ECOWASTE 4 FOOD
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Opportunities offered by eco-innovations to reduce food waste in project partners' territories

Collaborative Working Document for Project Partners and their stakeholders

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1. Introduction

The aim of this document is to provide guidance to identify all kind of opportunities (incl. economic and non-economic ones) under different domains of eco-innovations. Regarding innovations, four types are covered in this document: technological (process and product innovation), organizational (company chart...), marketing and social innovation.

The way we can collectively introduce those opportunities in each partner territory is to:

i) **describe/analyse those opportunities with extra evidence;**
ii) **illustrate opportunities already suggested in this document;**
iii) **add extra opportunities according to what each referent partner consider as important.**

In addition, as project Partners already know or support some opportunities and related good practices, they are invited to briefly comment their potential to rise (upscaling/outscaling). It's not excluded that overlaps may arise between the four domains of eco-innovations suggested in the application form (i.e. some eco-innovations belonging to many domains) and if so, it's up to the referent partner to re-adjust where it fit for purpose.

Different types of eco-innovations (i.e. product, process, organizational, marketing, social) do help to transform a linear economy into a resource-efficient circular economy. Regarding the food waste issue, the challenge is to move from a food waste management towards a resource-efficient and circular economy management that also contribute to a knowledge-based economy. Eco-innovation is about reducing our environmental impact and making better use of natural, financial and knowledge resources. This means developing approaches, products, techniques, services and processes that reduce food waste, use resources efficiently, promote recycling, reuse, etc. that have already generated outcomes and had social, economic, environmental impacts within the partners territories. Beyond their triple win strategy that benefit to people, planet and profits, eco-innovations to reduce food waste not only help city/regional authorities to meet their environmental objectives but also boost city/regional economic growth.

In this document we introduce the possible opportunities offered by the four domains of eco-innovations:

- Limitation of waste production at source in the food processing industry, introducing eco-efficient manufacturing processes (ECOINNOV1);
- Conception and design of products that help reducing the food waste by the end users, catering and individual consumers (ECOINNOV2);
- Use of products today considered as unusable or unserviceable products (ECOINNOV3);
- Services provided that help reduce food waste directly or by a modification of consumption patterns (including e-services, connected objects) (ECOINNOV4).

This collective identification and short analysis of opportunities of eco-innovations to reduce food waste will help project partners to handle and facilitate: i) the dialogue with stakeholders and ii) the unfolding of territorial investigations of eco-innovative good practices.

ECOINNOV1: limitation of waste production at source in the food processing industry, introducing eco-efficient manufacturing processes

Referent partners: MOWR & CIHEAM-IAMM

Question: how can eco-efficient processing and manufacturing process help to reduce food waste?

Scope

There's a need for new and innovative business models in the agrifood sector that are less extractive-based and more cascading and circular-based, while having less environmental impacts. Modern food processing is increasingly drawing attention not only to the sensory value of food, but also, perhaps even to a large extent, to the health aspect of the offered food. Increasing public awareness of the health impact of the food as well as the changing lifestyle of the population in the economic sphere, is becoming more and more focused on the technology of obtaining new products or enriching existing ones[1]. By-products of the food industry are unavoidable in production at all, and in the processing of foodstuffs in particular. This is despite the fact that all manufacturers are aiming for a waste-free production, thus leaving no by-products. Their development is varied and is closely connected with the advancement of science and technology. This is for some people already a by-product, for new participants in the production chain can be a basic raw material which will be a source of valuable, sometimes unknown or overlooked ingredients. Sometimes some were not worth gaining or their values were not fully appreciated. Some of them may have pro-health properties and they are extremely valuable. Others can be functional supplements, replacing not only synthetic compounds but also supporting the functioning of the human body. Their use is a challenge of time, stimulates the development of the economy, is the driving force behind scientific advances in biology and technology and processing technologies. EU food processing companies have already developed an efficient use of resources and materials in many regions. Powerful EU agrifood regions that have a main export-oriented strategy face extra challenge to lower their environmental and climate footprint (i.e. compliance with SDGs). Exchange of experiences, good practices and demonstrating effects at EU and international levels are therefore needed on bringing food innovations and efficient use of ingredients to companies and SMEs.

Costs of primary materials matters for all processing companies and fair sharing of added value alongside the food chain is a longstanding issue with farmers and retailers. In that respect one way to strengthen the competitiveness and profitability of food processing companies is to make innovation in general and eco-innovation in particular a leverage to drive change towards a resource efficient and circular economy. In doing so, sustainable management of food systems inputs as scarce resources since future competitiveness of food systems will not be based on productivity but rather on sustainability, productivity being a component of sustainability (i.e. see Falkenberg report[2], SCAR[3]).

[1] (Gorecka, D. and Pospiech, E. (2016) *Management of by-products of the food industry*, monography, ISBN 978-83-7160-836-0 , PL)

[2] https://ec.europa.eu/epsc/publications/strategic-notes/sustainability-now_en

This means in example: i) developing a clever use of natural resources, ingredients and materials, ii) creating new markets through new product innovations involving high level of processing, iii) developing sustainable and efficient processes in the food industry by supporting new product and service innovations. In such a circular and eco-efficient agrifood economy, the objective is to move towards a zero waste target.

In practice many leading food processing companies having high (eco)innovation investments do have highest innovative sales in return. Eco-innovation helps businesses to strengthen their competitiveness and profitability. However, it requires a favorable R&D ecosystem at regional level, enhancing the research potential and technological development that supports innovativeness, ICT and entrepreneurship. EU regions hosting a strong industrial network and ecosystem may benefit from easier access to R&D funding, innovation clustering networks with other bio-economy sectors.

Features

- Social innovation
- Organization eco-innovation
- Technological eco-innovation
- Circular economy business models

Eco-innovation approaches

- Improve storage technologies
- Introduce energy-efficient, low carbon food chains including implementation of RES
- Refine food processing stages to reduce losses of raw food/materials, especially valuable for human health ingredients
- Improve handling to reduce damage in food logistic chains
- Introduce new product lines made from food that would have been waste otherwise
- Organisational eco-innovations enabling savings in food waste management costs
- Volunteering commitments to encourage eco-innovations as well as social innovation (i.e. brands)
- Organisational eco-innovations increasing the companies / SMEs competitivenes and developing sinergies between businesses e.g. clusters

Good practices

- Focus on specific raw materials or by-products (i.e. whey in the dairy sector, expellers from rapeseed oil production as an additive for wheat bread, chokeberry pomace instead of dried chokeberry fruit to receive infusions, addition of dried apple pomace for the production of dry wafers)
- Focus on innovative production lines in food processing industry, e.g. comprehensive technology lines for drying fruit and vegetables based on drying technology in multi-drier vacuum dryer in MIVAC-3 (MicroFood company from Ostrzeszów)
- Within the project "New bioactive food with programmed pro-health properties" (structural funds project POIG 01.01.02-00-061 / 09), scientists from the Poznan University of Life Sciences have developed new technologies for the production of bioactive food of a pro-health nature. Researchers have designed several products enriched with a potato juice (one of the waste products in the potato starch production process) for people with non-specific

[3] https://ec.europa.eu/research/scar/index.cfm?pg=foresight4th

inflammatory bowel disease: gluten-free bread with potato juice, poultry soup cream with potato juice, turkey pudding with potato juice.
- Lyofood – finding a niche within the mountain climbing sector of extreme sports (use of lyophilisation process for meals which taste and look like homemade dishes which they really are, expending their shelf life even for years). [4]

Opportunities offered by eco-innovations

- Strengthen the local/regional food sector towards the sustainable regional economy by leading eco-efficient processing industries
- Create new jobs and new revenues in the food eco-processing
- Pave the way for voluntary measures and future standards (i.e. eco labels for products and services)
- Make eco-efficient food processing a non-price competitiveness advantage on the market (i.e. public procurement)
- Take advantage of regional innovative skills, favorable innovation ecosystem and capacities (if applicable)
- Contribute to lower significantly the amount of food waste generated by the regional food processing industry
- Development of bioactive food industry.

Obstacles to eco-innovations

- Low uptake of eco-innovations by food processing businesses
- Insufficient communication of the circular economy opportunities to businesses and SMEs
- Higher cost of eco-innovative processing equipment
- Lack of ambition of the EU policy framework on food waste (i.e. EU platform on food waste, lack of food waste hierarchy in the Waste Framework Directive…)
- Costs of eco-innovation implementation for industry

[4] https://lyofood.com/pages/why-lyo-food-taste-better

ECOINNOV2: Conception and design of products that help reducing the food waste by the end users, catering and individual consumers

Referent partners: Regional Council of South Ostrobothnia and Agencia de Résidus de Catalonia

Question: how can smart and eco-innovative designing and packaging solutions may help to reduce food waste?

Scope

The nature of the packaging and designing sectors make them concerned with regard to the transportation of food, non-recyclable waste produced and energy and water consumption of equipment process. It results in considerable environmental impacts: high consumption of energy and water in equipment and machinery used to process food and to perform catering services, production of non-recyclable food and packaging waste, emission of GHG from processing and food transportation.

While the environmental impacts resulting from food packaging activities are very high, there is considerable scope to reduce these. There are a number of current and emerging eco-innovation trends in the food and drink sector which can result in more sustainable packaging and catering services.

These include first the use of more sustainable food products and resources (organic and seasonal food), sustainable food processing, eco-sourcing, more resource-efficient outputs (e.g. biomass energy), packaging and waste recycling (e.g. smart or eco packaging) and industrial processes (e.g. automation). This is key aspect especially with regard to the amount of packaging waste as well food waste generated by mainstream behavioral eating patterns especially in cities (i.e. street food).

In that respect eco-design may help to reduce food waste and producers have a primary responsibility for ensuring high quality recycling. The objective behind this eco-innovation domain is to reduce the footprint of food packaging materials as well as the food catering one while making food product less perishable. Eco-design criteria may need to be boosted to force more circular and food waste reduction-oriented products (i.e. target of 100% renewable and recyclable food packaging).

One dimension of ecological packaging is to pay attention to the suitable package sizes and types. Research results in Finland indicate that among households, the largest amount of food waste originates from single households. Single household was the most common household type in the EU-28 in 2015 (33.4 %), recording also the highest increase from 2005 to 2015 (4.1 percentage points). Especially people living in single households also think that the package size of food products has an effect on the amount of food waste (e.g. too big packages that lead to food getting spoiled before eating). This is the case particularly with bread and other cereal products, meat products (e.g. cold cuts) and cheese [3]. According to a Swedish study, 20–25 % of the households' food waste could be related to packaging. Additionally three packaging aspects were found dominating the waste related to packaging: packages that were found too big, packages found too difficult to empty and wastage because of passed "best before" date [5].

While a remarkable amount of food waste in households originates from various behavioral and value reasons, studies show

that more suitable packages (type and size) and products with longer best before date could help reducing food waste in private households. As single households create the largest household group in Europe and produce the largest amount of households' food waste, solutions should especially be found to help single household consumers to reduce food waste. By new product and packaging innovations food companies could help reducing food waste by creating more attractive food products with potential high-value benefits for themselves.

In the future also the way of expressing the expiring dates of food products will probably change. Innovations are being developed to include smart sensors beside the "best before" and expiry dates. These sensors can vary from a colour-changing sticker to labels that give tactile information about the condition of the food. The challenges related to these innovations include healthy issues and questions of costs.

Features

- Social innovation
- Organization eco-innovation
- Technological eco-innovation
- Circular economy business models

Approaches

- Re-engineer manufacturing processes
- Improve supply chain management
- Improve packaging to keep food fresher for longer
- Optimize portion size accordingly with the user needs
- Reprocess or repackage food
- Change food date labelling practices
- Improve product handling taking into account packaging characteristics e.g. use in microwave ovens
- Smart packages including e.g. food expiring sensors (for example stickers that change their colour when food starts to perish)

Good practice examples

- Ultraclean packaging system that helps to extend the best before dates of milk, Dairy company Juustoportti, Finland
- Package innovation for minced meat: Vacuum packed minced meat requires no packing gases and extends the time for sale and use (and requires 50 % less packing material), Food company Atria, Finland
- Bump Mark, a bio-reactive food expiry label, UK
- Smart Buffet Service Line for food services and restaurants to help customers to follow the amount of nutrients and calories they collect from the buffet table and take the right amount of food (patented system of) Metos Manufacturing, Finland

Opportunities offered by eco-innovations

- Strengthen the local/regional food economy by leading eco-efficient processing industries
- Create new jobs and new revenues in the food eco-packaging industry
- Pave the way for voluntary measures and future standards (i.e. ecodesign labels for products and services)
- Take advantage of regional innovative skills (e.g. fat-proof and water resistant packages which can be recycled in material or energy recycling), favorable innovation ecosystem and capacities (if applicable)
- Anticipate future EU or private standards towards less toxic, eco-

efficient and climate-friendly materials (i.e. bio-nutrients for consumables such as food packaging and also recyclable materials however they should not contain the leftover food)

Obstacles to eco-innovations

- Low uptake of eco-innovations by food processing businesses
- Insufficient communication of the circular economy opportunities to businesses and SMEs
- Higher cost of eco-innovative materials, technologies and packaging equipment[5]
- Lack of standards and energy saving targets in the EU Ecodesign Directive (if applicable for manufacturers)
- Lack of ambition of the EU policy framework on food waste (i.e. EU platform on food waste, lack of food waste hierarchy in the Waste Framework Directive…)

[5] But the technological progress is so high that this is changing and there is an offer of environment-friendly packaging materials at relatively low price

ECOINNOV3: Use of products today considered as unusable or unserviceable products

Referent partners: Devon County Council

Question: how can reuse of imperfect food or unusable food may generate business opportunities within an eco-efficient circular economy?

Scope

A large amount of food that is produced, traded and consumed –incl. fresh food like fruits and vegetables- have a short live period and are perishable. Overproduction, climate hazards, weather conditions as well as incomplete market management schemes do contribute to generate food surplus at the production stage. In addition, marketing standards use to disqualify market access for imperfect/ugly food products due to their unusual aesthetic size (incl. fruits and vegs) and contribute to expand amounts of lost food.

A large range of reuse imperfect/ugly/out of consumption date food already exist in practice through various schemes, either business-oriented of charity-oriented. Basically food saving NGOs and social entrepreneurs have played a pioneer role thanks to philanthropic supports as well crowd-funding, with a view to improve the environmental/climate impacts of the food system (incl. lowering cost of food waste management at city/region levels) downstream or to improve access to food for less deprived people, or both.

In addition, food saving practices may generate new by-product business opportunities in the food chain (i.e. coffee to grow mushrooms, bread to make beer, municipal food waste to feed pigs…). Food resource efficiency is a key aspect: instead of feeding animal with regional or imported grains (incl. monogastric animals like poultry and pork livestock), some argues that it would be more eco-efficient to feed pigs with residues from municipal food waste. Unless food safety issues are solved by heating process of waste, the EU regulation does not allow such resource-efficient approach so far while it is possible in other countries (i.e. in Japan).

Regarding gleaning practices in the farm fields, some NGOs are very active and have a strong social engagement capacity (i.e. Feedback). However, eligibility of related-gleaning eco-innovations under ERDF has to be checked with every regional managing authority.

More recently new retail business models based on reuse have arisen in the food surplus economy. This trend is encouraged by some national legal obligations that ban supermarkets which do not donate but thrown away their food surplus. Whether such 'Second hand' food surplus markets are growing in many EU countries, environmental impact of surplus' distribution is questionable given the unsustainable patterns of agrifood systems.[6]

Features

- Social innovation
- Organization eco-innovation
- Technological eco-innovations
- City-Rural synergies
- Low cost eco-innovations

Good practices examples

- Surplus fruit air dried into crisps

[6] http://foodresearch.org.uk/is-it-appropriate-to-use-surplus-food-to-feed-people-in-hunger/

- Beer brewed using surplus bread (Toastale.com)
- Mushrooms grown in coffee grounds
- Distributing surplus food to less deprived people
- Making wonky veg into e.g. baby food, soup
- Using food waste as pig feed (the Pig Idea)

Opportunities offered by eco-innovations

- Create new jobs and new revenues through unsold food redistribution businesses
- Enhance local/regional food security by strengthening the viability of SMEs and charities, and increasing appropriately scaled processing facilities, distribution networks, and direct marketing
- Develop strategies that foster resilience, local innovation, and community development in both rural and urban economies

Obstacles to eco-innovations

- EU regulation on feeding animals from food waste (inc from municipal food waste)
- Aesthetic food standards that prevail on nutritional standards

ECOINNOV4: Services provided that help reduce food waste directly or by a modification of consumption patterns (including e-services, connected objects)

Referent partners: City of Ferrara Region Provence Alpes Côte d'Azur

Question: how could Information and communication Technologies (ICT) and social innovation improve awareness, resource efficiency and prevent food waste in consumers/eaters daily lives?

Scope

Emergent technologies, e-services and social innovations already contribute to reduce food waste. Innovations platforms and niche innovations have arisen in cities in food redistribution and food sharing. Increasing examples have become in the EU with the development of ICTs and business models which help food surplus producers to avoid food waste through alternative food supply chains that include charities, food bank as well as surplus food supermarket to reach end-consumers.

Regulations may be act as innovation triggers to reduce food waste. New food waste regulations established at national level (i.e. in France and Italy) require retailers to donate food which would be thrown otherwise. France government has imposed binding donation to supermarkets for unsold food that would be thrown otherwise. New charity and business models can illustrate at downstream level how a resource-efficient and circular economy can work to reduce food waste. In many cases combination of both technological and social innovations may enable social entrepreneurship business models that are food security/social inclusion-oriented.

In the design sector some researchers have outlined potential opportunities offered by what they call 'social recipes concept' to reduce food waste. Under this concept "i*ngredients available from different households are combined into one or more recipes, which are suggested to a group of users. The prospective is to collectively prevent food waste by encouraging collaboration and food sharing. Apart from this altruistic aim, the concept is expected to incentivize people to share, cook, learn and enjoy food together »*.[7]

In that respect some web 2.0 social networks facilitates engagement of people in new food sharing practices that contributes to reduce food waste in the end. In addition the challenge is to handle smartly and inclusively use of big data where e-developers and innovation platforms foresee participatory approaches with consumers and end-users for sharing individual data on food waste.

Last but not least, education and information might be pivotal to support food waste reduction and improve awareness on impact of consumption patterns. Pupils and their trainers/teachers should be targeted through dedicated workshop and labs at school.

France, the most virtuous country in terms of food waste according to the BCFN-EIU Food Sustainability Index, launched a few educational campaigns which begin in a child's first few years at school. In doing so, through the joint intervention of politics, businesses and individuals, it made up for the country's previous lack of progress in this sector. Rounding out such efforts are campaigns to better explain how to read

[7] Designing for action: An evaluation of Social Recipes in reducing food waste, Lim and al., 2017.

labels, how to store food once it's purchased, how to re-use leftovers, and so much more.

Features

- Social innovation
- Organization eco-innovation
- Technological eco-innovations
- City-level

Some good practices

- ResQ club, Finland
- Last minute market Business model, Italy
- "Last Minute sotto casa APP": connecting citizens and shops (available on Google and Apple store)
- Social Emporium: a meeting point among donors, beneficiaries and institution where citizens in life challenging situation "buy" donated food through a scoring system.
- Togoodtogo: : the TGTG app raises awareness of food waste by making surplus food available for collection before a store closes its breakfast, lunch or dinner service.
- Brixton community fridge, UK
- foodsharing.de
- FoodKeeper App
- RistoriAMO, Italy (an initiative promoting zerowaste restaurants)
- Project "AvanziAMO", Italy: a framework initiative to increase awareness, information and education on food waste and valorize local products.
- …

Eco-innovation opportunities

- Develop new e-services, apps, Internet of Things (IoT), etc, dedicated to local food sharing platforms
- Create new jobs and new revenues through new/emergent business models within a collaborative circular economy
- Improve access to food for low income people/households through food sharing platforms
- Develop strategies that foster resilience, local innovation, and community development in urban and peri-urban economies
- develop apps or websites with recipes for use of leftover food

Obstacles to eco-innovations

- Lacking institutional and R&D support to eco-innovations
- Access of e-start-ups and charities to financial support
- Low uptake of service eco-innovations due to a poor/insufficient engagement of users' communities. With this regards, financial incentives and deterrents should be designed in such a way as to effectively influence consumption patterns.

Table 1: Overview of opportunities offered by eco-innovations to reduce food waste

Reasons to reduce food waste	**Opportunities offered by eco-innovations to reduce food waste**				**Main narrative**	**Contribute to improve:**
	ECOINNOV1	ECOINNOV2	ECOINNOV3	ECOINNOV4		
	Efficient food processing...	Design of products for end users...	Re-use of food products...	Services, apps, IoT...		
Financial						
Reduce food' sourcing costs	X	X			Save money	SME competitiveness
Improve corporate/brand reputation	X	X				Purchasing power of consumers
Reduce waste management costs	x	X	X		Relieve the planet	Regional circular economy
...						Sound City/Region Governance
Non financial						
Observe international commitments (i.e. SDG 12.3)	X	X	X	X		Low carbon economy
Observe national, regional, local regulations	X	X	X	X		Envi & ressource efficiency
Ethical reasons			X	X	Value food	Local/Regional Food security
...Increase the range of bio-active products with pro-health nature	x					Social inclusion

Source: authors.