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Supplementary information files for "Embodied energy in preventable food manufacturing waste in the United Kingdom"

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Embodied Energy in Preventable Food Manufacturing Waste

Supplementary Information 1: References used for Specific Embodied Energy (SEE) Values

W13 is WRAP (2013). The W13 references used in this study are listed in Table 2. This source did not associate its individual sources to specific data, so it is not possible to do that here.

Table S1: Specific Embodied Energy (SEE) values and their sources

Preventable Production Waste (PRODCOM classification)	SEE Value (MJ/kg)	Data Source
Dairy Products		
SIC(07) 1051 - Operation of dairies & cheesemaking		
10511133 (CN 0401101) - Milk and cream of a fat content by weight not exceeding 1%, in immediate packings of a net content not exceeding 2 litres EXCLUDING: - concentrated - containing added sugar or other sweetening matter	0.89	W13
10511137 (CN 0401109) - Milk or cream of a fat content by weight not exceeding 1%, in immediate packings of a net content more than 2 litres EXCLUDING: - concentrated - containing added sugar or other sweetening matter	0.89	W13
10511142 (CN 04012011 + 04012091) - Milk and cream of a fat content by weight exceeding 1%, but not exceeding 6%, in immediate packings of a net content not exceeding 2 litres EXCLUDING: - concentrated - containing added sugar or other sweetening matter	0.89	W13
10511148 (CN 04012019 + 04012099) - Milk and cream of a fat content by weight exceeding 1%, but not exceeding 6%, in immediate packings of net content exceeding 2 litres EXCLUDING: - concentrated - containing added sugar or other sweetening matter	0.89	W13
10511210 (CN 04014010 + 04015011) - Milk and cream of a fat content by weight exceeding 6% but not exceeding 21%, in immediate packings not exceeding 2 litres. EXCLUDING: - concentrated - containing added sugar or other sweetening matter	0.89	W13
10511220 (CN 04014090 + 04015019) - Milk and cream of a fat content by weight exceeding 6% but not exceeding 21%, in immediate packings exceeding 2 litres. EXCLUDING: - concentrated - containing added sugar or other sweetening matter.	0.89	W13
10511230 (CN 04015031 + 04015091) - Milk and cream of a fat content by weight exceeding 21% in immediate packings not exceeding 2 litres. EXCLUDING: - concentrated - containing added sugar or other sweetening matter.	0.89	W13
10511240 (CN 04015039 + 04015099) - Milk and cream of a fat content by weight exceeding 21% in immediate packings exceeding 2 litres. EXCLUDING: - concentrated - containing added sugar or other sweetening matter.	0.89	W13
10512160 (CN 04021019 + 04021099) - Skimmed milk powder (milk or cream in solid forms, of a fat content by weight not exceeding 1.5%) in immediate packings exceeding 2.5kg	7.5	(ENTHALPY Project Consortium, 2015)
10512260 (CN 04022118 + 04022199 + 04022919 + 04022999) - Whole milk or full cream powder (milk or cream in solid forms of a fat content by weight exceeding 1.5%) in immediate packings exceeding 2.5kg	7.5	Used ENTHALPY source as separation energy is negligible
10513030 (CN 04051011 + 04051019 + 04051030 + 04051050) - Butter of a fat content by weight not exceeding 85%	5.4	W13
10513050 (CN 04051090 + 040590) - Butter of a fat content by weight exceeding 85% and other fats and oils derived from milk EXCLUDING: - dairy spreads of a fat content by weight of less than 80%	5.4	W13
10514030 (CN 040610) - Unripened or uncured cheese (fresh cheese) INCLUDING:	3	(Flysjö et al.,

- whey cheese and curd		2014)
10514050 (CN 040620 + 040640 + 040690) - Other non-processed cheese INCLUDING: - hard cheese, medium hard cheese - blue cheese - grated or powdered cheese EXCLUDING: - fresh cheese, whey cheese and curd cheese	13.35	(González-García et al., 2013)
10514070 (CN 040630) - Processed cheese EXCLUDING: - grated or powdered	16.69	W13 ¹
10515108 (CN 040299) - Condensed/evaporated milk, sweetened	-	No SEE used
10515241 (CN 0403101 + 0403103 + 0403105 + 04039013 + 04039019 + 0403903 + 04039053 + 04039059 + 0403906 + 0403907) - Curdled milk, cream, yoghurt and other fermented products INCLUDING: - powdered, in granules or other solid form EXCLUDING: - liquid products which are flavoured or contain added fruit, nuts or cocoa	3.6	W13
10515245 (CN 0403109 + 04039091 + 04039093 + 04039099) - Flavoured liquid yoghurt or acidified milk	3.6	W13
10515265 (CN 04039051) - Buttermilk	0.89	2001 data in (Ramírez et al., 2006) via (Wang, 2008) ²
10515530 (CN 04041002 + 04041004 + 04041006 + 0404101 + 0404102 + 0404103) - Whey and modified whey in powder, granules or other solid forms, whether or not concentrated or containing added sweetening matter	0.89	Ditto source
10515560 (CN 0404104 + 0404105 + 0404106 + 0404107 + 0404108) - Whey and modified whey in liquid or paste forms, whether or not concentrated or containing added sweetening matter	0.89	Ditto source
10515600 (CN 040490) - Fresh or preserved products consisting of natural milk constituents, whether or not containing added sweetening matter EXCLUDING: - whey - buttermilk, curdled milk and cream, kephir - other fermented or acidified milk or cream - yoghurt - butter and other fats and oils - cheese and curd	0.89	Ditto source
SIC(07) 1052 - Manufacture of ice cream		
10521000 (CN 2105) - Ice cream and other edible ice INCLUDING: - sherbet - lollipops EXCLUDING: - mixes and bases for ice cream	0.65	W13
Not included		
10515400 (CN 170211 + 170219) - Lactose and lactose syrup INCLUDING: - chemically pure lactose		
10515300 (CN 350110) - Casein and caseinates		
10515263 (CN 04039011) - Buttermilk powder		
10515104 (CN 040291) - Condensed/evaporated milk, unsweetened		
10513070 (CN 040520) - Dairy spreads of a fat content by weight of less than 80%		
10512230 (CN 04022111 + 04022191 + 04022911 + 04022915 + 04022991) - Whole milk or full cream powder (milk and cream in solid forms of a fat content by weight exceeding 1.5%) in immediate packings not exceeding 2.5 kg		
10512130 (CN 04021011 + 04021091) - Skimmed milk powder (milk or cream in solid forms, of a fat content by weight not exceeding 1.5kg) in immediate packings not exceeding 2.5kg		
Ambient Products		
SIC(07) 1039 - Other processing and preserving of fruit and vegetables		
10391390 (CN 0712901 + 07129030 + 07129050 + 07129090) - Dried vegetables and mixtures of dried vegetables, whole cut, sliced, broken or in powder, but not further prepared EXCLUDING: - potatoes, onions, mushrooms and truffles as single vegetables - beans, peas, chickpeas, lentils and other legumes - soup preparations	-	No SEE figure used

¹ No data. Added 25% to hard cheese figure.

² Wang (2008) listed figures from a Dutch 2001 study in Table 10.2 which put fermented products in the same category as milk, so the milk figure used here. Probably therefore a small underestimate.

based on dried vegetables		
10391710 (CN 200210) - Preserved tomatoes, whole or in pieces EXCLUDING: - by vinegar or acetic acid - dried - prepared vegetable dishes	4.4	W13
10391730 (CN 2003) - Prepared or preserved mushrooms and truffles EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes	4.4	W13
10391760 (CN 200560) - Prepared or preserved asparagus EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes	4.4	W13
10391770 (CN 200570) - Prepared or preserved olives EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes	4.4	W13
10391780 (CN 200580) - Prepared or preserved sweetcorn EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes	4.4	W13
10391790 (CN 20059100 + 20059910 + 20059920 + 20059930 + 20059950 + 20059980) - Other prepared or preserved vegetables and mixtures of vegetables EXCLUDING: - frozen - prepared vegetable dishes - dried - potatoes, peas, beans, tomatoes, mushrooms, asparagus, olives or sweetcorn unless part of a mixture	4.4	W13
10391800 (CN 2001) - Vegetables, fruit, nuts and other edible parts of plants prepared or preserved by vinegar or acetic acid EXCLUDING: - potatoes	1.6	W13 ³
10392230 (CN 200791) - Citrus fruit, marmalades, jellies, purees or pastes, being cooked preparations EXCLUDING: - homogenized preparations	1.6	W13 ³
10392290 (CN 200799) - Jams, fruit jellies, fruit or nut purees and pastes, being cooked preparations EXCLUDING: - of citrus fruit - homogenized preparations - peanut butter	1.6	W13 ³
10392330 (CN 200811) - Prepared or preserved groundnuts INCLUDING: - peanut butter EXCLUDING: - by vinegar or acetic acid - frozen - purees and pastes	2.76	(Center for Agricultural and Rural Sustainability, 2012) ⁴
10392390 (CN 200819) - Prepared or preserved nuts, other than groundnuts, and other seeds and mixtures EXCLUDING: - in vinegar or acetic acid - frozen - purees and pastes - drained, glaze or crystallised	2.76	(Center for Agricultural and Rural Sustainability, 2012) ⁴
10392410 (CN 0814) - Peel of citrus fruit or melons, fresh, frozen, dried or provisionally preserved in brine, in sulphur water or in other preservative solutions	2.2	(Ramírez et al., 2006)
10392510 (CN 080620) - Dried grapes	6	(Ramírez et al., 2006)
10392520 (CN 0813) - Mixtures of nuts or dried fruits; other dried fruit EXCLUDING: - bananas, dates, figs, pineapples, avocados, guavas, mangoes, mangosteens, citrus fruit or grapes unless part of a mixture	6	(Ramírez et al., 2006)
10392550 (CN 200820 + 200830 + 200840 + 200850 + 200860 + 200870 + 200880 + 20089) - Prepared or preserved fruit INCLUDING: - in water, syrup, chemicals, spirit or synthetic sweeteners EXCLUDING: - in vinegar or acetic acid, dried, frozen - jams, jellies, marmalades, purees and pastes - drained, glaze or crystallised - muesli	1.6	W13 ³
SIC(07) 1084 - Manufacture of condiments and seasonings		
10841130 (CN 2209001) - Vinegar and substitutes for vinegar made from wine	7.02	W13
10841190 (CN 2209009) - Vinegar and substitutes for vinegar EXCLUDING: - made from wine	7.02	W13

³ Used 'Wet Cooking Sauces' figure as substitute, because processes are chopping, heat treatment and packaging of wet material. Canned soup v close figure, so validates.

⁴ Calculated from this source.

10841210 (CN 210310) - Soya sauce	7.02	W13
10841230 (CN 210320) - Tomato ketchup and other tomato sauces	7.02	W13
10841255 (CN 21033090) - Prepared mustard	7.02	W13
10841270 (CN 210390) - Sauces and preparations thereof; mixed condiments and mixed seasonings EXCLUDING: - soya sauce, tomato ketchup and other tomato sauces - mustard flour or meal and prepared mustard	1.6	W13 ⁵
SIC(07) 1089 - Manufacture of other food products n.e.c.		
10891100 (CN 210410) - Soups and broths and preparations thereof	1.56	W13
Not included		
10391330 (CN 071220) - Dried onions, whole, cut, sliced, broken or in powder, but not further prepared		
10391350 (CN 07123) - Dried mushrooms and truffles, whole, cut, sliced, broken or in powder, but not further prepared		
10391500 (CN 20055) - Prepared or preserved beans EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes		
10391600 (CN 200540) - Prepared or preserved peas EXCLUDING: - by vinegar or acetic acid - dried - frozen - prepared vegetable dishes		
10391721 (CN 20029011 + 20029019) - Unconcentrated tomato puree and paste		
10391725 (CN 2002903 + 2002909) - Concentrated tomato puree and paste		
10391750 (CN 20059960) - Preserved sauerkraut EXCLUDING: - dried - frozen - preserved by vinegar _ prepared vegetable dishes		
Meat, poultry and fish		
SIC(07) 1011 - Processing and preserving of meat		
10111140 (CN 020110 + 02012020 + 02012030 + 02012050) - Fresh or chilled carcasses, half-carcasses and quarters with bone in, of beef and veal	5.08	W13
10111190 (CN 02012090 + 020130) - Fresh or chilled cuts of beef and veal	5.08	W13
10111230 (CN 020311) - Fresh or chilled carcasses and half-carcasses of pig meat INCLUDING: - fresh meat packed with salt as a temporary preservative	2.2	W13
10111250 (CN 020312) - Fresh or chilled hams, shoulders and cuts thereof with bone in, of pig meat INCLUDING: - fresh meat packed with salt as a temporary preservative	2.2	W13
10111290 (CN 020319) - Fresh or chilled pig meat INCLUDING: - fresh meat packed with salt as a temporary preservative EXCLUDING: - carcasses and half-carcasses - hams, shoulders and cuts thereof with bone in	2.2	W13
10111300 (CN 020410 + 020421 + 020422 + 020423) - Fresh or chilled carcasses, half-carcasses and cuts of lamb or sheep	8.33	(Wiedemann and Yan, 2014)
10112000 (CN 020610 + 020630 + 020680) - Fresh or chilled edible offal of bovine animals, swine, sheep, goats, horses, asses, mules and hinnies	3	(Wiedemann and Yan, 2014) ⁶

⁵ Allocated this to wet cooking sauces. This could be checked against the questionnaire sent out by the Office for National Statistics.

⁶ Used lowest W & Y figure (for pork) because their inventory included meat processing for products including for by-product destinations such as rendering.

10113100 (CN 0202) - Frozen carcasses, half-carcasses, quarters and cuts of beef and veal	6.08	(Wang, 2008) ⁷
10113250 (CN 020322) - Frozen hams, shoulders and cuts thereof with bone in, of pig meat	3.2	(Wang, 2008)
10113290 (CN 020329) - Frozen pig meat EXCLUDING: - carcasses and half-carcasses - hams, shoulders and cuts thereof with bone in	3.2	(Wang, 2008)
10113300 (CN 020430 + 020441 + 020442 + 020443) - Frozen carcasses, half-carcasses and cuts of lamb or sheep	9.33	(Wang, 2008)
10113910 (CN 02062 + 02064 + 020690) - Frozen edible offal of bovine animals, swine, sheep, goats, horses, asses, mules and hinnies	4	(Wang, 2008)
10113930 (CN 020810 + 020830 + 020840 + 020850 + 020890) - Fresh, chilled or frozen edible meat and offal INCLUDING: - rabbits and hares - game - venison EXCLUDING: - poultry - of bovine and equine animals - of swine, sheep and goat - frog legs	3	(Wiedemann and Yan, 2014)
SIC(07) 1012 - Processing and preserving of poultry meat		
10121010 (CN 020711) - Fresh or chilled whole chickens	2.79	W13
10121020 (CN 020724) - Fresh or chilled whole turkeys	2.79	W13
10121050 (CN 02071310 + 02071320 + 02071330 + 02071340 + 02071350 + 02071360 + 02071370) - Fresh or chilled cuts of chicken	2.79	W13
10121060 (CN 02072610 + 02072620 + 02072630 + 02072640 + 02072650 + 02072660 + 02072670 + 02072680) - Fresh or chilled cuts of turkey	2.79	W13
10122013 (CN 020712) - Frozen whole chickens	3.79	(Wang, 2008)
10122015 (CN 020725) - Frozen whole turkeys	3.79	(Wang, 2008)
10122053 (CN 02071410 + 02071420 + 02071430 + 02071440 + 02071450 + 02071460 + 02071470) - Frozen cuts of chicken	3.79	(Wang, 2008)
10122055 (CN 02072710 + 02072720 + 02072730 + 02072740 + 02072750 + 02072760 + 02072770 + 02072780) - Frozen cuts of turkey	3.79	(Wang, 2008)
10122057 (CN 02074510 + 02074521 + 02074531 + 02074541 + 02074551 + 02074561 + 02074571 + 02074581 + 02075510 + 02075521 + 02075531 + 02075541 + 02075551 + 02075561 + 02075571 + 02075581 + 02076010 + 02076021 + 02076031 + 02076041 + 02076051 + 02076061 + 02076081) - Frozen cuts of ducks, geese and guinea fowls	3.79	(Wang, 2008)
10122080 (CN 02071491 + 02072791 + 02074593 + 02074595 + 02075593 + 02075595 + 02076091) - Frozen poultry livers	3.79	(Wang, 2008)
10123000 (CN 020990 + 150190) - Fats of poultry	3.79	
10129901 = 10121030 + 10122017 (CN 02074120 + 02074130 + 02074180 + 02074230 + 02074280 + 02075110 + 02075190 + 02075210 + 02075290 + 02076005) - Fresh or chilled or frozen whole geese, ducks or guinea fowl	2.79	W13 ⁸
SIC(07) 1013 - Production of meat and poultry meat products		
10131120 (CN 021011) - Hams, shoulders and cuts thereof with bone in of swine, salted, in brine, dried or smoked	3	(Wiedemann and Yan, 2014)
10131150 (CN 021012) - Bellies and cuts thereof of swine, salted, in brine, dried or smoked	3	(Wiedemann and Yan, 2014)
10131180 (CN 021019) - Pig meat salted, in brine, dried or smoked INCLUDING: -	3	(Wiedemann and

⁷ Wang (2008) Energy Efficiency and Management in Food Processing Facilities (book) p208 & Table 10.3 puts the average energy for a freezing process at 1 MJ/kg.

⁸ Used lowest figure for poultry.

bacon, three quarter sides or middles, fore-ends, loins and cuts thereof EXCLUDING: - hams, shoulders and cuts thereof with bone in - bellies and cuts thereof		Yan, 2014)
10131200 (CN 021020) - Beef and veal salted, in brine, dried or smoked	5.81	
10131300 (CN 02109) - Meat salted, in brine, dried or smoked; edible flours and meals of meat or meat offal EXCLUDING: - pig-meat, beef and veal salted, in brine, dried or smoked	3	(Wiedemann and Yan, 2014) ⁹
10131430 (CN 16010010) - Liver sausage and similar products and food preparations based thereon EXCLUDING: - prepared meals and dishes	3	(Wiedemann and Yan, 2014) ⁹
10131460 (CN 1601009) - Sausages and similar products of meat, meat offal or blood INCLUDING: - pates and pastes in sausage casings or pressed into a sausage shape - black puddings EXCLUDING: - of liver - prepared meals and dishes	3	(Wiedemann and Yan, 2014)
10131505 (CN 1602201) - Preparations of goose or duck liver INCLUDING: - pates and pastes other than in sausage casings or pressed into a sausage shape EXCLUDING: - sausages and similar products - homogenized preparations - prepared meals and dishes	4.34	(Wiedemann and Yan, 2014)
10131515 (CN 16022090) - Preparations of animal liver INCLUDING: - pates and pastes other than in sausage casings or pressed into a sausage shape EXCLUDING: - sausages and similar products - homogenized preparations - of goose or duck - prepared meals and dishes ⁹	3	
10131525 (CN 160231) - Prepared or preserved meat or offal of turkeys INCLUDING: - pates and pastes other than in sausage casings or pressed into a sausage shape EXCLUDING: - fresh, chilled, frozen, salted, in brine, dried or smoked meat - sausages and similar products - homogenized preparations - prepared meals and dishes	4.34	(Wiedemann and Yan, 2014)
10131535 (CN 160232 + 160239) - Prepared or preserved poultry meat INCLUDING: - pates and pastes other than in sausage casings or pressed into a sausage shape EXCLUDING: - turkey - fresh, chilled, frozen, salted, in brine, dried or smoked meat - sausages or homogenized preparations - prepared meals and dishes	4.34	(Wiedemann and Yan, 2014)
10131545 (CN 160241) - Prepared or preserved hams and cuts thereof of swine EXCLUDING: - salted, in brine, dried or smoked - shoulders - prepared meals and dishes	3	(Wiedemann and Yan, 2014)
10131555 (CN 160242) - Prepared or preserved shoulders and cuts thereof of swine EXCLUDING: - fresh, chilled, frozen, salted, in brine, dried or smoked - prepared meals and dishes	3	
10131565 (CN 16024950) - Prepared or preserved meat, offal and mixtures of pork containing by weight less than 40% of meat, offal of any kind and fats of any kind EXCLUDING: - homogenized preparations - sausages and similar products - preparations of liver - prepared meals and dishes	3	
10131575 (CN 1602491 + 16024930 + 16024990) - Other preparations of pork meat or offal INCLUDING: - mixtures; fats of any kind or origin EXCLUDING: - sausages and similar products - pates and pastes - homogenized preparations - preparations of liver - prepared meals and dishes	3	(Wiedemann and Yan, 2014)
10131585 (CN 160250) - Prepared or preserved meat or offal of beef and veal EXCLUDING: - sausages and similar products - homogenized preparations - preparations of liver - prepared meals or dishes	5.81	(Wiedemann and Yan, 2014)
SIC(07) 1020 - Processing and preserving of fish, crustaceans and molluscs		
10201100 (CN 030431 + 030432 + 030433 + 030439 + 030441 + 03044210 + 03044250 + 03044290 + 030443 + 03044410 + 03044430 + 03044490 + 030445 + 030446 + 03044910 + 03044950 + 03044990 + 030451 + 030452 + 030453 + 030454 + 030455 + 03045910 + 03045950 + 03045990) - Fresh or chilled fish fillets and other fish meat without bones	0.35	W13
10201330 (CN 03031 + 030326 + 03033 + 03034 + 03035 + 03036 + 030381 + 030382 + 030383 + 030384 + 0303892 + 0303893 + 0303894 + 0303895 + 0303896 + 0303897 + 0303899) - Frozen whole salt water fish	9	W13

⁹ Used lowest figure from source.

10201400 (CN 03046 + 03047 + 03048) - Frozen fish fillets	9	W13
10201500 (CN 03049) - Frozen fish meat without bones EXCLUDING: - fillets	9	W13
10202100 (CN 030531 + 030532 + 030539) - Fish fillets, dried, salted or in brine, but not smoked	4.13	(Darvishi et al., 2012) ¹⁰
10202350 (CN 030551 + 030559 + 03056) - Dried fish, whether or not salted; fish, salted but not dried; fish in brine EXCLUDING: - fillets - smoked - heads, tails and maws	4.13	(Darvishi et al., 2012)
10202425 (CN 030541) - Smoked Pacific, Atlantic and Danube salmon INCLUDING: - fillets EXCLUDING: - heads, tails and maws	4.13	(Darvishi et al., 2012)
10202455 (CN 030542) - Smoked herrings INCLUDING: - fillets EXCLUDING: - heads, tails and maws	4.13	(Darvishi et al., 2012)
10202485 (CN 030543 + 030544 + 030549) - Smoked fish INCLUDING: - fillets EXCLUDING: - Pacific, Atlantic and Danube salmon - herrings - heads, tails and maws	4.13	(Darvishi et al., 2012)
10202510 (CN 160411) - Prepared or preserved salmon whole or in pieces EXCLUDING: - minced products - smoked - dried, salted or in brine - prepared meals or dishes	3	W13
10202540 (CN 160414) - Prepared or preserved tuna, skipjack and Atlantic bonito whole or in pieces, but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - smoked - dried, salted or in brine - prepared meals or dishes	3	W13 ¹¹
10202570 (CN 16041991) - Fish fillets in batter or breadcrumbs INCLUDING: - fish fingers EXCLUDING: - herring - prepared meals and dishes	6.5	(Foster et al., 2006) ¹²
10202580 (CN 16041700 + 16041910 + 1604193 + 16041950 + 16041992 + 16041993 + 16041994 + 16041995 + 16041997) - Prepared or preserved fish whole or in pieces but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - salmon, herrings, sardines, sardinella, brisling, sprats, tuna, skipjack, bonito, mackerel and anchovies - fillets and fish fingers - dried, salted, in brine, or smoked - prepared meals and dishes	3	W13
10202590 (CN 160420) - Prepared or preserved fish INCLUDING: - pastes - homogenized - minced EXCLUDING: - dried, salted, in brine, or smoked - fish whole or in pieces - caviar - prepared meals and dishes	6.884	(Ramírez et al., 2006) ¹³
10202660 (CN 160432) - Caviar substitutes prepared from eggs of fish other than sturgeon	3	W13 ¹⁴
10203100 (CN 03061110 + 03061190 + 03061210 + 03061290 + 03061410 + 03061430 + 03061490 + 03061590 + 0306169 + 0306179 + 03061910 + 03061990) - Frozen crustaceans; frozen flours, meals and pellets of crustaceans, fit for human consumption	9	W13
10203200 (CN 03072910 + 03072990 + 03073910 + 03073990 + 03074909 + 0307491 + 0307493 + 0307495 + 03074971 + 0307499 + 03075910 + 03075990) - Molluscs, frozen, dried, smoked, salted or in brine INCLUDING: - scallops, mussels, cuttle fish, squid and octopus EXCLUDING: - prepared meals and dishes	4.13	(Darvishi et al., 2012) ¹⁵
10203400 (CN 03061105 + 03061205 + 03061405 + 03061510 + 03061610 + 03061710 + 03061905 + 03062110 + 03062230 + 03062410 + 03062510 + 03062610 + 03062710 + 03062905 + 03071910 + 03072905 + 03073905 + 03074905 + 03075905 + 03076010 + 03077910 + 03078910 + 03079910 + 03081910 + 03082910 + 03083030 + 03089030 + 1605) - Prepared or preserved crustaceans, molluscs and other aquatic invertebrates EXCLUDING: - chilled, frozen, dried, salted or in brine - crustaceans, in shell, which have been cooked by steaming or by boiling in water - prepared meals and dishes	3	W13

¹⁰ Used fresh figure plus source

¹¹ 50,000 tonnes of tuna sold in 2014 in the UK and 92% was ambient (canned) (both figures Seafish, 2016).

¹² Source put the figure for product manufacture at 2.6 MJ per 400g pack of cod fish fingers.

¹³ Used Ramírez et al. (2006) figure for fish meal. Probably an underestimate, since this seems not to include packaging. However, the Ramírez figure was from a 2003 paper, so EE since then could balance this out.

¹⁴ Used canned figure.

¹⁵ May be understating, compared to WRAP 2013 figure for canned fish/seafood.

<i>Not included</i>
10111400 (CN 0204501 + 0204503) - Fresh or chilled goat meat
10111500 (CN 02050020) - Fresh or chilled meat of horses, asses, mules and hinnies
10113230 (CN 020321) - Frozen carcasses and half-carcasses of pig meat
10113400 (CN 0204505 + 0204507) - Frozen goat meat
10113500 (CN 02050080) - Frozen meat of horses, asses, mules and hinnies
10121040 (CN 020743 + 020753) - Fresh or chilled fatty livers of geese and ducks
10201200 (CN 030290) - Fresh or chilled fish livers and roes
10201360 (CN 030323 + 030324 + 030325 + 030329 + 03038910) - Frozen whole fresh water fish
10201600 (CN 03039010 + 03039090) - Frozen fish livers and roes
10121030 (CN 02074120 + 02074130 + 02074180 + 02075110 + 02075190 + 02076005) - Fresh or chilled whole geese, ducks and guinea fowls
10202630 (CN 160431) - Caviar (sturgeon roe)
10121070 (CN 02074410 + 02074421 + 02074431 + 02074441 + 02074451 + 02074461 + 02074471 + 02074481 + 02075410 + 02075421 + 02075431 + 02075441 + 02075451 + 02075461 + 02075471 + 02075481 + 02076010 + 02076021 + 02076031 + 02076041 + 02076051 + 02076061 + 02076081) - Fresh or chilled cuts of geese, ducks and guinea fowls
10122017 (CN 02074230 + 02074280 + 02075210 + 02075290 + 02076005) - Frozen whole geese, ducks and guinea fowls
10129902 = 10121070 + 10122057 (CN 02074410 + 02074421 + 02074431 + 02074441 + 02074451 + 02074461 + 02074471 + 02074481 + 02074510 + 02074521 + 02074531 + 02074541 + 02074551 + 02074561 + 02074571 + 02074581 + 02075410 + 02075421 + 02075431 + 02075441 + 02075451 + 02075461 + 02075471 + 02075481 + 02075510 + 02075521 + 02075531 + 02075541 + 02075551 + 02075561 + 02075571 + 02075581 + 02076010 + 02076021 + 02076031 + 02076041 + 02076051 + 02076061 + 02076081) - Fresh or chilled or frozen cuts of geese, ducks or guinea fowl
10202200 (CN 030510 + 030520) - Flours, meals and pellets of fish, fit for human consumption; fish livers and roes, dried, smoked, salted or in brine
10202520 (CN 160412) - Prepared or preserved herrings whole or in pieces, but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - smoked - dried, salted or in brine - prepared meals and dishes
10202530 (CN 160413) - Prepared or preserved sardines, sardinella, brisling and sprats whole or in pieces, but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - smoked - dried, salted or in brine - prepared meals or dishes
10202550 (CN 160415) - Prepared or preserved mackerel whole or in pieces, but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - smoked - dried, salted or in brine - prepared meals and dishes
10202560 (CN 160416) - Prepared or preserved anchovies whole or in pieces but not minced INCLUDING: - in vinegar, oil or marinades EXCLUDING: - smoked - dried, salted or in brine - prepared meals and dishes
10203300 (CN 03072930 + 03072990 + 03073050 + 03073090 + 03077990 + 03078990 + 03079050 + 03079090 + 03079911 + 03079913 + 03079917 + 03079980 + 03081930 + 03081990) - Aquatic invertebrates other than crustaceans and molluscs, frozen, dried, smoked, salted or in brine; flours, meals and pellets of aquatic invertebrates other than crustaceans, fit for human consumption EXCLUDING: - prepared meals and dishes
<i>Previously included but now excluded to conform with WRAP 2016</i>
10124020 (CN 02071391 + 02071399 + 02072691 + 02072933 + 02074491 + 02074499 + 02075491 + 02075499 + 02076091 + 02076099) - Fresh or chilled poultry offal EXCLUDING: - fatty livers of geese and ducks

Fresh fruit and vegetable processing¹⁶

Potatoes	0.35	W13
Other fresh veg	1	W13 ¹⁷
Fresh fruit	0.5	W13 ¹⁸

Pre-prepared meals

SIC(07) 1085 - Manufacture of prepared meals and dishes

10851100 (CN 1601 + 160220 + 16023 + 16024 + 160250 + 160290) - Prepared meals and dishes based on meat, meat offal or blood	3.816	(Berlin and Sund, 2010) ¹⁹
10851200 (CN 16041 + 160420 + 1605) - Prepared meals and dishes based on fish, crustaceans and molluscs	3.816	(Berlin and Sund, 2010)
10851300 (CN 200210 + 2003 + 200490 + 200540 + 20055 + 200560 + 200570 + 200580 + 20059) - Prepared meals and dishes based on vegetables	3.816	(Berlin and Sund, 2010)
10851410 (CN 190220) - Cooked or uncooked pasta stuffed with meat, fish, cheese or other substances in any proportion	3.816	(Berlin and Sund, 2010)
Chilled %		85.5% ²⁰
Frozen %		14.5%

10851430 (CN 190230) - Dried, undried and frozen pasta and pasta products INCLUDING: - prepared dishes - canned pasta in sauce EXCLUDING: - uncooked pasta - stuffed pasta	3.816	(Berlin and Sund, 2010)
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10851900 (CN 21069098) - Other prepared meals and dishes INCLUDING: - prepared sandwich fillers consisting of at least 2 ingredients - frozen pizza EXCLUDING: - meals and dishes based on meat, meat offal or blood - meals and dishes based on fish, crustaceans or molluscs - meals and dishes based on vegetables - meals and dishes based on pasta	3.816	(Berlin and Sund, 2010)
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Not included

Homogenised foods

Bakery, cake and cereals

SIC(07) 1071 - Manufacture of bread; manufacture of fresh pastry goods and cakes

10711100 (CN 19059030) - Fresh bread containing by weight in the dry matter	6	W13
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¹⁶ Output values are from (WRAP, 2016) which in turn are from (DEFRA, 2015)

¹⁷ Figure for 'other field veg'. Most types of veg are likely to undergo similar processing once harvested, involving movement along a conveyor, washing and packing.

¹⁸ There is no data available which isolates the processing stage. Since fruit is less washed or not washed compared to vegetables, the SEE has been halved compared to veg. In LCAs, the only data we have are from the EU Joint Research Centre report for apples & oranges, and these values are higher than for veg because the embodied energy of the chemical products used to preserve the fruit is included. This is not within the system boundary for this relatively small research exercise.

¹⁹ 'Hunter's meal' in the source. Also calculated the Schmidt Rivera et al. (2014) figure (see Calcs sheet) which was about double the Berlin figure, but theirs included refrigerated transport to the distribution centre and an unknown amount of frozen product, so using Berlin could underestimate the reality.

²⁰ Re: split between chilled and frozen prepared meals: Mintel's 2014 market review had the total market value in 2014 (their forecast) at £2.612b. Chilled was £2.233b (85.5%) and frozen £0.379b (14.5%).

state not more than 5% of sugars and not more than 5% of fat EXCLUDING: - with added honey, eggs, cheese or fruit		
10711200 (CN 19059060) - Cakes and pastry products, and other bakers' wares with added sweetening matter EXCLUDING: - crispbread - gingerbread and the like - biscuits, waffles, wafers - rusks, toasted bread and similar toasted products - fresh bread containing not more than 5% of sugars	6	W13
SIC(07) 1072 - Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes		
10721150 (CN 190540) - Rusks, toasted bread and similar toasted products	7	(Wang, 2008) ²¹
10721253 (CN 1905311 + 1905321) - Sweet biscuits, waffles and wafers completely or partially coated or covered with chocolate or other preparations containing cocoa INCLUDING: - countline types	1.6	W13
10721255 (CN 19053130 + 1905319) - Sweet biscuits INCLUDING: - sandwich biscuits EXCLUDING: - those completely or partially coated or covered with chocolate or other preparations containing chocolate	1.6	W13
10721259 (CN 1905329) - Waffles and wafers INCLUDING: - salted EXCLUDING: - those completely or partially coated or covered with chocolate or other preparations containing chocolate	1.12	(Ramírez et al., 2006) ²²
10721910 (CN 19059010) - Matzos	1.12	(Ramírez et al., 2006) ²³
10721940 (CN 19059045) - Biscuits EXCLUDING: - those completely or partially coated or covered with chocolate or other preparations containing cocoa - sweet biscuits - waffles and wafers	1.6	W13 ²⁴
10721950 (CN 19059055) - Extruded or expanded savoury or salted products	6	W13 ²⁵
10721990 (CN 19059090) - Bakers' wares without added sweetening matter INCLUDING: - crepes, pancakes, quiche, pizza EXCLUDING: - sandwiches - crispbread, waffles, wafers - rusks, toasted bread and similar products - extruded or expanded savoury or salted products	1.712	W13 ²⁶
SIC(07) 1061 - Manufacture of grain mill products		
10613351 (CN 19042010) - Muesli type preparations based on unroasted cereal flakes	0.36	W13 ²⁷
10613353 (CN 190410 + 1904209) - Other Prepared foods obtained by the swelling or roasting of cereals	6	W13
10613355 (CN 190430 + 190490) - Cereals in grain form, precooked or otherwise prepared EXCLUDING: - maize	6	W13
Not included		
10721130 (CN 190510) - Crispbread		
10721230 (CN 190520) - Gingerbread and the like		
10721257 (CN 19053205) - Waffles and wafers with a water content exceeding 10% by weight of the finished product EXCLUDING: - ice cream cornets - sandwiched waffles - other similar products		
10721920 (CN 19059020) - Communion wafers, empty cachets of a kind suitable for pharmaceutical use, sealing wafers, rice paper and similar products		

²¹ Fresh bread + 1MJ, on the basis that the source put average energy input for drying at 6MJ/kg of water (p208), so 1 MJ allows for ~16% water to be removed in toasting.

²² Table 2 in the source, and cut it to the delivered electricity.

²³ Used figure for waffles.

²⁴ Used sweet biscuits figure.

²⁵ Used Cakes & Pastry Products figure, since extrusion or expansion is likely to require more energy than these.

²⁶ Used Frozen Pizza figure from WRAP 2013, reduced by 20% to account for energy for freezing. 20% reduction used because (Wang, 2008) put average freezing requirement at 1MJ per kg of water removed, and maybe 0.2 kg per kg of product are removed in pizza and these similar products.

²⁷ Used figure for flours.

Alcoholic drinks

SIC(07) 1102 - Manufacture of wine from grapes

11021190 (CN 22041091 + 22041093 + 22041094 + 22041096 + 22041098) - Sparkling wine from fresh grapes (EXCLUDING alcohol duty) EXCLUDING: - Champagne	17.79	W13
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All other wines	6.16	W13 ²⁸
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SIC(07) 1103 - Manufacture of cider and other fruit wines

11031000 (CN 2206) - Fermented beverages; mixtures of fermented beverages, and mixtures of fermented and non-alcoholic beverages (EXCLUDING alcohol duty) INCLUDING: - cider, perry and mead - pre-mixed wine spritzers EXCLUDING: - beer made from malt - wine of fresh grapes - fortified wine of fresh grapes - vermouth and other wine of fresh grapes flavoured with plants or aromatic substances	1.93	W13 ²⁹
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SIC(07) 1105 - Manufacture of beer

11051000 (CN 2203) - Beer made from malt (EXCLUDING alcohol duty) EXCLUDING: - non-alcoholic beer - beer containing not more than 0.5% by volume of alcohol		
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Lager	1.93	W13 ³⁰
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Ale	3.52	W13 ³¹
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Not included

11051010 (CN 22029010) - Non-alcoholic beer and beer containing not more than 0.5% alcohol (EXCLUDE alcohol duty)		
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Soft drinks and fruit juices

SIC(07) 1107 - Manufacture of soft drinks; production of mineral waters and other bottled waters

11071130 (CN 22011) - Mineral waters and aerated waters, unsweetened	0.24	W13 ³²
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11071150 (CN 220190) - Unsweetened and non flavoured waters; ice and snow EXCLUDING: - mineral and aerated waters	0.08	W13 ³³
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11071930 (CN 220210) - Waters, with added sugar, other sweetening matter or flavoured, i.e. soft drinks INCLUDING: - mineral and aerated	0.08	W13
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SIC(07) 1032 - Manufacture of fruit and vegetable juice

10321100 (CN 200950) - Tomato juice	4.71	W13 ³⁴
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10321220 (CN 200912 + 2009199) - Unconcentrated orange juice EXCLUDING: - frozen	4.71	W13 ³⁵
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10321230 (CN 2009111 + 2009191) - Orange juice n.e.c. EXCLUDING: - unconcentrated orange juice, whether frozen or not	4.71	W13
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10321300 (CN 20092) - Grapefruit juice	4.71	W13
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²⁸ Data from (Food Standards Agency, 2016).

²⁹ No figure available from WRAP 2013, so used the lower figure for beer. WRAP 2013 has 4.71 for juice, so this is conservative and probably underestimates the specific energy for ciders.

³⁰ 74% of market 2015 - Beer & Pub Assn (pers. comm.).

³¹ 26% of market 2015 - Beer & Pub Assn (pers. comm.).

³² Mid point of bottled and carbonates value.

³³ Used carbonates figure because it's lower.

³⁴ May be understated a little because we don't have the specific density or gravity of tomato juice, so used the generic for fruit juice.

³⁵ Specific density of orange juice used for division (FAO source).

10321400 (CN 20094) - Pineapple juice	4.71	W13
10321500 (CN 20096) - Grape juice INCLUDING: - grape must	4.71	W13
10321600 (CN 20097) - Apple juice	4.71	W13
10321700 (CN 200990) - Mixtures of fruit and vegetable juices	4.71	W13

Not included

10321910 (CN 200931 + 2009393 + 2009395 + 2009399) - Unconcentrated juice of any single citrus fruit EXCLUDING: - orange - grapefruit		
10321920 (CN 20098131 + 2009815 + 2009819 + 2009895 + 2009896 + 2009897 + 2009898 + 2009899) - Unconcentrated juice of any single fruit or vegetable, not fermented and not containing added spirit EXCLUDING: - orange, grapefruit, pineapple, tomato, grape and apple juices - grape must		
10321930 (CN 2009391 + 2009811 + 2009891 + 2009893) - Other fruit and vegetable juices EXCLUDING: - orange; grapefruit or other citrus fruit - tomato - pineapple - grape - apple - unconcentrated juice of a single fruit or vegetable - mixtures of fruit and vegetable juices		

Confectionery

SIC(07) 1082 - Manufacture of cocoa, chocolate & sugar confectionery

10821200 (CN 1804) - Cocoa butter, fat and oil	7.4	(Perez Neira, 2016), (United States Department of Agriculture, 2017) ³⁶
10821300 (CN 1805) - Cocoa powder EXCLUDING: - containing added sugar or other sweetening matter	7.4	Ditto sources
10821400 (CN 180610) - Cocoa powder containing added sugar or other sweetening matter	7.4	Ditto sources
10822130 (CN 18062010 + 18062030 + 18062050) - Chocolate and other food preparations containing cocoa, in blocks, slabs or bars weighing more than 2kg, or in liquid, paste, powder, granular or other bulk form, in containers or immediate packings of a content exceeding 2kg, containing at least 18% by weight of cocoa butter EXCLUDING: - sweetened cocoa powder	7.4	Ditto sources
10822150 (CN 18062070) - Chocolate milk crumb containing 18% or more by weight of cocoa butter and in packings weighing more than 2kg	7.4	Ditto sources
10822170 (CN 18062080) - Chocolate flavour coating containing 18% or more by weight of cocoa butter and in packings weighing more than 2kg	7.4	Ditto sources
10822233 (CN 180631) - Filled chocolate blocks, slabs or bars consisting of a centre INCLUDING: - of cream, liqueur or fruit paste EXCLUDING: - chocolate biscuits	7.4	Ditto sources
10822235 (CN 18063210) - Chocolate blocks, slabs or bars with added cereal, fruit or nuts EXCLUDING: - filled - chocolate biscuits	7.4	Ditto sources
10822239 (CN 18063290) - Chocolate blocks, slabs or bars EXCLUDING: - filled - with added cereal, fruit or nuts - chocolate biscuits	7.4	Ditto sources

³⁶ Used 7.4 MJ/kg for the chocolate items. This is based on the datum from the source and a 2008 Cadbury figure of 20% of 44 MJ/kg (8.8) (USDA 2017 and one other source) for the whole lifecycle. The figure will have reduced since 2008. The Neira figure is for the manufacturing stage of pure cacao block in Ecuador. There seems no reason why milk chocolate should incur more energy use since the embodied energy of the milk production is accounted for prior to the chocolate factory. 7.4 MJ/kg is also in line with other partly comparable figures from WRAP 2013, such as butter at 5.4 (butter not needing a comminution stage), although the figure in WRAP 2013 for sweet biscuits at 1.6 is surprising, since they need to be baked.

10822243 (CN 18069011) - Chocolates containing alcohol EXCLUDING: - in blocks, slabs or bars	7.4	Ditto sources
10822245 (CN 18069019) - Chocolates EXCLUDING: - those containing alcohol - in blocks, slabs or bars	7.4	Ditto sources
10822253 (CN 18069031) - Filled chocolate confectionery EXCLUDING: - in blocks, slabs or bars - chocolate biscuits - chocolates	7.4	Ditto sources
10822255 (CN 18069039) - Chocolate confectionery EXCLUDING: - filled - in blocks, slabs or bars - chocolate biscuits - chocolates	7.4	Ditto sources
10822260 (CN 18069050) - Sugar confectionery and substitutes thereof made from sugar substitution products, containing cocoa INCLUDING: - chocolate nougat EXCLUDING: - white chocolate	7.4	Ditto sources
10822270 (CN 18069060) - Chocolate spreads	7.4	Ditto sources
10822280 (CN 18069070) - Preparations containing cocoa for making beverages EXCLUDING: - cocoa powder, unsweetened - cocoa powder, sweetened	7.4	Ditto sources
10822290 (CN 18069090) - Food preparations containing cocoa EXCLUDING: - cocoa paste, cocoa butter, cocoa powder - blocks, slabs, bars - liquid, paste, powder, granular and other bulk form in packagings exceeding 2kg - for making beverages - chocolate spreads	7.4	Ditto sources
10822310 (CN 170410) - Chewing gum	19	W13
10822320 (CN 17049010) - Liquorice cakes, blocks, sticks and pastilles containing more than 10% by weight of sucrose, but not containing any other substances	19	W13
10822330 (CN 17049030) - White chocolate	7.4	(Perez Neira, 2016), (United States Department of Agriculture, 2017)
10822353 (CN 17049051) - Sugar confectionery pastes in immediate packings of a net content of 1kg or more INCLUDING: - marzipan, fondant, nougat and almond pastes	19	W13
10822355 (CN 17049055) - Throat pastilles and cough drops consisting essentially of sugars and flavouring agents EXCLUDING: - pastilles or drops with flavouring agents containing medicinal properties	19	W13
10822363 (CN 17049061) - Sugar coated (panned) goods INCLUDING: - sugar almonds	19	W13
10822365 (CN 17049065) - Gums, fruit jellies and fruit pastes in the form of sugar confectionery EXCLUDING: - chewing gum	19	W13
10822373 (CN 17049071) - Boiled sweets INCLUDING: - butterscotch	19	W13
10822375 (CN 17049075) - Toffees, caramels and similar sweets	19	W13
10822383 (CN 17049081) - Compressed tablets of sugar confectionery INCLUDING: - cachous	19	W13
10822390 (CN 17049099) - Other sugar confectionery EXCLUDING: - chewing gum; white chocolate - pastes in immediate packings of a net content 1kg or more - throat pastilles and cough drops - sugar coated (panned) goods; gums, fruit jellies and pastes - boiled sweets; toffees, caramels and similar sweets; compressed tablets	19	W13
Not included		
10821100 (CN 1803) - Cocoa paste EXCLUDING: - containing added sugar or other sweetening matter		
10822190 (CN 18062095) - Food preparations containing 18% or more by weight of cocoa butter and in packings weighing more than 2kg EXCLUDING: - chocolate flavour coating - chocolate milk crumb		
10822400 (CN 2006) - Drained, glace or crystallised fruit, nuts, fruit-peel and other parts of plants		

Milling**SIC(07) 1061 - Manufacture of grain mill products³⁷**Source for all
unless stated:
(Jensen and
Arlbjörn, 2014)

10611230 (CN 100630) - Semi-milled or wholly milled (bleached) rice INCLUDING: - camolino rice	0.36	
10612100 (CN 1101) - Wheat or meslin flour	0.36	
10612200 (CN 1102) - Cereal flours EXCLUDING: - wheat or meslin	0.36	
10612300 (CN 1106) - Flour and meal of dried peas, beans, lentils or sago, or of manioc, arrowroot, salep, Jerusalem artichokes, sweet potatoes and similar roots and tubers with high starch or inulin content; flour, meal and powder of edible fruit, nuts or fruit peel	0.36	
10612400 (CN 190120) - Mixes and doughs for the preparation of bread, cakes, pastry, crispbread, biscuits, waffles, wafers, rusks, toasted bread and similar toasted products and other bakers' wares	0.36	
10613133 (CN 11031110) - Groats and meal of durum wheat	0.36	
10613135 (CN 11031190) - Groats and meal of common wheat and spelt	0.36	
10613230 (CN 110313 + 110319) - Groats and meal of oats, maize, rice, rye, barley and other cereals EXCLUDING: - wheat	0.36	
10613240 (CN 11032060) - Pellets of wheat	0.36	
10613250 (CN 110320) - Pellets of oats; maize; rice; rye; barley and other cereals EXCLUDING: - wheat	0.36	
10613333 (CN 110412 + 110419 + 11042) - Rolled, flaked, hulled, pearled, sliced or kibbled cereal grains EXCLUDING: - rice	0.36	
10613335 (CN 110430) - Germ of cereals, whole, rolled, flaked or ground EXCLUDING: - rice	0.36	
10614010 (CN 230210) - Bran, sharps and other residues from the sifting, milling or other working of maize (corn)	0.36	
10614030 (CN 23024002 + 23024008) - Bran, sharps and other residues from the sifting, milling or other working of rice	0.36	
10614050 (CN 230230) - Bran, sharps and other residues from the sifting, milling or other working of wheat	0.36	
10614090 (CN 23024010 + 23024090 + 230250) - Bran, sharps and other residues from the sifting, milling or other working of cereals EXCLUDING: - maize (corn) - rice - wheat	0.36	
SIC(07) 1062 - Manufacture of starches and starch products		
10621113 (CN 110812) - Maize (corn) starch	0.36	
10621115 (CN 110813) - Potato starch	0.36	
10621119 (CN 110814 + 110819) - Starches INCLUDING: - rice, manioc, arrowroot and sago palm pith EXCLUDING: - wheat, maize (corn) and potato	0.36	
10621130 (CN 110820) - Inulin	0.36	
10621170 (CN 350510) - Dextrins and other modified starches INCLUDING: - esterified or etherified - soluble starch - pregelatinised or "swelling" starch - dialdehyde starch - starch treated with formaldehyde or epichlorohydrin	0.36	
10621200 (CN 1903) - Tapioca and substitutes thereof prepared from starch, in the form of flakes, grains, pearls, siftings or similar forms	0.36	
10621310 (CN 170230 + 170240) - Glucose and glucose syrup EXCLUDING: - with added flavouring or colouring matter	11.75	(Juodeikiene et al., 2015) ³⁸
10621320 (CN 170250 + 170260 + 17029030) - Chemically pure fructose in solid	11.75	(Juodeikiene et al.,

³⁷ Table 7a in source, for rye milling. Approx midpoint of 2012 study and 2010 (industry) data.

³⁸ Specific embodied energy calculated from source, using their figure of 81% atom efficiency for hydrolysis from wheat starch and 9.4 GJ to convert wheat starch into dextrose (d-glucose) as part of a process of then making 1 ton of lactic acid. 81% would mean 11.75 GJ of energy per ton of LA final product would be needed for hydrolysis.

form; fructose and fructose syrup, containing in the dry state more than 50% by weight of fructose; isoglucose EXCLUDING: - with added flavouring or colouring matter		2015)
10621330 (CN 17029050) - Maltodextrine and maltodextrine syrup EXCLUDING: - with added flavouring or colouring matter	11.75	(Juodeikiene et al., 2015)
10621430 (CN 151521) - Crude maize (corn) oil and its fractions EXCLUDING: - chemically modified	-	No SEE used
10621460 (CN 151529) - Refined maize (corn) oil and its fractions EXCLUDING: - chemically modified	-	No SEE used

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Table S2: Sources used by W13
ordered by year

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