FoodE

D2.6

Extensive life cycle assessment, life cycle costing and social LCA of pilots and self-assessment tool

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List of Abbreviations

BCRS	Benefit-Cost Ratios
BMs	Business Models

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CBA	Cost-Benefit Analysis
C-LCC	Conventional Life Cycle Costing
CRFS	City Region Food System
CRFSI	City Region Food System Initiatives
D	Deliverable
DCP	Data Collection Protocol
DCT	Data Collection Template
E-LCC	Environmental Life Cycle Costing
FIA	Financial Investment Appraisal
FU	Functional Unit
GA	General Assembly
GCM	General Circulation Model
ILCD	International Reference Life Cycle Data System
IRRs	Internal Rate of Returns
KPI	Key Performance Indicators
LCA	Life cycle Assessment
LCC	Life cycle Costing
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LCSA	Life Cycle Sustainability Assessment
LCT	Life Cycle Thinking
N	Number
SDGs	Sustainable Development Goals
S-LCC	Social Life Cycle Costing
SME	Small and Medium enterprises
T	Task
WP	Working Package

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Executive Summary

The current deliverable describes the developments and outputs of the FoodE (Food Systems in European Cities) European research project in relation with the activities for the assessment of pilots and identification of best performances. FoodE, funded by the Horizon 2020, was launched in 2020 and will last for 4 years. The consortium involves 24 organisations from 8 European countries (France, Germany, Italy, Netherlands, Norway, Romania, Slovenia, and Spain) and aims at accelerating the growth of citizen-led food system initiatives and creating related innovative and inclusive job opportunities at local level. Building on the simplified assessment framework developed in the Data Inventory (FoodE D2.4) and in the Life cycle assessment, life cycle costing, and social LCA of 100+ CRFSI (FoodE D2.5), this work advances towards the extensive layer of the methodological framework previously developed. It collects, processes, and analyses primary data from the FoodE pilots across Europe, adopting a Life Cycle Thinking (LCT) approach, for assessing the social, economic, and environmental sustainability performances. The steps of the LCT are followed, entailing a) the goal and scope definition, b) the data inventory, c) the impact assessment, and d) the interpretation of results. Furthermore, it concretely defines the self-assessment tool providing a template able to deliver instant results on the sustainability performance of pilots. The presented extensive assessment paves the ground for the design of the pilot decision support tool. The integration of these specific outputs will deliver a useful set of tools for replicability and scalability of results to other pilot owners outside the FoodE project. Furthermore, they will also provide valuable support to decision makers in analysing the performance of initiatives in the CRFS context.

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1. Background

1.1 Project objective: FoodE – Food Systems in European Cities

The main objective of FoodE is to involve European Union local initiatives in the design, implementation, and monitoring of an environmentally, economically, and socially sustainable CRFS. The key challenge of the project is to improve food and nutrition security of European citizens by shaping a sustainable environment able to increase accessibility and availability of affordable, safe, and nutritious food. This challenge will be tackled by setting a co-created mechanism, based on Citizen Science and Responsible Research & Innovation principles, where public authorities, citizens, SMEs, and non-profit organisations can share ideas, tools, best practices, and new models, supporting cities and regions in developing innovative and sustainable food systems.

1.2 Objective of WP2 Methodological framework development and case studies sustainability assessment

Considering and integrating all the recent advancements on sustainability assessment of CRFS Initiatives (CRFSI), WP2 aims at developing a methodological framework and an analytical decision support tool for the development of innovative Business Models (BMs) and initiatives to enhance the approach of CRFS. More specifically, the WP2 roadmap (Fig. 1) aims to:

- create an inventory of innovative CRFSI;
- develop an integrated methodology for the interpretation and analysis of innovative BMs and their suitability to apply in specific contexts;
- apply, validate, and refine the integrated methodology on case studies, including a sustainability assessment, also integrating revisions proposed by stakeholders during cross-pollination;
- develop business case reports and carry out comparative analyses to identify barriers and key drivers of change;
- develop an analytical decision support tool, based on the FoodE integrated methodology, to support decision-making of innovative BMs and improve their performances and sustainability;
- develop an analytical decision support tool, based on the FoodE integrated methodology, to support decision-making of innovative BMs and improve their performances and sustainability.

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Figure 1 - Roadmap WP2

1.3 Task and Deliverable objective

Based on the methodological framework developed in T2.2, that explains the LCT approach to assess the environmental (e.g.: carbon footprint, land use, etc.), economic (costs, net present value, value added, etc.), and social (labour, health, vitality of regions, innovation, etc.) impacts, in a cradle (biomass supply) to grave (final use) to cradle (re-use/recycle) perspective, the specific Task (T2.4) aimed to perform an extensive Life Cycle Assessment (LCA), Life Cycle Costing (LCC) and Social LCA (S-LCA) of the FoodE pilots across Europe in order to identify major hotspots and improvement scenarios of their sustainability performances.

The extensive sustainability assessment has been conducted through a participatory approach with pilots owners to define the goal and scope of the analysis, the data inventory procedure, the life cycle impact assessment, and the interpretation of results. Specifically, the goal and scope phase has been defined by two main workshops (SUSTAIN I and SUSTAIN II), while primary data for the analysis has been collected by a specific Data Collection Template (DCT) customized for pilot. Data gaps has been covered by real estimation and forecasts provided by actors involved.

Results of the analysis are presented at the individual pilot level, across the three pillars of sustainability, furnishing an insight on current trade-offs and/or win-win situations. The final output of this task is D2.6 that also paves the ground for the specific activities of T2.5 in relation with the Pilot decision support tool, providing the specific output of the DCT tool for self-assessment and a deep overview of the extensive sustainability assessment procedures.

1.4 Linkages with other FoodE activities

Within the FoodE development, synergies and potential risks of overlapping have been explored and discussed. To perform the extensive sustainability assessment of the FoodE pilots, two main interactions are particularly crucial:

- Methodological framework development (T2.2)

  This contribution serves as methodological foundation of the FoodE pilots sustainability assessment, establishing the procedure to perform an extensive LCT analysis, with respect to the definition of consistent functions and functional unit(s) (FU) and system boundaries, the appropriate indicators to be used, the typology of data to be collected, and the procedures and methods for retrieving standardised data with an adequate level of detail.

- Data collection and inventory (T2.3)

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The data collected on 100+ CRFSI and the results served as starting point for the elaboration of consistent DCT for pilots' sustainability assessment and as a basis for the benchmarking system for the extensive social life cycle assessment of Pilots.

Besides, the present work is expected to provide fertile ground for several activities:

- Pilot decision support tool (T2.5)

Main findings from the extensive sustainability assessment will be used for the design and shaping of the pilot decision support tool, which will be the final task of FoodE's WP2.

- FoodE App (T3.2)

Main findings from the extensive sustainability assessment will feed into the development of extensive sustainability indicators for the FoodE app (see https://foode.sostenipra.cat), as contributing to the ranking system of CRFSI thanks to the score received on sustainability indicators.

- FoodE Pilot Monitoring (T4.4)

The main findings from the extensive sustainability assessment of pilot initiatives will provide a baseline scenario for the participatory pilot monitoring (T4.4). The task will develop an operational guide for the use of the self-assessment tool and evaluate pilots' progresses from the baseline scenario.

- Standard certification scheme (T5.4)

A list of indicators is extracted from the sustainability assessment framework from which to derive certification standards to be compiled by the CRFSI to get the FoodE label.

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2. Methodology for the assessment

2.1 Background for the extensive life cycle assessment, life cycle costing and social life cycle assessment of pilots and self-assessment tool development

Based on the CRFSI assessment framework (D2.2, D2.3) and building upon the simplified sustainability assessment performed on 100+ CRFSI, the current work aims at performing an extensive sustainability assessment of the FoodE pilots. Based on the definition operationalised in D2.2, such pilots are fully considered as CRFSI. The extensive assessment integrates the three pillars of sustainability under the perspective of LCT. Specifically, LCC, S-LCA, and LCA were the methodologies adopted.

To this end a participatory process involving the pilots' representative was conducted. First, aiming to launch the co-design process, the SUSTAIN I workshop was held in collaboration between WP2 and WP4 during the GA meeting in July 2021. This was a preliminary step meant for the FoodE pilot owners to get involved and introduced to the FoodE assessment framework and methodology. Following up, a second workshop (SUSTAIN II) was conducted in relation with the goal and scope phase definition. The SUSTAIN II workshop aimed at gathering information and expectations from the FoodE pilot owners specifically regarding the aim of the assessment, the main benefits expected, and the main functions of the system. Furthermore, the workshop served to understand the pilot owners' interest in specific environmental, economic, and social impact categories. Within the workshop, a survey was delivered to pilot owners, consisting of 17 multiple-choice questions with one open-ended question for additional comments (see Appendix 1 for more details). Based on the SUSTAIN II workshop results, an iterative dialogue started between LCT practitioners and each pilot owner for co-designing a data collection template (DCT). The DCT consists of a spreadsheet Excel file functioning as a guided data collection tool for pilots. This is composed of four main sheets, that can be later used by pilot owners for a semi automatized assessment on specific indicators. Some cells were formatted to deliver automatic calculations starting from the raw data included, while some others were used to collect primary data to base further analyses on, especially for social and economic assessments. Based on the automatically generated formula, graphs for a rapid assessment appraisal were also included to provide immediate user-friendly visualisation outputs for self-assessment (see Appendix 2). Precisely, the DCT was articulated into 1) General information sheet; 2) Economic sheet; 3) Social sheet; 4) Environmental sheet. The three sheets related to the sustainability dimensions were developed respectively based on information needed for a LCC, S-LCA and LCA analysis, and also the survey KPIs described in D2.3.

The DCT was first discussed among experts and then tested during a meeting in March 2022 with three pilot initiatives (Tenerife pilot, Bleiswijk pilot, AlmaVFarm pilot) to verify appropriateness. Based on the DCT, the data collection for the Life Cycle Inventory (LCI) was carried out relying on the methodology established within D2.3. The latter provides detailed guidance and examples on how to collect, manage, and process the data needed for the methodological framework. For some pilots, the data collection phase was supported by the work of master students interested in the topic and pilot activities.

The DCTs were delivered to the pilot owners with supplementary information and indications to support the filling of data. The whole data collection process was also guided by the direct intervention of LCT practitioners collaborating with the pilot owners in an iterative co-design process. Data collection in all pilots was concluded in May 2022.

2.2 Data Collection Template for self-assessment

In the following sections the four main sheets of the DCT are discussed: 1) General information; 2) Economic; 3) Social; 4) Environmental. More detailed info on the sheets is available in Appendix 2.

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2.2.1 General Info Sheet

The General info sheet consists of three main sections: the first one related to the general information on the pilot, the second one to the goal and scope definition, derived from SUSTAIN II workshop results, and the third on products, services and value provision per value chain step considered.

Among the general information, data on the name, city or region, location (urban, peri urban, or rural), assessment start date, extension of the estate and of the lot to be studied, land type (artificial, agricultural, or natural), duration of the productive cycle, total yearly revenue and revenue from sales, total yearly customers/users, and typologies of sold and purchased products were requested.

The goal and scope information was acquired by SUSTAIN II results for the system boundaries, i.e. the supply chain phases to be included in the assessment, the aim of the assessment (footprinting, perspective, comparative, or consequential), the expected benefits of the sustainability assessment, the functions of the initiative, the reference flow and the functional unit of the analysis.

Finally, all data referring to the quantities of produced, transformed or served products were requested, differentiating between the different life cycle phases.

2.2.2 Economic_Life Cycle Costing Sheet

The costing impacts have been evaluated with a conventional LCC approach (Hunkeler and Rebitzer, 2003). Such an approach considers "*all costs directly attributable to a product/process starting from production to use and end of life*" (Hunkeler, Lichtenvort and Rebitzer, 2008) and can concretely support decision making at the pilot level. LCC cost categories and their naming change depending on the study. They alternatively account for investment, operation, maintenance and end-of-life disposal costs (Luttenberger and Luttenberger, 2017), acquisition costs (European Commission, 2019), planning and testing costs (Cook *et al.*, 2022).

Within the present work, costs have been classified in a set of components, able to capture the peculiarity of the analysed pilots and consider the differences among them. Particularly, 5 components have been adopted, namely:

- C_{ac} = Acquisition
- C_{op} = Operation
- C_{mr} = Maintenance and repairment
- C_{di} = Disposal/end of life
- C_{ot}= Others

Acquisition costs include mainly those costs related to acquisition of appliances and infrastructures and material costs. Operation costs relate to those needed for running the activities, such as labour and utilities. Maintenance costs entail costs for the maintenance needs and repairs of the system, and disposal/end of life to the costs occurring for the disposal of any material or infrastructure. The other costs represent an additional category included to take into account the diversity of pilots.

Each of the pilot was free to select as much components as possible, considering data availability, and including costs across the entire life cycle of their pilot. Additionally, each pilot was asked to indicate the time span of the analysis, for the LCC evaluation period, and the life expectancy of the infrastructures and appliances. All data were included specifying their date of collection and source.

2.2.3 Social_S-LCAocialife ycle ssessment Sheet

The social impacts have been evaluated with a S-LCA approach based on the Guidelines for Social Life Cycle Assessment of Products and Organizations (Norris et al., 2020). S-LCA

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methodology adopts a stakeholder approach, as the social impacts assessed are allocated to stakeholder categories involved in the life cycle of the product or service under study.

Impact (sub)categories, which are measured through quantitative or qualitative indicators, are determined to identify key social aspects deriving from each stage of the life cycle and associated with the selected stakeholder categories. Following Norris et al. (2020) classification, five main categories of stakeholders were identified: workers, local community, society, consumers, and value chain actors. According to the scope of the assessment, the abovementioned stakeholder categories have been adjusted to the needs of the analysis, hence the following four stakeholder categories have been considered: workers and producers, consumers, local community and society. One of the key themes debated about the S-LCA methodology is the selection of impact sub(categories) and the corresponding indicators. As clearly stated by the Guidelines, the list of impact categories and subcategories is not exhaustive and it is only meant to provide examples, as additional categories can be defined according to the goal and scope of the study and depending on the specific social context. Within the extensive assessment of FoodE pilots, Appendix 3 reports indicators used in the general DCT, according to the presented structure.

Each of the pilot was free to select as much categories as possible, considering data availability. Hence, some indicators, sub-categories and categories were out of the scope for some pilots, and, thus, the related data was not included for their specific assessment. All data were included with their date of collection and source.

In the Impact Assessment phase, that aims at "*calculating, understanding and evaluating the magnitude and significance of the potential social impacts of a product system throughout the life cycle of the product*" (Norris et al., 2020, p.80), inventory data are linked and aggregated within impact subcategories (classification), and results for the subcategory indicators are calculated (characterization) (UNEP-SETAC, 2013). Given the nature of social phenomena, the impacts assessed through a S-LCA analysis are necessarily linked to a certain degree of uncertainty, as it is difficult to identify deterministic cause-effect relationships when dealing with social issues.

For the impact assessment phase, a reference scale assessment approach (Type I) was applied. The reference scale approach is based on the calculation of the social performance by establishing a scoring system for each inventory indicator and by associating the inventory data with a corresponding reference scale level, in order to describe how the initiative under study contributes to or deviates from the standard. Reference scales are defined as ordinary scales in which each level corresponds to a performance reference point (PRP), which set different levels of social performance (Norris et al., 2020, p.82). The reference scales used to define a scoring system for each indicator are generally based on defined international or national benchmark. Due to the high variability and heterogeneity of FoodE pilots, it was not possible to find a common international or national benchmark system. To deal with this specific aspect, and also be consistent with the nature of the different pilots, the strategy chosen was to use the results of the FoodE simplified sustainability assessment (D2.5) as a social benchmark reference for the pilots. Such procedure allows to compare the results of pilots with a broad spectrum of similar initiatives active in the same context. Appendix 4 highlights linkages underlying the benchmark system. Since some indicators in the DCT for the self-assessment were not directly linked with results of the simplified assessment, a set of questions were used as a proxy for the indicators. Pilot data were compared with the average value registered in the related country for the 100 CRFSI. Such procedure occurred in all the pilots except for Prison Honey, Ljubljana (SL), considering that Slovenia registered only 2 responses to the survey, one of which is Prison Honey. Hence, this specific case was compared to the European average values. The scoring system applied to the survey results (for the simplified sustainability assessment) was also applied to the pilots' results (with some exceptions and adaptations).

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Results for the social impact assessment are expressed in percentage with respect to the national average, which can be interpreted following the rationale:

- 100% is the same level as of the national average,
- more than 100% means that the pilot has higher social performances than the national average
- less than 100% means the pilot has lower social performances than the national average

2.2.4 Environmental_Life Cycle Assessment Sheet

The environmental impacts are determined through attributional LCA (ISO 2006). LCA is a widely used methodology to assess the environmental performance of products and systems by accounting for their entire life cycle. The methodological framework used for the assessment was based on D2.2, detailing the four phases of an LCA (goal and scope, LCI, LCIA and Interpretation). The software used to perform the life cycle impact assessment (LCIA) was Simapro 9.3 by PRé Consultants. All impact categories included in the ReCiPe 2016 v1.1 Midpoint (H) method (Huijbregts et al. 2016) were assessed, encompassing the mandatory classification and characterization steps (see Table 1). Background environmental information was retrieved from Ecoinvent 3.8 (Wernet et al., 2016), using the system model "APOS - Allocation at the point of substitution". More than 200 background processes were used to analyse the environmental impacts of all pilots. These processes were classified in 17 subsystems: Substrate for soilless cultivation, Beekeeping, Seeds and Seedlings, Synthetic Fertilizers, Organic Fertilizers, Pesticides, Electricity, Other energy sources, Water and Ice, Fuel Consumption for Boats, Transport, Construction materials, Packaging materials, Waste, Cooking ingredients, Catering materials and Kitchen Appliances and Other Appliances. It is worthy of special attention that these subsystems do not correspond to the original DCT sent to the pilots. Based on the inputs provided by pilot managers and consortium partners' expertise, the data collection template was changed right after the data collection to cover consistently the different type of CRFSI that the pilots represent.

Table 1 - Impact categories included in the Recipe 2016 (H) Method

Impact Category	Abbreviation	Units
Global warming	GW	kg CO_2 eq
Stratospheric ozone depletion	SODP	kg CFC11 eq
Ionizing radiation	IR	kBq Co-60 eq
Ozone formation, Human Health	OFHH	kg NOx e
Fine particulate matter formation	FPMF	kg PM2.5 eq
Ozone formation, Terrestrial ecosystems	OFTE	kg NOx eq
Terrestrial acidification	TA	kg SO_2 eq
Freshwater eutrophication	FE	kg P eq
Marine eutrophication	ME	kg N eq
Terrestrial ecotoxicity	TET	kg 1,4-DCB eq
Freshwater ecotoxicity	FET	kg 1,4-DCB eq
Marine ecotoxicity	MET	kg 1,4-DCB eq
Human carcinogenic toxicity	HCT	kg 1,4-DCB eq
Human non-carcinogenic toxicity	HNCT	kg 1,4-DCB eq
Land use	LU	m2a crop eq
Mineral resource scarcity	MRS	kg Cu eq
Fossil resource scarcity	FRS	kg oil eq
Water consumption	WC	m^3

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2.2.4.1 List of assumptions

Either due to lack of data in the foreground system or in the background environmental database, relevant assumptions had to be taken. Find below a summary of the assumptions:

- Lifespans: although most of the elements included in the system boundaries for all pilots would serve their purpose within the lifespan of their productive cycle, the impact of some elements in the inventory had to be readjusted since their lifespan was longer than the productive cycle of assessment. This specifically applies for infrastructure elements and appliances.
- Nitrogen emissions to air: NH_3, N_2O and NO_x emissions from nitrogen fertilization were calculated by quantifying the amount of nitrogen in all the organic and inorganic fertilizers and applying the corresponding Tier 1 emission factors as done in previous research (Sanjuan-Delmás et al., 2018).
- Size of kitchen and other appliances: to decrease the confusion from the pilot side, 3 different sizes were added (small, medium, big) for pilots to fill the number of units. To differentiate the impact between these three sizes, medium-size impact was set at 100%, small-size impact was set at 50% (of the medium-size impact) and big-size impact was set at 150% (of the medium-size impact).
- Lack of background processes: when a specific background process for an element in the foreground system was not found, the most appropriate proxy was selected based on author's expertise. Whether this choice represents a high impact on the life cycle impact assessment or not was discussed in each pilot assessment.

2.2.5 The Functional Unit

As described in D2.2, the FU choice for inputs, outputs and impacts depends on the function that a specific product or system (or in this case, a CRFSI) is providing, which will be in turn based on the goal of the assessment. In this sense, a great variety of functions can be extracted from the FoodE pilots. For example, most pilots dealing with cropping activities could be assigned a production-based FU: mainly kg of crops or economic revenue provided to the local market or pilots including livestock linked to animal-based products. However, the various workshops and direct communications with the pilots have suggested a more complex issue: a multi-functionality perspective, mainly involving education and services with schools or the local community. To deal with this multifunctionality, we opted to choose an organisation-based LCA (Martínez-Blanco et al., 2015; Dantas et al., 2022). The FU that we designed for this type of LCA was defined as "*the activities of a FoodE Pilot in a defined timeframe*". The FU states "*a defined timeframe*" instead of "*on a yearly basis*" because data for specific dimensions from a few pilots were based on other timeframes related to their activities (e.g., a specific productive cycle).

The main limitation of an organisation-based FU is that "*absolute impacts are highly dependent on the size of the activities*", as stated in D2.2. However, since the aim of the present deliverable is to assess the sustainability performances of pilots and not to compare them, the fact that absolute impacts across pilots may differ doesn't affect their isolated interpretation.

To provide fertile ground for future research development, for some of the pilots we included a section on potential complementary FUs that may be used to communicate the results with the goal to compare their performance with similar CRFSI.

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3. Discussions of results

This section presents the assessment of each of the FoodE pilots. Every subsection starts with a card that includes basic information about the pilot, its logo and introductory data to be used in the assessment. After this, assessments are separated by sustainability dimension and methodology used, i.e. economic and LCC, social and S-LCA, environmental and LCA. Finally, wrap-up conclusions are provided for each dimension, as well as potential FU suggestions for further assessments. LCA results are presented in a relative way with the aim of detect the main impacting hotspots within each pilot. Therefore, absolute impacts are not presented here, but in Appendix 5.

3.1 Pilot 1 - ALMA VFarm: An Indoor Vertical Farm for growing Food, Competences and Innovation

	ALMA VFARM
General	**Organisation Type**
	Non-Profit - University
	City and Country
	Bologna (Italy)
	Location
	Mainland - Urban
	Pilot short description
	The main goal is to obtain an experimental, demonstrative, educational pilot project, co-designed with their future users. In particular, the pilot will focus on the creation of a new indoor growing environment where students, professors, technicians of the University and, in general, experts will be involved in activities of co-design, management, and education.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Agricultural Production; Education and services
	Characteristics of the pilot (extension, type of land etc.)
	The pilot is developed within the Department of Agricultural food technologies (DISTAL) at Bologna University. The extension of the estate is 70 m^2, made of artificial surfaces. The extension of the lot to be studied is 58 m^2
	Time span of the analysis
	Differs depending on the sustainability pillar (2022)

LCC

Evaluation period: 46 days (a productive cycle)
Cost component included in the analysis: $C_{ac} + C_{op}$.

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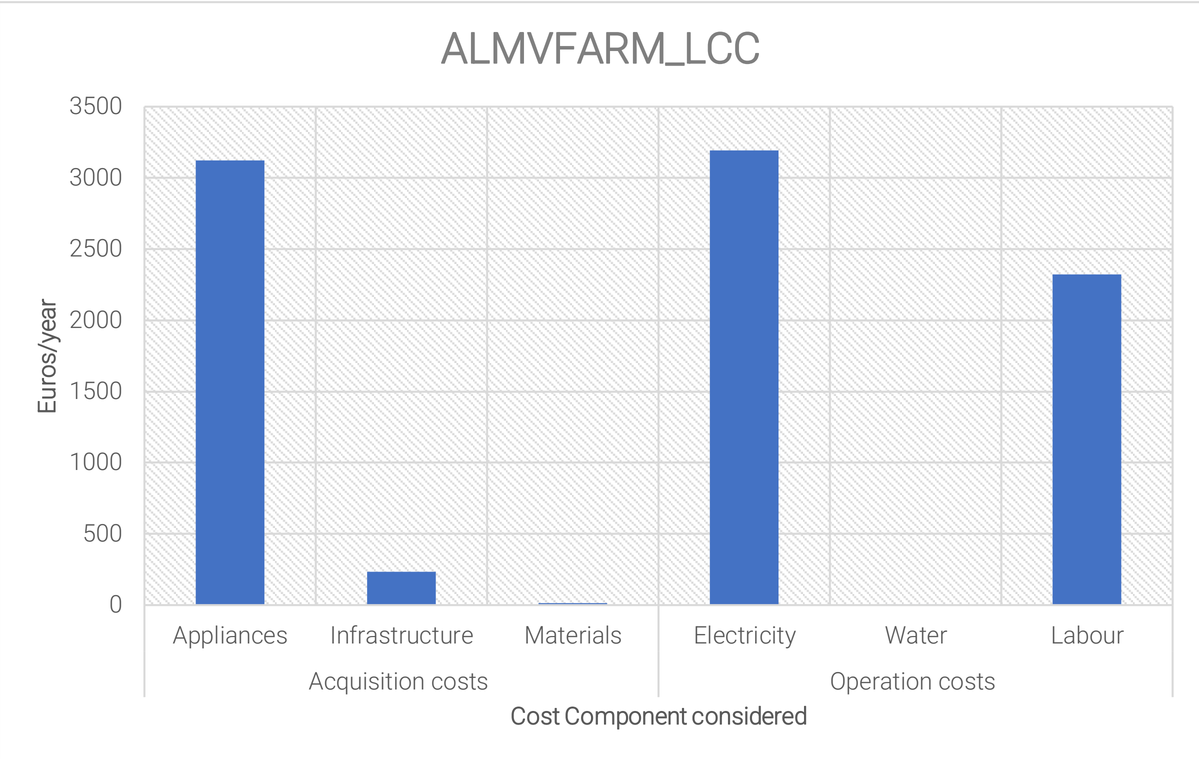
Analysis: a breakdown of the aggregate costs is detailed according to components considered in the analysis, including the specific cost items. Fig. 2 displays a bar chart related to these cost components. As for the acquisition costs several items are considered. Appliances costs include invoices for the temperature and humidity sensors, fertigators, LED lights, LED controller box, the aeroponic system, pods and pots, while infrastructure costs referred to isothermal cell, CO_2 locker and HVAC system. Material costs are related to the consumables for food production including the organic polymer needed, the peats and the seeds. Finally inputs costs are considered for calcium nitrate, magnesium nitrate, potassium sulphate, ammonium phosphate and carbon dioxide. For the life expectancies of the different acquisition costs, the following have been adopted: 30 years for shelves, 6 for trays and lids, 10 for the water recovery system and LED controller box, 6 years for LED lights, 10 for nebulization system, 30 years for the CO_2 locker, 20 years for the HVAC system and an average of 15 years for the isothermal cells (Martin, Weidner and Gullström, 2022). As for the operation costs electricity and water expenses are included, together with labour costs. The cost for electricity is referred to the first semester of 2022 and retrieved from ARERA (Autorità di Regolazione per Energia Reti e Ambiente).
The overall life cycle costing for the production cycle of 46 days adds up to 8890 euros. Most of the costs derives from the electricity expenses (36%), from the overall acquisition of appliances (35%) and from the labour costs (26%). Figure 2 reveals infrastructures, materials, and water expenses have a very low influence on the final cost.

Figure 2 - ALMAVFarm Life Cycle Costing (LCC) results in euros per year



S-LCA

Evaluation period: 12 months
Social indicators included in the analysis: <u>Workers and producers:</u> Jobs creation, contract typology, income level, trainings, gender balance, social inclusion, students' engagement; <u>Local community:</u> digital channels for activity dissemination, frequency or events for local

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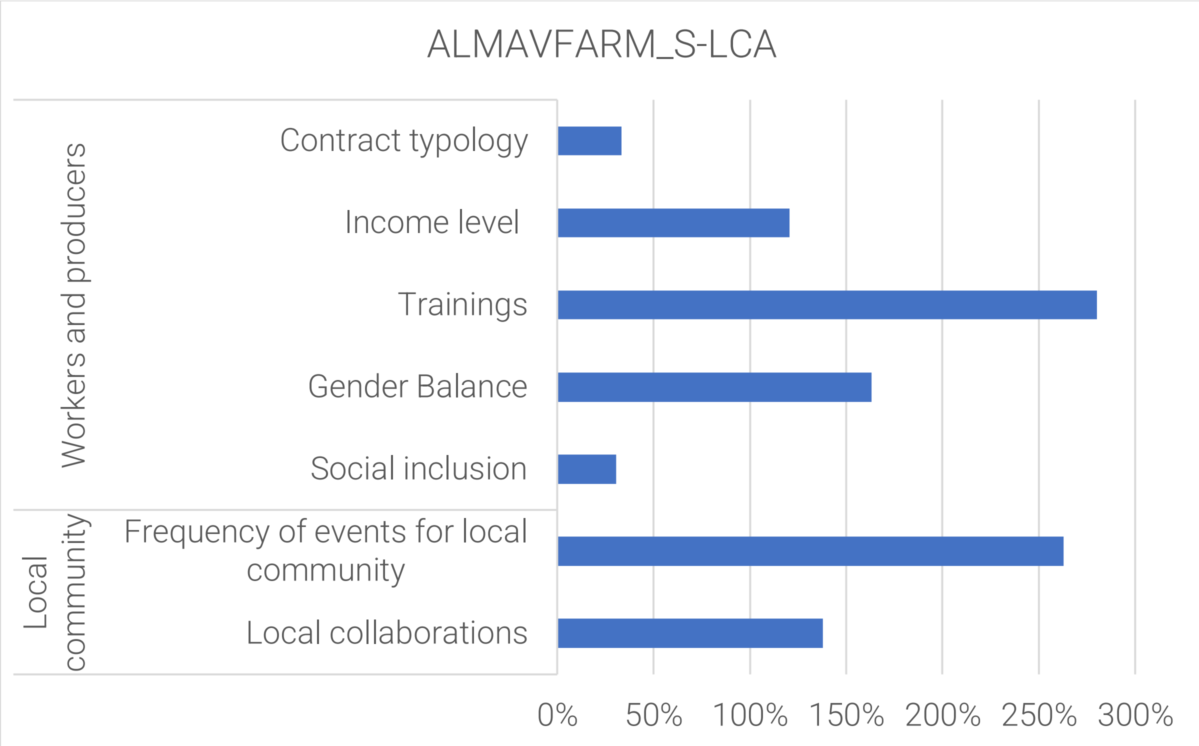
community, participation rate, educational events/visits/workshops, local collaborations, collaborations with activities and projects, collaborations with companies/companies interested in the topic who visited the pilot.

Discussion of results: Figure 3 represents a bar chart displaying social impact assessment for the elements included in the analysis. The AlmaVFarm social impact assessment reflects the educational nature of the pilot, which is mainly focusing on the stakeholder categories of "workers and producers" and "local community". The main contribution to social impacts is provided by trainings held for workers, followed by the frequency of events for the local community, which are both more than 2,5 times higher than the italian average. The only two social performances below the national average are on the social inclusion, calculated by the number of people belonging to vulnerable categories, and the contract typology which is evaluated in terms of number of non-fixed term contracts.

Figure 3 – ALMAVFARM Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



AlmaVFarm is clearly education-oriented hence there are significant social impacts to be considered in addition to the social impact assessment performed based on the benchmark strategy. Table 2 presents the additional indicators adopted to analyse the social performance of the pilot.

Table 2 - Additional indicators adopted for ALMAVFARM Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	Data
Workers and producers	Job creation & quality and	Jobs creation	N of jobs created every year	4
		Students engagement:		

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	skills development	a) Internship students	N of students performing the internship in the Pilot	10
		B) Bachelors and master thesis students	N of students performing the thesis in the pilot	7
		c) Visting PhD Students	N of students performing PhD research in the Pilot	3
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	3
		Participation rate	N of people participating per event (average)	14
		Educational events/Visits/Workshops	N of events specifically targeting education on food system per year	22
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	3
		Collaborations with companies/Companies interested in the topic who visited the Pilot	N of companies who visited the pilot	9

LCA

Evaluation period: 46 days (a productive cycle)

Discussion of results: the inventory and impact assessment were calculated for 46 days since this is the timeframe for 1 cycle of lettuce considering 14 days of germination and 32 days of growth cycle. The subsystems included in the assessment were substrate for soilless cultivation, seeds and seedlings, synthetic fertilizers, electricity, water and ice, construction materials and waste. Substrate for soilless cultivation included 0.87 m^3 of peat, calculated based on mass data provided by the pilot. Other data such as pots were excluded from the assessment due to lack of data in the background databases. Seeds and seedlings included 1850 seedlings of lettuce. Synthetic fertilizers included calcium nitrate, magnesium nitrate potassium sulphate, ammonium phosphate and carbon dioxide for carbon enrichment. Electricity was included separately data as components detailed by the pilot for further specific assessment: water pumps, climatic components, artificial lighting, etc. Water subsystem included tap water used directly for the irrigation of the lettuce plants. In the case of construction materials, steel, aluminium, acrylonitrile butadiene styrine, polyisocianurate and polyurethane were used to build different elements of the system such as an isothermal cell, and HVAC system, LED lights or central elements of the hydroponics and aeroponics system. In terms of waste, a composting process for organic waste was considered.

In terms of impacts, Figure 4 shows that the impact profile of the AlmaVFarm pilot was dominated by electricity consumption. The lowest impact exerted by electricity was found in land use (65%), while the largest was in ionising radiation (99%). Within electricity consumption, the elements that contributed the most to the impact of this subsystem were artificial lighting and the climatic components. Despite electricity consumption being the largest contributor, there are specific impact categories in which other subsystems played a relevant role in terms of impact contribution. Firstly, seeds and seedlings had an impact of over 10% in land use (11%) and water consumption (15%). Secondly, substrate for soilless cultivation had an impact surpassing 5% of relative contribution in global warming (5%), fossil resource scarcity (5%) and land use (21%). Thirdly, synthetic fertilizers had an impact of over 5% in stratospheric ozone depletion (13%) and terrestrial ecotoxicity (6%). Fourthly, construction materials also had 3

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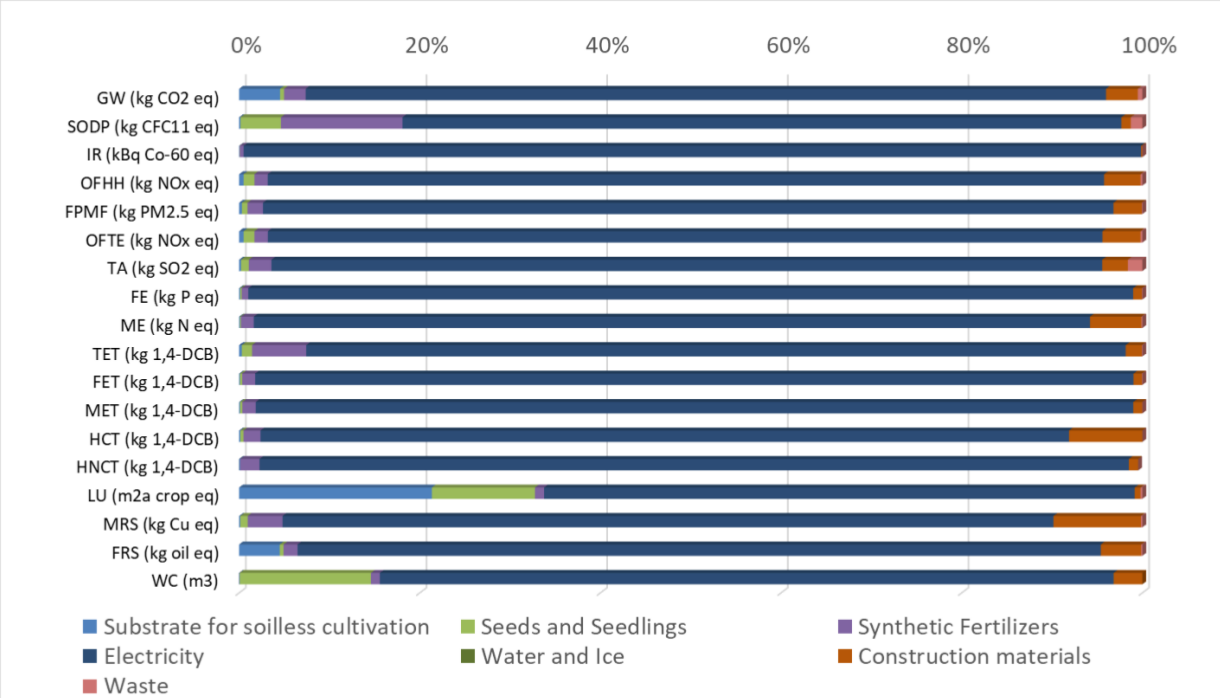
impact categories with higher impacts than 5%: marine eutrophication (6%), human carcinogenic toxicity (8%) and mineral resource scarcity (10%). Finally, water and ice and waste had negligible impacts in all impact categories analysed.

Figure 4 - AlmaVFarm Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU is represented by the mass FU. In fact, the LCT analysis can be allocated to 1 kg of lettuce without changing any inputs or outputs or without making allocation choices. Since the pilot seems to have crop areas dedicated to specific crops, growing other types of crops won't either imply allocation or substitution since the system is totally monofunctional.
- **LCC conclusions**: outcome from the analysis allows us to conclude that improvements in the cost performance of the pilot should be focused primarily on leveraging the three most prominent cost categories. However, it is worth noticing that AlmaVFarm is meant as a demonstrative and educational pilot and adopts practices different from a standard market-based pilot and hence requires a different interpretative outlook when looking at final results.
- **S-LCA conclusions**: improvements in the social performances of the pilot should focus on the increase of fixed-term contract employees and a more significant employment of people belonging to vulnerable groups. All the other dimensions rank above the national average, with some notable impacts in the education and dissemination spheres.
- **LCA conclusions**: to decrease the environmental impacts of the pilot, the focus should be put on electricity as the main impact drive in all categories. Since artificial lighting and climate components were in turn the main contributors to the electricity subsystem, strategies to improve energy efficiency should focus on them, either by decreasing the consumption (considering for example that artificial lighting might not be that relevant

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for the Mediterranean region compared to Northern Europe or by implementing renewable energy modules that could help the pilot increase its self-sufficiency).

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3.2 Pilot 2 - Urban Farming at SALUS Space

	SALUS SPACE
General	**Organisation Type**
	Profit - Cooperative
	City and Country
	Bologna (Italy)
	Location
	Mainland – Peri-Urban
	Pilot short description
	The area, where the private clinic Villa Salus once stood, has been recovered from abandonment and regenerated. Salus Space is a multifunctional centre with housing, art and craft workshops, a theatre, a study centre with coworking stations, an emporium, a weekly farmer's market, vegetable gardens, a food court and a community.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Agricultural Production; Food Processing; Food Distribution; Restaurants and catering; Education and services
	Characteristics of the pilot (extension, type of land etc.)
	The extension of the estate is 3.8 ha, including 1.5 ha of artificial surface, 0.3 ha of agricultural land ha and 2 ha of natural areas.
	Time span of the analysis
	12 months (year 2021-2022)

LCC

Cost component included in the analysis: $C_{ac} + C_{op}$

Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 5 displays a bar chart related to these cost components. The acquisition costs include the acquisition and installation of the 10 aquaponic systems used within the pilot for educational purposes. These latter refer to the bio-lake setting up, made up of waterproof sheets and expanded clay aggregate. As for the operation costs, the electricity and water expenses are included, together with labour costs and some other costs referring to the shipping of materials. The labour costs are made of two fixed term contracts of 15 hours and 20 hours/week respectively, plus an employee that spends a fraction of her/his work at the pilot. As for the life expectancies of the different acquisition costs, 15 years have been assumed based on the pilot owner's expertise. It is worth mentioning that some of the indicated costs are hypothetical values, due to limited data availability.

The overall life cycle costing for 12 months adds up to 38117 euros. Most of the costs derive from the labour expenses (69%). The electricity expenses are the second most relevant part (26%). The remaining cost items contribute only lightly.

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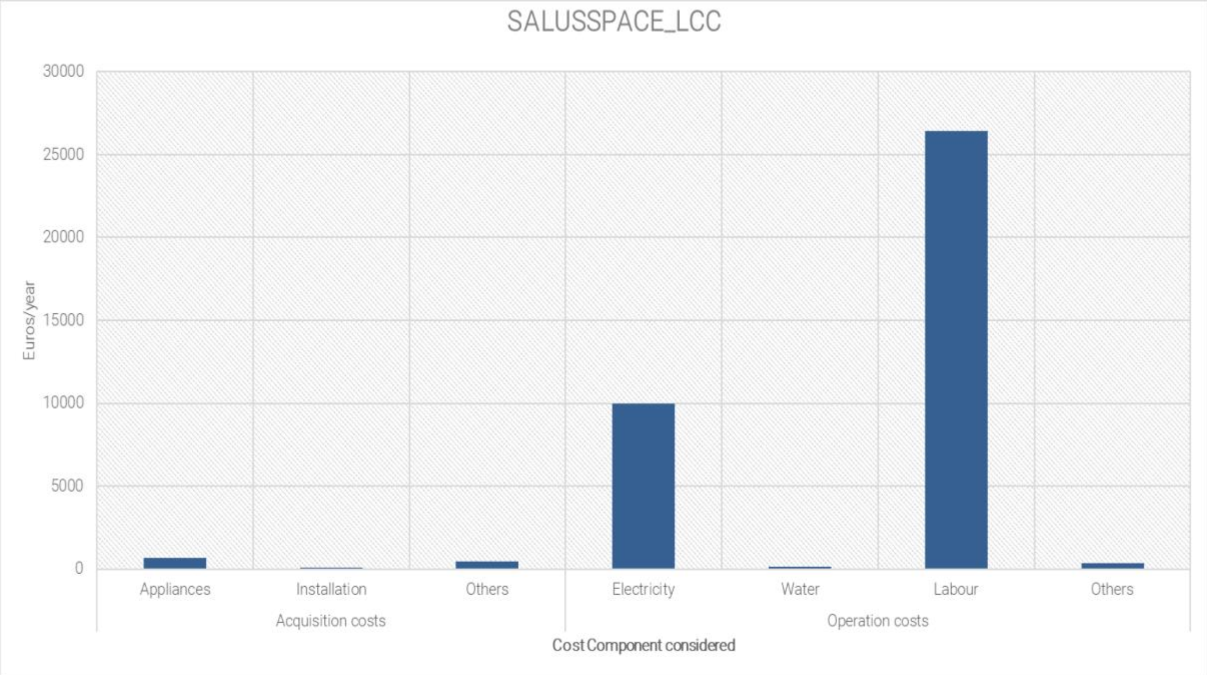
Figure 5 - SALUS Space Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: social inclusion; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects.

Discussion of results: According to Figure 5 displaying the pilot's social performances, SALUS Space is primarily focused on the stakeholder category of the local community, where the highest performance is the frequency of events for the local community, which is 2,5 times higher than the national average. SALUS Space also pays great attention to the social inclusion, particularly of migrants and refugees, not only in terms of job creation but also through engagement in community activities. In general, the results indicate that the pilot ranks above the national average in terms of social performances for the analysed aspects.

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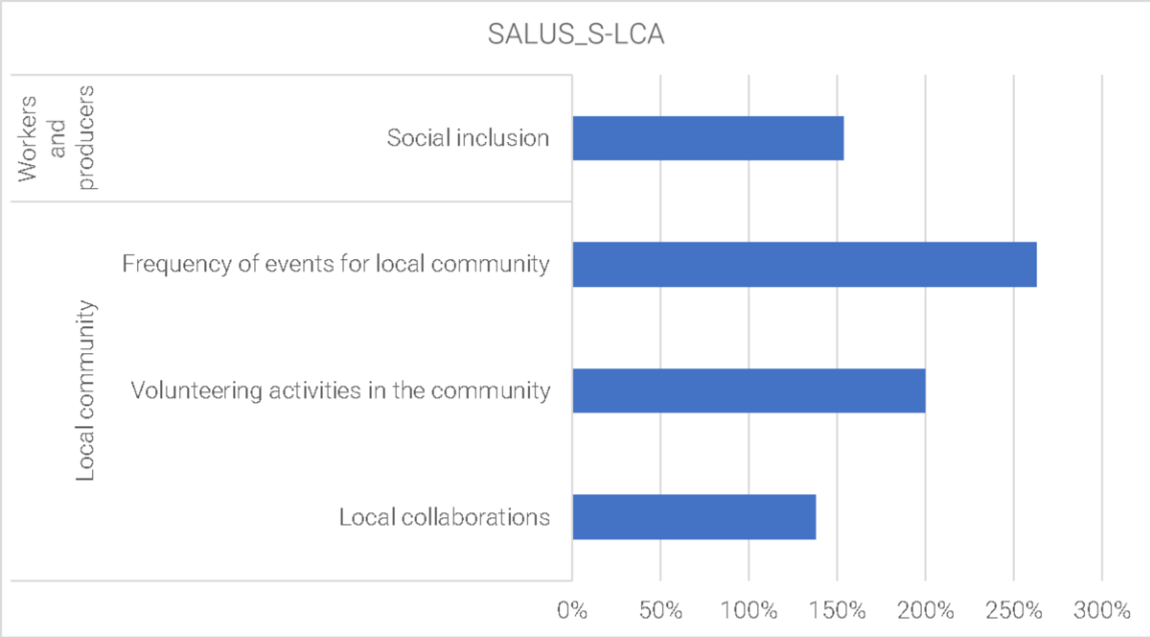

Additional indicators that have been analysed independently from a benchmark reference are presented in Table 3.

Table 3 - Additional indicators adopted for SALUS Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	3
		Participation rate	N of people participating per event (average)	24
		Educational events	N of events specifically targeting education on food system	35
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	1

LCA

Discussion of results: The inventory and impact assessment were calculated for 12 months of activities carried out at the pilot. The subsystems included in the assessment were seeds and seedlings, organic fertilizers, electricity, water, and ice, cooking ingredients and kitchen appliances and other appliances.

Seeds and seedlings included 5000 seedlings of various horticultural crops. Organic fertilizers included 30.000 kgs of compost from livestock (which was assumed to be fresh and from poultry) and 5.000 of compost from green biomass (which was assumed to have standard NPK ratios). The pilot produces electricity from own renewable sources, so the impact was subtracted from emissions, totalling –16000 kWh. However, the electricity consumption of the pilot is higher (50.000 kWh) than generated. Water subsystem included tap water (100 m^3) and rainwater (20 m^3) used directly for irrigation of plants and other domestic uses within the pilot.

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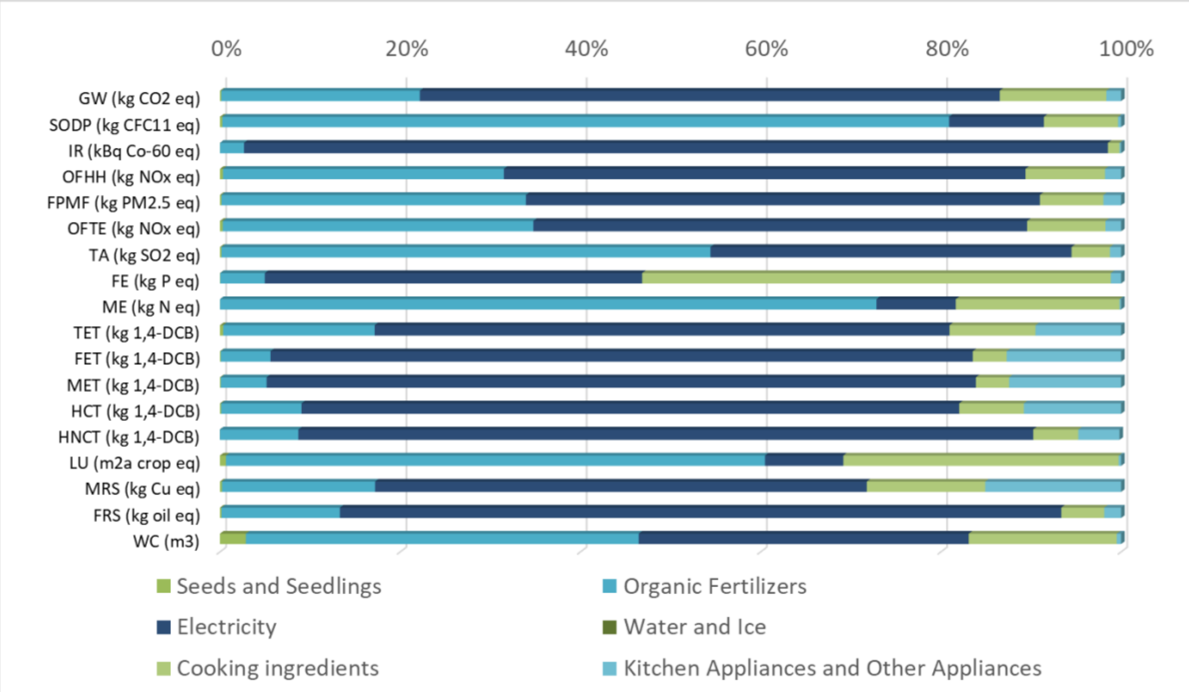
In the case of cooking ingredients, a total of 400 L of vegetable oil were used over the year of assessment. Finally, various kitchen appliances were included in the assessment: 2 medium and 3 large fridges, 4 large freezers, 2 large ovens, 1 medium microwave, 3 large hobs and 1 small and 1 large dishwasher.

In terms of impacts Figure 7 shows that the impact distribution of the SALUS pilot is split into four main subsystems: electricity, organic fertilizers, cooking ingredients and kitchen appliances and other appliances. On the other hand, seeds and seedlings and water and ice were found to have a negligible impact. Although it is not visible in Figure 7, electricity represents avoided emissions in the environmental profile of the pilot, as it has a renewable origin. These savings, although in some impact categories such as ionising radiation or fossil resource scarcity they surpass the current impact of the pilot if electricity consumption is removed from the figure, are lower than the total electricity consumption of the pilot (50.000 kWh). Organic fertilizers represented more than 50% of the relative contribution in terrestrial acidification (54%), stratospheric ozone depletion (81%), marine eutrophication (73%) and land use (60%), mainly due to organic fertilizers coming from manure. Cooking ingredients' greatest contribution was found in freshwater eutrophication (52%). Since most of the food consumed in the pilot is self-produced, additional impacts from food production are not expected.

Figure 6 – SALUS Space Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: although the pilot produces several crops, along with food processing, the primary function of the pilot seems to be more socially-focused, with more than 5000 visits, 100 workshops and 220 local events. Therefore, a social-based FU would be more appropriate than one focused on food production. For example, if food is served to low-income people in need, a potential FU could be related to meal provision. However, system boundaries should be redrawn to avoid allocating non-relevant inputs to this function.
- **LCC conclusions**: the most relevant costs come from labour. This should be also contextualised considering several volunteers run the activities in Salus Space.

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- S-LCA conclusions: although the relevance of the pilot's social impacts is demonstrated by a rank above national average for all indicators, further investigation is needed on social performance indicators to be included in the analysis.
- LCA conclusions: the outcome of the LCA highlights a limitation in terms of system boundaries that prevents a broad overview of the performance of a particular pilot like Salus Space. Further assessments should look at including food processing and consumption. However, Salus Space outcomes were relevant to designing the assessment tool for the next WP2 task.

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3.3 Pilot 3 - SERRA MADRE: A food hub for education, leisure and urban farming innovation

	
General	**Organisation Type**
	Profit - Cooperative
	City and Country
	Bologna (Italy)
	Location
	Mainland –Urban
	Pilot short description
	The pilot aims to strengthen and innovate in artistic and cultural proposal of the “Le Serre” by focusing on the creation of an artistic production centre that connects the world of research (scientific and humanistic), the world of business and the world of art around the great challenges of our time: sustainability and climate change. The available greenhouses and open spaces are suitable for growing a range of local horticultural products with the aim of defining protocols for sustainable urban cultivation and involving local organizations and citizens while also raising their awareness on food production and safety.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Agricultural Production; Restaurants and catering; Education and services
	Characteristics of the pilot (extension, type of land etc.)
	1 ha of artificial surface received by municipal concession, of which 0.5 ha is the extension of the lot to be studied. 10 employees are involved in the pilot Serra Madre.
	Time span of the analysis
	12 months (forecasted for year 2023)

LCC

Cost component included in the analysis: $C_{ac} + C_{op}$

Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 8 displays a bar chart related to these cost components. The acquisition costs include the acquisition and installation of the appliances and the refrigerator, the infrastructure costs and the installation ones. As for the operation costs, only electricity and water expenses exist. Additional items refer to the maintenance and service costs and to the disposal of appliances and materials. As for the life expectancies of the different acquisition costs, 15 years have been assumed based on the owner’s expertise. Despite having labour force for the pilot running, this cost is not bear by the pilot itself. Hence this voice was not included.

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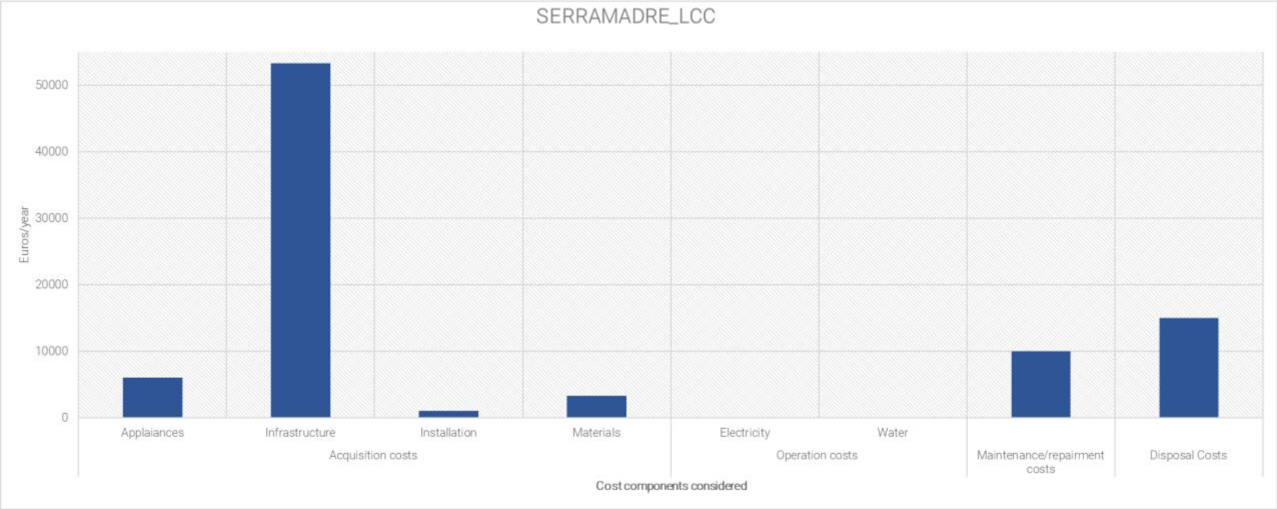
The overall life cycle costing for 12 months adds up to 88704 euros. Most of the costs derive from the overall infrastructure acquisition costs (60%). The cost of disposal (17%) and the maintenance cost (11%) are secondary. The remaining cost items contribute only lightly.

Figure 7 - SERRA MADRE Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Consumers: online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: According to Figure 9, Serra Madre impacts all the envisioned stakeholder categories, I.e., workers and producers, consumers, local community, and society. The majority of the indicators are rated above the national average, while two of them (contract typology and customers return rate) are completely in line with the national trend. The highest performance is for the purchase frequency, estimated to be three times higher than the national average; the frequency of local events is 2,5 times higher than the national average, while volunteering activities for the community and presence across the CRFS are expected by 2023 to be twice the Italian average. On the other hand, trainings for workers are expected to be more than two times lower than the national average, resulting in the lowest value of the social performance. Besides, several indicators rank below the national average, specifically: income level, online platform usage, local selling, and provenance of employees.

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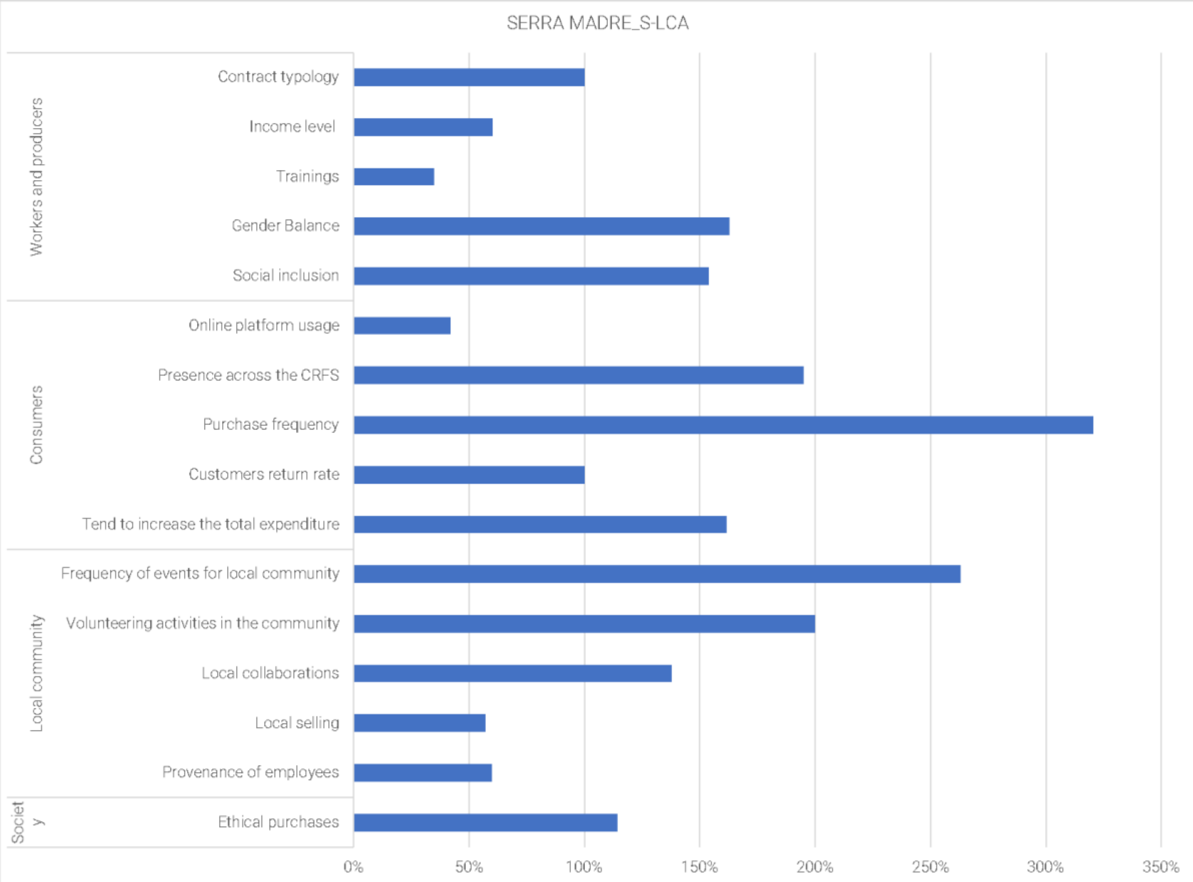
Figure 8 – Serra Madre Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Several indicators have been analysed without comparing to a national benchmark and are listed in Table 4.

Table 4 - Additional indicators adopted for Serra Madre Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	Data
Consumers	Food security	Average expenditure	Average receipt	17
	Food quality	Availability of products information	N of certified food products	90%
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	4
		Participation rate	N of people participating per event (average)	70
		Educational events	N of events specifically targeting education on food system	40
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	7

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Society	Raw materials traceability	N of food labels indicating the origin of products	35

LCA

Discussion of results: The inventory and impact assessment were calculated for 12 months of activities carried out at the pilot. The subsystems included in the assessment were seeds and seedlings, electricity, water and ice, cooking ingredients and kitchen appliances and other appliances.

Seeds and seedlings included 10000 seedlings of various horticultural crops. The pilot needed electricity for pumping water (550 kWh) and air (200 kWh). In terms of water, the pilot used 30 m^3 of tap water and 500 m^3 of rainwater. From the latest, 250 m^3 were recirculated. It is important to mention that although rainwater doesn't have associated environmental impacts in this assessment, it would be important to include all the infrastructure related to the rainwater harvesting system. In terms of cooking ingredients, the assessment included 1000 litres of vegetable oil, 150 kg of salt and 300 kg of butter. Finally, kitchen appliances and other appliances included 3 large fridges, 3 large freezers, 3 large ovens, 1 large microwave, 3 large hobs and 1 large dishwasher.

In terms of impacts Figure10 shows that the impact profile of the Sierra Madre pilot is dominated by the cooking ingredients, with more than 50% of the impacts in all categories: freshwater and marine eutrophication (both 99%), land use (99%) and stratospheric ozone depletion 97%. Among the cooking ingredients, vegetable oil was the biggest contributor in all impact categories except for land use, in which the butter doubles the impact of vegetable oil. Kitchen appliances and other appliances had a contribution lower than 20% for most impact categories apart from freshwater ecotoxicity (41%), marine ecotoxicity (40%), human carcinogenic toxicity (26%) and mineral resource scarcity (22%). Electricity consumption, mainly for pumping water represented more than one third of the impact in ionising radiation (34%). Finally, impacts from water and ice were negligible in all categories. The same can be seen for seeds and seedlings, with the exception of water consumption (10%).

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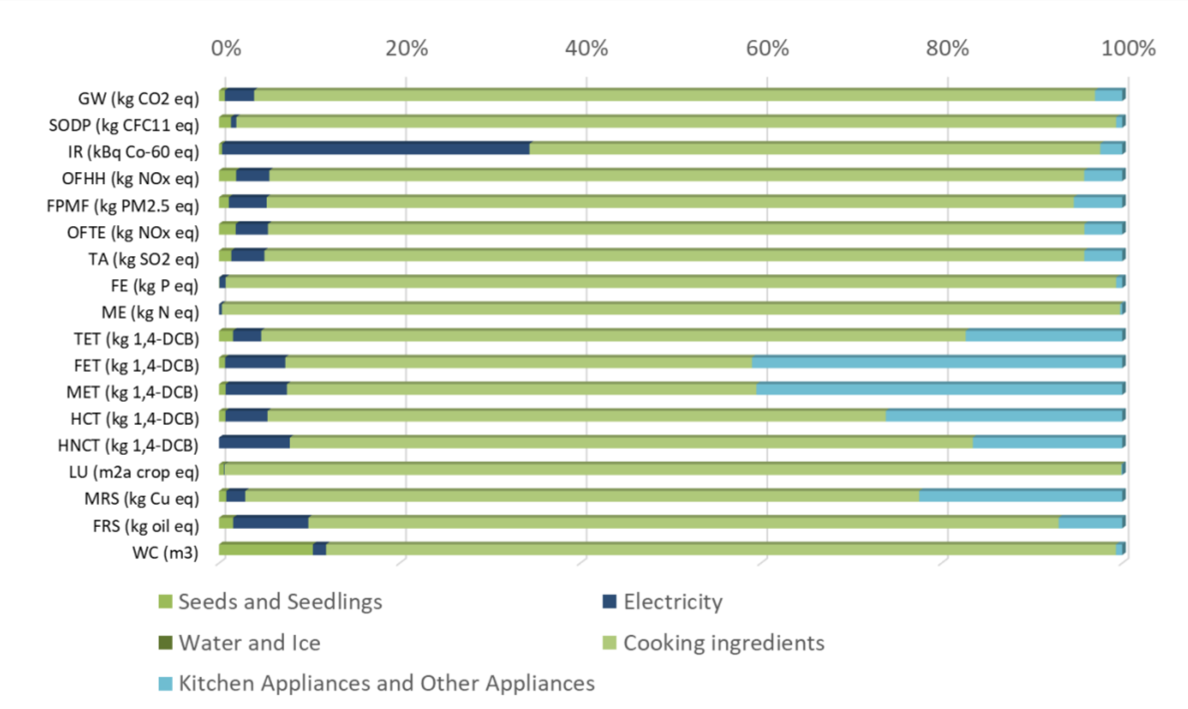
Figure 9 – SERRA MADRE Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU could be represented by economic revenue or caloric value related to the variety of horticultural products produced: tomato, lettuce, basil, mint, etc. However, since the focus of the pilot is on citizen engagement, a FU based on the amount of local people engaged or number of satisfactory events might be appropriate.
- **LCC conclusions**: outcome from the analysis allow to conclude that improvements in the costing performance of the pilot should be focused primarily on leveraging the infrastructure costs.
- **S-LCA conclusions**: findings demonstrate that improvements are needed in terms of trainings, income level, online platform usage, local selling, and provenance of employees. According to the expectations, the pilot will record great performances in the purchase frequency as well as the frequency of events for the local community.
- **LCA conclusions**: outcome of the LCA analysis show that the environmental profile is dominated by cooking ingredients. However, we would like to highlight that, despite using 530 m^3 of water, the impacts of this subsystem were negligible due to the use of mainly rainwater. Nonetheless, further assessments should take into account the impact of the infrastructure related to rainwater collection.
- **Potential limitations**: it is worth noticing that despite the collection of data was concluded in June 2022, some of the included values are hypothetical and referred to the year 2023. This is due to the preliminary phase of the pilot activities. Future impact assessments on the present pilot should aim at comparing the current analysis to an updated one, once the pilot is fully operative.

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3.4 Pilot 4 - Urban agricultural park for participatory agricultural test spaces

	
General	**Organisation Type**
	Non-Profit – Local Authority
	City and Country
	Sabadell (SP)
	Location
	Mainland –Urban and Peri-urban
	Pilot short description
	The pilot will convert two “council open-air fields” into “agricultural test spaces” where citizens will be able to participate in experimental tests on traditional local varieties grown in organic production systems. The objective is to collect information enabling to produce a local, qualitative product with a clean production system. Farmers from the Agricultural Park will also contribute by producing and marketing their products directly at the main market in Sabadell. There will also be participation of consumer cooperatives of local organic products as well as schools in the city. The pilot is on three separate locations: • Hort urbà • Parc Agrari • Ripoll River
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Agricultural production, Food processing, Food distribution
	Characteristics of the pilot (extension, type of land etc.)
	Agricultural surface with variable extension
	Time span of the analysis
	12 months (forecasted for year 2023)

LCC

Results will be presented separately for the three different pilot locations.

Hort urbà

Cost component included in the analysis: $C_{ac} + C_{mr}$

Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 11 displays a bar chart related to these cost components. The acquisition costs include the irrigation system with a programmer, construction shed and irrigation pond, a protective fence against wildlife, a pump, the agricultural warehouse, interpretation centre, class and conference room, and space for cold rooms. The life expectancy of those acquisitions is set at 15 years based on owners' expertise. The overall life cycle costing for 12 months adds up to 3900 euros. The costs are almost evenly shared between the acquisition (52%), and maintenance (48%) costs.

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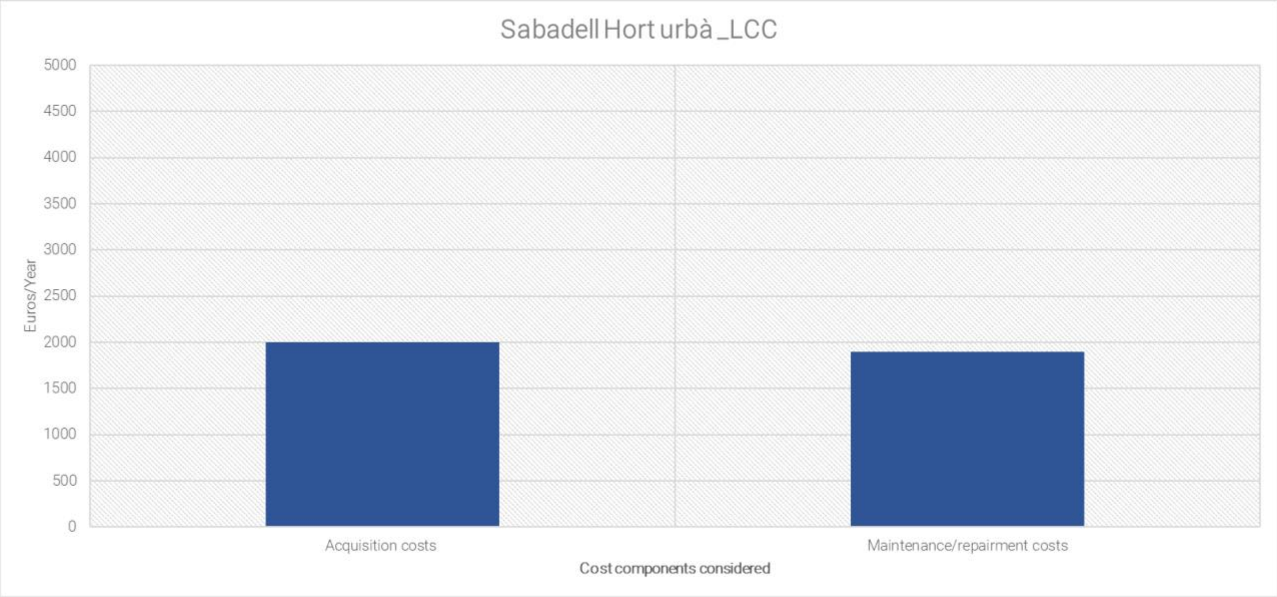
Figure 10 – Sabadell Hort urbà Life Cycle Costing (LCC) results in euros per year

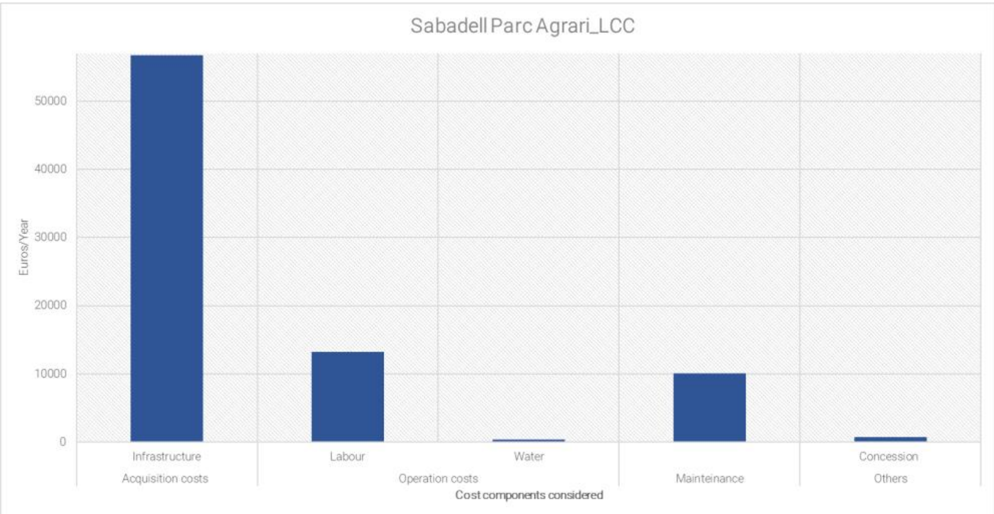


Parc Agrari

Cost component included in the analysis: $C_{ac} + C_{op} + C_{mr} + C_{ot}$

Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 12 displays a bar chart related to these cost components. The acquisition costs include the irrigation system with programmer, construction shed and irrigation pond, a protective fence against wildlife, a pump, the agricultural warehouse, interpretation centre, class and conference room, space for cold rooms. The life expectancy of those acquisition is set at 15 years based on owners' expertise. Water and labour expenses for one farmer managing the pilot are included in the operation costs. Finally, there are maintenance costs and other costs including the concession expenses for the land. The overall life cycle costing for 12 months adds up to 81046 euros. Most of the costs derive from the infrastructure (70%). The labour (16%) and maintenance (12%) costs are next. The remaining cost items contribute only lightly.

Figure 11 - Sabadell Parc Agrari Life Cycle Costing (LCC) results in euros per year



Ripoll River

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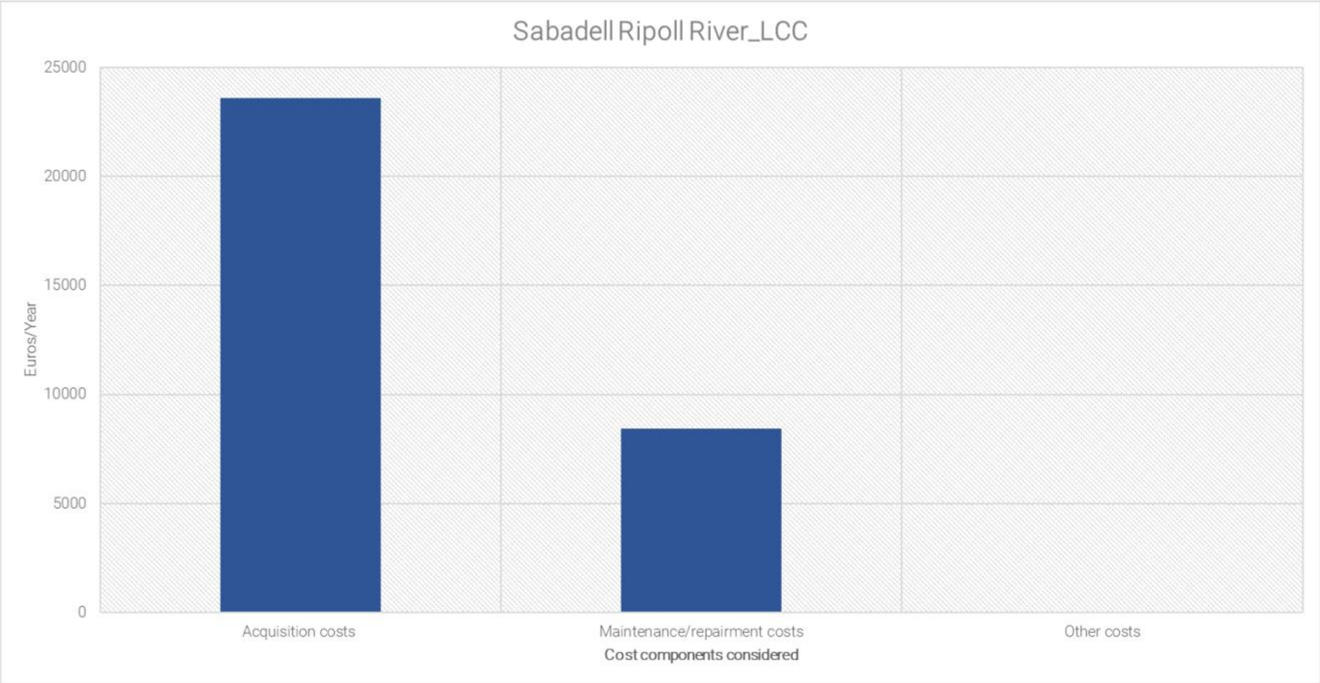
Cost component included in the analysis: $C_{ac} + C_{mr} + C_{ot}$
Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 13 displays a bar chart related to these cost components. The acquisition costs include the irrigation systems, wells for irrigation, deposits for agriculture tools, land preparation, protective fence and toilets. The life expectancy of those acquisition is set at 15 years based on owners' expertise. Finally, there are maintenance costs and other costs including the concession expenses for the land. The overall life cycle costing for 12 months adds up to 32016 euros. Most of the costs derive from the acquisition costs of infrastructure (74%) and the maintenance costs (26%).

Figure 12 - Sabadell Ripoll River Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: <u>Workers and producers:</u> contract typology, income level, trainings, gender balance, social inclusion; <u>Consumers:</u> online platform usage, presence across the CRFS, purchase frequency, average expenditure, tend to increase the total expenditure, availability of products information; <u>Local community:</u> digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; <u>Society:</u> raw materials traceability, ethical purchases.
Discussion of results: Results will be presented separately for the three different locations.
<u>Hort urbà</u>
For the activities located in the urban garden, indicators are either above or below the national average (Figure 14). As in the previous location, all the stakeholder categories have been included in the assessment. The most relevant performances are in the social inclusion and local collaboration dimensions, followed by the frequency of events for the local community. In the centre the pilot is less performant in the consumer category, paying major attention to the local community.

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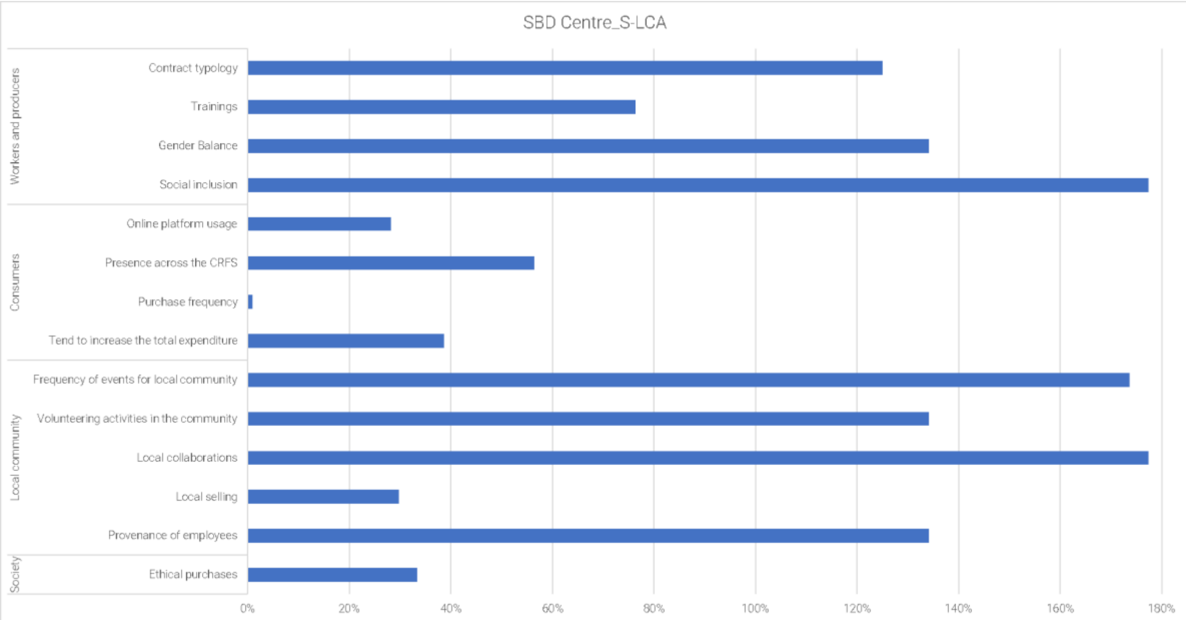
Figure 13 - Sabadell Hort urbà Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators not compared to a benchmark are presented in Table 5.

Table 5 - Additional indicators adopted for Sabadell Hort urbà Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	1
Local community	Community outreach, education & development	Participation rate	N of people participating per event (average)	20
		Educational events	N of events specifically targeting education on food system	4
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	4

<u>Parc Agrari</u>
Aligned with the other locations, social impacts have been assessed for all the considered stakeholder categories (Figure 15). The majority of indicators are ranked below the national average, except for the ones related to the workers and producer's category as well as for local

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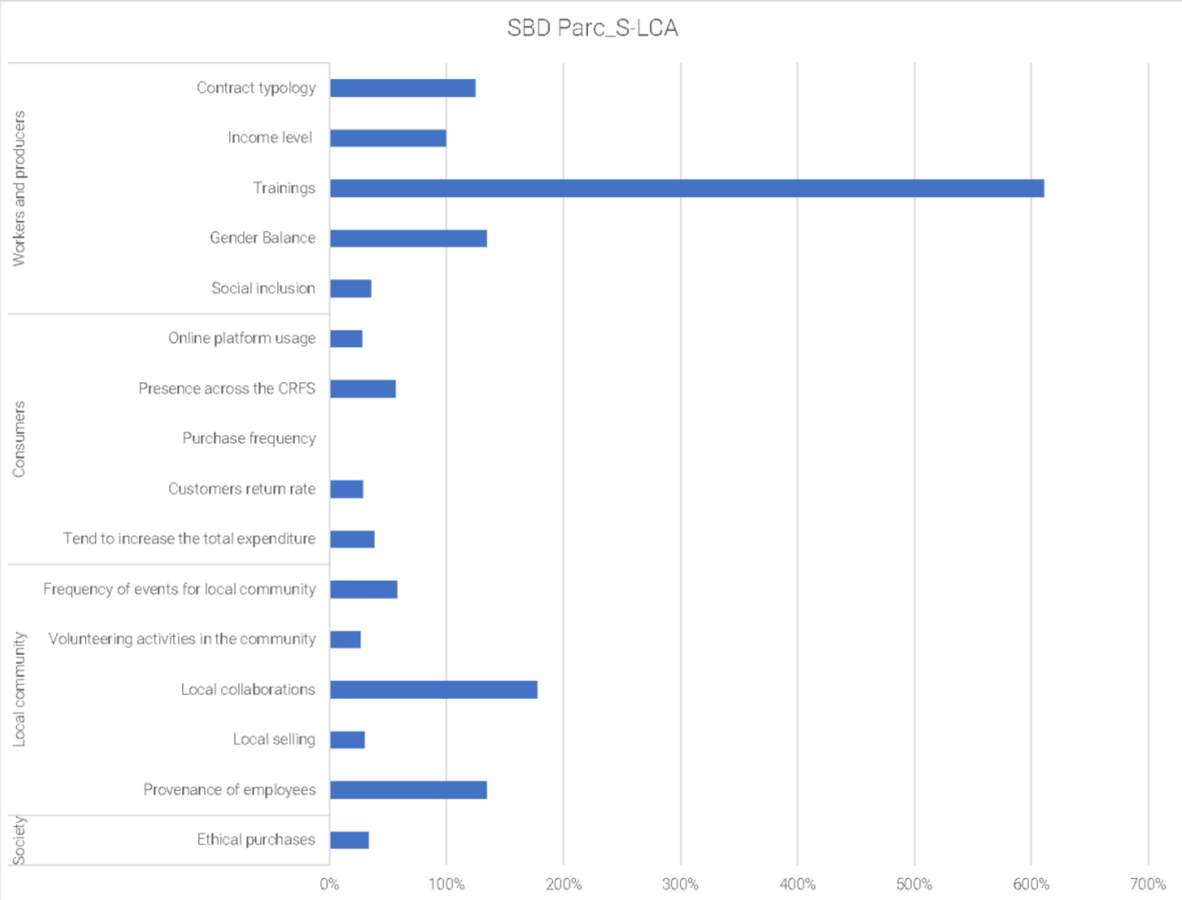
collaborations and provenance of employees. The most relevant performance is recorded for the trainings as six times higher than the national average.

Figure 14 - Sabadell Parc Agrari Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators not compared to a benchmark are presented in Table 6.

Table 6 - Additional indicators adopted for Sabadell Parc Agrari Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	3
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	3
		Participation rate	N of people participating per event (average)	200
		Educational events	N of events specifically targeting education on food system	2

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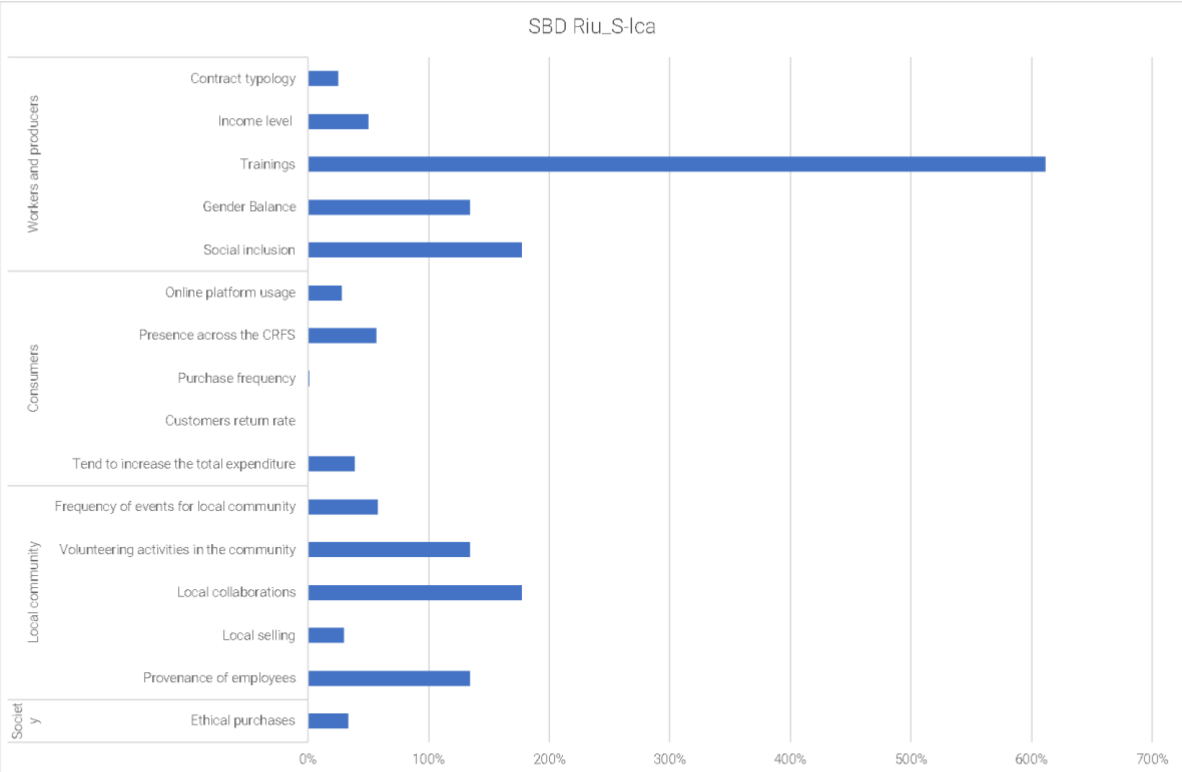
	Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	4
Society	Raw materials traceability	N of food labels indicating the origin of products	2

Ripoll River

According to the bar chart presented in Figure 16, social impacts have been assessed and allocated to all the considered stakeholder categories. Several indicators ranked above the national average, including gender balance, social inclusion, volunteering activities in the community and local collaborations, with the most significant results being the trainings indicator, which is six times higher than the national average. Nonetheless, the majority of the indicators rated below the national average, in particular with respect to the consumers category, with a minimum performance in the customer return rate indicator.

Figure 15 – Sabadell Ripoll River Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators not compared to a benchmark are presented in Table 7.

Table 7 - Additional indicators adopted for Sabadell Ripoll River Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Local community	Community outreach,	Digital channels for activity dissemination	N of channels	2

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	education & development	Participation rate	N of people participating per event (average)	70
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	3

LCA

Important considerations: since the 3 parts of the pilot were not under operation during the time of data collection, different proxies were used to proceed with the evaluation. To assess the production of vegetables we considered that all pilots were producing Garland tomatoes (local variety) from May until October and Sabadell onions (local variety) from November to February, resting the soil for two months (March and April). Data on water and nutrient consumption, production and other operational parameters were retrieved from a report by Institut de Recerca I Tecnologia Agroalimentàries (IRTA), that produced these two crops (among others) in similar conditions. Considering the total area of the pilots reported in the data collection template, we assumed that 1000 m^2 in all of them were not used to grow crops but to allocate the irrigation headboard or store tools.

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were seeds and seedlings, synthetic fertilizers, electricity, water and ice, construction materials and packaging materials.

The total impacts for Global Warming for the considered timeframe were 1148, 5260 and 189 kg CO_2 eq for the Hort urbà, Parc Agrari and Ripoll River sub-pilots, respectively.

Inventory data was qualitatively similar in all three sub-pilots due to mentioned forecasting, but quantities differed based on the extension of each sub-pilot. Seeds and seedlings included seedlings of onions (Sabadell variety) and tomatoes (Garland variety). Synthetic fertilizers included inorganic nitrogen fertiliser from a generic source, iron sulphate, monoammonium phosphate and potassium sulphate. All sub-pilots will use electricity mainly for water pumping since artificial lighting or active ventilation is not usually needed in the Mediterranean region of the Iberian Peninsula. Water subsystem included tap water for irrigation of both cycles of onion and tomato. In terms of construction materials to build the irrigation system, the headboard and basic infrastructure to store some tools included steel, aluminium, polycarbonate, polyvinyl chloride and polyester. Finally, packaging materials included high- and low-density polyethylene.

In terms of impacts Figure 17 shows the impact distribution of the Sabadell Parc Agrari sub-pilot, which was the first one enrolled in FoodE and the largest. We used it as the example to describe the impact distribution as it looks similar to the Ripoll River and Hort urbà sub-pilots. Three subsystems exerted the largest impacts across impact categories: seeds and seedlings, synthetic fertilizers and packaging materials. Water and ice and construction materials had negligible impact in all impact categories. As for the largest contributing subsystems, seeds and seedlings had contributions over 50% in marine eutrophication (87%) and terrestrial ecotoxicity (53%), especially due to onion seedlings because of its larger quantity (250,000 plants per hectare) compared to tomato seedlings. (7,400 plants per hectare). Synthetic fertilizers had contributions over 50% in stratospheric ozone depletion (91%) and mineral resource scarcity (63%), especially due to a generic nitrogen fertiliser. In terms of packaging

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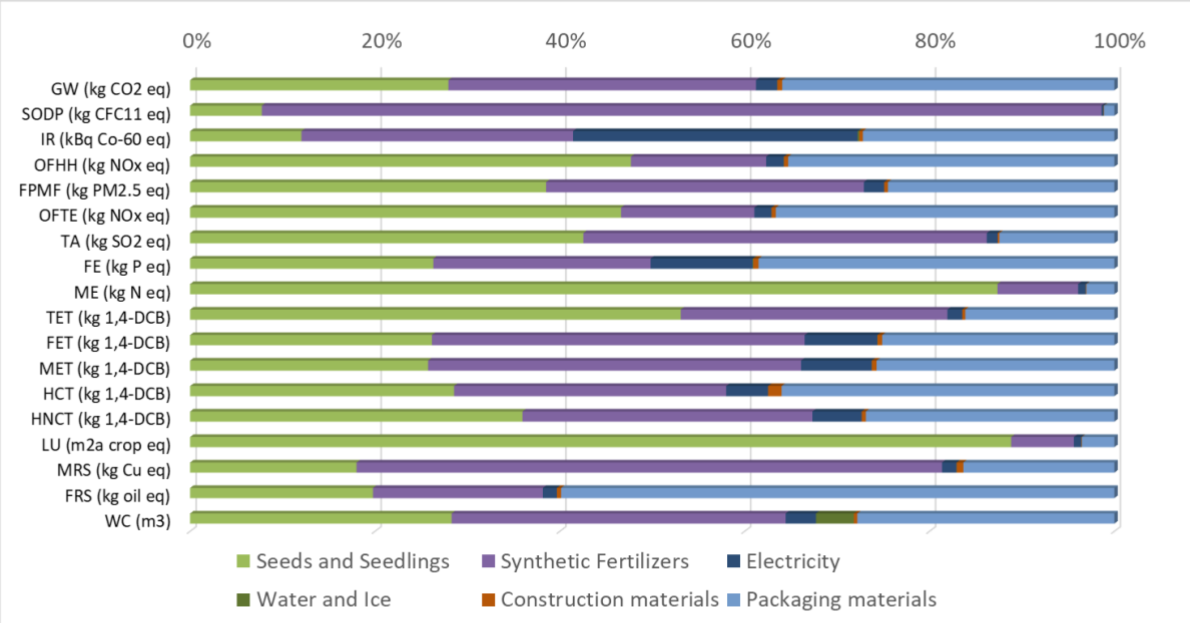
materials, this subsystem surpassed the 50% of relative contribution in only one impact category: fossil resource scarcity (60%). Finally, electricity had relatively lower contributions than the three most harmful subsystems but contributed to 30% to ionising radiation.

Figure 16 - Sabadell Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion:** since the objective of all three sub-pilots is to produce food, a FU based on individual horticultural products might be suitable if, as expected, different areas will be used for different crops. If different crops are mixed in the same growing area, a caloric value FU would be more suitable than one focusing on economic revenue because in 2 out of 3 pilots the production will be consumed by either volunteers or low-income families than won't pay for it.
- **LCC conclusions:** to improve the pilot cost performance across the three different locations, emphasis should be placed on the infrastructure cost reduction. In parallel, a more detailed data collection may be needed to better distinguish the different cost categories.
- **S-LCA conclusions:** considering the pilot as a whole, the majority of the assessed social impacts is below the national average. Special attention should be paid to the consumers category, as improvements are needed.
- **LCA conclusions:** the outcome of the analysis suggests that efforts should be put in gathering data related to the seedlings and decreasing the impact of synthetic fertilizers. However, since most data was either forecasted or based on literature due to the status of the pilot, further assessments should look at the final development of the pilot. As an example, packaging materials can be expected to be diminished due to the proximity of all sub-pilots to consumption points.
- **Potential limitations:** for all the three pilot locations, data was estimated based on forecasts for next year's activities, and several assumptions were made to conduct the analysis. Future assessments of the pilot should aim at comparing the present results with results derived from the pilot once activities will be fully running.

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3.5 Pilot 5 – The Cité Maraîchère: vertical farm, educational gardens, sustainable and social food, market gardening and mushrooms production, circular innovation and short food chain

<table>
<tr><td></td><td></td></tr>
<tr><td rowspan="8">General</td><td>Organisation Type</td></tr>
<tr><td>Non-Profit – Local Authority</td></tr>
<tr><td>City and Country</td></tr>
<tr><td>Romainville (FR)</td></tr>
<tr><td>Location</td></tr>
<tr><td>Mainland –Urban</td></tr>
<tr><td>Pilot short description</td></tr>
<tr><td>The Cité Maraîchère is a vertical greenhouse devoted to urban agriculture (700 m^2 for market garden production in boxes and 130 m^2 in the basement for mushrooms and French endive production). Its challenges: bring out a new way of eating in a popular area located near the city center; raise awareness and offer workshops on sustainable food, nature in the city and eco-citizenship; develop vocational training and promote social inclusion by setting up an integration project.</td></tr>
<tr><td rowspan="8">Sustainability Assessment Characteristics</td><td>Goal & Scope</td></tr>
<tr><td>To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)</td></tr>
<tr><td>System boundaries (Supply chain phases included in the assessment)</td></tr>
<tr><td>Agricultural Production; Food Waste and recovery; Education and Services</td></tr>
<tr><td>Characteristics of the pilot (extension, type of land etc.)</td></tr>
<tr><td>0.26 ha of artificial surface of municipality property, of which 0.07 ha of vertical greenhouse is the lot to be studied, to which are added: 0.013 ha for the basement for mushrooms and endives production, 0.0085 ha of outdoor gardens for educational purposes, and 0.0183 ha of café-canteen and professional kitchens.</td></tr>
<tr><td>Time span of the analysis</td></tr>
<tr><td>12 months (year 2021)</td></tr>
</table>

LCC

Cost component included in the analysis: $C_{ac} + C_{op} + C_{mr} + C_{ot}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis, including the specific cost items. Figure 18 displays a bar chart related to these cost components. As for the acquisition costs, the analysis includes the kitchen appliances, the infrastructure where the pilot is run, and the material costs made up of different inputs for agriculture. As for operation costs, the electricity and the water used, are considered. In parallel there are labour, including permanent staff, trainees and civic services, and training costs. The others operation costs consist of the internet, telephone rentals and subscription, and the wood needed for the operations. Maintenance and repairments costs also occur. Other costs refer to the insurance, and vacation fees and documentation and communication.

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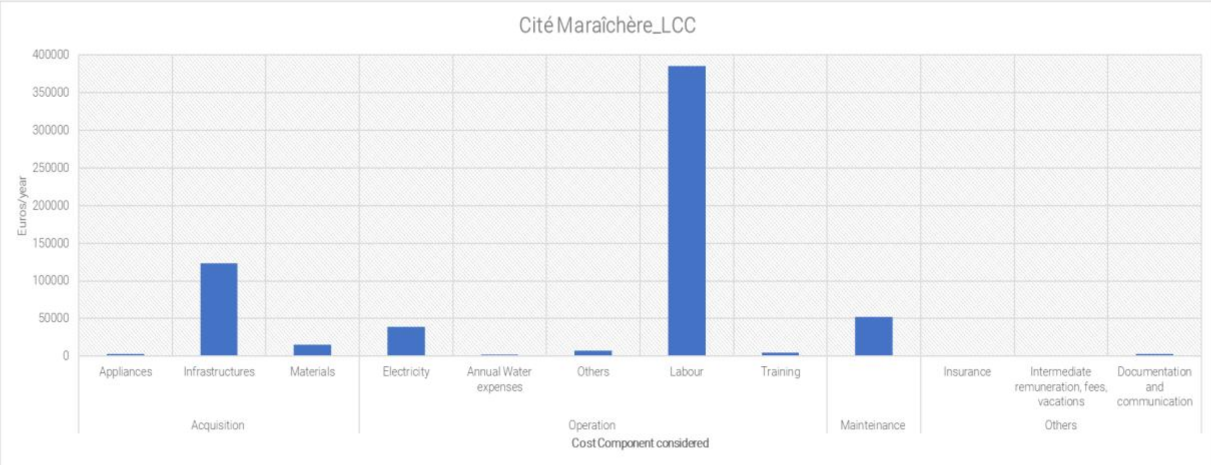
The overall life cycle costing for 12 months adds up to 637045 euros. Most of the costs derive from the labour (60%). The infrastructure cost (19%) follows. The remaining cost items contribute only laterally.

Figure 17 - Cité Maraîchère Life Cycle Costing (LCC) results in euros per year

S-



LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level (per permanent and integration employee), internships, gender balance, social inclusion; Consumers: online platform usage, presence across the CRFS, purchase frequency, customers, average expenditure, customer return rate, registered clients, availability of products information; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations (of which institutional), collaborations with activities and projects, kids engagement, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: The Cité Maraîchère involves all stakeholder categories considered in the study, with the local community category showing the highest performances (Figure 19). Data reports the maximum peak in the frequency of events for local community amounting to more than twice the national average, and a minimum for the online platform usage. Relevant performances can be observed for the local collaborations and local selling which almost reach twice the national average values. Several indicators are under the national average, most remarkably the ones related to the consumers and society categories.

Specific information is provided relatively to the average gross monthly salary of permanent employees (2000€/month) and of integration employees (1800€/month).

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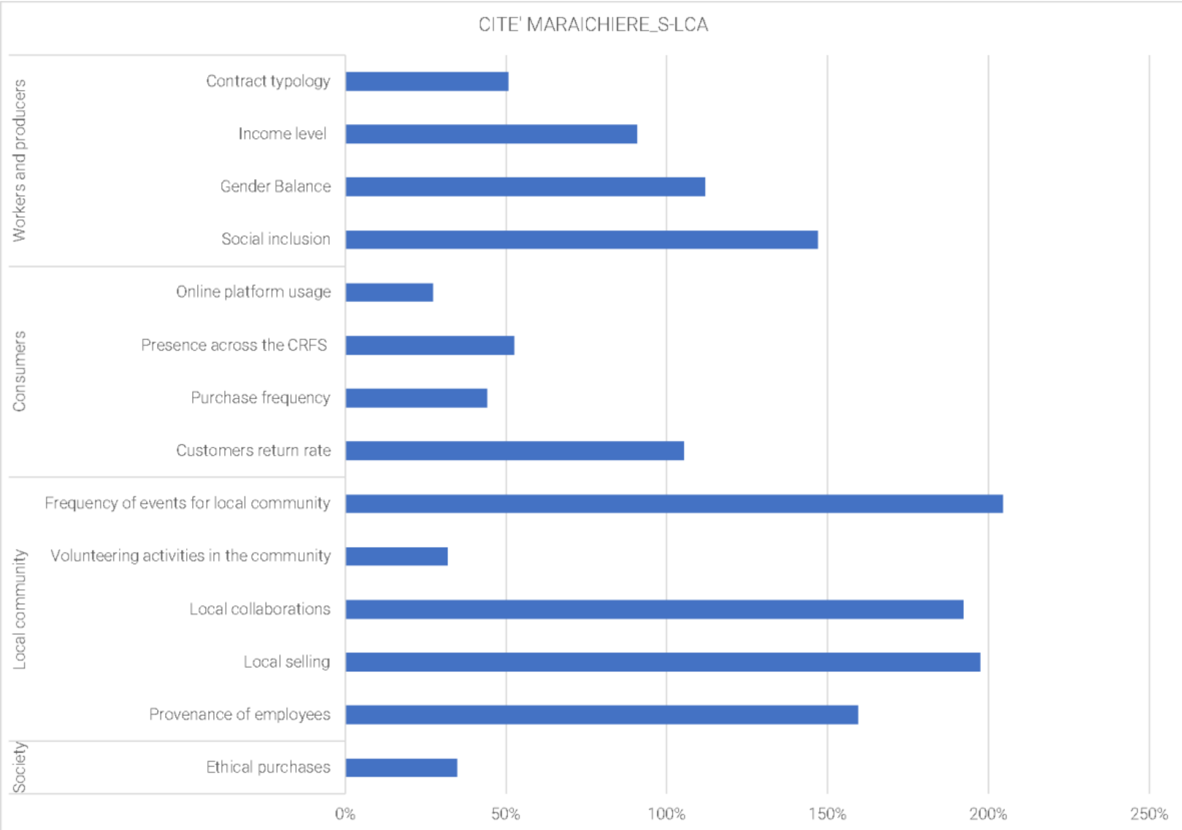
Figure 18 - Cité Maraichere Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators have been selected to better reflect the complexity of the pilot and highlight its potential social impacts. Table 8 introduces the indicators analysed for the pilot, which were not compared to a national benchmark.

Table 8 - Additional indicators adopted for Cité Maraichere Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	Data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	20
		Internship creation	N of interns per year	5
Consumers	Food security	Customers	N of customers	3106
		Average expenditure	Average sale amount	6,11
	Food quality	Client registration	N of total registered clients	341
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	6
		Participation rate	N of people participating per event (average)	300
			N of kids reached per year	2500

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	Educational events	N of events specifically targeting education on food system	50 (100%)
		N of hours of workshops	625
	Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	18
		N of institutional collaborators	13

Further specifications are provided for the restaurant activities, which opened on the 14th of October 2021 and is relying on 6 employees, of which 4 are female. The restaurant had on average 40 customers per day and sold 15% of the vegetables produced by the Cité Maraichère. Besides, the restaurant paid 1200 euro per month of fees to the city for the renting, in addition to a variable part linked to turnover (1% of the annual turnover between 0 and 200.000 euros).

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were substrate for soilless cultivation, seeds and seedlings, organic fertilizers, other energy sources, waste and kitchen appliances and other appliances.

Substrate for soilless cultivation included various sources of compost. Although this compost might be included in the "Organic fertilizers" subsystem, we included it in the substrate subsystem since we assumed holding the mushrooms was its main function. Seeds and seedlings didn't include mushrooms preliminary phase, but it included nursery plants of e.g. artichoke that are grown within the pilot premises. Organic fertilizers included 10 m^3 of compost from green biomass and 10 litres of nettle liquid manure. Several calculations had to be done to transform this units to units used by the background database, as well as assumptions related to the processes selection. Electricity consumption could not be defined for the pilot since only a general number for the whole growing plant could be obtained. In terms of other energy sources, 17.000 kg of pellets were used. In the case of waste, a total of 1507 kg of organic waste were composted. Finally, kitchen appliances were included in the assessment: a large electric hob and a medium dishwasher.

In terms of impacts Figure 20 shows that the environmental profile of this pilot is dominated by the subsystem other energy sources, followed by organic fertilizers and kitchen appliances and other appliances depending on the impact category under assessment. Seeds and seedlings and waste (except for terrestrial acidification (11%) and global warming (6%)) have always an impact below 5%, while substrate for soilless cultivation has impacts with over 5% of contribution in marine eutrophication (12%), water consumption (10%), stratospheric ozone depletion (10%), ozone formation – terrestrial ecosystems (8%) and ozone formation – human health (6%). As for the largest contributing subsystem, other energy sources greatest impacts were in land use (98%), terrestrial ecotoxicity (94%) and fossil resource scarcity (93%), while surpassing 50% of impact contribution in 14 more impact categories. These impacts were related to the production and distribution of 17 t of pellets used in the pilot without accounting for its combustion, which was left outside of the system boundaries. Organic fertilizers' contribution is especially large in stratospheric ozone depletion (63%), marine eutrophication (33%) and water consumption (29%), and it is due to the use of compost. Finally, kitchen appliances and other appliances exceeded 10% of impact contribution in freshwater (12%) and marine (11%) ecotoxicity and mineral resource scarcity (12%).

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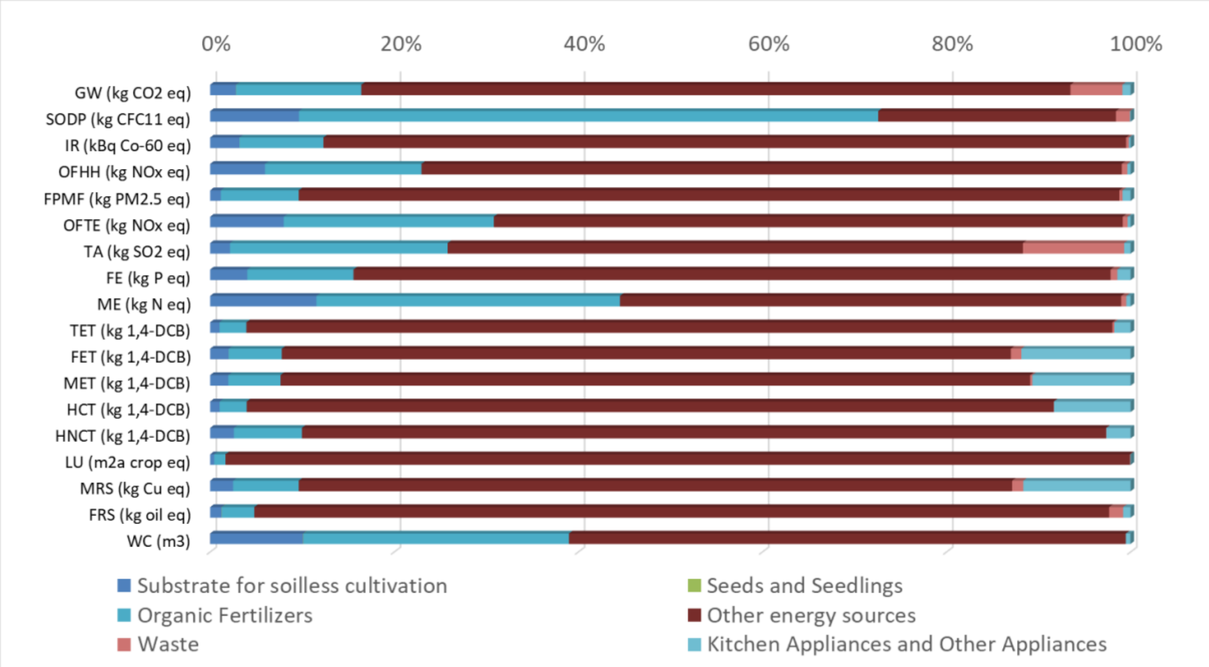
Figure 19 - Cité Maraichere Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: since most production of mushrooms is sold either to residents or the canteen, a mass-based or economic-based functional unit will be appropriate for the Cité Maraîchère pilot.
- **LCC conclusions**: to improve the cost performance of the pilot, emphasis should be placed on labour costs at first.
- **S-LCA conclusions**: findings showed the pilot has significant social impacts on the local community, whereas social performances should be improved for the consumers and society categories, with respect to the French average.
- **LCA conclusions**: the outcome of the LCA suggests that a massive use of pellets (although not considering their combustion) exerts the highest impact, surpassing all other activities more related to the pilot function.

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3.6 Pilot 6 - Plant factory for demonstrational purposes (WR)

	
General	**Organisation Type**
	Non-Profit – Local Authority and Research Center
	City and Country
	Bleiswijk (NL)
	Location
	Mainland –Peri- Urban
	Pilot short description
	The indoor farm is a powerful research tool to investigate a number of products and services with respect to their resource efficiency (water, CO_2, energy), sustainability and public appeal. In the FoodE project it will serve as a location for communication and dissemination due to its close connections with the local growers, producers, suppliers as well as the collaboration with the municipality of Lansingerland (NL). The program will facilitate training and dissemination workshops on closed plant production which will be accessible to over 300 local growers and other agricultural specialists.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting).
	System boundaries (Supply chain phases included in the assessment)
	Agricultural Production; Education and Services
	Characteristics of the pilot (extension, type of land etc.)
	The extension of the estate consists in 0.0576 ha of artificial surface. The lot studied for the assessment is 0.00412 ha.
	Time span of the analysis
	Differ depending on the analysed sustainability pillar

LCC

Evaluation period: 161 days (one productive cycle)

Cost component included in the analysis: $C_{aq}+C_{op}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis, including the specific cost items. Figure 21 displays the bar chart related to these cost components. As for the infrastructure an average life expectancy of 20 years is assumed (Martin, Weidner and Gullström, 2022). Infrastructures costs include the cell equipment and lighting, climate equipment, construction hall and research cells and electrical and computer equipment used to run the pilot. As for the operation costs electricity and water are included, multiplying the quantities used by the cost estimation based on Potplanten (2008). The labour costs refer to one full time employee (corresponding to a contract of 36 hours week^{-1}). Other operational costs include the industrial CO_2 needed for the OPAC system functioning. The overall life cycle costing for the production cycle of 161 days adds up to 52455 euros. Most of the costs derive from the labour expenses (51%) and the overall infrastructure acquisition (47%). The remaining cost items contribute only to a minimum extent.

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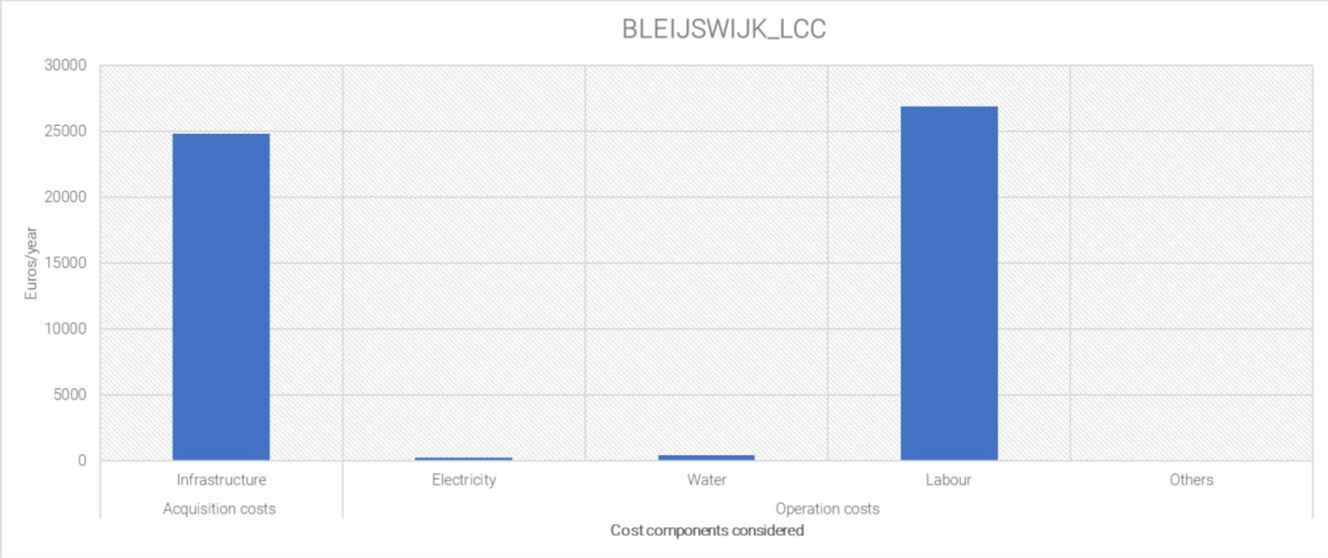
Figure 20 - Bleiswijk Life Cycle Costing (LCC) results in euros per year



S-LCA

Evaluation period: 12 months (year 2021)

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, local collaborations, collaborations with activities and projects, provenance of employees.

Discussion of results: Social impacts for the Bleiswijk pilot are displayed in Figure 22. The pilot is mainly oriented towards two stakeholder categories, namely workers and producers and local community. Being part of the Wageningen University and Research (WUR) institution, the pilot has a strong educational orientation, which also reflects in the social impact assessment. Indeed, the most significant performance emerges in the trainings reporting twice the national average value, followed by the frequency of events for local community which ranks above the national average together with gender balance and income level. By contrast, the social inclusion and local collaborations indicators record the lowest performances, below the national average together with provenance of employees and contract typology.

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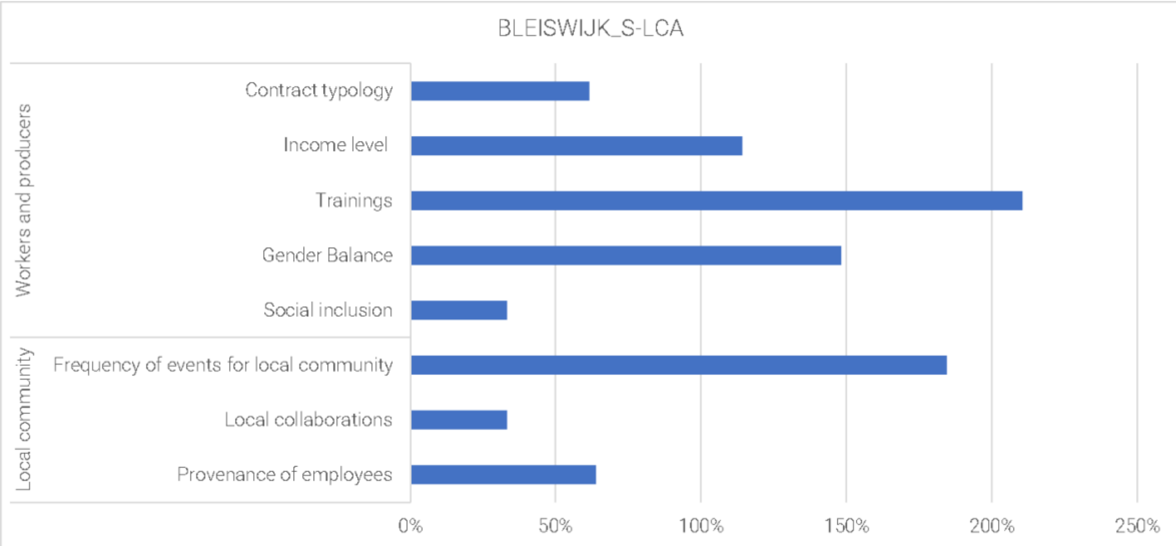
Figure 21 - Bleiswijk Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Several indicators used for the analysis were not compared to a national benchmark hence are not shown in the bar chart, these are presented in Table 9.

Table 9 - Additional indicators adopted for Bleiswijk Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	2
		Participation rate	N of people participating per event (average)	25
		Educational events	N of events specifically targeting education on food system	1
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	2

LCA

Evaluation period: 161 days

Discussion of results: the inventory and impact assessment were calculated for 161 days as a whole productive cycle as indicated by the pilot. The subsystems included in the assessment were substrate for soilless cultivation, seeds and seedlings, synthetic fertilizers, electricity, water and ice and construction materials. The total impacts for Global Warming for the considered timeframe were 6059 kg CO_2 eq.

Substrate for soilless cultivation included 19.7 kg of rockwool. Seeds and seedlings included 662 tomato seeds. Synthetic fertilizers included calcium nitrate, calcium chloride, magnesium nitrate, ammonium nitrate, 33% potassium fertilizers and other nutrient solutions (some of them were excluded due to lack of content data). Electricity consumption came mainly from artificial lighting and natural ventilation, while energy for water pumping is almost negligible. Water consumption for the considered growing cycle is 0.2 m^3 which was assumed to be equal

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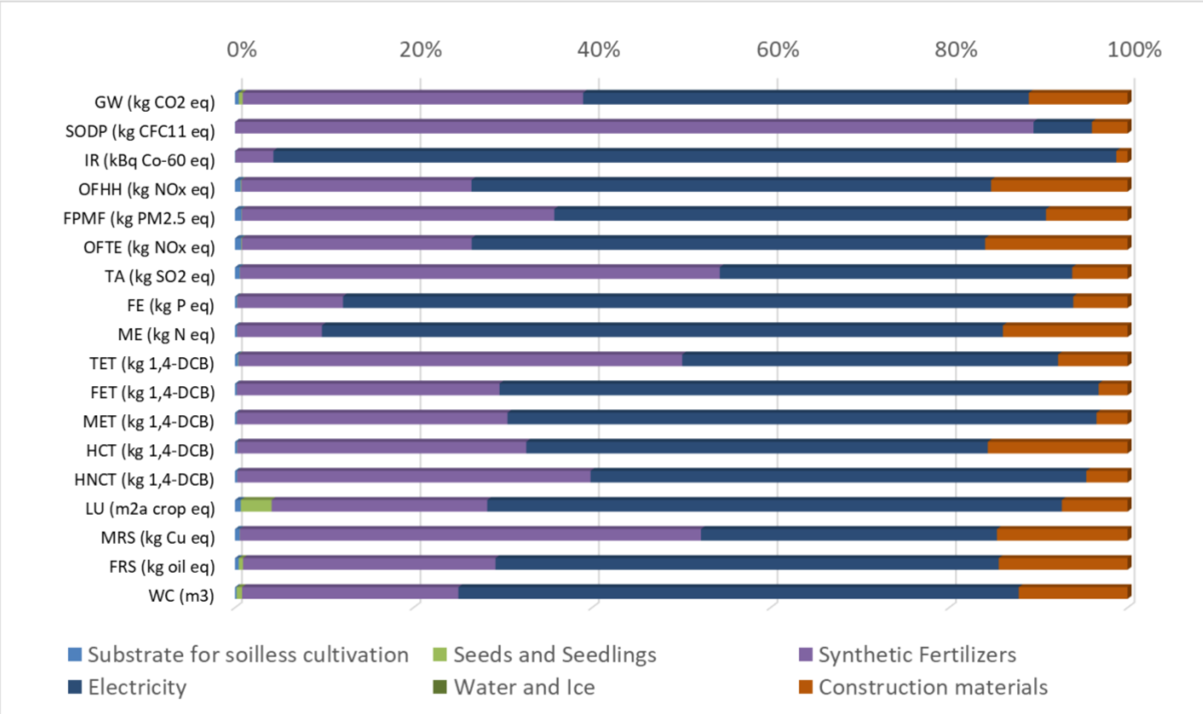
to the crop uptake. Finally, construction materials included concrete, steel, polycarbonate, polystyrene foam, polyisocyanurate and polyester.
In terms of impacts Figure 23 shows that the environmental profile of this pilot is distributed among three main subsystems across impact categories: synthetic fertilizers, electricity and construction materials. On the other hand, substrate for soilless cultivation, seeds and seedlings and water and ice have negligible impact (<1%) in all impact categories except for seeds and seedlings in land use (3%). As for synthetic fertilizers, their impact is especially relevant (>50%) in stratospheric ozone depletion (89%), terrestrial acidification (54%) and terrestrial ecotoxicity (50%), especially due to calcium nitrate not because it is implicitly harmful but because of the quantity of it that is used. Electricity's biggest contributions can be observed in ionising radiation (94%), freshwater (82%) and marine eutrophication (76%) or freshwater (67%) and marine ecotoxicity (66%). This contribution is coming mainly from artificial lighting (80%). Finally, the contribution from construction materials is always below 20%, with the largest ones being in human carcinogenic toxicity (16%) and ozone formation – human health (15%), especially due to concrete and polyisocyanurate. It is important to mention that because polyisocyanurate was not in the background database, polyurethane was used as a proxy.

Figure 22 - Bleiswijk Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU could be the mass FU. The LCT analysis can be allocated to 1 kg of tomatoes.
- **LCC conclusions:** to improve the pilot cost performance, emphasis should be placed on the reduction of labour and infrastructure costs. However, the present pilot is a non-profit one, with a research and educational scope, making cost considerations limited.
- **S-LCA conclusions**: although significant social impacts can be noticed for the workers and producers and the local community categories, with particular reference to the educational dimension, further investigation is needed on the social impacts to increase the number of indicators to assess the pilot's social performances.

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- LCA conclusions: the outcome of the analysis points out that synthetic fertilizers and electricity are the main contributors in most impact categories analysed. Improvement strategies that could be suggested are the substitution of mineral fertilizers with local and low-impact alternatives and the implementation of renewable energy to mitigate the impact of artificial lighting and ventilation.

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3.7 Pilot 7 - "PRISON HONEY" - Urban beekeeping for rehabilitation and social inclusion

	
General	**Organisation Type**
	Non-Profit – Association
	City and Country
	Ljubljana (SL)
	Location
	Mainland –Peri- Urban
	Pilot short description
	The pilot will be a unique, new project for the Urban Beekeeping Association. The objectives of the project go beyond business opportunities and food production as such, as they also include social activation in its core. In fact, the project offers a way to rehabilitate and empower underprivileged groups of society (it is aimed at imprisoned persons) primarily in Ljubljana, with the possibility of spreading the business model throughout Slovenia.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Livestock Agriculture; Food Distribution; Restaurants and catering; Education and Services
	Characteristics of the pilot (extension, type of land etc.)
	The lot to be studied consists of 0,002 ha of rented artificial surface.
	Time span of the analysis
	12 months (year 2021)

LCC

Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr} + C_{di}$

Analysis: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 24 displays a bar chart related to these cost components. The acquisition costs include the acquisition of appliances and infrastructures and the material expenses. Materials refer to bees feed and medications, the packaging used for the honey processing and the few additional inputs needed for honey transformation. As for the life expectancies of the appliances and infrastructures costs, 20 years have been assumed based on the owner's expertise. As for the operation costs electricity and water expenses occur, together with labour costs (considering the three employees working in the pilot) and commercial channels expenses. Yearly maintenance costs are also considered, as well as the cost occurring for two protection suits each year.

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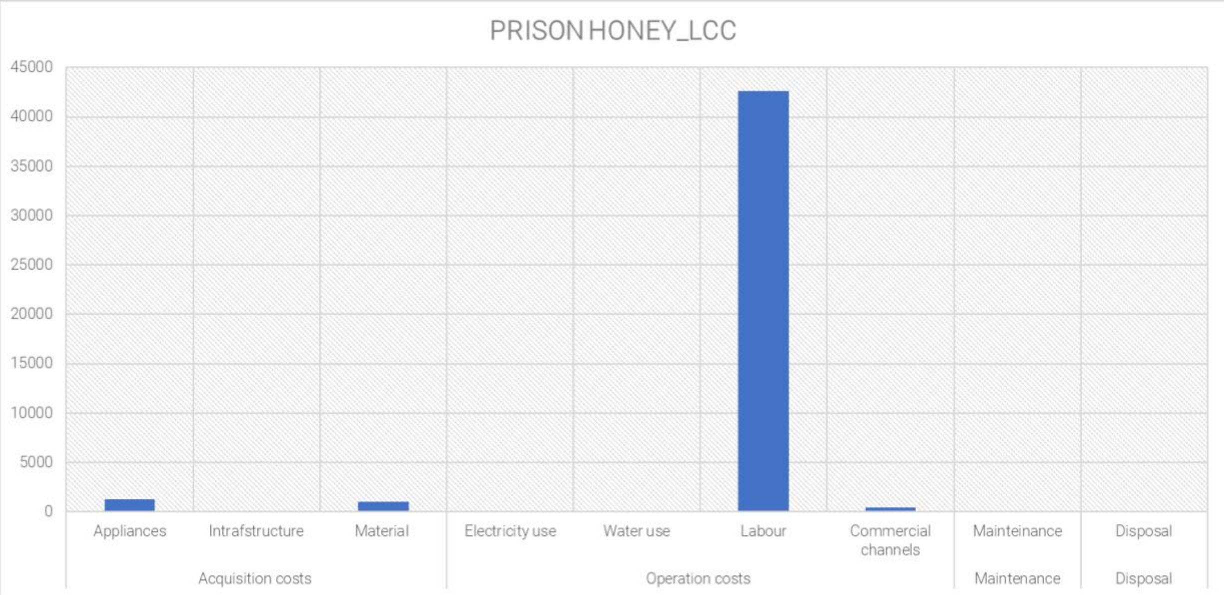
The overall life cycle costing for 12 months adds up to 45573 euros. The large majority of the costs derive from the labour expenses (93%), followed by a smaller share of appliances and materials costs. The remaining cost items contribute only lightly to the final cost performance.

Figure 23 - Prison Honey Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; consumers: online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; society: raw materials traceability, ethical purchases.

Discussion of results: Prison Honey pilot involves social impacts on all the considered stakeholder categories, with stronger evidence on the workers and producers and the local community. According to Figure 25, the highest performances were recorded in the social inclusion and trainings indicators. On the other hand, the majority of the indicators are below the European average, in particular the ones related to the consumers category. Specifically, the pilot is coping with the profitability potential of its activities, having had no purchase during the last year. It must be noted that social data collected for the Prison Honey pilot have been compared to a European benchmark, unlike all the other pilots which were instead compared to a national benchmark. For this reason, the results of the social impact assessment should be carefully contextualised when compared to other pilots' results.

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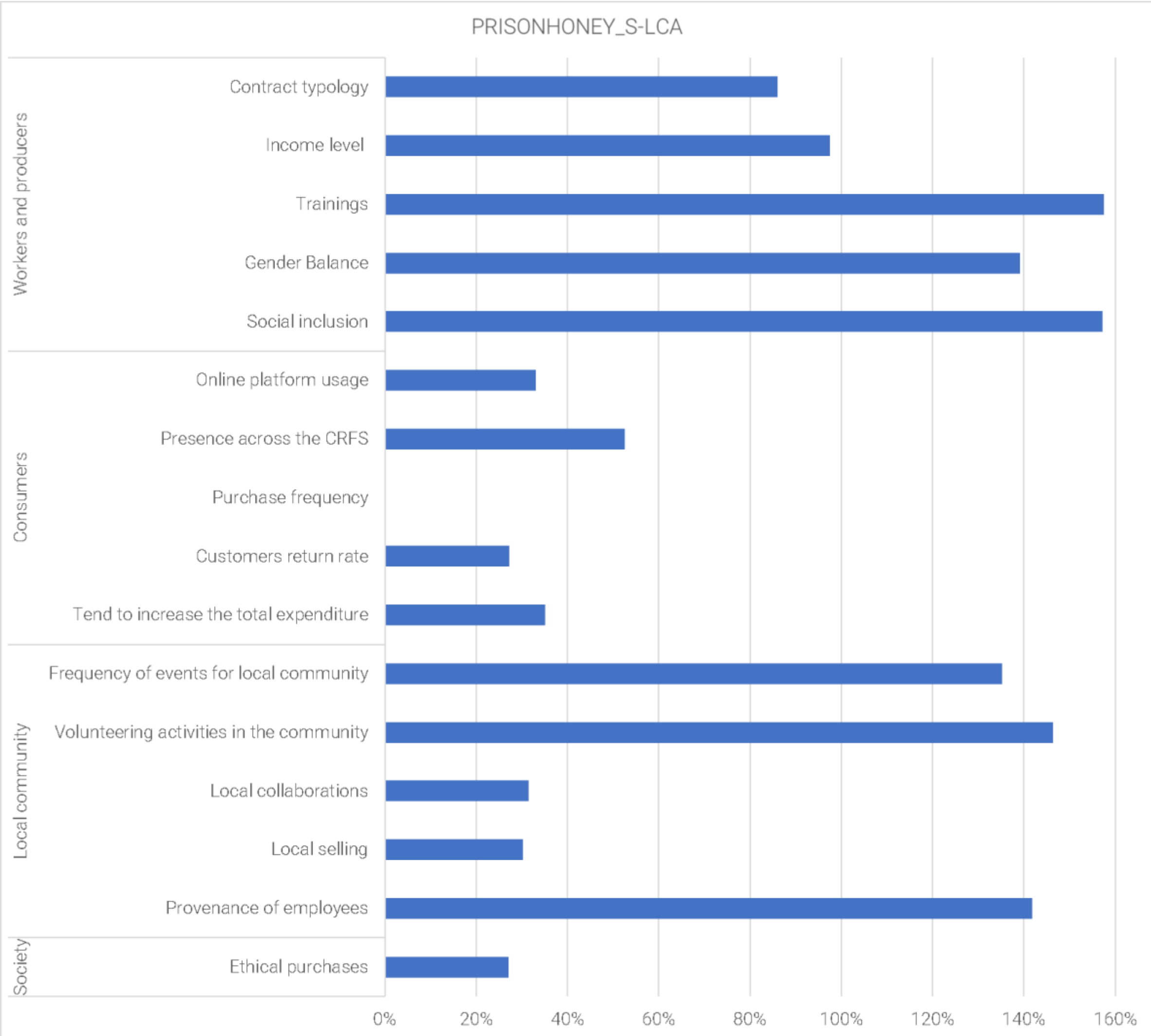
Figure 24 - Prison Honey Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators not compared to a benchmark are presented in Table 10.

Table 10 - Additional indicators adopted for Prison Honey Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	1
Consumers	Food quality	Availability of products information	N of certified products	1 (100%)
Local community		Digital channels for activity dissemination	N of channels	2

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	Community outreach, education & development	Participation rate	N of people participating per event (average)	25
		Educational events	N of events specifically targeting education on food system	4
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	1
Society		Raw material traceability	N of food labels indicating the origin of products	1 (100%)

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were beekeeping, electricity, transport, construction materials, packaging materials and catering materials. Beekeeping specific processes consisted of sugar to feed the bees and acids (formic and oxalic) for medication purposes. Electricity consumption, apart from artificial lighting, comes from specific beekeeping activities such as honey extraction, wax melting or a sublimator for antivarroa treatment. Some renewable electricity production happens on-site, but not enough to make the pilot self-sufficient. Water consumption (4 m^3) consists of tap water for cleaning purposes. Transport for pilot activities is done by two cars for a total of 1,568 km per year on average. Construction materials included concrete and steel for hives stand construction. Honey is packed using 50 glass jars that have an individual weight of 100 g. Finally, some catering materials are used for on-site events, consisting of plastic dishes and paper cutlery.
In terms of impacts Figure 26 shows that the environmental profile of this pilot is distributed among the different subsystems, as opposed to other pilots where one or two subsystems were the only ones visible in their respective figures. However, transport's impact contribution is the greatest in 14 out of 18 impact categories, ranging from 15% to 83% considering all categories. It is worth mentioning that the selection of the background process is linked to the transport made by a passenger car. In this assessment, we considered all the life cycle phases of the car (obviously with an implicit lifespan readjustment), including the allocated part of road construction and car maintenance. If we had selected only the use phase of the car, including mainly emissions from combustion, the impact would have been lower. The other subsystem with substantial impact is beekeeping, linked to feeding and medical processes exclusively linked to bees. This subsystem had impacts greater than 30% in stratospheric ozone depletion (39%), marine eutrophication (73%), land use (66%) and water consumption (57%). Impact from electricity consumed in general processes but also specific beekeeping materials were greater: 20% in ionising radiation (with the greatest contribution among subsystems – 80%), fine particulate matter formation (20%), terrestrial acidification (21%), freshwater eutrophication (39%), marine ecotoxicity (20%), human non-carcinogenic toxicity (25%) and water consumption (23%). Finally, impact below 10% in all impact categories were detected for construction, packaging and catering materials.

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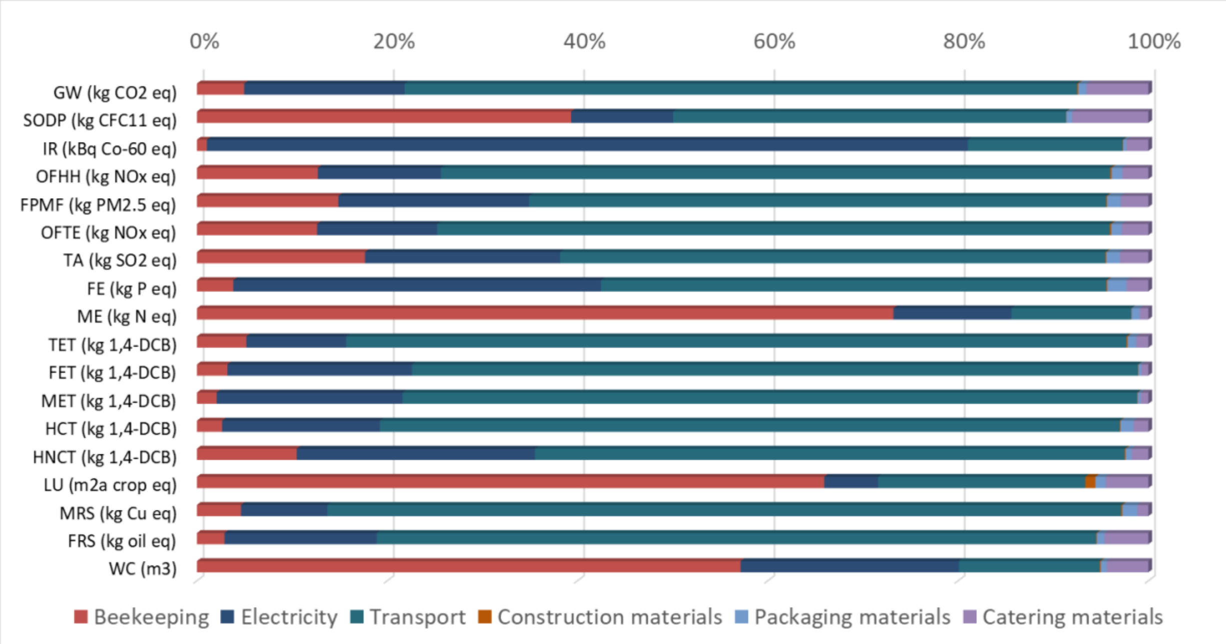
Figure 25 – PRISON HONEY Life Cycle Impact Assessment (LCIA) results



Conclusions

- Potential FU suggestion: for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of honey. However, since the focus of the pilot is on social inclusion, a FU based on the amount of people belonging to vulnerable groups engaged or the number of events might be appropriate.
- LCC conclusions: for the improvement of the cost performance of the pilot, larger attention should be placed on the labour cost. However, in future research development the cost analysis should be assessed against the pilot revenues to enlarge the understanding of results.
- S-LCA conclusions: findings demonstrate that social performances should be improved for the consumers category.
- LCA conclusions: outcome of the LCA analysis points that transport and beekeeping activities (feed, medication and electricity) are the main contributors. A straightforward mitigation strategy could be to look at alternative modes of transport such as an electric-powered car.

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3.8 Pilot 8 - Open-source Aquaponics Farm

	
General	**Organisation Type**
	Non-Profit – Association
	City and Country
	Amsterdam (NL)
	Location
	Mainland –Urban
	Pilot short description
	The greenhouse located on an old, polluted brownfield aims to be an open-source educational centre for sustainable urban food production, testing both high- and low-tech solutions integrating different grow systems, developing an open-source aquaponics management software for inexperienced growers, and implementing a stable and marketable production of fishes, edible flowers, herbs, and vegetables for local customers.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of your pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Fisheries/aquaponic; Food Distribution; Restaurants and catering; Education and Services
	Characteristics of the pilot (extension, type of land etc.)
	The lot to be studied consists of 0,0044 ha of publicly owned artificial surface.
	Time span of the analysis
	12 months (year 2021)

LCC

Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis. Figure 27 displays the bar chart related to these cost components.

The acquisition costs include the acquisition of an array of infrastructures and appliances, which consider six plant growing systems, 2 fish tanks, 2 filters, 1 sump tank, piping, pumps, sensors, other construction elements. The life expectancies of the different acquisition costs have been set to 8 and 10 years based on the owner's expertise. Material costs include seeds cost, fish feed, neem oil against bugs and extra fertilizer. As for the operation costs electricity and water are included with the labour cost of one employee and the employees training costs. Maintenance costs are also included.

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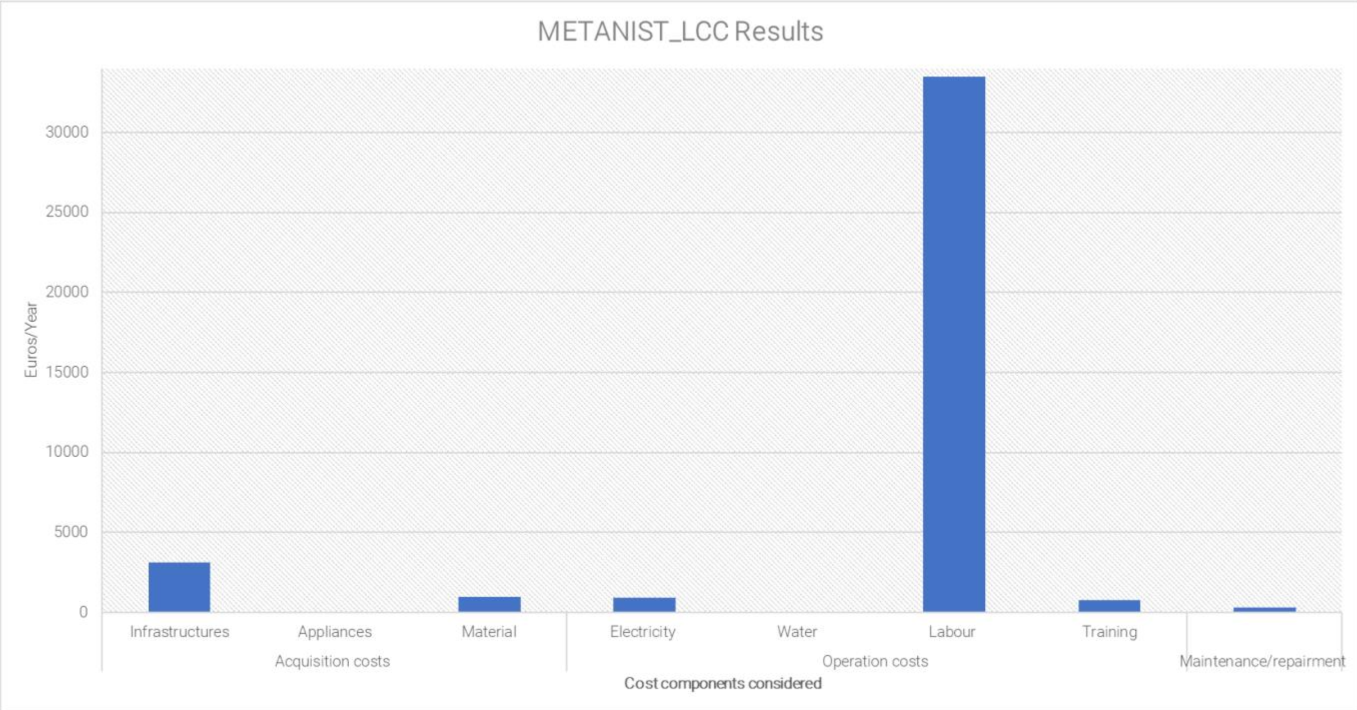
The overall life cycle costing for 12 months adds up to 39279 euros. Most of the costs derive from the labour (85%), followed by infrastructures (8%). The remaining cost items contribute only lightly.

Figure 26 - METANIST Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Consumers: online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: Figure 28 displays the results of the social impact assessment for the Metainstitute pilot. The social impacts of the pilot are to be allocated on all the considered stakeholder categories, with major emphasis on the "workers and producers" and "local community" categories. The frequency of events for local community showed the highest result, followed by trainings. By contrast, the lowest performance is the purchase frequency which amounts to 0,1% of the national average. Except for the customers return rate, all the indicators for the consumers category are under the national average with gender balance, social inclusion and ethical purchases. Other indicators are instead fairly aligned to the national average, such as local selling and provenance of employees.

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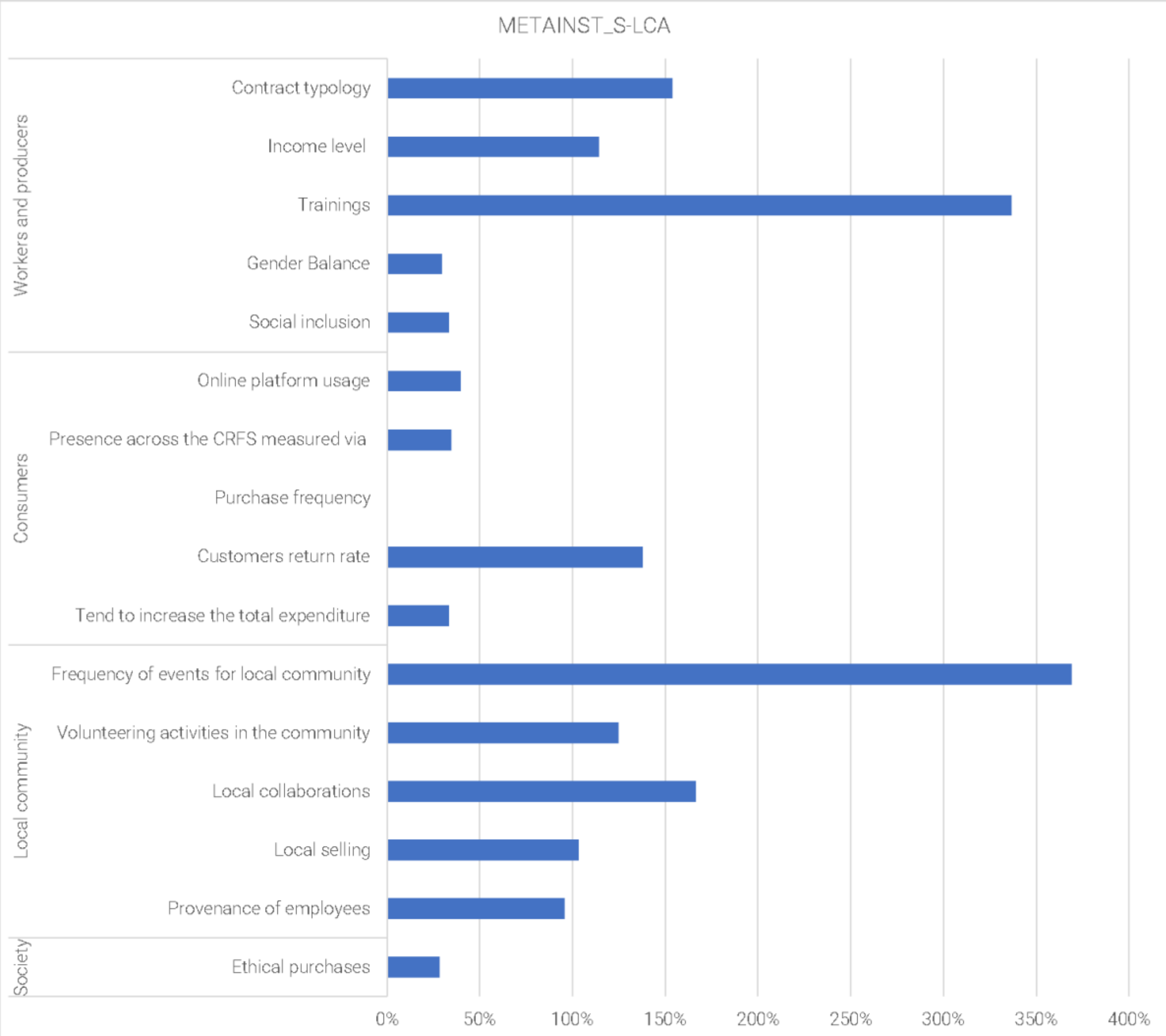
Figure 27 – METANIST Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Several additional indicators have been considered for the social impact assessment and are presented in Table 11.

Table 11 - Additional indicators adopted for Metainst Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	Data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	1
Consumers	Food security	Average expenditure	Average sale amount	60
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	4

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	Participation rate	N of people participating per event (average)	25
	Educational events	N of events specifically targeting education on food system	24
	Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	1
Society	Raw material traceability	N of food labels indicating the origin of products	100%

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were substate for soilless cultivation, organic fertilizers, pesticides, electricity, water and ice and construction materials. The total impacts for Global Warming for the considered timeframe were 2948 kg CO_2 eq.

Substrate for soilless cultivation included 25 kg of rockwool. Fertilization is done using organic fertilizers from compost, for which we assumed NPK content from the literature. Neem oil is the only pest control treatment applied. Electricity is used for various uses: multiple water pumps, air pump, artificial lighting and ventilation and a water heating system. Water consumption is mainly tap water, although a recirculation system is also in place which helps diminish the amount of water used. Finally, construction materials included steel, timber, stone, sand and polyvinylchloride.

In terms of impacts Figure 29 shows that the environmental profile is dominated by electricity in all impact categories except for stratospheric ozone depletion, in which 55% of the impact comes from the use of organic fertilizers. For the remaining impact categories, electricity contribution ranges from 78% to 99% of the impact. The majority of these impacts (50%) are exerted by the water heater, followed by water (27%) and air (11%) pumping. The other visible subsystem in Figure 29 is construction materials, with top contributions of 7% in fine particulate matter formation (mainly due to stone) and land use (mainly due to timber).

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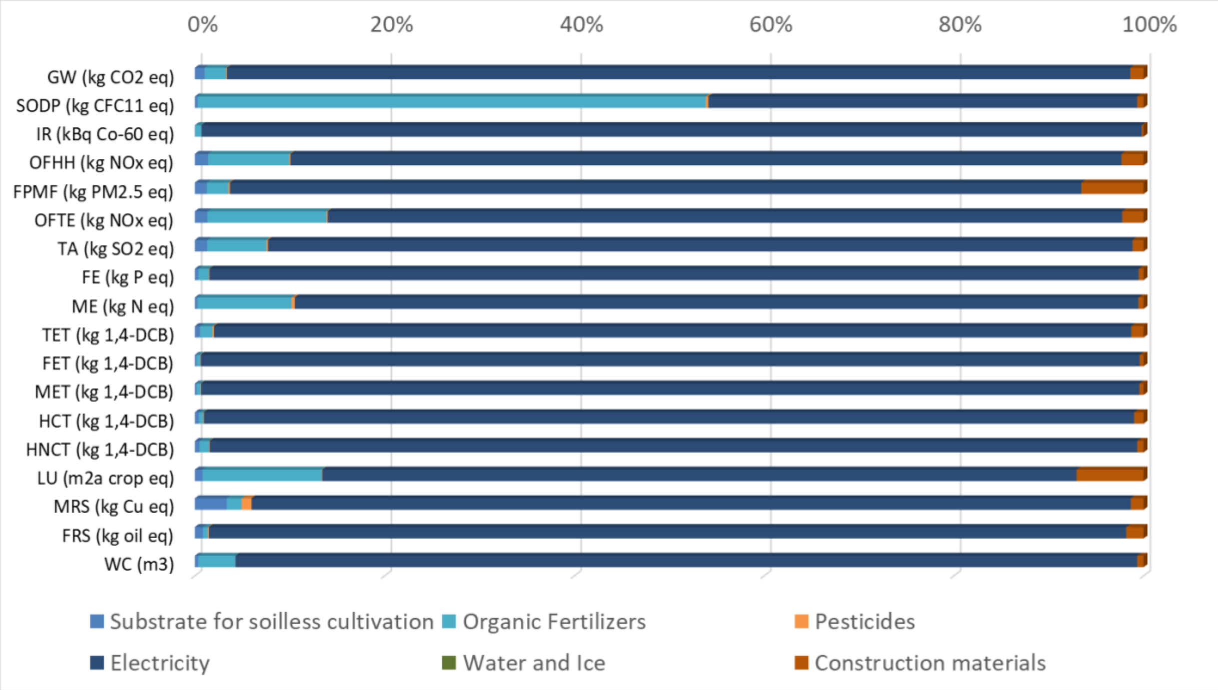
Figure 28 – METANIST Life Cycle Impact Assessment (LCIA) results



Conclusions

- Potential FU suggestion: for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of fish as the primary output in terms of food production. However, since the pilot's focus is on education, a FU based on the number of students and/or local people engaged or the number of educational events might be appropriate.
- LCC conclusions: to improve the cost performance, emphasis should be placed on the labour cost. However, results should be contextualised considering the pilot is developing educational and testing activities, not being profit oriented.
- S-LCA conclusions: findings show that social performances should be improved for the consumers and society categories.
- LCA conclusions: outcomes of the LCA analysis suggest that impact mitigation strategies should be focused on electricity consumption, especially in the water heater and pumping as they are the main impact drivers across impact categories.

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3.9 Pilot 9 – CUIB: Restaurant with local products

	
General	**Organisation Type**
	Non-Profit – Association non lucrative
	City and Country
	Iasi (RO)
	Location
	Mainland –Peri- Urban
	Pilot short description
	The “Centrul Urban de Inițiative Bune” (CUIB) is one of the most sustainable bistros in Romania, in terms of both environmental and social impact and it is one of the most popular local restaurants based in Iași, the second biggest city of the country.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Livestock Agriculture; Food Distribution; Restaurants and catering; Education and Services
	Characteristics of the pilot (extension, type of land etc.)
	The lot to be studied consists of 0,014 ha of rented artificial surface and 0,001 ha of agricultural area (urban agriculture garden).
	Time span of the analysis
	12 months (year 2021)

LCC

Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr} + C_{ot}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis, including the specific cost items. Figure 30 displays a bar chart related to these cost components. As for the acquisition costs, appliances (one refrigerator and one tablet) and food products costs are considered. For the refrigerator and tablet life expectancies of 10 and 5 years are respectively considered based on the owners’ expertise. As for the operation costs electricity and water expenses are included, as well as labour costs and some additional expenses (others) occurred for operations. These latter refer to gloves, cleaning liquids and other consumables, disinfection and washing devices, digital support, costs for the delivery system of foods for the running of the restaurant. The maintenance cost for the appliances is also present. Finally, other costs are included: a set of expenses due the COVID-19 pilot adaptation (other initial one-off costs), employers’ taxes and insurance and waste taxes.

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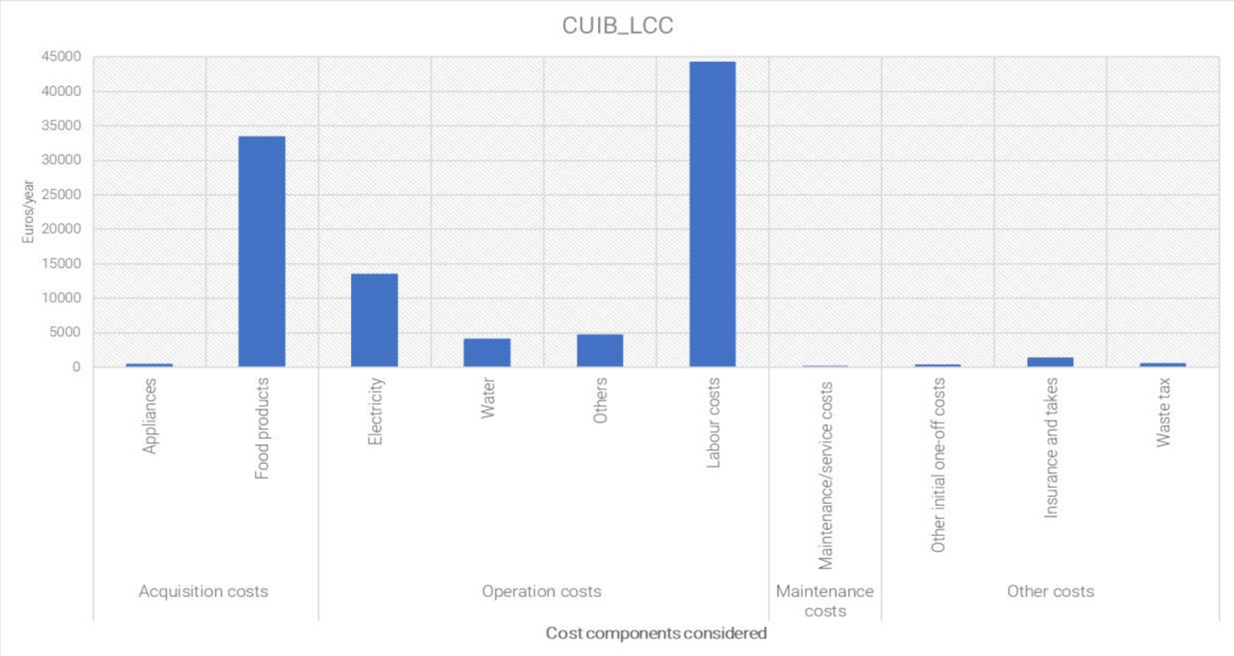
The overall life cycle costing for the production cycle of 12 months adds up to 102324 euros. Most of the costs derive from the labour expenses (43%), from the food products (33%) and from electricity use (13%). Figure 30 reveals the remaining expenses to have very low influence on the final cost.

Figure 29 - CUIB Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Consumers: online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: results from the social impact assessment are displayed in the bar chart of Figure 31. CUIB pilot involves social impacts concerning each of the considered stakeholder categories. The presence across CRFS records the highest performance, together with the frequency of events for local community amounting to twice the Romanian average and consists of the following event typologies: “Little lunch”, “Sunday coffee”, “Zero waste discussion”, among the others. The lowest performances are in the local collaborations, followed by the online platform usage. In fact, generally no food product is sold online except for some exceptional takeaway during year 2021 (affected by COVID-19 pandemic) inside the CRFS. Several specifications have been provided through comments included in the SAT.

As for the “contract typology” indicator, additional information is provided: out of 9-10 employees, 8 are non-fixed term, while the fixed term contracts are provided for day laborers and refugees, with a duration of maximum 9 months.

As for the “volunteering activities in the community”, “winter soup” and “sponsor student events” are the two types of activities mentioned in the DCT.

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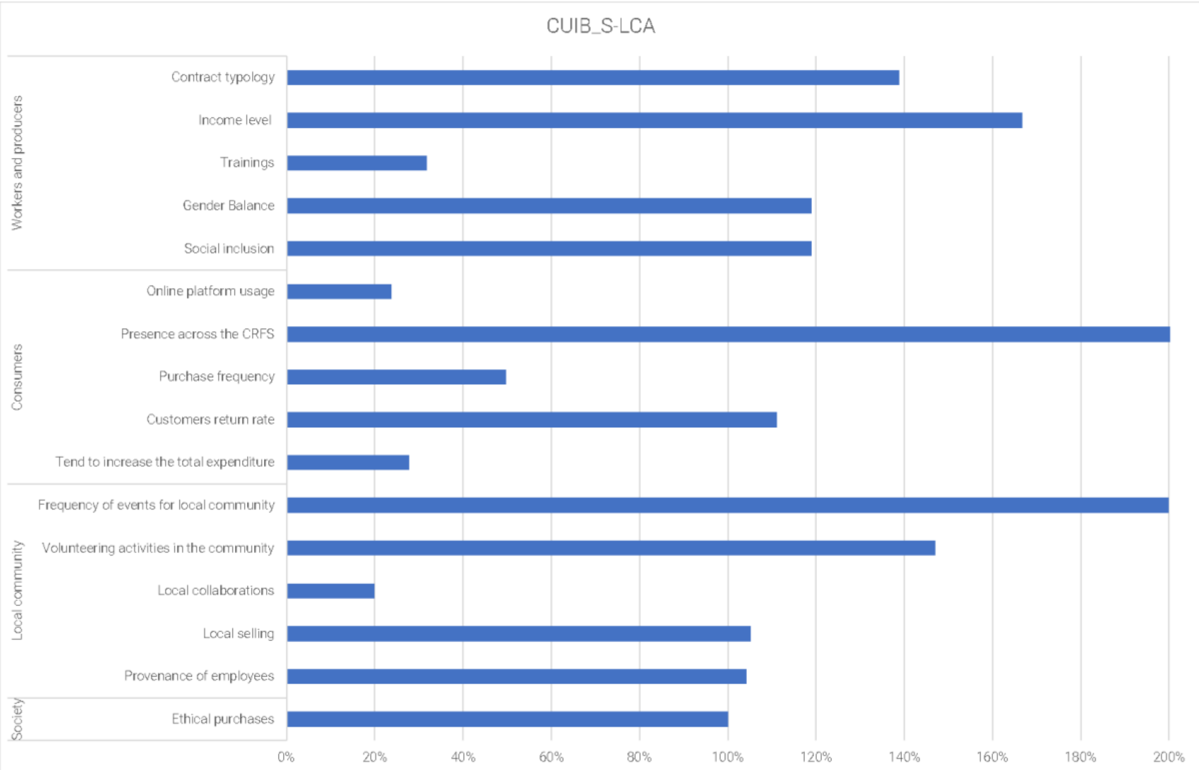
Of the products sold, 100% of the alcoholic beverages and approximately 70% of food products are bought from other local producers. Two fair trade certified products are mentioned in the "ethical purchases", i.e. coffee and tea.

Figure 30 – CUIB Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Other indicators have been analysed to complete the social impact assessment. These are presented in Table 12.

As for the "availability of products information", the following certified food products are specified: wine, vodka, syrup, honey, coffee, tea. For the events specifically targeting education on food systems, the following events are mentioned: Convivial lunch, degrowth day, food waste awareness day, food waste dinner on global food day, among the others. For the raw materials traceability, 50% of all food products (except for fruit and vegetables) have food labels indicating their origin.

Table 12 - Additional indicators adopted for CUIB Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	2
Consumers	Food security	Average expenditure	Average sale amount	9,62
	Food quality	Availability of products information	N of certified food products	6

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Local community	Community outreach, education & development	Participation rate	N of people participating per event (average)	25
		Educational events	N of events specifically targeting education on food system	17
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	1
Society		Raw material traceability	N of food labels indicating the origin of products	42

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were electricity, other energy sources, water and ice, waste, cooking ingredients, catering materials and kitchen appliances and other appliances.
Electricity consumption was aggregated to a total value of 19003 kWh. As regards to other energy sources, the restaurant uses 182 kg of briquettes for heating purposes. Water consumption was also aggregated to a final value of 3292 m^3. Different types of waste were quantified: organic (200 kg and composted) and plastic and paper (2513 kg and recycled). For cooking, 435 L of vegetable oil are consumed every year. Catering materials consists of stoneware dishes and steel cutlery. Finally, various types of kitchen appliances are used in the pilot: 2 small, 1 medium and 4 large fridges, 1 small freezer, 2 medium ovens, 2 medium microwaves, 1 small and 1 large hob and 1 medium dishwasher.
In terms of impacts Figure 32 shows that the environmental profile is dominated by two main subsystems: electricity (14 out of 18 impact categories) and cooking ingredients (4 out of 18 impact categories). No further interpretation can be extracted from electricity impacts since the results were aggregated into a total electricity consumption. Nonetheless, this is common in restaurants and facilities involved with services that don't have specific elements with predefined power that they can extract the individual consumption from. On the other hand, the impact of the cooking ingredients is related to the consumption of vegetable oil. The impact from these subsystems surpasses 50% of the relative impact contribution (considering only the impact with a positive sign) in land use (87%), marine eutrophication (79%), freshwater eutrophication (69%) and stratospheric ozone depletion (59%). We can expect this subsystem to increase its relative impact contribution if we expand the system boundaries in a future assessment to include all background and foreground processes related to food served at the restaurant. However, CUIB is a restaurant that uses only local products or even self-produced food, so the impact of a "food subsystem" can be lower compared to a standard restaurant. Impacts with a negative sign or avoided emissions are a result of waste recycling, with a major contribution from plastic recycling and a lower contribution from paper recycling. Finally, although kitchen and other appliances are a big part of the inventory of CUIB restaurant, this subsystem has visible contributions only in specific impact categories due to the readjustment of the lifespan of its elements, namely freshwater ecotoxicity (15%), marine ecotoxicity (14%) and mineral resource scarcity (14%).

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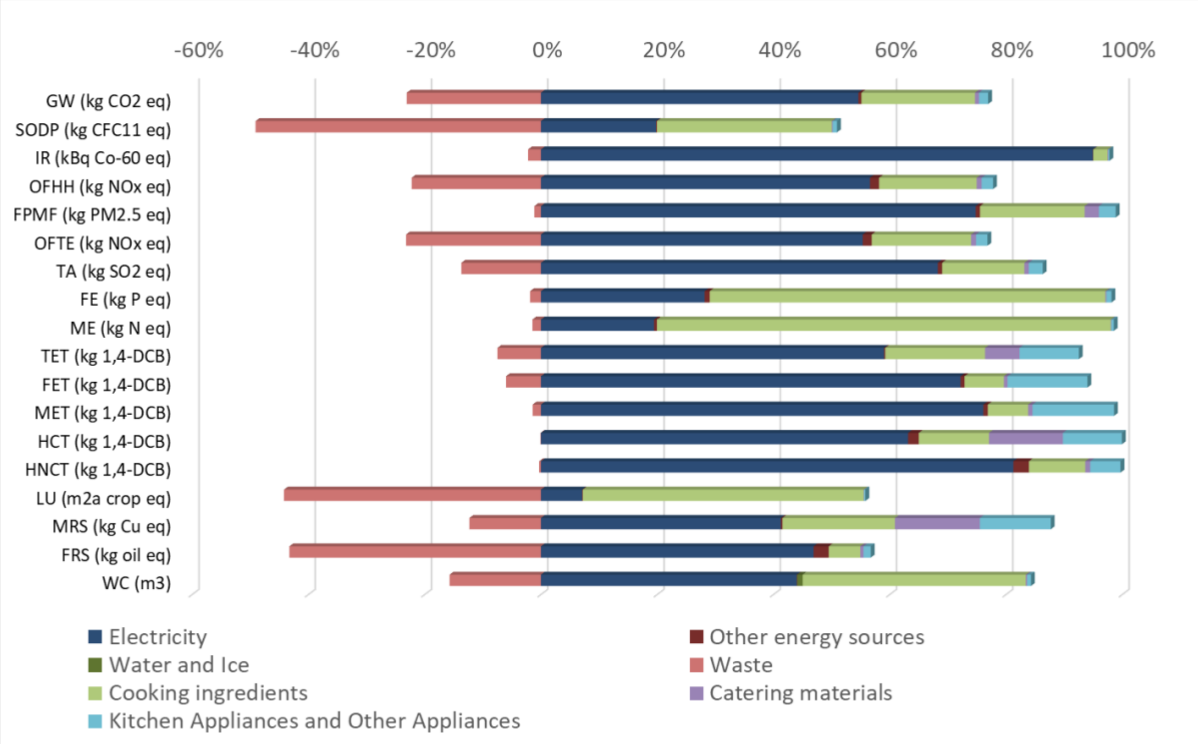
Figure 31 - CUIB Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of mixed vegetables processed and distributed in the restaurant.
- **LCC conclusions**: to improve the cost profile, the pilot should consider tackling the food products and labour expenses. However, given the nature of the pilot costs should be assessed against the revenues from the restauration service to derive a more detailed picture of the economic performance.
- **S-LCA conclusions**: the pilot could improve its social performances by increasing local collaborations and relying on an online platform to distribute its food, as well as increasing the hours of trainings provided to its employees.
- **LCA conclusions**: CUIB is already a well-designed pilot in terms of the use of local resources. The most prominent improvement strategy could be focused on implementing renewable energy modules to become a zero-waste energy self-sufficient restaurant.

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3.10 Pilot 10 – "Water House" Urban farm with hydroponic greenhouse and greywater pilot plant

	
General	**Organisation Type**
	Profit – Self-entrepreneur
	City and Country
	Berlin, Germany
	Location
	Mainland - Urban
	Pilot short description
	The "Water House" is a (first of its kind) greywater recycling plant in the center of Berlin, collecting greywater from a residential unit of 250 inhabitants, treating and feeding it back into the building to be re-used by the inhabitants for toilet flushing and gardening. The pilot project aims at replacing it with a newly developed version, integrating all technical and efficiency improvements, which will provide irrigation water to the connected hydroponic greenhouse.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Education and services
	Characteristics of the pilot (extension, type of land etc.)
	The lot to be studied consists of 0,15 ha of artificial surface.
	Time span of the analysis
	12 months (year 2021)

LCC

Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr} + C_{di}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis, including the specific cost items. Figure 35 displays a bar chart related to these cost components. The acquisition costs include the acquisition pilot plant, which has a lifespan of around 25 years. As for the operation costs, the electricity expenses are included, as well as labour costs. Water expenses are not present since the pilot is built upon wastewater recycling to run the activities. In turn, the wastewater recycled is sold representing a pilot revenue rather than a cost. The maintenance cost is also included as an average of costs occurring for repairment of appliances in the pilot. For the disposal of materials, the analysis considers costs for the transport to iron and PE recycling plants.

The overall life cycle costing for 12 months adds up to 7900 euros. Most of the costs derive from appliances acquisition (41%) and labour (25%). Electricity, maintenance and disposal expenses cover respectively 26%, 13% and 3% of the costs.

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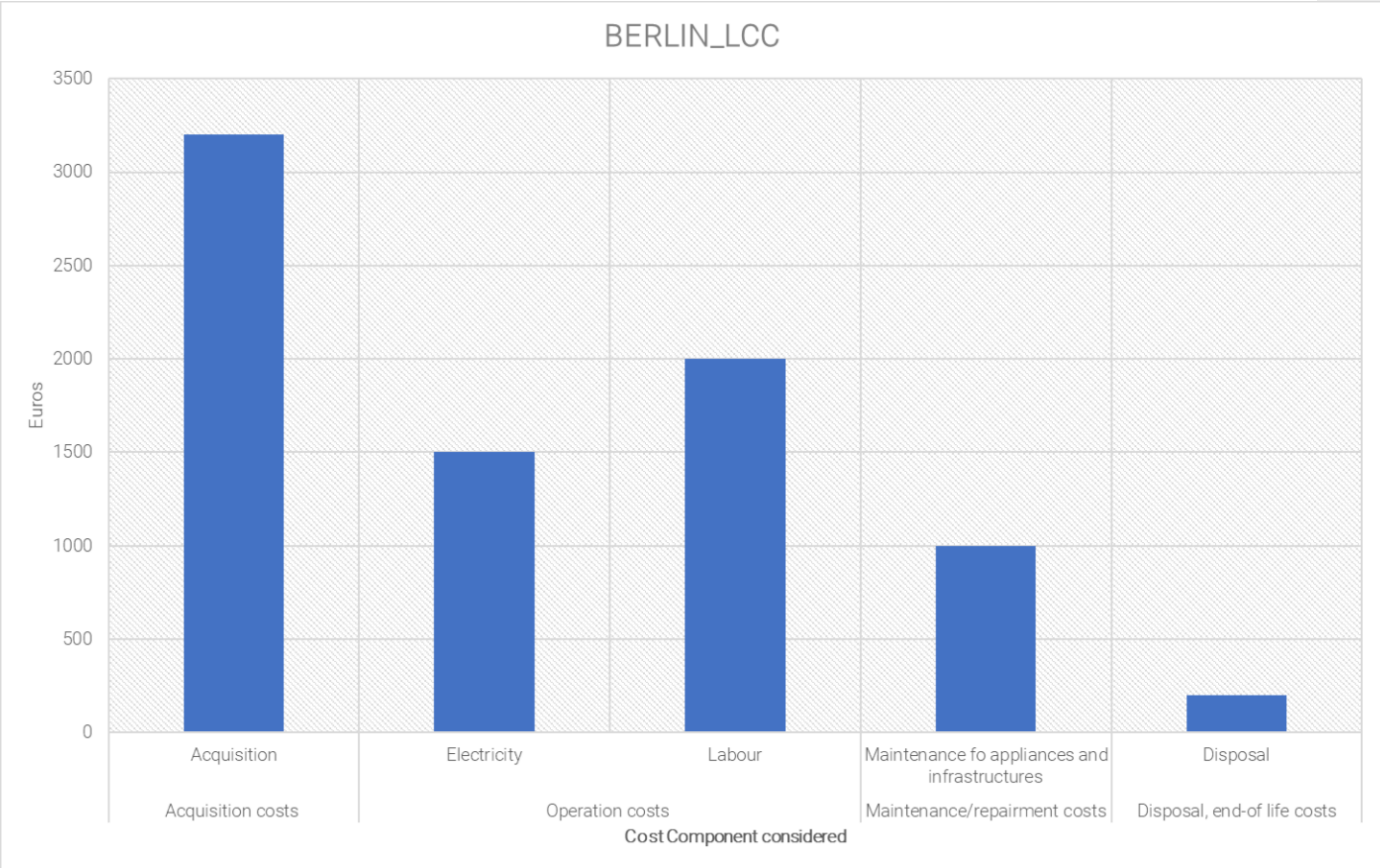
Figure 32 - Berlin Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees.

Discussion of results: considering the peculiarities of this pilot, social impacts have been assessed for the workers and producers and local community categories. For the consumers side, the pilot declared having only one customer for 16 years, meaning that the customer return rate is 100%. As shown in Figure 34, the most relevant performance is in the frequency of events for local community, amounting to more than twice the German average. By contrast, a slight majority of indicators is under the national average, particularly within the workers and producers category, with the most significant performance in the trainings indicator.

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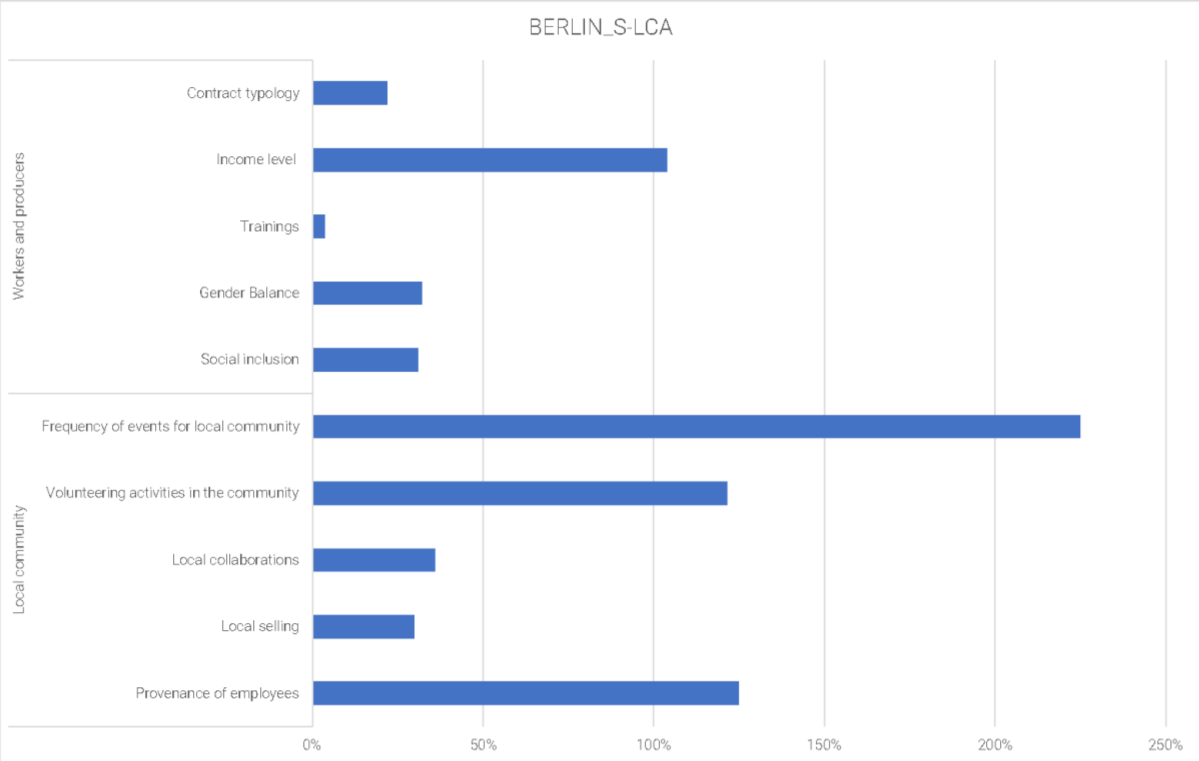
Figure 33 – Berlin Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators not compared to a benchmark are presented in Table 13.

Table 13 -. Additional indicators adopted for Berlin Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Local community	Community outreach, education & development	Participation rate	N of people participating per event (average)	18
		Educational events	N of events specifically targeting education on food system	40
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	2

LCA

Discussion of results: the subsystems included in the assessment were water and ice and construction materials. Since the focus of this pilot radically differs from most of the other pilots, the materials and processes included in the inventory do also differ significantly. In terms of construction materials, the pilot includes high density polyethylene for the different water tanks involved in the sanitation process and steel for the structure. However, these materials refer to the wastewater treatment plant that has been in place in Berlin for the past years and not the new plant that will be built soon. For the new plant, no steel is expected to be used. There is no water consumption in the plant, but wastewater is treated. Therefore, treated water provided to the neighbourhood was assumed to displace the same amount of tap water and thus it was considered as an input with a negative sign to the system.

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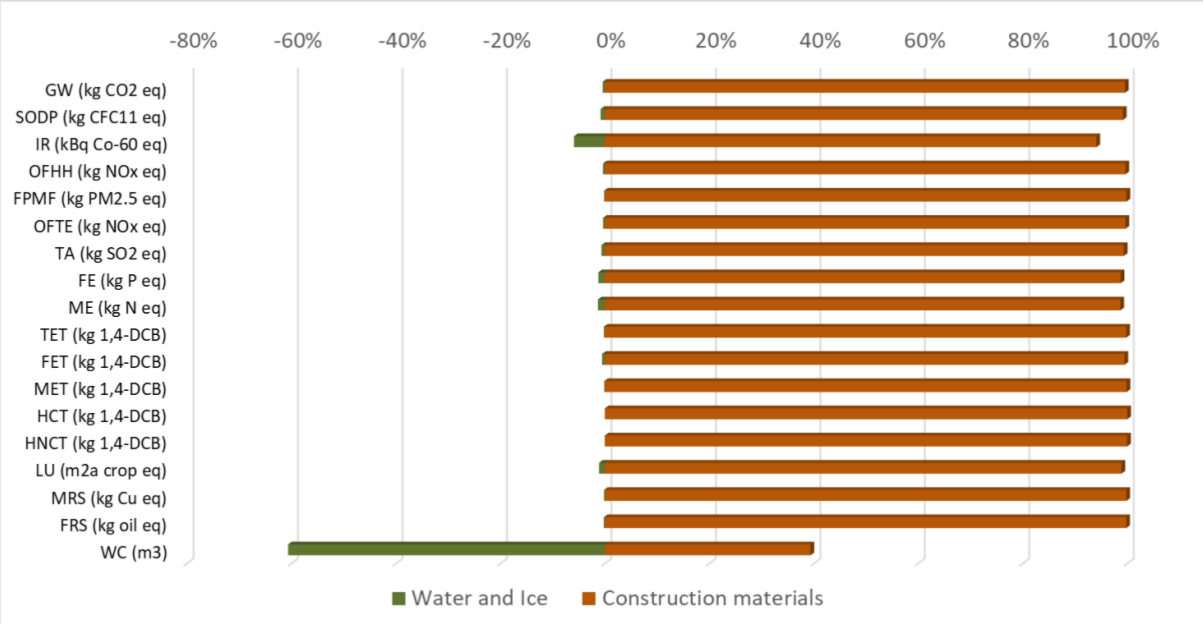
In terms of impacts Figure 35 shows that the environmental profile is dominated by construction materials. These results were easily expected since the inventory was only composed of two subsystems and of those two, one had a negative sign. Out of the construction materials that were used, there is not a dominance of impact contribution. For example, high density polyethylene for the water tanks had more impact than steel in global warming (137%), terrestrial acidification (140%) and marine eutrophication (11%). On the other hand, steel had more impact in freshwater (37%) and marine ecotoxicity (43%) and human carcinogenic toxicity (713%). As for the water and ice subsystem, it only provides impacts with a negative sign (avoided impacts) since the water is cleaned and thus the pilot avoids the use of tap water by the closest neighbourhood.

Figure 34 - Berlin Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion:** for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of vegetables produced by the hydroponic greenhouse.
- **LCC conclusions**: the peculiarity of the present pilot requires an additional cost discussion. In fact, the pilot treats greywater so that local residents in the area can use it, avoiding then the cost for buying tap water. Given the fact a conventional LCC was conducted in the present study, such trade-offs were not considered, and a future consequential analysis is suggested to economically consider the above-mentioned mechanism.
- **S-LCA conclusions**: social impacts should involve other stakeholder categories such as consumers and society, and social performances should be improved in the workers and producers' categories with respect to the national average.
- **LCA conclusions**: outcome of the analysis suggests that improvement should be focused on the construction materials, although the upgrade the pilot facility is currently undergoing already encompasses this mitigation strategy.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement n°862663

3.11 Pilot 11 - Oslo Incubator for Sustainable Food Production (NBL)

General	**Organisation Type**
	Profit – Private Firm
	City and Country
	Oslo (NO)
	Location
	Mainland –Urban
	Pilot short description
	The pilot aims to explore the synergies of social innovation and urban farming through participatory processes, leading to sustainable, long-lasting green jobs for vulnerable groups while enhancing CRFS sustainability. The pilot key activities will include the running of an incubator program across the Oslo region in order to test out and explore economic sustainability for CRFS. The lessons of this program will be used in a rooftop beekeeping project centred on entrepreneurship training and "living lab" methodology and tools.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Livestock Agriculture; Agriculture Production; Food processing; Education and Services
	Characteristics of the pilot (extension, type of land etc.)
	The extension of the estate is a few square meters, including a rooftop beekeeping area, a honey processing facility and a rooftop garden.
	Time span of the analysis
	12 months (year 2021)

LCC

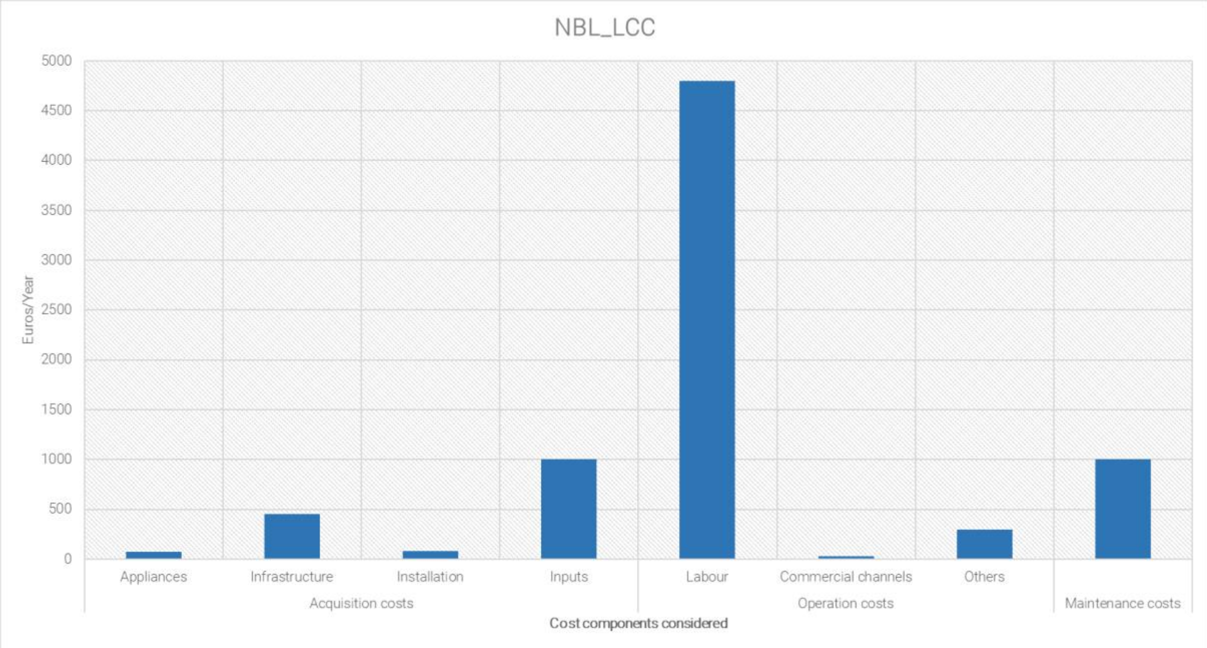
Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr}$

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis. Figure 36 displays the bar chart related to these cost components. The acquisition costs include the acquisition of an array of appliances, the infrastructure costs which consider the hive equipment, protective gears, harvest equipment, and storage tools, the installation of those equipment and inputs needed for the colonies management. The life expectancies of the different acquisition costs have been set to 8 years based on the owner's expertise. As for the operation costs electricity and water are not considered since they are used only very rarely to wash employees' hands or run very minor activities. However, the labour is included with the cost of the project coordinator as well as training costs and other costs (referring to visits and community activities). Maintenance costs consider the replacement of dead hives.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement n°862663

The overall life cycle costing for 12 months adds up to 7735 euros. Most of the costs derive from the labour (62%), maintenance and inputs (13%). The remaining cost items contribute only lightly.

Figure 35 - NBL Life Cycle Costing (LCC) results in euros per year



S-LCA

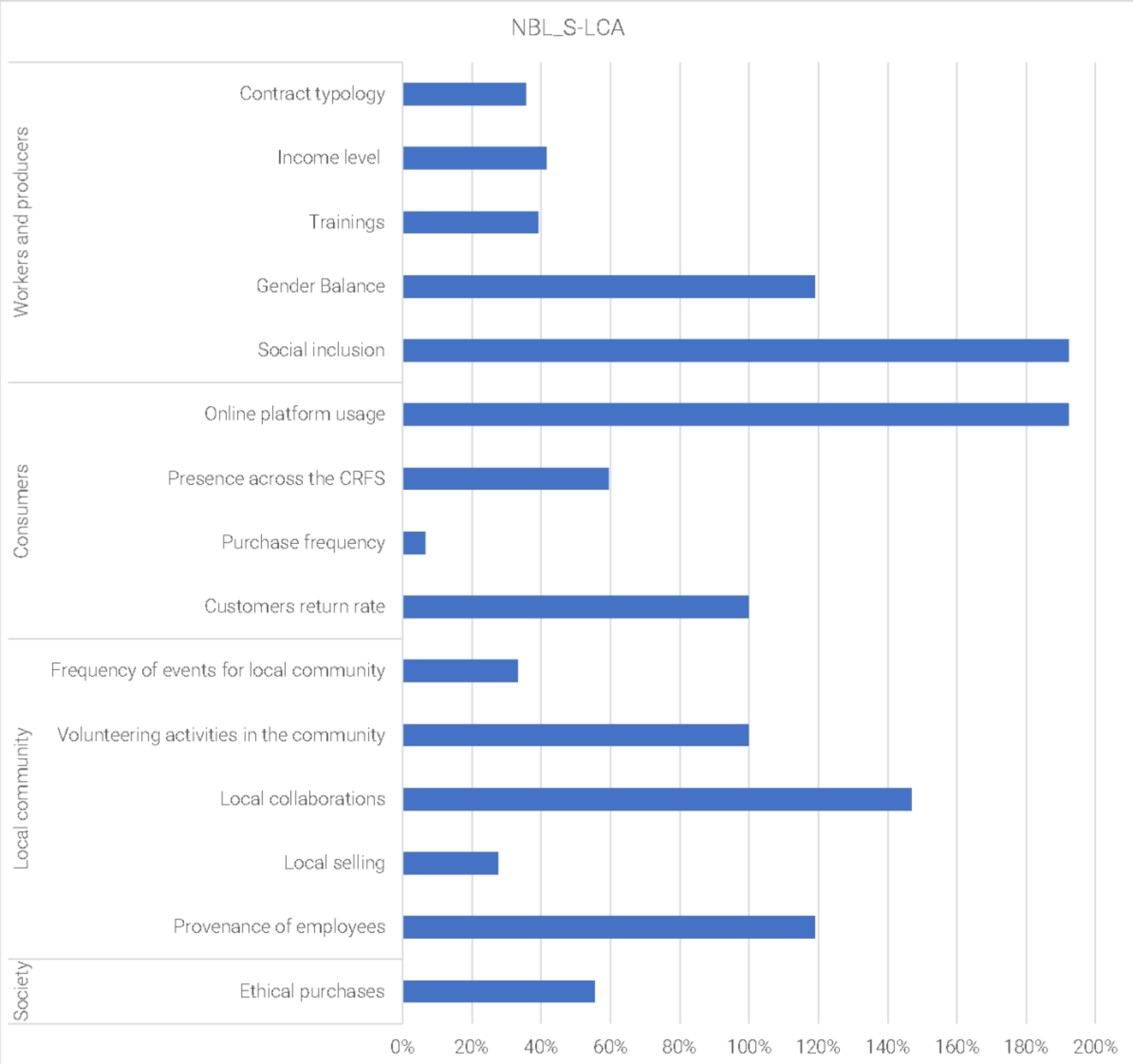
Social indicators included in the analysis: <u>Workers and producers:</u> jobs creation, contract typology, income level, trainings, gender balance, social inclusion; <u>Consumers:</u> online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; <u>Local community:</u> digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; <u>Society:</u> raw materials traceability, ethical purchases.

Discussion of results: an overview of the pilot social impact assessment is provided in Fig. 37 for each of the considered stakeholder categories. Indicators are slightly below the national average, with a minimum for the purchase frequency. Above the national average the most relevant performances are recorded for the social inclusion and the online platform usage indicators (nearly twice the national average), followed by local collaborations, gender balance, and provenance of employees.

It has to be noticed that the income level refers to seasonal workers, but for convenience reason it was equally distributed over the year, resulting in 400 €/month per employee, less than half of the Norwegian average.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement n°862663

Figure 36 – NBL Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



The additional indicators included in the analysis are presented in Table 14.

Table 14 - Additional indicators adopted for NBL Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	Data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	1
		Digital channels for activity dissemination	N of channels	6
Local community		Participation rate	N of people participating per event (average)	15

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	Community outreach, education & development	Educational events	N of events specifically targeting education on food system	4
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	2
Society		Raw materials traceability	N of food labels indicating the origin of products	6

LCA

Discussion of results: no quantitative data was available to perform the LCA analysis of the pilot. However, a detailed qualitative description was provided by the pilot.

In terms of hives, they are traditionally made of wood, preferably cedar, but also available in pine and spruce. In NBL pilot, wood-hard expanded polystyrene (EPS) foam hives are used because: (i) they provide the best insulation during winter, and (ii) they are lightweight (a tower of hives can exceed an average's human's height and one box can weigh around 35 kg). Even though they are made of synthetic materials, the EPS boxes are very durable and is used for many years. The hives are at least 5 years old, and they have 5 more years to go at the minimum. In this case, plastic is put to a very good, efficient, and beneficial use as a non-renewable material.

As for wax, beekeepers must change their wax every few years to prevent the accumulation of diseases. We make products out of wax: creams, beeswax food wraps, etc. Wax is a natural product produced by worker bees. By hanging a wax foundation in our frames, we help the bees to focus on honey production and brood rearing since wax production is a very energy consuming process for the bees. It takes 6 pounds of honey to make one pound of wax. Therefore, by giving the bees a wax foundation, we support the colony to reach their ideal population size, by redirecting their energy to brood rearing and foraging, as the growth season in Norway is pretty short.

In terms of pollen and nectar, the pilot does not provide these. The bees forage pollen, nectar, tree resin, water & minerals from the surrounding environment within the city. We are at the centre of the city by the way. While the bees do that, they support the pollination of numerous plants in our vicinity, from the countless raspberry bushes in the forest to countless apple trees in people's backyards. Since Oslo is a very green city, the pollination service bees provide is the most impressive, powerful and positive environmental impact our pilot facilitates.

Colonies are not feed with any artificial pollen or sugar but with a home-made organic sugar (from sugar beets) mixed in a chaga tea extract in the fall. Bees cannot survive during the Norwegian winter without additional food, because there are no foraging opportunities for them for 6 months (from October to April). Giving them more honey is not an option because of space restrictions (bees like to maintain 25 ºC inside their hive, so heating a very big space to 25 ºC when it is –15 ºC outside is an impossible task).

Finally, in terms of permanent equipment, boxes, frames, bottom boards, top boards, insulators, roofs, hive tools, brushes, smokers, harvest station, centrifuge, forks, hangers, suits, buckets, jars, and many other tools are used.

Conclusions

- **Potential FU suggestion:** for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of bees' products.

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- LCC conclusions: for the improvement of the cost performance of the pilot, larger attention should be placed on the labour cost. Since the pilot is for profit, future cost analysis can assess the present results against the pilot revenues to enlarge the understanding of the overall economic performance.
- S-LCA conclusions: although recording relevant social performances in terms of social inclusion and online platform usage, social impacts need to be incremented with particular reference to the society category.
- LCA conclusions: although no quantitative was data provided and hence a LCA could not be done, the description provided by the pilots gives an extensive overview on the environmental services that beekeeping activities provide in a city like Oslo.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement n°862663

3.12 Pilot 12 - Educational hydroponic garden prototype OSLO

	
General	**Organisation Type**
	Profit – Private Firm
	City and Country
	Oslo (NO)
	Location
	Mainland – Urban, Peri-Urban
	Pilot short description
	Development of a micro-hydroponic system for schools where children can learn how to grow salads and herbs take responsibility for cultivation, as well as recognize their role and contribution in the overall food systems. The collaborations with schools, teaching staff and students, will enable the concept of food systems to be effectively integrated into the students- curricula.
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Agricultural Production; Food Distribution; Restaurants and caterings; Food waste and other waste recovery; Education and services
	Characteristics of the pilot (extension, type of land etc.)
	The extension of the estate is of 0.4 ha of artificial surface
	Time span of the analysis
	12 months (forecasted for year 2023)

LCC

Cost component included in the analysis: $C_{aq} + C_{op} + C_{mr}$

Discussion of results: a breakdown of the aggregate costs is detailed according to the components considered in the analysis, including the specific cost items. Figure 38 displays bar chart relating to these cost components.

Acquisition costs include the appliances costs consisting in the 8 units of the pilot's areas and their installation, and the materials referring to the total food products costs and the inputs costs for fertilizers. For the appliances a life expectancy of 15 years is used. There are no infrastructure costs since the pilot uses an area which is abandoned. As for the operating costs, the pilot has free water directly piped from the mountain, at no costs. The annual expenses for electricity are instead included, together with the labour cost. The total labour cost adds up the expenses of a CEO, and 2 employees working in the farm. Finally, the cost of the pilot maintenance is included.

The overall life cycle costing is 4921382 euros per 12 months. The large majority of the costs derive from the materials cost (86%), followed by a smaller share of electricity expenses. The remaining cost items contribute only laterally to the final cost performance.

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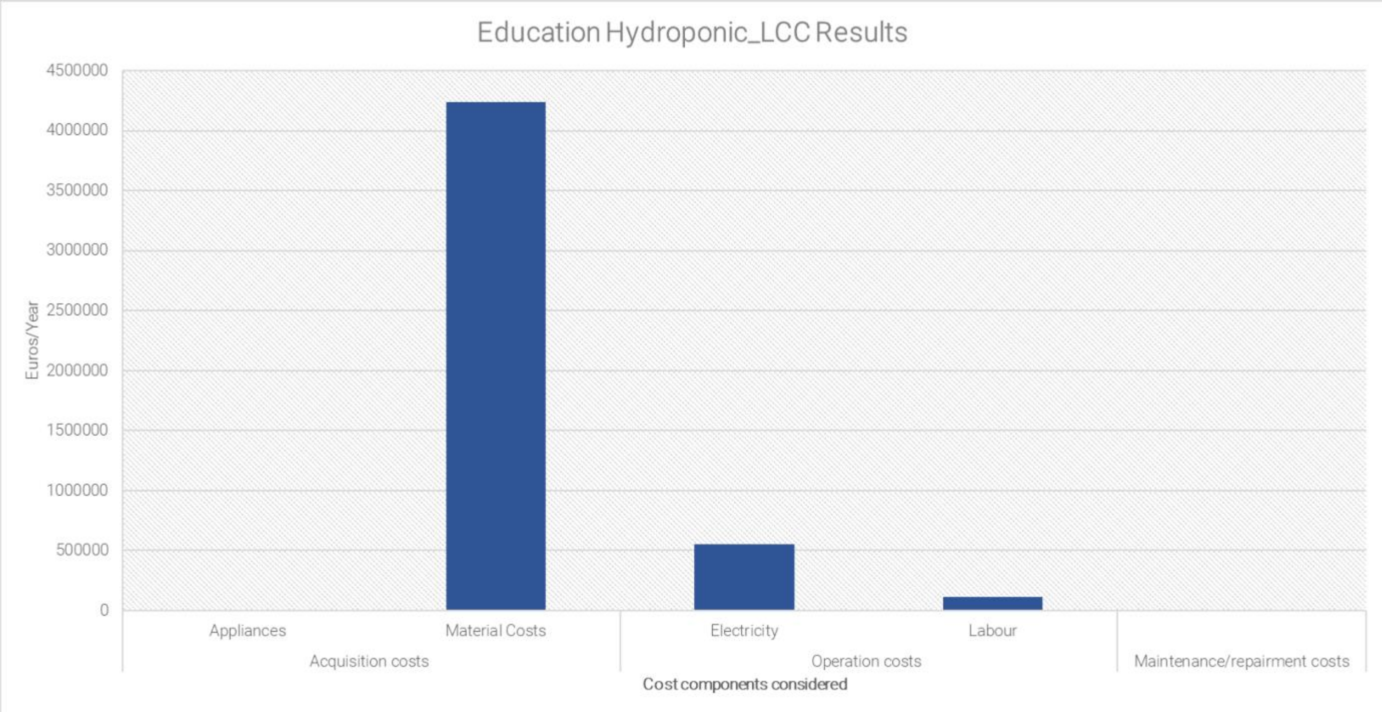
Figure 37 - Oslo Life Cycle Costing (LCC) in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, trainings, gender balance, social inclusion; Consumers: online platform usage, presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure, availability of products information; Local community: digital channels for activity dissemination, frequency of events for local community, participation rate, educational events, volunteering activities in the community, local collaborations, collaborations with activities and projects, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: Oslo Educational Hydroponics involves social impacts on all the selected stakeholder categories, with great relevance for the society one. As shown in Figure 39, presence across the CRFS performs the highest result, equal to nearly three times the national average, followed by ethical purchases and social inclusion. Nevertheless, the majority of indicators are below the national average. In particular, for the workers and producers category, the only indicator ranked above the national average is the social inclusion one, while for the local community category, the only indicator lying above the national average relates to the provenance of employees. The minimum result is performed by the purchase frequency, followed by trainings.

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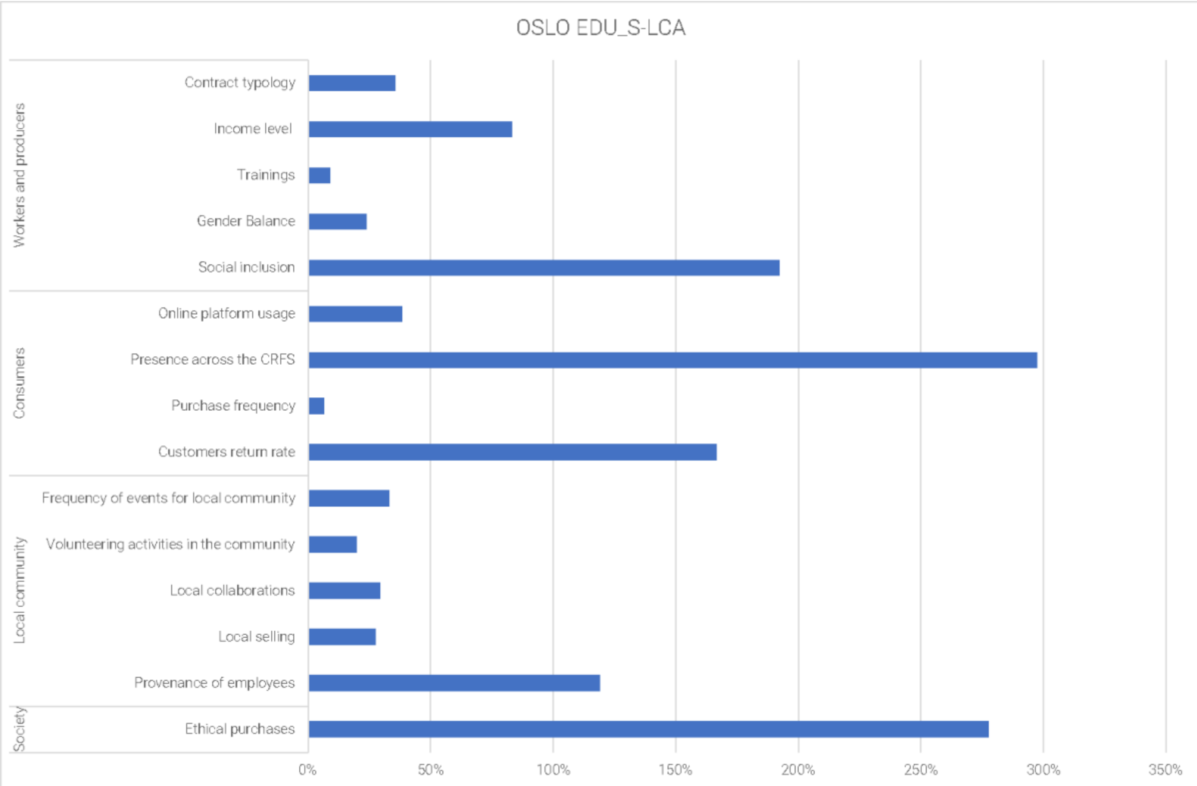
Figure 38 – Oslo Educational Hydroponics Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators included in the analysis are presented in Table 15.

Table 15 - Additional indicators adopted for Oslo Educational hydroponic Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	3
Consumers	Food quality	Availability of products information	N of certified food products	5
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	2
		Participation rate	N of people participating per event (average)	10
		Educational events	N of events specifically targeting education on food system	2
		Collaborations with activities and projects	N of research activities and projects	1

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		collaborating with the initiative	
Society	Raw materials traceability	N of food labels indicating the origin of products	5

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were seeds and seedlings, synthetic fertilizers, electricity, water and ice, transport, packaging materials and waste.

Seeds and seedlings include 1040000 seeds for microgreens to be used in salads. Synthetic fertilizers include the use of potassium nitrate. Electricity consumption was separated into water pumps, artificial lighting and artificial ventilation. 35 m^3 of tap water were used for irrigation and 274 kms were travelled for transport purposes linked to the pilot. Packaging materials consisted of plastic bags, which are assumed to have a weight of 5.5 g each for a final amount of plastic used is 572 kg. These plastic bags were assumed to be recycled while organic waste (13500 kg) was composted.

In terms of impacts Figure 40 shows that the environmental profile is dominated by the seeds and seedlings subsystem, with more than 50% of the impact in 14 out of 18 impact categories. It is relevant to mention this high impact can be highly affected by the choice of the most appropriate background process. Since neither a seed or seedling process for leafy greens can be found in the background database, we took the proxy of choosing “onion seedling”. However, modifying this choice and choosing for example “pea seed” affects substantially the environmental distribution and impacts of Figure 40. Apart from the seeds and seedling subsystem, we can see that electricity consumption represented almost 85% of the impact in ionising radiation and up to 52% and 33% of impact contribution in freshwater eutrophication and water consumption respectively (considering the impact with a positive sign). The main driver for this impact is linked to the electricity consumed for artificial lighting and artificial ventilation, that represent 50% and 31% of the total impact exerted by direct electricity consumption in the pilot. Packaging materials have more than 20% of impact contribution in fossil resource scarcity (44%), water consumption (24%) and global warming (24%). Finally, waste has a relevant contribution in terrestrial acidification (23%), although impact with a negative sign seems to be more important in Figure 40, especially for fossil resource scarcity, stratospheric ozone depletion and water consumption due to recycling of plastic waste.

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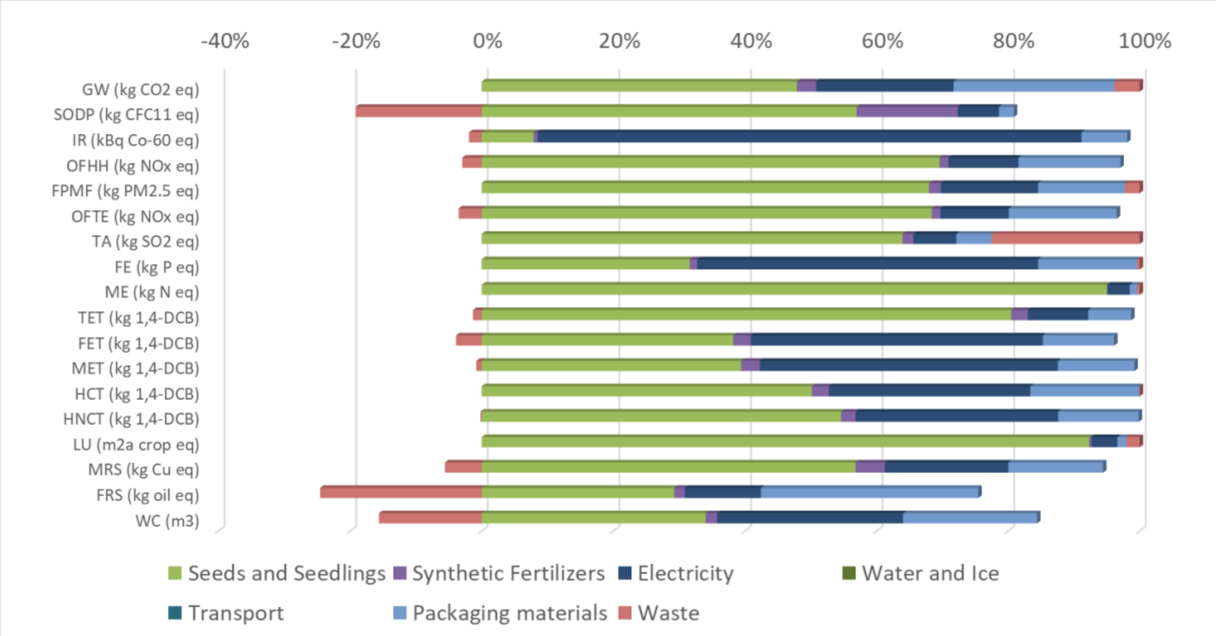
Figure 39 - Oslo Educational Hydroponics Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of salad produced. However, since the focus of the pilot is on education, a FU based on the number of students and/or local people engaged, or number of educational events might be appropriate.
- **LCC conclusions**: to improve the cost performance of the pilot, emphasis should be placed on the reduction of material costs, specifically the bought food.
- **S-LCA conclusions**: although involving relevant impacts on the society category, and the presence across the CRFS, social performances should be improved for the workers and producers and the local community dimensions.
- **LCA conclusions**: since seeds and seedlings impact might be more related to a choice of background processes, mitigation strategies should be focused on other subsystems such as electricity consumption, where artificial lighting and ventilation had the largest contribution in selected impact categories.
- **Potential limitations:** data was estimated based on forecasts for next year activities, and several assumptions were made to conduct the analysis. Future assessments of the pilot should aim at comparing the present results with results derived from the pilot once activities will be fully running.

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3.13 Pilot 13 - ECOTÚNIDOS - sustainable small-scale fishery in school canteens

	
General	**Organisation Type**
	Non-Profit - University
	City and Country
	Tenerife (SP)
	Location
	Island – Urban, Peri-Urban, Coastal
	Pilot short description
	The pilot project started to be implemented with the support of a fishers Producer Organization (“Islatuna”, with over 70 boats) and other stakeholders coordinated by the University of La Laguna under the project “Macarofood”. It involved school managers and cooks, fishers, researchers and institutions, trying to define together new ways to process and distribute the fish. Prestigious chefs developed recipes with local fish, trained the cooks and ten schools (2000 pupils) begun to receive fish, processed to facilitate the consumption (skipjack tuna and other fishes, refrigerated/speed-frozen) with lower prices than the imports
Sustainability Assessment Characteristics	**Goal & Scope**
	To analyse the current performance of the pilot and identify hotspots to be improved (Footprinting)
	System boundaries (Supply chain phases included in the assessment)
	Fisheries
	Characteristics of the pilot (extension, type of land etc.)
	0.23 ha of rented artificial surface, of which 0.48 ha is the extension of the lot to be studied.
	Time span of the analysis
	12 months (year 2021)

LCC

Cost component included in the analysis: C_{op} +C_{mr} +C_{di} + C_{ot}

Analysis: a breakdown of the aggregate costs is detailed according to the components included in the analysis, including the specific cost items. Figure 41 displays the bar chart related to these cost components.

Operation costs refer to the use of electricity and water, to the labour force made up of 25 employees and the commercial channels. The latter refer to the company in charge of the integrated logistics of sending goods to the Iberian Peninsula by plane and applies only for the fish provided to local school canteens in the island. Some general costs for maintenance, disposal of the pilot and taxes and feed are also included.

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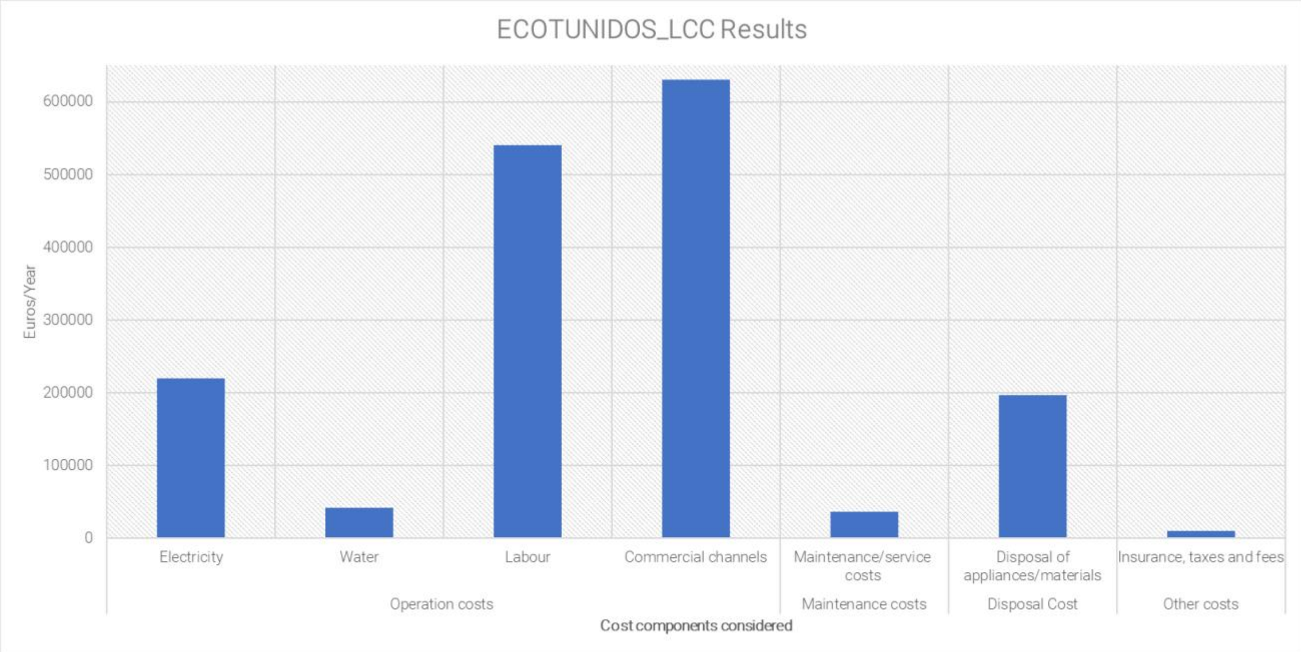
The overall life cycle costing is 1674833 euros per 12 months. The large majority of the costs derive from the commercial channels (38%), and labour costs (32%). These are followed by a smaller share of electricity expenses (13%), and disposal (12%). The water, maintenance and other costs contribute only to a minor extent to the final cost performance.

Figure 40 - ECOTUNIDOS Life Cycle Costing (LCC) results in euros per year



S-LCA

Social indicators included in the analysis: Workers and producers: jobs creation, contract typology, income level, gender balance, social inclusion; Consumers: presence across the CRFS, purchase frequency, average expenditure, customer return rate, tend to increase the total expenditure; Local community: frequency of events for local community, participation rate, educational events, local collaborations, collaborations with activities and projects, local selling, provenance of employees; Society: raw materials traceability, ethical purchases.

Discussion of results: for the ECOTUNIDOS pilot, all of the stakeholder categories have been considered for the social impact assessment. From Figure 42 displaying social impact assessment results, it emerges that the pilot has a strong focus on the consumers category, and the most performing indicator is the tend to increase the total expenditure. By contrast, the majority of the indicators are below the national average, with the least performing indicator being the contract typology, due to the absence of non-fixed term contracted employees. Except for the income level, none of the indicators for the workers and producers category is above the national average.

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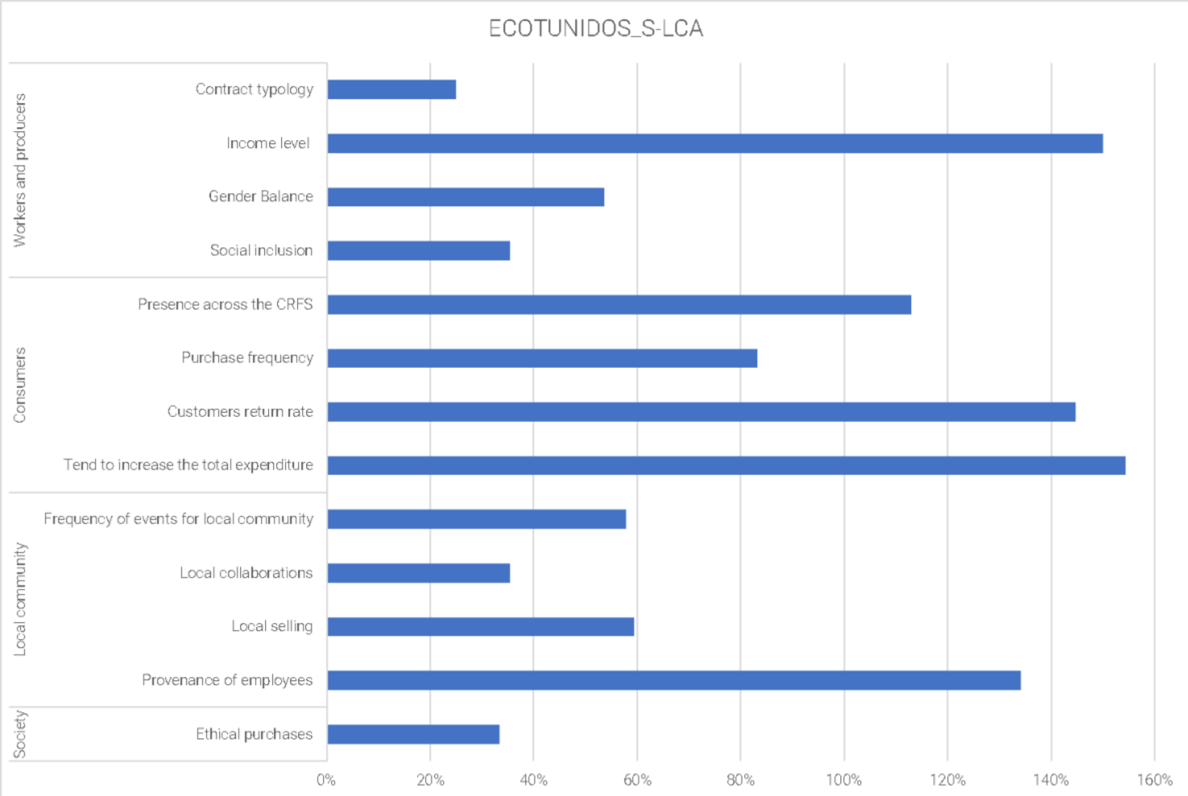
Figure 41 – Ecotunidos Social Life Cycle Impact Assessment (S-LCIA) results expressed in percentage in relation to the benchmark (national average)



Additional indicators included in the analysis are presented in Table 16.

Table 16 - Additional indicators adopted for Ecotunidos Social Life Cycle Assessment (S-LCA)

Stakeholder category	Subsystem	Element	Data needed	data
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	22
Consumers	Food security	Average expenditure	Average sale amount	270
Local community	Community outreach, education & development	Participation rate	N of people participating per event (average)	5
		Educational events	N of events specifically targeting education on food system	3
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	2

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Society	Raw materials traceability	N of food labels indicating the origin of products	2

LCA

Discussion of results: the inventory and impact assessment were calculated for 1 year of activities carried out at the pilot. The subsystems included in the assessment were electricity, water and ice, fuel consumption for boats, transport, packaging materials and waste.
Electricity consumption was separated between water pumping (40227 kWh), artificial lighting (93860 kWh), artificial ventilation (201134 kWh) and refrigeration (1005670 kWh), totalling 1340891 kWh. Tap water consumption adds up to 15620 m^3. Fuel consumption for boats dedicated to fishing activities was 34.071 L (converted to kg with the density). Transport linked with the pilot activities was done by three vehicles with carrying capacities of 18, 12 and 6 t. In terms of packaging materials, the pilot mostly uses polyvinyl chloride (7900 kg) and expanded polystyrene (42656 kg). 3500 m^3 of wastewater had to be treated while 32880 kg of organic waste were landfilled, mostly linked to fish non-edible parts. However, these numbers refer Isla Tuna, the company in charge of the fishing linked with the pilot that captured up to 1.2 million kg of fish in the year of assessment. If we consider only the part of this captures that were used in the pilot Ecotunidos, the number goes down to 2168 kg of fish, ranging between 0.03% (bigeye tuna) and 10.97% (wahoo) of the selected fish species compared to the total capture of Isla Tuna. Thus, in average 0.19% of the captures of Isla Tuna are used in the pilot. Considering a mass allocation, the inputs described beforehand should be recalculated to be 0.19% of the quantities for the whole company activities.
In terms of impacts Figure 43 shows that the environmental profile is dominated by the electricity consumption of the pilot, with more than 50% of the impact in all the analysed impact categories. The main driver for this impact is linked to the electricity consumed for fish refrigeration, which represented over 75% of the impact exerted by the electricity subsystem. Another relevant subsystem is packaging materials, especially in fossil resource scarcity but also in other impact categories such as global warming or water consumption. Finally, the impact from waste is especially relevant in marine eutrophication (33% of the total impact) due to the discharge of wastewater. The impact with a negative sign that we can see in water consumption are also due to wastewater, since water is discharged back into the water cycle.

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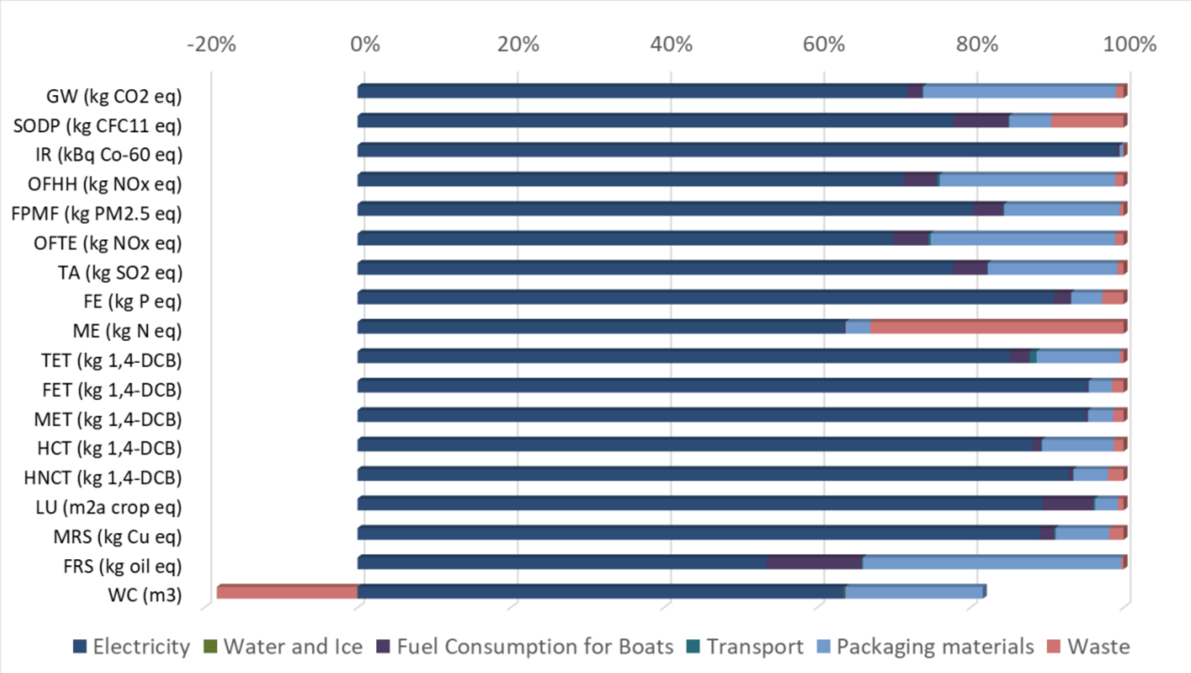
Figure 42 - ECOTUNIDOS Life Cycle Impact Assessment (LCIA) results



Conclusions

- **Potential FU suggestion**: for future applications, an alternative to the organisational FU could be mass FU. The LCT analysis can be allocated to 1 kg of mixed fish. However, a caloric value FU can be more appropriate consider the variability of nutritional properties related to each fish species.
- **LCC conclusions**: outcome from the analysis allows us to conclude that improvements in the cost performance of the pilot should be focused primarily on leveraging the commercial and labour costs. Future application of LCC should better explore the allocation of the commercial costs, since these might entail costs which are not fully applicable to the present pilot.
- **S-LCA conclusions**: notwithstanding relevant social impacts on the consumers category, social performances should be improved on the workers and producers (except for the income level), local community and society categories.
- **LCA conclusions:** the outcome of the LCA analysis points at electricity consumption and specifically to refrigeration as the main impact driver. In this case, we suggest that the mitigation strategy is the pilot itself, since it decreases the supply chain of fish and thus decreases the amount of refrigeration electricity needed between the capture and the consumption.

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4. Conclusions

The present report presents the extensive sustainability assessment results of the FoodE pilots. Based on the assessment framework developed (D2.2) and data collection protocol (D2.3) and taking advantage of the data inventory results (D2.4), the three sustainability pillars are investigated for each pilot from a LCT practitioner's point of view. Then, an overview of the pilots' performances and of the main hotspots for intervention is provided for further development.

The overall results for the three pillars highlight the great variety and diversity of pilots, relatively to the supply chain stages included in each. This evidence is also reflected in the definition of different functions for each pilot as well as in the impact categories selection. Additionally, results show a common aim in the goal and scope of the analysis regardless of geographical context. Indeed, most of FoodE pilots are interested in analysing the current performances of their system and identifying hotspots to be improved. The main learnings from each sustainability pillar is described below.

Learnings from the economic pillar. The economic pillar, analysed from a cost perspective, highlights that in most of pilots, the labour cost item is the most relevant. This raises concerns about how to leverage such a cost component without negatively impacting employees welfare and hence social pilot performance. Two major research needs emerge. Firstly, a cost-benefit analysis to include the revenues of each pilot might support to expand results by assessing the cost performance against the overall pilots' profitability. This was not applicable to all pilots due to part of them being not for profit. Secondly, a sensitivity analysis to better assess the uncertainty of data and understand the impact of the different cost components could also be conducted to precise results.

Learnings from the social pillar. Of the three pillars analysed, the social one proved to be the most complex in terms of defining common indicators for all pilots. This is also due to and confirmed by the absence of a standardised procedure for the S-LCA methodology. This specific aspect may represent a limitation of the model if comparison is needed between contributions of social impacts in the different pilots. However, the opportunity to co-define indicators with pilot owners in a participatory process allows us to provide an added value and take a step forward in the methodological discussion on social sustainability pillar by proposing specific customized indicators also related with the territorial context.

Learnings from the environmental pillar. Results from the environmental pillar suggest that both the inventory and impact data across different types of CRFSI differ significantly. Data that might be relevant in terms of impact contribution for CRFSI focused on agricultural production may exert low or even negligible impacts in other types of CRFSI. Therefore, getting to know the particularities of a specific CRFSI under assessment is of vital importance to draw system boundaries and plan a data collection protocol that is consistent with its activities. In terms of impact contribution, the electricity consumption exerted a great relative impact in multiple impact categories, especially in the pilots dealing with agricultural production including artificial lighting and ventilation.

Strengths and limitations. The work has a set of strengths. First, it made it possible to develop an integrated sustainability assessment able to consider the great diversity of pilots across Europe, based on the three sustainability pillars. Second, the level of detail of the analysis allowed to tackle some limitations of the simplified assessment framework in terms of functions definition, and impact assessment phase. Third, a concrete output of this activity is the Data Collection Template for the self-assessment. Such output allows practitioners and non-practitioners that aim to assess their pilot, to collect data through an established template

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organized by the three pillars, and to have instant results via graphical and tabular information. Through this first extensive assessment, it will be possible to plan specific intervention strategies in each pilot.

It is also important to highlight limitations to go further in the research filed. Despite the data collection phase being supported by experts, pilots experienced difficulties in providing accurate data. With clear evidence such an issue is strongly associated to the status of the pilot implementation. Such a limitation should be scrutinized in detail for future self-assessment tools.

Future research directions. The methodological procedure used for the extensive sustainability assessment of FoodE pilots can represent a baseline scenario for further improvements and monitoring activities. Additionally, the methodology can be used for CRFSI outside the FoodE project, to expand results and compare them across Europe.

In sum, with the self-assessment tool first, and the pilot decision support tool that will be finalized in D2.7 second, it will be possible to assess advancements of performance in terms of economic, social, and environmental sustainability impacts.

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Appendix

Appendix 1 - SUSTAIN II Survey for Pilots

FoodE_GA_workshop

General information

1 Please select the name of your Pilot

- ◯ Urban agricultural park with farmers and fishery market, Naples (Italy) (1)
- ◯ ALMA VFarm, Bologna (Italy) (2)
- ◯ SALUS Space, Bologna (Italy) (3)
- ◯ SERRA MADRE, Bologna (Italy) (4)
- ◯ Urban agricultural park for participatory agricultural test spaces, Sabadell (Spain) (5)
- ◯ The Cité Maraîchère, Romainville (France) (6)
- ◯ Plant factory for demonstrational purposes, Bleiswijk (Netherlands) (7)
- ◯ PRISON HONEY, Ljubljana (Slovenia) (8)
- ◯ Open-source Aquaponics Farm, Amsterdam (Netherlands) (9)
- ◯ CUIB: Restaurant with local products, Iasi (Romania) (10)
- ◯ Urban farm with hydroponic greenhouse and greywater pilot plant, Berlin (Germany) (11)
- ◯ Oslo Incubator for Sustainable Food Production (NBL), Oslo (Norway) (12)
- ◯ Plant factory for social inclusion, Oslo (Norway) (13)
- ◯ Educational hydroponic garden prototype, Oslo (Norway) (14)
- ◯ ECOTÚNIDOS - sustainable small-scale fishery in school canteens, Tenerife (Spain) (15)

Fine blocco: General information

Function and assessment goal

I Function and assessment goal

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1 What would you like to be the aim of the sustainability assessment for your pilot?

- ◯ To analyse the current performance of your pilot and identify hotspots to be improved (Footprinting) (1)
- ◯ To compare it with other pilots or similar activities (comparative) (2)
- ◯ To identify impacts not yet in place and/or evaluate improvement options (Perspective) (3)
- ◯ To evaluate a consequence of a specific choice you want to implement in your pilot (consequential) (4)
- ◯ Other (please specify...) (5) ____

2 What are the most relevant benefits you would like to gain from the sustainability assessment?

- ◯ Opportunities and risk analysis (1)
- ◯ Internal sustainability reporting (2)
- ◯ External sustainability reporting (3)
- ◯ Communicate impacts to costumers (4)
- ◯ Championing of sustainability cause (5)
- ◯ Other (please specify...) (6) ____

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3 What is/are the **main function(s)** of your pilot? (Please note that functions are different from goals)

- ☐ to produce food (1)
- ☐ to process food into food products (2)
- ☐ to distribute food and/or food products (3)
- ☐ to sell food and/or food products (4)
- ☐ to serve or cater food (5)
- ☐ to prevent, redistribute, or valorize food waste (6)
- ☐ to provide food-related services (7)
- ☐ other (please specify...) (8) ____

Function and assessment goal

Functional unit

II Functional unit

1 A reference flow is the basic unit to which all impacts are referred. For the assessment of your pilots, you would like to have a reference flow which is:

- ○ Mass based (e.g., 1 kg of a product you produce/handle) (1)
- ○ Economically based (# of euros of food value delivered or turnover) (2)
- ○ Nutritional based (# of kcal or other characteristics of a product you produce/handle) (3)
- ○ Time based (yearly operation) (4)
- ○ Other (please specify...) (5) ____

III System boundary

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1 Depending on your pilot typology, which supply chain phases would you like to include in the assessment?

- ☐ Primary Production (Agriculture & Fishing) (1)
- ☐ Food processing (transformation of agricultural products into food etc.) (2)
- ☐ Transport and storage (3)
- ☐ Retail (4)
- ☐ Foodservice/Catering service (5)
- ☐ End-of-life (6)
- ☐ Others (please explain) (7) ____

IV Impacts assessment

---

1 Which stakeholders' categories would you be interested to investigate in your assessment?

- ☐ Workers (1)
- ☐ Local community (2)
- ☐ Society (3)
- ☐ Consumers (4)
- ☐ Value (food) chain actors (5)

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2 For the stakeholder categories selected, which aspects you would be interested to investigate?

- ☐ Job quantity and quality (amount of jobs; Gender balance; Workplace safety) (1)
- ☐ Local economic development (Contribution to local GDP; Local supply) (2)
- ☐ Human health (Consumers' health) (3)
- ☐ Others (4)

---

3 Which one of the following sentences best fits with your pilot?

- ☐ I use some fossil fuels or energy (1)
- ☐ I use some freshwater (e.g., irrigation) (2)
- ☐ My pilot needs some land (3)
- ☐ I use refrigerants and/or refrigeration (4)
- ☐ I use pesticides (5)
- ☐ I use fertilizers (6)

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4 Which of the following impact categories do you think are relevant for your pilot?

- ☐ Climate change (1)
- ☐ Ozone depletion (2)
- ☐ Acidification (3)
- ☐ Eutrophication (4)
- ☐ Photochemical ozone formation (5)
- ☐ Depletion of abiotic resources (minerals & metals, fossil fuel) (6)
- ☐ Human toxicity (cancer, non-cancer) (7)
- ☐ Eco-toxicity (freshwater) (8)
- ☐ Water use (9)
- ☐ Land use (10)
- ☐ Ionising radiation, human health (11)
- ☐ Particulate matter emissions (12)

---

5 What level of analysis do you thinks is better to communicate environmental impact results?

- ○ Midpoint level (Climate Change, Eutrophication, Ecotoxicity, etc). (1)
- ○ Endpoint level (Damage to human health, Damage to ecosystems, Damage to resource availability) (2)

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6 Which aspects you would be more interested to investigate from a costing perspective?

- ☐ Labour use: Efficiency of labour. (1)
- ☐ Productivity: Labour Productivity Land productivity; Capital productivity (2)
- ☐ Profitability: Return on sales; Return on assets; Net present value; Labour profitability (3)
- ☐ Water use: m3 of water (euro) (4)
- ☐ GWP: tons of CO2-eq (euro) (5)

---

7 Would you like to compare your impacts with the average impact of a Pilot of:

- ○ Your country (1)
- ○ Europe (2)
- ○ World (3)

---

8 Would you prefer to have a single sustainability score?

- ○ Yes (1)
- ○ Not (2)
- ○ Unsure (3)

---

9 How would you rate the importance of the 3 pillars?

	0 1 2 3 4 5 6 7 8 9 10
Social pillar ()	
Environmental pillar ()	
Economic pillar ()	

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Q23 Would you like to translate the results of your assessment into a single sustainability score?

- ◯ Yes (1)
- ◯ No (2)

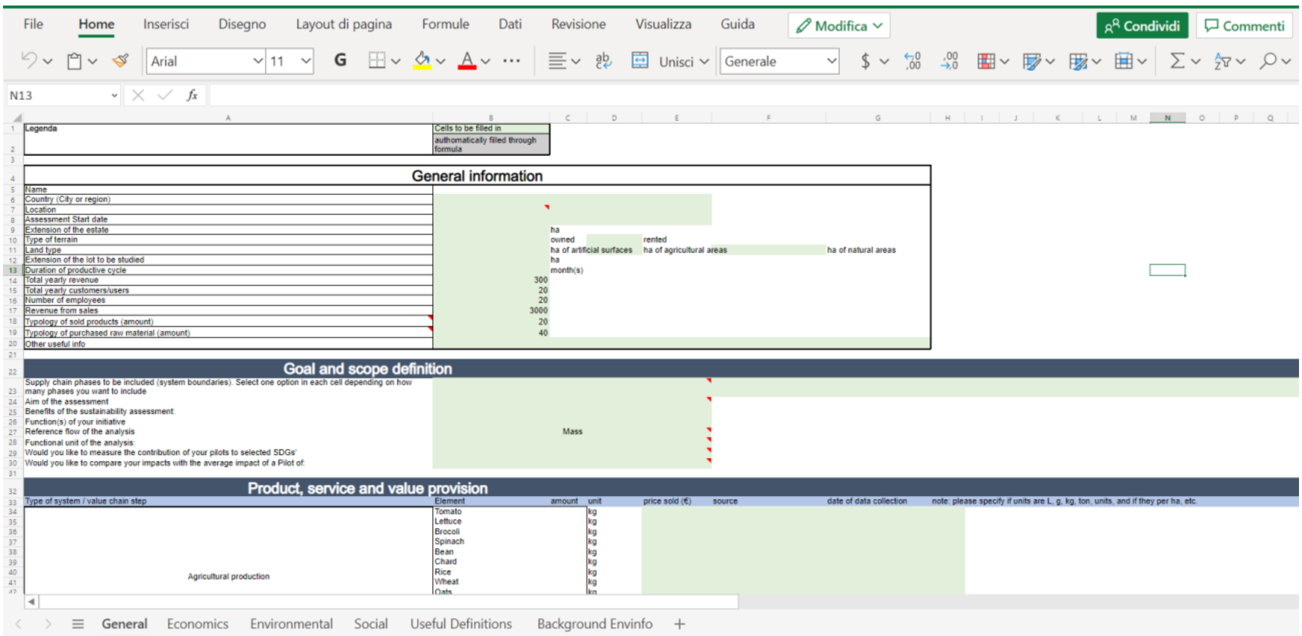
11 Would you like to measure the contribution of your pilots to selected SDGs?

- ◯ Yes (1)
- ◯ No (2)
- ◯ Unsure (3)

Q24 Other comments

____

Appendix 2- Data Collection Template



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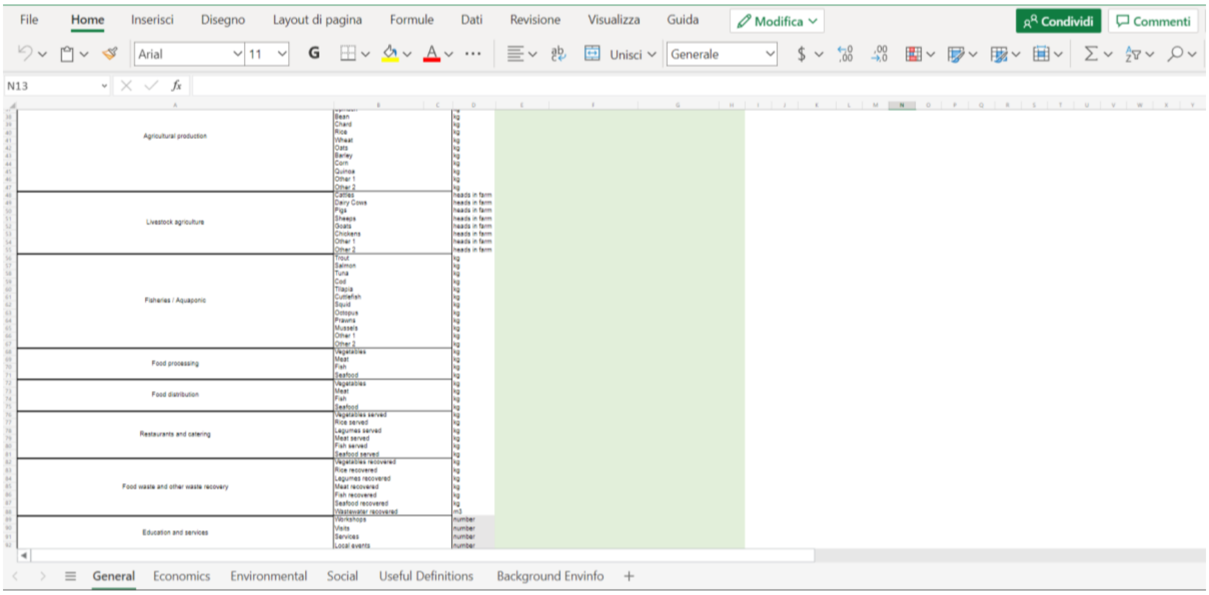

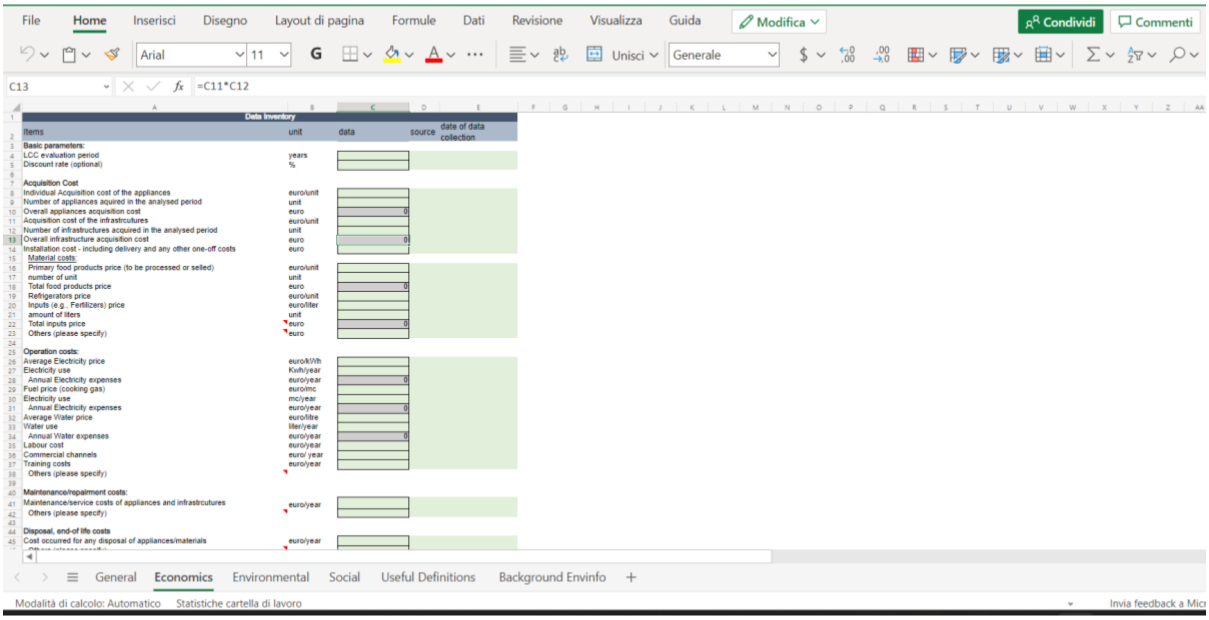

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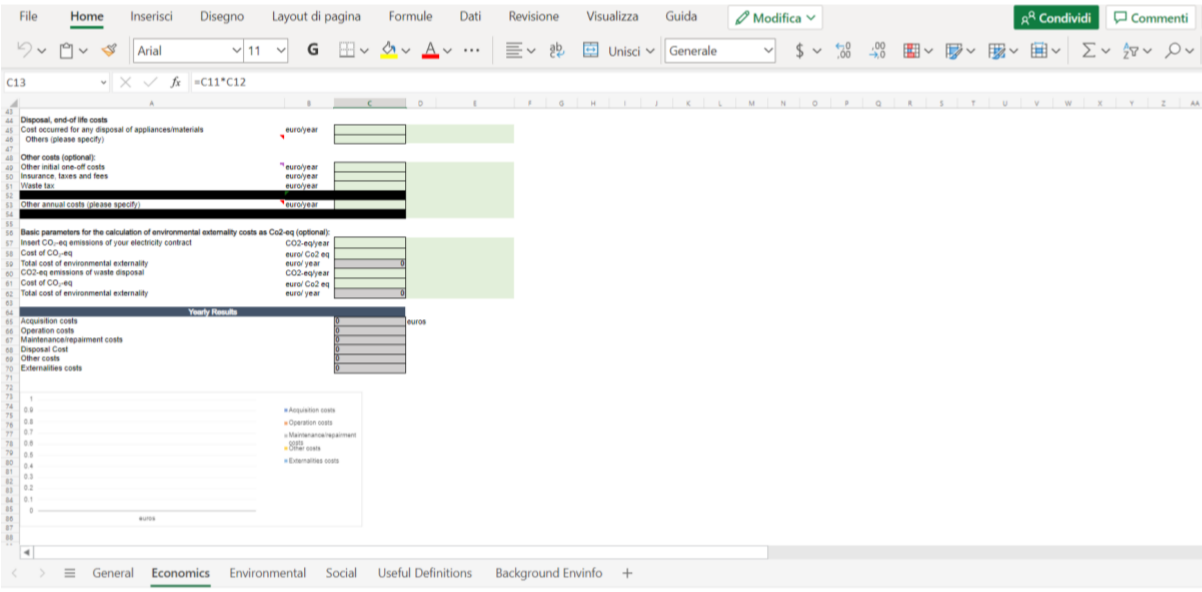

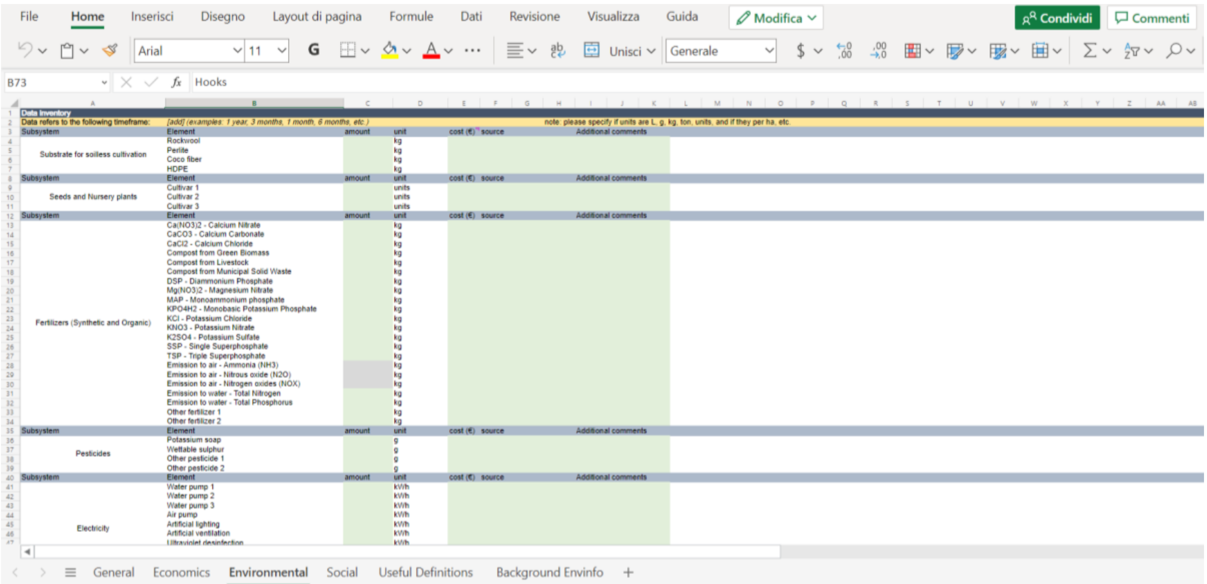

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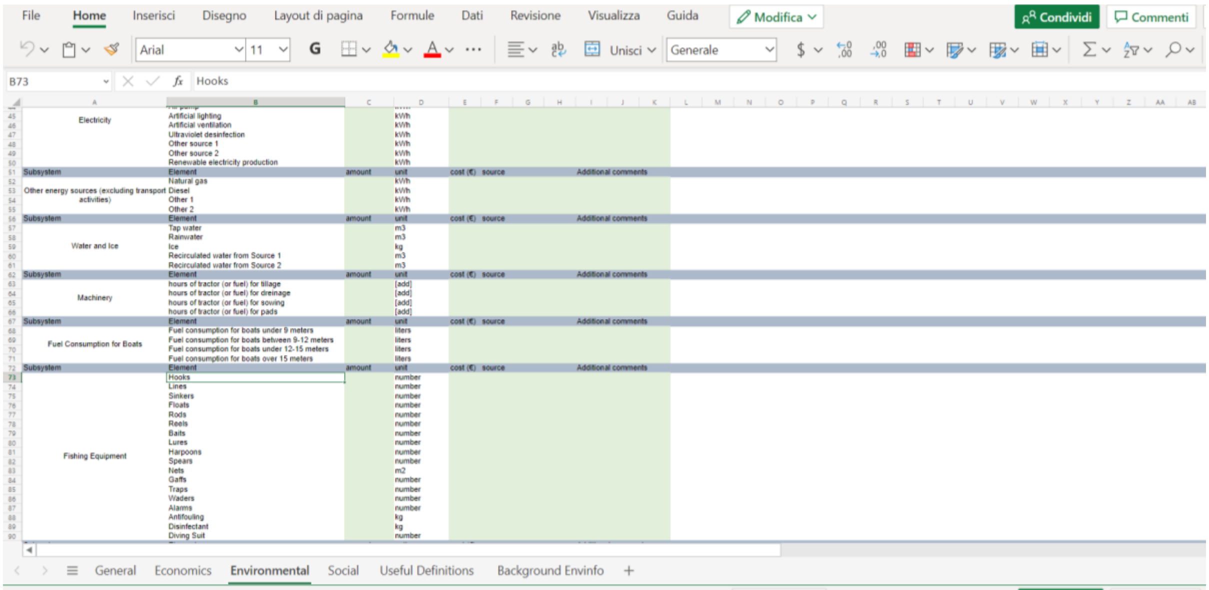

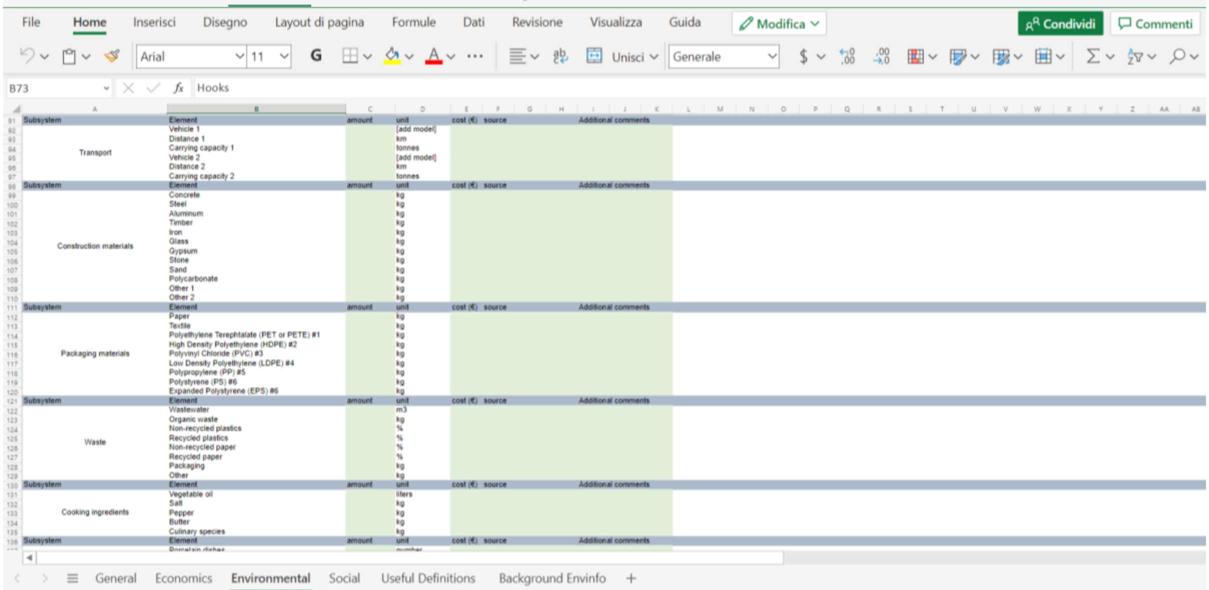

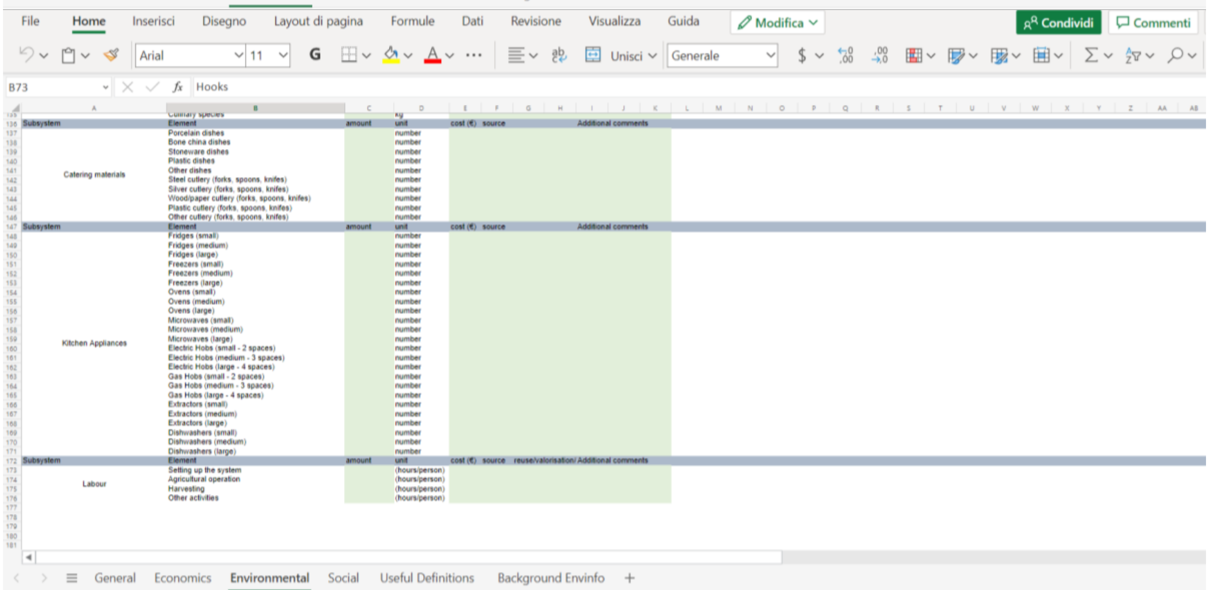

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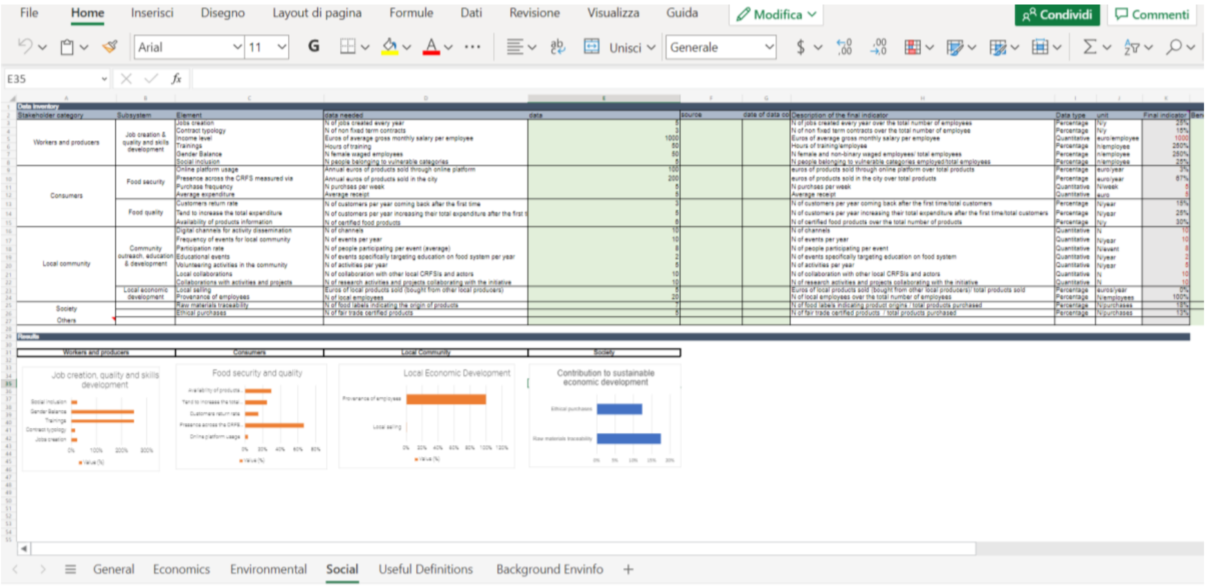
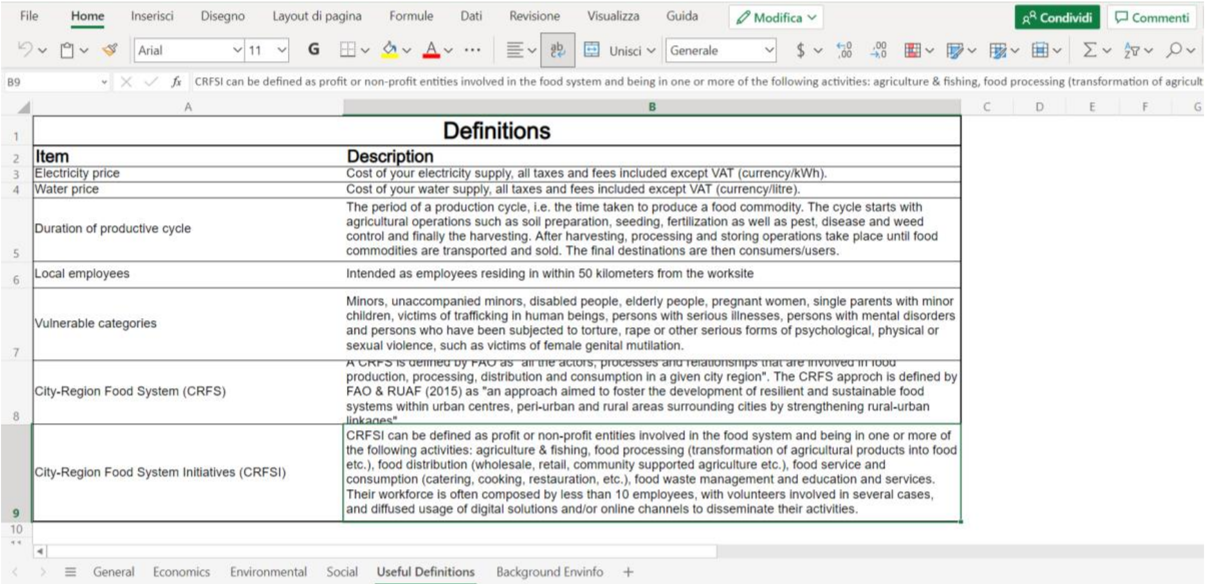


Stakeholder category	Subsystem	Element	data needed	data	source	date of data co	Description of the final indicator	Data type	unit	Final indicator
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year	5			N of jobs created every year over the total number of employees	Percentage	N/y	25%
		Contract typology	N of non fixed term contracts	3			N of non fixed term contracts over the total number of employee	Percentage	N/y	15%
		Income level	Euros of average gross monthly salary per employee	1000			Euros of average gross monthly salary per employee	Quantitative	euro/employee	1000
		Trainings	Hours of training	50			Hours of training/employee	Percentage	h/employee	250%
		Gender Balance	N female waged employees	50			N female and non-binary waged employees/ total employees	Percentage	n/employee	250%
		Social inclusion	N people belonging to vulnerable categories	5			N people belonging to vulnerable categories employed/total employees	Percentage	n/employee	25%
Consumers	Food security	Online platform usage	Annual euros of products sold through online platform	100			euros of products sold through online platform over total products	Percentage	euro/year	3%
		Presence across the CRFS measured via	Annual euros of products sold in the city	200			euros of products sold in the city over total products	Percentage	euro/year	67%
		Purchase frequency	N purchses per week	5			N purchses per week	Quantitative	N/week	5
		Average expenditure	Average receipt	5			Average receipt	Quantitative	euro	5
	Food quality	Customers return rate	N of customers per year coming back after the first time	3			N of customers per year coming back after the first time/total customers	Percentage	N/year	15%
		Tend to increase the total expenditure	N of customers per year increasing their total expenditure after the first t	5			N of customers per year increasing their total expenditure after the first time/total customers	Percentage	N/year	25%
		Availability of products information	N of certified food products	6			N of certified food products over the total number of products	Percentage	N/y	30%
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels	10			N of channels	Quantitative	N	10
		Frequency of events for local community	N of events per year	10			N of events per year	Quantitative	N/year	10
		Participation rate	N of people participating per event (average)	8			N of people participating per event	Quantitative	N/event	8
		Educational events	N of events specifically targeting education on food system per year	2			N of events specifically targeting education on food system	Quantitative	N/year	2
		Volunteering activities in the community	N of activities per year	5			N of activities per year	Quantitative	N/year	5
		Local collaborations	N of collaboration with other local CRFSIs and actors	10			N of collaboration with other local CRFSIs and actors	Quantitative	N	10
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative	10			N of research activities and projects collaborating with the initiative	Quantitative	N	10
	Local economic development	Local selling	Euros of local products sold (bought from other local producers)	5			Euros of local products sold (bought from other local producers)/ total products sold	Percentage	euros/year	0%
		Provenance of employees	N of local employees	20			N of local employees over the total number of employees	Percentage	N/employees	100%
Society		Raw materials traceability	N of food labels indicating the origin of products	7			N of food labels indicating product origins / total products purchased	Percentage	N/purchases	18%
Others		Ethical purchases	N of fair trade certified products	5			N of fair trade certified products / total products purchased	Percentage	N/purchases	13%



Definitions

Item	Description
Electricity price	Cost of your electricity supply, all taxes and fees included except VAT (currency/kWh).
Water price	Cost of your water supply, all taxes and fees included except VAT (currency/litre).
Duration of productive cycle	The period of a production cycle, i.e. the time taken to produce a food commodity. The cycle starts with agricultural operations such as soil preparation, seeding, fertilization as well as pest, disease and weed control and finally the harvesting. After harvesting, processing and storing operations take place until food commodities are transported and sold. The final destinations are then consumers/users.
Local employees	Intended as employees residing in within 50 kilometers from the worksite
Vulnerable categories	Minors, unaccompanied minors, disabled people, elderly people, pregnant women, single parents with minor children, victims of trafficking in human beings, persons with serious illnesses, persons with mental disorders and persons who have been subjected to torture, rape or other serious forms of psychological, physical or sexual violence, such as victims of female genital mutilation.
City-Region Food System (CRFS)	A CRFS is defined by FAO as "all the actors, processes and relationships that are involved in food production, processing, distribution and consumption in a given city region". The CRFS approch is defined by FAO & RUAF (2015) as "an approach aimed to foster the development of resilient and sustainable food systems within urban centres, peri-urban and rural areas surrounding cities by strengthening rural-urban linkages"
City-Region Food System Initiatives (CRFSI)	CRFSI can be defined as profit or non-profit entities involved in the food system and being in one or more of the following activities: agriculture & fishing, food processing (transformation of agricultural products into food etc.), food distribution (wholesale, retail, community supported agriculture etc.), food service and consumption (catering, cooking, restauration, etc.), food waste management and education and services. Their workforce is often composed by less than 10 employees, with volunteers involved in several cases, and diffused usage of digital solutions and/or online channels to disseminate their activities.

Appendix 3 - S-LCA assessment system from categories to inventory data

Stakeholder category	Subsystem	Element	Data needed
Workers and producers	Job creation & quality and skills development	Jobs creation	N of jobs created every year
		Contract typology	N of non-fixed term contracts
		Income level	Euros of average gross monthly salary per employee
		Trainings	Hours of training
		Gender Balance	N female waged employees
		Social inclusion	N people belonging to vulnerable categories

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Consumers	Food security	Online platform usage	Annual euros of products sold through online platform
		Presence across the CRFS measured via	Annual euros of products sold in the city
		Purchase frequency	N purchses per week
		Average expenditure	Average sale amount
	Food quality	Customers return rate	N of customers per year coming back after the first time
		Tend to increase the total expenditure	N of customers per year increasing their total expenditure after the first time
		Availability of products information	N of certified food products
Local community	Community outreach, education & development	Digital channels for activity dissemination	N of channels
		Frequency of events for local community	N of events per year
		Participation rate	N of people participating per event (average)
		Educational events	N of events specifically targeting education on food system per year
		Volunteering activities in the community	N of activities per year
		Local collaborations	N of collaboration with other local CRFSIs and actors
		Collaborations with activities and projects	N of research activities and projects collaborating with the initiative
	Local economic development	Local selling	Euros of local products sold (bought from other local producers)
		Provenance of employees	N of local employees
Society		Raw materials traceability	N of food labels indicating the origin of products
		Ethical purchases	N of fair trade certified products
Others			

Appendix 4 - S-LCA benchmark system pathway

Indicators for the self-assessment tool (pilot)	Survey question (Directly comparable)	Survey question (proxy used)
N of jobs created every year		
N of non fixed term contracts	Q3.2 Which contract type have you arranged with your waged employees?	
Euros of average gross monthly salary per employee	Q3.3 Could you indicate the monthly average gross wage (figured before any	

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	state and federal taxes, social security, and health insurance) in your organization (including both full and part time employees)?	
Hours of training	Q3.4 How often does your organization provide workplace training to each waged employee? Please indicate the estimated hours/year	
N female waged employees	Q3.5 What is the share of female waged employees over the total number of employees?	
N people belonging to vulnerable categories		Q3.7 Is your organization running activities for the disadvantaged people of your community? (yes/no)
Annual euros of products sold through online platform		Q4.11 Do you sell on line through your own or third party's own- or third-party platform? (yes/no)
Annual euros of products sold in the city	Q4.2 What are your estimated revenues per year?	Q6.13 How close are you approximately to your main clients/customers on average?
N purchases per week	Q5.1 Direct sale: on average, how many end customers per month do you sell to? [Please provide an indicative number]	
Average sale amount		
N of customers per year coming back after the first time	Q4.8 How often do your 1st time customers or users come back?	
N of customers per year increasing their total expenditure after the first time	Q4.9 Do your single customers or users tend to increase their total expenditure?	
N of certified food products		
N of channels		
N of events per year	Q3.6 What's the frequency of events (either in person or online) organized for the local community?	
N of people participating per event (average)		
N of events specifically targeting education on food system per year		
N of activities per year		Q3.9 Do you involve people from your communities in any volunteering activities? (yes/no)
N of collaboration with other local CRFSIs and actors		Q3.8 Do you sell or manage products that you buy from other local producers? (yes/no)
N of research activities and projects collaborating with the initiative		
Euros of local products sold (bought from other local producers)	Q4.5 What is the percentage of supplies sourced locally (from suppliers within a distance of maximum 50km from your venue)?	Q3.8 Do you sell or manage products that you buy from other local producers? (yes/no)
N of local employees	Q4.4 On average, where does your waged employees come from?	
N of food labels indicating the origin of products		

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N of fair trade certified products		Q4.6 Do you implement any specific fair practice towards suppliers? (yes/no)

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1 *Appendix 5 – Abolsute Life Cycle Impact Assessment (LCIA) results for all pilots*

Pilots	GW (kg CO2 eq)	SODP (kg CFC 11 eq)	IR (kBq Co-60 eq)	OFHH (kg NOx eq)	FPMF (kg PM2.5 eq)	OFTE (kg NOx eq)	TA (kg SO2 eq)	FE (kg P eq)	ME (kg N eq)	TET (kg 1,4-DCB)	FET (kg 1,4-DCB)	MET (kg 1,4-DCB)	HCT (kg 1,4-DCB)	HNCT (kg 1,4-DCB)	LU (m2a crop eq)	MRS (kg Cu eq)	FRS (kg oil eq)	WC (m3)
Alma VFarm	2,44E+03	1,50E-03	1,17E+03	4,43E+00	3,67E+00	4,48E+00	9,42E+00	2,33E+00	1,80E-01	7,40E+03	2,47E+02	3,13E+02	1,94E+02	3,57E+03	1,21E+02	6,45E+00	6,65E+02	5,48E+01
SALUS Space	1,11E+03	5,88E-02	-3,05E+03	6,47E+00	6,01E+00	9,02E+00	5,46E+01	1,29E+01	1,01E+01	4,00E+03	-2,77E+02	-3,74E+02	-1,07E+02	-5,30E+03	4,86E+03	1,23E+01	-8,04E+02	3,45E+02
SERRA MADRE	9,04E+03	2,72E-02	4,62E+02	1,51E+01	1,12E+01	1,57E+01	3,21E+01	4,49E+01	7,44E+00	2,92E+04	4,89E+02	6,06E+02	5,05E+02	6,00E+03	1,40E+04	3,54E+01	9,63E+02	4,14E+02
Sabadell Centre	1,15E+03	5,92E-03	9,37E+01	2,57E+00	1,91E+00	2,68E+00	8,74E+00	3,32E-01	2,31E-01	4,98E+03	4,47E+01	5,78E+01	5,03E+01	8,81E+02	1,13E+02	4,17E+00	4,62E+02	1,71E+01
Sabdell Parc	5,26E+03	2,93E-02	2,10E+02	1,20E+01	8,76E+00	1,25E+01	4,18E+01	1,15E+00	1,12E+00	2,34E+04	1,70E+02	2,21E+02	2,13E+02	3,63E+03	5,49E+02	1,96E+01	2,18E+03	7,57E+01
Sabdell Riu	1,89E+02	4,56E-04	6,66E+01	3,84E-01	3,07E-01	3,94E-01	1,03E+00	1,41E-01	2,40E-02	6,81E+02	1,55E+01	1,96E+01	1,24E+01	2,39E+02	1,16E+01	5,64E-01	6,15E+01	3,46E+00
Cité Maraîchère	3,14E+03	1,83E-02	7,44E+02	2,09E+01	8,33E+00	2,41E+01	1,99E+01	1,98E+00	4,99E-01	2,79E+04	1,46E+02	2,01E+02	2,47E+02	4,28E+03	8,96E+03	1,16E+01	8,01E+02	5,67E+01
Bleijswijk	6,11E+03	2,56E-02	1,73E+03	9,97E+00	8,86E+00	1,02E+01	3,10E+01	3,93E+00	3,07E-01	2,27E+04	5,04E+02	6,49E+02	4,73E+02	8,80E+03	1,74E+02	2,39E+01	1,48E+03	1,00E+02
Prison Honey	7,46E+02	6,48E-04	8,46E+01	1,85E+00	1,01E+00	1,91E+00	2,46E+00	3,45E-01	7,82E-02	3,73E+03	7,22E+01	9,07E+01	6,10E+01	8,08E+02	8,13E+01	3,54E+00	2,15E+02	1,13E+01
Metabolic	2,95E+03	3,51E-03	1,52E+03	6,14E+00	5,01E+00	6,51E+00	1,24E+01	3,03E+00	2,46E-01	9,04E+03	3,16E+02	4,00E+02	2,30E+02	4,62E+03	1,31E+02	7,73E+00	7,95E+02	6,12E+01
CUIB	7,31E+03	3,79E-04	4,02E+03	1,38E+01	1,55E+01	1,38E+01	3,17E+01	2,68E+01	2,85E+00	3,32E+04	1,01E+03	1,33E+03	9,42E+02	1,46E+04	4,45E+02	3,45E+01	5,83E+02	2,38E+02
Berlin	1,63E+02	3,04E-05	3,99E+00	3,65E-01	2,06E-01	3,89E-01	4,39E-01	4,79E-02	3,24E-03	4,10E+02	6,01E+00	8,26E+00	4,49E+01	1,00E+02	2,04E+00	1,93E+00	9,06E+01	-8,85E-01
Oslo Educational	5,98E+03	6,80E-03	7,82E+02	2,10E+01	1,35E+01	2,15E+01	7,66E+01	2,55E+00	2,84E+00	4,10E+04	2,89E+02	3,82E+02	3,28E+02	6,50E+03	1,17E+03	1,51E+01	1,51E+03	6,28E+01

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Ecotúnidos	7,29E+05	3,71E-01	2,84E+05	1,39E+03	1,04E+03	1,44E+03	2,70E+03	6,09E+02	6,35E+01	1,91E+06	6,12E+04	7,76E+04	4,77E+04	9,06E+05	2,14E+04	1,50E+03	2,68E+05	1,08E+04

2

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