Deliverable C1

LIFE CYCLE ASSESSMENT REPORT

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Life Effige
Environmental Footprint For Improving and Growing Eco-efficiency

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Abstract

This report includes the results achieved in LIFE EFFIGE by the companies that have implemented the Action Plan for the environmental improvement of the following selected products:

- Four types of raw casting products
- Three types of Mustard
- Five types of Nougat
- One school meal service
- One product of the supply chain of the school meal service
- Two office chairs and two office desks

The efficacy of the improvement actions has been measured by using the LCA (Life Cycle Assessment) method to perform Product environmental footprint (PEF) studies in compliance with the Recommendation 2013/179/EU.

Main aggregated results are presented in section "LCA Report: comparative analysis of the impact assessment results (first and second PEF studies)". The detailed results are included in Annex 1 and are confidential. Requests of specific data shall be sent to the project's coordinator (Scuola Superiore Sant'Anna di Pisa, www.lifeeffige.eu), who will provide them, upon company's authorization.

Questo documento include i risultati raggiunti in LIFE EFFIGE dalle aziende che hanno realizzato il Piano di Azione di miglioramento ambientale dei seguenti prodotti, da loro selezionati:

- *quattro prodotti di getti di fonderia*
- *tre diversi tipi di mostarda*
- *cinque diversi tipi di torrone*
- *un servizio di ristorazione scolastca*
- *un prodotto della catena di fornitura del servizio di ristorazione*
- *due sedute e due scrivanie da ufficio*

L'efficacia delle azioni è stata misurata utilizzando il metodo LCA (Life Cycle Assessment) per realizzare degli studi di Impronta Ambientale di Prodotto, cioè studi PEF (Product environmental footprint) in conformità con la Raccomandazione 2013/179/UE.

I principali risultati aggregati sono riportati nel capitolo "LCA Report: comparative analysis of the impact assessment results (first and second PEF studies)". I risultati dettagliati sono inclusi nell'Allegato1 e sono confidenziali. Eventuali richieste di conoscere tali dati dovranno essere indirizzate al coordinatore del progetto (Scuola Superiore Sant'Anna di Pisa, www.lifeeffige.eu), che potrà fornirli previa autorizzazione dell'impresa che è proprietaria dei dati.

LCA Report: comparative analysis of the impact assessment results (first and second PEF studies)

This report includes the results achieved in LIFE EFFIGE by the **companies that have implemented the Action Plan for the environmental improvement of the following selected products:**

- Two torque arms, an IR600 box, a flanged hub as foundry semi-finished products
- Three types of Mustard ('cotognata senapata', pear mustard, mixed fruit mustard)
- Five types of Nougat (three types of chocolate nougats, an almond nougat and a hazelnut nougat)
- One school meal service
- One product of the supply chain of the school meal service
- Two office chairs and two office desks

The efficacy of the improvement actions has been measured by using the LCA method to perform Product environmental footprint (PEF) studies in compliance with the Recommendation 2013/179/EU and more specifically with the following reference documents:

- Product Environmental Footprint (PEF) Guide; Annex II to the Recommendation 2013/179/EU, 9 April 2013. Published in the official journal of the European Union Volume 56, 4 May 2013;
- PEFCR Guidance document - Guidance for the development of Product Environmental Footprint Category Rules (PEFCRs), version 6.3, December 2017.

The latter document had been adopted for the development of the PEFCR during the European Environmental Footprint Pilot Phase.

Ecoinvent 3.6 and Agrifootprint Databases have been mainly used to model background data in LIFE EFFIGE studies, because EF-compliant datasets were available neither for free nor for a fee[1].

The results of the studies before and after the implementation of the improvement actions (first and second studies) have been calculated by using the Impact Assessment Method EF v.2 of the Guidance 6.3. Normalisation and weighting factors are shown in Table 1.

Table 1 Normalisation (global per person)) and weighting factors without toxicity (Method EF v.2)

Impact category	Unit for the normalisation	Normalisation factors	Weighting factors
Climate change	kg CO2 eq	7.76E+03	22.19
Ozone depletion	kg CFC-11 eq	2.34E-02	6.75
Human toxicity, cancer effects	CTUh	3.85E-05	-
Human toxicity, non-cancer effects	CTUh	4.75E-04	-
Particulate matter (Respiratory inorganics)	Disease incidence	6.37E-04	9.54
Ionizing radiation HH	kBq U235 eq	4.22E+03	5.37
Photochemical ozone formation	kg NMVOC eq	4.06E+01	5.1
Acidification	molc H+ eq	5.51E+01	6.64
Terrestrial eutrophication	molc N eq	1.77E+02	3.91

[1] EF-compliant datasets are available for free only for PEF studies in compliance with any PEFCR/OEFSR listed at the Commission website. Moreover, when LIFE EFFIGE first PEF studies were carried out, the EF-compliant datasets were not sold by LCA software providers.

Freshwater eutrophication	kg P eq	2.55E+00	2.95
Marine eutrophication	kg N eq	2.83E+01	3.12
Freshwater ecotoxicity	CTUe	1.18E+04	-
Land use	pt	1.33E+06	8.42
Water resource depletion	m3 world eq	1.15E+04	9.03
Resource use, fossil	MJ	6.53E+04	8.92
Resource use, minerals and metals	Kg Sb eq	5.79E-02	8.08

In Annex 1 the characterised, normalised and weighted results of the first and second studies are presented as well as the definition of the functional unit and system boundaries and the database used for background data. Improvement actions adopted and amount of 'PEF products' produced in 2017 are also reported. The amount of production allows an estimation of the total effects of the actions.

The Annex 1 is not publicly available due to confidentiality issues. Requests of specific data shall be sent to the LIFE EFFIGE coordinator (Scuola Superiore Sant'Anna di Pisa, www.lifeeffige.eu), who will provide them, upon company's authorization.

Here below main results, aggregated by class of product, are summarised.

Foundry: cast iron raw casting

Two companies of the foundry sector have completed the environmental improvement actions in LIFE EFFIGE. They have focused on reducing energy consumption and/or raw materials consumption for the production of 4 products: two torque arms, an IR600 box, a flanged hub. Moreover, they have increased the use of electricity from renewable sources. An average reduction of the total weighted impact equal to about 10% was achieved. The improvement of the results of 'climate change', 'resource, energy carriers' and 'resource use, mineral and metals' is directly related to the measures implemented. If we consider the total production of torque arm, IR600 box and flanged hub in 2017, the emission of about 1.2E06 kg CO2eq has been avoided thanks to the actions implemented and total savings have been obtained for energy resources (about 2.25E07 MJ) and mineral and metals use (about 41.1 kg Sb eq). For these impact categories, Table 1 shows the savings obtained per tonne of cast iron and the average values of the results of the first PEF studies of the 4 products[2].

Table 1 Effect of the improvement actions on the most significant impact categories and average results of the first PEF studies of the 4 foundry products

Impact category	Unit	Average variation per tonne of product	Average impacts of 1 tonne cast iron
Climate change	Kg CO2 eq	-185	2152
Resource use, energy carriers	MJ	-3500	24403
Resource use, mineral and metals	Kg Sb eq	-6.37E-03	1.89E-02

Agrifood: mustard

Three companies were involved in LIFE EFFIGE by the partner CAM and have completed the improvement actions: two companies that produce mustard and one that sells it with its own brand.

[2] Benchmark values are not available in the PEFCR "Cast iron-raw casting" developed in LIFE EFFIGE because these PEFCR cover an intermediate product.

One of the two producers supplies the product object of the PEF study to the third company. Three types of products have been object of the PEF studies ('cotognata senapata', pear mustard, mixed fruit mustard), for a total amount of products equal to about 6.4 tonne. Both producers have adopted 100% renewable electricity, backed by origin certificates. One of two has also increased the equipment efficiency and has improved its packaging. Thus, this company has achieved very good results for its own product (a reduction of 50% of the total weighted impacts of the PEF study) and satisfying results for the product supplied to the third company (-7% of the total weighted impacts). This latter product has higher impacts in the preproduction phase (where no improvement actions have been adopted), so that it could not take the same advantages from the increased equipment efficiency as the former product. The company that has only changed the power supply contract has obtained a reduction of about 3% of the total weighted impact of their product. The most relevant impact categories are: 'climate change', 'resource, energy carriers', 'resource use, mineral and metals', and 'water scarcity'. Table 2 shows the effects of the improvement actions on these impact categories and the benchmark values defined in the LIFE EFFIGE PEFCR for mustard.

Table 2 Effect of the improvement actions and benchmark values for some relevant impact categories of the product 'mustard'

Impact category	Unit	Average variation per kg of product	Benchmark values (1 kg of mustard)
Climate change	Kg CO2 eq	-1	3.6
Resource use, energy carriers	MJ	-18	51.6
Water scarcity	m^3 depriv	-0.2	5.7
Resource use, mineral and metals	Kg Sb eq	+2.8E-07	2.2E-05

Agrifood: nougat

Two companies producing nougat have also been involved in LIFE EFFIGE. The improvement actions have covered three chocolate nougats, an almond nougat and a hazelnut nougat, for a total production of about 80 tonne in 2017. The actions were focused on the packaging and included a reduced use of materials and an increase of the recycled material. One of two producers has also adopted 100% renewable electricity, backed by origin certificates, thus obtaining a reduction of the total weighted impacts of its products by about 7%. The results have been less relevant for the other three products, for which an average reduction of the total weighted impact less than 3% could be obtained.

The most relevant impact categories are: 'climate change', 'resource, energy carriers', 'resource use, mineral and metals', and 'water scarcity'. For chocolate nougats the impact category 'land use' must be added to this list. Table 3 shows the effects of the improvement actions adopted and the benchmark values defined in the LIFE EFFIGE PEFCR for nougat.

Table 3 Effect of the improvement actions and benchmark values for some relevant impact categories of the product 'nougat'

Impact category	Unit	Average variation per kg of product	Benchmark values (1 kg of nougat)
Climate change	Kg CO2 eq	-0.26	5.91
Resource use, energy carriers	MJ	-3.9	50.8
Water scarcity	m^3 depriv	-0.18	36.6
Resource use, mineral and metals	Kg Sb eq	-2.0E-06	1.28E-05

School meal service and supply chain

Camst has carried out the PEF study of a contracted school meal service. The Centralised Kitchen involved in LIFE EFFIGE has identified improvement actions concerning reduction of resources use by changing the meal sets from disposable to reusable, reduction of food waste through specific children education activities and adoption of an electricity mix with lower environmental impacts. The health emergency due to COVID-19, which occurred since the beginning of 2020, has severely affected the catering sector, especially the school sector, which has suffered continuous interruptions. To save service representativeness the second PEF study has considered the school year 2018-2019, since the following years were not representative. Only five additional dishwashers were installed to reduce the use of disposable meal sets: the effect, despite being small, seems positive in the use and end-of-life stages. Electricity mix with higher renewable content was not implemented at the Centralized Kitchen, because of the uncertainty of the service supply in this period. However, the introduction of new equipment with higher efficiency has led to lower energy and water consumption in the kitchen. Thanks to this, the following savings could be obtained for the total yearly production of school meals all through its life cycle: about 4.6E05 MJ for energy resources, 1.44E05 m^3 depriv. of water and 1.6E04 kg CO2 eq. Table 4 shows the improvements obtained for some relevant impact categories, and the benchmark values for 200 school meals, which have been defined in the PEFCR developed in LIFE EFFIGE. For the other relevant categories the differences are less than 1%. The potential reduction of food waste could not be verified because in March 2020, after two weeks of monitoring in two canteens and a first round of training in some classes, the activities have to be stopped. Though the difficulties encountered, the reduction of about 1.5% of the total weighted impact is encouraging, even if a comprehensive overview of the potential impact reduction will be possible only once the improvement actions are completely implemented.

Table 4 Effect of the improvement actions and benchmark values for some relevant impact categories of the 'contracted school meal service'

Impact category	Unit	Average variation for 200 school meals	Benchmark values (200 school meals)
Climate change	Kg CO2 eq	-5	454
Resource use, energy carriers	MJ	-140	4137
Water scarcity	m^3 depriv	-44	400

The supplier that has been involved in LIFE EFFIGE by CAMST has decided to focus the improvement actions on the packaging system of the product Italian organic Extravirgin olive oil in 1 L glass bottle. The new packaging system, now available on customers' request, has achieved a reduction of about 4% of the total weighted impact. As regards the most relevant impact categories, a reduction of the impacts equal to about 7% could be obtained for 'climate change' and 'resource, energy carriers', and about 5% for 'resource use, mineral and metals'. The other significant impact category, i.e. 'water scarcity', is not affected by the improvement actions. Benchmark values of the PEFCR draft for olive oil cannot be compared with the results achieved because they were calculated in agreement with a different impact assessment method and the update is not available yet.

Office furniture: chair and desk

Two companies producing office furniture have completed the improvement actions in LIFE EFFIGE. The companies have carried out the PEF studies on two office chairs and two office desks. The improvement actions included a reduction of the use of materials and packaging, and an increase of the use of recycled materials. The effectiveness of the actions strongly depends on the

type of product. The total weighted impacts of the office chairs and the office desks have decreased by about 4% and 20%, respectively. Considering the total production in 2017 of the 4 office furniture products, the emission of about 2.8E05 kg CO2eq has been avoided thanks to the improvement actions, and total savings have been obtained concerning energy resources and mineral and metals equal to about 3.4E06 MJ and 4.3 kg Sb eq, respectively. Tables 5 and 6 show the improvements of the impact categories most related to the actions adopted and the benchmark values of the two representative products (office chair and office desk) defined in the LIFE EFFIGE PEFCRs.

Table 5 Effect of the improvement actions and benchmark values for some relevant impact categories of the product 'office chair'

Impact category	Unit	Average variation per unit of product	Benchmark values (1 office chair)
Climate change	Kg CO2 eq	-2.5	113
Resource use, energy carriers	MJ	-84	1364
Resource use, mineral and metals	Kg Sb eq	0	4.5E-04

Table 6 Effect of the improvement actions and benchmark values for some relevant impact categories of the product 'office desk'

Impact category	Unit	Average variation per unit of product	Benchmark values (1 office desk)
Climate change	Kg CO2 eq	-95.6	163
Resource use, energy carriers	MJ	-910	1907
Resource use, mineral and metals	Kg Sb eq	-1.6E-03	2.2E-03

Annex 1: Detailed results of the LCA Studies and environmental improvements achieved

This Annex includes the results achieved in LIFE EFFIGE by the companies that have implemented the Action Plan for the environmental improvement of the selected products.

This Annex is confidential and is organised as follows:

1. Foundry: Cast iron raw casting
1.1 Company A: IR600 box
1.2 Company A: TORQUE ARM
1.3 Company B: FLANGED HUB
1.4 Company B: TORQUE ARM

2. Agrifood: Mustard
2.1 Company C: PEARS MUSTARD PRODUCT
2.2 Company D: COTOGNATA SENAPATA PRODUCT
2.3 Company E: MIXED FRUIT MUSTARD PRODUCT

3. School meal service and supply chain
3.1 Centralised kitchen Forlì: CONTRACTED SUPPLY SERVICE FOR SCHOOL MEALS
3.2 Meal service supply chain: ITALIAN ORGANIC EXTRA VIRGIN OLIVE (EVO) OIL

4. Office Furniture: Chair and Desk
4.1 Company F: AIRA ZERO 7 CHAIR
4.2 Company F: UPHOLSTERED AIRA CHAIR
4.3 Company G: MDL LAMINATE DESK
4.4 Company G: MDL WOOD DESK

5. Agrifood: Nougat
5.1 Company H: ALMOND NOUGAT
5.2 Company H: CHOCOLATE NOUGAT
5.3 Company H: CHOCOLATE NOUGAT (CROCCANTINO)
5.4 Company I: CHOCOLATE NOUGAT
5.5 Company I: HAZELNUT NOUGAT