i-REXFO Transferability Tool – USER GUIDE

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1. i-Rexfo Tool in brief

This manual describes the main functions of the Irexfo Tool Web App. This web application is designed and built within the IREXFO Project, that developed the solidarity and sustainable business model. The software is available for free 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.

Through an optimization algorithm the software selects the quantities and location of waste food to maximize the economic profit and the avoided emissions of CO_2, at the same time minimizing transport costs. The resulting economic benefits are then shared among partners and for the activities related to food waste minimization in retail and Ho.Re.Ca, consumer awareness campaigns and for the recovery and donation of surplus to charities.

1.1 Main features

Projects	A project contains a list of all the customers (Farm or Industries) in a certain area on which you want to apply the food waste reduction model.
Totals	Calculates the wasted food for each week of the year for a project, and outputs other fields such as methane yield , profit, electricity , avoided nitrogen and avoided maize.
Locations	Calculate the distances and travel time between the various customers and the Biogas using the OpenRouteService libraries. It returns a map where we can see further information on distance, time and positions of the entities involved in result of the optimization process.
Optimization	It is the result of the optimization in economic terms. The step displays further result on business model cash flow, environmental reductions, matrices of quantities of wasted food to be collected from each remaining customer involved and and the related information seen on the totals but related to the new quantities optimized.

1.2 Important terms

Carbon credit price	Carbon pricing is an instrument that captures the external costs of greenhouse gas (GHG) emissions.
Year Target	The specific tons/year of food waste that a biogas can accept.

Biogas	They would pay less the fuel (raw and processed food waste) while receiving the same amount of public incentives for renewable energy production; they would receive a share of the carbon credits resulting from the overall iREXFO chain, they would increase their sustainability and social responsibility performances and include them in their corporate yearly reports. As a result they can pay charities, HORECA's and consumer awareness campaigns.
Waste Management	They would be paid more by food industries to process their waste, they would receive a share of the carbon credits resulting from the overall iREXFO chain, they would increase their sustainability and social responsibility performances and include them in their corporate yearly reports. As a result they can sell the food waste derived product at a lower price to the biogas plant.
Farms and Industries	They would receive public incentives for disposal of food waste in solidarity circular chains, such as iREXFO; they would receive a share of the carbon credits resulting from the overall iREXFO chain, they would increase their sustainability and social responsibility performances and include them in their corporate yearly reports. As a result they could afford to pay more the waste management company (industry) or be paid less by the biogas plant (farm).
Charities, consumer awareness, HORECA	They are paid by the biogas plant for their actions in avoiding food waste, for example, referring to charities, by increasing ready meals and doggy bags intended to the needy; similar actions are provided from consumer awareness and HORECA.

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2. How to begin

2.1 How to access the website

Via a smartphone or tablet, go to https://irexfo.pythonanywhere.com/ or go the www.irexfo.eu and navigate to the tab "Transferability Tool" and click on "Visit the website" button. The homepage now appears, where we can Login or Register.
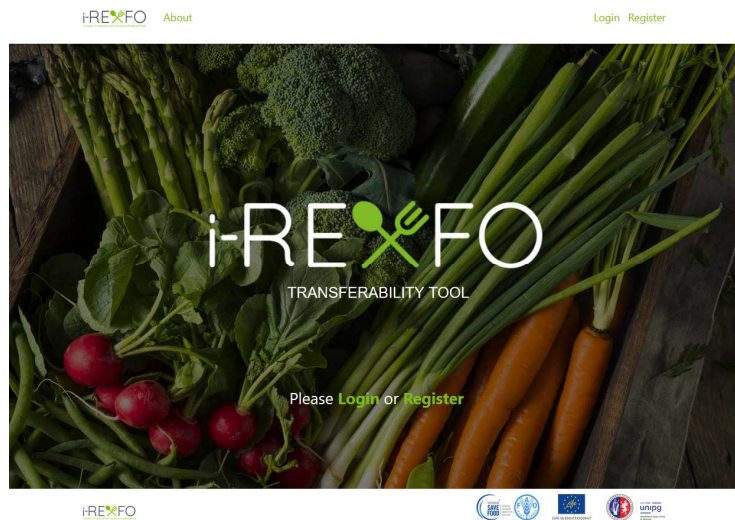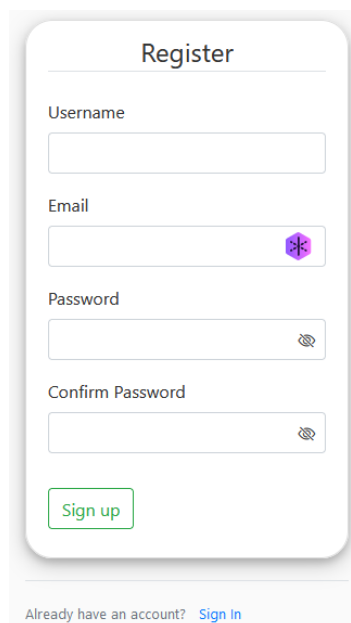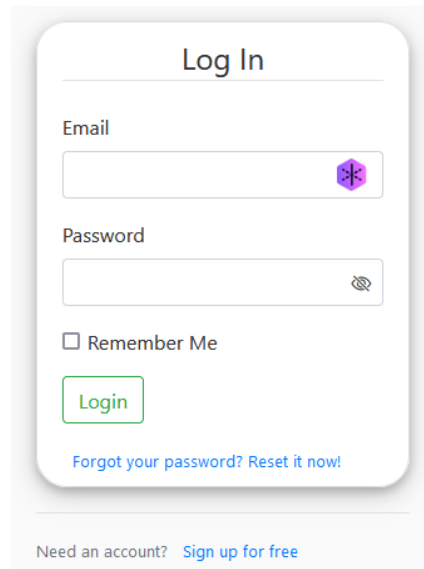

Figure 1: Homepage

2.2 Register

Figure 2: Register

When logging in for the first time, you must first register with an e-mail and after you choose a username and password click on "Sign up". Please remember your credentials in order to login.

2.3 Login

The user can click on Login in the Homepage or the *Login* on the navigation bar and enter the credentials used in registration phase. Insert the credentials and then click on "Login".
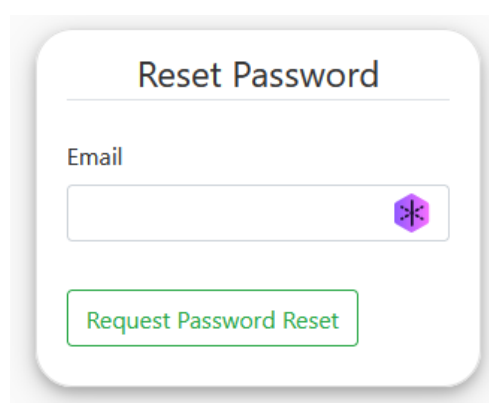

Figure 3: Login

2.4 Password Recovery

When you forget the password, you can click under the Login button on "*Do you forget your password? Send it by email*" to be redirected on the recovery phase. All you need to do is insert the email user for registration. An e-mail will be sent to you with a token. You can find the email probably on SPAM folder. You can click on this token (Figure 5) to get redirected to create a new password.

Figure 4: Password reset
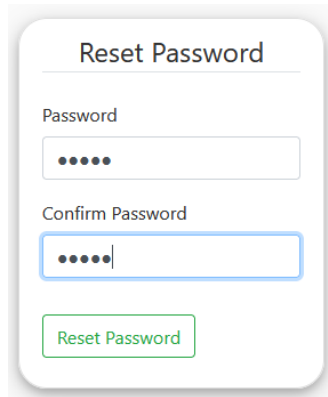
Figure 5: Token for password reset

Figure 6: Reset with new password

2.5 About

For more information about the i-REXFO tool project check out the "About" tab on the navigation bar. There you can find the Layman Report where you can find an overview of the project.
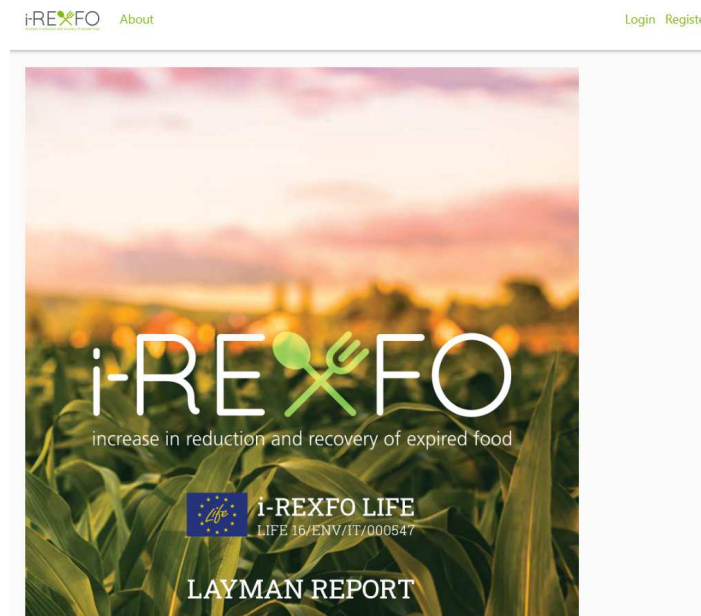

Figure 7: The "About" tab

3. Data entry

3.1 Create a project

After logging in, a new 'Projects' tab will appear on the navigation bar. You can access it from there at any time to see the list of projects created in your account or create new ones. To create a new Project click on the "+" sign (Figure 8).
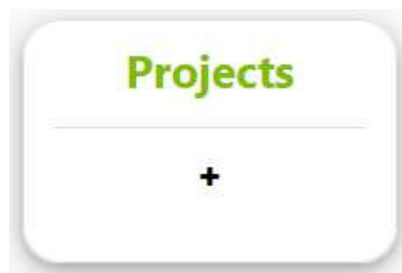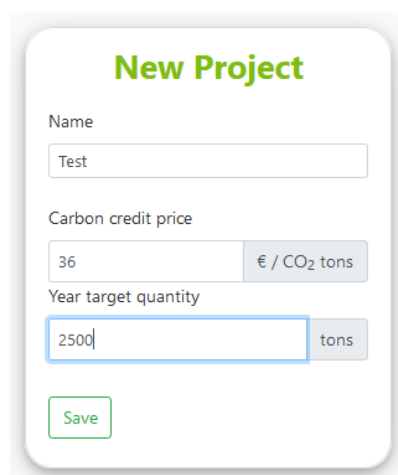

Figure 8: Create a project

You have to insert a project name, a carbon credit price and a year target (Figure 9). The current carbon price can be taken from any official site, searching on web, if it is unknown. **Please note that the tool generates an error if you want to use the comma. USE the dot instead of the comma!**

Click "Save" button to save this Project into database.

If something went wrong, the user can use the back arrow of the browser to go back or can delete a project and redo the process.

Figure 9: Insert Carbon Price and Year target

At this point the user can click on the newly created project, in this case "**Test**" and go on into the data entry phase. You should carefully follow the next steps and carry them out in order, as much as possible.
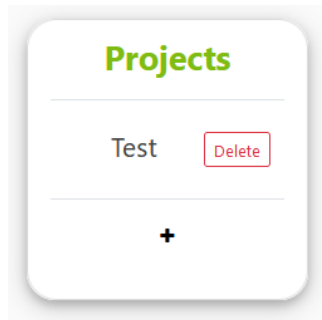
Figure 10: "Test" onto Project List

You will see a new page with the following main boxes: Attributes, Biogas, Waste Management and Customers. The attributes were inserted during project creation phase but can be changed by clicking on "**Update**".
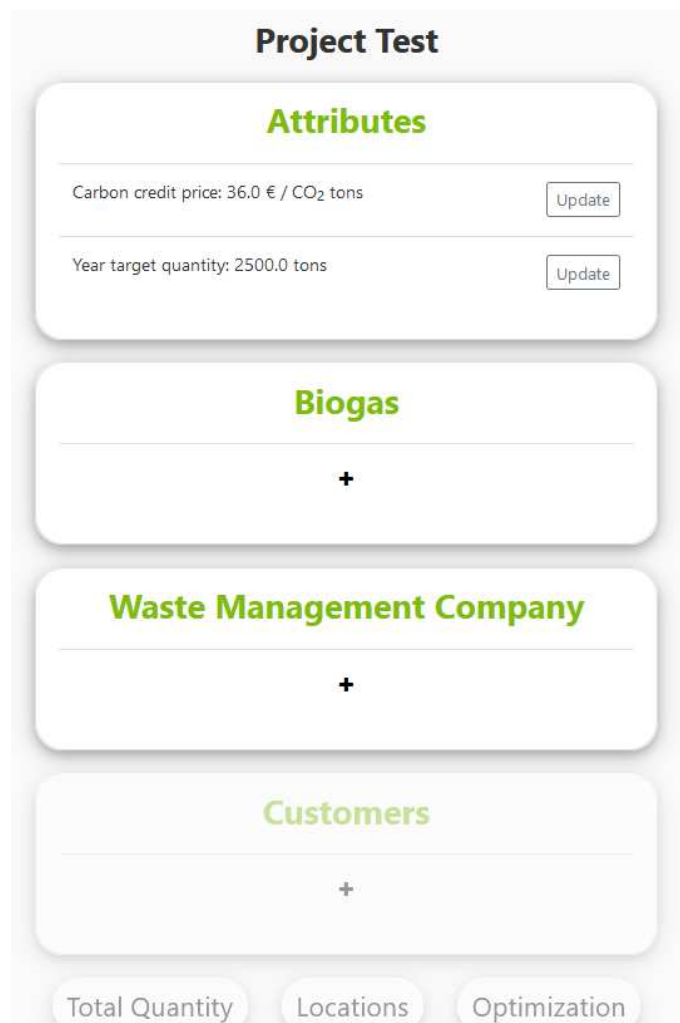

Figure 11: Project Detail

3.2 Create Biogas

First, a biogas entity (or depot) has to be created. The user will click on "+" on the Biogas section and that will lead him to the creation of this entity.
Pay attention to the address input: it must be written as in the suggestion and the street has to be complete.
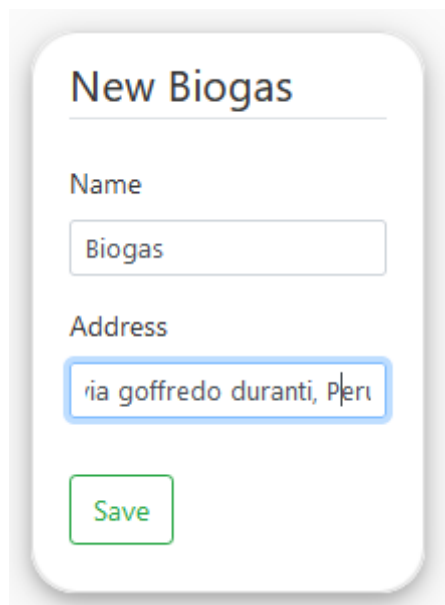

Figure 12: Biogas creation

If some internal error occurs, there may be a problem with the Bing library that retrieves the location and coordinates of the address, so it is recommended to go back, rewrite the address and save again. By **clicking on the Biogas name** you can see **detailed info about the exact location** with coordinates and can even delete the Biogas. If there is an error with the address, please delete the Biogas just created and repeat again the process with a more specific address.
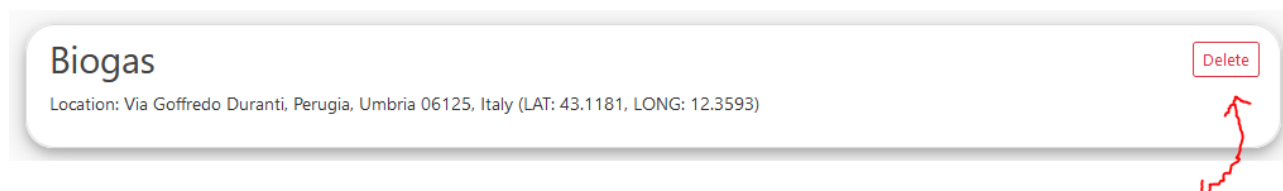

Figure 13: Delete Biogas

To go back onto the previous page always use the left arrow of your browser, here is an example in chrome browser:
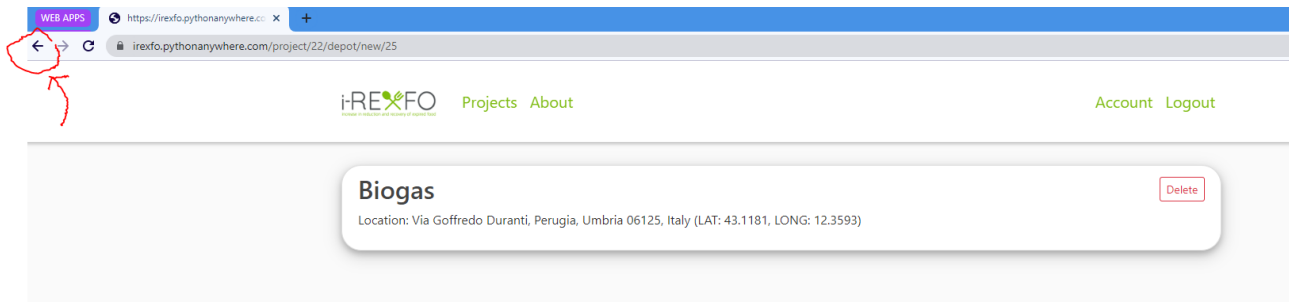
Figure 14: Back to the previous page

3.3 Create Waste Management

Once the Biogas has been saved into the database, we see a Waste Management section. It is important to add this concept even if there is no waste management involved. In that case we can add a Waste management company at the same address of the Biogas. If all the Customers participating in a project are Farms, then a Waste management company will not be used when calculating the model, but is needed when there are 1 or more Industries involved.

The creation process is the same as for biogas.
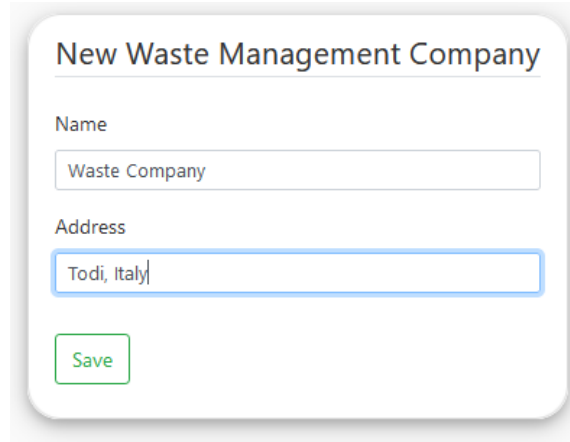
Figure 15: Waste Management Company creation

3.3 Create Customers
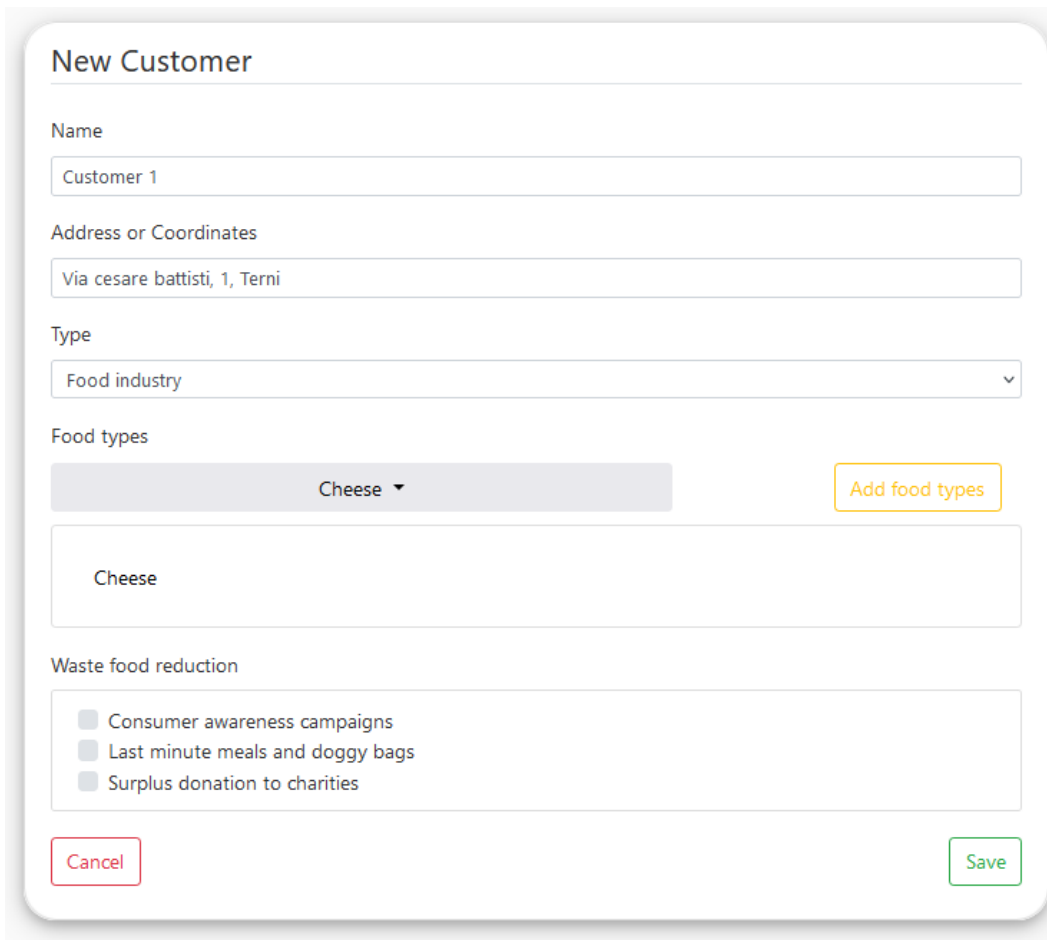
After you create the management company you will be redirected onto the project detail page and Customer field will also activate. You will have to add Customers for the waste reduction model to work, so you add a customer by clicking on "**+**" button, in the CUSTOMER FIELD.

You will be redirected on the create a customer page, where you enter all the necessary information:

• Name

• Address or Coordinates: *"Street, City, Country"* OR *"Latitude and Longitude"*

• Type: Food Industry or Farm

- Food types: **At least 1 food type must be chosen**. *IF you are not sure which category the customer belongs to, you can enter an entry starting with "Generic..."!*

- Waste food reduction: This field will be used in our model to sort the food and decide to which organization it should be sent. Currently, the food will be equally distributed among the 3 entities even if the user chooses a different combination.

After choosing the food category, click on ADD FOOD TYPE. This will bring up sections that the can be **clicked on to expand the field** and **enter the monthly food quantities** that the customer wants to distribute to the Biogas.

Figure 16: New customer view

Figure 17: ADD FOOD TYPE button. Insert customer quantities into the expanded fields

We will add another Customer for this DEMO, a farm with 2 food type categories: Mixed vegetable wastes and Potatoes, with random data for each month.

We see the project with the inclusion of Biogas, Waste Management and the two Customers in Figure 18. The Type and the Food categories made available by the customer for Biogas were highlighted.

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Customer infos saved

Project Test

Attributes

Carbon credit price: 36.0 € / CO$_2$ tons   Update

Year target quantity: 2500.0 tons   Update

Biogas

Biogas

Location: Via Goffredo Duranti, Perugia, Umbria 06125, Italy

Waste Management Company

Waste Company

Location: Todi, Umbr., Italy

Customers

Customer 1   Update | Delete

Location: Viale Cesare Battisti 1, Terni, Umbria 05100, Italy
Type: Food industry
Food types: Cheese

Customer 2   Update | Delete

Location: Rieti, Laz., Italy
Type: Farm
Food types: Mixed vegetable wastes, Potatoes

+

Figure 18: Project detail with customers inserted

If everything went fine we can proceed in adding more Customers. Every time a customer is added, the user should **click on the customer name** freshly created to **see details** or check if all went well. On the Customer detail page we can see the following units that were also calculated:

• Total Quantity (tons)

• Methane Yields (m3)

• Profit(€)

• Electricity (kWh)

• Avoided maize (tons)

• Avoided nitrogen (kg)

Again, if something went wrong, the user can update or delete the customer created, usually there can be some problems with addresses but this can be simply better inserted.

Customer 1

[Update] [Delete]

Location: Viale Cesare Battisti 1, Terni, Umbria 05100, Italy (LAT: 42.5667, LONG: 12.6485)

Week	Cheese	Total Waste Quantity (tons)	Methane Yields (m3)	Profit (€)	Electricity (kWh)	Avoided maize (tons)	Avoided nitrogen (kg)
1	4.615	4.615	1103.789	248.355	3283.772	5.519	207.675
2	4.615	4.615	1103.789	248.355	3283.772	5.519	207.675
3	4.615	4.615	1103.789	248.355	3283.772	5.519	207.675
4	4.615	4.615	1103.789	248.355	3283.772	5.519	207.675
5	2.308	2.308	551.895	124.155	1641.888	2.759	103.86
6	2.308	2.308	551.895	124.155	1641.888	2.759	103.86
7	2.308	2.308	551.895	124.155	1641.888	2.759	103.86
8	2.308	2.308	551.895	124.155	1641.888	2.759	103.86

Figure 19: Customer 1 details

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4. Results

4.1 Totals

The next step is to check the attributes also calculated on the customer detail but referred to the whole project, i.e. to the totality of customers added within a project.
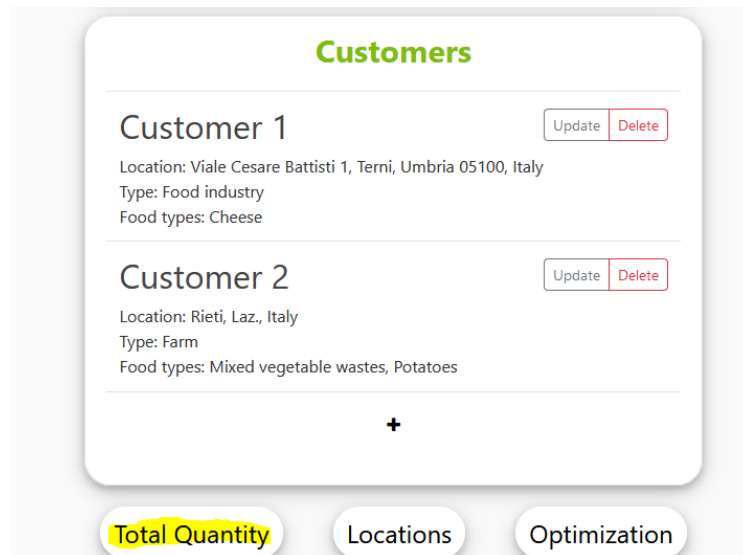

Figure 20: Result functions

Click on "**Total Quantity**" button to go see more details about quantities of all the customers inserted.
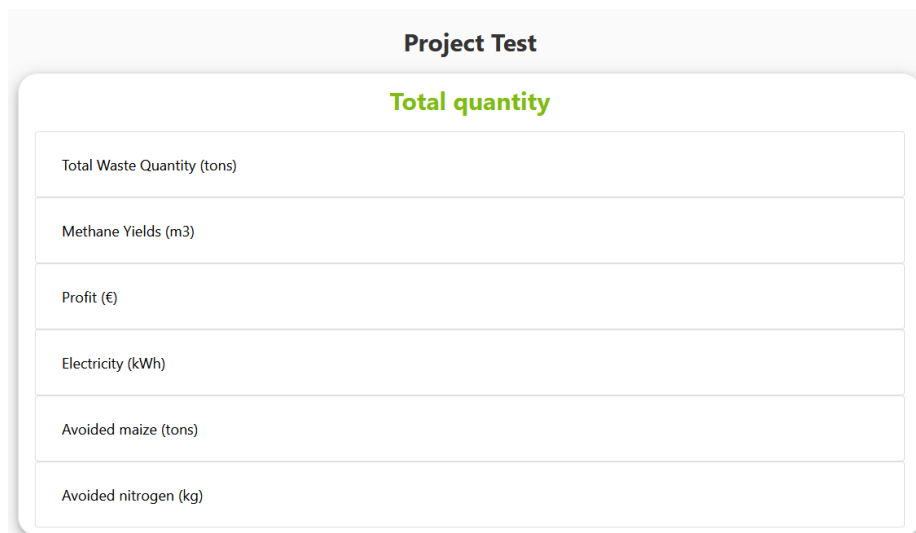

Figure 21: Totals view

To check more details click on the name of each section. Below an example of the total quantities for all customers involved is shown. Each table contains 52 rows, that indicates the quantities for each week of the year in tons. All these calculations are shown before applying the optimization model.
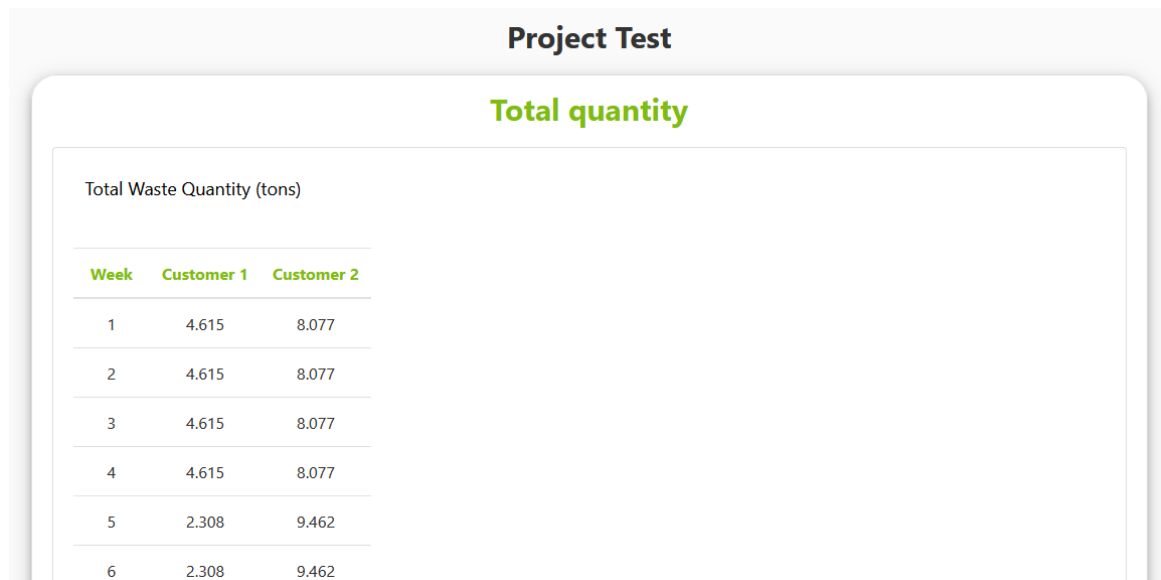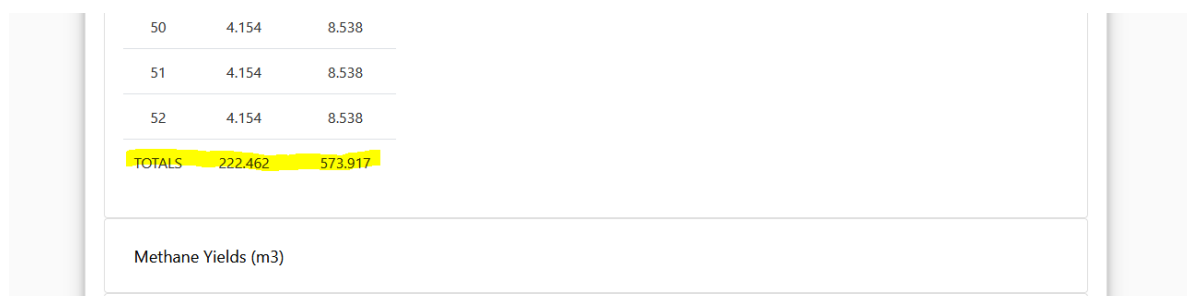

Figure 22: Detail for Total Waste Quantities

Figure 23: Sum of all 52 week for each customer

4.2 Locations

The Optimization begins here, with the "Locations" function. Click on "**Locations**" button to obtain the map with ONLY the customers involved in the optimization process, the ones that our model thinks are advantageous to take the wasted food from.

Further information on distance, time and positions of the entities involved are shown in the interactive map. You can zoom in or out or click on the paths between entities to see more information about the customers, biogas or waste management.

If there are many customers involved, then it will take some time to generate the map. Please, be patient!
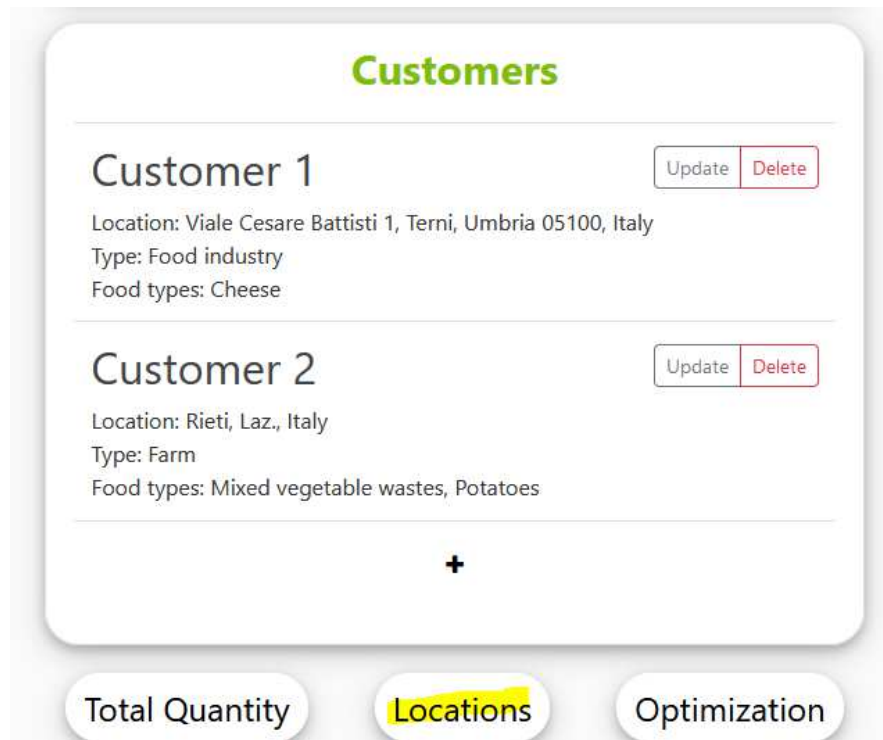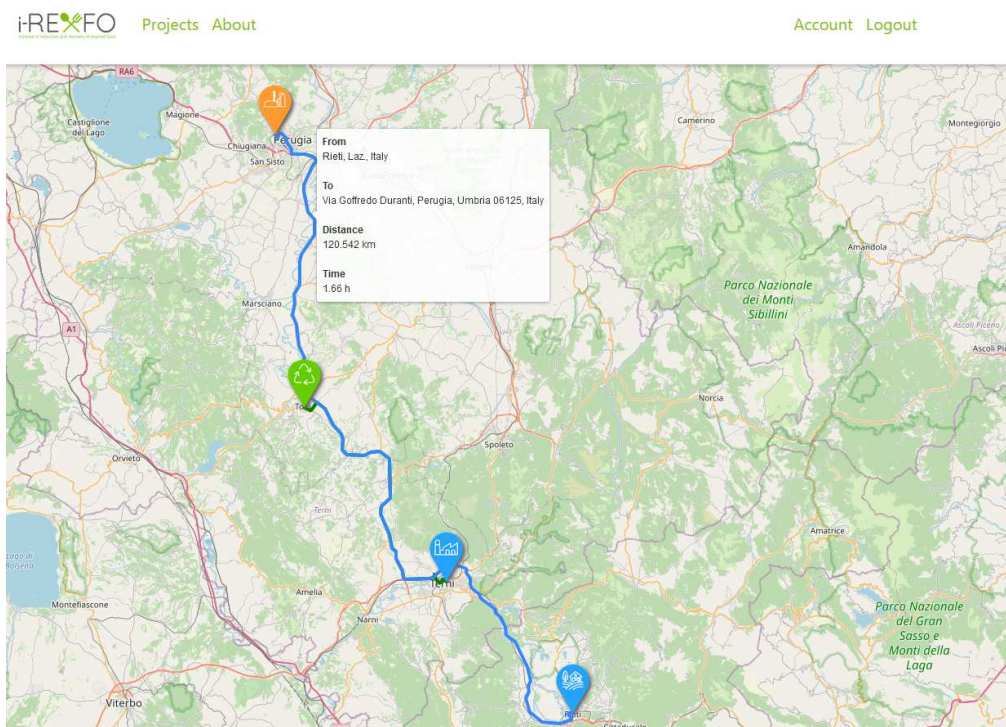
Figure 24: Locations function button

Figure 25: Map with locations and info about distances

4.3 Optimization

To see the business model cash flow and the matrices with the optimized quantities you have to go back from Locations and click on "Optimization" button. In the introduction we mentioned the business model.
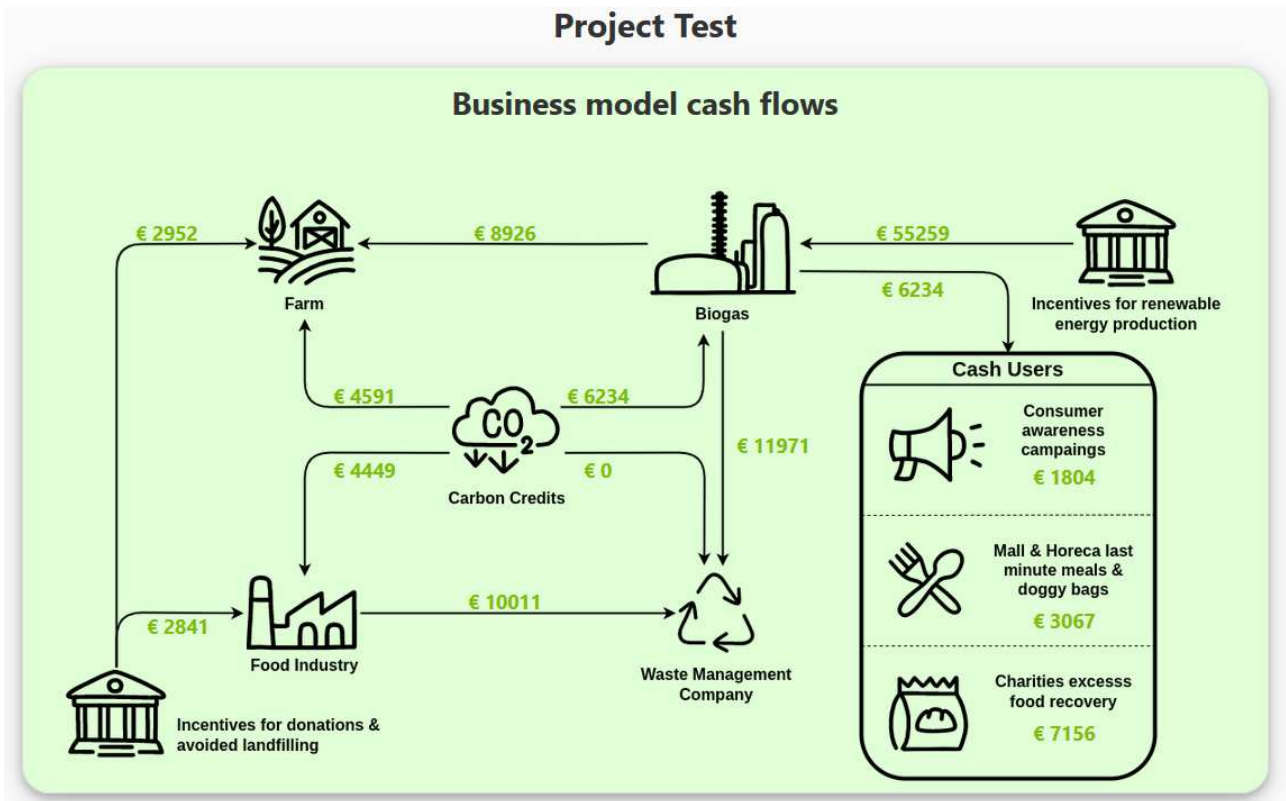
Figure 26: Business model cash flows

Scroll down for more information. In particular, we can see the optimization matrices for the categories listed above, i.e. Quantities, Methane Yields, etc. The rows represented in this example the weekly optimized quantities to collect from each customer. The column represents the customers.

If a "Cannot found the page" or other server error occurs, please go back with the arrow and try again or just reload the page!
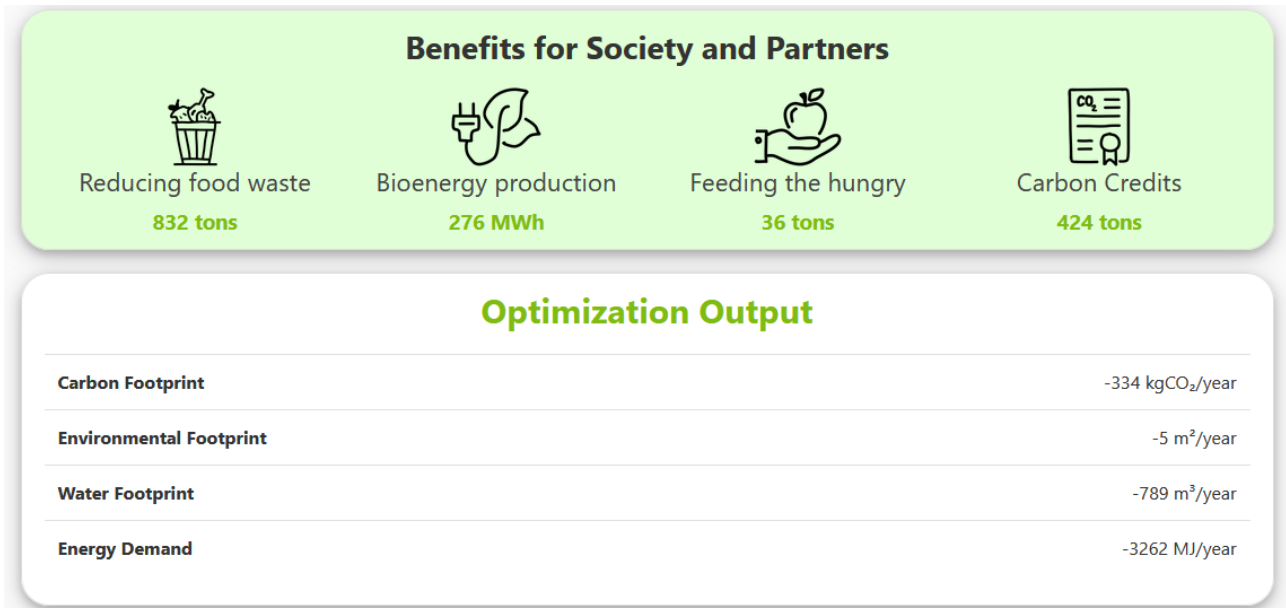
Benefits for Society and Partners

Reducing food waste	Bioenergy production	Feeding the hungry	Carbon Credits
832 tons	276 MWh	36 tons	424 tons

Optimization Output

Carbon Footprint	-334 kgCO$_2$/year
Environmental Footprint	-5 m²/year
Water Footprint	-789 m³/year
Energy Demand	-3262 MJ/year

Figure 27: Reduced emissions

Optimized Matrices

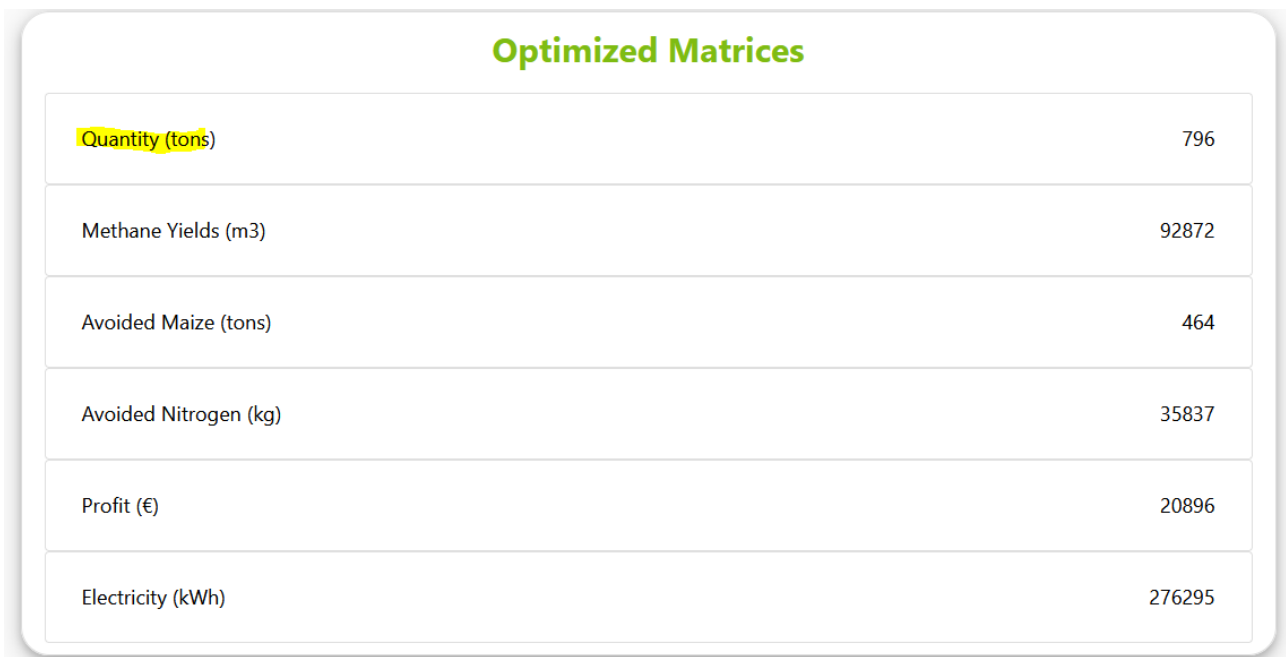|	
Quantity (tons)	796
Methane Yields (m3)	92872
Avoided Maize (tons)	464
Avoided Nitrogen (kg)	35837
Profit (€)	20896
Electricity (kWh)	276295

Figure 28: Optimized matrices

Click on "**Quantity**" card to open the table with the optimized quantities. To the far right 796 tons indicates the total annual quantity to collect by all customers. The year target is not reached but the model still works.

Optimized Matrices

Quantity (tons)   796

Week	Customer 1	Customer 2
1	4.615	8.077
2	4.615	8.077
3	4.615	8.077
4	4.615	8.077
5	2.308	9.462

Figure 29: Optimized quantity table

50	4.154	8.538
51	4.154	8.538
52	4.154	8.538
TOTALS	222.462	573.917

Figure 30: Sum of rows for each customer

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