i-REXFO

increase in reduction and recovery of expired food

i-REXFO LIFE

LIFE 16/ENV/IT/000547

LAYMAN REPORT

DAN - HUN - ITA - ENG

FOOD WASTE

CAUSES AND IMPACT

According to a FAO survey, around **one third of the food** produced for human consumption, roughly 1,3 billions tons, of which 80% still consumable, **is lost or wasted**. Every year the food produced and wasted consumes a volume of water equal to 250 km3, requires 1,4 billion ha of land, around 30% of the world agricultural land, and it is responsible for the emission of 3,3 billion tons of greenhouse gases. **If food waste were a country it would be the third emitting one.**

While in developing countries over 40% of losses occur during the harvest or processing phase, **food waste in industrialized countries is caused by a combination of supply chains inefficiencies and consumer behaviour**. The supply and distribution chains are not always able to provide excess food at low cost to consumers or for donation while reading correctly the expiration label may be difficult for consumers resulting on edible food that goes to waste.

Moreover, consumers are responsible of poor management of leftovers and poor planning of shopping, **buying more groceries than they can consume**, often ignoring not aesthetically sound fruits and vegetables that remain unsold at the counter or even go to waste at the farm.

In the Hotel Restaurant Catering (Ho.Re.Ca) food waste is caused by the **offering of ever larger portions** while doggy bags for leftovers or last minute meals at the end of day are still options that are not adequately considered.

Minimizing excess food production and making it available for human consumption before its expiration date is the first action to reduce food waste. This requires incentives to increase donation to charities and pre-expiration sales and also to raise consumer awareness on how to reduce food waste.

i-REXFO

BUSINESS MODEL

Energy from organic waste through **biogas production and use of the resulting digestate as a fertilizer**, yields great environmental benefits, in terms of CO2 and water avoided emission and consumption respectively. It also generates cash that can cover partially or totally the cost for incentives for donations and consumer awareness.

This is the basic concept of the i-REXFO business model in the circular economy that we demonstrated in Italy, precisely in Umbria Region.

i-REXFO reduces significantly the amount of food waste landfilled through an innovative approach that sustains actions to reduce food waste by promoting energy production from organic residues.

Focus is on food waste produced by farms and food industries, by retailers and Ho.Re.Ca and by consumers.

i-REXFO business model promotes biogas production from **food waste in substitution of energy crops**, resulting in an environmental benefit deriving from the **reduction in the use of fertilizers, irrigation, etc and from the avoided landfilling of the organic waste.**

Moreover, the **lower cost of the fuel** contributes to the economic sustainability of the i-REXFO business model together with the **carbon credits** that partners can claim for the environmental benefits produced.

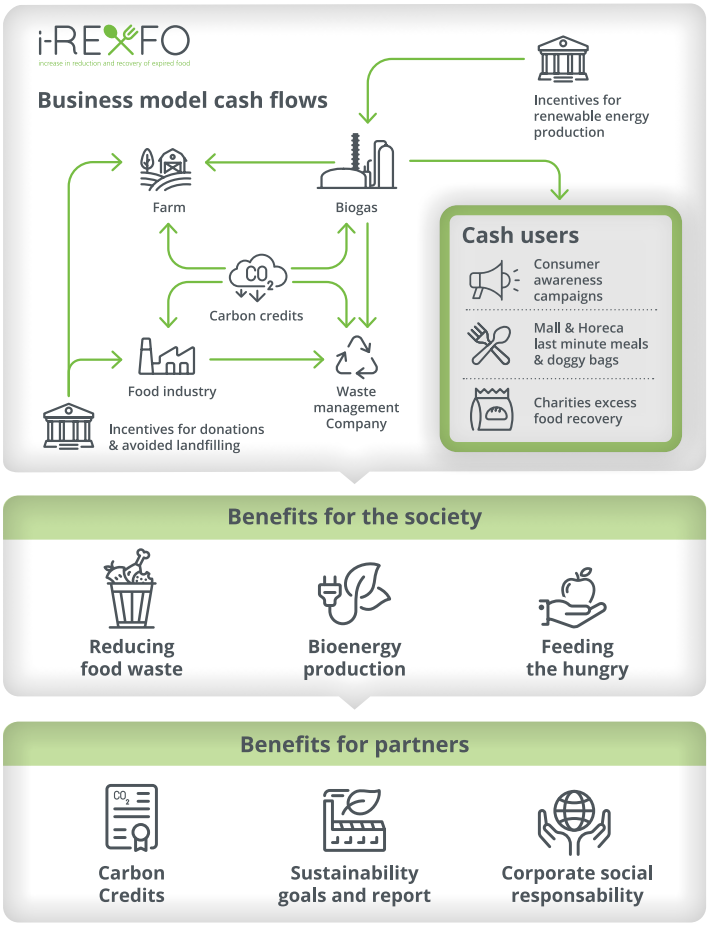
These **revenues cover the additional costs** for food waste transportation and selection and provide finances for waste reduction actions:

1. to charities in their **recovery and donation of excess food**.
2. to Ho.Re.Ca for the acquisition and distribution of **doggy bags** and the promotion of **last minute meals**.
3. to retailers for the design of **low cost areas for pre-expiration sales**.
4. to consumer oriented **awareness raising campaigns** on food waste reduction.

Benefits for the community are evident namely in: providing food to people in need, in reducing food waste and the related environmental impact, carbon footprint and energy-water consumption.

Benefits for partners are also evident namely in the **increased cash flow**, thanks to claimable carbon credits, and in an increase in the company social and environmental sustainability business performance, that can be disclosed in the **corporate sustainability reporting** ,according to the **2014 | 95 | EU Non-Financial Reporting Directive (NFRD)**.

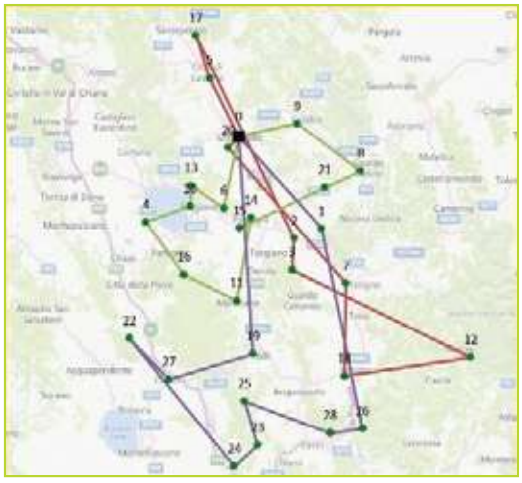
i-REXFO business model is in line with the classification of sustainable activities foreseen in the **Regulation (EU) 2020 | 852 on Taxonomy** that establishes a framework to facilitate sustainable investments.



OPEN SOURCE

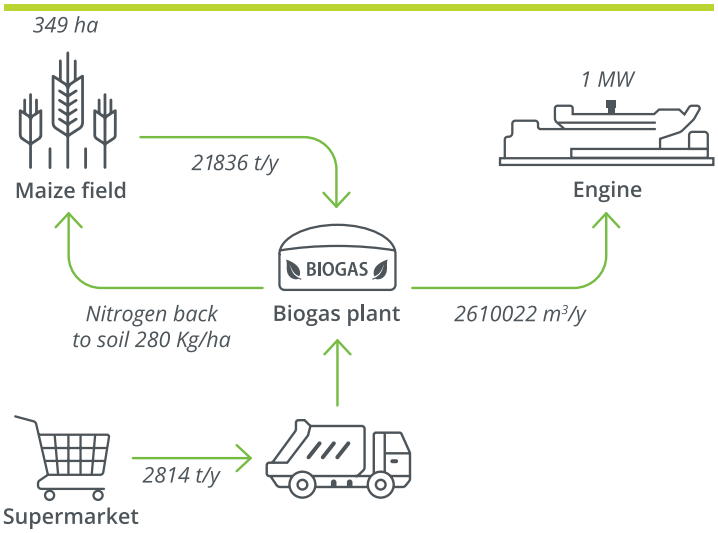
DESIGN TOOL

Starting from September 2017, i-REXFO designed and built the solidarity and sustainable business model with a **software especially developed and available for free in open source format** on the project website (www.irexfo.eu). The user identifies the batches of food waste available on EU territory, and the software evaluates the distance from the biogas plant and the **methane production potential, thanks to a database** created by SESLAB (Sustainable Energy Systems LABoratory) at the Department of Engineering of the University of Perugia, Italy.



To obtain this result, SESLAB has **analyzed 100 types of food waste** to determine their chemical-physical characteristics and above all the Bio-Methanation Potential (BMP), in bespoken mini reactors especially designed. The **database itself is an important contribution to the state of the art** and was therefore published in Golden Open Access format.

Through an optimization algorithm the software selects the quantities and location of waste food to **maximize the economic profit and the avoided emissions of CO2**, also considering transportation. The resulting **economic benefits are then shared** among partners and for the activities related to minimization of food waste in retail and Ho.Re.Ca, consumer awareness campaigns and for the recovery and donation of surplus to charities.



The software can be used in any EU country and has been used to design similar supply chains in Puglia and Piemonte in Italy and Észak Alföld Közép Dunántúl in Hungary, thanks to the Food Bank of Budapest and the biogas company Biogaz, both strategic project partners.

DEMO
i-REXFO TUNING

UMBRIA - ITALY

In the last 18 months of the project i-REXFO has **demonstrated in Umbria the economic and environmental feasibility** of the solidarity and sustainable supply chain. The marketing partner company A+ created and distributed to the Ho.Re.Ca of the provinces of Perugia and Terni, **100,000 design containers for the recovery of leftovers** (doggy bags) and **information material with practical advice** for sustainable shopping, leftovers management and for reading correctly the expiration labels.

Also 4 showcases for pre-expiration food sales were equipped with **video installations in large supermarkets** in Umbria (Coop, Conad and Emi), to **provide useful information** on how to reduce food waste and the environmental consequences.

CARITAS charities in Perugia and Terni took care of the **recovery of food surplus** which was eventually **distributed in the canteens and solidarity emporiums** they manage. Surplus food was recovered mainly from food industries and supermarkets but also through the **installation of plexiglass containers for the recovery of household packaged surplus food** in schools and parishes during awareness raising activities.

In the demonstration phase, **these activities were financed by the resources made available by the partners of the energy supply chain**.

Ecopartner srl collects waste from the food industry, separates the recoverable raw materials (paper, glass, iron) and treats organic matter to produce a fuel for biogas plants.

Iraci Borgia farm transforms agricultural crops and organic residues into biogas and fertilizer used in his own fields in a circular economy approach.

The possibility of using the fuel produced by Ecopartner was **approved by Umbria Region**, project partner also for the redaction of administrative guidelines, as an **experimental protocol (DGR 164 / 21)** however, the use of the resulting digestate as a fertilizer was carried out in another biogas plant property of Rapolano Green Energy srl in nearby Tuscany.

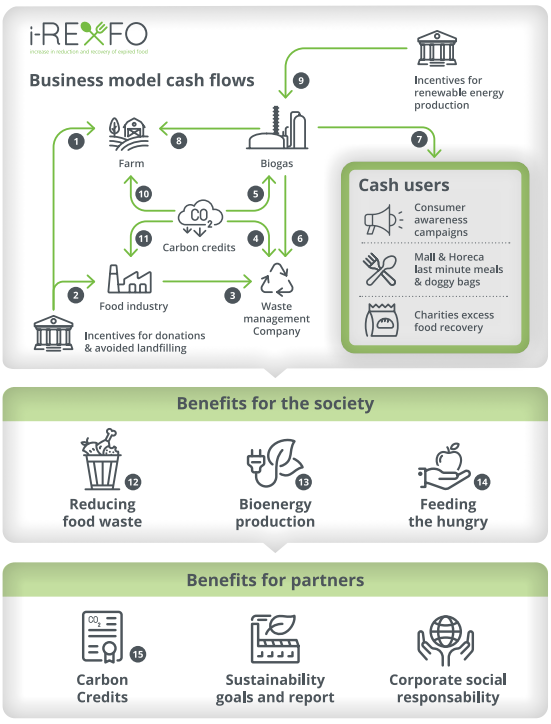
IMPACT
TRANSFERABILITY

PIEMONTE-PUGLIA | ITALY
ÉSZAK ALFÖLD - KÖZÉP DUNÁNTÚL | HUNGARY

The i-REXFO software tool was used to **design different scenarios in geographical areas** characterized by different sensitivity towards food waste, different legislation regarding the use of food waste in biogas plants and of digestate on fields and different incentives for renewable energy production. Different cash flows resulted from **varying bio-methanation potential of residues** also considering **possible oscillation in carbon credits market value**.

i-REXFO demonstrated that in the **best case scenario**, in which food waste with high bio-methanation potential is recovered (e.g. oil & fats, chocolate, cereals, etc.) and carbon credits are valued at 96 €/ton (February 2022 value), **the business model is self-sustaining without the need for additional incentives** besides those available for renewable energy production.

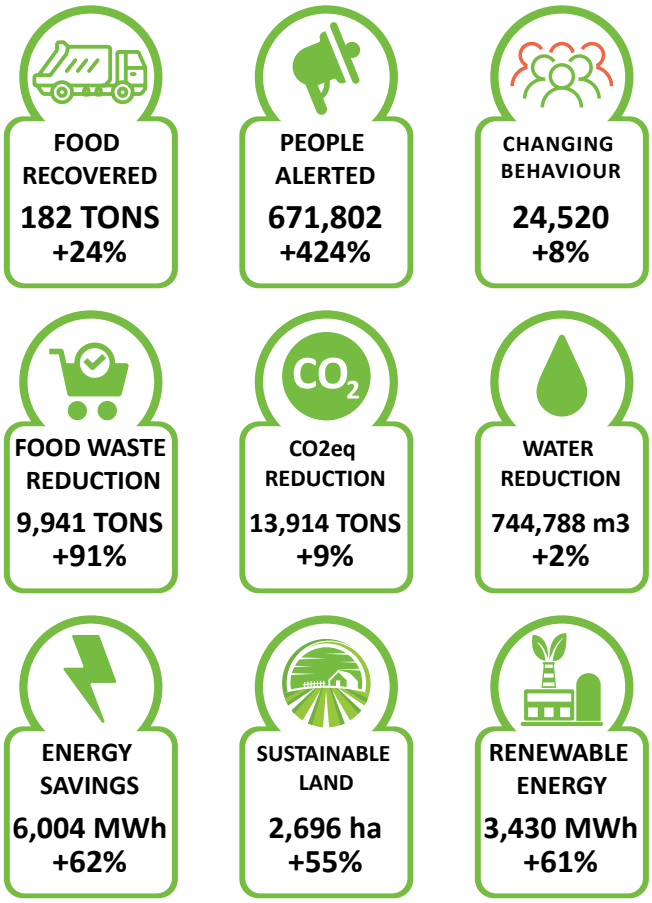
In the **worst-case scenario**, in which food waste with low bio-methanation potential is recovered (e.g. fruit & vegetables, juices, beverages, etc.) and carbon credits are valued at 20 €/ton (May 2020 value), **the business model requires support in the form of an additional public incentive** provided to food waste suppliers **as a reward for sustainable disposal**.



	Carbon credits @ 96 €/ton		Carbon credits @ 20 €/ton	
	High CH4 yield Food Waste	Low CH4 yield Food Waste	High CH4 yield Food Waste	Low CH4 yield Food Waste
1	€ 0	€ 0	€ 0	€ 16.940
2	€ 0	€ 0	€ 45.614	€ 0
3	€ 112.500	€ 0	€ 112.500	€ 0
4	€ 0	€ 0	€ 0	€ 0
5	€ 140.346	€ 97.931	€ 29.239	€ 20.402
6	€ 198.563	€ 0	€ 198.563	€ 0
7	€ 191.396	€ 148.442	€ 29.239	€ 20.402
8	€ 0	€ 53.438	€ 0	€ 53.438
9	€ 315.053	€ 84.788	€ 315.053	€ 84.788
10	€ 0	€ 20.000	€ 0	€ 20.000
11	€ 50.000	€ 0	€ 50.000	€ 0
12	2921 tons	2794 tons	2588 tons	2561 tons
13	1575 MWh	424 MWh	1575 MWh	424 MWh
14	421 tons	294 tons	88 tons	61 tons
15	2515 t CO_2eq	1755 t CO_2eq	1681 t CO_2eq	1173 t CO_2eq

EU RECOMMENDATION FOR POLICY MEASURES & KPI

i-REXFO has demonstrated in Umbria the possibility of **avoiding the landfilling of over 2500 tons/year of food waste** that instead contributed to the **production of over 2200 MWh/year of renewable energy** and the **donation of over 120 tons/year for surpluses**. The integrated system has avoided the production of over 9200 tons/year of CO2 equivalent and the consumption of over 496,000 m3 of water, i-REXFO KPI were measured also considering a 5% engagement of people alerted.



i-REXFO Key Project Indicators - KPIs

BARRIERS TO iREXFO APPLICATION	EU RECOMMENDATION FOR POLICY MEASURES	SPECIFIC DG RECIPIENT
Multiple operators are needed	Establishment of legal COnsortia of operators of circular business models to Reduce Food Waste (CORFOWA).	JUST
Subsidies to food waste fuelled biogas plants	Encourage EU incentives for renewable energy/fuel production from food waste prioritizing biogas plants in CORFOWAs.	ENER-ENV
Facilitate reuse of digestate in fields	- Encourage member states to roll out EoW criteria (2008/98/EC) for food waste derived biogas fuels. - Promote the direct use of digestate (no composting) as a fertilizer and the uptake of Regulation (EU) 2019/1009. - Allow reduced authorization procedures for CORFOWAs.	ENV-SANTE
Promote recognition of carbon credits for all operators	- Facilitate and promote the access to the ETS market (Directive 2003/87/EC) to voluntary and third parties Verified Emission Reduction (VER). - Consider CORFOWA a sustainable activity according to Taxonomy Regulation (EU) 2020/852 and include as a listed activity in a specific delegated act. - Extend PEF procedures and PEFCR methodologies to biogas, surplus food donation and food waste prevention measures and awareness campaigns.	ENV CLIMA

i-REXFO EU Recommendations

SOCIAL
COMMUNITY

i-REXFO CONFERENCES & EVENTS

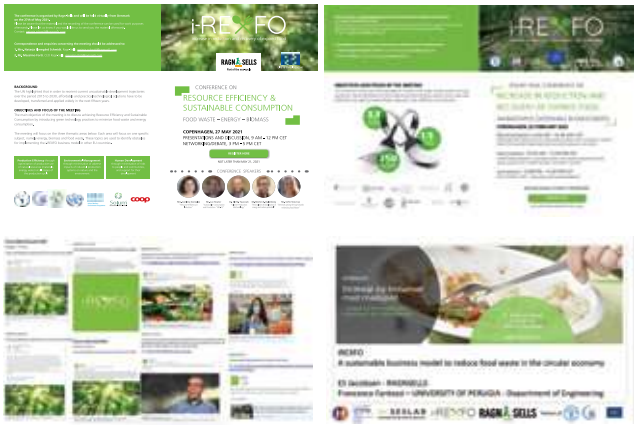
The i-REXFO community comprises also Danish partners Primetime communication company and Ragnsells waste management company, responsible for good practices and EU networking, and NOESIS for financial managing.

During the course of the project, partners shared experiences, **organized and participated in events and conferences**, produced and distributed informative and consumer awareness material presenting the i-REXFO model to the civil and scientific community with **numerous papers published in specialized journals and conference proceedings**.

When **the pandemic hit Europe**, Italy was on the front line, paying a very high price in victims and imposing one of the strictest lockdowns. **i-REXFO then had to restructure and reprogram and again modify the calendar of events and their methodology**, to cope with events and assist people in need.

The **social channels** of i-REXFO have proved to be an irreplaceable resource to reach the initially targeted audience as well as the organization of **online conferences and networking events**, especially with successful outcomes on the event on May 2021 and DAKOFA webinar and final conference in February 2022 which took place in Copenhagen and were organized by Ragn-Sells.

Ragn-Sells CEO Massimo Forti at i-REXFO mid term conference.



We also met **Dr. Muhammad Yunus**, inventor of micro-credit and **Nobel Peace Prize winner 2006**, in Assisi, in 2019, on the occasion of his Lectio Magistralis entitled "Circular economy and micro credit". Yunus argues the **importance of encouraging young people to become social entrepreneurs**, not just to earn, because "earning is not fun, helping to change the world is much more fun".

The coordinator of i-REXFO prof. Francesco Fantozzi with the Nobel Prize winner for Economics Muhammad Yunus (Assisi, 2019)

This is why when he talks about microcredit he says that: "**it is not charity but a business with a social objective: to help people get out of poverty**".

He confirmed with a smile that i-REXFO is moving in the right direction.

PARTNERS & ASSOCIATES

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