An initiative of the Food Sector for the protection of the environment

LIFE+ FOODPRINT

LIFE13 ENV/GR/000958

Action C: Monitoring of the impact of the project actions

Deliverable C.1.	**Evaluation of the current environmental situation of the food industries in Greece and Italy**

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Version 3

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Disclaimer

The information included herein is legal and true to the best possible knowledge of the authors, as it is the product of the utilization and synthesis of the referenced sources, for which the authors cannot be held accountable.

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ABBREVIATIONS AND ACRONYMS

BAT	Best available techniques
CSD	Commission on Sustainable Development
EU	European Union
GHG	Greenhouse gas
GHGE	Greenhouse gas emissions
GDP	Gross domestic product
IED	Industrial Emissions Directive
OECD	Organisation for Economic Co-operation and Development
PSR model	Pressure –state –response model
SEVT	Federation of Hellenic Food Industries
WLO	Waste Lube Oils

1 INTRODUCTION

Dealing with the impact of human activities on climate change is one of the biggest challenges and highest priorities of EU environmental policy. The food industry is one of the most dynamic sectors of the European economy, but it also accounts for 15 to 20% of total EU greenhouse gas (GHG) emissions; 5-6% coming from transport, 8-10% from food processing and packaging, 1-2% from refrigeration and an estimated 1-2% from retail.

A changing climate also adversely affects food production through, for example, drought or extreme weather events. The Greek food industry sector contributes a 25% share to the annual gross domestic product (GDP). The pastry and flour sub-sector accounts for around 60% of food and drink companies in Greece, and the sub-sector is similarly important in Italy.

The objectives of Action C.1 are the following:

- ✓ Assessment and evaluation of the current environmental situation, and the
- ✓ Identification and analysis of the environmental problems (*especially in waste management*) in the selected regions (Greece and Italy).

For the successful monitoring of the environmental impact of the project, specific indicators will be set and subsequently used for measuring the project's impact on the environmental problem targeted. For this purpose, data on the initial situation from which the project starts regarding the chain supply of pastry & flour related products of JOTIS company and nationally will be used for the evaluation of the current environmental impact.

Finally, the selected environmental impact measured during this Action will be compared to the environmental impact during the project implementation (Action C.3) in order for the overall environmental impact of the project to be evaluated.

2 CURRENT ENVIRONMENTAL SITUATION RELATED TO INDUSTRIAL ACTIVITY

2.1 Legislation regarding industrial activity and environmental protection.

The European Union (EU) defines the obligations to be met by industrial activities with a major pollution potential. It establishes a permit procedure and lays down requirements, with the objective to avoid or minimize pollution of air, water and soil, as well as waste from industrial and agricultural installations, in order to achieve a high level of environmental protection.

According to Article 11 of Directive 2010/75/EU (EU, 2010), any industrial installation which carries out industrial activities with a major pollution potential (energy industries, production and processing of metals, mineral industry, chemical industry, waste management, rearing of animals, food production etc) must meet a series of basic obligations. More specifically it must ensure that[2]:

- all the appropriate preventive measures are taken against pollution
- the best available techniques are applied
- no significant pollution is caused
- the generation of waste is prevented
- where waste is generated, it is, prepared for re-use, recycled, recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment
- energy is used efficiently
- the necessary measures are taken to prevent accidents and limit their consequences
- the necessary measures are taken upon definitive cessation of activities to avoid any risk of pollution and return the site of operation to a satisfactory state.

2.2 Environmental impact of food industry in Europe

The food and beverage industry in Europe has a prominent position among industrial sectors. However, food production and consumption is responsible for a significant part (20-30%) of all anthropogenic environmental impacts (EC, 2014).

At a macro level, a study that was conducted in Finland in 2009, estimated that the food chain is responsible for a significant amount of GHG emissions. In summary food production is accountable for 7% of all carbon dioxide emissions, 43% of methane emissions, 50% of nitrous oxide emissions, 12% of per fluorocarbon gas emissions and 69% of ammonia

[2] *Makuch Karen & Pereira Ricardo, 2012.*

emissions produced in Finland. The food chain is therefore estimated to contribute 14% to Finland's impact on climate change (Virtanen et. al, 2011).

This problem is also faced by countries worldwide, such as the United States of America, where the Food-related emissions comprise 21% of total emissions (Virtanen et. al, 2011).

Although the reduction of food consumption in Europe conflicts with welfare strategies, climate change mitigation is possible through avoiding the production of un-necessary food and behavioral changes touching upon our diet patterns. In recent years, food industry is increasingly using eco-design tools to optimize the environmental performance of products and packaging and is turning to reusable packaging solutions wherever environmentally beneficial and feasible (Food Drink Europe, 2012). The "green" growth of the food industry sector, not only offers environmental benefits, but also supports the competitiveness and sustainability of the industry.

2.3 Food industry and environment in Greece

2.3.1 Greek food industrial sector

The Greek food industrial sector is the leader of the Greek economy, with considerable contribution to the country's GDP, since it accounts for 25% of turnover, controls 25% of total capital, produces 24% of total value added and employs more than 22% of all employees of the entire manufacturing sector. It is a dynamic, competitive, export-oriented industry, with extensive investments and trade in Greece, the Balkans and the rest of Europe.

As indicated by Federation of Hellenic Food Industries (SEVT) the sector of food industry in Greece has adopted a growth model that aims to integrate environmental protection. Enterprises are encouraged to direct their activities towards the development of "green" initiatives focusing on (SEVT, 2012):

- reducing carbon dioxide emissions and packaging waste
- the careful management of water usage
- use of environmentally friendly packaging
- supporting environmentally friendly cultivation methods
- use of renewable energy sources

As stated in the Official Government Gazette, Standards of Environmental Commitments by sector of activity (within the scope of Law 3982/11 are classified in category B of Article 1 of L.4014/11), include, among other commitments, for the production of gristmill products,

starches and starch products, bakery and floury products, as well as other food products, the following:

- Proper operation, regular maintenance, suction systems' cleaning and retention of dust generated during the production process.
- Training employees in the implementation of emergency plans.
- Stable combustion for space and water heating work on fuels and specifications determined by the Ministerial Decision 189533/11 (Gazette 2654 / B) as applicable. Illustration, it should be kept stamped book-Register, where the maintenance of the burner is recorded.
- Regular cleaning and adjusting burners, flue gas ducts (hob, chimney, etc.) In combination with regular measurements of licensed conservator pursuant to Ministerial Decision 189533/11 (Gazette 2654 / B / 2011).
- The evacuation of combustion gases in compliance with Article 107 of the building codes, as applicable, and at a height that does not occur environmental problems.
- For gas waste arising from the operation of industrial boilers, steam generators, thermal oil boilers and heaters using heavy fuel oil (sulphuric content up to 1% - based on 284/2007 Joint Ministerial Decision (Government Gazette 1736 / B / 2007)), diesel or gas to respect the emission limits specified in the Joint Ministerial Decision 11294/1993 (Government Gazette 264 / B / 1993) as amended and kept the necessary maintenance records.
- Observe the Presidential Decree 1180-1181 (OG-293 A) limits for greenhouse gas waste.
- Adopt all necessary measures to prevent the release of unpleasant odors.
- Cutters should have suitable wetting system that prevents dust emission.
- Provide dedusting unit at all stages of production where dust is generated.
- Urban wastewater from the plumbing installation should be diverted to a sewage treatment plant.
- Urban wastewater from the plumbing of the installation should be channeled into septic tank system - absorbent cesspool, operating in accordance with the Joint Ministerial Decision 145 116 (Government Gazette 354 / B / 2011) as applicable.
- Urban waste generated should be collected daily and removed at regular intervals by appropriate bodies.
- Management of non-hazardous solid waste should be in compliance with the provisions of Joint Ministerial Decision 50910/2727/03 (Government Gazette 1909 / B / 2003) as amended and the Law. 4042/2012 (Government Gazette 24 / A / 2012). All non-hazardous solid waste, should be stored temporarily, be delivered to the carrier / contractor, who must obtain a permit for collecting and transporting non-hazardous waste and contract with the final recipient of the waste. If the waste delivered for disposal or recovery in the country, the decision of Environmental

Conditions Approval of the final recipient to authorize the acceptance of such waste in installation.

- Management of waste streams, which fall within the scope of Law. 2939/01 (Government Gazette 179 / A / 2001), as applicable, should be in accordance with the provisions of this Law and of that for each current Presidential Decree or Common Ministerial Decision. In particular:
    1. The packaging of various materials used in the unit, should be delivered to appropriate licensed collector for further use in an approved installation. If the company introduces complete packages of raw and auxiliary materials is liable administrator about these packages. Therefore should contract with an approved alternative management system. The same requirement applies to the packaging of products available on the market.
    2. Collection of end of life electrical and electronic equipment of used batteries and accumulators and used vehicle tires should occur through approved alternative management systems in accordance with the provisions of the respective PD 117/04 (Government Gazette 82 / A) as amended by Presidential Decree 15/06 (Government Gazette 12 / A) and PD 109/04 (Government Gazette 75 / A) and the Joint Ministerial Decision 41624/2057 / E103 / 10 (Government Gazette 1625 / B) as applicable.
    3. Waste Lube Oils (WLO) originated by the maintenance and repair of plant's electro-mechanical equipment, and company vehicles (in case of changing of lubricating oil in the factory) should be temporarily stored in watertight containers with secure cap and be kept within the field of plant, as provided in the Joint Ministerial Decision US 24944/1159/06 (Government Gazette 791 / B) as applicable, and periodically be delivered by appropriately licensed collector, to an approved alternative management system for further processing, with priority given to regeneration. Their management should be in compliance with PD 82/2004 (Government Gazette 64 / A) as applicable.
    4. The management of End of Life Vehicles (ELVs) should be in accordance with the provisions in Decree 116/04 (Government Gazette 81 / A).
    5. Management of waste excavation, construction and demolition should be in accordance with the provisions of the Joint Ministerial Decision36259/1757 / E103 (Government Gazette 1312 / B / 2010) as applicable.
- Sludge resulting from the Wastewater Treatment Plant of the business should be used:
    1. for reuse in agriculture or forestry, in accordance with the Joint Ministerial Decision 80568/4225/1991 (Government Gazette 641 / B),
    2. to licensed facility production of compost,
    3. for landscape restoration and territories,
    4. in Landfills

5. to another sludge treatment facility in accordance with applicable provisions of law.

- The termination of the operation of the unit should follow the restoration of its installation space. In particular:
  1. Hazardous waste management facilities should be rehabilitated - rectified in accordance with the terms of the Joint Ministerial Decision 13588/725 / 6.3.28 (GG 383 / B) and 24944/1159 / 30- 6-2006 (Official Gazette 791 / B) as applicable.
  2. Mechanical equipment should be used to the extent possible, in whole or in part, revolving and in any case available, in accordance with applicable provisions.

2.3.2 Common environmental issues related to industrial activity.

As it is reported in the official website of the Ministry of Reconstruction of Production, Environment and Energy, the industry sector, which belongs to the secondary sector of production, is one of the key pillars of Greece's national economy. However, industrial activity is often accompanied by major environmental problems (YPEKA, 2014).

Such problems are related to the discharge of polluting compounds into the environment, to the inappropriate location of industrial plants, or a combination of these two factors. Polluting compounds, can be found in the form of air pollutant emissions, wastewater, solid or hazardous waste and noise. Problems caused by inappropriate location of industrial plants are more often attributed to poor choice of the installation of industrial activity, for various reasons, such as absence of adequate waste disposal recipient, lack of adequate waste management infrastructure, occupation of land that could be reserved for other uses such as agriculture, livestock, tourism, etc, proximity to archaeological sites, cultural sites sensitive recipients, urban or residential centers, etc. Moreover, a second major factor that indicates poor choice of the installation of industrial plants is the over-concentration of industrial activities in an area, where the overall environmental impact exceeds the region's carrying assimilative capacity.

Regarding the development of industrial activity in Greece, from the 50´s and onwards there has been a rapid growth. However this development was achieved in a disorderly manner, as far as the location of the industrial plants is concerned, and without adequate integration of environmental protection. Thus, the Greek industry (with few exceptions of industrial areas, specifically designated for industrial activities) is geographically disperse with concentration trends around major urban centers. Currently, for financial as well as other reasons, this intensive development has given way to a declining trend.

Nowadays, the state has at its disposal two important methodological tools aiming at the reduction of the environmental impact of industrial activity:

a) the environmental licensing and
b) the best available techniques (BAT).

Both of these tools have been established by a series of regulations included in European Union and National legislation.

The environmental licensing is implemented through environmental permits, granted by the state after the examination of an environmental assessment (Environmental Impact Assessment or Environmental Report), that is carried out and submitted by the liable industry (YPEKA, 2014).

2.4 Food Industry and environment in Italy

2.4.1 Italian food industrial sector

The F&D Industry is the largest manufacturing sector in Europe with an annual turnover of €1,017 trillion, half of which is generated by SMEs (49,3%). The sector is a leading employer in the EU manufacturing sector (15.0%) employing about 4.3 million people and is highly fragmented comprising some 287,000 companies. Even if the European agro-food industry is a leading global exporter and affords significant value addition, its competitiveness is at risk and the European Commission has consistently urged the food sector to become more competitive by increasing its spending on R&D as a means of introducing new products and processing techniques to the market. The food and drink industry, traditionally a sector with low R&D investments (of which often more than 80% is development and less than 20% is research), must change its course after a long period of incremental innovation ('mixing and stirring'). FEDERALIMENTARE and its 17 adhering branch Associations plus 3 associated branch Associations represent the FOOD&DRINK INDUSTRY, one of the pillars of the national economy. Along with agriculture, induced activity and distribution, the FOOD&DRINK INDUSTRY is the CENTRAL ELEMENT of the 1st ECONOMIC CHAIN of the COUNTRY:

- It is the 2nd MANUFACTURING SECTOR IN OUR COUNTRY, after the engineering industry and it is the 3rd FOOD & DRINK INDUSTRY IN EUROPE, behind Germany and France.
- It purchases and processes 72% of the NATIONAL AGRICULTURAL RAW MATERIALS.
- It is generally recognized as the AMBASSADOR OF MADE IN ITALY IN THE WORLD considering that almost 80% of the Italian agro-food export is represented by high quality industry brands and PDOs / PGIs.
- It is characterized by a SIGNIFICANT PREVALENCE of SMES: about 6.250 companies of which 30 are large, about 220 are medium in size and the remaining 6.000 are small, but very small size (up to 10 employees).

Focus on energy demand in ITALY

1. Energy Demand

If compared to other EU Member States, Italy's energy need is characterized by more vulnerable supplies, higher dependence on hydrocarbons (oil and gas), a limited carbon contribution and the total lack of electronuclear generation. The primary energy demand, in 2012, was on the order of 176.3 Mtep, i.e., 2.7% lower than in 2011.

2. Final Energy Consumptions

In 2012, the final energy consumption was 127.9 Mtep, 5.2% less than 2011. Traditionally, Italy is one of the most energy-efficient countries among the industrialized ones: the final energy consumption per capita of 2.4 tep/capita is actually one of the lowest among the countries with similar industrial development.

USE OF ENERGY IN THE AGRO-FOOD SECTOR

The agro-food sector includes agriculture (primary production that provides the raw materials), the food industry that operates processing and agro-processing sector and the distribution of the final products to consumers. The amount of fossil energy consumed for production of foodstuffs and vegetables (vegetables, fruits, etc.) that animals (meat, sausages, etc.) and dairy (mozzarella, cheese) is remarkable: for 2012 were estimated 16.31 Mtoe of final energy consumption for the entire agro-food, of which 2.8 Mtoe attributable to the agriculture sector.

Referring to the fruit and vegetable products, food industry consumes electricity and heat for the processing (processing), in particular for the chemical-physical treatments of the products, as well as for packaging and for storage at temperatures suitable to maintain the quality of fruit and vegetables within cold chain. Smil calculated that the energy consumption for the maintenance of food products, particularly for the operations of freezing, requiring 1-3 MJ / kg of the product ready for the market. **In general half of the final energy consumption is involved in the interventions of heating, cooling, drying, chilling and freezing**, sterilization and sanitization, i.e. for the processing of primary products, while 10% of the final energy required for air conditioning of buildings environmental industrial, transport and domestic services. In Italy, it is estimated that the final energy consumption of the food industry is due to the 60% electricity consumption and for 40% to the consumption of thermal energy, the latter due, in large part, to the processes of production **requiring pasteurization and sterilization** of the products.

2.4.2 Common environmental issues related to industrial activity.

Sustainable development is a form of economic development that does not compromise the possibility of future generations to go on, preserving the quality and quantity of natural heritage under a regime of social equity and environmental balance. The Italian food and

drink Industry has a strong interest in the **affirmation of global scale models of sustainable production and consumption,** able to meet the growing demand of the world population and to ensure the competitiveness of agrifood systems while respecting the environment and local communities. The food and drink Industry - in collaboration with the primary production - is engaged in a series of concrete actions and initiatives aimed at promoting environmental sustainability in agriculture. The aim is to ensure supply of raw materials, in sufficient quality and quantity, respecting the environment and enhancing the competitiveness of agricultural systems.

Actually there are 4 strategic areas of intervention:

- **Sustainable supply and exploitation of agricultural raw materials;**
- **Efficient use of basic resources (energy and water);**
- **Optimization of packaging and proper management of after - use packaging;**
- **Promote sustainable consumption.**

Main steps and policy makers working groups:

The **"CARTA DI MILANO"** was the main outcome of the **Private Sector Forum to Reduce Food Insecurity** held on **November 12 and 13 2009**, in **Milan.** In the "**CARTA DI MILANO"** representatives of the private sector expressed their **engagement on food and nutritional security**. The "CARTA DI MILANO" is at once a **declaration of intention and a programmatic document** that affirms the vigorous commitment by the private sector to be an integral part of the solution to FOOD INSECURITY. The "CARTA DI MILANO" has been updated in occasion of the **INTERNATIONAL CONFERENCE "THE SUSTAINABILITY OF FOOD SYSTEMS AND DIETS FOR STABILITY**" held in FAO (Rome) on the 24th of October 2011.

On 26th April 2012, Federalimentare shared and signed the Charter of Principles for Environmental Sustainability of Confindustria. The Charter identifies areas for the implementation of industrial commitments on sustainability at national level. Several relevant large F&D companies and SMEs gradually adhered. Record of environmental certifications obtained by F&D Companies.

Other initiatives:

The initiatives undertaken by the Italian Food Industry:

- **Promotion of supply chain eco-design (requirements of environmental quality of the process and of the product).**
- **Definition of guiding principles for the harmonization of sustainable supply (selection of suppliers, environmental certification).**

- **Start of integrated management systems upstream of the food chain, with particular regard to the chains of the main commodities from developing countries.**
- **Valorization of primary productions through the use of by-products.**

3 LITERATURE REVIEW ON ENVIRONMENTAL INDICATORS

3.1 The necessity of the implementation of environmental indicators

In order to control and assess the progress and improvement of the established environmental objectives, it is necessary to set measurable criteria as indicators. The UN Conference on Environment and Development (1992), has pointed out that this need is urgent (Farsari & Prastakos, 2002).

Environmental Indicators cover performance related to inputs (e.g., material, energy, water) and outputs (e.g., emissions, effluents, waste). In addition, they cover performance related to biodiversity, environmental compliance, and other relevant information such as environmental expenditure and the impacts of products and services (Global Reporting Initiative, 2002).

Sustainable development indicators contain information about the state of the environment, economy and society, describing a situation. Also, they state the deficiencies, weaknesses and potential problems, the performance and effectiveness of actions (performance assessment tools) which checks whether development choices were successful and therefore the performance of human societies on the path to sustainability. In connection to the above, indicators offer support to developing strategies and policies (Farsari & Prastakos, 2002).

Among the most well known international efforts for establishing sustainable development indicators are:

- OECD's Pressure - State - Response Framework
- World Bank: Measuring the wealth of nations
- United Nations – CSD Indicators
- Barometer of Sustainability
- Ecological Footprint

Of these, OECD's Pressure-State-Response Framework, World Bank: Measuring the wealth of nations, and United Nations – CSD Indicators, have been developed by international organizations (Farsari & Prastakos, 2002).

3.1.1 OECD key environmental indicators

In 2004 OECD set the following key directions in order to identify environmental indicators:

- Climate change and greenhouse gas emissions, especially carbon dioxide emissions
- Ozone hole and the substances that deplete ozone
- Air quality and SOx and NOx emissions

- Waste production
- Water quality and management of used water
- Sources of freshwater and their use
- Forest resources
- The fish resources
- Energy resources
- Biodiversity

3.1.2 Industrial Emissions Directive (IED) 2010/75/EU

Legislation on industrial emissions is contained in Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC), Integrated Pollution Prevention and Control (2008/1/EC) and subsequently in Industrial Emissions Directive (IED) 2010/75/EU.

Directive 2010/75/EU on industrial emissions covers highly polluting industrial activities that have a significant share of pollution in Europe. Adopted in November 2010, consolidates and brings together all relevant instructions (waste incineration, volatile organic compounds (VOCs), large combustion plants, integrated prevention and control of pollution, etc.) into a coherent legislation text, designed to facilitate the implementation and the achievement of minimizing pollution from various industrial sources.

This Directive defines the requirements that should be observed form industrial businesses, contains measures to prevent water, air and soil pollution and provides a basis for licensing composition or industrial plants creation. Via an integrated approach, takes into account the overall environmental performance of a facility, including the use of raw materials and energy efficiency. In order to prevent, reduce and eliminate pollution from industrial activities, it is necessary to establish a general framework for the control of the main industrial activities. Priority should be given to intervention at source, ensuring prudent management of natural resources and taking into account, the economic situation and specific local characteristics of the place in which the industrial activity is taking place. BATs, flexibility, environmental inspections and public participation play a central role in this Directive.

3.1.3 DPSIR model

Most current indicators are based on the relationship between the environmental and the human system. To structure thinking about the interplay between the environment and socio-economic activities the European Environment Agency (EEA) uses the "DPSIR" framework, a slightly extended version of the "PSR" (pressure –state –response) model used by e.g. the OECD (European Commission) . According to this analysis system, economic and social development exert pressure (P: Pressure) in the environment, as a result the state of

the environment is changing. Subsequently we are led to health, ecosystems and raw materials Impact (I: Impact), that may infer a social Reply (R: Response) leading either back into driving forces (D: Driving Forces) or the Status (S: State) or impact directly. (Mauraki et al., 2005) .

3.2 Basic characteristics of valuable environmental indicators

Effective indicators should be based on the following characteristics:

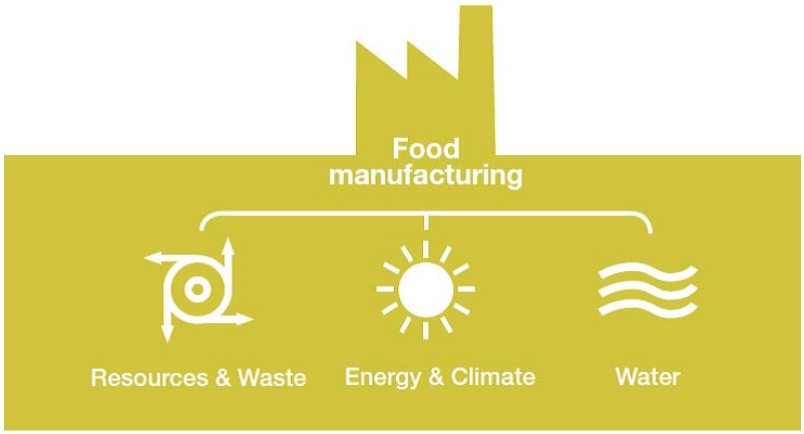
1. Relevant.
2. Easy to understand, even by people who are not experts.
3. Reliable, in order for people to be able to trust the information of the indicator.
4. To be based on accessible data, that is available or can be gathered while there is still time to act.

3.3 Examples of environmental indicators in the food industry

Indicators are not identical to the primary data or statistics, as they provide centralized information and meaning, facilitating and accelerating the evaluation process. The main problem arising at the stage of selection and use of indicators is the high level of subjectivity, both in selecting and evaluating indicators (Farsari & Prastakos, 2002).

According to the University of Aegean, indicators are measurement series aimed at simplification, quantification and communication of information. Their use serves to highlight information that is not readily apparent. Moreover, it is stated that the three key functions of indicators are:
• to increase the amount and quality of information,
• to provide understandable information to decision makers and
• to measure "progress" towards achieving a goal.

The picture below shows the main axes in food production, on which Member States base their more environmentally friendly practices. These axes are raw materials and waste, energy and climate change, and water(Food Drink Europe, 2012)



Picture 1: Main directions for action in the food industry[3]

The life cycle assessment (LCA) of products facilitates the estimation of raw materials used and energy spent on the acquisition of raw materials, production, processing, packaging, use and retirement of the product. This process may lead to the environmental profile of a product (Heller & Keoleian, 2000).

According to the GRI (Global Reporting Initiative, 2002) additional relevant information is required to understand organizational performance, such as:

- Key successes, disadvantages / shortcomings and challenges
- Major organizational environmental risks and opportunities
- Major changes in the reporting period to systems or structures to improve performance
- Key strategies and procedures for implementing policies or achieving goals.

The following table presents the proposed indicators in food production, as well as the stakeholders at each production stage.

Some of these indicators, related to our research are the ratio of renewable to non renewable energy, the energy input per unit of production, the quantity of chemical inputs per unit of production, energy requirement for processing, packaging and transportation etc.

[3]Source: Food Drink Europe, 2012

Table 1: Life Cycle Sustainability Indicators for the Food System[4]

Stakeholders	Life cycle stage	Environmental Indicators
Farmers **Breeders** **Seed Companies**	Origin of (genetic) resource – seed production, animal breeding	✓ ratio of naturally pollinated plants to genetically modified/hybrid plants per acre ✓ reproductive ability of plant or animal ✓ % of disease resistant organisms
Farm operators **Farm workers** **Ag. Industry** **Ag. Schools** **Government Animals**	Agricultural growing and production	✓ rate of soil loss vs. regeneration ✓ soil microbial activity, balance of nutrients/acre ✓ quantity of chemical inputs/unit of production ✓ air pollutants/unit of production ✓ number of species/acre ✓ water withdrawal vs. recharge rates ✓ # of contaminated or eutrophic bodies of surface water or groundwater ✓ % waste utilized as a resource ✓ veterinary costs ✓ energy input/ unit of production ✓ ratio of renewable to non-renewable energy ✓ portion of harvest lost due to pests, diseases
Food processors **Packaging providers** **Wholesalers** **Retailers**	Food processing, packaging and distribution	✓ energy requirement for processing, packaging and transportation ✓ waste produced/unit of food ✓ % of waste and byproducts utilized in food processing industry ✓ % of food lost due to spoilage/mishandling
Consumers **Food service** **Nutritionists/Health professionals**	Preparation and consumption	✓ energy use in preparation, storage, refrigeration ✓ packaging waste/calories consumed ✓ ratio of local vs. non-local and ✓ seasonal vs. non-seasonal consumption
Consumers **Waste managers** **Food recovery & gleaning orgs**	End of life	✓ amount of food waste composted vs. sent to landfill/incinerator/waste water treatment

Fritz and Matopoulos (2008) based on an extensive literature review presented fifteen major sustainability objectives, as well as measurement criteria that are related directly to the food chain (Matopoulos & Bourlakis, 2010).

Some of these criteria are: productivity, staff training, reducing imports, energy and water use, the impact on biodiversity, tactics followed by transport, engine performance, health and safety, product distribution in the community, etc.

[4]Adapted from Heller & Keoleian, 2000

Table 2: Overview of sustainability objectives & measurement criteria (Fritz & Matopoulos, 2008)

Sustainability	Sustainability objectives	Measurement criteria
Economic dimension	Economic growth Work skill investment Open & competitive economy Changing pattern of consumption	✓ Productivity ✓ Training ✓ Industry's diversity & structure ✓ Transportation reduction of imports
Environmental dimension	Waste Water Energy Biodiversity Food distribution	✓ Packaging ✓ Water used ✓ Energy used ✓ Contributions to biodiversity ✓ Transportation mode-tactic used ✓ Vehicle fill ✓ Time utilization ✓ Engine performance
Social dimension	Urban distribution Nutrition & health Food safety Workplace improvements Community Ethical trading	✓ Vehicle kms (congestion, noise and accidents) ✓ Unloading ✓ Total driving time ✓ Signposting ✓ Contamination ✓ Equality ✓ Health & Safety ✓ Employment volumes ✓ Employment quality ✓ Contribution to community ✓ Economic linkages with communities ✓ Ethical trading schemes

Based on the above, Matopoulos & Bourlakis (2010) mention indicators concerning the distribution of products such as:

- the percentage of transports by air
- the percentage of direct deliveries to stores
- the number of deliveries per week
- the rate of conventional to alternative fuels
- fuel consumption
- emissions

Given that the indicators should reflect the evolution of a phenomenon or problem, the Global Initiative - Sustainability Reporting Guidelines propose the below environmental issues:

I. Raw materials savings
II. Energy Saving
III. Use of water
IV. Reducing emissions and waste
V. Checking suppliers
VI. Supplied products and services
VII. Compliance with legislation
VIII. Transport - Supply Chain

and the following equivalent environmental indicators:

1. The total amount of raw materials
2. The amount of energy from renewable sources
3. The amount of water recycled
4. The ratio of land to land use
5. Reduction of toxic, CFCs and other hazardous materials
6. The percentage of suppliers with environmental awareness
7. The number and type of environmental problems arising from the business supply chain
8. The ratio of the cost of compliance with the law to the cost of possible fines
9. Identification of the major problems arising from the final use of the products - services

4 SELECTION AND IMPLEMENTATION OF ENVIRONMENTAL INDICATORS IN LIFE+ FOODPRINT PROJECT

As previously stated, the basic selection criteria was for the indicators to be effective, reliable, easy to understand and to measure. Based on that, after consultations with partners, literature review and analyses of the data obtained from the JOTIS industrial plant, the following environmental indicators have been selected:

1. Energy consumption - general (including buildings' support, air conditioning, ventilation, lighting, compressed air network, Elevators, computers etc.)
2. Energy consumption related to product group (1-5) specific processing
3. GHG emissions general
4. Direct GHG emissions (fuel burning)
5. GHG emissions related to product group (1-5) specific processing
6. Percentage of electrical energy from renewable sources
7. Heat energy from waste heat recovery
8. Percentage of water reused
9. Quantity of solid waste per product unit
10. Percentage of recycled packages that are used

Furthermore, in order to cover the rest stages, the following environmental indicators have been selected:

11. Energy consumption from the production of each ingredient
12. GHG emissions from the production of each ingredient
13. Energy consumption from the production of all ingredients per product
14. GHG emissions from the production of all ingredients per product
15. Fuel consumption from transportation of each ingredient
16. GHG emissions from transportation of each ingredient
17. Fuel consumption from transportation of all ingredients per product
18. GHG emissions from transportation of all ingredients per product

5 ACTION PLAN FOR THE QUANTIFICATION OF ENVIRONMENTAL INDICATORS

5.1 Data collection for the quantification of environmental indicators

The relevant methodology for each indicator calculation is presented next.

Certain indicators presented in the initial proposal had to be substituted by more specific ones in order to clearly define the improved resulting. Furthermore many of them were proven pointless as they would describe general sizes and mixing different sources of GHG emissions, either exaggerating results or diminishing the findings of the outcome study. As an example the “Energy used per ton of flour processed” can be distinguished between flour that goes strictly to mixing process (extremely low GHGE source) and baby food production that is most intensive GHGE sourcing. Certain costly measures that can significantly save the second process line (reducing Natural gas consumption by more than 50%) will seem unimportant through such a general indicator that mixes up results.

The indicators that were withdrawn along with reasons for deciding so, are:

- ✓ Energy used per ton of flour processed – Substituted by analytical energy consumption per final product
- ✓ Air Emissions per ton of flour processed - Substituted by analytical energy per final product
- ✓ Energy used per ton of each raw material used – specific raw materials were chosen instead. The statistical impact of other materials was assessed as indifferent to the scope
- ✓ CO2 emissions savings per year – More analytical indicators were chosen instead
- ✓ Energy savings per year - More analytical indicators were chosen instead
- ✓ Energy and CO2 emissions savings per ton of waste processed using BAT - More analytical indicators were chosen instead
- ✓ Economic Cost per ton of product - More analytical indicators were chosen instead as “Waste heat recovery” & “Electrical energy from Renewable resources”

Table 3: Selected environmental indicators and relevant methodology.

No	Indicator*	Methodology / Input Data Need
1	Energy consumption general (buildings support, air conditioning, ventilation, lighting, compressed air network, Elevators, computers)	MWhs electrical = (MWh-meter central)-MWhs (production processing) MWhs Natural Gas = (MWhs NG Central) - MWhs NG (production processing) Liters of oil consumed by mobile water presses (data logging).
2	Energy consumption related to product group (1-4) specific processing **	kWhs electrical per product group (1-4) processing kWhs NG per product group (1-4) processing
3	GHG emissions general	Calculations based on measurements and data analysis (indirect + direct emissions)
4	Direct GHG emissions (fuel burning)	Calculations based on declared data
5	GHG emissions related to product group (1-4) specific processing	Calculations based on measurements and data analysis
6	Percentage of electrical energy from renewable sources	kWh-meters data logging - Calculation based on measurements
7	Heat energy from waste heat recovery	Calorimeters data logging - Calculation based on measurements
8	Percentage of water reused	Flow-meter data logging - Calculation based on measurements
9	Quantity of solid waste per product unit	Scales' data logging
10	Percentage of recycled packages that are used	Logistics data logging
11	Energy consumption from the production of each ingredient	Kwh / tone ingredient (based on indicators 1&2 or simpler if no data are available)

12	GHG emissions from the production of each ingredient	Kg GHG emissions / tone ingredient (based on indicators 3-5 or simpler if no data are available)
13	Energy consumption from the production of all ingredients per product	Kwh / tone of final product (based on indicator 11 and the % participation of each ingredient in the final product)
14	GHG emissions from the production of all ingredients per product	Kg GHG emissions / tone of final product (based on indicator 12 and the % participation of each ingredient in the final product)
15	Fuel consumption from transportation of each ingredient	Kg fuel / tone of each ingredient (total fuel consumption divided with total freight)
16	GHG emissions from transportation of each ingredient	Kg GHG emissions / tone of each ingredient (emissions based on fuel consumption and type)
17	Fuel consumption from transportation of all ingredients per product	Kg fuel / tone of final product (based on indicator 15 and the % participation of each ingredient in the final product)
18	GHG emissions from transportation of all ingredients per product	Kg GHG emissions / tone of final product (based on indicator 16 and the % participation of each ingredient in the final product)

**All above indicators, are regarded as "per ton of useful production"*
*** General indicators cannot be representative since they are totally connected to the type of processes according to product. Therefore it is of great importance to define general categories of processes according to intensity of energy utilization. E.g. Mixing is a mild energy consuming process, while Drying is one of the most energy demanding processes.*

The proposed categories for the JOTIS pilot are:
1. Flour & Powder (mixing)
2. Chocolate (mixing and heat transferring)
3. Syrup (mixing and boiling)
4. Baby foods (mixing, steam cooking & steam drying)

5.2 Calculation of baseline environmental indicators

THIS CHAPTER INCLUDES CONFIDENTIAL INFORMATION, AND HAS BEEN REMOVED.

6 REFERENCES

- DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on industrial emissions (integrated pollution prevention and control) *Official Journal of the European Union*. Available from: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:334:0017:0119:en:PDF
- EC (2014) Commission staff working document impact assessment on measures addressing food waste to complete SWD (2014) 207 regarding the review of eu waste management targets.
- Farsari, G., Prastakos, P., (2002). Sustainable Development Indicators: Their contribution and International Trends. International Conference "Citizens, Sustainable Development, Environment" Mediterranean Partnership Foundation, Athens, April 2002
- Fritz, M., Matopoulos, A., (2008). Sustainability in the agri-food industry: a literature review and overview of current trends. In Proceedings (USB) of *the 8th International Conference on Chain & Network Management in Agribusiness & the Food Industry*, 26-28 May, Ede, The Netherlands.
- Food Drink Europe, 2012. ENVIRONMENTAL SUSTAINABILITY VISION TOWARDS 2030. Achievements, Challenges and Opportunities. Available from: http://sustainability.fooddrinkeurope.eu/uploads/section-images/USE_SustainabilityReport_LDFINAL_11.6.2012.pdf
- Global Reporting Initiative, 2002.Sustainability Reporting Guidelines, Boston. Available from: https://www.globalreporting.org/resourcelibrary/G3-Sustainability-Reporting-Guidelines.pdf
- Heller, M., C., Keoleian, G., A., 2000. Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System. Centre for Sustainable Systems. University of Michigan.
- Makuch Karen & Pereira Ricardo, (2012) Environmental and Energy Law. John Wiley & Sons
- Matopoulos, A. and Bourlakis, M. (2010). Sustainability practices and indicators in food retail logistics: Findings from an exploratory study. *Journal on Chain and Network Science,* Vol. 10, No. 3, pp. 207-218.
- Mavraki, D., Sitara, A., Loukatos, A., (2005). Environmental Indicators. The case of Romania. Helesco '05-TEE, 3rd -6th February 2005. Available from: http://library.tee.gr/digital/m2045/m2045_mavraki.pdf
- OECD, 2004. OECD Key Environmental Indicators 2004. Paris:France. Available from: http://www.oecd.org/environment/indicators-modelling-outlooks/31558547.pdf
- SEVT (2012) Business – Society – Environment. Available at http://www.sevt.gr/en/priorities-details/FcON/epixeirhsh-koinwnia-periballon
- Virtanen, Y., Kurppa, S., Saarinen, M. *et al.* (2011) Carbon footprint of food - approaches from national input-output statistics and a LCA of a food portion. *Journal of Cleaner Production*. 19: 1849-1856

- Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC, and repealing Directives 2004/8/EC and 2006/32/EC Article 8: Energy audits and energy management systems. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013SC0447&from=EN

Websites

- Knowledge sharing and developments EEA Integrated Assessment Portal: http://ia2dec.pbe.eea.europa.eu/knowledge_base/Frameworks/doc101182/
- University of Aegean: http://www.env.aegean.gr/eda/Envirohelp/greece/bestpractices/EnvIndicators.html
- YPEKA - Greek Ministry of Environment (2014) Industrial Pollution http://ypeka.gr/default.aspx?tabid=547&language=en-us

7 ANNEX

7.1 AKTINA's Environmental Management Report