Development of a tool to optimize economic and environmental feasibility of waste food chains

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www.irexfo.eu
Presentation structure

- Introduction to the project
- Aim of the work
- Methodology
- Results
WHY THE IREXFO PROJECT?

IN THE EU

(Estimates, 2012)

FOOD IS LOST OR WASTED THROUGHOUT THE ENTIRE SUPPLY CHAIN

from agricultural production to final household consumption

- 173 kg per person
- 170 million tonnes of CO2 emitted from production and disposal of EU food waste

88 million tonnes of food are wasted per year
i-REXFO is an innovative BUSINESS MODEL to reduce waste food. It promotes actions to avoid waste food to be disposed in landfills and to produce bioenergy with the non-edible fractions.

iREXFO will provide an open source tool to transfer the Reduction of Expired Food (REF) chains and the Expired Food Energy (EFE) chains that will be tested in the Umbria region that is identified as a pilot case study.
i-REXFO model based on the EU package on Circular Economy

Circular diagram of the i-REXFO approach
Focus on:

- Food Industries;
- Farms;
- Retailers;
- HORECA;

i-REXFO model based on the EU package on Circular Economy

Circular diagram of the i-REXFO approach
i-REXFO model based on the EU package on Circular Economy

Circular diagram of the i-REXFO approach

Actions towards food waste reduction
➔ training
➔ donations
➔ last minute market & doggy bags

Food Waste users
With packaging ➔ Requires separation of Cardboard, tin and plastics

Without packaging ➔ Directly used for biogas
i-REXFO model based on the EU package on Circular Economy

Circular diagram of the i-REXFO approach

Bioenergy produced from food waste is sold on the market
iREXFO is optimised on a Life Cycle perspective

An OPEN SOURCE tool will optimize the:
- Technical performances;
- Economic performances;
- Environmental performances.
1. Transferability tool

2. Design

Good practices: Denmark

3. Demo - Umbria

4. Transfer - Hungary
1. The transferability tool

Transferability tool

LAB ANALYSIS
DATABASE EXPIRED FOOD
- CHEMICAL PROPERTIES
- BMP

DATA COLLECTION
DATABASE AREA
- FACILITIES
- AVAILABILITY
- COSTS & INCENTIVES
- PERMITS
- DISTANCES

SCENARIO OPTIMIZER
MASS AND ENERGY INVENTORY
LCA TOOL
CASH FLOW TOOL

i-RExfo indicators
i-RExfo Business Plan
NORMATIVE GUIDELINES
OPTIMIZATION SOFTWARE

DATABASE - CHEMICAL AND PHYSICAL CHARACTERIZATION

Substrate: CHOCOLATE PUDDING

Ultimate analysis:

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>H</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>43.5%</td>
<td>3.8%</td>
<td>1.1%</td>
</tr>
<tr>
<td>C/He</td>
<td>11.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Proximate analysis:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>15.06%</td>
</tr>
<tr>
<td>Total solids (%)</td>
<td>84.34%</td>
</tr>
<tr>
<td>Volatile solids (%)</td>
<td>93.15%</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>1.10%</td>
</tr>
<tr>
<td>Total Carbon (%)</td>
<td>12.51%</td>
</tr>
</tbody>
</table>

Experimental design:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substrate/microbe ratio</td>
<td>2.00</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>40</td>
</tr>
<tr>
<td>Stir rate</td>
<td>7.5</td>
</tr>
<tr>
<td>Total solids content (%)</td>
<td>12.11%</td>
</tr>
<tr>
<td>Volatile Solids content (%)</td>
<td>9.09%</td>
</tr>
<tr>
<td>C/N ratio</td>
<td>18.13</td>
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</tbody>
</table>

Results:

Cumulative production

Biogas yield: 0.747 Nm³/kg GVe
Methane yield (gMPN): 0.527 Nm³/kg GVe
2. DESIGN

Tool

1) DATA INSERTION, WASTE FOOD AVAILABILITY ASSESSMENT

SITE i
- DISTANCE
- TYPOLOGY
- QUANTITY

WASTE FOOD DB

2) SCENARIO GENERATOR
ALL PERMUTATIONS

SCENARIO j

BMP DB

BIODIGESTER MASS/ENERGY BALANCE

VEHICLE ROUTING PROBLEM

LCA DB

ENVIRONMENTAL INDEX j

ECONOMIC INDEX j

SCENARIO DB

3) OPTIMIZATION
BEST ENVIRONMENTAL AND ECONOMIC PERFORMANCE

SCENARIO OPTIMIZER

i-REXFO OPTIMIZED SCENARIO

Logic

FOR LOOP CHARACTERISTICS

i = 0

SITE TABLE POPULATION

FOR LOOP CHARACTERISTICS

j = 0

CREATE SCENARIO j

FOR LOOP CHARACTERISTICS

k = 0

DIFFERENT SCENARIOS

- OBJECTIVE FUNCTION
- CONSTRAINTS

OPTIMUM SOLUTION

YES

NO

374 ha

MAIZE FIELD

21,836 t/y

Nitrogen back to soil
340 kg/ha

BIODIGESTER

261,022 m³/y

1 MW

ENGINE

SUPERMARKET

5,190 t/y

Cash Flow

Cash flow assessment

Feed-in Tariff [€/MWh]

Graph showing the cash flow for different scenarios.
INTRODUCTORY PAGE

i-REXFO
increase in reduction and recovery of expired food

Start
PROJECT INITIALIZATION
PROJECT INITIALIZATION
DATA UPLOAD 1
DATA UPLOAD 2
DATA VISUALIZATION

![Image of a spreadsheet showing data on bread, sweets, and canned food, with columns for week, bread & sweets, canned food, total waste quantity, methane yields (m3), profit (€), electricity (kWh), avoided maize (kg), and avoided nitrogen (kg).](image-url)
CALCULATION OF THE TOTALS

<table>
<thead>
<tr>
<th>Week</th>
<th>misto</th>
<th>supermercato2</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>277.5</td>
<td>918.75</td>
</tr>
<tr>
<td>2</td>
<td>277.5</td>
<td>918.75</td>
</tr>
<tr>
<td>3</td>
<td>277.5</td>
<td>918.75</td>
</tr>
<tr>
<td>4</td>
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<td>5</td>
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<td>918.75</td>
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<td>6</td>
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<td>918.75</td>
</tr>
<tr>
<td>7</td>
<td>277.5</td>
<td>918.75</td>
</tr>
</tbody>
</table>
LOCATIONS
FINAL RESULTS
i-REXFO Partners

- University of Perugia (CO)
- A + Srl. Outsourced marketing
- Biogáz Unió ZRT.
- Solidarietà Caritas Onlus
- Associazione di Volontariato SAN MARTINO
- ECOPARTNER srl
- Hungarian Food Bank Association
- Noesis snc
- Primetime Kommunikation A/S
- Regione Umbria
- Azienda Agricola Iraci Borgia

- Communication strategy in IT
- Transferability (EFE chain)
- Pilot action on REF (charity)
- Pilot action on REF (charity)
- Pilot action on EFE
- Waste pre-treatment
- Transferability (REF chain)
- Reporting and administration
- Communication, good practice
- Legislation and permit
- Pilot action on EFE (biogas plant)
https://www.linkedin.com/company/i-rexfo/
https://www.facebook.com/iREXFO/
https://twitter.com/iREXFO

budget: 2,324,915 Euro
Duration: September, 2017 - February, 2021

Partner of