

REFRESH Final Results

The REFRESH Project: Resource Efficient Food and dRink for the Entire Supply cHain

REFRESH ("Resource Efficient Food and dRink for the Entire Supply cHain") was an EU funded project taking action against food waste. Twenty-six partners from 12 European countries and China worked towards the project's goal to contribute towards the Sustainable Development Goal 12.3 of halving per capita food waste at the retail and consumer level and reducing food losses along production and supply chains by 2030.

Specifically, the project aimed to:

- Build a pan-European evidence base exploring and explaining the factors influencing current 'sub-optimal' consumer and business practice in order to support effective interventions.
- Provide better estimations of the environmental impacts of food waste and benefits of avoided food waste.
- Design and develop technological innovations to improve valorisation of food waste and surplus food, e.g. from food processing.
- Develop strategic agreements to reduce food waste with governments, business and local stakeholders in five countries: Spain, Germany, Hungary, the Netherlands and China. Within these countries, participating stakeholders tested new approaches to reduce food waste.
- Formulate EU-level policy recommendations and support the implementation of national food waste policy frameworks.

This document provides an overview of the work undertaken within the project including key insights and links to the results that are available online.

A full list of the results from the project is available on the REFRESH website: eu-refresh.org/results

Brochure, February 2020

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All project results can be found on the REFRESH website:
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1. Understanding Consumer Behaviour and Household Relationships with Food and Food Waste

The main objective of our research on consumer behaviour was to develop a better understanding of consumer behaviour in relation to waste generation, handling, reuse and by-product valorisation. To reach this objective, we built a research framework to explain household food waste, validated this framework in focus group discussions and tested it quantitatively across four European countries. For this latter test, we developed a new survey method to measure household food waste and validated it against other existing measures. We focused on consumer responses to three distinct strategies to diminish food waste: the use of ICT tools, providing on-pack information, and by-product valorisation.

Key results

Our theoretical framework of the [causes and determinants of consumers' food waste](#) describes household food waste as resulting from an accumulation of behaviours performed earlier in time. It distinguishes between three key factors determining household food waste: (1) consumer *motivation* to avoid waste, (2) consumers' *skills and abilities* concerning household food management processes, and (3) the *opportunities* present in consumers' environments.

[Focus group discussions](#) in Hungary, Germany, Spain and The Netherlands, using [the REFRESH qualitative research protocol](#), confirmed that these broad factors are indeed important, and furthermore that the goal of food waste competes with many other food consumption goals, such as taste, variety and food safety. In the end, these other goals may take precedence over preventing food waste. Another key result was that consumers generally seem aware of the issue of food waste and stress the importance of waste prevention. However, when placed in the context of everyday life, consumers acknowledge that food waste happens frequently nonetheless and is difficult to avoid completely.

We also wanted to quantitatively test the impact of motivation-, ability-, and opportunity-related constructs on household food waste. This needed a valid measurement of household food waste. We therefore [compared various household food waste measurement methodologies](#), showing that general questions on food waste (e.g., how much uneaten food is thrown away in the household) appear less appropriate to measure food waste, whereas diaries, kitchen caddies, and photograph coding appear to be suitable measures. Importantly, we also developed a [REFRESH survey measure](#), which can properly assess differences in household food waste, although giving a systematic underestimation.

Our [quantitative survey](#) in the same four European countries showed that various household practices determine the amount of household food waste: households, which buy less on impulse, have a good overview of the food that is in stock, cook precisely, and use leftovers, report less food waste. Surprisingly, the extent to which consumers are aware of the consequences of food waste does not seem to influence the amount of household food waste, whereas the belief that others waste little has a relatively large effect. Based on these insights, attempts to influence household food waste that focus solely on increasing consumer awareness would not have the intended effect. Rather, promising strategies to reduce consumer food waste should aim to change the social norm (i.e., convince people that it is normal to not waste). Additionally, strategies to strengthen consumers' skills and knowledge, as well as to improve the accessibility of good supply and to help consumers reduce the chance and impact of unforeseen events on their household food management are also promising.

REFRESH also examined three additional strategies to diminish food waste: the use of ICT tools, providing on-pack information, and by-product valorisation. [Consumer responses to ICT tools](#) that have been developed to diminish household food waste (mostly apps) showed that consumers are interested in these, but at the same time do not perceive a clear need to use

them as they think that they do not waste much food. An inventory of existing apps shows large differences in functionality and popularity between the different types of apps. Moreover, based on focus groups and discussions with consumers using different apps, user-friendliness appeared as a key component.

Another medium to provide advice to consumers is [on-pack information about expiration dates and optimal product storage](#). Results indicate that consumers do not always react to date labels as intended, and generally do not adjust their response depending on the type of date label (best before / use by / display until). Providing guidance about optimal storage location is likely to change consumer behaviour in a positive direction, and consumers find this type of information helpful.

Finally, [consumer understanding and acceptance of different valorisation methods for food surplus and side flows](#) was assessed. Using a social experiment, consumers evaluated four waste valorisation processes in the context of school meals:

- (1) Gleaning¹ vegetables for soups or creams,
- (2) Extracting ingredients from food surpluses and using these for food enrichment,
- (3) Converting food-processing by-products to animal feed for animals intended for human consumption, and
- (4) Converting catering food surpluses to liquid feed for pigs intended for human consumption.

Results show that option 1 (using gleaning vegetables) was deemed acceptable in the setting of a school lunch, whereas the other valorisation options for school meals did not find a high acceptance, even though they were generally considered to be suitable for human consumption.

¹ Gleaning: collecting leftover crops from farmers' fields after they have been commercially harvested.

2. Developing of Voluntary Agreements in four EU Member States

A main ambition of the REFRESH project was to develop an adaptable 'Framework for Action' (FA) model that promotes collaboration along the whole food and drink value chain to address food waste at a national level.

The four "Pilot Working Platforms" or 'steering groups', established through REFRESH in Hungary, Germany, the Netherlands and Spain developed and tested these Frameworks for Action on food waste together with partners from business, civil society, and governments. The 2019 report "[Evaluation of Framework for Action pilots](#)" summarises the achievements.

All four countries have supported the FA by implementing [specific actions](#), covering topics such as measurement, employee engagement, redistribution, event catering, packaging and use of surplus food products. In addition, members engaged with REFRESH have identified new and innovative ways to address food waste within their own operations.

A process evaluation has provided valuable insights into the establishment and management of the Framework for Action in each country. The findings were used to inform the development of a [Blueprint](#), an interactive tool to support other countries opting to take a voluntary agreement approach to tackling food waste. The Blueprint provides step-by-step advice to interested countries, drawing on earlier research and backed by the experiences of the four REFRESH pilots.

To facilitate effective decision-making REFRESH also developed the Food Waste Monitor, a decision support tool aimed at retailers, by providing tailored advice of reducing food waste based on insights gathered through the monitor and submitted data.

The FA approach was replicated in [China](#) with the official launch of the SAVE 12.3 Platform at the end of 2018. Based on the REFRESH FA model, the Platform has three committed lead partners and an active WeChat (media) channel. A [catering workshop](#) was held in May 2019, bringing together representatives from across the sector to share experiences and discuss potential solutions to reducing food waste.

In collaboration with the EU Platform on Food Losses and Food Waste (FLW), REFRESH launched the online knowledge-sharing site 'Community of Experts' (CoE) in October 2017. The 'Community of Experts' provides an interactive space for users to share and learn from their own experiences, with relevant tools and resources to support them. It can be accessed via www.refreshcoe.eu. As of June 2019, the CoE had 473 registered users and 235 published resources. In spring 2019, the CoE ran a series of [four webinars](#) featuring experts from REFRESH presenting key outcomes of the project.

Legacy

Each pilot FA will continue in some form: Germany included voluntary agreements within their Food Waste Strategy, and in the Netherlands, the Ministry has provided funding for the Dutch FA post-REFRESH. Most groups that have been set up in the Pilot Working Platforms continue to meet regularly.

The Blueprint has already been used to shape the FA approach in other Members States, with workshops held, for example, in Sweden, Denmark and Belgium.

The Community of Experts will be integrated onto the EU Platform FLW website in 2020.

For more information about the Frameworks of Action and supporting pilot projects, see eu-refresh.org/national-platforms.

3. EU Policy Options to Reduce Food Loss and Food Waste

REFRESH provided evidence-based policy recommendations to improve the policy framework for preventing, reducing, reusing and valorising food loss and waste in the European context. It showed that an integrated food policy and food systems approach is necessary that increases synergies and policy coherence with other policy areas and has a holistic perspective on the drivers of food waste along the whole value chain.

Studying the food supply chain in a bottom-up fashion, including a system mapping, led to the [identification of food waste drivers](#) at each stage of the food chain for five relevant food categories: bread, dairy, potatoes/tomatoes, prepared meals (sandwiches), and processed meat/poultry. The identified drivers can be grouped into three main types:

- product specific (specific to the selected food products at a particular stage of the supply chain);
- generic (concerning two or more selected products, e.g. labelling errors or limited shelf life) and
- systemic (inter-linked drivers concerning more than one step of the supply chain, e.g. minimum orders or last minute cancellation).

Key drivers at the system level were the lack of cooperation and power imbalances along the supply chain. To address these issues, a [comparative analysis of two case studies – Unfair Trading Practices \(UTPs\) and Voluntary Agreements \(VA\) – across EU countries](#) illustrated how interacting policies can decrease food waste and enhance the sustainability of food systems. It demonstrated that the food supply chains are particularly susceptible to unfair trading practices in Member States where market power is concentrated. To address power imbalances, the report suggests creating an independent authority to investigate UTPs along with a wider recognition of the issue at the European level. Despite the difficulty of dealing with power imbalances along the supply chain, if soundly implemented, voluntary agreements can support action against UTPs. As a tool to facilitate collaboration, voluntary agreements can help a wide range of players to cooperate, find ways to respond to dynamic changes in the policy context over time and to create a framework for action in the absence of legal measures.

In parallel, REFRESH provided a [screening of some of the most relevant EU policy areas addressing food waste](#) (waste and resource policy, food safety and hygiene, bioenergy, agriculture and fisheries, date labelling, etc.). It demonstrated that food waste is the symptom of a dysfunctional food system at the interface between several policies (agriculture, energy, safety, etc.). The challenges show that an integrated food policy perspective is essential and that operating in silo hinders synergies and increases trade-offs. Windows of opportunities exist both to introduce new policy instruments (e.g. in the area of unfair trading practices) as well as to reform existing policies (e.g. in the area of waste regulation or with regard to the use of surplus food for animal feed). Furthermore, a process and/or policy defining the overall EU objectives, strategies and instruments concerning food in general (not only food waste), can be a relevant step to address many of the trade-offs and to increase of synergies.

To implement an ambitious food waste reduction policy in the EU, the “food use hierarchy” as developed by REFRESH (see figure 1) can act as a guiding principle for policy design, e.g. for the reform of bioenergy policies that often provide false incentives to use food that is still fit for human consumption or feed. The food use hierarchy emphasises the need to keep food in the human food chain as long as possible and to use resources effectively before they are recycled, recovered or disposed.

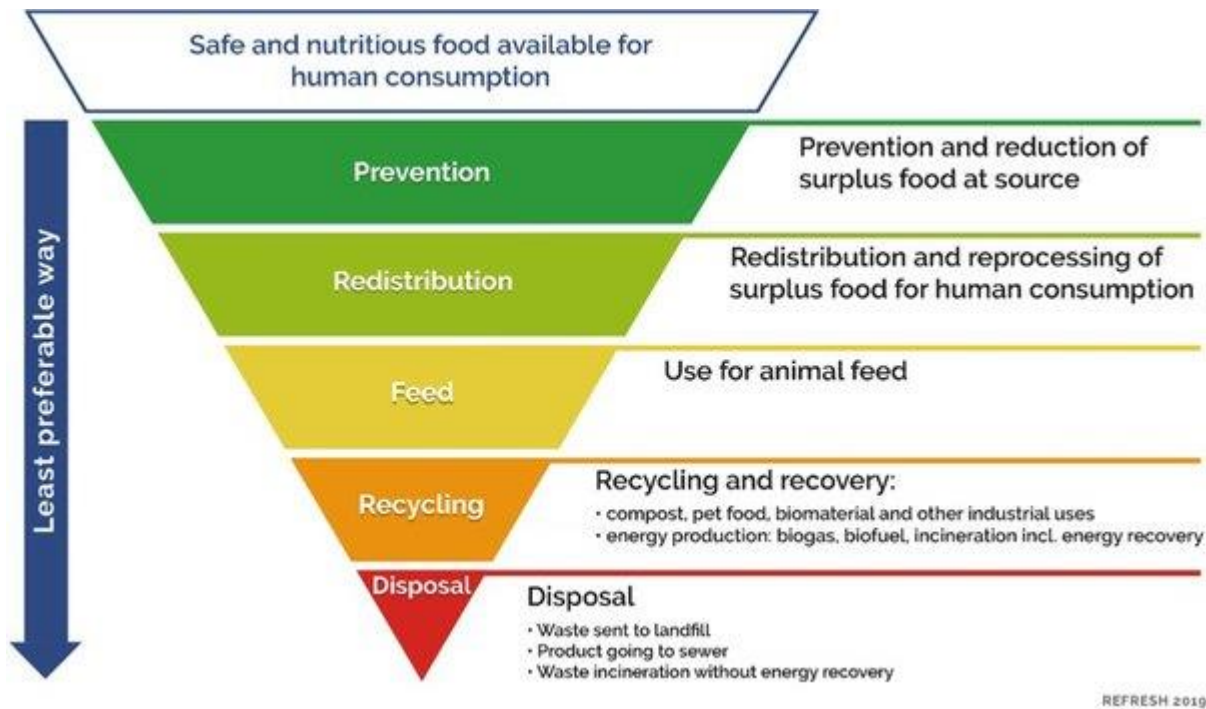


Figure 1: REFRESH food use hierarchy

Based on this work, REFRESH identified key policy areas to investigate further and develop policy recommendations. In order to discuss policy options with all relevant stakeholders, REFRESH organised a [series of workshops](#). Key outcomes per policy area were summarised in four policy briefs:

- The policy brief [Reducing consumer food waste](#) encouraged policy makers to implement campaigns influencing social norms and to consider regulatory, economic and nudging approaches. It also underlined the need for an integrated approach to food waste reduction, relating it to health policies, the economic framework, resource efficiency and waste policies. The policy brief was backed by a more detailed report: [Policy options for behaviour change including public campaigns](#).
- The magnitude of the [role of unfair trading practices in food waste generation](#) is complex to assess due to the lack of quantitative data. The policy brief underlined the need for a consistent EU approach in order to build fairer supply chains.
- The [policy brief about the role of voluntary agreements](#) demonstrated that voluntary cooperation is a powerful and flexible tool to fight food waste. Voluntary agreements can be set up either as a complement or as an alternative option to conventional regulatory processes. The establishment of a neutral third party, the support from government bodies, clear targets and a consistent monitoring framework are key success factors of a voluntary agreement.
- The policy brief "[Avoiding food waste through feeding surplus food to omnivorous non-ruminant livestock](#)" demonstrated large environmental and cost benefits if EU law was to enable surplus food containing meat to be fed to omnivorous non-ruminant livestock like pigs. More specifically, as a result of changing legislation to ensure the safe treatment of such surplus, 16% of food waste could be processed into non-ruminant feed.

4. Understanding Food Waste through Behavioural Economic Approaches

REFRESH aimed at providing new information on consumer and business food waste reduction performance applying behavioural economics approaches². Identifying and analysing socioeconomic conditions and driving factors that influence consumers' choices and businesses' decisions in the creation and/or reduction of food waste, can support the design of more effective policies and market interventions. Methodologically, the analysis took advantage of different modelling approaches, more specifically Agent-Based Models³ (ABM) and Bayesian Networks⁴(BN).

Key results

The relevant literature identifies many characteristics (age, income etc.) which suggest potential typologies of consumers in relation to food waste. Yet, many of these relationships are likely to be spurious, for example due to small sample sizes, selective reporting or multiple testing. The report "[Consumers' behavioural economic interrelationships and typologies](#)" addressed these problems by analyzing two of the largest available datasets (by WRAP and Eurobarometer) to define consumer behavioural typologies and develop a systems map to illustrate potential links between consumer behaviour and the creation/reduction of food waste. The analysis consistently identified household composition as a key determinant of food waste, with large households generating more waste than small households do.

As for business actors, the report "[Socioeconomic implications of food waste: Business behavioural typologies and interrelationships](#)" identified a set of behavioural typologies. It suggests that, beyond economic aspects, specific psychological factors may affect the adoption of innovations by food companies. Overall, the adoption of innovations aimed at addressing food waste emerged as a multidimensional phenomenon and implies high uncertainty concerning the relation to food waste. The behaviour of every business results from its idiosyncratic characteristics, its structural and managerial features, and the environment in which it operates. Uncertainty may be addressed by sharing information, or through inter-firm coordination. Focusing on food processors and retailers, behavioural typologies correspond roughly to structural typologies that can predict behaviour to a certain extent. Two structural typologies can be identified: large businesses implement indirect reciprocity, favour formal coordination schemes, and tend to create innovations or to be early adopters. Small firms resort to satisficing behaviour and prefer to imitate the innovation patterns of their most successful peers, thus complying later or merely partially with food regulations.

As innovation is fundamental for preventing or reducing business food waste, the report "[Socio-Economic Implications of Food Waste: Economics of Innovation](#)" analysed the drivers of technological and organisational innovation and their impact on waste. The results show that costs, and their associated risks, are the most important determinants of organisational innovations. Furthermore, product and process innovations need to be accompanied by organisational innovation, and combining both technological and non-technological innovation. Territorial and cultural differences increase the challenge of implementing new management practices. For this reason, innovation does not follow the same diffusion pattern everywhere, resulting in different local outcomes.

² Behavioural economics: the study of the influence that psychological, cognitive, emotional, heuristic and cultural considerations exert on economic agents' (individuals, organisations) decisions.

³ Agent-based model: computational (probabilistic) model for simulating economic agents' behaviours (decisions, interactions).

⁴ Bayesian network: a graphical model, which provides the end user with a visual image of the problem or system, rather than a series of mathematical equations, which often disengage stakeholders.

Given that food waste is generated in the context of a complex set of interacting behaviours of both food consumers and suppliers, both need to be analysed. Both Agent-Based Models and Bayesian Networks provide a modelling approach that fits this purpose, since they allow for the study of complex systems. The extensive analysis of different data sets represented a preliminary activity for model development.

Looking at the Eurobarometer data, the REFRESH report "[Model development and data protocol](#)" suggests that where people come from is an important predictor of food waste generation. Countries with grocery spending per capita exceeding €3,000 had higher food waste. However, there was no clear relationship with GDP. Concerning age, education and occupation, different analyses yielded varying results. Therefore, they can only be used tentatively as predictors of food waste.

To draw up a road map for the reduction of European Food Waste by 50% in 2030, an integrated whole-of-system modelling approach was built as a decision-relevant and dynamic support tool. The report "[Integrated socio-economic model on food waste](#)" described the model with which consumer and retail-level food waste practices can be simulated.

In addition, a model to assess the impact of policy interventions on reducing food waste among consumers was developed in "[Behavioural Economics: Linking Bayesian and agent-based models to assess consumer food waste](#)".

Furthermore, in order to identify and describe the main drivers for innovation adoption at the retail level, simulations of the Italian and Dutch market for fresh fruit and vegetables were conducted in the study "[Behavioural economics: assessing Food Waste innovations diffusion through ABM models: Insights from Italy and the Netherlands](#)". Results showed that the adoption of innovations by retailers aimed at reducing food waste is influenced by several factors which are not only of strictly economic nature. In particular, the presence of strong networks among retailers and a high level of awareness among consumers play a prominent role in retailers' decisions to adopt food waste reduction innovations.

Building on this work a web-based tool - the "[REFRESH Roadmap](#)" - was developed which simulates food waste and the impact of interventions at the regional, national and European level. Utilising a Bayesian hierarchical mixed-effects modelling approach, this web-based tool provides different scenarios of food waste generation at the household level by quantifying the relationships between socioeconomic and demographic indicators and household food waste.

The REFRESH web-based tool allowed the development of country estimates. These are presented in the report "[Pan-European scenarios of food waste levels](#)", that collects 30 single food waste scenarios (EU 28, EU Member States and Norway), describing the amounts of food wasted every year by an average household based on predictions of food waste levels considering the current values of different socioeconomic and demographic factors.

In addition to simulating country-specific profiles of food waste based on current socioeconomic and demographic factors but keeping other factors constant, further scenarios were simulated. These took into account further factors that may accelerate change. The report "[A pan-European simulation of selected interventions](#)" discusses four different scenarios, illustrating how they lead to different amounts of food waste in each European country and for the whole EU28.

5. Environmental and Cost Dimensions of Food Waste

REFRESH assessed environmental impacts using Life Cycle Assessment, (LCA) and life cycle costs using Life Cycle Costing, (LCC) and provided recommendations on prevention, valorisation, and waste management options for food waste. Key results include guidance for a harmonised assessment approach, decision support tools and case studies.

Key results

The report [Generic Strategy LCA and LCC](#) provides guidance to practitioners and policymakers on how to apply Life Cycle Assessment (LCA) and Life Cycle Costs (LCC) when exploring questions about the handling of side flows from the food supply chain. The recommendations build on existing standards and state-of-the-art LCA/LCC research and were developed to support a coherent assessment of cost and environmental impacts.

The FOod side flow Recovery LIfe cycle Tool ([FORKLIFT](#)) is a decision support system designed to provide stakeholders with a better understanding of the environmental impacts and costs of selected valorisation routes. It is a hands-on tool that enables the user to easily evaluate different options, modify certain parameters, and add customised-generated data. The report [Simplified LCA & LCC of food waste valorisation](#) describes the FORKLIFT approach and explains the methodology for systems boundaries, allocation rules, waste management and so forth.

In [two case studies](#), combined LCA and LCC assessments were applied to highlight the implications of potential changes. The [first case study](#) assessed the impact of preventing losses and waste in peach & nectarine supply chains for fresh consumption. Specifically, the environmental impacts and life cycle costs of peaches & nectarines for fresh consumption from farm to retail were compared to a 50% prevention of spoiled and overproduced fruit from farm to retailer. The analysis was built on Italian and Spanish peaches & nectarines sold by a UK wholesaler. In this case, the UK wholesaler sold 1.4 million kg of peaches and nectarines while 0.5 million kg of the harvested peaches and nectarines were not sold and distributed through the channels they were intended for. Fresh peaches & nectarines were lost early on in the process, namely at the farm and the wholesaler in the country of origin. The impact assessment revealed that most of the impacts and costs currently derive from long-distance transport with climate-controlled trucks and from peaches & nectarines handling. The report showed that it would be possible to decrease the climate impact by 4% and the overall life cycle cost by 2.6% by preventing peaches & nectarines being lost compared to the current supply chain. When it comes to prevention strategies, the report underlines that actions to prevent food loss at later stages in the supply chain (e.g.: wholesaler in the destination country) should be prioritised, since this would lead to less peaches & nectarines shipped per kg sold. Prevention strategies to avoid loss later in the supply chain may also depend on actions undertaken early on. For example, a strategy is to improve sorting in the country of origin, aiming to ship fruit with longer expected shelf life and the relaxation of cosmetic standards related to size or shape. Another strategy to be encouraged along the food chain is the redistribution of food, for example to food banks and secondary markets for surplus fruits with a short expected shelf life.

The second case study raised the question “*What would be the environmental and economic costs and benefits of replacing conventional pig feed with heat-treated surplus food from retailers, compared to the current use of surplus food from retailers?*” Specifically, the environmental impacts and cost of the utilisation of food surplus as pig feed in UK and France through the introduction of the processing techniques already applied in Japan were assessed. Currently, surplus food is managed through a combination of landfill, incineration, composting facilities, and anaerobic digestion. The case study explored the impact of heat-treating the food surplus and using it as pig feed.

It was found that Greenhouse gas (GHG) emissions of about 1 million tonnes and 2 million tonnes CO₂eq/year could be saved in the case of UK and France respectively, depending on how much conventional feed is replaced and the transport distances covered.

The study showed that the net cost would be an overall saving of €278 million (or £250 million) in the case of UK, thanks to the displacement of conventional feed products, while in France, costs increased by €413 million, due to the large distance between food surplus dense areas and pig farming regions.

Thus, the alternative scenario using the surplus food for pig feed could be of interest for countries or regions with high amounts of side flows with pig farms located relatively nearby.

Finally, synergies and trade-offs of different interventions/market changes were investigated. Specifically, [waste prevention and valorisation options in European tomato supply chain and German meat supply chain](#) (beef, pork, and poultry) were assessed based on a material flow analysis (MFA). Mass and energy flows, as well as GHG emissions were assessed for these specific agri-food supply chains. Five major reduction measures - production efficiency, process optimisation, food waste reduction, trade pattern change, and dietary structure change - were assessed. It was demonstrated that if production can be decreased and resources can be used more efficiently, a considerable potential to global warming mitigation could be achieved.

The results indicate that:

- Waste reduction could significantly reduce GHG emissions along the entire supply chain. For the German meat supply chain, the total GHG emissions could be reduced by 43% compared to the current level. For the EU tomatoes chain, the combined effects of different mitigation strategies could reduce GHG emissions by 45% compared to the current level.
- A reduction of food waste from retailing and consumption stages by half, as addressed in SDG12.3, would reduce GHG emissions by approximately 11% in Germany's meat supply chain and EU28's tomato supply chain.
- A majority of the GHG emissions of the EU tomato supply chain comes from greenhouse tomatoes. For meat, the majority of GHG emissions originates from the production sector.
- Large variations in GHG emissions exist within the different options of waste management (disposal versus recycling options). Although GHG emissions of waste management are rather neglectable compared to emissions of the entire supply chain, a significant GHG reduction potential could be achieved if the landfilling of bio-waste was finally phased out in favour of valorisation options.
- Dietary structure change leading to reduced meat or tomato consumption (and increased consumption of other vegetables or nuts) is the most promising scenario to reduce GHG emissions, if a reduced consumption of meat or tomatoes would lead to a reduced production of meat and tomatoes. However, the market consequences of a dietary structure change can have multiple effects, which are not easy to predict.

6. Valorisation of Waste Streams and Co-products

REFRESH aimed to increase the exploitation of unavoidable food chain waste. To do this, it provided support to policy makers, professionals, businesses and other interested stakeholders to identify waste streams that are appropriate to valorise. This included valorising post-consumer putrescible waste and helping policy makers identify and implement improvements of legislation to reduce unnecessary restrictions on valorisation.

Key results

REFRESH has evaluated the utilisation of key unavoidable EU food production by-products, in respect to European consumption and environmental impact. In the report, [Medium List of Waste Streams Appropriate for Valorisation](#), over 290 food production residues were identified, scored and reviewed to produce a list of priority waste streams. Thirty-seven priority waste streams defined in this report were further reviewed to produce a list of the [top 20 waste streams](#) that are deemed the most appropriate edible and inedible waste streams for valorisation. The focus lay specifically on waste streams from foodstuffs which have the greatest environmental impact, which are present in sufficient quantities, and which are unavoidable. Over 20 different existing valorisation approaches (such as use as animal feed, energy generation, pectin production, land spread etc.) have been further studied to assess process energy inputs and provide relevant information to business stakeholders, researchers and professionals.

The results have been used to develop a decision support tool for stakeholders in the food industry on how to use food surplus and food waste streams in an environmentally and economically better way. Inventories from the 20 top valorisation approaches were used to develop the Excel tool "[FORKLIFT](#)". FORKLIFT indicates how the overall net cost and greenhouse gas impact differs with various valorisation approaches and scenarios. It is designed to be interactive, introduce users to whole lifecycle thinking and indicate the significant factors that impact the environmental and cost performance of valorisation options (see chapter 5).

Questions around the safety and the environmental and economic impacts of feeding treated surplus food to omnivorous livestock, such as pigs, were analysed in the "[Technical Guidelines Animal Feed](#)". These technical guidelines describe in detail the environmental, economic, nutrition and safety considerations of reforming EU law to enable surplus food containing meat to be fed to omnivorous non-ruminant livestock like pigs, in order to drive food waste valorisation through animal feed.

In order to use "former foodstuffs" (inherently different from catering waste, which is prohibited to be used as animal feed in the EU) such as broken biscuits or incorrectly shaped loafs of bread as farm animal feed, an [Animal Feed Tool](#) was developed. The web app aims to make it as easy as possible for food businesses to understand the legislation and requirements that are applicable to their specific context. They thereby overcome barriers, such as logistical challenges and complicated legislation that so far make it difficult for food businesses to know what kind of surplus foods are allowed to be used as animal feed and which are not.

REFRESH has also conducted an investigation into the [suitability of using chicory and carrot fibre as ingredients](#) in bakery products and breakfast drinks. This research is particularly relevant for food manufacturers where incorporation of fibre into a 'high-fibre' product is of interest. In addition, specific strains of bacteria that can successfully [utilise unavoidable food waste have been identified](#), genetically characterised and grown. This work demonstrates the potential for harvesting bacteria for production of fine chemicals from unavoidable food waste.

As it can be difficult for businesses to identify in which conditions a valorisation option is economically feasible, REFRESH undertook a [case study on a chicory processing by-product](#)

and presents a methodology for a well-underpinned assessment of practical economic feasibility.

Valorising food waste by extracting high value food ingredients such as bioactives is a preferable alternative to traditional valorisation approaches, such as animal feed. In this context, REFRESH investigated the potential benefits and drawbacks, as well as favorable conditions for such processes in a number of case studies, using [tomato side streams as an example](#). More specifically, an example of tomato pomace was tested as a possible case for high value products (tomato extracts) compared to moderate value products (tomato paste) compared to low value products (mixed food waste for animal feed).

Researchers have also considered how [external conditions \(legislative, environmental, social and economic\) can influence](#) the development of food waste conversion options, specifically through conversion of currently wasted food to animal feed. An assessment on the [role of waste valorisation in meeting EU food waste targets](#) (SDG 12.3) is available to view.

The project also developed the [FoodWasteExplorer](#) - a food waste compositional database that brings together compositional information on the macronutrients, micronutrients and bioactive components present in the top food side streams in a searchable format. It is a tool for exploring how food waste might be better used, e.g. citrus peel limonene can be used to make medical plastic, and is likely to be used by a wide range of users including researchers, government agencies, industry and the public. A complementary [Food Waste Valorisation Quiz](#) that lets you guess which products can be made from different types of food waste, was developed in addition to the FoodWasteExplorer.

These tools and research will help business stakeholders find the best approach for valorising food waste and food surplus whilst taking into account food waste composition, production costs, legislation, environmental impact, safety and opportunities.

7. REFRESH Communication and Events: Engaging Stakeholders across Policy, Practice and Research

REFRESH dissemination and communication activities aimed at increasing the impact of REFRESH outputs on external stakeholders.

The dissemination related objectives of REFRESH were:

- Facilitate knowledge exchange and ongoing mutual learning between different stakeholders and between different regions.
- Raise awareness among food chain stakeholders, policy makers and the wider public on the economic, environmental and social impact of food waste, opportunities for its prevention, and the benefits of reducing food waste.
- Involve relevant stakeholders in the development and implementation of strategies against food waste undertaken within REFRESH, and ensure that the findings of the project are taken up by the relevant stakeholders.
- Share best practice across the EU28, third countries (incl. China) and internationally and improve opportunities for implementation.
- Showcase the impacts and outcomes of the project's research and innovation activities.
- Maximise the availability, accessibility and awareness of the results and learnings from the project to maximise its ongoing impact and legacy.

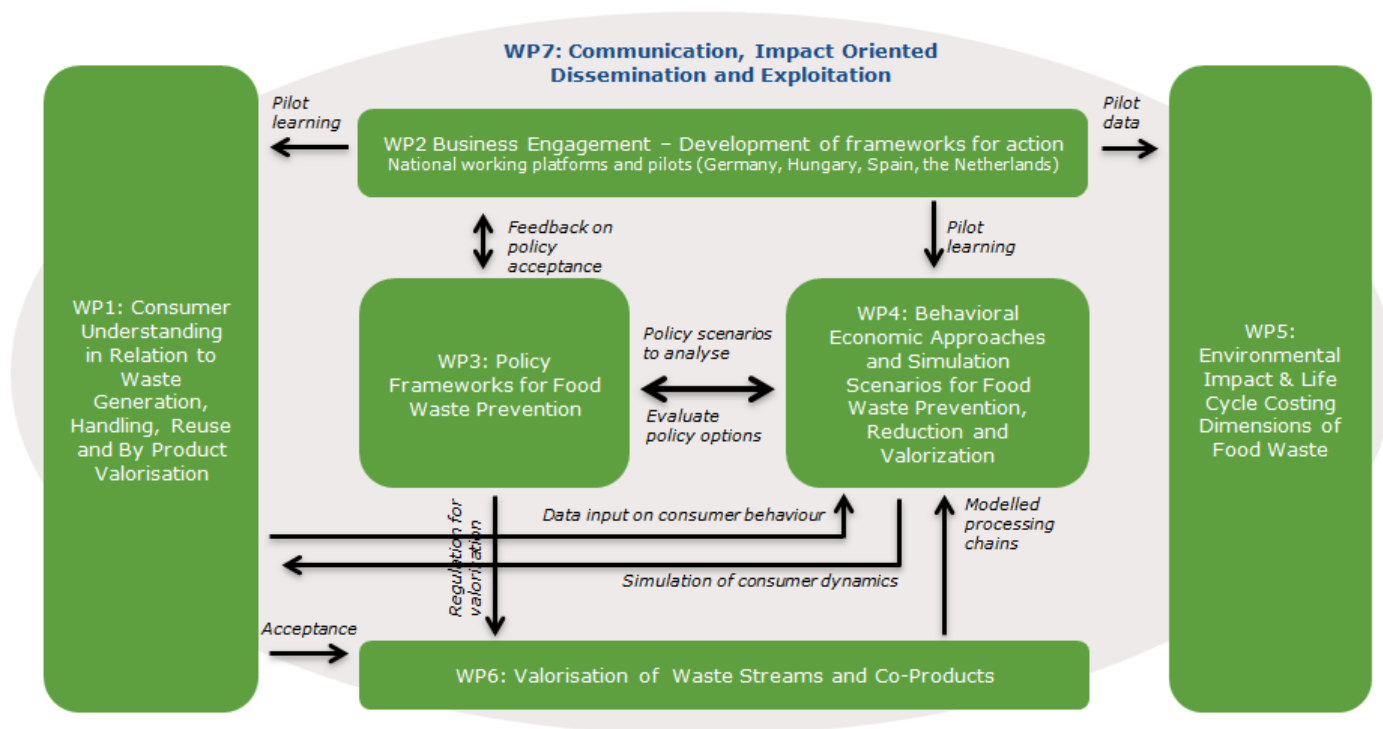
To achieve these objectives REFRESH used different communication and dissemination tools and activities. A detailed overview of REFRESH's activities as well as an assessment of their outreach and impact is given within the report "[Final report on dissemination and exploitation of REFRESH results](#)". It also reflects on the lessons learned of REFRESH's communication activities, including barriers and success formats. Key highlights from the communication and dissemination research activities are:

- REFRESH website:** The project's website at eu-refresh.org served as the backbone of all communication and dissemination activities. Until July 2019, 348 articles have been posted. The total amount of website visits in the last three years – once the first REFRESH research results were published – was 282.970. These visits resulted in 511.051 page views. Articles have been viewed 20.820 times. Attachments have been downloaded 8.028 times.
- Online network "Community of Experts":** REFRESH also created an online network for knowledge and best practice on food waste prevention: the 'REFRESH Community of Experts' (CoE). The CoE launched on 16 October 2017 at www.refreshcoe.eu. On the REFRESH CoE, experts can register as users to share their own research results, tools and innovative approaches, as well as interact with the contributions of other experts. The CoE has been created in partnership with the EU Platform on Food Losses and Food Waste. The Platform has decided to use the CoE as its main source for new and updated food waste prevention web content. In July 2019, the CoE counted 437 members.
- REFRESH events:** Events were a central communication instrument in the project. Two conferences, a series of policy workshops, national platform meetings and webinars were held. Overall, REFRESH organised 43 events in eight countries (including China). In total, approximately 4.000 participants attended the REFRESH events. The evaluation of feedback from participants showed that REFRESH workshops and conferences were valued for their innovative approach, interactive elements and good atmosphere (facilitating informal networking and interaction through speed dating,

excursions and participative group working phases, including art, design, live pigs, disco chop, food waste beer, photo props etc. to communicate results) as well as for their high quality of research results that were presented and summarised according to the needs of scientific and practice stakeholders. It also broadened the reach to interested Member States that wanted to test and implement REFRESH results. For example, after the policy workshop on voluntary agreements, seven further Member States were seriously considering taking this approach to address food waste within their country. Until the end of the project, three of them received a training by the REFRESH team.

- National platforms and pilot activities:** The work within the national platforms – particularly the setup of pilot projects achieved significant impacts as well, e.g. through the training of apprentices at the retailer Penny, the introduction of a food waste measuring at the Spanish trade fair “Gastrofira”, the significant food waste reduction at catering events in the tests of the Hungarian guidance “Event Catering Food Waste Reduction Guideline” and the introduction of a surplus food shelf at the Dutch retailer Jumbo (see chapter 2).
- REFRESH publications:** Within the four years project duration, REFRESH published 75 reports and articles, 4 policy briefs, 9 academic journal articles (with another 12 planned for publication after the project’s end), 42 project reports, 3 frameworks for action, 4 decision support systems (Voluntary Agreement Blueprint, Animal Feed Tool FORKLIFT and FoodWasteExplorer), 12 videos and 3 results brochures (2 interim and 1 final).
- REFRESH contests:** A REFRESH “Food Waste Solution Contest” was organised at the end of 2016. Individuals, organisations, start-ups and large companies made contest submissions. The REFRESH Food Waste Solution Contest received over 50 project submissions from across Europe. Besides two jury prizes the contest also included a public prize. The public voting for the best ideas counted over 61.000 votes. Several contest participants seized the opportunity of the public award to reach out to their communities and the public and increase the visibility of their initiatives. The REFRESH Food Waste Solution Contest was a very helpful tool to communicate to the public and broaden the REFRESH network that has later been used to disseminate REFRESH research results. The contest was replicated in China and received even more attention.
- The REFRESH Twitter account** (@EUrefresh) counted 2.165 followers by 31 July 2019. In terms of community building, it is the most successful REFRESH channel. In the last three years of the project, a total of 763 tweets have been posted and @EUrefresh has been mentioned 1.640 times by other Twitter channels.
- Facebook:** On facebook.com/eurefresh, the REFRESH page has reached 1001 likes by 31 July 2019. In the last three years of the project, a total of 629 posts have been made on Facebook.
- Videos/YouTube:** Within the project several videos were produced and uploaded to YouTube. These videos resulted in over 5.000 views (with more than 7.000 minutes watch time) until July 2019, not including four videos with project results that were published by the end of 2019 after the project ended.
- Media mentioning: 90 mentions** of REFRESH in other media (newspapers, newsletters, blogs, websites, radio, TV etc.) have been reported.
- Direct networking/presentation at external events:** During the whole project, REFRESH partners widely interacted with existing groups and networks at numerous conferences and events. REFRESH partners reported to have represented REFRESH at 173 external events. Moreover, the REFRESH project intensively interacted with the EU Platform on Food Loss and Waste.

8. Project Structure and Responsibilities



WP1: Consumer understanding in relation to waste generation, handling, reuse and by-product valorisation – Wageningen University & Research (Hans van Trijp & Erica van Herpen)

WP2: Business engagement: Frameworks for Action – WRAP (David Rogers & Kate Bygrave)

WP3: Policy framework for food waste prevention, recycling, and reuse – Deloitte Development Durable (Manuela Gheoldus)

WP4: Behavioural economic approaches and scenarios for food waste prevention, reduction and valorisation – University of Bologna (UNIBO) (Matteo Vittuari)

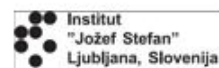
WP5: Environmental and life cycle costing dimensions of food waste – RISE Research Institute of Sweden (Karin Ostergren)

WP6: Valorisation of waste streams and co-products – Quadram institute (Paul Finglas)

WP7: Communication, impact oriented dissemination, and exploitation – Ecologic Institute (Stephanie Wunder)

WP8: Project management – Wageningen University & Research (Hilke Bos-Brouwers & Toine Timmermans)

Project Partners



University of Natural Resources and Life Sciences, Vienna

