Side streams valorisations from food (cold) chain

'Best cases and examples of industrial symbiosis'

Europe
TRL 9

Main NEBs (other benefits)

Circular Economy

Energy-recovery from wastes or by-products

Sustainable Resource Management

The environmental impact of wood waste is an economic and ethical challenge, in some regions of the world, 25-50% of the food produced, could be lost on supply chain.

In this light European Commission promotes the concept of circular economy providing the ground for a sustainable waste management of 88–100 million tonnes of food waste are generated every year, with an economic impact estimated at 143 billion Euros in 2012. Based on the so called "waste hierarchy" (i.e. preventing, reuse, recycle and recovery, and disposal) many EU countries made their own policies with putting an emphasis on food supply chain.

Currently, there are two main technological process for food waste valorisation in Europe: composting and biogas production, both aiming to energy and/or bio fertilizers production. Studies at municipal or district level have shown the great impact, policy makers and governmental bodies have in tackling down food waste and increasing recycling rates, not only for food side streams but also for the packaging material.

Introduction

The food waste (FW) generation covers all the food life cycle: from the agriculture phase, up to industrial manufacturing and processing, transport activities, retail and household. Aside from the fresh food production and transportation chain a relevant aspect is addressed to the cold supply chain. Estimations showed between 25% and 50% of food produced was wasted along the food supply chain in America [2] by 2009, while in Europe, it was estimated that 88–100 million tonnes of food waste were generated every year [3] by 2012.

What is the improvement focus (i.e. industrial symbiosis and synergy)?

During years, organic waste, including food leftovers have been researched for its use as nutrient source or feedstock for multiple techniques. The main method used until now is composting, but it has been criticized due to the whole use of nutrients for simultaneous microbial growth [4]. According to [5], the most economical process for renewable energy production is the waste utilization, especially when the biohydrogen and biogas production is intended from FW and food processing waste. The use of waste to produce any energy type is known as waste to energy (WtE) and plays an important role in sustainable development by providing clean and affordable renewable energy limiting the negative social and environmental impacts. There are several WtE technologies for producing energy sources, being the mainly widespread: steam gasification, supercritical conversion, pyrolysis, gasification, and microbial conversion. Some them are not ready for commercial deployment.

Consequently, composting and anaerobic digestion for biogas production are the preferred routes for FW management under the recycling, reuse and recovery scenario (promoting landfill reduction of disposal of FW without energy recovery).

Benefits: potentials interventions for valorisations

Food wastes along its supply chain, must be addressed basically in four ways: prevention or avoiding of the side stream, valorization of the side stream (recycling, reuse and recovery), waste management exploiting the side stream to substitute a product or as a feedstock to an energy source (recycling and recovery), and FW disposal as last resource.

Vegetables and fruits.

The food industry and agricultural sector generate large amounts of vegetable and fruit wastes affecting municipal landfills due to FW high biodegradability resulting in leachate and methane emissions [6].

Side streams from apples production and consumption have been studied finding several options for industrial symbiosis. Potential production of an apple powder ingredient was developed by [7], which could be a valuable addition to the healthy food products portfolio since it was found that a small amount of it has the power to increase significantly the phytochemical content and antioxidant properties of foods if used as a dietary supplement. Another potential product from the apple peel was developed by [8], a powder ingredient suitable for food preparation, increasing the dietary fiber and as source of phenolic compounds.

Also, the recovery of phenolic antioxidants, even after oil content extraction from seed of different kind of berries, were proven to be valuable components [9]. Another use for berries was proposed in [10], where raspberry pomace in a dried form was used as replacement of flour for cookies in a 25 – 50 % level, resulting in fiber content increase without any negative effect. Similar applications have been studied for exotic fruits such as citrons, passion fruit, pineapple and mango, resulting in the technical feasibility for producing bioactive compounds in form of powder and food supplements [11], [12], [13] [14].

Since potatoes are one of the most consumed vegetables around the world, mainly containing carbohydrates, especially starch, vitamins, minerals and phytochemicals, valorization of the FW can have a large environmental and social impact in the food sector. Peels are the major side stream of potato processing industries and food services and contain the same amount of valuable macro and micronutrients of edible vegetable. Due to the large amount of potatoes waste, it can be a quantitatively important energy source in beef cattle diets and solved a potentially massive disposal problem [15].

Most of the cases presented up to this point, correspond to side stream valorisation, it means a by-product is recycled into the production of a new food related product, adding value to the initial feedstock and to the food sector.

Dairy products.

The dairy industry is an important part of the food industry and it is a major contributor of liquid wastes, which can contain proteins, salts, fatty substances, lactose and cleaning chemicals [16]. In 2011, the annual production of cheese was 9 million tonnes in the EU [16], and the waste coming from its production is the one, most studies have been paying attention of. Recently, the use of cheese whey combined with vinasse coming from the bioethanol production in Brazil, was studied for anaerobic co-digestion process, with excellent results for the biomethane production [17]. This case corresponds to the archetypal definition of waste management of side stream, where the FW is recovered for manufacturing another product or, as a source for renewable energy production.

Meat and derivative products.

Due to the global average reduction of poverty, less valuable meat products such as entrails and some muscles that used to be consumed, are now part of the by-products discarded by the slaughterhouses. By 2007, meat waste or by products accounted for 60-70 % of the slaughtered carcass [18], hence, the searching for recovery solutions of meat wastes is vital for environment and human health; however the recycling of this side stream is bound by several health and hygiene limitations and regulations.

Three ways for meat waste recovery have been initially identified, human food, pet food and other non-food and non-feed applications [19], nevertheless, other authors claim that there exist a large variety of non-food applications for this FW. So far, the major use for meat waste is the protein production for food preparations or protein powders [18] [20].

Best cases of waste management and industrial symbiosis

The cases considered as the initial leaders in waste management at municipal level in Europe are: Hammarby Sjöstad, a district in Stockholm (Sweden); Augustenborga, a neighborhood in Malmo (Sweden); Western Harbour Bo01, a district also in Malmo; the district of Rieselfeld, situated in the West of Freiburg (Germany); the Lincoln Neighborhood in Munster (Germany); and Pilestredet Park, an urban redevelopment project in central Oslo (Norway); South East False Creek district in Vancouver (Canada); and Yeongdeungpo-gu, an administrative district in Seoul (Korea) are some of these best municipal cases. In all of them the FW recycling rate increased up to 75-93% after implementing regulations an action plans [21]. For these specific cases environmental policies were set in place by implementing new legislations while for others by undertaking research and development projects funded by governmental entities, including not only the desired recycling rate and the logistics procedures, but also technological paths to follow for FW management, being the predominant composting, followed by biogas conversion, bio-fertilizers, and conversion to animal feed after electricity production. However, in most cases, an LCA for the FW management valorisation strategies has not been conducted yet to obtain a better understanding on the current and future operational conditions and what are the economic and environmental benefits.

Opportunities	*Barriers*
Industrial Symbiosis	Technological deployment
Energy Generation	High initial investment costs
Management and waste management	Behavioural changes and initial investment costs

Opportunities and barriers to implementation

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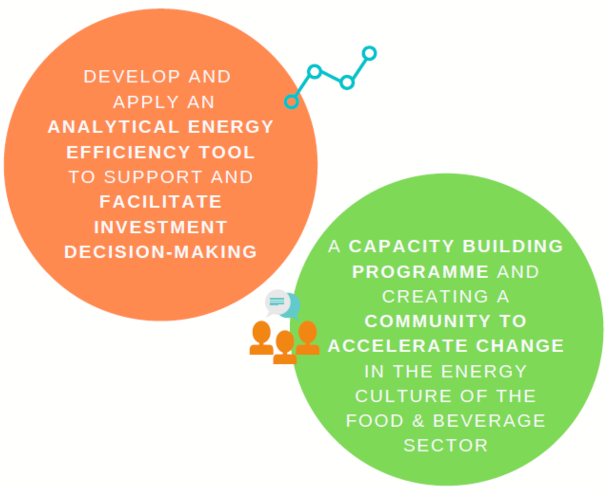
About ICCEE

The project ICCEE, www.iccee.eu, funded by the EU programme Horizon 2020, aims at improving energy efficiency in the cold chain of the food & beverage sector and making it easier for the sector to:

- undertake energy efficiency measures across the entire supply chain and
- accelerate the implementation of energy audit results.

ICCEE follows a holistic approach that moves from a single company perspective to the assessment of the entire cold supply chain. Existing financing schemes for SMEs will be assessed: the optimal ones will support the implementation of energy efficiency measures. ICCEE objectives build on 2 pillars:



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