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EU coordinated **ME**thods and procedures based on **Re**al **C**ases for the effective implementation of policies and measures supporting energy efficiency in the **I**ndustry

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Technical analysis – Food and Beverage sector (NACE C10 – C11)

WP4: Picture of efficiency projects implemented by the Industry sector-by-sector and process-by-process



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1 Introduction

Food and Beverage industry covers NACE sectors C10 and C11. The main subsectors are:

- C10: Manufacture of food products
 - C10.1: Processing and preserving of meat and production of meat products
 - C10.2: Processing and preserving of fish, crustaceans and molluscs
 - C10.3: Processing and preserving of fruit and vegetables
 - C10.4: Manufacture of vegetable and animal oils and fats
 - C10.5: Manufacture of dairy products
 - C10.6: Manufacture of grain mill products, starches and starch products
 - C10.7: Manufacture of bakery and farinaceous products
 - C10.8: Manufacture of other food products
 - C10.9: Manufacture of prepared animal feeds
- C11: Manufacture of beverages
 - C11.01: Distilling, rectifying and blending of spirits
 - C11.02: Manufacture of wine from grape
 - C11.03: Manufacture of cider and other fruit wines
 - C11.04: Manufacture of other non-distilled fermented beverages
 - C11.05: Manufacture of beer
 - C11.06: Manufacture of malt
 - C11.07: Manufacture of soft drinks; production of mineral waters and other bottled waters

Since the products (and so the processes) have a wide variety, only a classification of the general processes is reported. Detailed information about each process is available in each “Good Practice” and “Best Practice” description in the EU-MERCI Portal (<http://www.eumerci-portal.eu/>).

2 Key products per subsector

According to EUROSTAT statistic classification of sectors NACE C10 and C11, the main products of the above mentioned subsectors are reported below, divided per products classes.

Processing and preserving of meat and production of meat products (NACE C10.1). The activity of this group involves slaughtering of livestock for the production of fresh meat and poultry in cuts, which could be chilled or frozen. This also includes rendering of animal fats and production of non-edible products (originating from the slaughterhouse) like hide, skin, wool, feathers and down.

Processing and preserving of fish, crustaceans and molluscs (NACE C10.2). The activity of this group involves preparation, processing and preserving of fish, crustaceans and molluscs. The processes include freezing, drying, cooking, smoking, canning and etc for human consumption or animal feed.

Processing and preserving of fruit and vegetables (NACE C10.3). The activity of this group is categorized into 3 classes. (1) Processing and preserving of potatoes, which includes production of frozen potatoes, dehydrated mashed potatoes, potato snacks, crisp, potato flour and meal. (2) Manufacture of fruit and vegetable juice. (3) other processing and preserving of fruit and vegetables or food products primarily containing fruit and vegetable (salads, jam, marmalade, nuts, paste, bean curd, etc.).

Manufacture of vegetable and animal oils and fats (NACE C10.4). The activity of this group involves manufacture of crude and refined (blowing, boiling, dehydration, hydrogenation, etc.) oils and fats from vegetable and animal feedstock (olive oil, soya bean oil, palm oil, sun flower seed oil, cotton seed oil, rape, linseed, extracted fish and marine mammal oil, margarine, spreads, compound of cooking fats, etc.). This also includes non-edible animal oils and fats.

Manufacture of dairy products (NACE C10.5). The activity of this group involves manufacture of dairies and cheese products including fresh liquid milk (pasteurized, sterilized, homogenized or heat treated), milk based drinks, cream from fresh liquid milk, dried concentrated milk, solid milk or cream, butter, yogurt, cheese, whey, curd, casein and lactose). This group also includes the manufacture of ice cream and edible such as sorbet.

Manufacture of grain mill products, starches and starch products (NACE C10.6). The activity of this group involves milling of flour or meal from grains of vegetables, production (milling, cleaning and polishing) of rice and flour mixes or doughs from these products. This group also includes wet milling of corn and vegetable and production of starch and starch products (glucose, glucose syrup, maltose, inulin, gluten and tapioca).

Manufacture of bakery and farinaceous products (NACE C10.7). The activity of this group is categorized into 3 classes. (1) Manufacture of bread, fresh pastry goods and cakes (bread, rolls, pastry, cakes, pies, tarts, pancakes, waffles, etc). (2) Manufacture of rusks and biscuits, preserved pastry goods and cakes. (3) Manufacture of macaroni, noodles, couscous and other farinaceous products.

Manufacture of other food products (NACE C10.8). The activity of this group includes production of sugar, confectionary, prepared meals, coffee, tea, spices, perishable and specialty food products. This is categorized into 7 classes. (1) Manufacture of sugar. (2) Manufacture of coca, chocolate and sugar confectionery. (3) Processing of tea and coffee. (4) Manufacture of condiments and seasoning (spices, sauces, mayonnaise, mustard, vinegar, salt, etc). (5) Manufacture of prepared meals and dishes. (6) Manufacture of homogenized food preparations and dietetic food (infant formulae, baby foods, low energy food intended for weight control, gluten-free food, foods intended to meet the expenditure of intense muscular effort, etc.). (7) Manufacture of other food products (soups, broth, perishable prepared foods, food supplement, yeast, extracts of meat/fish/crustaceans or molluscs, non-dairy milk, cheese substitutes and artificial concentrates.

Manufacture of prepared feeds for farm animals (NACE C10.9). The activity of this group is the production of prepared feeds for farm animals, including concentrated animal feed, feed supplement, preparation of unmixed feeds and treatment of slaughter waste to produce animal feeds.

Distilling, rectifying and blending of spirits (NACE C11.01). The activity of this group includes manufacture of distilled and potable alcoholic beverages (whisky, brandy, gin, liqueurs, etc.), manufacture of drinks mixed with distilled alcoholic beverages, blending of distilled spirits and production of neutral spirits.

Manufacture of wine from grape (NACE C11.02). The activity of this group involves manufacture of wine, sparkling wine, wine from concentrated grape must and low or non-alcoholic wine. This includes blending, purification and bottling of wine.

Manufacture of cider and other fruit wines (NACE C11.03). The activity of this group includes manufacture of fermented but non-distilled alcoholic beverages (sake, cider, perry and other fruit wines), mead and mixed beverages containing fruit wines.

Manufacture of other non-distilled fermented beverages (NACE C11.04). The activity of this group includes manufacture of vermouth and like.

Manufacture of beer (NACE C11.05). The activity of this group includes manufacture of malt liquors (beer, ale, porter and stout). It also includes low or non-alcoholic beer.

Manufacture of soft drinks, mineral waters and other bottled waters (NACE C11.07). The activity of this group includes manufacture of non-alcoholic beverages including production of natural mineral water, other bottled waters, soft drinks and non-alcoholic flavored or sweetened waters (lemonade, cola, fruit drinks, tonic waters, etc.).

3 Key processes

The key processes in production of food and beverage can be categorised into the following 9 categories extracted from IPPC Best Available Techniques Reference Documents (BREF) in food and beverage sector.

A. Materials reception and preparation	
A.1	Materials handling and storage
A.2	Sorting/screening, grading, dehulling, destemming/destalking and trimming
A.3	Peeling
A.4	Washing
A.5	Thawing
B. Size reduction, mixing and forming	
B.1	Cutting, slicing, chopping, mincing, pulping and pressing
B.2	Mixing/blending, homogenisation and conching
B.3	Grinding/milling and crushing
B.4	Forming/moulding and extruding
C. Separation techniques	
C.1	Extraction
C.2	Deionisation
C.3	Fining
C.4	Centrifugation and sedimentation
C.5	Filtration
C.6	Membrane separation
C.7	Crystallisation
C.8	Removal of free fatty acids by neutralisation
C.9	Bleaching
C.10	Deodorisation by steam stripping
C.11	Decolourisation
C.12	Distillation
D. Product processing technology	
D.1	Soaking
D.2	Dissolving
D.3	Solubilisation/alkalising
D.4	Fermentation
D.5	Coagulation
D.6	Germination
D.7	Brining/curing and pickling
D.8	Smoking
D.9	Hardening
D.10	Sulphitation
D.11	Carbonatation
D.12	Carbonation
D.13	Coating/spraying/enrobing/agglomeration/encapsulation
D.14	Ageing

Figure 1: Main processes in Food and Beverage industry - part 1/2 (Source: IPPC Best Available Techniques Reference Documents (BREF) in the food and beverage sector).

E. Heat processing	
E.1	Melting
E.2	Blanching
E.3	Cooking and boiling
E.4	Baking
E.5	Roasting
E.6	Frying
E.7	Tempering
E.8	Pasteurisation, sterilisation and UHT
F. Concentration by heat	
F.1	Evaporation (liquid to liquid)
F.2	Drying (liquid to solid)
F.3	Dehydration (solid to solid)
G. Processing by removal of heat	
G.1	Cooling, chilling and cold stabilisation
G.2	Freezing
G.3	Freeze-drying/lyophilisation
H. Post processing operations	
H.1	Packing and filling
H.2	Gas flushing and storage under gas
U. Utility processes	
U.1	Cleaning and disinfection
U.2	Energy generation and consumption
U.3	Water use
U.4	Vacuum generation
U.5	Refrigeration
U.6	Compressed air generation

Figure 2: Main processes in Food and Beverage industry – part 2/2 (Source: IPCC Best Available Techniques Reference Documents (BREF) in the food and beverage sector).

3.1 Group A: Materials reception and preparation

- A1. Materials handling and storage: it applies to the reception, unpacking, storage and internal conveying of raw materials, intermediate products, final products and other outputs, including waste. It is applied to all Food and Beverage Industry.
- A2. Sorting/screening, grading, dehulling, destemming/destalking and trimming: most raw materials contain some components which are inedible or have variable physical characteristics. Processing techniques such as sorting or screening, grading, dehulling, destemming or destalking and trimming are necessary to obtain the required uniformity of the raw material for further processing. A metal detector may also be used to ensure any metal particles in the raw material are removed. This is usually the first step of fruit and vegetables processing and is used also in meat, fish and egg processing.
- A3. Peeling: the objective of peeling is to remove the skin/peel from raw fruit and vegetables. This improves the appearance and taste of the final product. During peeling, the losses need to be minimized by removing as little of the underlying food as possible but still achieving a clean

peeled surface. It is applied in fruit and vegetable processing, including roots, tubers and potatoes.

- A4. Washing: the objective of washing the material is to remove and separate unwanted components to ensure that the surface of the food is in a suitable condition for further processing. Unwanted components can include dirt or residual peel, brine used for preservation, soil, micro-organisms, pesticide residues and salts. It is widely applied as a first processing step for root crops, potatoes, cereals, fruit and vegetables.
- A5. Thawing: when raw materials, are received frozen, thawing is needed before further processing is carried out. Thawing is sometimes called defrosting, that however it is not properly correct, being the removal of frost from the inside of a refrigerator or coldstore. Thawing is mostly applied in fish and meat processing.

3.2 Group B: size reduction, mixing and forming

- B1. Cutting, slicing, chopping, mincing, pulping and pressing: the objective of cutting, slicing, chopping, mincing, pulping and pressing is to reduce the size of material either for further processing or to improve the eating quality or suitability for direct consumption. The main difference among the processes is related to the size and the quality of the processed food and the fact that it is then homogenized or not. It applies to almost all food products.
- B2. Mixing/blending, homogenisation and conching: the aim of this group of operations is to obtain a uniform mixture of two or more components or to obtain an even particle size distribution in a food material. This can also result in improved characteristics and eating quality. It is applied to almost all food products.
- B3. Grinding/milling and crushing: grinding or milling is used for the size reduction of solid dry material. It may also improve the eating quality and/or suitability of the material for further processing. It is the main process in the cereal and animal feed industry and is also used to crush cane sugar and to facilitate the extraction of sugar in sugar and rum factories. Crushing covers, for instance, breaking the skin of berries and grapes to liberate the must. Grinding or milling is applied where dry solid materials are processed, e.g. in the flour milling, animal feed, semolina, brewing, sugar and dairy sectors. Crushing is necessary to facilitate the yeasts' multiplication and also to conduct traditional macerations before pressing, e.g. in winemaking.
- B4. Forming/moulding and extruding: forming or moulding and extruding are operations used to achieve a specified shape for solid materials. Forming or moulding is an operation widely applied in the production of chocolate, bread, biscuits, confectionery and pies. It is also an important process step in cheesemaking. Extruding is widely used in the production of meat sausages, confectionery products and starch-based snack foods.

3.3 Group C: Separation techniques

- C1. Extraction: the objective of extraction is to recover valuable soluble components from raw materials by primarily dissolving them in a liquid solvent, so that the components can be separated and recovered later from the liquid. It is not always the objective to recover one particular compound in pure form from a raw material, i.e. sometimes extraction is intended to separate all of the soluble compounds from the residue; an example of this is the extraction of coffee. Extraction is applied in most subsectors. For example, in the extraction of sugar from sugar beets or sugar cane, oil from oilseeds and from virgin pomace, coffee extract from coffee beans, caffeine from coffee beans and various other compounds such as proteins, pectins, vitamins, pigments, essential oils, aroma compounds and flavour compounds from many different materials.
- C2. Deionisation: Deionisation or ion exchange is used to remove unwanted organic and/or inorganic constituents from water and food products. In the dairy industry, deionisation is applied in whey processing. For the application of whey solids in human food and in baby food, low levels of mineral constituents are required. Deionisation is also widely used in the whole sector for the treatment of boiler feed-water for power and steam generation and for the production of deionised process water. Deionisation is also applied to remove minor ionised organic substances.
- C3. Fining: it is the process of clarifying liquids, i.e. removing suspended particles which give the liquid a cloudy appearance. It is applied in the production of sparkling wines and beers.
- C4. Centrifugation and sedimentation: they are used to separate immiscible liquids and solids from liquids. Separation is carried out by the application of either centrifugal forces or natural gravity. Typically used in the dairy industry in the clarification of milk, the skimming of milk and whey, the concentration of cream, the production and recovery of casein, in the cheese industry and in lactose and whey protein processing. It is also used in drink technology, vegetable and fruit juices, coffee, tea, beer, wine, soy milk, oil and fat processing/recovery, cocoa butter manufacturing, sugar manufacturing and waste water treatment.
- C5. Filtration: Filtration is the separation of solids from a suspension in a liquid by means of a porous medium, screen or filter cloth, which retains the solids and allows the liquid to pass through. Filtration is used in the F&B sector to clarify liquid products by the removal of small amounts of solid particles with the subsequent recovery of the filtrate, e.g. for wine, beer, oils and syrups and to separate a liquid from a significant quantity of solid material to obtain the filtrate or cake, or both, e.g. for fruit juices or beer.
- C6. Membrane separation: membrane separation is aimed at the selective removal of water, solutes and/or suspended material from a solution by using semi-permeable membranes. It is considered to be a fractionation technique. Membrane separation is applied for the concentration of liquids, e.g. with cheese whey, the removal of salts from whey or water, whey fractionation and water purification.
- C7. Crystallisation: its goal is to separate a solute from a solvent. Crystallisation is applied in the dairy industry, where lactose is produced from cheese whey or casein whey and the sugar

- industry. It is also used in the edible oil industry to modify the properties of edible oils and fats; in this case it is also called fractionation.
- C8. Removal of free fatty acids (FFA) by neutralization: the objective of the chemical neutralisation process is to remove the ffa and the phosphatides from vegetable oils, using caustic and phosphoric acid or, in some cases, citric acid. Chemical neutralisation is applied in the refining process of vegetable oils such as soybean oil, sunflower oil, rapeseed oil and of animal oils and fats such as tallow or fish-oil.
- C9. Bleaching: the objective of bleaching is to remove pigments, metals, e.g. nickel or iron from other oil refinery processes; residual soaps and phospholipids from the oil or fat. It is applied in the refining of edible oils and fats.
- C10. Deodorisation by steam stripping: the objective of deodorisation is to remove ffa and other highly volatile compounds from crude degummed and/or alkali refined edible oils and fats after bleaching. It is applied in the refining of edible oils and fats.
- C11. Decolourisation: decolourisation is carried out to improve the colour, purity, ageing, microbiological stability and shelf-life of certain food products. It is used in the sugar, glucose, syrup and fermentation industries.
- C12. Distillation: distillation is the separation of the components of a liquid mixture by partial vaporisation of the mixture and separate recovery of the vapour and residue. The more volatile components of the original mixture are obtained at a higher concentration in the vapour, the less volatile in a higher concentration in the liquid/solid residue. Distillation enables the separation and purification of volatile food products from aqueous blends. Distillation can be used to separate flavours or essential oils, but is mainly used either for the production of potable alcohol or spirits, or for the industrial production of alcohol from agricultural raw materials, e.g. fruit and grain, which can then be used in alcoholic drinks or liquors. Distillation normally follows alcoholic fermentation.

3.4 Group D: Product processing technology

- D1. Soaking: the objective of soaking, e.g. of vegetable seeds such as lentils, is to moisten and soften the seeds to reduce the cooking time or to aid in seed coat removal. In the malting process, the objective of soaking is the uptake of water to activate the germination process in the kernel. Soaking is predominantly applied in the processing of vegetable seeds. It is also applied with grain, where the grain is soaked in the malting process prior to germination. This is often called steeping.
- D2. Dissolving: it is the addition of powder to liquid to produce solutions or suspensions for further processing. This process is used in a variety of products to recombine and reformulate them. For example, dissolving is used for recombining or reformulating milks in the dairy industry.
- D3. Solubilisation/Alkalizing: Solubilisation or alkalising is the neutralisation of cocoa nibs or cocoa liquor with an alkaline solution, resulting in a darker colour and a milder taste. The milder taste is mainly the result of the neutralisation of the light acidity of fermented beans. Considerable

- experience and skill is required to obtain end-products with a constant colour and hue. It is mainly used in cocoa processing.
- D4. Fermentation: it is the controlled action of selected micro-organisms to alter the texture of foods, to preserve foods by the production of acids or alcohol, or to produce or modify flavours and aromas. It also preserves products by lowering the pH tolerance limits of many microorganisms. Fermentation is an important processing step for a number of F&B products. Typical applications include beer, wine, various dairy products, vegetables, meat and fish. Alcoholic fermentation is used in beer and winemaking and for the production of spirits, mostly with cereals, grape musts, sugar juices and molasses as a raw material. Lactic acid fermentation is used for making yoghurt and other fermented dairy products, fermented meat products such as certain types of sausages and vegetables, i.e. sauerkraut. In the lactic acid fermentation of vegetables, the sliced raw material, e.g. green cabbage in the case of sauerkraut production, is salted and then fermented under anaerobic conditions.
- D5. Coagulation: it is the agglomeration of suspended particles and separate solids from liquids or viceversa. Coagulation is used in cheese production and in the recovery of casein from milk. It is often used in milk processing to separate the curd from the whey and it is also called curdling.
- D6. Germination: the objective of germination is to activate and develop the enzyme system in the grain kernel. This activated enzyme system is necessary to activate the starch and protein breakdown at the mashing stage before the later brewing process. Germination is an important processing step within the malting process of cereals. Malted cereals, mainly barley, are used for beer production and the production of distilled drinks, e.g. whisky. Malt is also used in food flavouring.
- D7. Brining/curing and pickling: brining or curing is a process whereby a product is treated with common salt (NaCl) and curing salts which aims for the preservation of products by lowering the aw below microbial tolerance limits. Pickling is the preservation of products by lowering the pH, especially for vegetables. The objectives of these techniques are the long-life preservation of the control of the growth of spore forming micro-organisms, a decrease in the energy needed for heat treatment and adding taste to the product. Brining or curing is applied in the production of certain types of cheese, meat, fish, vegetables and mushrooms. Salt levels in the product can range from 1 to 5%. Pickling is applied in the fruit and vegetable sector.
- D8. Smoking: the aim of smoking is the preservation of food by exposure to smoke, which has a bacteriostatic effect. Preservation is also achieved by the drying of the surface layers and heat effects. In addition, smoking adds flavour and, in some cases, the smoking process is used to cook the food. Smoking is commonly used in the processing of fish, cheese, meat and meat products.
- D9. Hardening: the objective of hardening is to increase the melting point of the product and to change the solid-fat content of edible oils into edible fats. It is applied in the processing of edible oils for the production of margarine and other edible fats.
- D10. Sulphitation: the aim of sulphitation is to prevent either microbiological degradation, unwanted colour formation or to adjust pH. Sulphitation is applied in winemaking, potato

- processing and shellfish processing. It is also sometimes applied in sugar production to adjust the pH.
- D11. Carbonatation: the aim of carbonatation is to remove impurities from a solution. It is applied in sugar industry.
- D12. Carbonation: The aim of this process is to dissolve a quantity of carbonic gas into different products to obtain a gasified or carbonated final product. When dissolved in water, carbon dioxide (CO₂), is sparingly soluble and thus, slowly released, forming bubbles that provide a characteristic mouthfeel and a unique taste when consumed. In addition to an organoleptic property, under suitable conditions, CO₂ has a preserving property by the inhibition of the development of harmful aerobic micro-organisms. This, however, is not a substitute for other methods used to ensure microbiological safety. Carbonation is an important process step in the preparation of many soft drinks and certain types of mineral waters. It is also applied in the wine and brewing industries. In the manufacture of still wines, carbonation is used to protect the colour and increase the aroma.
- D13. Coating/spraying/enrobing/agglomeration/encapsulation: the aim of this group of operations is to cover a food product with a layer of material to improve the eating quality, to provide a barrier to the movement of moisture and gases, or as protection against mechanical damage. Coating, by one of the above-mentioned techniques, is applied to confectionery, ice-cream, baked goods, snack foods, fish, poultry and potato products.
- D14. Ageing: the aim of this process is to mature the product, especially for products aged in wooden casks that allow some gas exchange between the product contained in the cask and the environment. It is also part of the legal requirements when manufacturing some products. Ageing is commonly applied to wine and brown spirits.

3.5 Group E: Heat processing

- E1. Melting: the objective of melting is to obtain a phase change from solid to liquid, to prepare the material for further processing, e.g. for fats and processed cheese, or to recover the melted fraction, i.e. in fat recovery. The main applications of melting in the F&B sector are in chocolate moulding, the production of processed cheese, the processing of oils and fats and the recovery of animal fat from meat residues.
- E2. Blanching: blanching is designed to expose the entire product to high temperatures for a short period of time. The primary function of this operation is to inactivate or retard bacterial and enzyme action, which could otherwise cause rapid degeneration of quality. Two other desirable effects of blanching include the expelling of air and gases in the product and a reduction in the product volume. Blanching is an important step in the processing of fruit and green vegetables.
- E3. Cooking and boiling: Cooking and boiling are heat processing techniques applied to foodstuffs, principally to make the food edible. They also alter the texture, colour and moisture content of the food and may facilitate other later processes. Cooking and boiling are applied on an

- industrial scale for the preparation of ready-to-eat meals, in the preparation of complete meals and for meal components, such as in various meat products. They are also applied to heat foodstuffs prior to final processing.
- E4. Baking: it is a heat processing technique, principally to make the food edible. It can also change the taste and texture. Another objective of baking is to preserve the food by destruction of the micro-organisms and reduction in the aw at the surface of the food. However, the shelf-life of most baked foods is limited, unless products are refrigerated or packaged. Baking is used to prepare ready-to-eat products such as bread, cakes and biscuits. Baking can be applied to fruit and vegetables. Baked vegetables may be used as a filling or as a topping component in many food products such as pies, pizzas and snack foods.
- E5. Roasting: the aim of the process is to cook the food to make it edible, to produce dry products and/or to enhance the structure of raw products. Typical ingredients that are roasted are coffee, nuts, cacao, chicory, fruit, cereals and preprocessed cereals.
- E6. Frying: the objective of frying is to cook in edible oil at temperatures in the region of 200 °C. Vegetable oil, or a mixture of animal fat and vegetable oil, is normally used. Raw materials such as fish, potatoes and chicken can be fried, e.g. in the production of products such as fish fingers, potato chips and chicken nuggets.
- E7. Tempering: The objectives of tempering are to ensure product quality and appearance, enable handling of liquid chocolate for various applications, e.g. demoulding and ensure viscosity control and enable net weight requirements to be met. Tempering is also the controlled thawing of meats. Tempering is applied in the manufacture of chocolate and products containing chocolate. Chocolate formulations containing cocoa butter, or cocoa butter equivalents, need to be
- E8. Pasteurisation, sterilisation and UHT: the conservation of food and feed products is achieved by the killing of the micro-organisms present. Heat treatment for the conservation of products is one of the main techniques used in the F&B sector. Heat treatment stops bacterial and enzyme activity and so prevents loss of quality and reduces food perishability. In heat treatment processes, various time/temperature combinations can be applied, depending on the product properties and shelf-life requirements. Pasteurisation is a controlled heating process used to eliminate viable forms of any microorganism, i.e. pathogen or spoilage causing, that may be present in milk, fruit-based drinks, some meat products and other foods, or to extend shelf-life as is the case with beer. A similar controlled heating process, referred to as blanching, is used in the processing of fruits and vegetables. Both pasteurisation and blanching are based on the use of the minimum heat requirement needed to deactivate specific micro-organisms or enzymes, thus minimising any quality changes in the foods. In pasteurisation, generally a heating temperature below 100 °C is applied. Sterilisation is a controlled heating process used to eliminate viable forms and spores of any micro-organism, i.e. pathogen or spoilage causing, that may be present in a preserved food. This can be achieved by moist heat, dry heat, filtration, irradiation, or by chemical methods. Compared to pasteurisation, a heat treatment of over 100 °C is applied for a period long enough to lead to a stable product shelf-life. UHT is a heat treatment of over 100 °C for a very short time. Pasteurisation and

sterilisation are used to treat all types of FDM products; these include milk, juices and beer. UHT is applicable to low viscosity liquid products.

3.6 Group F: Concentration by heat

- F1. Evaporation (liquid to liquid): it is the partial removal of water from liquid food by boiling. For instance, liquid products can be concentrated from 5% dry solids to 72%, or even higher, depending on the viscosity of the concentrates. Evaporation is used to pre-concentrate food, to increase the solid content of food, to change the colour of food and to reduce the water content of a liquid product almost completely, e.g. as in edible oil drying. Evaporation is used in many Food&Beverage sectors. For example, it is used to process milk, starch derivatives, coffee, fruit juices, vegetable pastes and concentrates, seasonings, sauces, sugar and edible oil.
- F2. Drying (liquid to solid): it is defined as the application of heat under controlled conditions to remove the water present in liquid foods by evaporation to yield solid products. It differs from evaporation, which yields concentrated liquid products. The main purpose of drying is to extend the shelf-life of foods by reducing their humidity. Typical applications for drying techniques include dairy products, e.g. milk, whey and creamers, coffee, coffee surrogates, tea, flavours, powdered drinks and processed cereal-based foods.
- F3. Dehydration (solid to solid): Dehydration is defined as the application of heat under controlled conditions to remove, by evaporation, the water present in solid foods or by-products from agricultural raw material processing. The main purpose of dehydration is to extend the shelf-life of foods by reducing their humidity. Some examples of dried foods are dried potatoes, starch derivatives, sugar beet pulp, flour, pasta, beans, fruit, nuts, cereals, meal of oilseeds, tea leaves, vegetables and spices. The dehydration of wet germinated grain is applied in the production of malt which is also called kilning. For the malting process, the drying step is essential and is required to create the desired colour and flavour.

3.7 Group G: Processing by the removal of heat

- G1. Cooling, chilling and cold stabilization: cooling is used to reduce the temperature of the food from one processing temperature to another or to a required storage temperature. Chilling is a processing technique in which the temperature of a food is reduced and kept at a temperature between -1 and 8°C. The objective of cooling and chilling is to reduce the rate of biochemical and microbiological changes in foods, to extend the shelf-life of fresh and processed foods, or to maintain a certain temperature in a food process, e.g. in the fermentation and treatment of beer. Cooling is also used to promote a change of state of aggregation, e.g. crystallisation. The objective of cold stabilisation is to precipitate out tartrates in wines, or fatty acids in spirits before bottling. Cooling, chilling and cold stabilisation are widely used in the whole sector. Chilling is used for preservation of a lot of perishable foods. In the wine sector, cooling and

chilling are applied to clarify the must before fermentation. Cold stabilisation is used in the beer, wine and spirit sectors. Beer is cold stabilised to precipitate the protein-polyphenol adduct. The beer is kept between -2 and -3 °C for at least 12 hours.

- G2. Freezing: it is a preservation method. In freezing, the temperature of a food is reduced to below the freezing point and a proportion of the water undergoes a change in state to form ice crystals. The sector standard for freezing food is to reduce the temperature to around -18 °C. Several types of food can be frozen, e.g. fruits, vegetables, fish, meat, baked goods and prepared foods such as ice-cream and pizzas.
- G3. Freeze-drying/lyophilisation: freeze-drying or lyophilisation, is the process of removing water from a product by sublimation and desorption. The aim of the process is to preserve sensitive material that cannot be dried by evaporation. Beware of the risk of degradation of specific components at high temperatures, which would result in a loss of taste or other quality aspects. The technique is used, e.g. for drying coffee extracts, spices, soup vegetables, instant meals, fish and meat.

3.8 Group H: Post processing operations

- H1. Packing and filling: the objective of packing is to use any products made of any materials of any nature for the containment, protection, handling, delivery and presentation of goods. Packing may be applied to raw materials and to processed goods. Filling is the process of putting the product in the package in a proper way. The majority of food products are packaged before they enter the distribution chain. In some cases packing is an integral part of the production process, which means that the packaged product is further processed. An example of this is the canning and bottling of foods and subsequent heat conservation.
- H2. Gas flushing and storage under gas: gas flushing is a process in which products are stored in an artificially produced atmosphere, normally within a plastic container such as a hermetically sealed tray or pouch. The process is also referred to as modified atmosphere packing (MAP) and is used to enhance the colour retention of, e.g. fresh meat or cured meats such as bacon and cooked ham, especially in sliced form. MAP is also applied to extend shelf-life. The impact of MAP depends on the combination of product, packaging materials and gas mix. Storage under gas is applied to wines. Inert gas is applied to wines in tanks in place of Sulphur dioxide (SO₂). This is carried out to preserve an adequate CO₂ content and the organoleptic qualities of the wine, to protect it from oxidation and to the prevention of bacterial deviations. It also allows the prevention in the alteration of tanks which would be emptied, e.g. in the case of bulk sales to private individuals. Finally, it permits the conservation of sterile fruit juices. Gas flushing is mainly used for meat and meat products. It is also used for bakery products. Storage under gas is, above all, applied to white wines, rosés and red primeurs.

3.9 Group U: Utility processes

Utility processes, being cross-cutting and very often cross-sectoral, will be only listed here.

- U1. Cleaning and disinfection
- U2. Energy generation and consumption
- U3. Water use
- U4. Vacuum generation
- U5. Refrigeration
- U6. Compressed air generation

4 Energy intensity

Due to the high variety of processes, energy intensity for specific processes is very difficult to retrieve. According to the BREF documents, in Food processing around 29% of the energy is used for process heat requirements and 16% for refrigeration. It is however possible to obtain, from BREF, a synthesis of the Energy intensity for the production of the main categories of products:

Table 1: Energy intensity for some key processes in food industry.

	Product category	Thermal energy [GJ/t]		Electric energy [kWh/t]	
		min	max	min	max
Meat processing	Beef meat	0.16	1.97	45	547
	Pig meat	0.26	1.82	37	253
	Ovine meat	1.66	3.31	461	920
	Mix	0.21	1.90	41	400
	By-products	1.58	3.55	46	120
	Poultry	0.22	1.24	91	516
	Cured meats	4.32	9.36	1,000	1400
	Canned meat	2.24	2.52	150	400
Fruit and vegetables processing	Frozen vegetables	0.00	2.41	115	338
	Vegetables	0.00	2.41	5	46
	Jams	0.84	0.84	60	100
	Tomato sauce	4.44	7.84	90	125
	Fruit Juices (*)	0.68	0.93	0.1	0.2
	Canned tomatoes	2.10	2.38	19	24
Dairy products	Milk	0.18	1.50	42	694
	Cheese	0.15	4.60	22	806
Production of oil and vegetable and animal fats	Olive oil			50	100
	Seed oil	0.56	1.40	20	50
	Refined olive oil	1.09	4.27	74	164
	Refined seeds oil	1.65	5.68	44	114
	Byproducts	1.58	3.55	46	120

(*) production in liters, thermal consumption in MJ/l; electrical consumption in kWh/l.