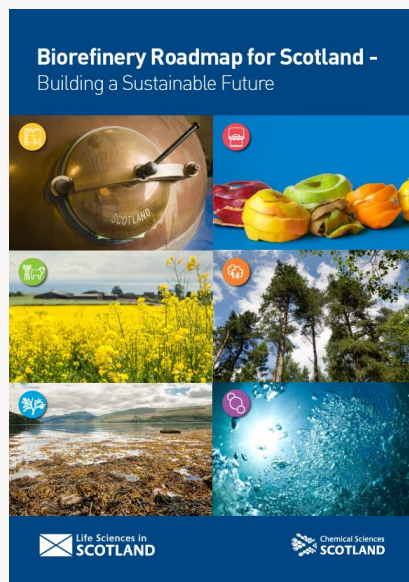
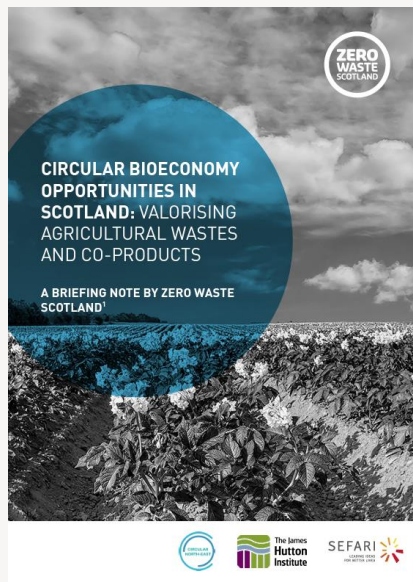
**But in 2023 valorisation is somewhat absent from UK FLW documents (Courtauld) etc ...**

**but not from Wales and Scotland, or other countries...**

# Scotland

27 Mt. of bioarisings, 16.7Mt. agricultural-related bioarisings .

Several common valorisation technologies identified.



<https://www.zerowastescotland.org.uk/resources/maximising-value-agricultural-waste>

<https://www.sdi.co.uk/media/tw/ejlm2/biorefinery-roadmap-for-scotland-2019.pdf>

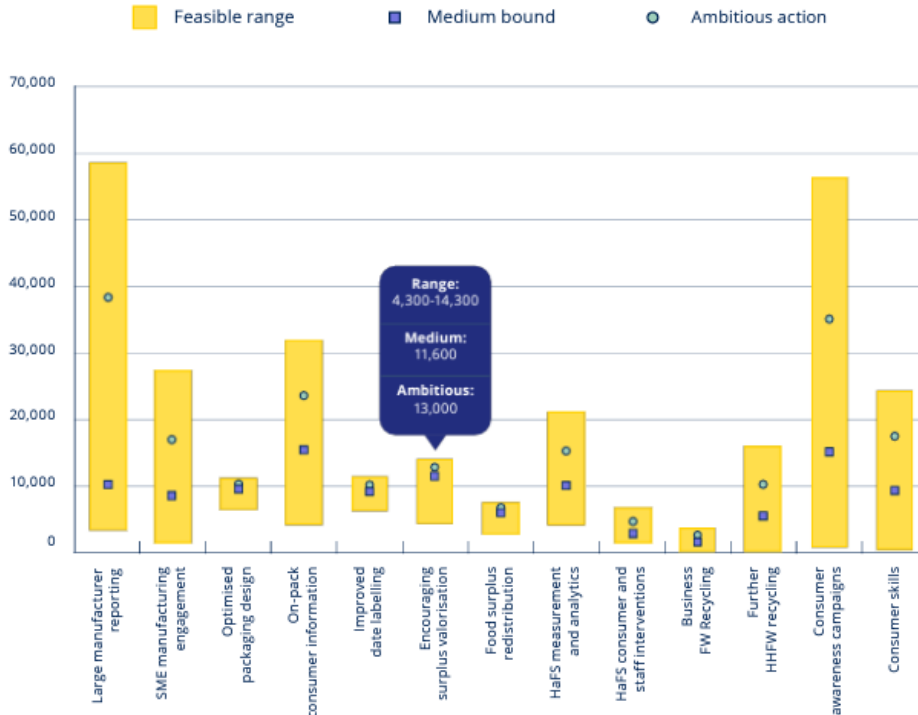
[https://sefari.scot/sites/default/files/documents/SEFARI%20Gateway\\_Fellowship\\_%20Agbyproduct\\_FINAL.pdf](https://sefari.scot/sites/default/files/documents/SEFARI%20Gateway_Fellowship_%20Agbyproduct_FINAL.pdf)

<https://www.zerowastescotland.org.uk/resources/report-biorefining-potential-scotland>

# Welsh FW Routemap: 3rd largest reduction solution

"Unless action taken very quickly, <valorisation> is unlikely to have most impact until after 2030"

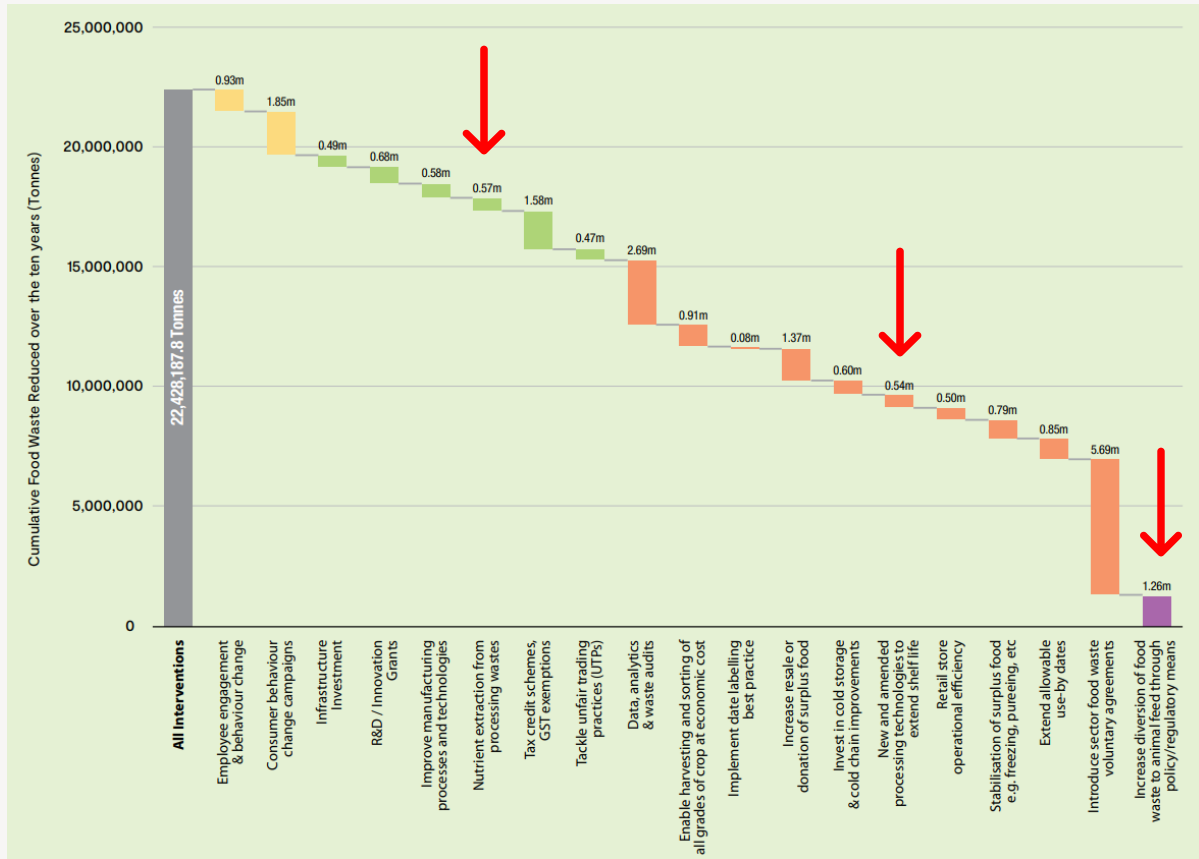
Figure 4: Estimated savings in 2030 by intervention



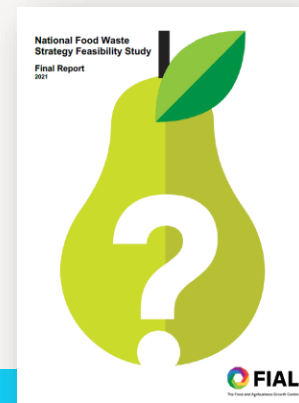
- "Most achievable is to divert **manufacturing and retail waste** up the waste hierarchy, from disposal/recycling to **valorisation into feed**, expected to be substantial
- If able to address **contamination risks** associated with household/HaFS food surplus, opportunity becomes significantly larger"
- ~9% of total (medium) FLW reduction



# Australian FLW strategy

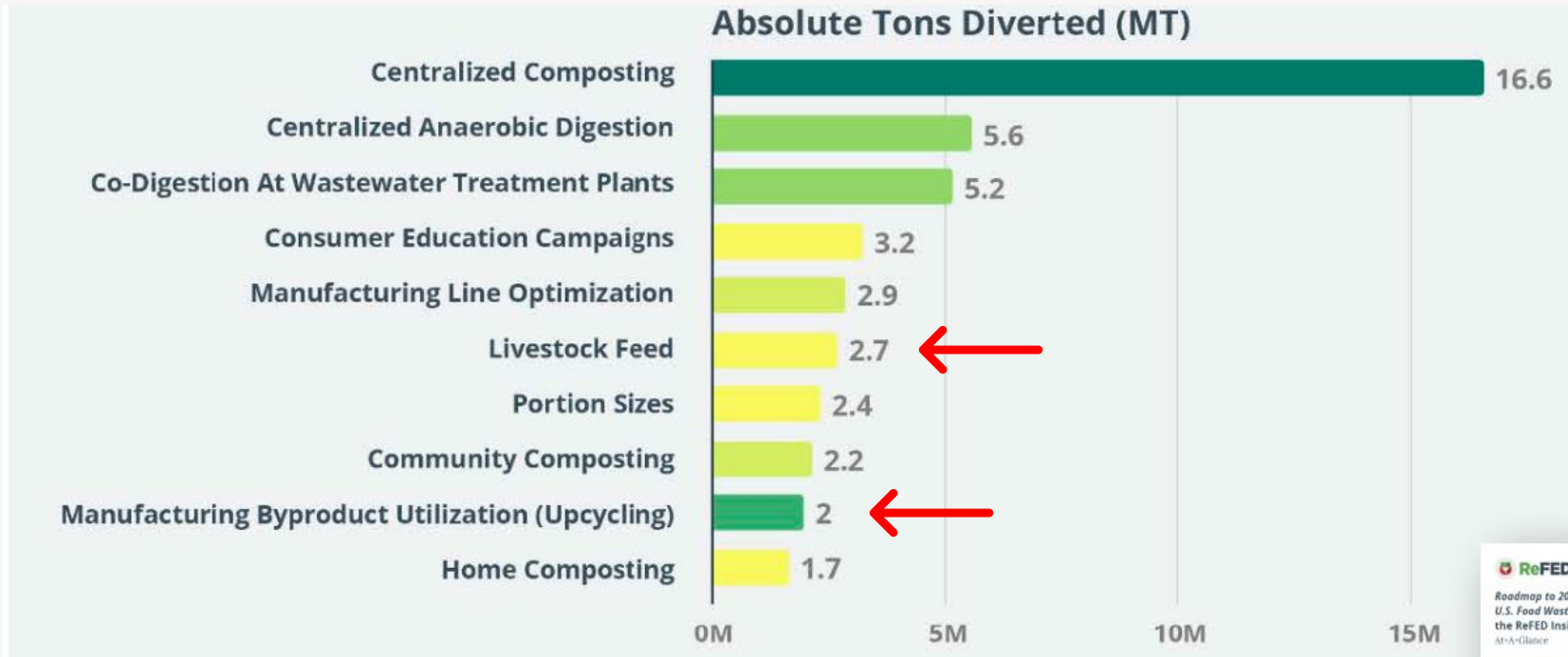


- Nutrient extraction from processing wastes (3%)
- New and amended processing technologies to extend shelf life (2%) ?
- Increase diversion of food waste to animal feed through policy/regulatory means (6%) ?
- Combined are **11% 3rd largest reduction**





# USA – 6th and 9th largest reduction solution





Currently Valorisation is not framed by UK policy  
as scalable before 2030.

But it *is* one of the largest FLW solution categories.

We need to reframe to highlight systems benefits.



We need to reduce barriers to scale/access through policy.

**We need better policy coherence.**

# Multiple solutions need policy coherence

## Food policy coherence

*The alignment of policies that affect the food system with the aim of achieving health, environmental, social and economic goals, to ensure that policies designed to improve one food system outcome do not undermine others.*  
**Food policy incoherence creates problems and misses opportunities.**

Health (social) policy  
goal = to prevent disease and treat and manage ill-health in the population

Environmental policy  
goal = less deforestation, water pollution, greenhouse gases

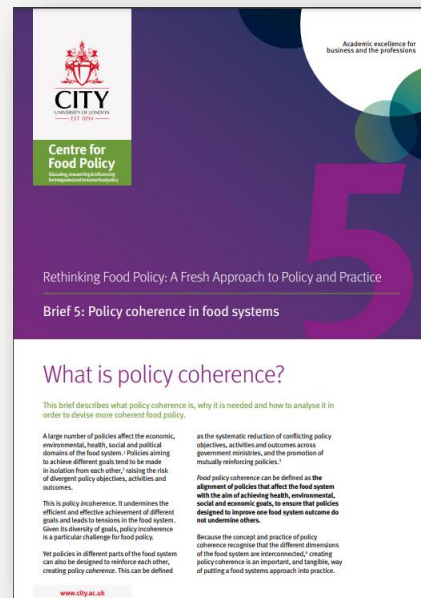
Economic policy  
Goal = growth and competitiveness for income generations and jobs

Policy incoherence



Economic policy or economic policy instruments not fit for purpose in reinforcing environmental and health policy goals

Policy made in different spaces



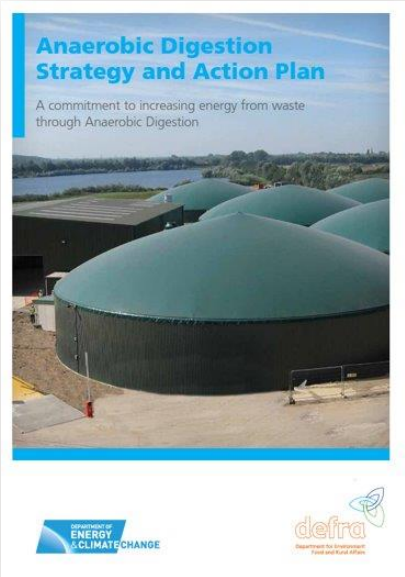


# Multiple government departments linked to Valorisation... (but not enough?)



- BEIS (2021) => Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ)
- Defra
- FCDO (overseas funding)
- Are they all talking?
- Who is leading?

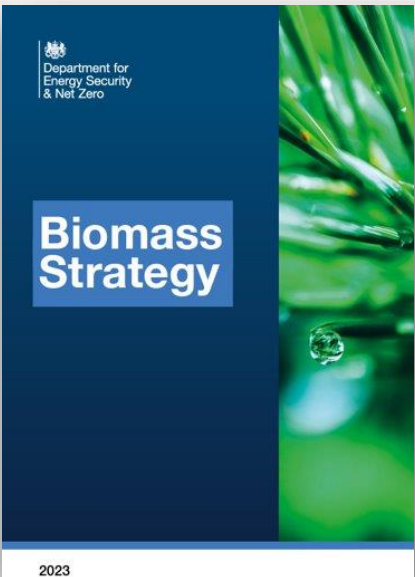
# So where is valorisation discussed in the UK?



2011



2018



2023

- Wider circular economy framing.
- Focus on feedstock capacity.
- Energy generation focus
- FSA report provides a systems view.



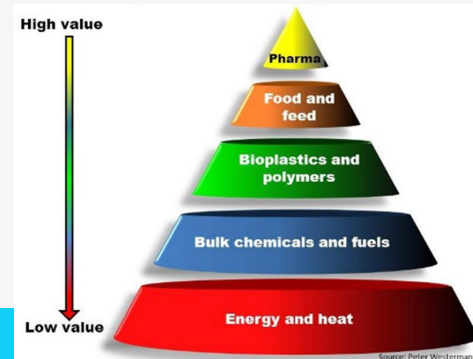
**Food Standards Agency**

**The Future of Animal Feed**

Area of research interest: [Emerging challenges and opportunities](#)  
Planned completion: 2 February 2023  
Project status: Completed  
Project code: FS900202  
Authors: Dr. Georgios Poxas; Prof. Illias Kyriazakis; Prof. Bob Doherty  
Date published: 28 April 2023  
DOI: <https://doi.org/10.46756/sci.fsa.gz1586>

# Why is valorisation incoherent in the UK?

- Until the FSA report there has been little discussion of the **health, social, net zero** benefits of valorisation in a UK level policy document.
- This lack of wider systems framing may mean that for other govt departments it is not high priority .
- The valorisation community is also not the best at co-ordinating messages and policy work. (food vs feed vs fule)



# Do we have the policy environment and scalability yet for valorisation, bio-economy hubs and spokes etc. ?

- Do we have consistent feedstocks?
- Technical solutions: Solving mixed vs separate waste streams (contamination risks etc.)
- **What policy framing do we need to get there?**
  - Engagement of primary producers and feed stock producers.
  - Multiple support mechanisms for different types of valorisation
  - Farmer and industry diversification into "Net Zero enterprises"
  - Protein/crop valorisation as part of wider food system change

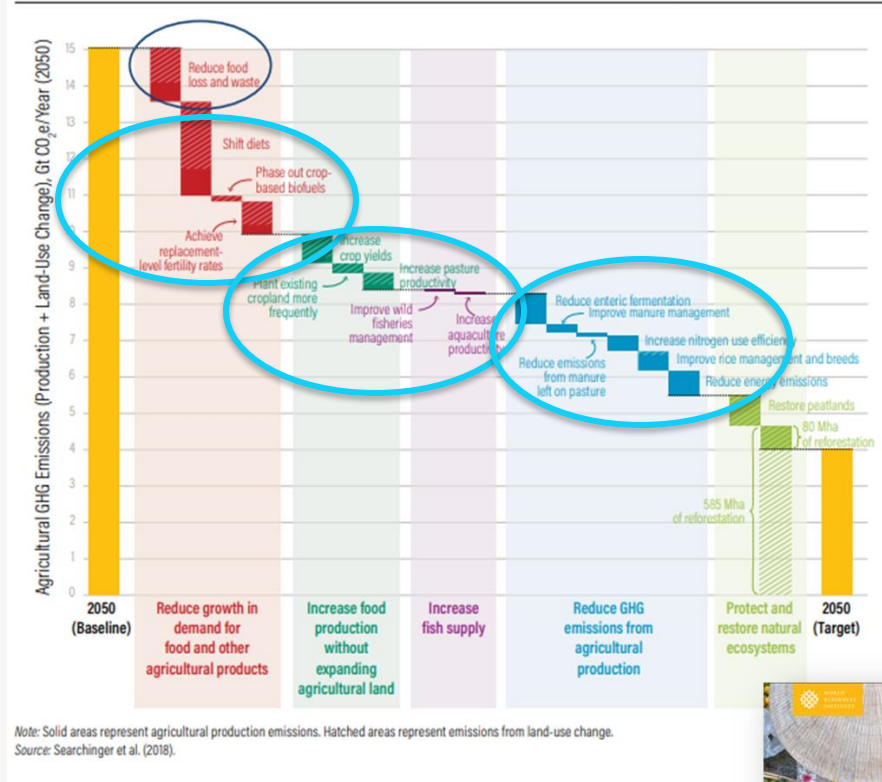


# End objective:

## Can we link valorisation to these wider food systems actions?

## Making it a wider food systems solution?

Figure I.2 | Reducing Food Loss and Waste Can Play an Important Role in Eliminating the Projected 15 Gt of Greenhouse Gas Emissions from Agriculture and Land-Use in 2050 (CO<sub>2</sub> equivalent)



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<https://www.city.ac.uk/about/schools/health-sciences/research/centre-for-food-policy>

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University of London offers the following  
courses

### **Nutrition and Food Policy BSc (Hons)**

Undergraduate degree

### **Food Policy MSc/PGDip/PGCert/MSc**

### **Distance Learning**

Postgraduate taught degree

### **PhD/MPhil Food Policy**

Postgraduate research degree

<https://www.city.ac.uk/prospective-students/courses/postgraduate/food-policy>

