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Application of ISO 14067 standard to assess events' Carbon Footprint: Hero Dolomites' case study

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1. Introduction

1.1 Premise: importance of the Carbon Footprint for events

Events have always played an important role in our society since they are a way to gather and share experiences. There are many types of events according to different purposes, they might have their focus on music rather than sport or socialisation. The number and variety of events has increased over the past years and the process of globalization has facilitated the constantly increasing participation at international level. Some examples are sporting events, cultural and social events, corporate events, networking meetings, fundraising events, festivals, community events, concerts and performing arts events[1].

However, events are subjected to an evolution as all other aspects of our life; currently the topic of environmental responsibility is growing in importance. We see people comparing products to find the most environmentally friendly or a growing number of people converting to public transport. Events do undergo the same process, the issue of carbon footprint assessment concerns them as well. The realization of bigger and bigger events which leads to a relevant participation of international attendees, implies also the generation of climate impacts in general and climate change issues in particular which are increasingly relevant[2]. Many events' organisers are developing GHG emissions reduction plans with the aim to, firstly, measure the environmental impacts linked to their events and secondly to decrease and monitor them over future editions. Interest in carbon footprint assessment is increasing since it also provides valuable information in order to reach carbon neutrality[3].

Awareness about the climate impact of events is constantly rising and there are a series of methodological approaches which could be used. However, the methodology of quantification is not always clear since events are sometimes considered in the form of an

[1] Jones, Meegan. *Sustainable Event Management: A Practical Guide*. 3rd ed., Routledge, 2018, page 2

[2] *Events and sustainability: why making events more sustainable is not enough*, Judith Mair and Andrew Smith, 22/07/2021

[3] *Why measure Environmental Impact?*, eventIMPACTS (eventIMPACTS is the result of a collaboration between Department for Culture, Media and Sport, Discover Northern Ireland, EventScotland, London & Partners, UK Sport and Welsh Government)

"organisation" and some others in the form of a "service". The two main approaches are Carbon Footprint of Organisation (CFO) and Carbon Footprint of Product (CFP)[4].

This thesis is intended to increase clarity about the approach to better quantify the carbon footprint of an event. The clarity on the most effective methodology for the carbon footprint quantification is fundamental for allowing the implementation of suitable GHG emissions reduction plans by event's organisers, considering the reliable quantification as the base for any GHG mitigation path towards credible carbon neutrality targets.

In this thesis, CFP is proposed as the most suitable approach for the event sector. To support this position, a Product Category Rule (PCR) was developed with the purpose to establish common rules for the CFP quantification, increasing consistency in the methodology and comparability of the results with other events. The PCR was developed on the basis of the Hero Dolomites event case study.

1.2 Existence of several standards (14064-1, ISO 14067, GHG Protocol and ISO 20121)

The Carbon Footprint is a single indicator representing the impact on climate change of a subject under study, and is expressed in units of mass (g, kg or tons) of CO_2 equivalents (CO_2e).

The applicable standards are divided in two main groups: one concerning CF of organisations (CFO) and the other CF of products (CFP).

Regarding GHG emissions assessment, the most important standards are ISO 14064-1, ISO 14067, GHG Protocol and ISO 20121, which are described in the following paragraphs.

[4] *Commission recommendation of 16.12.2021 on the use of the Environmental Footprint methods to measure and communicate the life cycle environmental performance of products and organisations*, European Commission, Brussels 16/12/21

1.3 ISO 14067:2018

ISO 14067 (Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification) is an international standard which describes the principles, requirements and guidelines for spreading uniformity among the measurement and reporting of Carbon Footprint of Product (CFP). With the aim of increasing clarity and standardisation in the quantification of CFPs, the approach is based on the Life Cycle Assessment (LCA).

The peculiarity of the CFP approach lays in the fact that it assesses GHG emissions related to every stage of the life cycle of a product from the sourcing of raw materials to the manufacturing stage followed by the use and end of life stages. The assessment of a product's CF enables to identify the hotspots of emissions which are the starting point of emission reduction strategies.

A CFP study shall include the four LCA phases:

1) Goal and scope definition;
2) Life cycle inventory (LCI) comprehending:
    - Data collection and validation,
    - Associating data to their related processes and functional or declared unit,
    - Improvement of system boundaries,
    - Allocation;
3) Life cycle impact assessment (LCIA);
4) Interpretation.

CFP is based on LCA but considers only the climate change category among all environmental impact categories. Thanks to the calculation of GHG emissions and removals expressed as CO_2 equivalent, the potential contribution of a product life cycle to global warming is estimated. Furthermore, the LCA approach allows to gather a better understanding of the CFP performances of the product and helps in the assessment of alternative designs, resource choices as well as production processes and end of life scenarios which might lead to a reduction of GHG emissions. In addition, a higher level of reliability, consistency and transparency in the quantification and communication of the CFP is reached.

CFP is told apart from other Carbon Footprint approaches thanks to its focus on products' GHG emissions. Examples of products could be services as well as goods (processed or raw materials, hardware, software, etc.).

A further peculiarity of CFP consists in the definition of a functional unit (FU) and a declared unit (DU). Their aim is to provide a reference with which inputs and outputs flows can be expressed in order to facilitate comparison. An instance of functional unit could be 1 kg of delivered goods transported from the loading site(s) to the unloading site(s) while the declared unit could be the information related to the whole shipping transported from the loading site(s) to the unloading site(s)[5]. For the product system under study, the different life cycle stages such as sourcing of raw materials, product's development and manufacturing, transportation, use and end of life, are analysed. In addition, within each stage, GHG emissions are subdivided according to specific processes from which they arise.

Included rather than excluded processes should be identified in order to determine the system boundary. Exclusions are permitted only for those processes which do not significantly influence the results of the CFP since their contribution to the overall GHG emissions is negligible. Any exclusion of life cycle stages, processes, inputs or outputs has to be stated and justified.

Data used for the CFP calculation shall be described as well as their origin and quality. Assumptions made during the study must be explained in detail and justified. Eventual allocation procedures should be described as well as the limitations of the CFP study.

Data play a fundamental role in the CFP study, however they can be characterised by a different quality level according to their origin. Site-specific data are the most accurate and should be collected for processes of major importance. Primary non-specific data can be used if collected from reliable sources and only if site-specific data cannot be gathered.

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[5] PCR - PCR 2021-0001 "*Transport services of general cargo*", version 1.0, Publication date: 18/11/2021

If no other data types are available or for processes of limited importance, secondary data can be used.

The CFP study report, which contains all data, methods, assumptions and results of the study according to its defined goal and scope, shall contain the following information:

- Functional and declared unit;
- Processes, inputs and outputs included in the study;
- Description of considered life cycle stages;
- Data sources and type;
- Emission factors used for the CFP calculation and their source;
- Cut-off criteria;
- Possible allocation procedures;
- Considered time frame;
- Results of CFP assessment, conclusions, limitations and possible recommendations.

One of the most important phases of a CFP study consists in the interpretation of results obtained by the calculations carried out. During this final step, the most significant emission hotspots can be identified according to the goal and scope of the study. Results shall be expressed in CO_2e for functional and declared unit. Limitations of the CFP study should always be included in the CFP study report.

1.4 ISO 14064-1:2018

ISO 14064-1 standard (Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals) contains the guidelines and requirements for the assessment and reporting of Carbon Footprint of Organisation (CFO). Its focus is on the methods to evaluate organisations' GHG emissions and removals, GHG quantification and the actions which could improve emission management.

GHG emissions can be classified as direct, which comprehends all emissions for which the organisation is directly responsible and over which it has full control. An example of direct emissions could be the generation of CO_2e during an industrial process such as cement production.

Indirect emissions comprehend all GHG emissions for which the organisation is not directly responsible and over which it has a limited control. During the CFO quantification, criteria to evaluate which indirect GHG emissions to include in the study are clearly stated. Only emissions of minor importance can be omitted, and all exclusions shall be justified. The volume of emissions rather than the quality of collected data or employee engagement are examples of factors to take into consideration while identifying significant indirect emissions.

According to ISO 14064-1 standard, GHG emissions can be divided into three major groups:

- Scope 1 which comprehends all direct greenhouse gas emissions, such as emissions from combustion in owned or controlled boilers and vehicles;
- Scope 2 which includes indirect greenhouse gas emissions from the generation of purchased electricity, heat or steam consumed by the company;
- Scope 3 which comprehends other indirect emissions, such as emissions from the extraction and production of purchased materials and fuels, vehicles not owned or controlled by the reporting entity, outsourced activities and waste disposal.

In the second edition of the standard (2018), a further subdivision for GHG emissions was introduced. The new version provides a set of six different GHG inventory categories:

1) Direct GHG emissions and removals, which corresponds to Scope 1;
2) Indirect GHG emissions deriving from purchased energy, which correspond to Scope 2;
3) Indirect GHG emissions due to transportation;
4) Indirect GHG emissions deriving from products used by organisation;

5) Indirect GHG emissions associated with the use of those products;

6) Other indirect GHG emissions not included in the previous categories.

Categories from 3) to 6) are comprehended into Scope 3.

For each category, non-biogenic emissions, biogenic anthropogenic emissions and biogenic non-anthropogenic emissions[6] shall be quantified separately.

The organisation is requested to identify and report all significant GHG sources and sinks in accordance with the categories defined above. Data have to be displayed as tonnes of CO_2e for each GHG category.

The main characteristic of CFO approach consists in the establishment of a base year which is a precisely identified year with which all further GHG emissions and removals will be compared. Base year comprehends data concerning the organisation within a specific period or averaged from multiple periods. In the case in which the organisation has implemented initiatives to reduce GHG emissions or increase GHG removal, results shall be compared to the base year values in order to assess their efficiency.

Data quality contributes to influence the accuracy of the CFO study's result therefore primary data, if available, should be preferred. Secondary data from literature or recognised databases are allowed if primary data cannot be collected.

The CFO study shall be documented through a report which includes the following information:

- Purpose and objectives of the document;
- Brief description of the organisation goals;
- Explanation of the processes and activities taken into consideration;
- Description of the emissions categories included;
- Results of the quantification of GHG emissions and removals;
- Possible emission reduction initiatives implemented by the organisation.

[6] The term biogenic carbon can be defined as the carbon generating from biomass while fossil carbon is defined as the carbon contained in fossilized material such as coal or oil. Carbon from direct land use change (dLUC) comprehends the carbon originated from a change in the use of land due to anthropic activities.

1.5 GHG Protocol

The Greenhouse Gas Protocol is a document containing a set of tools and guidelines developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) to provide a framework to organisations and governments while accounting for and manage their GHG emissions.

In addition, the GHG Protocol also provides standardised sector-specific guidance, quantification methods and reporting frameworks for different types of organisations from private and public sector operations, value chains and mitigation actions.

In fact, the aim of the GHG Protocol is to provide assistance to companies in drafting a GHG inventory which represents a transparent and reliable assessment of their emissions. This can be achieved thanks to the use of standardised approaches and principles, thus, increasing transparency and consistency. The document contains useful information for companies to develop an effective strategy to manage and reduce their GHG emissions.

The standard was developed to be a guide for businesses developing a GHG inventory and one of its main characteristics is to provide useful information to ease the participation in voluntary and mandatory GHG programs by the companies.

To facilitate GHG inventory, the GHG Protocol divides emissions into three scopes:

- Scope 1 which comprehends direct emissions from sources that are owned or controlled by the organisation such as fuel used in site plants, equipment and vehicles;
- Scope 2 which includes indirect emissions that are a consequence of the activities of the company but occur at sources owned or controlled by another company, an example are emissions the generation of purchased energy;
- Scope 3 comprehends all other indirect emissions that occur in the value chain such as vehicles not owned by the organisation.

Companies are required to account separately for and report on scopes 1 and 2 while scope 3 is an optional reporting category, however, companies have the possibility to further divide emissions data within scopes where this increases transparency or facilitates comparability over time.

The GHG Protocol requires that companies identify and report a base year to be used for comparison for the following years' reports and to justify the choice of that particular year.

However, companies often undergo multiple structural changes, such as acquisition or mergers, which determine significant modifications to the original situation during which the base year was calculated. These changes are an issue to comparison between the GHG emission performances of the company over the years since the base year values will lose in meaning. In order to maintain consistency over time, the GHG Protocol provides for a recalculation of base year emissions.

The Standard identifies five steps to undertake during companies' GHG emissions assessment:

1) Identifying and calculating a company's emissions by categorising the GHG sources within that company's activities. According to the scopes described above, companies need to firstly identify their direct emissions. The next step is to identify indirect emission sources arising from their purchased energy. The third step is optional and provides for the definition of other indirect emissions from a company's upstream and downstream activities and all other emissions not included in scope 1 or scope 2. This step might be more challenging than the previous ones, however, it enables to gain a broad overview over significant GHG emission reductions opportunities that may exist outside the company's direct activities.

2) Select a GHG emissions calculation approach, usually the most common approach for calculating GHG emissions implies the use of documented emission factors. These factors are coefficients which allows to convert data about a certain activity into GHG emissions.

3) The third step consists in the collection of activity data and the choice of emission factors. As far as the majority of companies are concerned, scope 1 GHG emissions are quantified starting from the purchased quantities of commercial fuels such as natural gas or diesel and using published emission factors. Scope 2 emissions are

based on measured electricity consumption and supplier-specific, local grid, or other published emission factors. Scope 3 GHG emissions might be quantified from data collected during the different activities such as fuel used, or distance travelled and using published or third-party emission factors. Emission factors which are specific for a certain source or facility, if available, should be preferred to more generic emission factors. Industrial companies, however, should follow the sector-specific guidelines of GHG Protocol.

4) The fourth step consists in the application of calculation tools which are divided into two main categories:

   - Cross-sector tools which can be applied to several different sectors;
   - Sector-specific tools which have been designed to quantify emissions in specific sectors such as iron and steel, cement, oil and gas, and office-based organisations.

For each calculation tool, the GHG Protocol provides an overview on the purpose of the tool, the calculation method used and a description of the process to follow. It also includes sector-specific good practices and references for default emission factors and guidance on internal documentation to support emissions calculations.

5) Direct data by each facility should be collected and aggregated into a consolidated database of the entire company. This process might involve spreadsheets templates or paper reporting forms which are filled in by the different division offices and then inserted into a unique database.

The following paragraphs describe the similarities and differences occurring between the ISO 14064-1 and GHG Protocol.

Both GHG Protocol and ISO 14064-1 standard divide emissions into scope 1, scope 2 and scope 3 and their aim is to provide guidance to organisations in order to quantify and report their GHG emissions. A major characteristic that both share is the requirement to identify a base year in order to compare the performances of the following years respect to the initial situation.

However, GHG Protocol addresses the issue of companies making significant changes to their organisational structure which could affect comparability with base year values. In fact, it provides for a recalculation of base year emissions to ensure consistency is maintained over time while ISO 14064-1 standard does not consider the problem. In addition, GHG Protocol includes sector-specific guidelines in order to better address the needs of certain industrial sectors.

ISO 14064-1 standard and GHG Protocol have two different purposes. GHG Protocol is more comprehensive and specific, it addresses a wider range of sectors and activities and provides detailed guidance. On the other hand, ISO 14064-1 is intended to be more generic and concise since its aim is to provide a standardised approach to quantification, reporting and verification for GHG emissions.

GHG Protocol is a longer and more complete document in which wider guidance is provided on the principle to apply while selecting the emissions to consider. ISO standard does not discuss in detail the process to follow in order to decide which emissions to report.

Finally, ISO standard does not address voluntary targets since its objective is to provide a standardised approach to assess the carbon footprint of a company. GHG Protocol, instead, provides reasons and encouragements to improve quality management and includes broader guidance since its objective is to facilitate the participation in voluntary and mandatory GHG programs by the companies.

1.6 ISO 20121:2012

ISO 20121 standard (Event sustainability management system – Requirements with guidance for use) describes the requirements needed for a sustainable management system concerning events. This standard can be applied to any kind of organisation despite dimensions and geographical, cultural and social conditions. Its aim is to help organisations increase awareness about their impact on society and the environment. The main characteristic of ISO 20121 is the fact that it is not intended as a checklist or a framework for the assessment of sustainability performances of an event. The document contains helpful definitions and suggestions for organisations to approach to a more sustainable management system of events.

To comply with ISO 20121 requirements, organisations should firstly undergo a process of self-evaluation, subsequently a confirmation about the conformity to the standard should be obtained. This confirmation can be provided by stakeholders or by an independent party for example through a certification.

The main topics to address in order to move to a more sustainable events' management system are:

- Stakeholder identification and engagement;
- Sustainable management system's goal and field of application;
- The organisation's sustainable development principles;
- Leadership and policy;
- Specific, measurable, achievable, and timely planned targets;
- Communication;
- Supply chain management;
- Monitoring, measurement, analysis and assessment.

While assessing sustainable development topics, organisations might take into consideration the following factors:

- The event type and its purpose, activities involved and dimension;
- The event's location considering:
  - The existence of a regulatory framework referring to sustainable development activities,
  - Social, environmental and economic characteristics of the location;
- Employees and workforce's characteristics (age, education and training);
- Event's organisations to which the considered organisations belongs;
- Stakeholders' concerns.

ISO 20121standard addresses the issue of GHG emission assessment from a qualitative, rather than quantitative, point of view. It provides guidelines for a self-evaluation analysis which organisers should perform in order to understand the impact of their event and the hotspots of emissions which should be improved. ISO 20121 standard does not focus on the method to use for measuring GHG emissions instead it emphasises the establishment of a road map to improve the overall sustainability of the event. The identification of the changes needed in the event management system and their possible implementation, as well as the evaluation of alternative solutions for products, services and supply chain to be involved in the event are the main focus of the standard. The impact assessment of the event which comprehend GHG emissions is intended as a final step to understand if the strategies and changes carried out have improved the sustainability performance of the event.

1.7 The use of CFP rather than CFO methodology

The main issue while considering carbon footprint assessment of events is the lack of clarity about the most suitable approach and methodologies to use. The thesis aims to discuss the most suitable approach for Carbon Footprint quantification of events. An analysis about possible changes to improve the event management system according to ISO 20121 will be provided in chapter 8.4. In fact, the two most widespread approaches are Carbon Footprint of Product and of Organisation, which follow different methodological approaches of GHG accounting.

The choice of an approach rather than another is linked to the interpretation of the event as “service” or “organisation”. In the case in which the Carbon Footprint assessment is mainly focused on the environmental impact generated by the organisers of the event (for example the organising committee of an Expo), the most suitable methodology is the Carbon Footprint of Organisation (CFO) or, more precisely, the GHG inventory of Organisation. If, on the other hand, the aim is to emphasise the impact on climate change of the whole event, from its design to all post-event activities, the Carbon Footprint of Product (CFP) approach should be preferred. In the second case the event has to be intended as a service provided to participants, therefore in full consistency with the definition of product[7] as "good or service". The two approaches imply a different methodology on how to consider indirect GHG emissions, which are the most significant emissions for events, and in the results interpretation.

1.8 Sport for Climate Action (S4CA) initiative to share a common CF assessment methodology

The UNFCCC's Sport for Climate Initiative (S4CA)[8] intends to raise awareness about the carbon footprint in the field of sporting events and to promote climate actions for the GHG mitigation. It is important to explain this initiative since S4CA can be considered as an opportunity to share the different approaches used by many sporting societies around the world for CF assessment and as a way to spread the most suitable methodology which needs to be well adapted to all kind of events. S4CA pursues two main targets, the first one is the identification of a clear pathway towards GHG emission reduction through commitment, measurement, reduction and reporting for the global sport community while the second one is the creation of solidarity and unity among all citizens worldwide to tackle climate change. S4CA is persuaded that the key to reduce GHG emissions is cooperation in fact it promotes the exchange of ideas and best practices as well as learning from each other. Sport organisations are invited to sign up to S4CA committing to work together to develop solutions to face the climate crisis and to achieve certain standards. Many sporting societies, among which Hero S.r.l., have already joined this initiative and have started a mapping of their own GHG emissions in order to work towards halving them by 2030 and reaching net-zero emissions by 2040 in compliance to S4CA requirements. In addition, from 2021 onwards signatories have to provide an annual public report.

[7] ISO 14067: 2018, clause 3.1.3.1 – *Carbon footprint of products; Requirements and guidelines for quantification*

[8] https://unfccc.int/climate-action/sectoral-engagement/sports-for-climate-action

2. Available methodologies

2.1 Pre-existing reports and approaches used

Several sporting organisations have joined S4CA; by taking part into the initiative, they commit to a GHG emissions reduction roadmap and to publish yearly reports about the sustainability performances of their events. The reports contain GHG emissions estimation, social and economic initiatives, and current and future emission reduction activities. From the analysis of the available reports, it is clear that the most used approach for GHG emissions estimation among the signing organisations is CFO, as reported in the flowing examples:

- 2018 **FIFA World Cup** Greenhouse gas accounting report[9], which calculates its emissions according to the GHG Protocol;
- **Juventus** Climate Report 2020/2021[10], which follows the GHG Protocol guidelines;
- **Formula E** Season 8 Sustainability report 2022[11], which calculates its emissions as required by the GHG Protocol;
- **11th hour racing team** 2020 sustainability report[12], which calculates its emissions dividing them between scopes following the GHG Protocol;
- **McLaren** racing Sustainability report 2021[13], which also follows the GHG Protocol;
- 2021 **WM Phoenix Open** Sustainability report[14], which calculates its emissions following the GHG Protocol guidelines.

It is clear that all reports listed above have preferred the CFO approach, it is now appropriate to explain why it was chosen to utilize the CFP approach for the Carbon Footprint of Hero Dolomites rather than the CFO.

[9] https://digitalhub.fifa.com/m/a96fa2c95a79242/original/bs36nsonccbtfs5v7ppu-pdf.pdf
[10] https://www.juventus.com/en/sustainability/reports
[11] https://resources.formula-e.pulselive.com/formula-e/document/2023/03/02/0883aacc-f242-493e-9b7d-45d2fe5297d6/FE-Season-8-sustainability-report.pdf
[12] https://www.11thhourracingteam.org/wp-content/uploads/11th-hour-racing-team-2020-sustainability-report.pdf
[13] https://mclaren.bloomreach.io/delivery/resources/content/assets/mclaren-assets/sustainability/2021-sustainability-report.pdf
[14] https://www.wm.com/content/dam/wm/assets/inside-wm/phoenix-open/2021-wm-phoenix-open-sustainability-report.pdf

2.2 Weakness of CFO

Even though CFO is a widely spread approach for assessing the carbon footprint of events as previously discussed, it is characterised by a crucial weakness. The fundamental principle on which the CFO is based consists in the creation of a yearly GHG inventory, in order to compare it with the reference baseline inventory calculated at time zero. The CFO guidelines require a comparison between the impact of yearly activities which are repeated over time with the impact of those activities at time zero. The objective consists in creating a traceability of the GHG emission reduction pathway undertaken by the organisation over time usually aiming to certain stated emission reduction targets. The characteristics discussed above make the CFO a perfect approach in the case of organisations, such as manufacturing companies, which have committed to follow specific emissions reduction roadmaps.

In the event sector, the CFO logic is suitable in the case of events which are repeated over time such as yearly expositions or yearly sport championships. Occasional events or events which require a multiannual preparation such as the Olympic Games, are not designed to fit the annual GHG inventory logic.

To better explain the criticalities in the carbon footprint assessment arising from an event which does not possess the optimal characteristics for the application of CFO, the example of FIFA World Cup 2018 can be analysed in detail.

Figure 1 is taken from the "2018 FIFA World Cup Greenhouse gas accounting report" and displays the start and end dates of the preparation period and the FWC (FIFA World Cup) period of 2018 GHG accounting. The event preparations started on the 25th of July 2015 and include the FIFA Confederations Cup Russia 2017 (FCC). The FWC took place from the 14th of June to the 15th of July 2018.

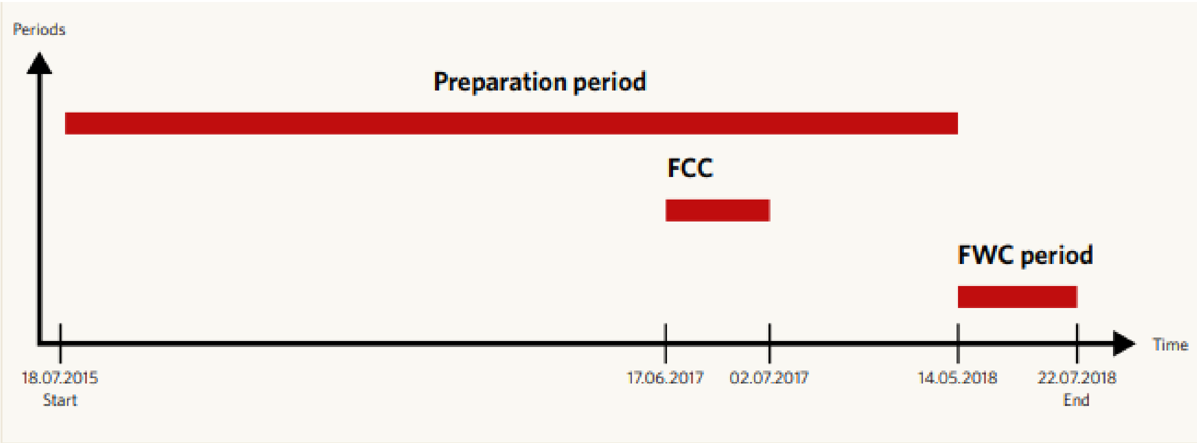

Figure 1 Starting and ending dates of the 2018 FIFA World Cup from 2018 FIFA World Cup Greenhouse gas accounting report

It appears immediately clear that the event took place over a multiannual period, the preparation phase required almost three years. However, the preliminary phase of preparation of the event is not comparable with the event itself in terms of activities carried out and consequently of GHG emissions. In this case, comparing GHG emissions year after year without taking in consideration the entire service life of the event, makes no sense because in one year there would be accounted the GHG emissions of event preparation and in the following one the event execution. It should be expected that in the year of the event GHG emissions will significantly increase and in this case there is no reason to use the CFO for tracking potential GHG reductions even if the organiser implemented several actions to mitigate its GHG emissions.

The chart in *Figure 2* shows the percentage of GHG emissions distributions between scopes and phases.

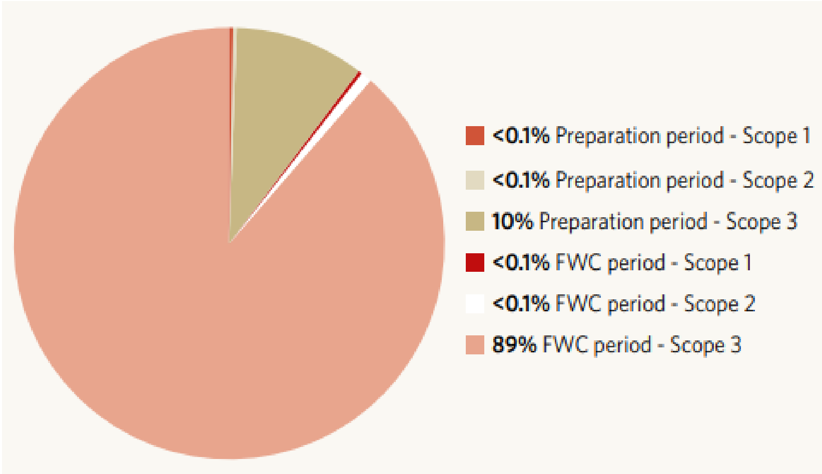

Figure 2 Percentage of GHG emissions divided into scopes and phases from 2018 FIFA World Cup Greenhouse gas accounting report

The preparation period, although it required three years, contributes to around 10% of the total impact of the event, while the 2018 yearly GHG inventory includes 89% of the whole event's GHG emissions.

The fact that the display of a series of yearly GHG inventories is not a reliable representation of the total impact of multiannual events, is a further reason for not preferring the CFO approach. Representing the impact of the event as a whole and not divided into years provides an easier and more precise way to understand the impact of a certain event and the possible improvements in respect to previous editions.

Another fundamental weakness of CFO approach consists in the complexity of comparisons between similar events. For example, a sporting competition attended by 2000 people, even if sustainable management best practices are put into action, will for sure generate a greater impact if compared to a sporting competition attended by 200 people. Comparisons are, therefore, very hard unless impacts are represented in a way in which the size of the event is not an obstacle for comparability. Data need to be displayed in a relative way, in this example it should be assessed the impact generated by a single attendee which becomes a comparable unit rather than the impact of the whole event. This is the principle of the functional unit that is a fundamental characteristic of the CFP logic.

2.3 CFP as most suitable approach for events

CFP approach is valid independently from the event's duration or dimension which makes it suitable for every type of event. In addition, it does not assess GHG emissions yearly, instead it calculates the carbon footprint considering the entire lifecycle of a product. Impacts are, therefore, divided into upstream, core and downstream. ISO 14067 standard introduces the concepts of functional and declared units which enable comparability between similar events.

Furthermore, GHG emissions have all the same importance and are easily associated to the activities which generate them, differently from Scope 1, 2 and 3 (CFO).

Another reason to prefer the CFP logic rather than the CFO for events is the fact that in the ISO 14067 standard, events are included in the definition of product, as clearly stated in paragraph 3.1.3.1: "The product can be categorized as follows: — service (e.g. transport, implementation of events); …". The main characteristic which differentiates the CFP from the CFO approach is the fact that events are assessed in the same way as products are and thus the GHG emissions accounting depends only on their lifecycle and not on their duration. Finally, the CFP requires the division of GHG emissions into three phases (upstream, core and downstream) which fit well with the logic that characterises events in the three phases of preparation of the event (pre-event), realisation of the event (event) and the phase of decommissioning or closure of the event (post-event).

3. PCR for the use of ISO 14067 for event's CF

3.1 Introduction about PCRs

Product Category Rules (PCRs) comprehend specific rules, requirements and guidelines for the quantification and communication of CFP for one or more product categories.

ISO 14067 requires the use of a PCR (Product Category Rule) which ensures a standardisation among all operators calculating the emissions of a specific product category. The PCR is essential since ensuring the application of common rules is the first fundamental step in order to develop studies which are comparable to each other.

As part of the development of this PCR, existing PCRs were considered in order to avoid overlaps in scope. The existence of such documents was checked in the public PCR listings of the following programmes based on ISO 14025 or similar:

- International EPD® System
- EPDItaly

The following existing PCR was identified:

PCR name	Programme	Registration number	Scope	Motivation for exclusion
Eventos en Costa Rica	INTECO	INTE/RCP 10:2021	This document provides Product Category Rules (PCR) for events in Costa Rica	This PCR refers only to events in Costa Rica.

This PCR (RCP 10:2021 "Regla de categoria de producto. Eventos en Costa Rica") about events was written by the program operator of Costa Rica, in fact, it is only applicable to events taking place in Costa Rica. Since no PCR with global application are available, a new PCR[15] was developed as part of the Carbon Footprint Italy (CFI)[16] program for the Hero

[15] https://www.carbonfootprintitaly.it/media/pcr-2022-0004-events-v1-0-compressed.pdf

[16] https://www.carbonfootprintitaly.it/en/

Dolomites' study. Carbon Footprint Italy is the Italian programme dedicated to communicating the results of the quantification of greenhouse gas emissions of products and organisations and their reductions.

Further examples of PCRs about various product categories can be found on the website https://www.carbonfootprintitaly.it/it/pubblicazione-pcr/

3.2 Product category definition

Product categories consist in a set of products which can fulfil equivalent functions.

The product category assessed in the PCR corresponds to the UN CPC code, defined under the UNSD-CPC Ver 2.1 classification. Events are part of the division number 96 (Recreational, cultural and sporting services) and group number 962 (Performing arts and other live entertainment event presentation and promotion services).

3.3 Product category description

The product covered by this PCR is event's organisation and management. This product is classified hereinafter as "event".

This product family encompasses all the possible kinds of events, independently from the size, location and duration. It includes:

- Sporting events;
- Cultural and social events;
- Corporate events;
- Networking meetings;
- Fundraising events;
- Festivals;

- Community events;
- Concerts;
- Performing arts events.

Online events are excluded.

3.4 Functional unit (FU)

To ensure full comparability between the environmental results, in this PCR the functional unit is defined as 1 attendee for an event of any dimension, magnitude and duration organised by public and private entities. Results are expressed in kg of CO_2 equivalent per person regardless of the geographic location.

In addition, the organisation should report the following information:

- Mandatory information:
    - Name of the organisation planning the event;
    - Main activities of the organisation;
    - Geographic location of the event (venue, Province, Region);
    - Number of attendees;
    - Duration of the event (days).

- Optional information:
    - Certifications and awards about environmental management obtained by the organisation on a voluntary basis.

3.5 Declared unit (DU)

As additional information, it is possible to report the declared unit, namely the whole event of any dimension, magnitude and duration organised by public and private entities.

3.6 System boundaries

The scope of this PCR and of CFPs based on this document is cradle to grave.

For the purpose of different data quality rules and for the presentation of results, the life cycle of products is split into three different life cycle phases shown in *Figure 3*:

- Pre-event;
- Event;
- Post-event.

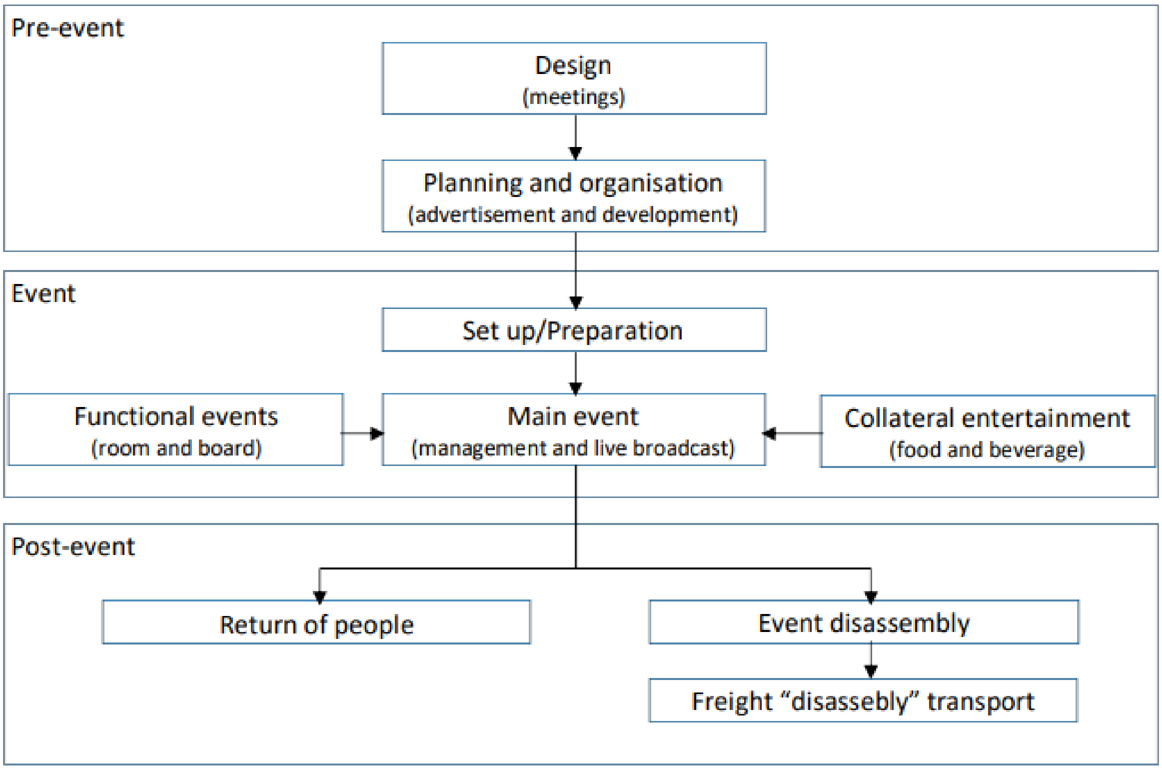

Figure 3 Scheme displaying the organisational steps of an event divided into Upstream (pre-event), Core (event) and Downstream (post-event)

Figure 4 shows the subdivision of the possible activities carried out during an event into the three phases described above.

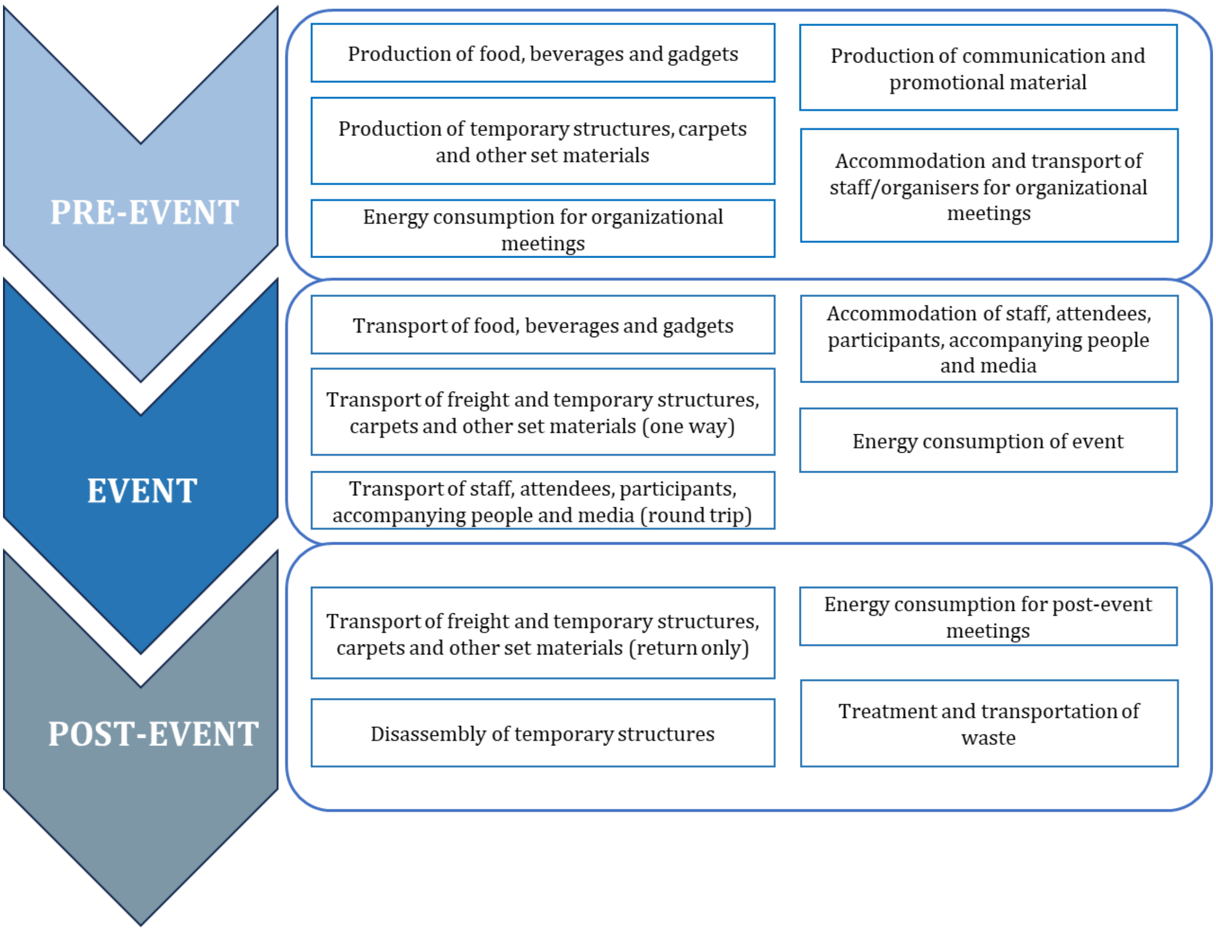

Figure 4 System diagram displaying the activities included in the product system, divided into Upstream (pre-event), Core (event) and Downstream (post-event)

3.6.1 Upstream (pre-event)

The pre-event processes include the following inflow of raw material and energy wares needed for the activities carried out in order to organise the event.

- Electrical energy and resources consumption for organisational meetings (if relevant, as number of meetings);
- Accommodation[17] of staff/organisers for the organisational meeting (if relevant, number of people and meetings);
- Transport of staff/organisers for organisational meetings;
- Production of communication and promotional material;
- Production of food, beverages and gadgets;
- If disposable, production of temporary structures, carpets and other set materials.

  Note: to exclude if material is suitable for multiple use.

3.6.2 Core (event)

The event processes include the following inflow of raw material and energy wares needed for the activities carried out during the event throughout all of its duration.

- Transport of food, beverages and gadgets;
- Transport of freight and temporary structures, carpets and other set materials (one way);
- Transport of attendees, staff, participants, accompanying people and media (round trip);

[17] Meant as infrastructure, cleaning consumables, other materials used in the hotel (such as coffee maker, lamps, computers, cookstoves, dryers, furniture, mattresses, chemicals, textiles, …), tap water, electricity, heat and waste.

- Accommodation[18] of staff, attendees, participants, accompanying people and media;
- Energy consumption during the live broadcast of the event and for its management (cooling, heating, entertainment, ...);
- Refrigerating gases escapes from fridges and air-cooling systems (if relevant, as quantity).

3.6.3 Downstream (post-event)

The post-event processes include the following inflow of raw material and energy wares needed for the activities carried out after the end of the event.

- Transport of freight and temporary structures, carpets and other set materials (return only);
- Disassembly of temporary structures;
- Energy consumption for significant post-event meetings (if relevant, as number of meetings);
- Treatment and transportation of waste generated during the event.

Any exclusion of data shall be justified.

As far as calculation rules are concerned, the requirements listed below apply to the study:

- Data from pre-event activities related to the supply chain over which the organisation has direct control have to be primary data (site-specific data);
- Data related to suppliers of relevant materials, goods and infrastructures should be requested to the suppliers by the organisation;

[18] Meant as infrastructure, cleaning consumables, other materials used in the hotel (such as coffee maker, lamps, computers, cookstoves, dryers, furniture, mattresses, chemicals, textiles, ...), tap water, electricity, heat and waste.

- If site-specific data are unavailable, generic data may be used. If generic data cannot be collected, proxy data can be used provided that the environmental impact arising from them does not exceed 10% of the overall impact of the product under study. This 10% might not include proxy data from food and accommodation since collection of site-specific data for these categories is usually very complicated for the organisation. Nevertheless, the use of primary data should always be preferred and secondary data should be used only in the case no other options are available.
- For electrical energy, fuels and water consumption assumptions can be carried out if specific data cannot be collected. However, any assumption shall be justified and based on mass, energy or economic data.

The cut-off rules considered in this PCR state that all contributing to a minimum of 95% of the declared environmental impacts shall be included. Only activities which altogether make up less than 5% of the overall impact of the product under study can be excluded after the preliminary assessment of the processes included in the study.

4. Case study

4.1 About Hero Dolomites

Data and results reported in the present article are the outcomes of the CFP study for the Hero Dolomites event and were presented at Sharm el Sheikh during COP 27 (27th Conference of the Parties, which includes all counties who signed the United Nations Framework Convention on Climate Change – UNFCCC).

Hero Srl is an amateur sport association, below called Hero, which organises the event Hero Dolomites, a mountain bike event usually taking place in June in Selva di Val Gardena over a period of 4 days, even though the main event takes place only in one of the 4 days. The focus of the festival is, in fact, the mountain bike marathon Hero Dolomites, which is considered to be the world's toughest mountain bike marathon and attracts over 2000 attendees from more than 40 countries every year. The event takes place from Thursday to Sunday and comprehends a few collateral events such as Pasta Party and VIP Lounge.

Hero is responsible for the organisation of other races around the world (Dubai and Thailand) in addition to the one in the Dolomites which constitute the Hero Series. Thanks to these initiatives, Hero has created a circuit of international competitions, but our study is limited to the Hero Dolomites[19] edition.

In April 2022 Hero joined the initiative Sport for Climate Action (S4CA) launched by the UNFCCC (United Nations Framework Convention on Climate Change) Secretariat and subsequently (30th of May 2022) Race to Zero (R2Z); as a consequence, Hero is committed to reducing 50% of its GHG emissions within 2030 and reaching zero net emissions within 2040.

[19] https://www.herodolomites.com/it

4.2 Objective

The study aims to quantify the Carbon Footprint related to the event Hero Dolomites following the requirements of ISO 14067:2018. This approach takes into consideration the entire lifecycle of the event from the upstream (pre-event) to the downstream (post-event) activities.

The first step expected by R2Z, program signed by Hero in May 2022, is the definition of a GHG emissions reduction plan in the short period (within 2030). This implies an initial quantification of direct and indirect GHG emissions due to the event activities, a subsequent yearly monitoring is required in order to track their evolution over time.

The CFP report was drafted in English, submitted to Sports for Climate Action of the UNO and presented at Sharm el Sheikh during COP 27.

4.3 Functional and declared unit

The functional unit was identified, according to the PCR, as 1 attendee while the declared unit is considered to be the whole event.

4.4 System boundaries

The system boundaries shall build the basis used to determine the unit processes included in the CFP study.

The phases included in the life cycle for the 2022 edition of Hero Dolomites can therefore be summarised as follows:

Upstream (pre-event)

Activities carried out in order to organise the event;

- Printing (flyers and other documents useful in the event's management);
- Organisers' transport;

- Meals;
- Beverages.

Core (event)

- Freight transport (food, merchandising, equipment, etc.);
- Accommodation of staff;
- Accommodation of attendees;
- Live broadcast;
- Travel of staff (round trip);
- Attendees' travel (round trip);
- Electrical energy.

Downstream (post-event)

- Freight return;
- Waste materials.

Inclusion and exclusion criteria have to be defined while deciding the objective and the scope of application, thanks to these criteria the omission of processes of minor importance can be assessed. Exclusions carried out during the study regarded the organiser's transport during the preliminary meetings since they are negligible.

Regarding the goods, in the case of equipment, merchandising, stands, banners and temporary infrastructures only the transport phase was considered. The production phase was not included since the specific production processes and materials are unknown and most of the items are durable and can be reused several times.

In the current study, no allocations were made.

Specific data were collected by the organisation before, during and after the event about all activities included in the study. When primary data were not available, secondary data were obtained by database or literature. Those activities were associated to the different event's phases and emission factors for each datum were gathered.

In this study, as far as possible, site-specific data were collected for:

- Number of attendees;
- Number of meals served;
- Quantity of beverages served;
- Freight transport;
- Quantity of printed paper;
- Quantity of waste materials generated during the event;
- Distance travelled by the organisers;
- Data concerning live broadcasting;
- Accommodation of staff and attendees;
- Transport of staff and attendees.

The generic data selected were used for those processes in which the organisation has no influence.

In this study, the Ecoinvent database (version 3.8) was used, it is a solid database (more than 12.800 Life Cycle Inventory datasets) recognised at European level as a global leader in the creation of LCI datasets.

5. Inventory analysis

The data inventory follows all the phases of the life cycle indicated in point 3.6 "System boundaries", detailed below.

The total number of attendees (cyclists taking part in the race) is equal to 2,344.

5.1 Upstream (pre-event)

This phase includes all activities carried out to organise the event and, in particular, the transport of organisers, the printing of sheets and magazines for the event's management and food and beverages.

For each activity considered, data were collected either from the organisation itself or from reliable databases and literature. Each datum, such as km travelled or litres of beverages consumed, was associated to its specific dataset and thus emission factor (EF) in order to quantify the amount of CO_2e arising from it. If available, specific emission factors were collected separately for fossil (EF fossil), biogenic (EF biogenic) and direct land use change (EF dLUC)[20]. Each datum was multiplied by its EF in order to obtain its total climate impact, results were summed separately for each activity and for the three event phases. The sum of all impacts is equal to the declared unit while the functional unit is obtained dividing the impact by the number of attendees.

5.1.1 Transport of the organisers

Available data

Specific data about the type of vehicle and the distance travelled were collected by the organisation.

[20] The term biogenic carbon can be defined as the carbon generating from biomass while fossil carbon is defined as the carbon contained in fossilised material such as coal or oil. Carbon from direct land use change (dLUC) comprehends the carbon originated from a change in the use of land due to anthropic activities.

A major part of the preliminary meetings took place in Selva di Val Gardena and required minimum travel (1-3 km) of the organisers since they live in the areas nearby, this data is therefore considered negligible.

During this phase, the number of km travelled by the organisers was considered concerning:

- Two meetings with the managers of the other valleys, one in Corvara and Arabba (60 km round trip with a car) and one in Canazei (40 km round trip with a car). The total distance travelled is 100 km.
- In addition, the race director travels 5 rounds in the other valleys using his own car (60 km for 5 rounds = 300 km) in order to organise tracks and signage. While travelling on the racetrack, he moves through e-bike.

The organisation team travels during the event through 6 electric cars provided by BMW Italy.

Assumptions

The GHG emissions of the organisational team using 6 electric and plug-in hybrid cars during the event were considered negligible as GHG emissions of these type of cars are low and no specific data were available on the distances travelled.

The type of vehicle used by managers and the race director is a car, however no specific data about the type of car were available; it was assumed to be a medium size EURO 4 car powered through diesel (*Transport, passenger car, medium size, diesel, EURO 4 {RER}| transport, passenger car, medium size, diesel, EURO 4 | Cut-off, U*)[21].

Data expressed according to the functional unit

The number of km travelled by the organisers expressed according to the functional unit is 0.17 km.

[21] Process chosen in the Ecoinvent database for modelling the GHG emissions.

5.1.2 Printing

Available data

The amount of printed paper considered in the study comprehends single- and double-sided printing as well as single sheets and magazines. Specific data about paper sizes, weight (g/m^2), number of copies and number of sheets per copy were collected as displayed in *Table 1*. The additional information to the input data and elaboration used to quantify the amount of paper printed for the event are shown in *Table 2*.

Type	Basis weight (g/m^2)	Number of copies	Number of sheets per copy	Type of printing
A4	120	600	1	Single-sided
A3	120	2,500	1	Double-sided
A4	120	500	1	Double-sided
A4	200	10	1	Double-sided
4.5x7	320	160	1	Double-sided
5.5x12.5	350	100	1	Double-sided
9x13	350	493	1	Double-sided
A4	250	3,700	1	Double-sided
A4	115	3,700	115	Double-sided

Table 1 Input data about printed material

Assumptions

Starting from the data provided by the organisers, it was possible to calculate the kg of printed paper distributed during the event. To obtain the final result, first of all the measures of the sheets were collected (e.g. A4, A3, etc.), then the area of each type of sheet was calculated. Afterwards, the area was expressed as % in relation to 1 m^2, then the weight (g/m^2) of each sheet was multiplied by the number of copies, the number of sheets per copy and the % of m^2. The results were summed in order to achieve the total weight (expressed in kg). The Ecoinvent dataset from which the emissions factors have been sourced is shown in *Table 3*.

Type	Measure (m)		Area (m^2)	% of m^2	Sheet's weight (g)	Total weight according to type (kg)	Total weight (kg)
A3	0.30	0.42	0.126	12.6	15.12	37.8	3,259.67
A4	0.23	0.28	0.064	6.44	7.73	4.64	
A4	0.23	0.28	0.064	6.44	7.73	3.86	
A4	0.23	0.28	0.064	6.44	12.88	0.13	
4.5x7	0.05	0.07	0.003	0.32	1.01	0.16	
5.5x12.5	0.06	0.13	0.007	0.69	2.41	0.24	
9x13	0.09	0.13	0.012	1.17	4.10	2.02	
A4	0.23	0.28	0.064	6.44	16.1	59. 57	
A4	0.23	0.28	0.064	6.44	7.41	3,151.25	

Table 2 Further information for the quantification of printed material

kg	Corresponding dataset
3,259.67	Printed paper {Europe without Switzerland}| operation, printer, laser, colour, per kg | Cut-off, U

Table 3 Corresponding dataset for paper printing

Data expressed according to the functional unit

The kilograms of printed paper expressed according to the functional unit are 1.39 kg.

5.1.3 Meals

Available data

The study includes data about meals served during two collateral events (VIP Lounge and Pasta Party), specific data are available for the number of meals served according by type (*Table 4*) and the kind of food served. A major part of the food was sourced locally and travelled on average 50 km from the production site to the event's location. For the Pasta Party local Felicetti Pasta, an apple and a dessert from Alto Adige were served. The tableware provided is a recyclable cardboard tray with recyclable wooden cutlery. As far as VIP Lounge is concerned, solely local products of Alto Adige were served.

Type of event	Number of meals
VIP Lounge	130
Pasta Party	1,465

Table 4 Data about the number of meals served

Assumptions

No specific data about the quantity of each kind of food served and the emissions due to their production were available. Two studies were found about the GHG emissions of meals which are "*Studio di valutazione degli impatti ambientali derivanti dalla gestione di servizi scolastici*"[22] and "*Valutazione degli impatti ambientali nelle principali fasi del servizio delle mense scolastiche del Comune di Torino*"[23]. However, only the first study provides an emission value about meals, even though it regards a school canteen, this value was considered valid since no other data were found. For both collateral events the same emission factor per meal was taken even though different kind of food were served.

Data expressed according to the functional unit

The number of meals expressed according to the functional unit is 0.69 meals.

[22] *Studio di valutazione degli impatti ambientali derivanti dalla gestione di servizi scolastici, Arpa Emilia Romagn*a, 31 May 2004
[23] *Valutazione degli impatti ambientali nelle principali fasi del servizio delle mense scolastiche del Comune di Torino, A. Cerutti et al., Università degli Studi di Torino*, 31 March 2015

5.1.4 Beverages

Available data

Specific data for beverage consumption by type are available (*Table 5*), information about the type of container/packaging were provided as well. During Pasta party: water was provided in glass carafes, while during VIP Lounge only beverages in glass bottles from a local supplier were served.

Type of beverage	Additional information	Quantity considered	Unit of measure
Draft beer		360	l
Bottled beer	Weizen	288	l
	Other	39.6	l
Alcohol-free beer		1,113	l
Champagne		22.5	l
Coffee		12	l
Fruit juice		875	l
Soft drinks	Coca-Cola	1,579.20	l
	Iced tea	110.88	l
	Lemonade	10	l
Water	VIP Lounge (glass bottles)	150	l
	Pasta Party (carafe)	750	l
	Arrival (tap water)	1,000	l
Wine		63	l

Table 5 Data about the quantity and type of beverages served

Assumptions

Generic data from Ecoinvent database and literature were used to estimate the emissions due to the production of the served beverages according to the following specific assumptions:

- Iced tea was assumed as San Benedetto water in PET 0.5 l bottles;
- No data on emissions from the production of alcohol-free beer were available, therefore, it was assimilated to the production of normal beer in 33 cl bottles;
- Draft beer was assumed to be contained in steel drums of 25 litres each;
- Coffee emissions were estimated for a cup of coffee of 110 ml prepared with a full automat machine;
- Fruit juice was assumed to be apple juice contained in steel drums of 200 kg each and 1 kg of juice is assumed to be equal to 1 litre;
- Wine was assumed as Prosecco;
- Data about Champagne GHG emissions were not available, therefore the value taken into consideration is an average between the one of Prosecco wine and the one reported in the study "Analisi del ciclo di vita della produzione di vino di Ca'Avignone"[24];
- The water provided in glass bottle was assumed to be Ferrarelle since an EPD for this type of water is available;
- Data about lemonade GHG emissions were not available, therefore it was assumed to have the same value as Coca-Cola since both are soft carbonated drinks;
- Water served at the Pasta Party and at the arrival of the marathon was assumed to be tap water.

[24] *Analisi del ciclo di vita della produzione di vino di Ca'Avignone*, E. Neri e R. M. Pulselli, 7 December 2020

The sources of the various emission factors taken into consideration are explained in the table below (*Table 6*):

Type of beverage	Corresponding dataset or study
Draft beer	EPD birra Carlsberg e Tuborg[25]
Bottled beer	EPD birra birrificio Angelo Poretti 4 luppoli originale[26]
Champagne	Mean value between the following studies: Analisi del ciclo di vita della produzione di vino di Ca'Avignone and EPD Ius Naturae Valdobbiadene Prosecco Superiore D.O.C.G. Brut Millesimato
Coffee	Life cycle assessment (LCA) of a lungo cup of coffee made from a Nespresso original capsule compared with other coffee systems in Europe[27]
Fruit juice	EPD cloudy apple juice NFC[28] (VOG products)
Coca-Cola	Life cycle environmental impacts of carbonated soft drinks[29]
Iced tea	EPD acqua minerale naturale oligominerale San Benedetto[30]
Lemonade	Life cycle environmental impacts of carbonated soft drinks[31]
Water (glass bottles)	EPD dell'acqua minerale Ferrarelle[32]
Water (tap water)	Tap water {Europe without Switzerland}| market for | Cut-off, U

[25] *Dichiarazione ambientale di prodotto (EPD) Birra Carlsberg® e Tuborg®*, Registration number: S-EP-00264, date of approval: 31/12/2010
[26] *Dichiarazione ambientale di prodotto (EPD) convalidata birra birrificio Angelo Poretti 4 luppoli originale®*, Registration number: S-P-00313, date of approval: 13/02/2020
[27] *Life cycle assessment (LCA) of a lungo cup of coffee made from a Nespresso original capsule compared with other coffee systems in Europe*, Quantis
[28] *Environmental product declaration (EPD) Cloudy apple Juice NFC*, Registration number: S-P-02384, date of revision: 08/02/2022
[29] *Life cycle environmental impacts of carbonated soft drinks*, D. Amienyo et al., date of publication: 03/07/2012
[30] *Environmental Product Declaration Acqua Minerale Naturale Oligominerale San Benedetto In 0,5 l, 1,5 l, 2,0 l PET bottles*, Registration number: S-P-00212, date of publication: 27/01/2010
[31] Refer to note number 19
[32] *Dichiarazione ambientale di prodotto dell'acqua minerale Ferrarelle*, Registration number: S-P-00281, date of publication: 26/05/2011

Wine	EPD Ius Naturae Valdobbiadene Prosecco Superiore D.O.C.G. Brut Millesimato[33]

Table 6 Corresponding dataset or study for the beverages

Data expressed according to the functional unit

The litres of different beverages expressed according to the functional unit are shown in *Table 7*.

Type of beverage	Litres
Draft beer	0.15
Bottled beer	0.61
Champagne	0.01
Coffee	0.01
Fruit juice	0.37
Coca-Cola	0.67
Iced tea	0.05
Lemonade	0.004
Water (glass bottles)	0.06
Water (tap water)	0.32
Water (tap water)	0.43
Wine	0.03

Table 7 Litres of each type of beverage expressed through the functional unit

[33] *Environmental product declaration (EPD) Ius Naturae Valdobbiadene Prosecco Superiore D.O.C.G. Brut Millesimato*, Registration number S-P-03412, date of publication: 01/04/2021

5.2 Core (event)

This phase comprehends all activities carried out during the event. As far as cleaning activities and especially cleaning products are concerned, their respective impacts were not counted due to lack of inventory data.

5.2.1 Freight transport

Available data

In this category, the transport of freight was calculated. In particular the freight included stage, tents, cars, stands and banners, sound, barriers, big screens, prizes, food and beverages, gadgets and lanyards.

The freight transportation data were catalogued according to type of transport and type of vehicle used (*Table 8*).

Specific data were available about distance travelled by type of vehicle, weight transported and place of origin.

Type of transport	Type of vehicle	km	kg	kgkm[34]
Road transport	Van < 3.5 t	5,062	8,272	41,872,864
	Van 3.5 t	4,503	3,106	13,983,166
	Truck 7.5 – 16 t	1,076	9,660	10,394,160
	Truck 16 – 32 t	660	15,800	10,428,000
Sea transport	Ship	34,317	1,100	37,748,799

Table 8 Data about freight transport

Assumptions

The quantification of the freight transport was mainly based on two pieces of information. The first was the indication regarding the distance travelled by each transport mode and

[34] Unit of measure used in the Ecoinvent database to model the transport of goods.

vehicle type. The other information was about the transported weight; in this way, it was possible to calculate the kgkm transported by every vehicle type, as displayed above, each vehicle was associated to a specific process in a dataset from which specific emission factors were sourced (*Table 9*).

Information about the place of origin of some items are generic (at country level) and assumptions (at city level) were made to calculate the amount of km travelled by ship and by truck. An example of the assumptions made is the fact that goods coming from China, for which no specific cities of origin were available, were assumed to come from Shanghai.

Type of transport	Type of vehicle	kgkm	Corresponding dataset
Road transport	Van < 3.5 t	41,872,864	*Transport, freight, light commercial vehicle {Europe without Switzerland}| market for transport, freight, light commercial vehicle | Cut-off, U*
	Van 3.5 t	13,983,166	*Transport, freight, lorry 3.5-7.5 metric ton, EURO5 {RER}| transport, freight, lorry 3.5-7.5 metric ton, EURO5 | Cut-off, U*
	Truck 7.5 – 16 t	10,394,160	*Transport, freight, lorry 7.5-16 metric ton, EURO5 {RER}| transport, freight, lorry 7.5-16*
	Truck 16 – 32 t	10,428,000	*Transport, freight, lorry 16-32 metric ton, EURO5 {RER}| transport, freight, lorry 16-32*
Sea transport	Ship	37,748,799	*Transport, freight, sea, container ship {GLO}| transport, freight, sea, container ship | Cut-off,*

Table 9 Elaborated data and corresponding dataset for freight transport

Data expressed according to the functional unit

The number of kgkm for freight transport expressed according to the functional unit is contained in *Table 10*:

Type of vehicle	kgkm
Van < 3.5 t	17,864
Van 3.5 t	5,966
Truck 7.5 - 16 t	4,434
Truck 16 -12 t	4,449
Ship	16,104

Table 10 kgkm for each vehicle category according to the FU

5.2.2 Accommodation of attendees

Available data

The accommodation data taken into consideration comprehend the days between June 15th and June 20th. Specific data about the number of overnight stays according to accommodation type were available, however, not all people staying overnight might have attended the event. The number of people per night was estimated (by Hero) starting from the total amount of people who stayed overnight in Selva di Val Gardena during the days of the event which is 17,359.

According to the average number from previous years, 70% of the total number of overnight stays was assumed to be linked to the event which is equal to 12,188 and it was subdivided as shown in the table below (*Table 11*).

Accommodation type	Number of overnight stays
Camping	484
5 stars hotel	387

4 stars hotel	2,924
3 stars hotel	3,276
2 stars hotel	289
B&B	1,993
Apartment	2,834

Table 11 Number of overnight stays according to accommodation type

Assumptions

Accommodation number for camping nights was calculated starting from the assumption of an average occupancy of 3 people per camper; 5 and 4 stars hotels were considered luxury hotels; while 3 and 2 star hotels, B&B and apartments were assumed as budget hotels since no specific data were available on emissions of B&Bs and apartments.

Data taken into consideration for the hotels, B&Bs and apartments come from the dataset referred to Perù[35], however, data about tap water, electrical energy and building materials were substituted with the Italian reference data if available.

For camping data, the study "Reviewing the carbon footprint analysis of hotels: Life Cycle Energy Analysis (LCEA) as a holistic method for carbon impact appraisal of tourist accommodation"[36] was used. To obtain the emission factor for camping, an average was calculated between the value 4 kg CO_2 e per guestnight[37] for New Zealand and the value 7.9 kg CO_2 e per guestnight for UK, the result is 5.95 kg CO_2 e per guestnight. The source of the emission factors for each type of accommodation are displayed in *Table 12*.

[35] Ecoinvent 3.8
[36] *Reviewing the carbon footprint analysis of hotels: Life Cycle Energy Analysis (LCEA) as a holistic method for carbon impact appraisal of tourist accommodation*, V. Filimonau et al., November 2011
[37] The unit of measure used in the Ecoinvent database to model the number of overnight stays for a certain accommodation type.

Accommodation type	Corresponding dataset or study
Camping	Reviewing the carbon footprint analysis of hotels: Life Cycle Energy Analysis (LCEA) as a holistic method for carbon impact appraisal of tourist accommodation
5 and 4 stars hotel	Building operation, luxury hotel {PE}| building operation, luxury hotel | Cut-off, U - ITALIA
3 and 2 stars hotel, B&B and apartment	Building operation, budget hotel {PE}| building operation, budget hotel | Cut-off, U - ITALIA

Table 12 Corresponding dataset or study per accommodation type

Data expressed according to the functional unit

The number of overnight stays for each accommodation type expressed according to the functional unit is contained in *Table 13*.

Type of accommodation	Overnight stays
Camping	0.21
5 stars hotel	0.17
4 stars hotel	1.25
3 stars hotel	1.40
2 stars hotel	0.12
B&B	0.85
Apartment	1.21

Table 13 Number of overnight stays according to the FU

5.2.3 Accommodation of staff

Available data

The accommodation data for the staff involved in the event comprehend the days between the 16th and the 19th of June. Specific data are available for the number of people staying overnight and the number of total guests per night for the days considered. In addition, the total number of overnight stays is 60 (23 people for an average overnight stay of 2.6 days) and the type of accommodation is a 3 stars hotel.

Assumptions

For the emission factor of the 3 stars hotel, the same modified dataset used for attendees' hotels was taken into account, which is "*Building operation, budget hotel {PE}| building operation, budget hotel | Cut-off, U – ITALIA*".

Data expressed according to the functional unit

The number of staff members who stayed overnight expressed according to the functional unit is 0.03.

5.2.4 Live broadcast

Available data

Live broadcast data comprehend data about distance travelled during the event as well as distance travelled to reach the venue of the event by staff such as speakers and DJs according to vehicle type (*Table 14*).

Type of vehicle	Quantity	Unit of measure
Motorcycle	344	km
Quad	146	km

Van < 3.5 t	2,614	km
Truck 7.5 – 16 t	231	km
Helicopter	2	hour
Airplane	1,378	km

Table 14 Data about distance travelled by type of vehicle

Assumptions

Data about quad emissions are not available in the Ecoinvent database, therefore, it was assumed that its emissions are equal to the once of motorcycles since both travel around 10-12 km per litre of fuel. However, neither motorcycle nor quad emission factors are available in the Ecoinvent database and therefore both were modelled through the motor scooter database. *Table 15* shows the corresponding dataset for each vehicle type used during the live broadcasting activity.

Type of vehicle	Corresponding dataset
Motorcycle	Transport, passenger, motor scooter {RoW}| processing | Cut-off, U
Quad	Transport, passenger, motor scooter {RoW}| processing | Cut-off, U
Van < 3.5 t	Transport, freight, light commercial vehicle {Europe without Switzerland}| market for transport, freight, light commercial vehicle | Cut-off, U
Truck 7.5 – 16 t	Transport, freight, lorry 7.5-16 metric ton, EURO5 {RER}| transport, freight, lorry 7.5-16 metric ton, EURO5 | Cut-off, U
Helicopter	Transport, helicopter {GLO}| processing | Cut-off, U
Airplane	Transport, passenger aircraft, long haul {GLO}| transport, passenger aircraft, long haul | Cut-off, U

Table 15 Corresponding dataset for each vehicle type

Data expressed according to the functional unit

The distance travelled by each vehicle type expressed according to the functional unit is displayed in Table 16.

Type of vehicle	Inputs and outputs for reference flow
Motorcycle	0.15 pkm [38]
Quad	0.06 pkm
Van < 3.5 t	1.12 km
Truck 7.5 – 16 t	0.10 km
Helicopter	0.001 h
Airplane	0.59 km

Table 16 Data about distance travelled by each vehicle type according to the FU

5.2.5 Travel of staff (round trip)

Available data

The study takes into consideration the travel by car from the place of origin of the staff to the event's venue and vice versa. *Table 17* shows the input data considered for quantification of the carbon footprint of staff travel.

Distance travelled (one way)	Number of people
< 50 km	360
150 – 500 km	40

Table 17 Input data about staff travel

[38] The unit of measure in the Ecoinvent database to model the distance travelled by motorcycles and quads (passenger per km). The specific emission factor varies according to the number of km travelled and the number of people using the vehicle.

Assumptions

Collected data from the organisation provide accurate figures about the number of staff traveling but are not specific about the distance travelled and the type of vehicle thus assumptions were made in order to estimate GHG emissions.

It was assumed that half of the people traveling less than 50 km one way (180 people) were traveling by car, 25 km from their houses to the event's venue and 25 km return trip each of the four days of duration of the event. However, since it is probable that they know each other, it was assumed that the average occupancy was 4 people per car.

As far as the other 180 people were concerned, it was assumed that they live very close to the event's venue and thus their transport is negligible.

Staff members (40 people) traveling for an average distance of 325 km one way (from the house to the event) were assumed to travel by car, each using his/her own car. At the end of the event, they were assumed to travel back to their original location for the same distance and with the same vehicle.

The type of car used was assumed to be a medium size EURO 4 diesel powered as displayed in *Table 18*.

Average distance travelled (km)	Total km	Corresponding dataset
25	9,000	*Transport, passenger car, medium size, diesel, EURO 4 {RER}| transport, passenger car, medium size, diesel, EURO 4 | Cut-off, U*
325	26,000	

Table 18 Corresponding dataset for staff travel

Data expressed according to the functional unit

The number of km travelled by the staff members expressed according to the functional unit is 14.9 km.

5.2.6 Travel of attendees

Available data

The study takes into consideration the travel by type of vehicle from the place of origin of the attendees to the event's venue and vice versa (*Table 19*).

Distance travelled one way (km)	Number of attendees	Type of vehicle
< 50	127	car
50 – 150	28	car
150 – 500	1,334	car
500 – 1500	581	car
>1500	274	airplane

Table 19 Data about attendees' travel

Assumptions

Collected data from the organisation provide accurate figures about the number of attendees travelling but are not specific about the distance travelled and the type of vehicle thus assumptions were made in order to estimate GHG emissions.

It was assumed that people traveling an average distance under 1,500 km one way came by car (one person per car) and an average distance was estimated starting from the collected data. Attendees traveling for an average distance one way of more than 1,500 km were assumed to take the airplane and the distance travelled is an average between 1,500 and 4,000 km (2750 km) one way.

The type of car used was assumed to be a medium size EURO 4 diesel powered; the corresponding dataset for each type of vehicle is contained in *Table 20*.

The total number of km travelled was calculated multiplying the average distance and the number of people traveling that distance, the number was subsequently doubled to consider the return trip as well. It was assumed that each attendee reached the location with his own car. The return trip of attendees was assumed to have the same distance and vehicle type as the trip to reach the event's venue.

<table>
<tr><th>Average distance travelled one way (km)</th><th>Total km</th><th>Corresponding dataset</th></tr>
<tr><td>25</td><td>6,350</td><td rowspan="4">Transport, passenger car, medium size, diesel, EURO 4 {RER}| transport, passenger car, medium size, diesel, EURO 4 | Cut-off, U</td></tr>
<tr><td>100</td><td>5,600</td></tr>
<tr><td>325</td><td>867,100</td></tr>
<tr><td>1,000</td><td>1,162,000</td></tr>
<tr><td>2,750</td><td>1,507,000</td><td>Transport, passenger aircraft, medium haul {GLO}| transport, passenger aircraft, medium haul | Cut-off, U</td></tr>
</table>

Table 20 Corresponding dataset for each vehicle type

Data expressed according to the functional unit

The distance travelled by attendees expressed according to the functional unit is equal to 871 km by car and 643 pkm[39] by airplane.

5.2.7 Electrical energy

Available data

Data about electrical energy consumption were collected by the organisation, however, electricity was provided by the municipality. The amount of energy used for the event is equal to 400 kWh.

[39] The unit of measure used in the Ecoinvent database to model the distance travelled by airplane (passenger per km). The specific emission factor varies according to the number of km travelled and the number of passengers on the airplane.

Assumptions

The total consumption of electrical energy is based on the power requirement of each equipment used and its percentage of use (*Table 21*).

Type of equipment	Required power (kW)	Percentage of use	Actual required power (kW)
Sound	10.5	50%	5.25
Lights	19.8	70%	13.86
Video	13.6	100%	13.6
Director	4	100%	4
Total	**47.9**		**36.71**

Table 21 Data about electrical energy consumption

Knowing that the total energy consumption is equal to 400 kWh and considering the actual power requirements (36.71 kW), it was estimated an average use of 11 hours of the whole equipment which is consistent with two after dinner activities and a few tests.

The dataset used to calculate the emission factors of electrical energy is "Electricity, medium voltage {IT}| market for | Cut-off, U - RESIDUAL MIX".

Data expressed according to the functional unit

The amount of kWh consumed expressed according to the functional unit is equal to 0.17 kWh.

5.3 Downstream (post-event)

5.3.1 Freight return

Available data

At the end of the event part of the freight was transported back to its original location. Freight such as prizes, food and beverages, gadgets and lanyards were not considered for the return trip.

Assumptions

The return trip of freight was assumed to have the same distance and vehicle type as the trip to reach the event's venue. In this phase the same assumptions made for the travel of freight to the event have to be taken into consideration (see chapter 5.2.1).

The categories of freight assumed for the return trip are tents, stage, stands and banners, sound, teams, physiotherapists and barriers.

Data expressed according to the functional unit

Data regarding freight transport (return trip) by each type of vehicle expressed according to the functional unit are displayed in the following table (*Table 22*).

Type of vehicle	kgkm
Van < 3.5 t	7,186
Van 3.5 t	3,055
Truck 7.5 – 16 t	251
Truck 16 – 32 t	4378

Table 22 kgkm for each vehicle type expressed according to the FU

5.3.2 Waste materials

Available data

This category comprehends waste materials produced during the event activities throughout its duration. Specific data were available about the quantity generated according to waste type. The amount of compost generated is equal to 480 litres while the amount of rubber and plastic is 1,720 kg.

Assumptions

Data about the quantity of compost produced were expressed in litres, therefore, an average density of compost from food waste of 0.4 kg/l[40] was assumed to convert to kg.

For plastic and rubber wastes, only the emissions arising from the transport from the event's venue to the disposal site were considered and not the emissions generated from the waste treatment.

Assumptions were made to estimate the average distance travelled by trucks to move waste materials from the venue of the event to the disposal site which is equal to 32 km. The number of km comes from the average distance between the three waste collection sites of the main waste management company of the area (Chiocchetti Luigi Srl) and the event's venue. *Table 23* contains the corresponding dataset and the amount considered according to waste type, the transport of compost was considered negligible.

Type of waste	Quantity considered	Corresponding dataset
Compost	192 kg	Biowaste {RoW}| treatment of biowaste, industrial composting | Cut-off, U
Plastic and rubber	40,640 kgkm	Municipal waste collection service by 21 metric ton lorry {RoW}| processing | Cut-off, U

Table 23 Corresponding dataset for waste materials

Data expressed according to the functional unit

The amount of waste produced during the event expressed according to the functional unit is equal to 0.08 kg for compost and 17.34 kgkm for transport of plastic and rubber.

[40] https://www.isprambiente.gov.it/contentfiles/00003500/3526-manuali-2002-07.pdf

6. Impact assessment

6.1 Method

The software SimaPro Developer 9.3.0.2 was used for the study to analyse the impact of global warming: "IPCC 2021 GWP 100", version 1.0 with the GWP (Global Warming Potential) values updated to the sixth IPCC report of 2021.
The method is adapted to the specific requirements of ISO 14067 in order to calculate fossil and biogenic emissions and removals and land use change.

6.2 Total CFP

The total CFP of the Hero Dolomites event, according to the description provided in the previous chapters, is equal to **498.22 kg CO_2e/FU** and **1,167,837 kg CO_2e/DU**, where the functional unit is 1 attendee, while the declared unit is the whole event, as previously stated.

7. Interpretation

7.1 Analysis and results interpretation

The following tables and charts display the results of the CFP for the case study. *Table 24* contains the total CFP expressed in kg CO_2e according to the declared and functional unit and the percentage for each activity in the three phases of the event.

As anticipated in the previous chapter, the CFP is equal to 498.22 kg CO_2e/FU and 1,167,837 kg CO_2e/DU.

Category	Total CFP (kg CO_2e/DU)	Total CFP (kg CO_2e/FU)	% CFP
Organisers' transport	124	0.05	0.01%
Printing	6,582	2.81	0.56%
Meals	1,577	0.67	0.14%
Beverages	3,819	1.63	0.33%
Freight transport	88,275	37.66	7.56%
Staff accommodation	1,184	0.51	0.10%
Attendees' accommodation	235,694	100.55	20.18%
Live broadcast	394	0.17	0.03%
Attendees' transport	782,701	333.92	67.02%
Staff transport	10,840	4.62	0.93%
Electrical energy	205	0.09	0.02%
Freight return	36,379	15.52	3.12%
Waste	63	0.03	0.01%
Total	**1,167,837**	**498.22**	**100%**

Table 24 Amount of CO_2e emitted for each category in the life cycle phases considered according to FU, DU and in %. The blue colour defines the activities carried out during the pre-event, the orange one the activities carried out during the event and the green one the post-event activities

The detailed analysis of the results is reported below.

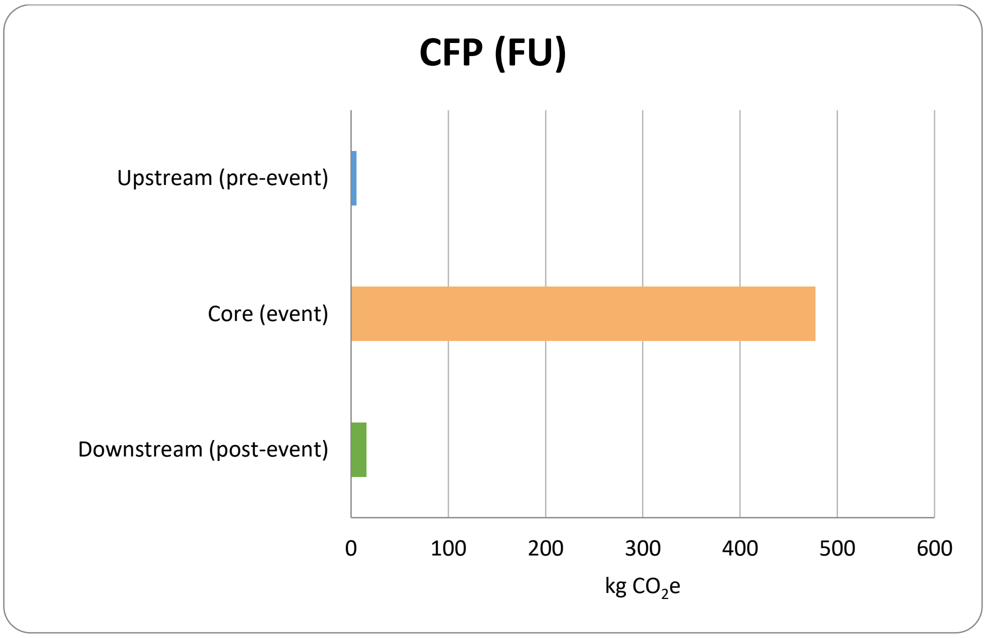

Figure 5 Amount of CO_2e generated during each event phase

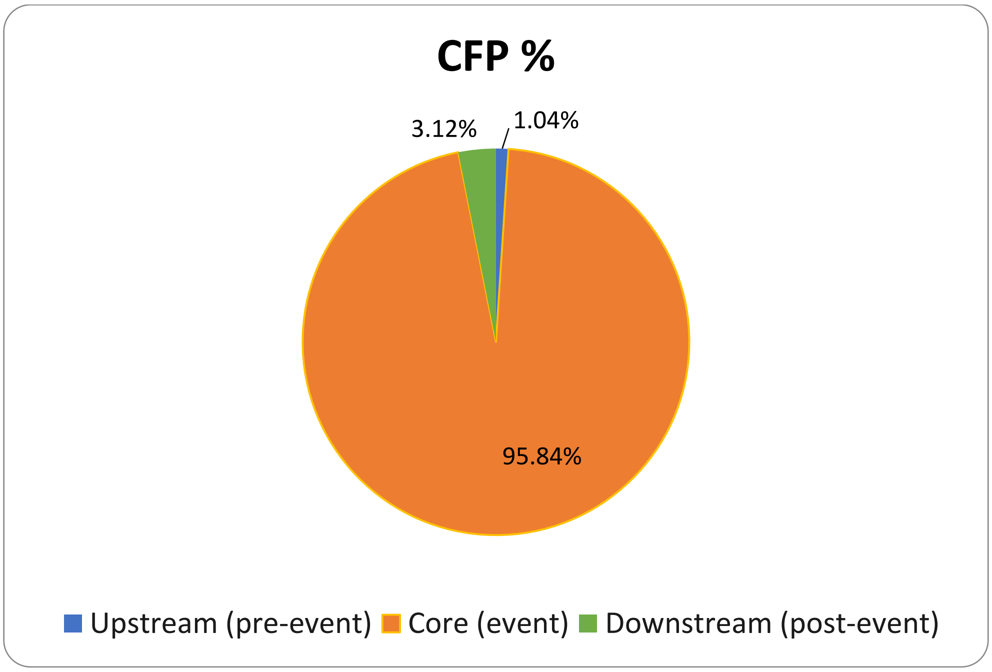

Figure 6 Percentage of the total CF arising from each event phase

Core (event) activities generate around 480 kg CO_2e per attendee according to functional unit, which is equal to 95.8% of the total CO_2e generated by the event. Downstream (post-event) activities generate around 16 kg CO_2e per attendee equal to 3.1%, while upstream (pre-event) activities generate 5 kg CO_2e, equal to 1%. Both upstream and downstream impacts are very low compared to the one of the core phase (*Figures 5 and 6*).

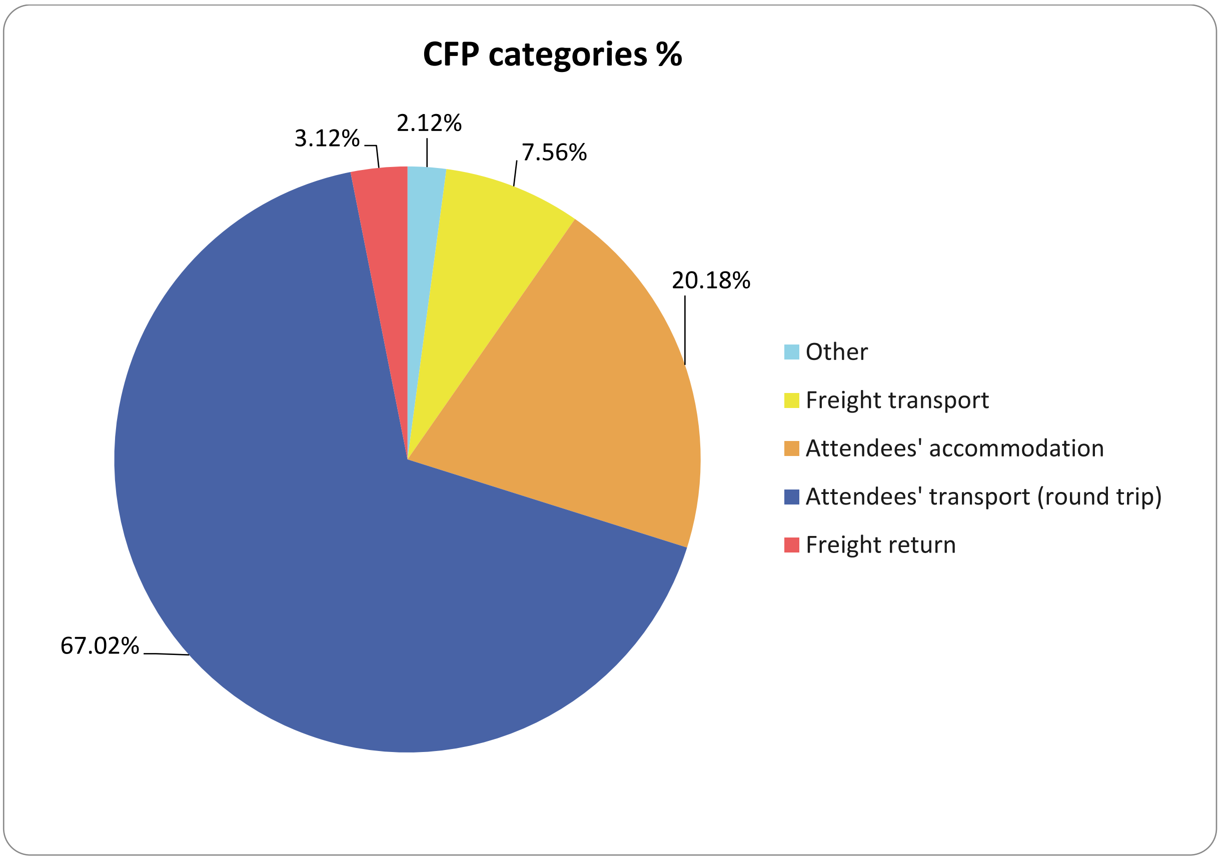

Figure 7 Percentage of the total CF according to the activity carried out

The chart above (*Figure 7*) shows the percentage contribution of category considered during upstream (pre-event), core (event) and downstream (post-event) phases. As stated before, it is immediately clear that two thirds of the total CFP are due to the transport of attendees to and from the event (around 70%). Another important category is attendees' accommodation which contributes to the total impact with 20% of GHG emissions. Considering the number of guests per night (12,188) this result is quite understandable.

Freight transport is also relevant as it generates the third largest impact (8%).

Each phase of the considered life cycle was analysed. A detailed description according to the functional unit is displayed below.

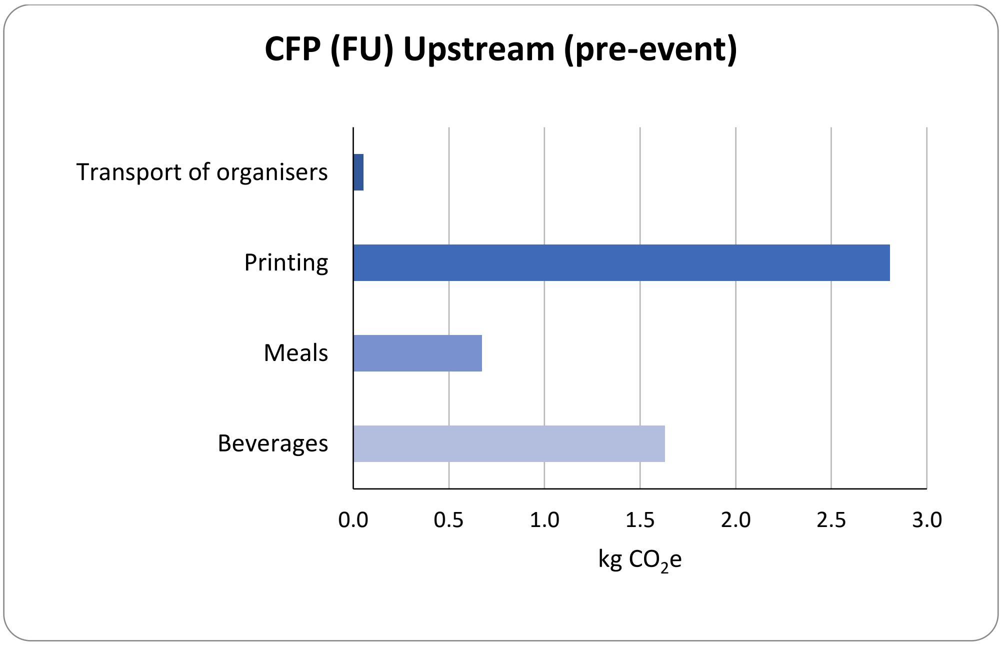

Figure 8 Amount of CO_2e arising from the activities included in the pre-event phase

Taking into consideration only the upstream (pre-event) activities, printing is far more impactful than the others.

While developing emissions reduction plans for future editions of the event, decreasing the amount of printed paper should be taken into consideration even though it impacts for only 0.56% of the total event's emissions as displayed in *Figure 8*.

As anticipated, core (event) activities generate the major impact and among those, attendees' transport and accommodation as well as freight transport are the emissions hotspots. More specifically, GHG emissions per attendee are around 334 kg CO_2e for the transport from the original location to the event's venue, 100 kg CO_2e for the accommodation and 38 kg CO_2e for freight transport (*Figure 9*).

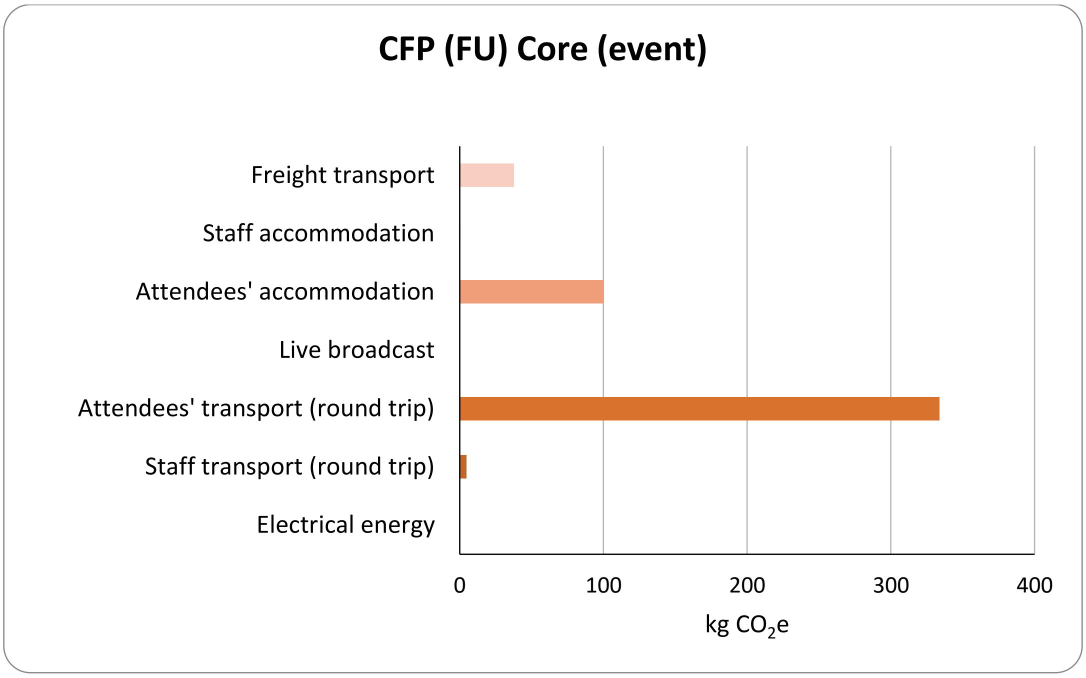

Figure 9 Amount of CO_2e arising from the activities included in the event phase

In the downstream (post-event) phase, the most relevant activity is freight's return trip, which is responsible of around 16 CO_2e per attendee (*Figure 10*).

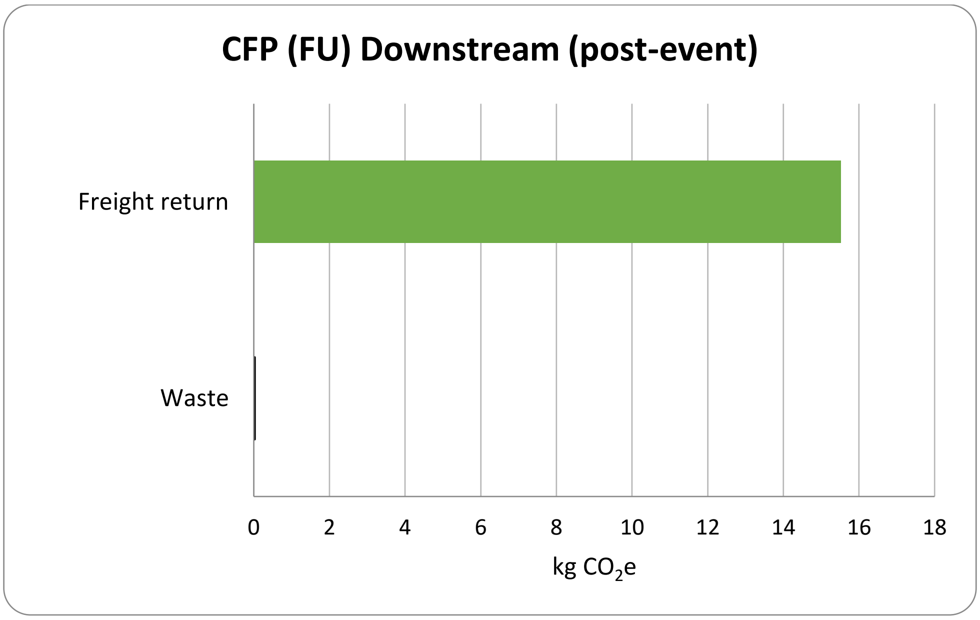

Figure 10 Amount of CO_2e arising from the activities included in the post-event phase

Overall, as shown in *Figure 11*, transports play a fundamental role in the CFP of the event. In particular, the transport of attendees to and from the event, freight transport and freight return generate a considerable amount of GHG emissions.

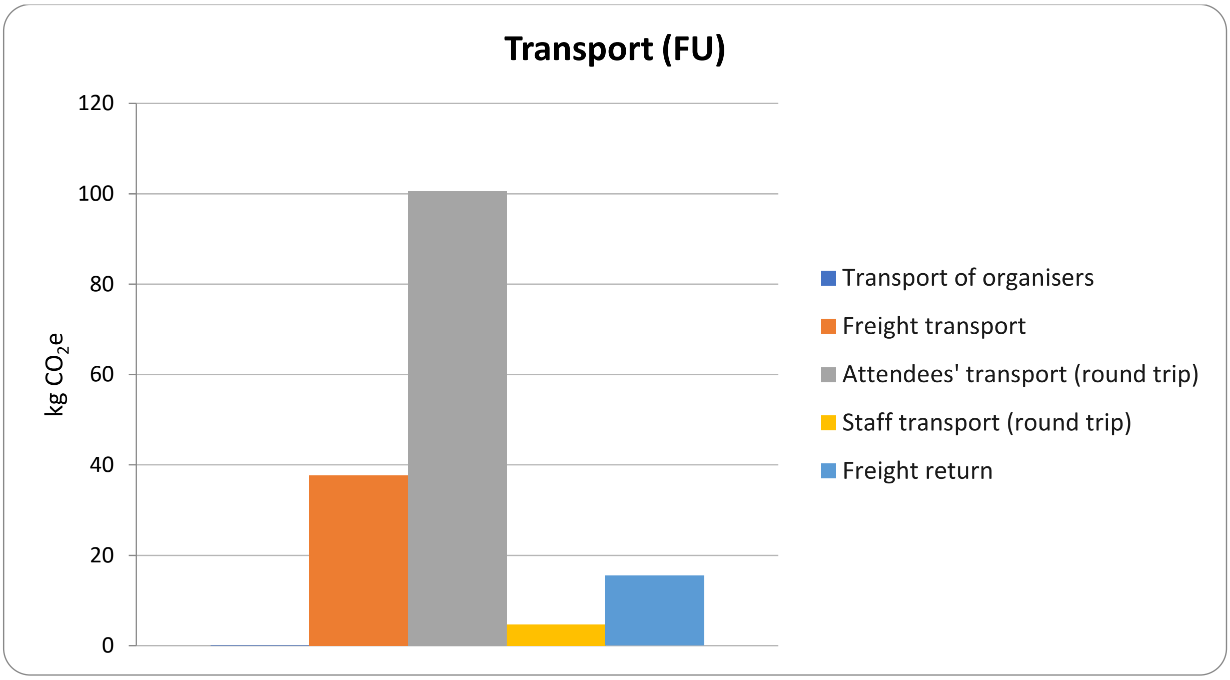

Figure 11 Amount of CO_2e generated by the transport

As already reported in *Figure 7*, the most impactful categories are attendees' travel and accommodation and freight transport, which are further discussed in the following paragraphs, through *Figures 12, 13 and 14*.

Among all vehicles used and distance ranges travelled, the main impacts derive from long distance travels by car (325 and 1000 km) and airplane travels, as shown in *Figure 12*.

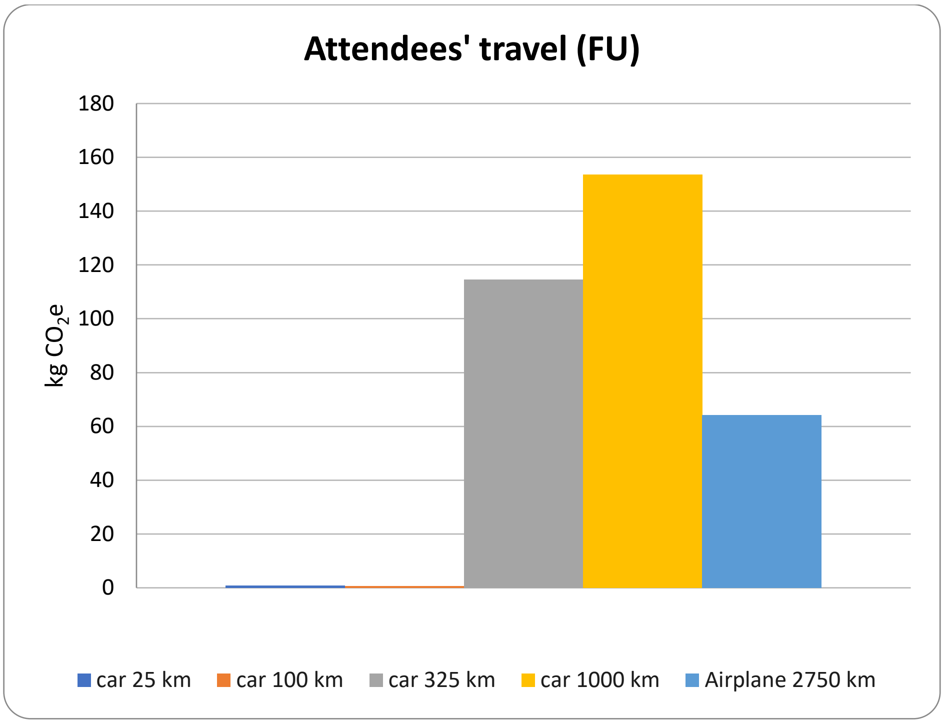

Figure 12 Amount of CO_2e generated by the attendees' travel

Among all types of accommodation considered, 4 and 3 stars hotels as well as B&Bs and apartments are responsible for the majority of the impacts as displayed in *Figure13*.

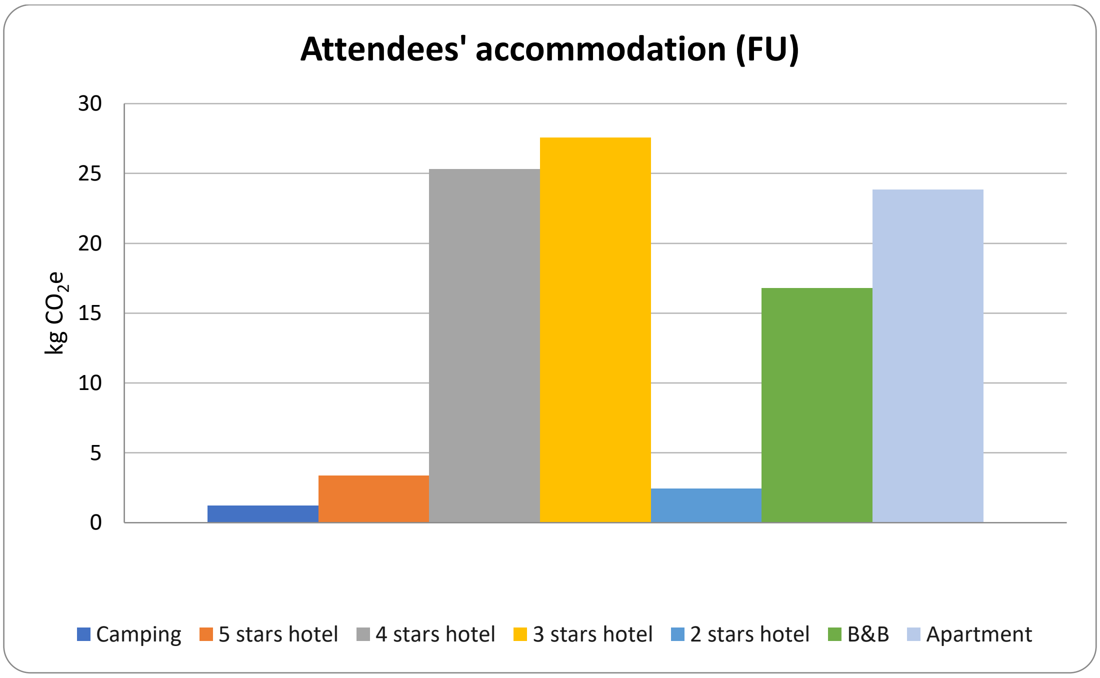

Figure 13 Amount of CO_2e generated by the attendee's accommodation

Freight transport is also important when accounting the carbon footprint of the event, in particular, the chart shows that the vast majority of goods are transported through a van weighting less than 3.5 tons which is the most impactful vehicle among all vehicles considered (see *Figure 14*).

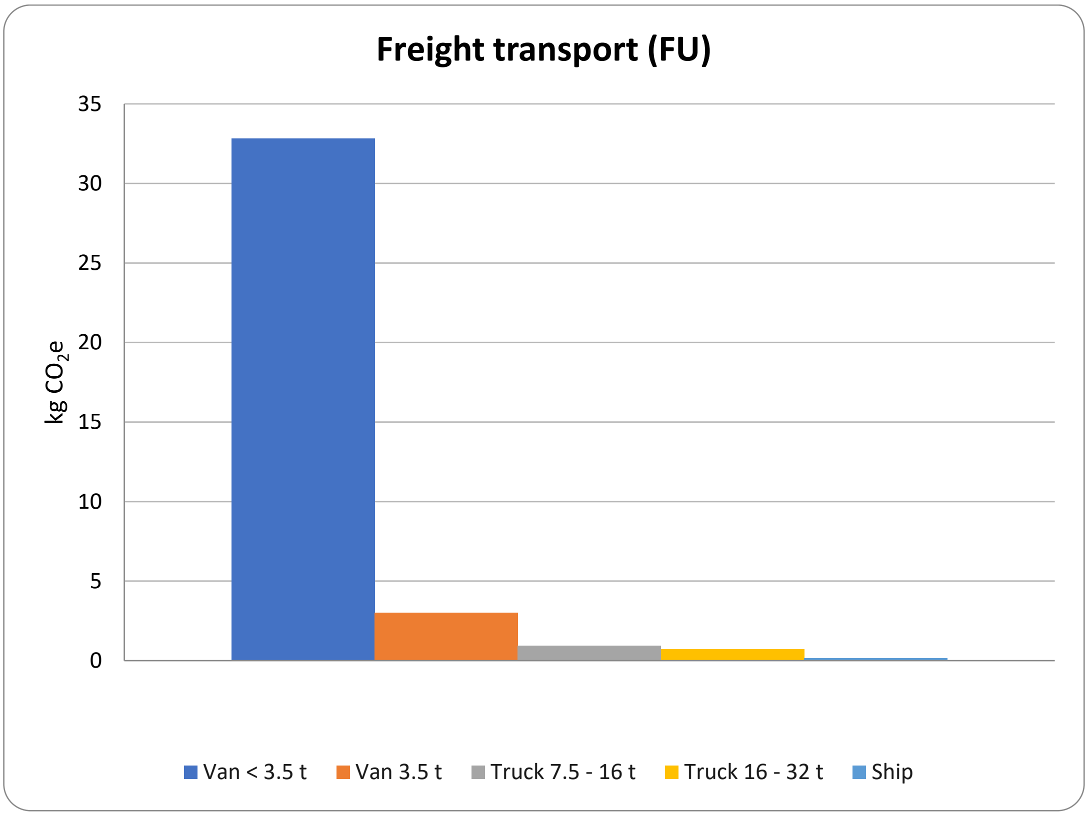

Figure 14 Amount of CO_2e generated by the freight transport

While considering only the activities under the direct control of the organisers, which are reported in *Table 25*, the emissions are pretty low, as equal to only 2.12% of the total.

Category	Total CFP (kg CO_2e/DU)	Total CFP (kg CO_2e/FU)	% CFP
Organisers' transport	124	0.05	0.01%
Printing	6,582	2.81	0.56%
Meals	1,577	0.67	0.14%
Beverages	3,819	1.63	0.33%
Staff accommodation	1,184	0.51	0.10%
Live broadcast	394	0.17	0.03%
Staff transport	10,840	4.62	0.93%
Electrical energy	205	0.09	0.02%
Waste	63	0.03	0.01%
Total	24,787	10.57	2.12%

Table 25 Amount of CO_2e emitted for each category of the main event (race) considered according to FU, DU and %, the colour blue defines the activities carried out during the pre-event, orange for the activities carried out during the event and green for the post

It is, therefore, clear that the event itself has a very low environmental impact, in fact, the great majority of the impact is linked to indirect activities generated by the people attending the event.

8. Conclusions

8.1 CFP Conclusions

The calculation of the CFP of the event Hero Dolomites allowed to analyse impacts due to the organisation and management of the event and to identify a baseline for future emissions monitoring and reduction plans as requested by S4CA. The largest impacts were generated during the event and post-event phases; hotspots of emissions were attendees' travel and accommodation and freight transport which were not directly under the organisation's control.

The CFP study allowed us to identify weaknesses in the quality of the data collected for the present event in order to develop strategies to acquire high quality data for future impact assessments; sure enough, the study showed that the phases responsible for the greatest impacts were linked to phases characterised by data of low quality.

The Hero Dolomites study helped prove that the correct approach for the carbon footprint calculation of events is the approach of product rather than the approach of organisation since it better describes the contribution of activities in pre-event, event and post-event thanks to the use of the life cycle assessment methodology embedded into the ISO 14067 standard. By considering the event as a product, the hotspots of GHG emissions are more easily identifiable and specific reduction plans can be developed.

In addition, CFP approach does not require a comparison with a baseline year which constitutes a major issue for multiannual evens. It considers the entire lifecycle of the event whether it lasts a few days or a few years. Another fundamental characteristic of CFP approach is the definition of a functional unit and a declared unit, which enables comparison between events of different size and duration.

The Hero Dolomites study also enabled us to create a PCR (Product Category Rule) which will become a public and international reference for the calculation of environmental impacts of events.

Moreover, this CFP study set up reference values of emissions for each studied material/process and identified hotspots of GHG emissions which will be the issues to focus on during the organisation of future events on the way to carbon neutrality.

8.2 Recommendations

Particular attention and care have to be used by the organisation while collecting specific data since data quality has a huge influence on the precision and accuracy of the CFP study. Careful assessment of the data categories requested for the study should be scheduled to identify the best solutions to collect those data. The organisation should pay as much attention while collecting data about their direct impacts such as paper printing as while collecting data about indirect impacts such as accommodation and transport of attendees.

The organisation has collected high quality data about their activities and the activities of their supply chain, however, an improvement in the quality of data from activities which are not directly under their control is recommended. Data quality should be improved, especially about attendees and staff travel as well as accommodation.

In fact, these activities are the first issue to address. It is clear that it might be a difficult task, however, emission reduction plans should contain strategies to encourage attendees to travel by public transport, carpooling or combined travel modes instead of using cars especially for long distances. Travel information should include specific data about place of origin, vehicle type (and type of fuel if relevant) and occupancy of the vehicle (if relevant).

For accommodation, the organisation might ask to hotel and camping operators to collect information about the purpose of their stay to guests checking in during the event period. The aim is to gather more precise data about the number of people attending the event, especially those who will not take part in the race.

Hero has already improved the quality of data collected for the 2023 edition of the festival by asking participants exactly from where they come from and with which vehicle they will reach the event during the registration phase.

Further incentives should be developed in order to decrease the number of attendees reaching the event by car or, at least, to maximise the cars' occupancy. Suitable incentives could be the setting up of shuttles from and to the closest train and bus station to the event's venue.

8.3 Limitation of the study

CFP studies are characterised by some limitations which are inherent to the methodology itself. One of the main limitations of CFP consists in the fact that it focuses solely on the impact category of climate change. It represents the contribution of emissions linked to the life cycle of a certain product (raw material acquisition, production, transport and disposal) to the greenhouse effect expressed as CO_2e. Even though climate change is an impact category of great concern, product's life cycle might generate relevant impacts on other categories as well such as marine or terrestrial ecotoxicity, freshwater eutrophication or resource depletion. As a consequence, decisions made on the basis of the sole CFP could result in conflict with the achievement of goals and objectives linked to other impact categories. For this reason, CFP is only one of the components to be taken into consideration during decision-making processes.

In addition, the CFP is calculated based on LCA methodology which depends on the definition of a functional and declared unit, the availability of suitable allocation rules and assumptions. The requirements listed above play an important role in the outcome of the calculations.

8.4 Improving the CF as well as the environmental impact of events

The major focus of the thesis was the identification of the most suitable methodology for the Carbon Footprint quantification of an event. However, calculating the amount of CO_2e produced by the event is just the first step towards the reduction of its environmental impact. Aspects to consider in order to improve the carbon footprint as well as the overall environmental impact of events are discussed below.

According to the guidelines of ISO 20121 standard and the book "*Sustainable Event Management: A Practical Guide*"[41] by Meegan Jones, the following are some of the topics which might be significant to consider carefully while organising an event.

[41] Jones, Meegan. *Sustainable Event Management: A Practical Guide*. 3rd ed., Routledge, 2018

- **Paper:**

Printed paper can be found in many events since it might be used for advertising as well as for the event management itself which includes printed menus, timesheets, guidelines and magazines. During the Hero Dolomites' event, characterised by a four-day duration and 2,344 attendees during the 2022 edition, around 3,260 kg of printed paper were used. For bigger events the amount could be much larger, therefore, carefully evaluating the alternatives available while organising the event could improve its overall environmental impact.

The easiest and most common choice is usually to source paper, which is certified, two world known paper certifications are FSC (Forest Stewardship Council) and PEFC (Programme for the Endorsement of Forest Certification). A further option is to choose recycled paper or, at least, paper containing a certain percentage of recycled material.

Another aspect to take into consideration is the location of the print company which influences the distance travelled by the paper.

When thinking about paper sourcing, toilet paper, paper hand towels, serviettes and kitchen paper towels should be considered as well.

- **Signage:**

A wide variety of events require signage in order to provide directions to attendees as well as for sponsorships. This is especially true for sporting events such as Hero Dolomites' event. While evaluating the possible options for signage great care should be put in choosing the materials, Polyvinyl chloride (PVC) is usually the most commonly used, however, it is very difficult to recycle. Suitable solutions are timber and bamboo signage which could be reused several times. The focus should be on choosing or designing signage to enable reuse in future events which implies for example to avoid writing the date on it.

- **Merchandise, gifts, giveaways and awards**

Merchandise and giveaways are embedded in events' activities, at many sporting events items such as hats and T-shirts from sponsors can be easily found. The principles to pursue while sourcing for such products should be to buy them locally or fair trade and free of toxic substances. At events such as conferences lanyards and name tags are commonly used, suitable options are rPET (recycled Polyethylene terephthalate), organic cotton and bamboo fibres for lanyards. If possible, plastic pockets for name tags should be avoided. As far as gifts and awards are concerned, sustainable options could be bags made from previous year's banners, which is a good way to recycle them, containing environmental friendly products or biodegradable bags with locally sourced food sample products. In addition, virtual bags are a suitable option; they can include exclusive contents, sponsor materials, discount codes as well as vouchers, apps, games, online subscriptions and competitions.

- **Cleaning products:**

Another issue to be taken into consideration and which is usually not discussed in the assessment of environmental performances of events are cleaning products. Toilets, areas in which meals are eaten and kitchen require a frequent and deep cleaning throughout the event. Products containing non-toxic ingredients which are 100% biodegradable should be chosen. Moreover, the best options for cleaning products should be solvent-free and phosphate-free, should use renewable raw materials and have as little packaging as possible. Usually a cleaning service is hired, however, organisers should gain information about the products used and ask for ecological options if available. Another hotspot for the use of cleaning products are accommodations such as hotels and campsites. In the case of events in which a great number of attendees will sleep in the event's venue such as in the Hero Dolomites' case, accommodation structures should be made aware of this topic.

- **Food:**

Food is another major topic to carefully evaluate while organising an event. First of all, the origin and characteristics of the food to be sourced should be analysed, the less impactful options are sustainably produced products which are local, seasonal, organic and chemical-free. Especially in the case of events which aim to promote healthy lifestyles, such as sporting events, unprocessed and fresh meals should be provided while foods high in fats and sugars should be restricted. Another aspect to be considered is animal welfare: the use of meat and animal products should be reduced, if possible, and products should be sourced from companies which ensure that animals are treated with respect throughout the stages of the production of food. Seafood should come from sustainable fishing and products such as tea, coffee or chocolate should be fair trade certified.

- **Serviceware:**

The sustainable event management does not include only food sourcing but the sourcing of products to serve food on as well. The best option is reusable serviceware if a washing facility can be put in place. Other valid alternatives are compostable or bioplastic serviceware if adequate bins are provided and attendees are informed on how to correctly handle the used items. Beverage containers are also a topic to discuss, plastic bottles should be avoided, if possible, or at least correctly segregated into appropriate bins, aluminium cans should also be collected according to the needs of the local waste management facility. A suitable alternative can be to establish a deposit for glass bottles in order to give them back to the supplier for reuse instead of recycling glass and remanufacture them.

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