Report of the environmental footprint for the baseline scenario

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(Task 5.1.2)

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Authors:

Sant’Anna School of Advanced Studies: Tiberio Daddi, Luca Marrucci, Matteo Donelli

Members of the GREEN COACH Working Group:

Ecoserveis: Aniol Esquerra Alsius, Cristina Bajet, Marcello Avanzini

Sant’Anna School of Advanced Studies (SSSA): Tiberio Daddi, Luca Marrucci, Matteo Donelli

TDM 2000 International (TDM Int): Federico Gaviano

Association des Clubs Francophones de Football (ACFF): Matthieu Benadon

French Football Federation (FFF): Thomas Seille

Lithuanian Grassroots Football Association (LGFA): Greta Guižauskaitė

Norwegian Football Association (NFF): Erik Loe

Swedish Football Association (SFA): Annina Åman, Güncel Ömer

Contact: info@greencoacherasmus.eu

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1. Introduction

As part of the Task 5.1 "Baseline study of sports' facilities" which aimed to assess the "state of the art" of environmental management in the targeted sport organisations, we conducted environmental footprint to rate football organisations' environmental current status and get information of what they can do in order to apply changes to reduce their environmental footprint. This data will represent the starting baseline to measure the project's activities actual impact. This data will represent our baseline to measure different actions and tools impact.

The objective of the task is conducting an environmental footprint calculation of the main activities conducted by grassroots football clubs, to identify environmental improvement opportunities. This analysis will aim at identifying the most impactful processes, so-called "hotspots", associated with the activities of the grassroots football clubs.

Environmental footprint is based on a life cycle approach. An LCA assesses and quantifies the environmental impact of a product or service over its entire life cycle. The main phases of LCA are goal & scope setting, inventory analysis, life cycle impact assessment (LCIA), and interpretation. An inventory analysis provides information on all relevant energy and material inputs, and on the emission of toxic and non-toxic pollutants, but that alone does not provide enough information to guide decision-making. To be able to understand the consequences of these inputs and emissions, we need to translate them into environmental impacts. The impact assessment phase provides this translation.

2. General aspects

This report is based on the data obtained through data collection campaign that was conducted between January 2021 and May 2021 in five European countries (Belgium, France, Lithuania, Norway, and Sweden) under the framework of the Erasmus+ co-founded project named GREENCOACH.

The environmental footprint assessment was conducted in order to assess the impact of a football match. The analysis focused on calculating the environmental footprint of a single amateur football match (e.g., lighting of the stadium, use of equipment, mobility of athletes and supporters, etc.).

This document attempts to comply with the requirements of:

- Guide to the Product Environmental Footprint (PEF), Annex II of Recommendation 2013/179 / EU;

- PEFCR “Guidance version 6.3”, with the exception of all the parts that are already attributable to existing PEFCR. Deviations from the requirements of PEFCR Guidance 6.3 have been made based on old versions of the Guidance or on expert judgment;
- ISO 14040:2006 - Environmental management -- Life cycle assessment -- Principles and framework;
- ISO 14044:2006 - Environmental management -- Life cycle assessment -- Requirements and guidelines /14043.

This PEF report is not meant to be periodically reviewed. This study follows the requirements for the data collection and quality control procedures described in chapter 7.19 of PEF Guidance 6.3.

This supporting study is part of the co-founded Erasmus+ GREENCOACH project and includes the following purposes:

- create a database for the creation of the GREENTOOL;
- help in defining performance levels where possible;
- provide results that can be used as a basis for communicating the PEF profile (including any other future applications)

A total of 22 data collection questionnaires were collected throughout the data collection campaign (see Table 1 and Figure 1).

National Football Association / Country	Number of respondents from grassroots football clubs
Belgium	5
France	5
Lithuania	5
Norway	4
Sweden	3
Total	**22**

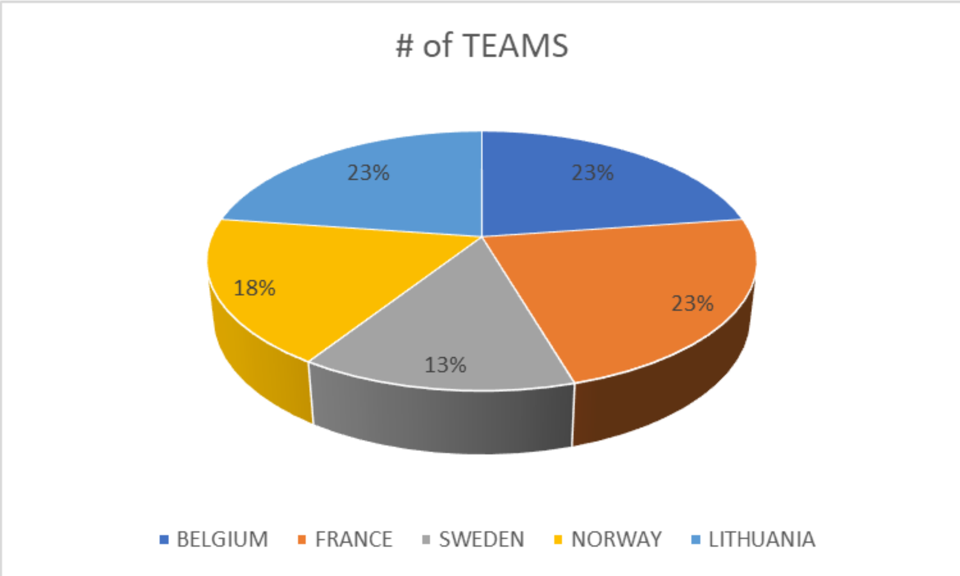

Figure 1 *- Sample description (countries)*

The sample is exclusively composed of grassroot football clubs. Even if in the case of Sweden, we received a slightly lower percentage of responders, we can say that the sample is equally distribute among all the five Countries.

3. Methodology overview

Life cycle assessment (LCA) is a methodology to assess the overall environmental burden associated to the whole life cycle of a product or service. Being quantitative, standardised and scientific, this methodology allows the production of reliable information about the environmental performance of a product and it overcomes some issues that might arise while focusing on a single life cycle phase, typically the production one. It is generally considered the most reliable tool to assess properly the sustainability of a product. Due to its overall life cycle perspective, LCA avoids:

- shifting the environmental burden from one life cycle phase to another,
- shifting the environmental burden from one impact category to another.

Simultaneously, LCA can help in:

- comparing different alternatives in the product life cycle (i.e., packaging solutions, logistics, energy sources, raw materials and supply chain processing, use phase and or end of life),
- identifying environmental "hotspots" (where “it matters most”), allowing the selection of effective actions aimed at lowering the environmental footprint of a product.

This methodology finds its roots in the late sixties and was applied mainly for energy efficiency purposes and the comparison of different scenarios for packaging material. It finally reached the goal of being declared an international standard published by the International Organization for Standardization (ISO) in the late nineties.

Today, LCA is defined in two ISO standards:

- ISO 14040:2006 - *Environmental management -- Life cycle assessment -- Principles and framework*,
- ISO 14044:2006 - *Environmental management -- Life cycle assessment -- Requirements and guidelines.*

The first standard included all the principles and main features of the methodology, whose technical requirements are defined in the second one.

In a nutshell, LCA allows to sum all the inputs and outputs taken from and released to the environment in all the activities and processes included in the whole life of a given product or service, and to evaluate the potential impact of such consumptions and releases on the environment.

Indeed, one of the first definitions of LCA (SETAC 1993[1]), was the following:

"*Life Cycle Assessment is a process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and materials used and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing, extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling, and final disposal*".

LCA was conceived and designed to produce quantitative reliable scientific information to be used in decision making, increasing the awareness of companies and economic actors on the real burden and responsibilities of the product and service life cycles.

ISO 14040 defines LCA as the "*compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle*".

According to the ISO standard, the methodology encompasses 4 steps (Figure 2), and "*it can assist in*:

- *identifying opportunities to improve the environmental performance of products at various points in their life cycle,*
- *informing decision-makers in industry, government or non-government organizations (e.g. for the purpose of strategic planning, priority setting, product or process design or redesign),*

[1] LCA "Code of Practice" from the Society of Environmental Toxicology and Chemistry (SETAC) Workshop held at Sesimbra, Portugal 31 March - 3 April 1993.

- *the selection of relevant indicators of environmental performance, including measurement techniques, and*
- *marketing (e.g., implementing an ecolabelling scheme, making an environmental claim, or producing an environmental product declaration).*"

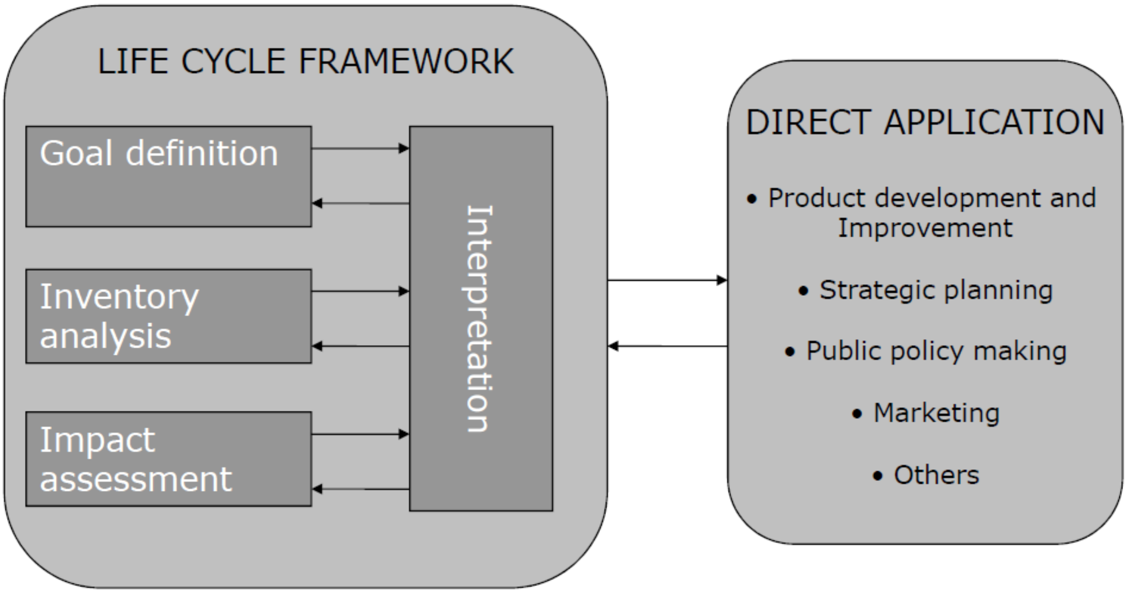

Figure 2 *- ISO 14040 Life cycle assessment diagram: methodology phases and application*

As depicted in Figure 2, public policy making is one of the intended direct applications of LCA techniques, as it has been the case for several European Union environmental Directives, such as Directive 2008/98/EC on waste (Waste Framework Directive)[2]. Another major application of LCA is marketing, particularly for affixing Environmental labels and declarations.

Following this path, the European Commission in 2013 published the Recommendation 179/2013/EC "on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations"[3], the so-called PEF (Product Environmental Footprint) and OEF (Organization Environmental Footprint). The Recommendation contains the guidelines of the LCA methodology to be applied to a product/service or to the activities carried out by an organization in order to communicate their potential life cycle environmental impact.

LCA is an iterative process, which consists of 4 main phases (see also Figure 2):

- goal and scope definition,
- inventory analysis (Life Cycle Inventory - LCI),

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[2] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013H0179&from=EN

- impact assessment (Life Cycle Impact Assessment - LCIA),
- interpretation of the results.

Therefore, an LCA study starts with the definition of the goal of the study, the features of the system that needs to be studied and the requirements to be complied (goal and scope definition); then it moves to the compilation of the inventory of all the flows that are included in the life cycle of the product (Life Cycle Inventory, LCI); it subsequently evaluated the environmental impacts associated to the flows listed in the inventory (Life Cycle Impact Assessment, LCIA) and finally it draws the conclusions by interpreting the results and by producing a list of actions aimed at improving the overall environmental performance (life cycle interpretation).

4. Scope of the study

The scope of the study is to assess the product environmental footprint of a football match, considering the following system boundaries:

- energy and water consumption associated to the football match processes (i.e., irrigation of the pitch, lighting, showers of the players, heating of the locker rooms)
- production and end of life of the sport apparel and equipment (sport leather shoes, t-shirt, shorts, sport suit, balls, sport bags, goalkeeper pants, socks, winter jackets, rain jackers, goalkeeper gloves)
- production and end of life of waste materials associated to the football match, and related production of the corresponding materials (paper, plastic, glass, metal, household waste, plus wastewater treatment)
- transport of the players to the football pitch (home team and away team)
- transport of the public attending to the football match (home team and away team)

The functional unit of the study is 1 match played on a football pitch.

5. Life cycle inventory analysis

The life cycle model has been designed in accordance with the system boundaries.

All the data have been collected directly by the teams involved in the study, as described in section 2.

The specific model assumptions, for each process included in the assessment, are reported in the following sub-sections of the report.

All the life cycle secondary datasets used in the model belongs to the Ecoinvent 3.6 database.

5.1 Energy and water consumption associated to the football match processes

For the production of electricity consumed (low voltage), the national mix of sources has been applied, unless it was differently specified in the questionnaires.

Water consumed has been considered as tap water from municipal aqueduct, unless specified otherwise in the questionnaires.

5.2 Production and end of life of the sport apparel and equipment

For the production of the sport apparel and equipment, generic assumptions about the type and weight of materials have been done according to secondary data.

For the whole life cycle of sport leather shoes, data from a previous life cycle assessment carried out by S.Anna School of Advanced Studies have been used[4].

For the end-of-life scenario of each material, national statistics reported in the Annex C[5] for the PEF methodology have been applied.

The PEF CFF (Circular Footprint Formula) has been applied to the model in order to properly balance the burdens and the credit of recycling operations. This formula is composed by 2 parts:

- the material part;
- the energy part;
- the disposal part.

The first section of the “material” part of the Circular Footprint Formula (CFF) needs to be applied to input materials as follows:

$$\text{Material } (1 - R_1)E_V + R_1 \times \left(AE_{recycled} + (1 - A)E_V \times \frac{Q_{Sin}}{Q_p}\right)$$

where,

- R_1 (recycled content) varies between 0 and 1;
- A (allocation parameter) can be set at 0.2, 0.5 or 0.8 according to the market demand for secondary raw materials (0.2 for high demand, 0.8 for low demand, 0.5 for the other cases);
- Qsin/Qp (quality degradation ratio of the recycled material) is 1 or lower depending to the loss of quality after recycling operations;

[4] Life Prefer – Fashion District of Tuscany.
[5] Environmental Footprint Category Rules Guidance – Annex C - Default values for EU Annex_C_V2.1_May2020)

- E_v are the specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material;
- $E_{recycled}$ are the specific emissions and resources consumed (per functional unit) arising from the recycling process of the recycled (reused) material, including collection, sorting and transportation process.

The second section of the “material” part of the Circular Footprint Formula (CFF) needs to be applied at the end of life, in case of recycling takes place as follows:

$$+ (1 - A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{Sout}}{Q_P}\right)$$

where,

- R2 is the recycling rate (% of the material which is bound to be recycled)
- A is the allocation parameter (it allocates the burden and benefit of recycling according to market demand for recycled materials);
- QSout/Qp is the quality degradation ratio of the recyclable material;
- E*v are the specific emissions and resources consumed (per functional unit) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials (i.e the “credits” for avoiding the use of virgin material);
- ErecyclingEol are the specific emissions and resources consumed (per functional unit) arising from the recycling process at EoL, including collection, sorting and transportation process (i.e the “burdens” related to the recycling operations).

The energy section of the CFF refers to the incineration process taking place at the end of life of the disposed materials, according to the following formula:

$$\text{Energy} \quad (1 - B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$$

where,

- R_3 is the incineration rate (% of the packaging material which is bound to be incinerated).
- B is the allocation parameter (it allocates the burden and benefit of incineration). In PEF studies the B value shall be equal to 0 as default;
- Eer are the specific emissions and resources consumed (per functional unit) arising from the energy recovery process (e.g., incineration with energy recovery, landfill with energy recovery, etc.);
- LHV is the Lower Heating Value of the material in the product that is used for energy recovery;
- XER, heat and XER,elec are the efficiency of the energy recovery process for both heat and electricity.

- ESE, heat and ESE, elec are the specific emissions and resources consumed (per functional unit) that would have arisen from the specific substituted energy source, heat and electricity respectively.

Finally, the last section of the CFF refers to the landfill process, according to the following formula:

$$\text{Disposal } (1 - R_2 - R_3) \times E_D$$

where,

- R_2 is the recycling rate (% of the packaging material which is bound to be recycled);
- R_3 is the incineration rate (% of the packaging material which is bound to be incinerated);
- E_D are the specific emissions and resources consumed (per functional unit) arising from disposal of waste material at the EoL of the analysed product, without energy recovery.

For the current study the average vales included in the PEF Annex C have been applied for the aforementioned parameters.

5.3 Production and end of life of waste materials associated to the football match

Starting from the list of waste materials associated to a football match, as reported in the single questionnaires provided by teams involved in the study, the corresponding average production processes of the raw materials have been designed in the model, by using secondary datasets taken from Ecoinvent database.

For the end-of-life scenario of each material, national statistics have been applied, according to the before mentioned PEF Annex C, for R2 (% of recycling), R3 (% of incineration with energy recovery) and the remaining fraction sent to landfill.

The PEF CFF (Circular Footprint Formula) has been applied to the model in order to properly balance the burdens and the credit of recycling operations.

5.4 Transport of the players to the football pitch

In accordance with the information reported in the single questionnaires provided by teams involved in the study (average distance, average transportation means used), the transport processes of the players to the football pitch have been modelled with secondary datasets taken from Ecoinvent database.

5.5 Transport of the public attending to the football match

In accordance with the information reported in the single questionnaires provided by teams involved in the study (average attendance, average distance, average transportation means used), the transport processes of the public attending to the football match have been modelled with secondary datasets taken from Ecoinvent database.

6. Results of the impact assessment

In the characterization phase, all substances are multiplied by a factor that reflects their relative contribution to the environmental impact, quantifying how much impact a product or service has in each impact category.

The PEF methodology proposes a default list (Figure 3) of impact categories which relates to:

- emissions into air,
- emissions into water,
- use of natural resources,
- toxicity,
- use of land.

According to the European Commission-Joint Research Centre - Institute for Environment and Sustainability[6], the recommended characterisation models and associated characterisation factors are classified according to their quality and reliability into 3 levels (or a mix of them):

- "I" (recommended and satisfactory),
- "II" (recommended but in need of some improvements),
- "III" (recommended, but to be applied with caution).

[6] ILCD (International Reference Life Cycle Data System) Handbook "Framework and requirements for LCIA models and indicators", "Analysis of existing Environmental Assessment methodologies for use in LCA" and "Recommendation for life cycle impact assessment in the European context" (http://lct.jrc. ec.europa.eu/)

EF Impact category	Impact category Indicator	Unit	Characteri-zation model	Robust-ness
Climate change, total	Radiative forcing as global warming potential (GWP100)	kg $CO_{2\ eq}$	Baseline model of 100 years of the IPCC (based on IPCC 2013)	I
Ozone depletion	Ozone Depletion Potential (ODP)	kg CFC-11 $_{eq}$	Steady-state ODPs as in (WMO 2014 + integrations)	I
Human toxicity, cancer	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model 2.1 (Fankte et al, 2017)	III
Human toxicity, non-cancer	Comparative Toxic Unit for humans (CTU_h)	CTUh	USEtox model 2.1 (Fankte et al, 2017)	III
Particulate matter	Impact on human health	disease incidence	PM method recomended by UNEP (UNEP 2016)	I
Ionising radiation, human health	Human exposure efficiency relative to U^{235}	kBq $U^{235}{}_{eq}$	Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000)	II
Photochemical ozone	Tropospheric ozone concentration increase	kg NMVOC $_{eq}$	LOTOS-EUROS model (Van	II

formation, human health			Zelm et al, 2008) as implemented in ReCiPe 2008	
Acidification	Accumulated Exceedance (AE)	mol H+ $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, terrestrial	Accumulated Exceedance (AE)	mol N $_{eq}$	Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008)	II
Eutrophication, freshwater	Fraction of nutrients reaching freshwater end compartment (P)	kg P $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	II
Eutrophication, marine	Fraction of nutrients reaching marine end compartment (N)	kg N $_{eq}$	EUTREND model (Struijs et al, 2009) as implemented in ReCiPe	II
Ecotoxicity, freshwater	Comparative Toxic Unit for ecosystems (CTU_e)	CTUe	USEtox model 2.1 (Fankte et al, 2017)	III
Land use	• Soil quality index[24] • Biotic production • Erosion resistance • Mechanical filtration • Groundwater replenishment	• Dimensionless (pt) • kg biotic production • kg soil • m^3 water • m^3 groundwater	Soil quality index based on LANCA (Beck et al. 2010 and Bos et al. 2016)	III

Water use	User deprivation potential (deprivation-weighted water consumption)	m^3 world $_{eq}$	Available WAter REmaining (AWARE) as recommended by UNEP, 2016	III
Resource use , minerals and metals	Abiotic resource depletion (ADP ultimate reserves)	kg Sb $_{eq}$	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002.	III
Resource use, fossils	Abiotic resource depletion – fossil fuels (ADP-fossil)	MJ	CML 2002 (Guinée et al., 2002) and van Oers et al. 2002	III

***Figure 3** - Impact categories: PEF default list (categories, methods, indicators, classification)*

The characterized results emerged before normalization and weighing, distributed for the relative environmental aspects included in the study, are shown in the following table and figure. All data reported refer to the functional unit of 1 match played, according to what stated in chapter 4 of the current report. The characterized results indicate the absolute impact of 1 football match.

Impact category	Unit	Total	Electricity	Water	Packaging production	Waste	Sportswear &equipment	Transports
Climate change	kg CO2 eq	293,00	50,44	5,98	20,43	2,76	53,13	160,27
Ozone depletion	kg CFC11 eq	5,8E-05	1,3E-05	5,3E-07	1,7E-06	1,4E-08	1,2E-05	3,2E-05
Ionising radiation, HH	kBq U-235 eq	127,83	107,43	2,08	2,54	- 0,80	4,76	11,83
Photochemical ozone formation, HH	kg NMVOC eq	1,26	0,12	0,02	0,07	0,02	0,06	0,99
Respiratory inorganics	disease inc.	3,3E-05	1,7E-06	3,0E-07	1,5E-06	7,5E-07	1,9E-05	1,0E-05
Non-cancer human health effects	CTUh	9,8E-05	9,3E-06	2,8E-06	7,1E-06	4,5E-05	1,8E-05	1,5E-05
Cancer human health effects	CTUh	2,5E-05	1,3E-06	6,7E-07	9,7E-07	1,5E-06	1,8E-05	2,5E-06
Acidification terrestrial and freshwater	mol H+ eq	1,76	0,21	0,03	0,13	0,05	0,42	0,92
Eutrophication freshwater	kg P eq	0,08	0,02	0,00	0,01	0,02	0,01	0,02
Eutrophication marine	kg N eq	0,87	0,04	0,01	0,02	0,34	0,15	0,31
Eutrophication terrestrial	mol N eq	5,55	0,44	0,06	0,23	0,20	1,25	3,37
Ecotoxicity freshwater	CTUe	1.001,87	36,62	9,20	22,51	86,57	559,81	287,17
Land use	Pt	4.329,28	1.448,27	52,85	2.376,24	-1.234,10	239,40	1.446,63
Water scarcity	m3 depriv.	157,57	20,60	744,99	13,52	- 648,20	16,09	10,57
Resource use, energy carriers	MJ	5.903,33	2.462,37	101,49	319,88	- 16,93	787,44	2.249,08
Resource use, mineral and metals	kg Sb eq	1,9E-02	9,7E-04	1,7E-04	9,3E-04	1,5E-04	7,9E-03	8,6E-03

Table 2 *- Characterized results of PEF (non-normalized and non-weighted)*

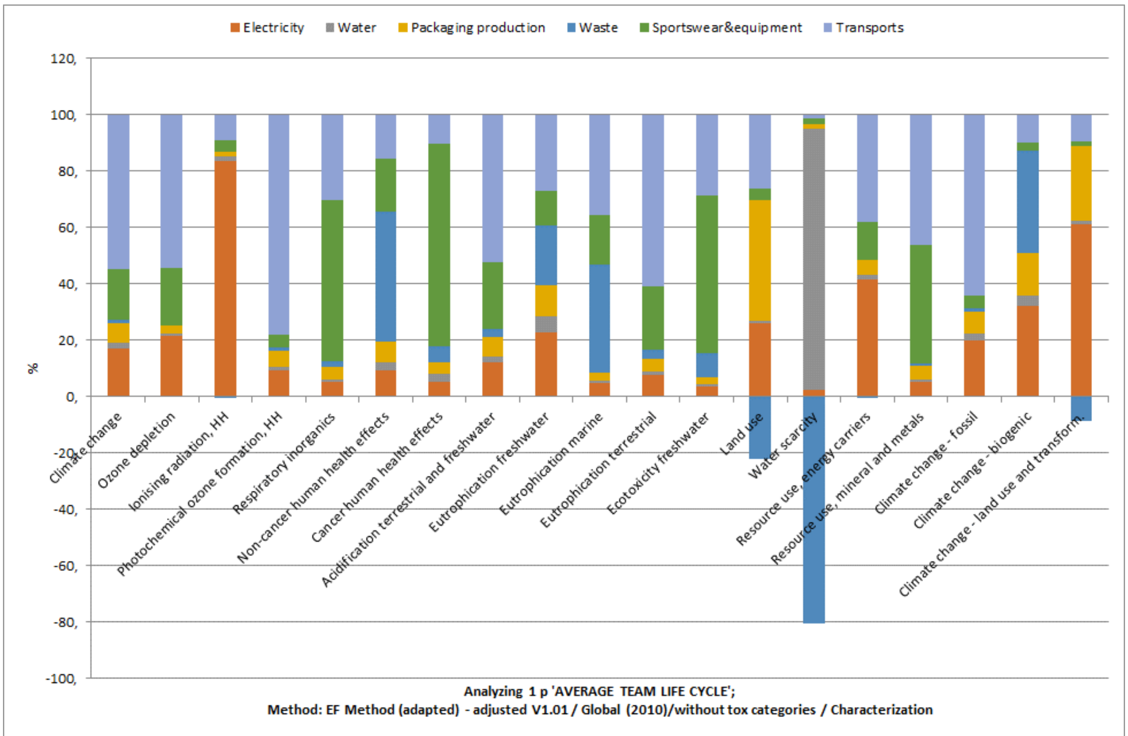

Figure 4 *- Characterized results of PEF (non-normalized and non-weighted)*

The weighted results are shown in the following table and figure. All data reported refer to the functional unit of 1 match played, according to what stated in chapter 4 of the current report. The weighted results indicate the most relevant impact categories related to 1 football match.

Impact category	Unit	Total	Electricity	Water	Packaging production	Waste	Sportswear &equipment	Transports
Total	mPt	57,7001	8,83	6,62	3,25	- 4,13	17,84	25,29
Climate change	mPt	8,38064	1,44	0,17	0,58	0,08	1,52	4,58
Ozone depletion	mPt	0,16767	0,04	0,00	0,00	0,00	0,03	0,09
Ionising radiation, HH	mPt	1,62685	1,37	0,03	0,03	- 0,01	0,06	0,15
Photochemical ozone formation, HH	mPt	1,58811	0,15	0,03	0,09	0,02	0,07	1,24
Respiratory inorganics	mPt	4,99464	0,26	0,05	0,22	0,11	2,84	1,51
Non-cancer human health effects	mPt	0	-	-	-	-	-	-
Cancer human health effects	mPt	0	-	-	-	-	-	-
Acidification terrestrial and freshwater	mPt	2,10689	0,26	0,04	0,15	0,06	0,50	1,10
Eutrophication freshwater	mPt	0,89096	0,20	0,05	0,10	0,19	0,11	0,24
Eutrophication marine	mPt	0,96006	0,05	0,01	0,03	0,37	0,17	0,34
Eutrophication terrestrial	mPt	1,22696	0,10	0,01	0,05	0,04	0,28	0,74
Ecotoxicity freshwater	mPt	0	-	-	-	-	-	-
Land use	mPt	0,27318	0,09	0,00	0,15	- 0,08	0,02	0,09
Water scarcity	mPt	1,2406	0,16	5,87	0,11	- 5,10	0,13	0,08
Resource use, energy carriers	mPt	8,06716	3,36	0,14	0,44	- 0,02	1,08	3,07
Resource use, mineral and metals	mPt	26,1764	1,36	0,23	1,29	0,21	11,04	12,05

***Table 3** - Weighted results of PEF (single score)*

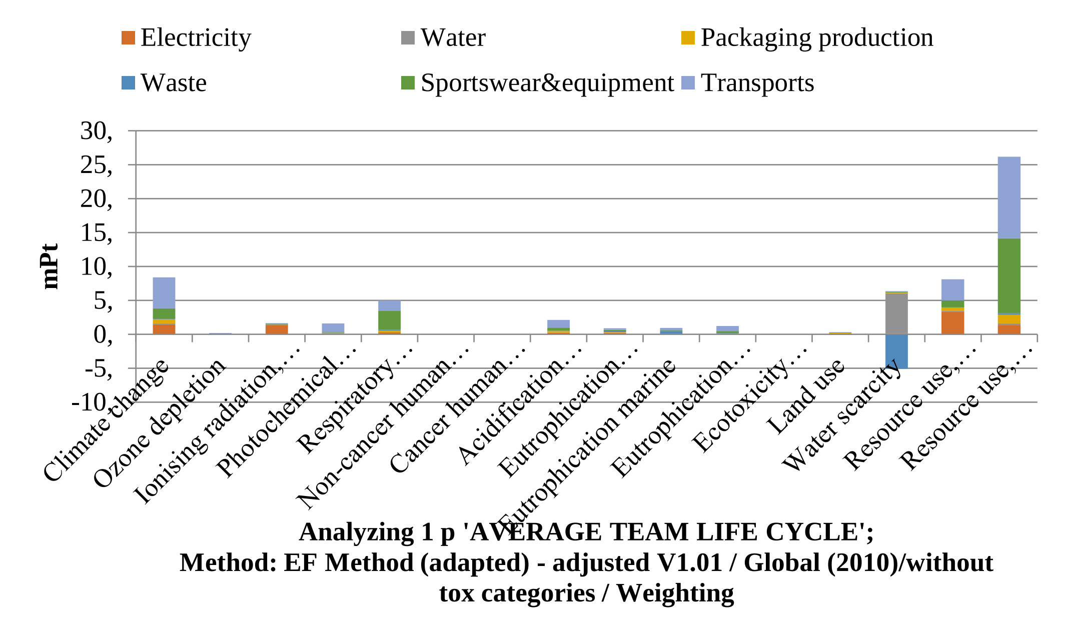

Figure 5 *- Weighted results of PEF (single score)*

7. Interpretation of results

According to table 2, the most relevant impact categories[7] are:

- Resource use, minerals&metals
- Resource use, energy carriers
- Climate Change
- Respiratory inorganics

Moving to the most relevant life cycle phases, transport operations is the largest contributor (though it is not under direct control of the football team) followed by sporstwear&equipment and electricity, as shown in the following table.

Impact category	Electricity	Water	Packaging production	Waste	Sportswear&equipment	Transports
Single score (weighted results - absolute value)	13%	10%	5%	6%	27%	38%

Table 4 *- Weighted results of PEF (life cycle phases contribution) – Single score*

[7] According to the PEF methodology the most relevant impact categories are those contributing to reach the 80% treshold of the cumulated weighted results.

Impact category	Electricity	Water	Packaging production	Waste	Sportswear &equipment	Transports
Climate change	17%	2%	7%	1%	18%	55%
Ozone depletion	22%	1%	3%	0%	20%	54%
Ionising radiation, HH	84%	2%	2%	-1%	4%	9%
Photochemical ozone formation, HH	9%	2%	6%	1%	4%	78%
Respiratory inorganics	5%	1%	4%	2%	57%	30%
Non-cancer human health effects	10%	3%	7%	46%	19%	16%
Cancer human health effects	5%	3%	4%	6%	72%	10%
Acidification terrestrial and freshwater	12%	2%	7%	3%	24%	52%
Eutrophication freshwater	23%	6%	11%	21%	12%	27%
Eutrophication marine	5%	1%	3%	39%	18%	35%
Eutrophication terrestrial	8%	1%	4%	4%	23%	61%
Ecotoxicity freshwater	4%	1%	2%	9%	56%	29%
Land use	33%	1%	55%	-29%	6%	33%
Water scarcity	13%	473%	9%	-411%	10%	7%
Resource use, energy carriers	42%	2%	5%	0%	13%	38%
Resource use, mineral and metals	5%	1%	5%	1%	42%	46%

***Table 5** - Weighted results of PEF (life cycle phases contribution) – 16 Impact categories*

It is interesting to see that, if we consider the total results without the transport impacts (see Table 4), which are not under the direct control of the football team, the major areas of possible intervention aimed at improving the overall footprint seem to be:

- sportswear&equipment
- electricity

Impact category (transports excluded)	Electricity	Water	Packaging production	Waste	Sportswear&equipment
Single score (weighted results - absolute value)	22%	16%	8%	10%	44%

Table 6 *- Weighted results of PEF (life cycle phases contribution - transportation excluded)*

Within sportswear and equipment, the most relevant process contributing to the overall score is, by large shoes production, followed by sport suit and sports bag, which shows a significant contribution to photochemical ozone formation, which, however, is not listed among the most relevant impact categories. At single score overall results (weighted results), ball contribution is the largest after shoes. The following tables report these results.

Impact category	Shoes	Balls	Gloves	Sportsuit	Sportsbag	Winter jacket	Rain jacket	T-shirt	Shorts	Socks
Climate change	79%	2%	0%	9%	7%	0%	0%	2%	2%	0%
Ozone depletion	93%	2%	0%	2%	2%	0%	0%	1%	0%	0%
Ionising radiation, HH	81%	3%	0%	7%	5%	0%	0%	2%	1%	0%
Photochemical ozone formation, HH	13%	8%	0%	34%	26%	0%	1%	10%	6%	0%
Respiratory inorganics	97%	0%	0%	1%	1%	0%	0%	0%	0%	0%
Non-cancer human health effects	94%	1%	0%	2%	2%	0%	0%	1%	0%	0%
Cancer human health effects	99%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Acidification terrestrial and freshwater	87%	1%	0%	5%	4%	0%	0%	1%	1%	0%
Eutrophication freshwater	63%	3%	0%	15%	11%	0%	1%	4%	3%	0%
Eutrophication marine	93%	1%	0%	3%	2%	0%	0%	1%	0%	0%
Eutrophication terrestrial	92%	1%	0%	3%	2%	0%	0%	1%	1%	0%
Ecotoxicity freshwater	99%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Land use	78%	4%	0%	7%	6%	0%	0%	2%	1%	1%
Water scarcity	65%	4%	0%	12%	9%	0%	0%	4%	2%	4%
Resource use, energy carriers	71%	4%	0%	11%	9%	0%	0%	3%	2%	0%
Resource use, mineral and metals	93%	5%	0%	1%	1%	0%	0%	0%	0%	0%

Table 7 *- Characterised results of PEF (sportswear&equipment contribution)*

Impact category - Total sportswear&equipment	Shoes	Balls	Gloves	Sportsuit	Sportsbag	Winter jacket	Rain jacket	T-shirt	Shorts	Socks
Single score	90,5%	3,6%	0,0%	2,6%	2,0%	0,0%	0,1%	0,7%	0,5%	0,1%

Table 8 **-** *Weighted results of PEF (sportswear&equipment contribution)*

8. Ranking of the baseline scenario

Based on the data collected, we determined which football club won the competition on the basis of the achieved reduction results. The single score refers to the environmental footprint of a single match organized by the club.

N°	Name of the football club	National Football Association	Single score (mPt)
1°	Heming	NORWAY	16.16557
2°	Skedsmo FK	NORWAY	22.20114
3°	Vind Idrettslag	NORWAY	24.37547
4°	Konyaspor KIF	SWEDEN	27.72184
5°	FC Matzenheim	FRANCE	38.88757
6°	Raec Mons	BELGIUM	39.25766
7°	Arquet	BELGIUM	41.69061
8°	Union Namur	BELGIUM	47.45116
9°	Florennes	BELGIUM	49.27506
10°	Football Club De Saint Etienne Du Rouvray	FRANCE	56.62063
11°	PI Football Academy Siauliai	LITHUANIA	57.70817
12°	FK Riteriai	LITHUANIA	59.34981
13°	Etoile Sportive Oesienne Football	FRANCE	59.52762
14°	Utenos UTENIS	LITHUANIA	62.59255
15°	CS Beaumontais Football	FRANCE	65.70659
16°	Annebergs GIF	SWEDEN	68.8467
17°	FK Vilnius	LITHUANIA	69.99468
18°	Association Football Bouchardais	FRANCE	70.49906
19°	Borås AIK	SWEDEN	72.82367
20°	Royal Racing Club Mormont	BELGIUM	102.7529
21°	FK Kauno Žalgiris	LITHUANIA	103.5561
22°	Tromso IL	NORWAY	119.3397
Average Impact			**58.01565**

Table 9 *– Ranking of the football clubs according to baseline scenario*

Based on these results, the consortium created the following criteria for getting the GREENTEAM seal.

GOLD: Single score (mPt) < 30

SILVER: Single score (mPt) < 50

BRONZE: 50 < Single score (mPt) < 65

WOODEN SPOON: Single score (mPt) > 65

In this regard, the Green Seal for each club will be:

N°	Name of the football club	National Football Association	Green Seal Achieved
1°	Heming	NORWAY	GOLD
2°	Skedsmo FK	NORWAY	GOLD
3°	Vind Idrettslag	NORWAY	GOLD
4°	Konyaspor KIF	SWEDEN	GOLD
5°	FC Matzenheim	FRANCE	SILVER
6°	Raec Mons	BELGIUM	SILVER
7°	Arquet	BELGIUM	SILVER
8°	Union Namur	BELGIUM	SILVER
9°	Florennes	BELGIUM	SILVER
10°	Football Club De Saint Etienne Du Rouvray	FRANCE	BRONZE
11°	PI Football Academy Siauliai	LITHUANIA	BRONZE
12°	FK Riteriai	LITHUANIA	BRONZE
13°	Etoile Sportive Oesienne Football	FRANCE	BRONZE
14°	Utenos UTENIS	LITHUANIA	BRONZE
15°	CS Beaumontais Football	FRANCE	WOODEN SPOON
16°	Annebergs GIF	SWEDEN	WOODEN SPOON
17°	FK Vilnius	LITHUANIA	WOODEN SPOON
18°	Association Football Bouchardais	FRANCE	WOODEN SPOON
19°	Borås AIK	SWEDEN	WOODEN SPOON
20°	Royal Racing Club Mormont	BELGIUM	WOODEN SPOON
21°	FK Kauno Žalgiris	LITHUANIA	WOODEN SPOON
22°	Tromso IL	NORWAY	WOODEN SPOON

In addition to the seal obtained in the baseline scenario, the benchmarking will be based on the change in the environmental performance within a given time period, in order to reward the effort, and not only on the absolute values of environmental performance. The consortium will take into account the company's relative performance change from the status quo.

The seal will be used by sport organisations to:

- Benchmark the organisations' performance;
- Identify opportunities for efficiency;
- Encourage adoption of lower impact actions
- Assurance of environmental credentials;
- Differenciate the center from others;
- Engage staff and users with sustainability.

9. Improvement actions

In the aim of reducing the environmental footprint of a football match, the interpretation of the LCA results, after the impact assessment, allowed to design a list of possible improvement actions, whose impacts have been quantified according to alternatives based on different assumption. The quantification of the impacts of the improvement actions has been performed as a direct comparison of the LCA results of the baseline alternative and the related improvement actions. The calculations include, according to the data availability, the following PEF impact categories:

- climate change
- water depletion
- resource use, energy carriers
- total impact (single score pf the 16 impact categories – weighted results).

The following table reports all the proposed improvement actions, as well as the different alternatives and assumptions.

Action N°	Description	Alternatives and related assumptions
1	Led lights vs. Halogen lights	Baseline: halogen lights on during the match

Action N°	Description	Alternatives and related assumptions
		Improvement: led lights on during the match (led light consumption -90% of halogen light)
2	Life extension (2 and 3 years) for football kit	Baseline: 1 football kit (sport suit in polyester+shirt+socks+shorts) each year per player
		Improvement 1: the football kit lasts 2 years
		Improvement 2: the football kit lasts 3 years
		Improvement 3: the football kit lasts 5 years
2 bis	End of Life scenario for football kit	Baseline: football kit to landfill
		Improvement 1: football kit sent to recycling (1 reuse, e.g. donation)
		Improvement 2: football kit sent to recycling (2 reuses, e.g., donation)
3	Water well vs. public water (per m3 of consumed water)	Baseline: all water consumption comes from public water
		Improvement 1: all water comes from wells
4	Car sharing: 3 people 1 car vs. 4 people 1 car (100km)	Baseline: 2 people in 1 car
		Improvement 1: 3 people in 1 car
		Improvement 2: 4 people in 1 car
5	Team bus vs. players' cars (100km - 16 people per team)	Baseline: no bus all players in car 2 persons per car
		Improvement 1: team bus no players with car
6	Adoption of photovoltaic panel kwh	Baseline: no solar energy production
		Improvement 1: panel of 15 kw
7	Reusable water bottle vs. Single-use bottle	Baseline: single use bottle (1L, plastic weight 35 g)
		Improvement 1: refillable bottles made of aluminium (used 1000 times with 200 g of water consumed per single washing)
8	Adoption of water flow optimizer	Baseline: no water flow optimizer (16 l per minute per shower)

Action N°	Description	Alternatives and related assumptions
		Improvement: water flow optimizers in all showers and toilets (-30% consumption)
9	Duration of the shower	Baseline: 1 shower 8 minutes for player (16 l per minute per shower)
		Improvement 1: shower lasts 4 minutes instead of 8
10	Duration of the lights after the end of the match (2000 w halogen – 13 lamps per pitch)	Baseline: keep the lights on 1 hour before the match and 30 minutes after the match (tot 3 h)
		Improvement 1: keep the lights on only for 1 hour instead of 1,5 hour match (tot 2,5 h)
		Improvement 2: keep the lights on only for the duration of the match (tot 1,5 h)
11	Separate collection vs. No separate collection	Baseline: all waste to landfill
		Improvement: all waste to recovery
12	Diesel/petrol car vs. electric car (use phase: 100km)	Baseline: diesel/petrol car used
		Improvement: electric car used (EU electricity mix applied)
13	Jumpsuit in cotton vs jumpsuit in polyester	Baseline: all jump suit in 100% polyester
		Improvement 1: jump suit 50% polyester 50% cotton
		Improvement 2: 100% cotton
14	Virgin plastic seats vs. Recycled plastic seat	Baseline: 1 seat 100% virgin PET
		Improvement 1: 60% virgin PET 40% recycled PET

Table 10 - *List of the possible improvement actions*

The next table shows the results of the analysis of each improvement action. The improvement actions were calculated in relation to the baseline, i.e., how much will change the environmental footprint if the club would adopt this improvement action?

Table 11 - *Results of the possible improvement actions (comparison against the baseline)*

ACTION 1 - Led lights vs. Halogen lights (results per h of lighting) - EU average electricity

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: halogen lights on during the match	11,25901	2,5725217	229,67355	1,1589949
Improvement: led lights on during the match	1,125901	0,25725217	22,967355	0,11589949
Difference improvement/baseline	**-90%**	**-90%**	**-90%**	**-90%**

ACTION 1 - Led lights vs. Halogen lights (results per h of lighting) - NO average electricity

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: halogen lights on during the match	0,63120955	0,63817059	8,3853175	125,13486
Improvement: led lights on during the match	0,063120955	0,063817059	0,83853175	12,513486
Difference improvement/baseline	**-90%**	**-90%**	**-90%**	**-90%**

GREEN COACH

ACTION 2 - Life extension (2 and 3 years) for football kit (per person)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: 1 football kit (sport suit in polyester+shirt+socks+pantaloncini) each year per player	30,435302	10,441406	446,55219	9,8622058
Improvement 1: the football kit lasts 2 years	15,217651	5,220703	223,27609	4,9311029
Improvement 2: football kit lasts 3 years	10,145101	3,4804686	148,85073	3,2874019
Improvement 3: football kit lasts 5 years	6,0870605	2,0882812	89,310438	1,9724412
Difference improvement 1/baseline	**-40%**	**-40%**	**-40%**	**-40%**
Difference improvement 2/baseline	**-67%**	**-67%**	**-67%**	**-67%**
Difference improvement 3/baseline	**-80%**	**-80%**	**-80%**	**-80%**

ACTION 2bis - Life extension (2 and 3 years) for football kit (football kit end of life included) (per person)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: 1 football kit (sport suit in polyester+shirt+socks+pantaloncini) each year per player	30,449912	10,456187	446,89405	9,8644106
Improvement 1: the football kit lasts 2 years	15,224956	5,2280935	223,44703	4,9322053
Improvement 2: football kit lasts 3 years	10,149971	3,4853957	148,96468	3,2881369
IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Improvement 3: football kit lasts 5 years	6,0899824	2,0912374	89,37881	1,9728821
Difference improvement 1/baseline	**-40%**	**-40%**	**-40%**	**-40%**
Difference improvement 2/baseline	**-67%**	**-67%**	**-67%**	**-67%**
Difference improvement 3/baseline	**-80%**	**-80%**	**-80%**	**-80%**

ACTION 3 - Water well vs. public water (per m^3 of water)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: all water consumption comes from public water	0,34568043	43,088611	5,8702258	382,9643
Improvement 1: all water comes from wells	0	42,95	0	338,15639
Difference improvement/baseline	**-100%**	**0%**	**-100%**	**-12%**

ACTION 4 - Car sharing: 3 people 1 car vs. 4 people 1 car (per 100 km)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: 2 people in 1 car	16,068112	1,4631609	219,96904	2,871165
Improvement 1: 3 people in 1 car	10,712075	0,97544062	146,64603	1,91411
Improvement 2: 4 people in 1 car	8,0340559	0,73158046	109,98452	1,4355825
Difference improvement 1/baseline	**-33%**	**-33%**	**-33%**	**-33%**
Difference improvement 2/baseline	**-50%**	**-50%**	**-50%**	**-50%**

ACTION 5 - Team bus vs. players' cars (per personkm)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: no bus all players in car 2 people per car	257,08979	23,410575	3519,5046	45,938641
Improvement: team bus no players with car	160,71297	2,5744491	2369,9066	19,106606
Difference improvement/baseline	**-37%**	**-89%**	**-33%**	**-58%**

ACTION 6 - Adoption of photovoltaic panel (per kwh)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: no solar energy production	0,43303935	0,098935002	8,8335987	44,576686
Improvement: panel of 15 kwp	0,080118348	0,075601724	0,99067483	22,773482
Difference improvement/baseline	**-81%**	**-24%**	**-89%**	**-49%**

ACTION 7 - Reusable water bottle vs. Single-use bottle (per l)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: no single use bottle 1L, plastic waste produced	0,13436689	0,061517012	2,9528352	31,348018
Improvement: refillable bottles	0,001107614	0,008838144	0,013396519	0,18962814
Difference improvement/baseline	**-99%**	**-86%**	**-100%**	**-99%**

ACTION 8 - Adoption of water flow optimiser (per minute of shower)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: no water flow	0,005530887	0,68941778	0,093923613	6,1274288
Improvement: water flow optimizer on showers	0,003871621	0,48259244	0,065746529	4,2892002
Difference improvement/baseline	**-30%**	**-30%**	**-30%**	**-30%**

ACTION 9 - Duration of the shower (per shower per person)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: 1 shower 8 minutes for player	0,044247096	5,5153422	0,7513889	49,01943
Improvement: shower lasts 4 minutes instead of 8	0,022123548	2,7576711	0,37569445	24,509715
Difference improvement/baseline	**-50%**	**-50%**	**-50%**	**-50%**

ACTION 10 - Duration of the lights after the end of the match (per hour)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: keep the lights on 1 hour before the match and 30 minutes after the match	33,77703	7,717565	689,02066	3,4769847
Improvement 1: keep the lights on only for 1 hour instead of 1,5 hour match	22,51802	5,1450433	459,3471	2,3179898
Improvement 2: keep the lights on only for the duration of the match	16,888515	3,8587825	344,51033	1,7384923
Difference improvement 1/baseline	**-33%**	**-33%**	**-33%**	**-33%**
Difference improvement 2/baseline	**-50%**	**-50%**	**-50%**	**-50%**

ACTION 11 - Separate collection vs. No separate collection (per kg of waste treated)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: all waste to landfill	32,815208	16,943585	461,04702	4,6585854
Improvement: all waste to recycling	21,728622	9,5493397	356,55725	3,4289228
Difference improvement/baseline	**-34%**	**-44%**	**-23%**	**-26%**

ACTION 12 - Use of Diesel/petrol car vs. electric car (per 100 km)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: use of diesel/petrol car	32,136224	2,9263219	439,93808	5,7423301
Improvement: use of electric car	16,731583	4,5580566	285,7725	3,4740813
Difference improvement/baseline	**-48%**	**56%**	**-35%**	**-40%**

ACTION 13 - Jumpsuit in cotton vs jumpsuit in polyester (per jumpsuit)

IMPACT CATEGORIES	Climate change	Water scarcity	Resource use, energy carriers	Total Environmental Footprint
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.	MJ	mPt
Baseline: jump suit made of 100% polyester	4,5961417	2,0296678	78,147054	0,44493392
Improvement 1: jump suit made of 50% polyester/50% cotton	9,6804004	86,249844	111,15944	1,7778377
Improvement 2: jump suit made of 100% cotton	14,764659	170,47002	144,17184	3,1107416
Difference improvement 1/baseline	**111%**	**4149%**	**42%**	**300%**
Difference improvement 2/baseline	**221%**	**8299%**	**84%**	**599%**

ACTION 14 - Virgin plastic seats vs. Recycled plastic seats (per seat)

IMPACT CATEGORIES	Climate change	Water scarcity
ACTIONS	kg $CO_{2\text{-eq}}$	m^3 depriv.
Baseline: 1 seat 100% virgin PET	5,34	1,65
Improvement: 1 seat 60% virgin PET 40% recycled PET	3,47	0,98
Difference improvement/baseline	**-35%**	**-41%**

10. Conclusion

Our analysis assessed the environmental footprint of grassroots clubs aimed at estimating the environmental hotspots of a football match. We collected data from 5 different EU countries, Belgium, France, Lithuania, Norway and Sweden for a total of 22 different amateur clubs. In order to calculate the environmental footprint of a grassroots football match we asked information and data related to both the organization (e.g., number of teams, the number of matches played, etc.) and the main environmental aspects (e.g., waste production, energy, water and material consumption, etc.).

Using LCA (Life Cycle Assessment) and PEF (Product Environmental Footprint) methodology and secondary data from database where primary data were not available, we calculated the average environmental footprint of a grassroots football match. Considering the limited dimensions of our sample, our results should be applied to other context with caution. However, the narrowness of our sample, we can draft some main recommendations. In fact, they can be the basis for a deeper and wider analysis on the whole football universe.

Considering the environmental impact categories included in our analysis, climate change and resource consumption are by far the most relevant. If we considered the activities connected to the life cycle of a football match, transport and sportwear and equipment are the most relevant followed by electricity and water consumption. If we focus on sportwear and equipment, leather football shoes production is by far the most impactful, followed by sport suit and sports bag.

Our study proved the importance of working outside the clubs' boundaries focusing on activities on which they do not have a direct control. As regard the transport, football clubs should collaborate with public authorities, supporters and other main stakeholders in order to foster a more sustainable mobility.

Green procurement practices should be developed in order to buy more sustainable products especially in the field of sportwear and equipment. However, even in the case of transport, green procurement may have role, i.e., purchasing of a team bus, etc.

A series of green governance and operational practices were proposed and their potential benefits assessed. While for the governance practices (e.g., carpooling) there is no economic costs for the clubs, most of the operational practices requires economic investments. Policymakers should support football clubs both from a normative and economic perspective, facilitating the transition towards a circular economy and the fight against climate change.

Lastly, another issue to be considered when we calculate the environmental footprint of grassroots football are the events organized by football clubs. In fact, in order to gather economic resources, some clubs organized during the year some events, such as tournaments with the participation of a high number of teams. During these events, the clubs provide food and other "extraordinary" services for also more than one day. This activity naturally causes environmental impacts per match that that are higher than the "average" environmental impacts. For instance, during the data collection, one of the French football team of our sample told us that they organized a tournament with more 1,500 people hosted for a whole day. Considering that the data for the environmental footprint of a single match were collected on an annual basis and not specifically for each single match, the environmental impacts connected to the events organized by the club are coated along the footprint of the matches. To have the opportunity to separate the environmental impacts of events could allow to have a more reliable result referred to the environmental impact of a grassroots match.