

EPSRC CENTRE FOR INNOVATIVE
MANUFACTURING IN



Embodied Energy in Preventable Food Manufacturing Waste

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Content



Research Question: How much energy could be saved by preventing waste arising in food factories?

Step 1: How much manufacturing waste could be prevented from arising?

Step 2: How much embodied energy is in each product?



Step 1: How much manufacturing waste could be prevented from arising?



Source: WRAP (2016) - Estimates of Food Surplus and Waste Arisings in the UK

Definitions (WRAP 2016):

Manufacturing Surplus: Products & material diverted to secondary use (redistribution or animal feed) – e.g. overruns, products not sold within date.

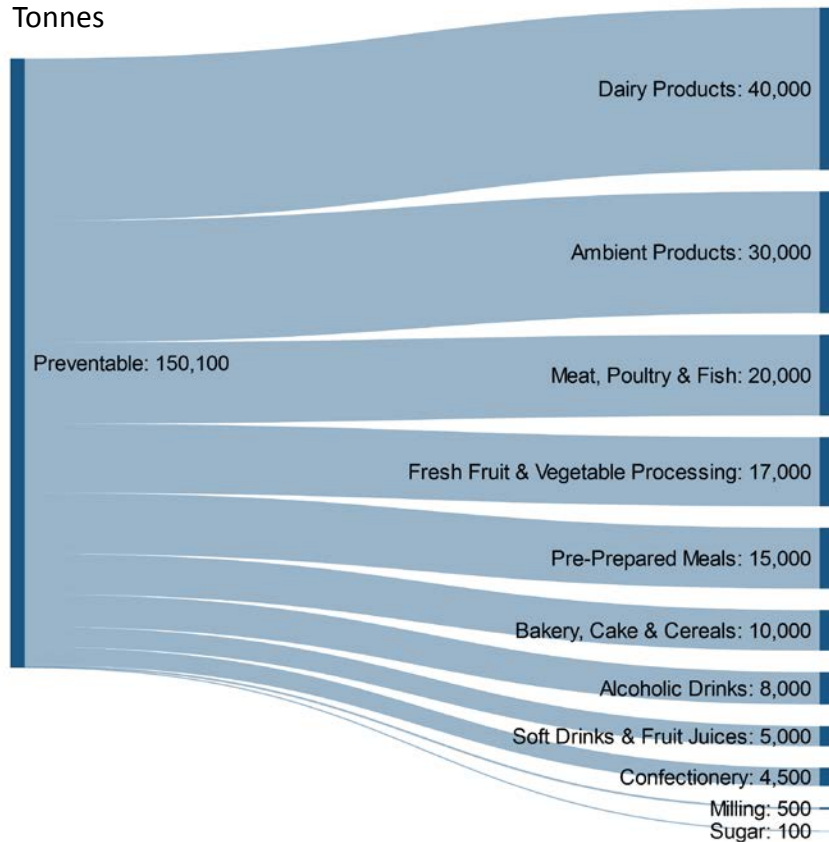
Unavoidable Waste (By-Products): Material not suitable for the manufactured product but which can be diverted to secondary use or conversions – e.g. peelings, bone, sludges from cleaning.

Preventable Waste: Products & material not sent for sale, or surplus material which need not have been manufactured – e.g. spilt products, below-quality rejects.



Step 1: How much manufacturing waste could be prevented from arising?

Preventable Manufacturing Waste, UK 2014 (WRAP 2016)



Achievable through better planning, management and control (Industry 4.0?)

Why not just calculate average energy consumption?



Total process energy consumed by UK F&B manufacturing (2014):	29.9 TWh
UK food manufacturing output (2014):	58m tonnes
Average specific embodied energy:	516 kWh/tonne
UK Preventable Manufacturing Waste (2014):	150,000 tonne
Total PMW embodied energy:	77.4 GWh

BUT

- PMW categories (Dairy Products, Ambient Products etc) have different energy intensities (embodied energy values, MJ/kg)
- PMW sub-categories (e.g. milk, cheese, ice cream) also have different energy intensities

so the sub-categories need to be disaggregated

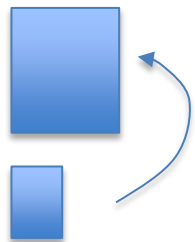
Step 1: How much manufacturing waste could be prevented from arising?



58m tonnes

PRODCOM (Level 1)

UK F&B Output



9.9m tonnes

Food Category (Level 2)

e.g. Dairies & Cheesemaking

0.48m tonnes

Food Sub-Category (Level 3)

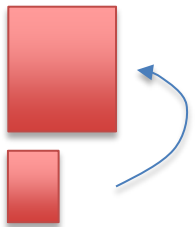
e.g. Ice Cream



150k tonnes

PMW (Level 1)

(WRAP 2016 estimate)



40k tonnes

Food Category (Level 2)

e.g. Dairy Products

= 1,926 tonnes

Food Sub-Category (Level 3)

e.g. Ice Cream

Simplified Assumption:

Preventable waste arises in the same proportions as output.

Step 1: How much manufacturing waste could be prevented from arising?

Examples:

	% of output & PMW	PMW /yr (tonnes)
Dairy Products		
Liquid milk	80.2	32,077
Butter	1.5	602
Ambient Products		
Canned vegetables	30.4	7,831
Table sauces	10.5	2,717
Meat, Poultry & Fish		
Beef (fresh)	13.5	2,733
Pork (fresh)	10	2,081
Frozen fish/seafood	3.4	685



**Step 2: How much embodied
energy is in each product?**

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Sources: WRAP (2013), more recent individual Lifecycle Inventories and Assessments, JRC (2015)

Examples:

	Specific embodied energy (MJ/kg)
Dairy Products	
Liquid milk	0.89
Butter	5.4
Ambient Products	
Canned vegetables	4.4
Table sauces	16
Meat, Poultry & Fish	
Beef (fresh)	5.1
Pork (fresh)	2.2
Frozen fish/seafood	9



Step 3: How much embodied energy is lost in Preventable Manufacturing Waste?

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Product Sub-Category	UK output (Tonnes) (2014)	% of total for Dairy Products	PMW for Dairy Products (T)	PMW for Ice Cream etc	Specific Embodied Energy – Ice Cream (MJ/kg)	Total Embodied Energy – Ice Cream (GWh)
10521000 (CN 2105) - Ice cream and other edible ice	475,196	4.8%	40,000	4.8% * 40,000 (= 1,926)	0.65	0.35 (350 MWh)

Simplification

1. Waste could be prevented at a point in manufacture when less energy had been embodied in the product than these end product values.
2. Against this, energy is required to deal with preventable waste at any stage, and this is not included in the embodied energy values.

Step 3: How much embodied energy is lost in Preventable Manufacturing Waste?



	Embodied Energy in PMW(GWh/yr)	Corrected for EE reduction 2004-14, (GWh/yr)
Dairy products	17.5	14.9
Ambient products	24.3	20.6
Meat, poultry and fish	21.9	18.6
Fresh fruit and vegetable processing	2.6	2.2
Pre-prepared meals	15.9	13.5
Bakery, cake and cereals	14.3	12.1
Alcoholic drinks	8.8	7.5
Soft drinks and fruit juices	1.4	1.2
Confectionery	14.4	12.3
Milling	0.16	0.14
Sugar	-	-
TOTAL	121.3	109.6
% of total F&B manufacturing energy	0.41	0.37
% of a 20% reduction over 2015-25 target	2.0	1.85
% of energy management part of CCA target (~4%)	51	46

Conclusions



- Embodied energy in Preventable Manufacturing Waste is small in absolute terms.
- **Useful contribution** to sector energy efficiency targets (~20% by 2025).
- **Significant part of** Energy Management contribution to targets.
- Further work at national level probably disproportionately costly.
- For sub-sectors or individual companies, quantifying PMW may be an effective way to meet two targets at once as well as reduce costs.
- Preventing manufacturing waste should perhaps be a higher priority for Energy Managers.

Thank you for listening!



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