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Master Dissertation

Measuring and Reducing The Travel-Related Carbon Footprint Of Sport Events In The Example Of Meo Rip Curl Portugal Pro 2023

Christoph Albrecht Zepf

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I Preliminaries

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Abstract

This work explores the ecological dimensions of sporting events, with a primary focus on the MEO Rip Curl Portugal Pro 2023 as a case study. The main aim of this research is to calculate the travel-related carbon footprint of the event's visitors and to investigate the potential for mitigating their carbon footprint. The research methodology comprises a quantitative survey questionnaire conducted among event attendees. The carbon footprint of various transportation modes was calculated using established emission factors. The study revealed that visitor travel constitutes a significant majority of the event's total carbon footprint. Additionally, it identified the need for enhanced efforts in promoting environmental-friendly transportation options. Finally, an all-encompassing carbon footprint reduction plan was devised to provide event managers with recommendations to mitigate the carbon footprint associated with their events. This work underscores the important role of sports events in environmental education and advocacy. It highlights the importance of measuring, reducing, and mitigating carbon footprints, especially in the context of event visitor travel. The findings emphasise the potential for sports events to adopt more environmental-friendly practices and contribute to global environmental goals. Overall, this research calls for increased awareness and action towards a more eco-conscious sports industry.

Keywords: Carbon Footprint, Events, Surf, Travel-Related Emissions, Environmental Sustainability

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List of Abbreviation

Abbreviation	Definition
1 Tonne	1 metric ton or 1000kg
AISTS	International Academy of Sport Science & Technology
BWE	Bundesverband Windenergie
CDM	Clean Development Mechanism
CO2e	Equivalent carbon dioxide
CSR	Corporate Social Responsibility
CT	Championship Tour
DEHSt	Deutsche Emissionshandelstelle
EF	Emission Factor
EPA	Environmental Protection Agency
ESTM	Escola Superior de Turismo e Tecnologia do Mar
gha	Global hectares
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICAO	International Civil Aviation Organization
ISO	International Standard Organisation
JI	Joint Implementation
LCA	Life-Cycle-Assessment
LPG	Liquefied Petroleum Gas
m	Transportation mode
QS	Qualifying Series
REDD+	Reduce Emissions from Deforestation and forest Degradation
SEI	Stockholm Environmental Institute
VCS	Verified Carbon Standard
VO	Average vehicle occupancy rate in passengers per vehicle
WBSCD	World Business Council for Sustainable Development
WRI	World Resource Institute
WSL	World Surf League

1. Introduction

1.1 Problem Statement

Event organisers put increasing attention on the environmental creation of their events, by reducing CO2 emissions, improving waste management, as well as promoting to be more conscious about sustainable practices (Chumakova, 2020). This is a result of the increasing environmental impact that events have, and the event organisers aim to be compliant with responsible practices that are increasingly required by both visitors and other interest groups (Dickson & Arcodia, n.d.; Yuan, 2013). In this aspect, besides making an effort to be as environmentally friendly as possible, the measurement, reduction, and mitigation of the event's carbon footprint are important practices event organisers must do, to fulfil their part in becoming more environmentally responsible (Wilby et al., 2023).

However, one area that often goes overlooked is the carbon footprint associated with the travel of event visitors (Fulton & Monteiro, 2023). While mega and major sports events like the Olympics or World Cup are pressured by the public to report and address their Scope 3 emissions, which are mainly from visitor's travel (Fulton & Monteiro, 2023), there is not much literature about smaller sports events that consider the measurement of travel-related emissions of their visitors. Thus, limited research addresses the subject of measuring and including the travel-related emissions in the carbon footprint of smaller sized sports events (Dolf & Teehan, 2015). A variety of research has shown that the biggest CO2 emitter of an event is the transportation of its visitors since many people travel from far away and use transportation means like planes, cars, and public transport, mostly inefficiently (Collins et al., 2009; Fulton & Monteiro, 2023; R. P. T. Pereira et al., 2017). Thus, given their significant contribution to the event's carbon footprint, it is suggested that sports managers and organisers should include these emissions in their carbon footprint. Furthermore, not including the emissions of visitors' transportation will distort the calculated total CO2 footprint and will result in a false representation of the true environmental impact of the event. The inclusion of travel-related CO2 emissions of visitors is also recommended by the Greenhouse Gas Protocol and specifically by *The Corporate Value Chain (Scope 3) – Accounting and Reporting Standard* (Callahan et al., 2011; Ranganathan et al., 2004). Furthermore, Osborne Clarke suggests that sports organisations should think about including indirect emissions that are created by drawing visitors to sports events despite being just a voluntary practice (Clarke et al., 2022).

The World Surf League (WSL) is one of the sports organisations, that makes increasing efforts to reduce its overall environmental impact by direct eco-friendly and CO2-reducing measures at their major events as well as proactively setting up programs that increase sustainability in their event stops while encouraging its communities for sustainable actions. In addition, WSL claims to achieve 100% global carbon neutrality by offsetting all the emissions that occur due to their "*staff and athlete travel, events, and business operations*" since 2018 and promotes itself as leading "*the Way for Global Professional Sports by Becoming Carbon Neutral and Eliminating Single-Serve Plastics*"(WSL, 2019d).

However, even as WSL makes increasing efforts to reduce its environmental impact and achieve carbon neutrality, it belongs to the majority of sports event organisers and calculates its events' carbon footprint without including the emissions that are caused by the transportation of visitors. Taking this into consideration, it raises doubts about whether a carbon-neutral status should be publicly communicated if a significant part of its total carbon emissions were not addressed because they have not been tracked. Given WSL's ambition to lead the global sports industry, they have the opportunity to set a new benchmark by fully accounting for all Scopes 1-3 emissions, including visitor travel, and serve as a role model for other sports organisations and the entire event industry. By including all Scope 3 emissions WSL would also show the sports world that they take environmental sustainability as their main objective. Sotiriadou & Hill (2015) mention that sports managers, the academic community, and practitioners "*share the responsibility to earn credibility among communities, spectators and fans, large corporations or small local businesses, sponsors with naming rights or young children aspiring to represent their countries*"(Sotiriadou & Hill, 2015, p. 7), which demonstrates that it is crucial to be transparent and realistic when it comes to environmental sustainability and making very powerful statements such as carbon neutrality.

By implementing that, WSL can primarily address the majority of carbon emissions of an event that hasn't been addressed so far, which enables to put carbon emissions by different areas into perspective and enables WSL to proactively take measures to reduce them.

1.2 Aim

This work focuses on the following two aims.

- Calculating the estimated overall CO2 footprint of the MEO RIP CURL PORTUGAL PRO 2023 with a focus on the travel-related CO2 footprint of visitors, allowing to put it into perspective with the from WSL established CO2 footprint of the event, and proofing to be the main driver of the total CO2 footprint.
- To elaborate recommendations and best practices to primarily reduce the travel-related CO2 emissions to a minimum, and for unavoidable CO2 emissions, presenting a carbon-offsetting concept, that incorporates WSL and visitors.

Ultimately, this work has not only the purpose of addressing the necessity to include all relevant and decisive areas of an event that emits CO2 in its carbon accounting but aspires to inspire WSL to take a leading role as an organisation that fully accounts for its entirety of events' CO2 emissions, setting a new benchmark for not only other sports organisations but also for the event industry. Hopefully, this would motivate event managers across the entire industry to introduce similar best practices to reduce visitors' travel-related CO2 emissions as well as apply a similar carbon offsetting concept to fully account for all events' CO2 emissions.

1.3 Approach

To achieve the stated aims, an onsite survey questionnaire was applied to gather data about the carbon footprint of visitors travel to and from the event. Furthermore, data about their perceptions, preferences, and familiarity with regard to subjects related to environmental sustainability were collected. This data was then used to calculate the total travel-related CO2 footprint of the visitors. The calculated CO2 footprint was used to establish corresponding measures to reduce the CO2 footprint. Thus, the second part of this work focused on presenting solutions to reduce the calculated CO2 footprint. These solutions were based on data from the survey questionnaire and were established in form of a carbon footprint reduction plan. The data was also used to explore the potential of these solutions. The carbon footprint reduction plan comprises two parts. The first part focuses on the reduction of CO2 emissions by offering environmental-friendly transportation alternatives. The second part focuses on the remaining CO_2 emissions that could not have been avoided in the first part and comprises a carbon offsetting concept.

Chapter 2, presents the chosen Literature Review, guiding the research, namely the concepts of Carbon Emissions, Carbon Footprint, and Carbon Offsetting, and a contextualization of environmental issues in sport events. In Chapter 3, the methodology is presented, namely the survey questionnaire applied to collect data and the approach followed to estimate the visitors' travel-related CO_2 footprint during the MEO RIP CURL PORTUGAL PRO 2023. To gather reliable data for the calculations, an onsite survey questionnaire was conducted during the event. Chapter 4 will present the results of this survey, enhancing the understanding of the estimation of the travellers' CO_2 footprint and visitors' attitudes towards sustainability.

Building upon the methodology and survey results, Chapter 5 will present the discussion and unveils a comprehensive carbon footprint reduction plan. This plan comprises two main parts. The first part proposes a prototype aimed at reducing the carbon footprint of WSLs' visitors. The second part introduces a prototype application that offers carbon offsetting opportunities for event visitors. In Chapter 6, the study concludes by providing a comprehensive summary of the findings and insights gained throughout the research process.

2. Literature Review

2.1 Carbon Emissions, Carbon Footprint, and Carbon Offsetting

In this chapter, we explore the complex realm of *Carbon Emissions*, *Carbon Footprint*, and *Carbon Offsetting*. Besides exploring the profound significance of these interconnected aspects within the context of environmental sustainability it will also provide comprehensive definitions for each term. By understanding the precise meanings and implications of carbon emissions, carbon footprint, and carbon offsetting, we can gain a deeper understanding and pave the way towards a more ecologically conscious approach.

2.1.1 Definition and Explanation of Carbon Emissions as a Greenhouse Gas

As the largest share of greenhouse gases (GHG), carbon dioxide (CO2) emissions are mainly by-products of energy production and use of energy like the burning of oil, coal, gas, wood, and waste materials (World Bank Group, n.d.). Furthermore, these emissions are primarily created by fossil fuel combustion from cement manufacturing processes.

NASAs' definition of carbon dioxide emissions is as follows:

"Carbon dioxide (CO2) is an important heat-trapping gas, also known as a greenhouse gas, that comes from the extraction and burning of fossil fuels (such as coal, oil, and natural gas), from wildfires, and natural processes like volcanic eruptions."(NASA, 2023).

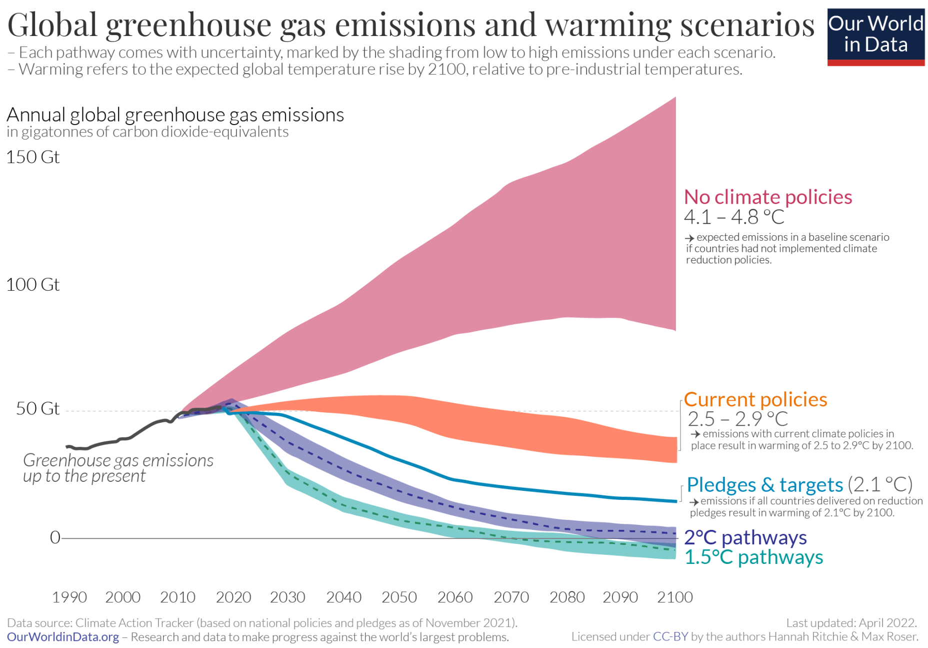
CO2 emissions have a very significant impact on the world's climate, contributing to global warming and are the main driver for climate change (World Bank Group, n.d.). Moreover, in 2021, CO2 contributed around 66% to total greenhouse gas emissions (Lindsey, 2023). Furthermore, CO2 is the reference gas that serves as the benchmark against which the measurements of other greenhouse gases such as methane (CH4) and nitrous oxide (N2O) are compared (World Bank Group, n.d.). The conversion to carbon dioxide equivalents (CO2e) allows us to compare all greenhouse gas emissions and determine their individual and combined contributions to global warming.

Despite CO2 receiving a very bad reputation because of the negative impact it has on the climate, the gas is Earth's most important greenhouse gas because it absorbs and radiates heat from the Earth in all directions, including the Earth's surface (Lindsey, 2023). Without this gas, the natural greenhouse effect of the Earth would not be strong enough to maintain a global average surface temperature above the freezing point. The problem with greenhouse gases and especially CO2 emissions is that people are accelerating the natural greenhouse effect which increases the global temperature with irreversible consequences. Annual CO2 emissions have risen from around 11 billion (metric) tonnes of carbon dioxide per year in the 1960s to an estimated 36.6 billion tonnes in 2022.

As previously explained, CO2 is the most impactful greenhouse gas whose overall impact on the world's average temperature is shown in Figure 1 "Global greenhouse gas emissions and warming scenarios". It demonstrates three different scenarios projecting the course of temperature until the year 2100 (Ritchie et al., 2020). As it is explained in the figure, each scenario comes with uncertainties which is shown by the shading from lowest possible emissions to highest possible emissions under each scenario.

Figure 1

Global Greenhouse Gas Emissions and Warming Scenarios



Note. Reprinted from "CO_2 and Greenhouse Gas Emissions", by Ritchie, Roser, Rosado, 2020, Retrieved from: https://ourworldindata.org/co2-and-greenhouse-gas-emissions

The red area shows the most devastating scenario with a global temperature between 4.1°C - 4.8°C that are estimated if there would have not been done any climate reduction policies by countries. The blue area shows the desired targets of 2.1°C by 2100 which would occur if all countries delivered on reduction commitments set within the Paris Climate Agreement. Unfortunately, the orange area is the projected course with current climate policies in place which will result in 2.5°C - 2.9°C of global temperature by 2100. The purple area which would bring global temperature down to 2°C by 2100 would imply a significant increase in ambitions of the current commitments made under the Paris Agreement. The green area limiting average warming to 1.5°C by 2100 would require an immediate and expedited decrease in global greenhouse gas emissions.

2.1.2 Definition and Significance of Carbon Footprint

In order to comprehensively address the environmental impact of activities and products, it is essential to have a clear understanding of the concept of carbon footprint and the methods used to measure and calculate it.

The scientific community has yet to reach a consensus on a universally accepted definition of carbon footprint. This is also recognized by Wiedmann & Minx (2008), who state that it seems there is no clear definition of carbon footprint and that there is still confusion about its meaning and what it measures. Originally, carbon footprint was rooted in the language of Ecological Footprinting, and there is general consensus within the scientific community that carbon footprint represents the amount of emissions linked to human production or consumption activities as well as that it is impacting climate change. However, there is a lack of consensus among experts about the measurement and quantification of carbon footprint. First, it is not clear if only carbon dioxide (CO2) emissions should be included or also other greenhouse gases. Second, a key point of contention revolves around whether the carbon footprint should encompass indirect emissions, which are embedded in upstream production processes, or if it is satisfactory to solely examine the direct, on-site emissions of the product, process, or individual. Additionally, there is also disagreement, about whether carbon footprint should be quantified in just tonnes of CO2, or whether it should be quantified in tonnes of CO2 equivalents (CO2e) which would be used when considering the impact is global warming potential (GWP), or if it should be quantified in an area-based unit such as hectares or global hectares (gh) if the impact is land appropriation.

This study focuses on assessing the environmental impact of events, and therefore, the definition provided by Carbon Trust, which explicitly incorporates the concept of events, will be used and which is as follows:

“The total set of greenhouse gas emissions caused directly and indirectly by an individual, organisation, event or product is commonly called their carbon footprint. “ (Carbon Trust, 2007, p. 1).

The concept of carbon footprint is very important for an entity such as a country, company, event, or an individual to better understand how the entity is contributing to climate change, identifying where it creates emissions, and therefore which areas it needs to address to reduce the emissions (greenofficemovement, n.d.). According to Carbon Trust (2007), the importance of calculating its carbon footprint is also recognized by an increasing number of organisations, which conduct detailed calculations of their carbon footprint with the intention of publicly disclosing this information in various contexts. For example, organisations recognise the importance of Corporate Social Responsibility (CSR) and therefore incorporate sustainability practices into their operations. Furthermore, it serves as a valuable marketing tool to differentiate the organisation as an environmentally responsible entity. Another reason why carbon footprints are calculated is to fulfil the request of other businesses or investors, which seek transparency and sustainability from these organisations. Lastly, the calculation is an important measure to know how many emissions need to be addressed and effectively offset in order to become carbon neutral. The concept of carbon offsetting will be addressed later in this work in more detail.

Carbon Trust states that these purposes require a more detailed approach to encompass all emissions within the organisation's responsibility. Furthermore, it may also be advisable for the calculation to undergo independent verification to ensure the proper application of the methodology and the accuracy of the results.

2.1.3 Measurement and Calculation of Carbon Footprint

To achieve an accurate calculation of a carbon footprint it is important to have a systematic approach, which includes the most relevant steps 1-3 that are inspired by Carbon Trust (2007). In the following, these steps will be explained in detail because of their relevance to this work.

1. Definition of an accurate methodology
2. Specification of the boundaries and scopes of coverage
3. Accurate collection of emission data and calculation of footprint

2.1.3.1 Definition of an Accurate Methodology

Ensuring accuracy in calculating a footprint requires a consistent approach, highlighting the significance of establishing the organization's methodology from the beginning (Carbon Trust, 2007). This not only enables systematic handling of any issues that may arise but also proves crucial in large organisations where multiple individuals are involved in data collection and interpretation.

The most commonly used methodology is the Greenhouse Gas (GHG) Protocol from the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) (Carbon Trust, 2007). This publicly available methodology offers comprehensive guidelines for reporting corporate emissions. Another more recent standard is ISO 14064 developed by the International Organization for Standardization, which offers comprehensive guidance on the calculation of corporate footprints and the reporting of emissions. This methodology builds upon several key concepts introduced by the Greenhouse Gas Protocol.

2.1.3.2 Specification of the Boundaries and Scopes of Coverage

Defining the boundary is a very important step because it determines the set of emissions that will be quantified within the carbon footprint of an organisation. As it is described in the GHG Protocol, after determining the organisational boundaries, regarding the operations it owns or controls, the organisation needs to define the operational boundaries (Ranganathan et al., 2004). This entails the identification of emissions linked to the organization's operations, the classification of these emissions into direct and indirect categories, and the selection of the accounting and reporting Scope for indirect emissions. The concept of scopes (Scope 1, Scope 2, and Scope 3) for GHG accounting and reporting purposes was created to help define direct and indirect emission sources, improve transparency, and offer practical benefits for a variety of organizations and climate policies as well as business objectives. Furthermore, Scopes 1 and 2 are precisely delineated within this standard to prevent multiple companies from accounting for emissions in the same scope.

Scope 1 – Direct GHG emissions

Direct greenhouse gas (GHG) emissions arise from sources that the company owns or has control over (Ranganathan et al., 2004) and are presented in Table 1.

Table 1

Scope 1 – Direct GHG emissions

Emission Source	Scope 1 – Direct GHG emissions
Generation of electricity, heat, or steam	Included
Physical or chemical processing	Included
Transportation of materials, products, waste, employees	Included
Fugitive emissions	Included
Biomass combustion emissions	Not included (reported separately)

Scope 2 – Electricity indirect GHG emissions

Scope 2 (see Table 2) encompasses greenhouse gas emissions resulting from the consumption of purchased electricity which is consumed by the company (Ranganathan et al., 2004).

Table 2

Scope 2 – Electricity indirect GHG emissions

Emission Source	Scope 2 – Indirect GHG emissions
Electricity acquired or brought into the organizational boundary of the company from external sources	Included

Scope 3 – Other indirect GHG emissions

Emissions of Scope 3 represent a voluntary reporting category that encompasses the management of all other indirect emissions (Ranganathan et al., 2004). These emissions occur as consequences of the activities of the organisation but come from sources that are not owned or controlled by the organization.

Although Scope 3 emissions are optional, it provides an opportunity for organisations to be innovative in the management of GHG. This is a very important aspect that is given by the GHG Protocol because it informs and encourages organisations to include Scope 3 emissions as part of their carbon footprint by implementing innovative approaches. Furthermore, it is suggested that organisations may want to focus on the accounting and reporting of activities that align with their business objectives and goals, and for which they have data that is reliable.

The following section (see Table 3) provides an illustrative compilation of some, for this work relevant, scope 3 categories, accompanied by case studies that exemplifies various categories within this scope. Certain activities falling within this scope will be incorporated into Scope 1 if the corresponding emission sources are under the ownership or control of the company.

Table 3

Scope 3 – Other indirect GHG emissions

Emission Source	Scope 2 – Indirect GHG emissions
Activities related to transportation and the movement of goods and people	
Transportation of materials or goods that were purchased	Included
Transportation of fuels that were purchased	Included
Business Travel of employees	Included
Commuting to and from work of employees	Included
Transportation of products that were sold	Included
Transportation of created waste	Included
Extraction and production of materials and fuels that are purchased from external sources	Included
Electricity-related activities that are not included in Scope 2	Included
Utilization of products and services that are sold	Included
Disposal of waste	Included

The GHG Protocol states that while offering specific recommendations for the inclusion of Scope 3 emissions in the carbon footprint can be challenging, there are general steps that can be outlined. Besides crucial steps such as *Describing the value chain*, *Identifying partners along the value chain*, and *Quantifying Scope 3 emissions*, the step that is most significant in this work is the *Determination of which Scope 3 categories are relevant*.

Thus, only some types of either downstream or upstream emission categories are significant for the company and could be relevant for the following reasons:

- *They are large (or believed to be large) relative to the company's Scope 1 and Scope 2 emissions*
- *They contribute to the company's GHG risk exposure*
- *They are deemed critical by key stakeholders (e.g., feedback from customers, suppliers, investors, or civil society)*
- *There are potential emissions reductions that could be undertaken or influenced by the company.* (Ranganathan et al., 2004, p. 30)

A case study about the company DHL Nordic Express which accounts for outsourced transportation services can be drawn as an example of including and addressing relevant emissions in the organisation's carbon footprint (Ranganathan et al., 2004). The company found that 98 % (see Fig.2) of its emissions in Sweden originate from the transportation of goods via outsourced firms. With the inclusion of Scope 3 emissions and promotion of GHG reductions throughout the value chain, DHL Nordic Express showed an active step towards a more responsible approach to its environmental impact and enhanced the significance of its emissions footprint. Furthermore, the company increased opportunities for impact reduction and enhanced its capacity to identify opportunities for cost savings. Scope 3 crucially helped to show the necessary information in order to understand and effectively address and manage the company's emissions.

Figure 2

Emission Data of DHL Nordic Express by Scopes 1-3

SCOPE	EMISSIONS (tCO_2)
Scope 1	7,265
Scope 2	52
Scope 3	327,634
Total	**334,951**

Note. Reprinted from "GHG Protocol", by World Business Pub, 2004, p.30. Retrieved from https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf Copyright by World Resources Institute and World Business Council for Sustainable Development, March 2004

Another case study stated in the GHG Protocol, and which comes closest to the relevance of this work about the environmental impact of travel-related CO2 emissions of an event, is the transportation of customers to and from retail stores of the Swedish company IKEA. Thus, the company decided to include emissions of Scope 3 from customer travel after it was realized, that these emissions were high in relation to Scope 1 and 2 emissions. Moreover, these emissions are most especially relevant for IKEA's store business model as they are directly impacted by the company's choice of store location and the warehouse shopping concept, which often requires customers to travel long distances to reach the stores.

The relevant data to calculate the customer transportation emissions were derived from surveys, asking about distance travelled, number of customers in the car, number of other stores that would be visited and whether there was public transportation offered to arrive at the store. Thanks to this information, IKEA can take active measures in reducing Scope 3 emissions by considering them when creating public transportation options and services for home delivery for existing and future stores.

While researching the GHG Protocols' detailed information on Scope 3 emissions, as an important part of this work's purposes, there was no included information about the GHG emissions that occur from the travel of visitors to an event. The only information about the transportation of event visitors was found in Chapter 11.2 *"Optional Information"* as part of the "Corporate Value Chain (Scope 3) Accounting and Reporting Standard" which states that a public GHG emissions report should include the emissions from Scope 3 activities (not included in the above-provided list of Scope 3 categories) such as transportation of visitors to events/conferences (Ranganathan et al., 2004). These emissions should be reported separately, for example, "other" Scope 3 category.

2.1.3.3 Accurate Collection of Emission Data and Calculation of Footprint

It is suggested, to categorise the GHG sources within the previously defined boundaries of an organisation as the first out of five steps in identifying and calculating the carbon emissions of an organization (Ranganathan et al., 2004). Typically, GHG emissions originate from sources such as stationary combustion (boilers, turbines, engines), mobile combustion (fuels in transportation devices like cars, buses, trains, and airplanes), process emissions (cement manufacturing), and fugitive emissions (intentional and unintentional releases like equipment leaks).

The next step is to select a calculation approach. Since direct measurement of GHG emission by the approach of monitoring is very unusual, there are documented emission factors (EF) that can be used. This is also the most common approach to calculating carbon emissions. These factors represent calculated ratios that correlate GHG emissions to a surrogate measure of activity at a specific emissions source.

In the third step, the data needs to be collected as well as accurate emission factors chosen. In many companies, both small and large, Scope 1 GHG emissions are calculated based on purchased quantities of commercial fuels using published emission factors. For Scope 2 GHG emissions, calculations are primarily based on metered electricity consumption and supplier-specific or local grid emission factors. Importantly for the purpose of this work, Scope 3 GHG emissions will be mainly calculated from data such as fuel use or passenger kilometres and published or third-party emission factors. If available, source- or facility-specific emission factors are preferred over more general emission factors.

Then, the appropriate calculation tools will be applied to calculate the carbon footprint for each Scope. It is suggested to collect consumption data in kWh or MWh for gas and electricity (Carbon Trust, 2007). For fuels, data can be collected in different types of units such as kWh, MJ, Litres etc. All GHG emissions should be measured in equivalents CO2 (CO2e), using the global warming potential factors (GWP).

There are various methodologies and approaches available to measure the carbon footprint, and one widely recognized approach is the Life Cycle Assessment (LCA). LCA is an internationally accepted method used for assessing the environmental impacts of a product, service, or process throughout its entire life cycle (Dolf & Teehan, 2015). An LCA is an empirical method employed to quantify environmental impacts throughout the various stages of a product's life cycle, whether it be from its creation to disposal or from its creation to its reuse or recycling.

2.1.4 Carbon Offsetting and its Role in Environmental Sustainability

In this section, the controversial concept of carbon offsetting will be presented by providing first a definition and explanation of the concept as a means to compensate for GHG emissions. It will also address the controversies and effectiveness of carbon offsetting, and lastly, the importance of prioritizing emission reduction as the primary approach to combating climate change will be given.

2.1.4.1 Definition and Explanation of the Concept of Carbon Offsetting

In the context of carbon offsetting, it is crucial to note that there exists rather an individual approach of different companies and organisations that define the term, than a common approach for a universal definition. Neither within the scientific community, it is suggested that a common definition needs to be established. For the context of this work the definition of Hyams & Fawcettand (2013) is seen as appropriate and suitable and is as follows:

> *Carbon offsetting can be loosely characterized as a mechanism by which an organization or individual contributes to a scheme that is projected either to remove carbon dioxide from the atmosphere or to deliver carbon dioxide emission reductions on the part of other organizations or individuals.* (Hyams & Fawcett, 2013, p. 1).

Furthermore, the authors state that examples of such initiatives encompass a range of endeavours, such as reforestation projects, the establishment of wind farms, and the provision of energy-efficient cooking stoves in underserved regions of developing countries (Hyams & Fawcett, 2013). An emission reduction of one tonne of CO2e equals one carbon credit which is a transferable instrument recognized by governmental entities or independent certification bodies (Broekhoff et al., 2019). Thus, with the purchase of one carbon credit, the organization can then officially claim the reduction of one tonne of CO2e that occurred within its organization.

There are two different forms of carbon offsetting. Whereas compliance or regulated offsetting focuses on the intention to provide developed countries with flexibility in achieving their legally binding targets for carbon reduction, voluntary carbon offsetting allows organisations and individuals to offset their emissions voluntarily and not because of external obligations (Hyams & Fawcett, 2013).

2.1.4.2 Controversies and Effectiveness of Carbon Offsetting

The usefulness of the concept of carbon offsetting as a measure to address climate change is very disputed (Hyams & Fawcett, 2013). On one hand, there are the United Nation (UN)

which has established and oversees the primary global framework for creating and verifying carbon offsets such as the Clean Development Mechanism (CDM) indicates that it promotes sustainable development and encourages emissions reductions, provides flexibility to industrialized nations in achieving their emission reduction targets. On the other hand, critics express doubts about the concept and say that carbon offsets are a distraction and that it is not based on scientific validity and that they are very misleading.
This controversy is also recognized by Bushnell (2010) who states that although offset mechanisms offer enticing possibilities to reduce mitigation costs and overcome jurisdictional boundaries, they still face significant controversy. Therefore, offset programs are criticised because they doubt whether they are actually achieving the claimed reductions in emissions. Additionally, they are concerned that the amount of emissions reduced through these programs may not be as much as they claim.

The Stockholm Environment Institute (SEI), which is a non-profit, independent research and policy institute specializing in sustainable development and environmental issues, states in its offset guide the two common critical points of carbon offsetting, concerning the use of credits, and the quality of credits (Broekhoff et al., 2019).
The concerns about the use of carbon offset credits are that with the credits an organization can easily achieve its GHG reduction goals, instead of doing the needed investment to significantly reduce their carbon footprint in the first place (Broekhoff et al., 2019). Since this point describes a very crucial aspect of the subject of climate change solutions, Chapter 2.1.4.3 will delve deeper into the complexities of this common criticism.
On the subject of the quality of credits, there are a number of independent studies that have identified major problems with carbon offset credits (Broekhoff et al., 2019). This was proven by studies of the world's two largest offset programs Joint Implementation (JI) and CDM, suggesting that up to 60-70% of their offset credits may not truly signify valid GHG reductions. Further critics have pointed out cases where carbon offset projects had negative impacts on local communities or caused broader environmental harm. Therefore, the Institute suggests being careful and critical when approaching the carbon offset market.
Hyams & Fawcett (2013) indicate that from an ethical point of view, there are two main issues with carbon offsetting, which are the problem of scientific legitimacy and the problem of carbon accounting such as additionality.

In terms of the debates about the scientific legitimacy of carbon offsetting, the focus is concentrated on projects in agriculture or forestry which are mostly sold as voluntary offsets. Taking the example of tree planting, numerous concerns have been raised regarding the reliability of evidence concerning carbon sequestration rates by trees, and how these new forests can guarantee variety over time and in terms of species. Additional doubts include the security of savings, risk of diseases, lodging, and wildfires of these plantations. Ethical issues would concern what areas these plantations replace, whose land will be used for it, and what happens to the rights of local communities.

In the case of issues of additionality, the report "*Study on the Integrity of the Clean Development Mechanism*" from the Stockholm Environment Institute at the request of the European Commission identified six issues to be investigated in detail (Ruthner et al., 2011). These are: Baseline setting and additionality testing; CDM Governance; Competitiveness distortion and carbon leakage; Technology transfer through the CDM; Sustainable development through the CDM; and Political lock-in. Among these issues, baseline setting, and additionality testing emerged as the most controversial aspect of the CDM, frequently cited as problematic in various literature on offsetting.

The offset guide of SEI states that the quality of an offset credit is closely connected with the confidence people have that it will fulfil the basic principle of quality. That's why the guide established five criteria of carbon offset quality, meaning that these carbon offsets must be linked to GHG reductions or removals that are:

- *Additional*
- *Not overestimated*
- *Permanent*
- *Not claimed by another entity*
- *Not associated with significant social or environmental harms* (Broekhoff et al., 2019)

<u>Additionality</u>

As previously mentioned by Hyams & Fawcett (2013), additionality is the biggest problem of carbon offsetting. Therefore, Greenhouse gas (GHG) reductions are considered additional if they wouldn't have happened without the carbon offset market (Broekhoff et al., 2019). In other words, if the reductions would have occurred regardless of the opportunity to sell carbon offset credits, then they are not considered additional.

Additionality is a very essential criterion for the quality of carbon offset credits and when not achieved the purchase of credits makes climate change even worse.

No Overestimation

Carbon offset projects can lead to overestimations of GHG reductions in different ways (Broekhoff et al., 2019). One issue is the overestimation of baseline emissions, which are the reference for calculating reductions. Another problem arises when actual emissions are underestimated due to measurement errors. Failing to account for indirect effects, known as "leakage", can also lead to overestimations. Additionally, forward crediting, where credits are issued for future reductions, can be problematic. To ensure the accuracy of carbon offsets, rigorous monitoring, verification, and scientifically sound data collection procedures are essential.

Permanency

Carbon offsetting faces a challenge due to the long-lasting effects of CO_2 emissions (Broekhoff et al., 2019). That's why offset credits must be linked to GHG reductions that are also long-term and permanent to effectively compensate for emissions. If a reduction is later reversed, it loses its compensatory value. In the example of protection forests, there is always the risk of the forest being illegally logged or burned down due to wildfires.

Exclusively claim to GHG reductions

Carbon offset credits must represent exclusive ownership of GHG reductions, meaning that two different entities can't claim carbon credits of the same amount worth of CO_2 reductions and therefore would have a double counting effect (Broekhoff et al., 2019). As with additionality, this would also negatively contribute to worsening climate change.

Avoiding Social and Environmental Harms

In order for a project to generate high-quality offset credits, it must not significantly contribute to social and environmental harms (Broekhoff et al., 2019). This entails complying with all legal requirements in its location jurisdiction. However, depending on the project type and location, additional reviews and safeguards may be essential to prevent adverse impacts unrelated to GHG emissions.

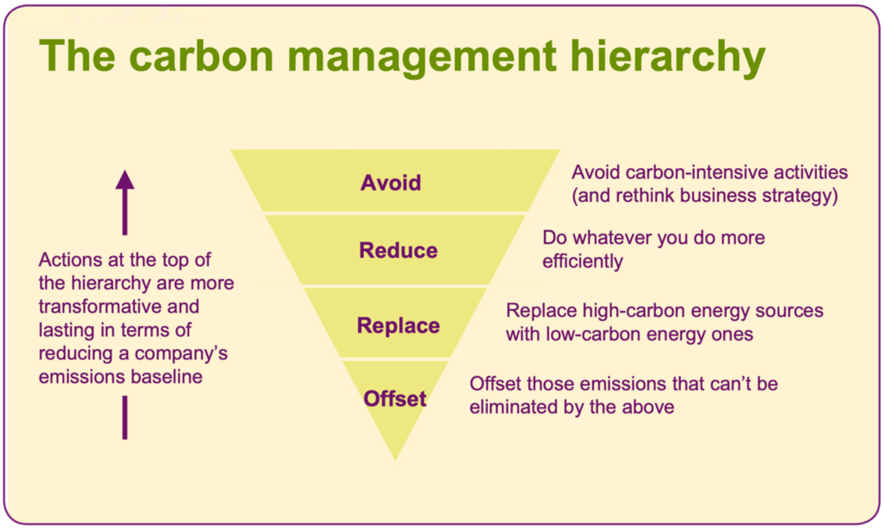
2.1.4.3 Importance of Prioritising Direct Emission Reduction

The concerns about carbon offsetting being used as an effective strategy to tackle climate change that was shown in the last chapter indicate a very crucial understanding of the overall approach to addressing climate change. It is suggested that carbon offsetting practices hinder the focus on the actual importance of carbon avoidance and carbon reduction (Broekhoff et al., 2019). The problem that the possibility of offsetting its carbon emissions creates is that many organisations can "*continue to pursue high-emitting activities – and invest in high-emitting equipment and facilities*", (Broekhoff et al., 2019, p. 16) which incentivizes two dangerous developments. The first is the risk of rather increasing emissions than decreasing emissions over time. The second is the problem that technologies and innovations won't be designed and established with the intention of reducing carbon emissions, maybe also because offsetting might be cheaper than the investment in carbon-efficient technologies. Carbon offsetting is therefore often seen as a supplementary approach to support aggressive internal climate actions rather than a primary method of mitigation (Broekhoff et al., 2019). That's why it should be emphasized that when it comes to carbon mitigation, other more efficient practices should be considered that are actually aiming for direct emission reductions, before offsetting.

The Forum for the future developed the carbon management hierarchy to provide broader insights and information for discussions on corporate climate strategy (Burtis et al., 2008). It helps companies to prioritise actions that are most impactful on their baseline emissions. The order of the hierarchy as shown in Figure 3 is first the avoidance, then reduction, then replacement, and as a final step the offsetting.

Figure 3

The Carbon Management Hierarchy



Note. Reprinted from "Getting to Zero: Defining Corporate Carbon Neutrality", by Burtis & Watt, 2008, p.18. Retrieved from https://www.forumforthefuture.org /Handlers/Download. ashx?I DMF=f06b2bd1-5a51-4bbe-8ad3-bcec1a1e5133 Copyright by Clean Air-Cool Planet and Forum for the Future 2008

The most important step for a company to reach carbon neutrality is to avoid activities that are carbon-intensive, which may require the business to reflect on its strategy. If everything possible was stressed to avoid carbon emissions, the company should reduce their emissions, by being most energy efficient in their activities. If the maximum energy efficiency is achieved, the company should replace all high-carbon energy sources with low or zero-carbon alternatives. Only as the last resort offsetting should be considered. Despite being a valuable tool to reduce GHG emissions, offsetting comes very last in the carbon management hierarchy, because of the important reason that it does not directly reduce the emission baseline of a company. The practice of offset should therefore only be used for emissions that still exist after the implementation of all the measures above.

Organisations like the Worldwide Fund for Nature (WWF) strongly advocate for this approach and state that "*first things first: Avoid, Reduce…and only after that - Compensate*" (Stevenson & Weber, 2020). The organisation thinks that offsetting can be misleading and that it takes the focus away from effective climate change actions, with "*The temptation to skip to steps lower in the hierarchy that are easier or cheaper will at best provide a temporary bandaid to these complex global challenges and at worst, cannibalize efforts for meaningful change.*" (Stevenson & Weber, 2020).

2.2 Environmental Sustainability in Sports Events

In this section an overview of the Environmental Sustainability of Sport Events will be provided, by pointing out the importance of it, particularly considering the dimensions and impacts of these events. Furthermore, it will emphasise the *Significance of Addressing Environmental Concerns in the Sports Industry* with a focus on the opportunities that the Sport has to promote environmental sustainability globally. Next, the *Importance of Including Visitors' Impact on Environmental Sustainability* will be explained, followed by *Case Studies and State of Knowledge on Visitors' Impact on Environmental Sustainability at Sports Events*.

2.2.1 Importance of Environmental Sustainability in Sport Events

Sports events have gained more and more popularity after the long-forced break from COVID-19. Financial increases are guaranteed. The industry is projecting a market value growth from $184.61 billion in 2021 to $609.07 billion by 2031 (Anil K. & Roshan D, 2022). The German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection mentions that millions of visitors get inspired by sports events and host cities profit a lot from them (bmuv, 2016).

However, a constant economic rise such as the one in the sports event industry, usually comes with environmental issues. This is also recognized by many official sports organisations, sports associations, leaders of the industry, and institutions such as the International Academy of Sport Science & Technology (AISTS). The latter says that with the increase in the number of sports events held as well as visitor numbers, the environmental impact increases as well (Yang, 2023). Especially major sports events have a particularly high impact on the environment. The main areas that account for the highest environmental impact are the construction and dissembling of the venues, the use of energy and resources, as well as the travel of competitors, staff, media, as well as spectators.

To understand the environmental impact of sports events, it is crucial to recognize that sports, in general, have a significant impact on the environment. McCullough et al. (2016) mention, that sport causes a significant environmental footprint for example on venues, attendance, and energy usage.

This can be very easily comprehended when realising that sports and environment have a very closely intertwined and interdependent relationship (Yang, 2023). This is also suggested by McCullough et al. (2016), who say that sports by their nature are highly dependent on the natural environment and therefore rely on it and contribute to the environmental degradation of nature. Furthermore, sports create environmental issues and accelerate the social necessity to analyse the relationship between human behaviour and the environment. Moreover, sports events not only have big impacts on the environment but also vice versa, environmental issues and climate change caused by the global community pose a big threat to sports in general and sporting manifestations (Yang, 2023). There are estimations, that between 30% and 50% of sportive practices will be cancelled due to poor air quality and extreme heat by 2050. This further highlights the interconnection between sports and the environment in which it takes place.

Sotiriadou & Hill (2015) indicate that sports events and their venues "*impose a significant impact on the environment*" (Sotiriadou & Hill, 2015, p. 1). The authors mention that the transportation of athletes, coaches, officials, and entourage, as well as visitors, events' merchandise, and sporting goods as well as equipment produce an abundance of products that require natural resources. Sports activities like these are also contributing to negative environmental consequences like the production of waste, pollution of water, air, and land, as well as the deterioration of the natural environment. As mentioned earlier, the impact is highest when sports events reach a size such as the Football World Cup, Olympics, and other major sports league events. For example, the 2010 Football World Cup in South Africa had negative environmental effects, including increased pollution, elevated waste generation, noise pollution, high water consumption, destruction of natural habitats, as well as loss of biodiversity (Cerezo-Esteve et al., 2022). This has enormous consequences on the carbon footprint. Pereira et al. (2017) mention, that the 2014 Football World Cup in Brazil generated a total carbon footprint of 2.7 million tonnes of GHG emissions, which is excessively high considering the short duration of the event. This figure appears even higher considering that it is nearly as high as the CO_2 emissions of the entire nation of Malta in the year 2014 (425,000 citizens). The Olympic Games in Rio in 2016 emitted a total of 3.6 million tonnes of carbon emissions, created more than 17,000 tonnes of waste, consumed 29,500 Gigawatts of electricity which came mostly from non-renewables, and consumed at least 23,500 litres of fuel (Shah, 2021).

The magnitude of these immense CO_2 emissions requires event managers and organisations to pay more attention to reducing CO_2 emissions, waste, as well as environmental harmful practices that are caused by their events. McCullough et al. (2016) show that the sports industry acknowledges this environmental impact of their events systemically and globally, and actively takes measures, also with great financial investments. For instance, more than US$17 billion were spent from the Olympic Games in Beijing to address environmental concerns between 2001 and 2007, which were contributed to areas such as preparation purposes, including transportation infrastructure upgrades, water protection & treatment, and energy development (120,000+ solar-powered streetlights and 1.8 million energy-efficient lights in restaurants, schools, and government buildings). Importantly, the authors point out that given the overall energy consumption and size of the host metropole and the country, these measures were relatively small.

Recent sports events like the 2020 Olympic Games in Tokyo, and the 2022 World Cup in Qatar incorporated sustainable practices (Yang, 2023). These were the controlling and offsetting of the event's carbon footprint, by using low or zero-emission technologies, including renewable energy projects, and supporting reforestation initiatives. Furthermore, the use of already existing sporting venues, repurposing temporary facilities, and building sustainable facilities if new infrastructures are necessary can be another sustainable practice. The author also states that practice can be the use of renewable energy solutions like solar and wind power, and the employment of energy-efficient equipment and technologies like LED lights and low-flow water fixtures to use water more efficiently. According to Yang (2023), keeping the food suppliers at a local level, as well as considering only seasonal food, will help in reducing the CO_2 emissions as well as ensuring a strengthening of the local economy. Additionally, by controlling, reducing, and recycling the waste of the event by using biodegradable food packaging, replacing plastic waste through water dispensaries, digital instead of physical tickets, and adequate recycling options, the impact on the environment can be effectively reduced. Finally, the encouragement of participants and visitors to use more eco-friendlier transportation like public transport to get to the venue represents another sustainable practice. Here event manager could include the cost of the public transport ticket in the event ticket price as well as provide information about public transportation options on their event website, to encourage more sustainable travel. In the example of the World Cup 2022, Doha provided electric bicycles and scooters at metro stations for visitors to not use combustion engine vehicles.

2.2.2 Significance of Addressing Environmental Concerns in the Sports Industry

As was established earlier, the impact that sports as an industry, including sports events have on an environmental level is very high. Equally as impactful is the international stage or platform that sports events automatically create with their mega and major events (Dolf & Teehan, 2015). The Institute for Applied Ecology is also of the opinion that major sporting events such as the FIFA World Cup and the Olympic Games serve as highly effective channels for communicating messages to a global audience (Stahl et al., n.d.). On the one hand, this can be explained that major sports events always draw the attention of substantial media coverage and eventually reach a fast and diverse audience, including "casual viewers" who are individuals who usually don't follow sports regularly but show interest and engage with them specifically during significant tournaments. On the other hand, these events make it possible to broadcast a message and information on an emotional level which leads to a more powerful and effective impact. Furthermore, by incorporating a strategy to protect the environment and the climate, organisers can hold events with a smaller environmental footprint and at the same time raise the awareness of its visitors of these issues. In this way, sports events can show the initiative in showcasing how environmental and climate issues can be effectively integrated into sports, while also demonstrating sustainable operations within venues. This unique position for sports to globally show responsibility and take a leadership role is also underpinned by the United Nations' view on sports, establishing that *"its broad social platform makes it a strategic tool in influencing people's attitudes; its reach extends to almost all geographical areas and social backgrounds"* (Bas et al., 2022). Furthermore, the UN says that sports can play a central part in the education and promotion of awareness regarding global warming and, more broadly, environmental concerns, including the promotion of a healthy and sustainable lifestyle. The World Organisation continues by referring to a study that states that fans demonstrate a willingness to embrace environmental initiatives, actively participating in endeavours to minimize ecological footprints. Interestingly in this context, is that the fans' engagement in these activities does not only happen during their visit to sports events, "*but also in their everyday behaviours and as advocates within their local communities*" (Bas et al., 2022). Particularly athletes and teams can have a vital role in being inspirational and guiding their supporters in environmental sustainability campaigns. The UN also says that with athletes' influential status, they have the chance to educate individuals and communities about climate change, inspiring their supporters to adopt sustainable lifestyles. However, it needs to be emphasised that this is a sensitive topic, and that caution must be exercised with this statement from the UN. As athletes and teams themselves tend to generate a much higher carbon footprint than their supporters, there is a complex aspect to consider. Furthermore, according to the organisation, sports are progressively acknowledged as a cost-effective and influential mechanism to achieve sustainable development objectives, encompassing the mitigation of global warming. Lastly, and one of the most crucial declarations is that with the incorporation of sustainability standards sports can have a great impact on other industries which then positively affects sustainable production and consumption standards of these industries.

2.2.3 Importance of Including Visitors' Impact in Environmental Sustainability

In Chapter 2.2.1 it was explained, that within sports events, there are different areas that contribute to carbon emissions and that each of them weighs differently into the equation of the total CO2 footprint of the event. In consideration of that, it is necessary to understand their distribution, also when addressing and developing potential solutions to reduce CO2 emissions. Therefore, it needs to be emphasised on the significant role that visitors play in shaping and influencing environmental impacts which was addressed in some parts of Chapter 2.2.1. For example, during the World Cup in Brazil which sectorial distribution of greenhouse gas emissions (GHG) from transportation was by far the biggest with 83,7%, of which international travel led (60.5%), followed by long-haul domestic travel (35.2%) and short-haul domestic/local travel (4.3%) (Pereira, R. et al., 2017). Further, but comparably less significant sectors were sporting venues with 9,65%, tourist accommodation with 5,7%, and lastly different tourist activities with 0,95%. Pereira, R. et al. (2017) highlight that the element of transportation is a key carbon generator that needs urgently to be mitigated. The high number of transportation particularly international travel is very plausible when considering, that a significant amount of people travel from other continents which impracticably results in high CO2 emissions. Moreover, it seems that with smaller sports events, the biggest contributor to CO_2 emissions is the transportation of visitors. Collins et al. (2009) shows in a survey of the 2004 Wales Rally GB, which was done with the participation of spectators, that the sector that contributed the most to CO_2 emissions (35,6%) was the travel of spectators. Here the spectators' CO_2 emissions were estimated with the information of the travel mode and distance that was used. Another example that shows how much the transportation sector influences the total CO_2 footprint of an event is the study about the measurement of the footprint of the 2004 Football Association (FA) Cup Final. According to Collins et al. (2009), the findings showed, that the average visitor's footprint was seven times bigger than someone engaging in normal, everyday activities. Furthermore, as with the previous examples the primary contributor to the environmental footprint in this event case was the consumption associated with visitor travel patterns, in which travel emitted 54% of the total CO_2 emissions. Of these emissions, car travel accounted for around 2/3 of them, which is more than air travel and could be explained that this event attracted mostly national visitors. This shows that in events in which air travel is not the primary GHG contributor, the sector of transportation is still contributing the most to the total CO_2 emissions of an event.

The previously demonstrated efforts from sports organisations and managers in improving the environmental situation and reducing the carbon emissions of their events must be particularly in the transportation sector intensely concentrated. Stahl et al. (n.d.) is also in alignment with this perspective and suggests that eco-friendly visitor offers such as attractive green transport schemes can contribute to carbon mitigation. Osborne Clarke recognises that the fundamental operations of sports organizations require domestic and international travel for competitive engagements and emphasises that the travel related emissions are a "*key reduction area*" (Clarke et al., 2022) for sports organisations to recognise when they want to analyse and resolve areas of concern within the framework of their net-zero timeline (Clarke et al., 2022).

As it was established with the given examples, the environmental impact of travel by visitors to an event is despite their size the most significant one. Consequently, transportation of event visitors must be recognized as the sector that shows the highest potential to be reduced which leads to the question of what the current examples and practices are, that address this issue. Therefore, in the next section, relevant case studies will be presented to showcase the recent state of knowledge in this field.

2.2.4 Case Studies and State of Knowledge on Visitors' Impact on Environmental Sustainability at Sports Events

In the realm of scientific literature, an abundance of research has been conducted on the environmental sustainability of sport events. Notably, a significant portion of this research has cantered around major and mega sport events, owing to their global visibility and considerable environmental implications. Within this extensive body of work, main thematic areas focused on critical and inquiry-based analysis, and sport event stakeholder perception of environmental sustainability and sport events (Dingle & Mallen, 2021). The most researched area is the environmental impact of sport events.

This is also shown by the previously mentioned studies, especially about sports organisations with mega and major sports events, addressing the calculation of CO2 emissions by sector of sports events. In the case of mega and major sports events, it is not necessarily a surprise that these publications are being made, because of the enormous public attention and calls for more environmental actions. However, there remains a significant gap when it comes to addressing the pressing issue of transportation as the primary source of carbon emissions in smaller-scale sports events. Although the significance of transportation in contributing to the overall carbon footprint of sports events is recognised, limited research has been undertaken to specifically tackle and reduce its environmental impact. In the following section case studies will be presented all of which focus on (1) the measurement of travel-related carbon emissions. Additionally, one of these case studies will also include (2) carbon-reducing measures implemented in sports events, with a particular emphasis on the critical aspect of transportation. By exploring these studies, we can additionally gain valuable insights into approaches that could be adopted to mitigate carbon emissions associated with transportation in sports events.

One study conducted by Triantafyllidis et al. (2018) examined the spectators' transportation choices and distances travelled to collegiate sporting events, comparing those held at an on-campus university stadium to those at an off-campus stadium, assuming equal capacity (90,000 spectators). Here, the authors made estimations about the CO2 emissions of the travel of spectators by asking about the transportation modes as well as the miles travelled. It was found that the on-campus event had significantly higher CO2 emissions than the off-campus event, which had to do with the high density/low density of the different locations. The authors also indicated that although sports events are mainly connected with beautiful memories and positive experiences, it needs to be emphasised that they simultaneously cause pollution and indirectly impact outcomes on environmental sustainability in a negative way.

Despite addressing the significance of visitors' impact on the environmental sustainability of a sports event, the authors were not putting the travel-related CO2 emissions in relation to the overall CO2 emissions, and more importantly, they were not addressing approaches or possible solutions to decrease the CO2 footprint of the visitors.

A brief report by Triantafyllidis (2018), published in the Journal of Carbon Research addresses sustainable transportation to sports events and outlines that "*No previous study has illustrated the negative impact of the sports industry on climate change.*" (Triantafyllidis, 2018, p. 3). The report only suggests that there is an urgency for strategic management approaches and policy development to reduce emissions, especially in the context of locations of venues with regards to accessibility of public transportation and renewable energy sources of sports facilities and electric car stations. However, the report does not concretise recommendations and makes broad suggestions rather than proposes actual concepts.

Apart from these studies that didn't emphasise possible solutions, there only exists one study that incorporates the calculation of travel-related CO2 emissions of visitors, as well as provides alternatives that aim to reduce the visitors' carbon footprint. The study by Dolf & Teehan (2015) examined the carbon footprint of visitors and team travel for small-scale varsity sports events at the University of British Columbia, using the Life Cycle Assessment (LCA)-based carbon footprint method. The reason for conducting the study was their recognition, that there is a need for sports management literature *"for quantitative environmental impact studies of events, in particular to seek out transport footprint reduction opportunities"* (Dolf & Teehan, 2015, p. 244) which will also be the main focus in this work. In the study of 2015, the travel patterns of spectators and teams were analysed and different scenarios for impact reduction were presented.

In the study, the spectator's travel-related carbon footprint was calculated by asking for information about the transportation mode used by spectators (walking, bike, car, bus for transit, coach for private use, as well as plane) and the travelled distance in km. To receive the emission factors of the transportation modes they used the Swiss coinvent Life Cycle

Inventory database v2.2 adapted for North America. The formula employed to simulate travel impacts for an individual utilizing transportation mode *m* is as follows:

$$I = d * \left(\frac{Ef_{vkm,m}}{Vo_m}\right).$$

The carbon emissions or I = Impact is calculated in kg carbon dioxide equivalents (CO2e), the emission factor $EF_{vkm,m}$ is expressed in CO2e per vehicle km for the corresponding transportation mode, and the average vehicle occupancy rate in passengers per vehicle is expressed in VO_m.

Interestingly, they found out that only 4% of spectators from outside the events' host location had a personal footprint of 330 kg CO2e per person and constituted 52% of the total spectators' footprint. Car travel usage accounted for 66% and had a much smaller average footprint with 17 kg CO2e per person, contributing to a significant overall carbon footprint of 47% of travel emissions. On the other side, the emissions of walking, biking, bus, and coach usage had a combined carbon footprint of only 2%.

Another interesting observation of the study was that there were higher car occupancy rates (2,7 person per vehicle) for event spectators than for commuters of the University of British Colombia, suggesting that spectators of sporting events may be significantly more likely to use carshare than commuters. A similar difference in occupancy rates also applied to bus usage.

In addition to the detailed calculation and estimation of the CO2 emissions of spectators' travel to sports events, the study also focused on addressing these emissions with the aim of reducing them by proposing several approaches, including the provision of data about the potential reduction of CO2 emissions. The established key opportunities for the reduction of the environmental footprint, both for spectators and teams primarily revolve around strategies that focus on:

(a) reducing long-distance air travel,

(b) increasing vehicle occupancy rates, and

(c) promoting the adoption of low-emission travel modes.

The primary emphasis is directed towards long-distance travel by car, plane, and coach, as their findings indicate that this is the primary source of the dominant carbon footprint. A bicycle incentive was proposed as well because of its common understanding of being an environmentally friendly initiative found at events. Furthermore, the authors emphasised that the purpose of their work was to highlight the potential for reducing CO2 emissions rather than to examine the feasibility of the proposed options. In the case of spectators, the authors analysed three strategies (a,b,c) aimed at reducing their overall carbon footprint. For each strategy, they demonstrated the net outcome of CO2 emissions resulting from a 10% change in behaviour, thereby emphasising the relative differences.

The most impactful scenario assumed solutions aiming to reduce plane travel with an estimated decrease of total CO2 emissions of 5.1%. The authors proposed a live stream possibility or a public viewing initiative for spectators with the goal for them to watch the event from their homes since asking fans to simply stay at home would not be expedient. The authors indicate that such an approach would bring the benefit of a decrease in spectator travel and facilitate the participation of a larger number of individuals beyond the seating capacity of the stadium.

In the second scenario, with an estimated reduction of overall CO2 emissions of 4.7%, the authors suggested increasing the occupancy rate of cars, which could be achieved through an incentive program of car sharing. The third and least effective scenario which would reduce total CO2 emissions by 0.8% suggested an initiative to use bicycles to get to the event reducing car use. Here only cars that would arrive from a distance of < 22 km to the event site were replaced since this was the maximum distance travelled by survey participants.

Dolf & Teehan (2015) state that their approach to estimating the CO2 footprint of spectators' travel increases the accuracy and detail when compared to commonly utilized carbon footprint calculation tools. This is achieved by adjusting parameters related to occupancy rates, vehicle technologies, travel distances based on participant type, and localized distribution of transportation modes.

However, the study suggests that CO2 emissions were tracked rather in a generalised matter, meaning that the CO2 footprinting didn't take into account, that there have been certainly spectators travelling with more than just one transportation mode. For instance, plane users needed also to get to and from the airport to the event with a second transportation mode, resulting in more distance travelled. Furthermore, CO_2 footprinting was also generalised in terms of the used occupancy rates, where a mean of 2,7 person per vehicle was calculated resulting from 577 car users. As the authors exemplify:

> *the carbon footprint of one spectator travelling 10 km by car =10 km * (0.368 kg CO2e/vkm ÷ 2.7 p/v) = 1.36 kg CO2e. The car travelled 10 km during that trip but carried (on average) 2.7 people, and thus accounted for 27 person-km.* (Dolf & Teehan, 2015, p. 248)

As the example shows, by using an average the CO_2 footprint of the spectators is not calculated in the most accurate way. Since this study was one of the first that also addresses possible solutions to reduce CO_2 emissions, it is assumed that solutions were kept relatively humble and were not established in very detail. Here it is suggested to use the survey to ask for actual future-based travel behaviour, which can provide an overall more accurate calculation of the reduction of CO_2 emissions. Furthermore, there was no actual model provided for any of the recommended initiatives which would be beneficial to convince the organisers to implement these models to reduce CO_2 emissions.

The authors indicate that their work did not refrain from taking a stance on the debate about assigning responsibility for greenhouse gas emissions, which is necessary for organizations reporting their carbon footprint according to the GHG Protocol. However, the challenge for event management adhering to these guidelines is that the travel emissions of participants, which belong to Scope 3 "optional" emissions, may be ignored by assessors. However, since it was established in the paper that these emissions are significantly high, the authors recommend sports managers and organisers to "*take an inclusive approach to holistically assess major impacts and design solutions that influence maximum impact reduction.*"(Dolf & Teehan, 2015, p. 254).

This work addresses the assigning of responsibility for GHG emissions of a sports event which is the MEO RIP CURL PORTUGAL PRO 2023 and gives recommendations as well as proposes models that can be implemented to effectively reduce CO_2 emissions of the event. Furthermore, this work will contribute to the much-needed research on the environmental impact of small and medium-sized sports events, which have a much higher impact than mega sports events because they happen in much higher numbers (Dolf & Teehan, 2015).

2.2.5 Openness to Pro-Environmental Behaviour

In the context of sports events, studies have been conducted examining the willingness of event attendees to pay for greener and more environmentally sustainable products and initiatives (Dingle & Mallen, 2021). These investigations have shed light on some important findings in terms of the preferences and motivations of event visitors in relation to carbon offsetting.

Van Tonder et al. (2013) revealed that there are demographic differences in the carbon offsetting preferences of attendees. It was observed that older individuals and those who are self-employed tend to show a greater willingness to support greener initiatives. This suggests that age and occupational status play a significant role in influencing an individual's tendency to engage in carbon offsetting activities within the context of sports events. Furthermore, Saayman et al. (2016) focused on the willingness of event attendees to financially contribute to initiatives aimed at reducing the CO_2 footprint of these events. This research found that specific types of environmentally conscious attitudes and beliefs are positively associated with the willingness of event visitors to pay for climate change mitigation efforts. In summary, demographic variables such as age, occupation, and education, as well as a pro-environmental attitude, were identified as significant predictors of an individual's willingness to pay for climate change mitigation. These findings emphasise the importance of adjusting carbon offsetting strategies to the preferences and values of event attendees, considering their demographic characteristics and environmental attitudes.

Moreover, some studies about the correlation of knowledge and education of environmental subjects and pro-environmental behaviour concluded that education and knowledge of environmental issues influence an environmental-friendly behaviour (Heeren et al., 2016; Vicente-Molina et al., 2013). This shows that when the awareness and education of people about the environment increases, there could be an increase of pro-environmental behaviour.

2.3 World Surf League

The World Surf League was established in 1976 and is the international organisation of the surfing sport, with its headquarters in Santa Monica, USA (WSL, n.d.-a). WSL incorporates Tours and Events in the whole world, in which the world’s best professional surfers across all surfing disciplines compete. Every year there are more than 180 global contests to crown the undisputed World Champions across all disciplines. Besides the most watched men's and women's Championship Tours (CT), there are also the Qualifying Series (QS), the Longboard Championships, the Junior Championships, the Big Wave Tour and the XXL Big Wave Awards.

2.3.1 WSL Pure and WSL One Ocean: Promoting Environmental Sustainability in Surfing

WSL created WSL Pure (Progressive Understanding and Respect for the Environment), which is a non-profit organisation and an initiative that is dedicated to supporting ocean health with the help of research, education, and advocacy (WSL, 2016). The initiative was founded in 2016 and aims to educate and empower the protection of the ocean, starting with the global surf community.

Furthermore, WSL One Ocean, formerly known as "WSL We Are One Ocean" was established, which is an initiative "*to inspire the global surf community to protect and conserve the global ocean, preserving the future of our sport*" (Suhar, 2023). Its objective is "*to position the WSL as a leader among sports organizations in the conservation and sustainability spaces—a league that operates with purpose and leads with values*" (Suhar, 2023). WSL mentions that within two years, they have brought together more than 100 organisations, educated 35,015 youth on cultural and environmental stewardship, protected, or conserved 347,219 hectares of land, including the establishment, and strengthening of 8 surf-protected areas, reduced their CO2 emissions by 49% from events and operations since 2018, as well as reduced their waste by 70% from events and operations since 2018 (WSL, 2022).

WSL (2019d) announced on June 4th, 2019, that a series of sustainability commitments will be taken, setting a new standard for global professional sports and their associations. These commitments have the goal to "*inspire, educate and empower ocean lovers, while addressing critical environmental issues*" (WSL, 2019d) and will be incorporated in all WSL Championship Tour and Big Wave Tour events which include the following actions:

1. *Becoming carbon neutral globally by the end of 2019;*
2. *Eliminating single-serve plastics by the end of 2019; and*
3. *Leaving each place better than it was found* (WSL, 2019d)

These commitments resulted because of the organisations' concerns about increasing global temperatures, which causes more extreme weather events and dangerously rising sea levels; the acidification of the ocean that destroys coral reefs and marine life; and the increasing amount of microplastics that are ingested by marine life and ultimately entering our food and water.

The only public data of a more detailed demonstration of WSL's commitment regarding their sustainability actions are described in the following:

1. Becoming carbon neutral globally by the end of 2019

WSL claims to offset its carbon footprint of all events, business operations, and staff and athlete travel of the Championship Tour and Big Wave Tour by investing and supporting certified carbon offset projects such as REDD+ (reduce emissions from deforestation and forest degradation) and VCS (Verified Carbon Standard) (WSL, 2019a). These projects have the aim to restore and protect natural ecosystems and renewable energy ecosystems that are based in the regions in which WSL Championship Tour events are held.

Furthermore, WSL aims to reduce its carbon footprint by regionalising its operation, limiting unnecessary travel, and creating policies, that reduce CO2 at its offices. According to WSL, staff flights were the largest source of emissions in the 2018 season, accounting for 53.1% of all emissions. This number has been brought down to 45.8% of all emissions.

The calculation of WSL CO2 footprint was done in cooperation with a certification organisation called "STOKE" (Sustainable Tourism & Outdoors Kit for Evaluation) until the 2022 season and is currently done with "One Carbon World".

2. Eliminating single-serve plastics by the end of 2019

To eliminate single-serve plastic, WSL specifically targets items that are related to the catering at an event, which include bottled beverages, cutlery, and cups arguing that they can't be recycled. In addition, to reduce plastic at the events, refill stations of clean drinking water and compostable materials are provided.

3. Leaving each place better than it was found

WSL commits to leaving every beach in a better condition than they found it by reducing the footprint of their events and developing a financial grant program, that provides money to local projects and non-profit organisations that work in safeguarding the coasts and protect coastal habitats.

2.3.2 Calculation of Carbon Footprint by WSL

WSL is calculating their event carbon footprint according to Scope 1, Scope 2, and Scope 3 of Greenhouse Gases at the United States Environmental Protection Agency (EPA) (Suhar, 2023). WSL uses data sheets to capture all the information they need at each event.

The following requests are sent to each event lead (see Table 4).

Table 4

Calculation of Event's Carbon Footprint by Scope (WSL)

Scope 1 Direct emissions from owned or controlled sources at your business such as on-site fossil fuel combustion (e.g., generators, propane/LPG for cooking, etc.) and fleet fuel consumption (e.g., staff and/or guest shuttles, boats, jet skis, etc.).
Diesel fuel in litres or gallons (not cost) for generators, vehicles, etc.
Biodiesel blend (e.g., B20, B80, etc.) in litres or gallons to track emissions savings
Petrol fuel in litres or gallons (not cost) for generators, jet skis, ATVs, shark planes, etc.
If applicable, any propane/LPG used on-site for heating or cooking in whatever unit of measurement they can provide
Scope 2 Indirect emissions from the generation of purchased energy such as electricity and natural gas from the grid.
Electricity usage in kWh from the grid (if applicable)
Natural gas usage in kWh or Btu from the grid (if applicable)
Scope 3 Indirect emissions that are not controlled by you but are a result of your operations and supply chain (e.g., guest travel, employee commuting, vendor transport, waste management, food sourcing, etc.).
Waste management for all waste streams needs to be clearly identified (e.g., cardboard, plastic, mixed recyclables (and what is included in the mix) or glass only, etc.) and recorded by weight or we can take volume and convert it to weight based on the type of waste (e.g. plastics weigh less than composted food). This is critical to tracking emissions savings
Any shuttles provided to staff and/or attendees on-site (by mi or km travelled and type of vehicle/fuel).
(If possible) Vendor travel to the event e.g., local caterers, etc.

WSL mentions that on average each event emits around 15 tonnes of CO_2. In their carbon accounting outline, they include the following points:

- WSL Events (Fuel, Grid Energy, Waste Management, Vendor Travel)
  - 11 - Championship Tour
  - 2 - Big Wave
  - 3 - Longboard
- Freight (broadcasting)
- Offices (energy and waste)
  - Santa Monica, Hawaii, Australia, Europe, South Africa, Brazil, Surf Ranch, KSWC Culver City
- Employee commuting & teleworking
- Surf Ranch (energy and waste data for the entire year)
  - Culver City
  - Lemoore

WSL does not include athletes and staff travel in the CO_2 emission calculation of a CT tour stop, but the CO_2 emissions of athletes and staff travel are tracked separately and offset. That is why the average of 15 tonnes of CO_2 emissions per event is relatively low. However, WSL is on one side calculating their events' CO_2 emissions by the three scopes of EPA, on the other side it is not including spectators' travel, which is the biggest contributor to most events and is listed under Scope 3. Furthermore, the CO_2 emissions caused by event spectators have also never been tracked.

2.3.2 WSL as Participant of the United Nations Sports for Climate Action

Since 2018, WSL has been a participant and signatory of the United Nations Sports for Climate Action which is an initiative that is designed to assist and lead sports actors in reaching global climate change objectives (United Nations, n.d.). By joining forces in the climate neutrality journey, sports organisations can demonstrate climate leadership. Assuming responsibility for their climate footprint will incentivise climate action not only within the sports sector but also beyond it, ultimately contributing to a higher global ambition to address the challenges of climate change.

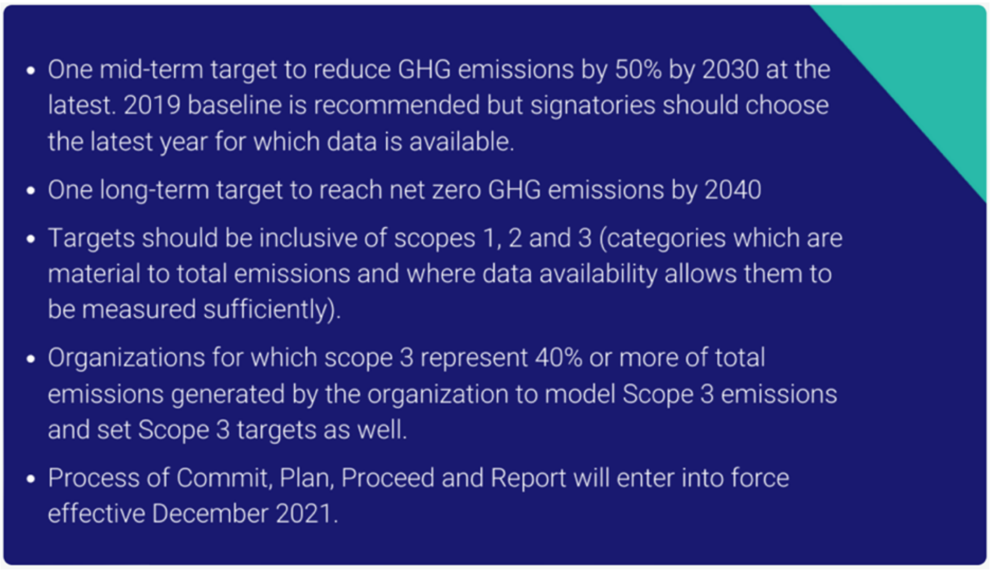
Furthermore, the Sports for Climate Action has two main objectives:

1. Establishing a definite path for the global sports community to combat climate change by making commitments and forming partnerships based on verified standards. This includes measuring, reducing, and reporting greenhouse gas emissions in alignment with the goals set by the Paris Agreement to keep global warming well below 2 degrees Celsius.
2. Utilising sports as a unifying force to bring people together and foster solidarity among global citizens in support of climate action.

As part of the Sports for Climate Action signatories must adopt the targets and requirements that are presented in Figure 4.

Figure 4

Sports for Climate Action - Targets & Requirements



Note. Reprinted from "Sports for Climate Action", by United Nations, n.d., Retrieved from https: //unfccc.int/climate-action/sectoral-engagement/sports-for-climate-action Copyright 2023 by UNFCCC

2.3.3 MEO RIP CURL PORTUGAL PRO 2023: Introduction of the Surfing Event

As part of the WSL Championship Tour, the MEO RIP CURL PORTUGAL PRO was the third stop of the 11 tour stops of the 2023 season. The professional surfing competition is part of the WSL Championship Tour since 2010 and is the only European tour stop. The event took place between the 8th and 14th of March 2023 at Supertubos beach in Peniche, Portugal. Due to bad surf conditions, the first rounds of surfing started on the 11th and continued until the finals day on the 14th. The arguably most prestige surfing event in Europe draws every year tens of thousands of visitors from all over the world to the

Portuguese coast. In the 2023 edition, more than 150,000 fans gathered which record for the biggest beach sports event ever held in Europe (Ascensão, 2023).

3. Methodology

In this chapter the methods applied in this research are presented. First, a general explanation of the research methods and a comprehensive description of the survey will be provided. Subsequently, the information will be organised by the key survey categories, starting with the *Estimation of the Travel-Related CO2 Footprint*, which is the primary objective of this study. This category also includes the Statistical Analysis of the carbon footprint estimation. Additionally, the survey category related to the *Awareness of Promotion of Environmental-Friendly Travel* will be discussed, followed by the section on the *Openness to More Environmental-Friendly Transportation* practices, which also includes the calculation of the change of the samples' CO2 footprint based on the participants' perception of future transport preferences. Moreover, the category *Familiarity with Environmental-Related Concepts* will be addressed, and finally, the topic of *Offsetting CO2 Emissions* will be discussed.

3.1 Quantitative Analysis

To assess the environmental impact of the MEO RIP CURL PORTUGAL PRO 2023 and estimate the travel-related carbon footprint of the visitors, a quantitative research approach was employed. This method involved surveying 121 event attendees to gather quantitative data. The results obtained from this survey were subsequently analysed and interpreted.

Survey Questionnaire Description

The survey was carried out at the Supertubos beach event site in Peniche between the 11th and 14th of March 2023. On the 8th of March, on which the event was supposed to start but then called off because of bad surf conditions, the event site was visited to get familiar with the infrastructure of the event and the different areas. Furthermore, it was decided to test the survey and assess the duration and comprehensiveness of the questionnaire. The full version of the survey questionnaire, available in both English and Portuguese languages, can be found in Appendix A. The assistance of the Turismo do Surf study course at ESTM was instrumental in gathering responses from visitors on one of the days. To facilitate data collection, participants were asked to fill out the survey online using Google Forms. They could access the survey questionnaire by scanning a QR code corresponding to their preferred language, English or Portuguese, with their mobile phones (see Appendix B). The English version ensured the accessibility to the survey questionnaire for international tourists as well. In cases where participants did not have a phone or internet access, the conductor's phone was used to fill out their responses.

QR code sheets were distributed throughout the event site, allowing for the approach of visitors and invitation to take part in the survey. Additionally, QR code sheets were set up at the Municipality of Peniche's stand and Peniche Surfing Club stand, enabling visitors to complete the survey independently without assistance.

Questions regarding the calculation of the CO2 emissions of visitors' travel were derived from previous work by Dolf & Teehan (2015) and Wicker (2018).

The questions were formulated in various formats, including multiple-choice, Likert scale, open-ended questions, and Yes or No questions.

The survey was thoughtfully structured into five distinct categories, which will be presented and discussed in the following sections:

(1) Estimation of Travel-Related CO2 Footprint

(2) Awareness of Promotion of Environmental-Friendly Travel

(3) Openness to More Environmental-Friendly Transportation

(4) Familiarity with Environmental-Related Concepts

(5) Offsetting CO2 Emissions

3.1.1 Estimation of Travel-Related CO2 Footprint

i) Questionnaire Description

The method used to calculate the CO2 footprint of the visitors was derived from Stahl et al. (n.d.) and Dolf & Teehan, (2015). The CO2 footprint of the sample size of each of the 121 participants was calculated in terms of their travel from their place of residence or temporary accommodation to the event destination and back, as it was done by Dolf & Teehan (2015). In Question 1-8, information that was necessary to calculate the CO2 footprint of the spectators were collected (see Appendix A). The aim was to figure out from which place participants started their travel journey knowing that they would visit the MEO Rip Curl Portugal Pro. Additionally, it was important to determine what transportation means (plane, car, campervan, bus, train, bicycle/foot) participants used in order to get to the event. The selected transportation means were derived from the study of Triantafyllidis (2018).

ii-a) Statistical Analysis

In the following the methods to calculate each transportation mode will be presented.

Airplane

To compute the CO_2 footprint of plane travel, the carbon emission calculator provided by the International Civil Aviation Organization (ICAO) was used (ICAO, n.d.). By inputting the origin and destination into the website, the calculator generated the total travelled distance in kilometres and the corresponding CO_2 footprint per passenger for a one-way flight.

Car, Campervan, Bus

To calculate the CO_2 footprint of car, campervan, and bus travel journeys, it had to be determined where participants arrived from in order to get to the event, knowing that they would visit the event. Furthermore, they had to state which modes of transportation, they used in order to arrive at the event destination. This way, it was included that some people may travel with more than one transportation mode. After collecting this data, the distances in kilometres were determined by using viamichelin (n.d.), choosing the shortest distance to the event destination to provide the most conservative CO_2 footprint. In the next step, the emissions factor (EF) per kilometre for each vehicle type was determined in the "PORTUGUESE NATIONAL INVENTORY REPORT ON GREENHOUSE GASES, 1990 - 2020" by the Agência Portuguesa do Ambiente, which is a report, that focuses on CO_2 emissions of different sectors in Portugal (T. C. Pereira et al., n.d.). The formula from Dolf & Teehan (2015) was employed with some adjustments to calculate travel carbon emissions *I = Impact* in kg carbon dioxide equivalents (CO_2e) for an individual utilising the corresponding transportation mode *m*. The *emission factor* = $EF_{vkm,m}$ is expressed in CO_2e per vehicle km for the corresponding transportation mode. The vehicle's number of occupants is expressed in VO_m. For car and campervan, it was aimed to receive the most accurate occupancy rate by asking each questionee how many passengers were in the vehicle to go to the event. For bus travel, there was no information provided by the bus companies, so it was assumed an occupancy rate of 50% for a standard coach with a maximum capacity of 34 seats.

$$I = d \ * \ \left(\frac{Ef_{vkm,m}}{Vo_m}\right).$$

The kilometres of each vehicle type were then multiplied by that vehicle's EF per km and then divided by the corresponding number of occupants of the vehicle to calculate the total CO2 emissions.

ii-b) Statistical Analysis

In the following the methods used to extrapolate the sample to the population will be presented.

A key issue was to estimate the global carbon footprint of the visitors attending the event. To understand how the overall carbon footprint is comprised of contrasting inputs the data can be broken down into its primary contributory components. The approach taken was to characterise individual visitors by different behaviour types defined by their mode of transport (and associated distance travelled), thus facilitating subsequent discussion of possible solutions (to reduce the CO2 footprint) arising from their respective travel characteristics. The carbon footprint associated with each mode of transportation was assessed separately, including car, bus, campervan, and plane. For all respective modes of transport, corresponding frequency distributions were highly skewed (rendering statistical tests contingent upon assumptions of normality inappropriate). Hence, bootstrapping was applied to obtain 95% confidence intervals for the mean carbon footprint per mode of transportation (Manly, 2018). For each mode of transport, the derived carbon footprint of visitors was bootstrapped. By performing sampling with replacement (N=10,000), bootstrapped estimates for the mean CO2 footprint and associated 95% confidence intervals were derived using the Efron percentile method (Efron & Tibshirani, 1994). The same approach was employed to obtain 95% confidence intervals for the proportion of visitors using respective modes of transport.

Travel by plane and campervan were characterised by relatively small sample sizes (N=11 and N=8, respectively). These comparatively small sample sizes necessarily produce less robust statistical estimates; the risk may be particularly acute for these data, given that frequency distributions for all modes of transport are characterised by highly right-skewed data. Given the importance of aviation and campervan to the travel plans of visitors attending surf events, and their significant contribution to the overall CO_2 footprint, results for these modes of transport are presented, while their interpretation should bear in mind the usual caveats associated with small sample (Simmons, 2018).

The global carbon footprint for respective modes of transport was based on these derived mean values and then scaled up to estimate values for the overall number of visitors reported to have attended the event by extrapolation of these data. In consultation with WSL, a total visitor number of an estimated 150,000 people was provided. This process was repeated using the lower (2.5%) and upper (97.5%) confidence intervals (CI) to derive the most conservative (least carbon footprint) and extreme (highest carbon footprint) scenarios, respectively.

3.1.2 Awareness of Promotion of Environmental-Friendly Travel

In Question 9 of the survey participants were asked whether they noticed any efforts by WSL to encourage them to travel by public transport or carsharing to the event (see App. A). If they answered yes, they were further prompted to specify which efforts they observed.

3.1.3 Openness to More Environmental-Friendly Transportation

i) Questionnaire Description

In question 9b, participants were asked to indicate how likely it would be for the next event to switch to carsharing, public transport, or reserved bus alternative to arrive to and from the event if managed and organised on the WSL website (see App. A). They had to choose in a 5-point Likert scale for likelihood from the following options: very unlikely, unlikely, neutral, likely, or very likely for each transportation option.

ii) Analysis

The subsequent explanation focuses on estimating the potential reduction in CO_2 emissions from samples' travel based on the participants' responses regarding their transportation preferences for the next event.

Thus, a *New carbon footprint* of participants was calculated that selected "Very likely" or "Likely" to use either Organised buses, Carsharing, or Public transportation. It was always used the least emitting transportation mean when the options were rated with the same score. Thus, when rated Organised buses, Public transportation, and Carsharing each with "Likely", the least emitting transportation means, Organised buses would be used. Furthermore, participants that came from outside of Portugal were not included because of the complexity for WSL to organise buses or Carsharing from other countries than Portugal. The *New carbon footprint* was then used to establish the potential CO_2 reduction.

To calculate the change in the CO_2 footprint based on participants' perceptions of future transport choices, the same emission factors (EF) as presented in Chapter 3.1.1, *Estimation of CO_2 Footprint* (Buses = 0,69347 kg CO_2/km), (Cars = 0,19653 kg CO_2/km) were used. For Public transportation, the same EF (0.69347 kg CO_2/km) as that of buses was used. Because busses would be organised, the event organiser could offer the most carbon-efficient transportation option. Therefore, it was assumed that Organised buses would operate with 100% occupancy rates, meaning that EF of (0,69347 kg CO_2/km) would be divided by a factor of 34, which represents the maximum seats of a standard coach. Similarly, for Carsharing, it was assumed that the event organiser could offer the most carbon-efficient transportation and therefore with a 100% occupancy rate, the EF of (0,19653 kg CO_2/km) would be divided by a factor of 5 (standard 5-seat car). However, for Public transportation, a lower occupancy rate of 50% was assumed since WSL would not have control over the occupancy rate of Public transportation offers. Thus, the EF of (0,69347 kg CO_2/km) would be divided by a factor of 17. Hence, the difference in CO_2 emissions between Organised buses and Public transportation can be explained.

3.1.4 Familiarity with Environmental-Related Concepts

In question 10, participants were asked to indicate their level of familiarity with each of the terms "Carbon footprint," "Carbon Offsetting," and "Environmental projects supported by

WSL focusing on coastal restoration and conservation (We Are One Ocean)". (see App. A) They had to choose from the following options: very unfamiliar, unfamiliar, somewhat familiar, familiar, or very familiar for each term.

3.1.5 Offsetting CO_2 Emissions

In question 11, participants were asked if they would offset their travel-related emissions to and from the event if WSL would give them the opportunity at the event, by choosing any of the programs of "We Are One Ocean" (see App. A). They were provided with three response options: "Yes, but only up to a certain amount of money", "No", or "I don't know the concept of carbon offsetting and therefore can't give an answer on that".

Participants who answered with "Yes" were then asked to specify the maximum amount they would be willing to spend. They were given a reference that 1 tonne of CO_2 equals 25€ or approximately 4,900 km driven by a middle-class gasoline car. The price of 25€ for 1 tonne of CO_2 is based on the baseline year of 2021 from the "Deutsche Emissionshandelsstelle" (DEHSt), which is the German Emissions Trading Authority at the German Environment Agency (Umwelt Bundesamt, n.d.). National emission trading is a new climate protection instrument of Germany since 2021 to reduce CO_2 emissions. After that, they were asked the maximum amount they would be able to spend if WSL would match their contribution. This question was directed also to those who previously answered "No" to the carbon offsetting question. Participants who responded with "I don't know the concept of carbon offsetting and therefore can't give an answer on that" were directed to the Demographic Questions. In Question 12, participants who previously answered "Yes" or "No" to carbon offsetting were asked if they would prefer to support a local project that benefits the environment in the event's location, or if the location of the project is not an important factor in their decision.

Finally, in Question 13, these participants were asked whether they think that CO_2 offsetting is effective in protecting the environment and were invited to explain their decision.

3.2 Calculation of Event's Total CO_2 Footprint by WSL

In Chapter 2.3.2, the total CO_2 footprint of the CT stop in Peniche was briefly discussed. According to WSL, CO_2 emissions are tracked from diesel/petrol and propane/LPG consumption (Scope 1), electricity/natural gas (Scope 2), and waste management/shuttle bus for staff and attendees, as well as travel from vendors (Scope 3). The provided CO_2 footprint of these activities amount to around 20 tonnes of CO_2. This number does not include travel of athletes and staff. According to WSL, 25 staffs were traveling from Los Angeles to Lisbon. Here, it was assumed that the staffs were also returning to Los Angeles. Furthermore, 50 athletes were travelling from their last event stop in Hawaii to Portugal. A round trip was not considered since it was assumed that athletes would continue to the next surf event in Australia.

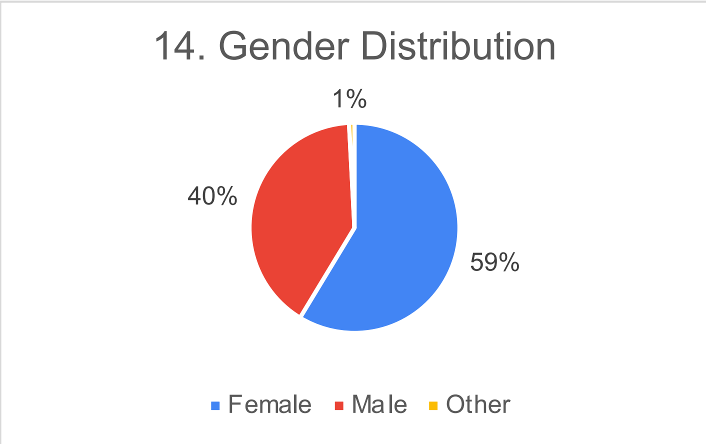
The CO_2 footprint of staff and athletes were calculated by using the International Civil Aviation Organization (ICAO, n.d.). The least emitting flight routes were chosen for both staffs and athletes.

4. Results

In total, 121 visitors of the MEO RIP CURL PORTUGAL PRO 2023 participated in the survey questionnaire, with 40% identified as male, 59% as female, and 1% as other or preferred not to disclose (see Fig. 5).

Figure 5

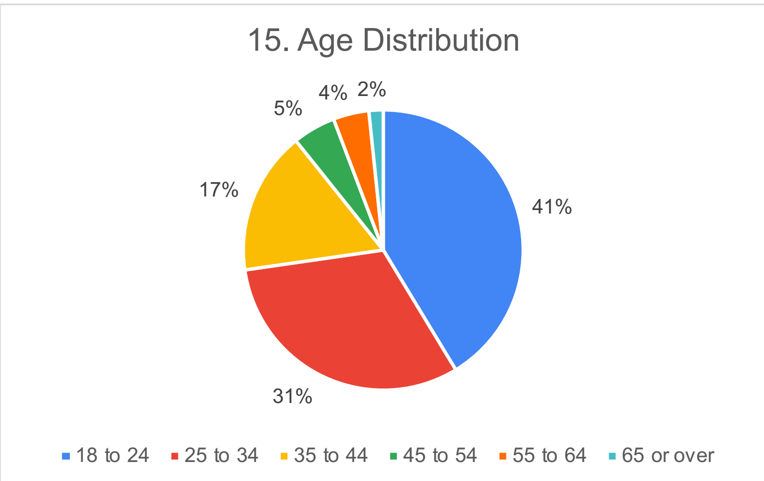
Gender Distribution



Furthermore, the participants in the survey were distributed across various age groups (see Fig. 6), with the majority (41%) falling between the ages of [18-24], followed by 31% of the age group [25-34], followed by 17% of the age group [35-44], and smaller proportions in the age group [45-54], accounting for 5%, followed by 4% of the age group [55-64], and 2% of the age group [65 or over].

Figure 6

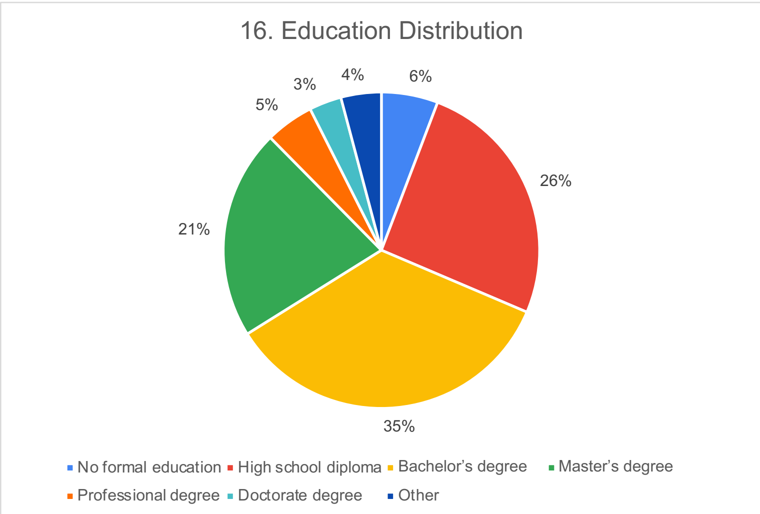
Age Distribution



The participants in the survey of the MEO RIP CURL PORTUGAL PRO 2023 exhibited diverse educational backgrounds, with varying levels of educational attainment (see Fig. 7). A significant portion of the participants held a bachelor's degree, representing 35%. Additionally, 26% reported having obtained a high school diploma. Furthermore, 21% indicated having completed a master's degree. Moreover, 5% had a professional degree, and 3% finished a Doctorate degree. 4% of participants chose "other" as their education level, reflecting diverse educational backgrounds beyond conventional categories. Additionally, 6% of participants did not have any formal education.

Figure 7

Education Distribution



The findings of the five categories of the survey will be presented in the following.

(1) Estimation of Travel-Related CO2 Footprint
(2) Awareness of Promotion of Environmental-Friendly Travel
(3) Openness to More Environmental-Friendly Transportation
(4) Familiarity with Environmental-Related Concepts
(5) Offsetting CO2 Emissions

4.1 Estimation of Travel-Related CO2 Footprint

The CO2 footprint was calculated according to the transportation means of plane, campervan, car, bus, train, and bicycle/walking, which distribution of usage by transportation can be seen in Figure 8. Since some participants used more than just one transportation mean the figure shows the number of transportations used. Hence, cars were the most used transportation means (88). Bus travel was chosen 25 times and Bicycle/Walking was selected 20 times. Planes were chosen 11 times and Campervan 8 times. The transportation by train was not used by any of the participants.

Figure 8

Usage Distribution by Transport

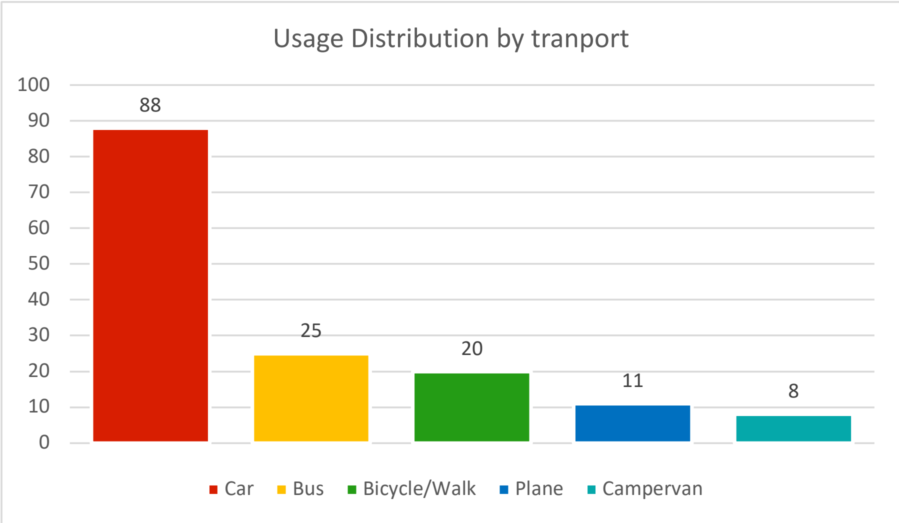


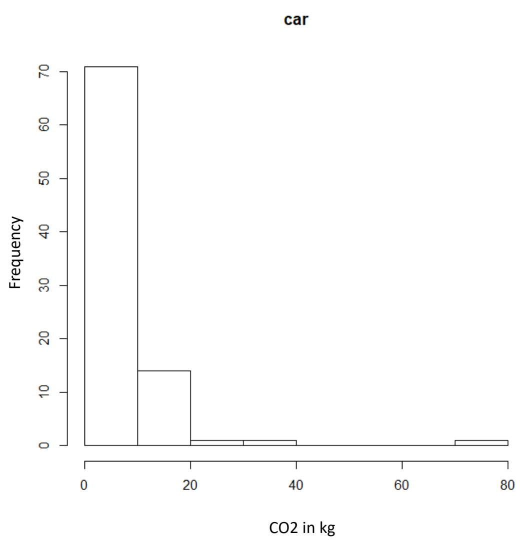
Figure 9 represents the frequency distributions for the carbon footprint associated with respective modes of transport. It should be pointed out that the x-axis scales of the histograms are not the same, revealing the very different ranges of carbon impact of the different means of transportation.

The graphs are right-skewed, representing a comparatively smaller number of long-distance travellers.

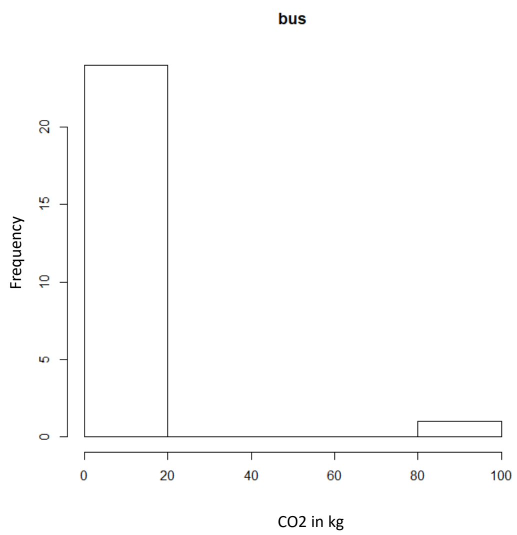
Figure 9

Carbon footprint distribution per mode of transportation

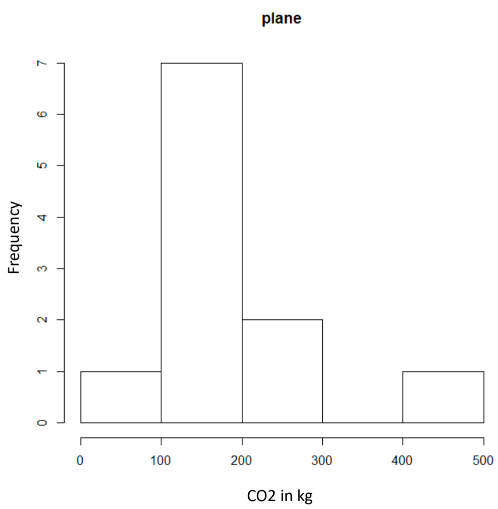
Car carbon footprint distribution (n=88)



Bus carbon footprint distribution (n=25)



Plane carbon footprint distribution (n=11)



Campervan carbon footprint distribution (n=8)

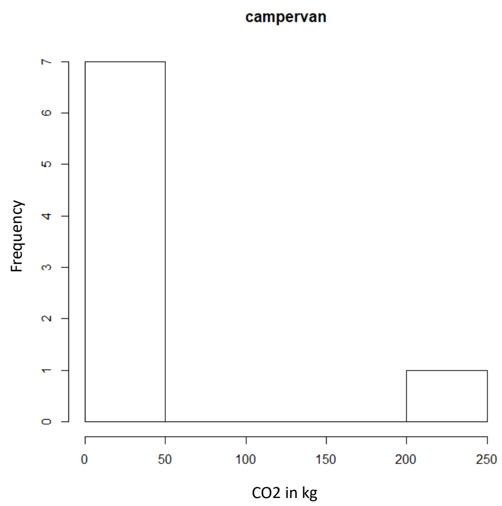


Table 5 represents the results from bootstrapping simulation including the 95% confidence interval for the proportions of visitors using each transportation mode.

Table 5

95% Confidence intervals for proportion of visitors using each mode of transportation

Mode of transportation	n	Proportion	CI lower bound	CI upper bound
Car	88	0,7272	0,6529	0,8017
Bus	25	0,2067	0,1405	0,2810
Plane	11	0,0910	0,0413	0,1488
Campervan	8	0,0663	0,0248	0,1157

Table 6 presents the bootstrapped mean for the carbon footprint associated with respective modes of transport and the 95% confidence interval around the mean value.

Table 6

95% confidence intervals for mean of carbon footprint (one-way trip, in kg) per mode of transportation

Mode of transportation	Mean	CI lower bound	CI upper bound
Car	7,0310	5,4574	9,0198
Bus	6,6542	2,8871	13,7083
Plane	190,3012	144,3907	249,1495
Campervan	45,4034	13,5152	100,1654

Combining the estimations in Tables 5 and 6 the carbon footprint for each mode of transport was estimated and is presented in Table 7.

Table 7

Estimation of CO2 footprint per mode of transport using the centres of CI (one-way trip, in tonnes, for 150,000 visitors)

Mode of transportation	Car	Bus	Plane	Campervan	Total (one-way)	**Total (round trip)**
Carbon footprint estimation (tonnes)	766,9414	206,3134	2597,6113	451,5368	4022,4031	**8044,8062**

The most conservative scenario was also calculated, considering the CI lower bounds of Table 5, for the mean carbon footprint and the corresponding proportions in the confidence intervals in Table 6 to derive the minimum carbon footprint (Car – 0,7272; Bus

– 0,2067; Plane – 0,0910; Campervan – 0,0663). The estimations for this scenario are summarised in Table 8.

Table 8

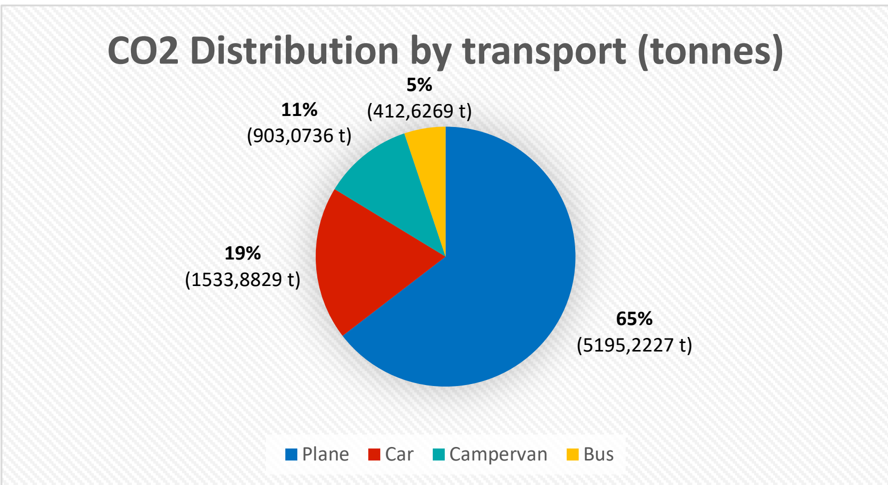
Conservative estimation of CO2 footprint per mode of transport (one-way trip, in tonnes, for 150,000 visitors)

Mode of transportation	Car	Bus	Plane	Campervan	Total (one-way)	**Total (round trip)**
Carbon footprint estimation (tonnes)	534,4704	577,8048	894,5003	50,2765	2057,0522	**4114,1044**

Figure 10 illustrates the distribution of transportation modes based on their CO2 emissions for the centres of CI which is shown in Table 7. It is worth noting that bicycle and walking, as environmentally friendly options, were not considered in the figure since they do not produce any CO2 emissions. Among the 150,000 participants, plane travel was the highest emitter, contributing to 65% of the total CO2 emissions. Specifically, plane travel accounted for 5195,2227 tonnes of CO2. The second largest contributor, with 19%, was car travel, responsible for 1533,8829 tonnes of CO2. Campervans were responsible for 11% of the total CO2 emissions, amounting to 903,0736 tonnes of CO2. Finally, buses produced the least amount of CO2 emissions, constituting 5% of the total, and accounting for 412,6269 tonnes of CO2.

Figure 10

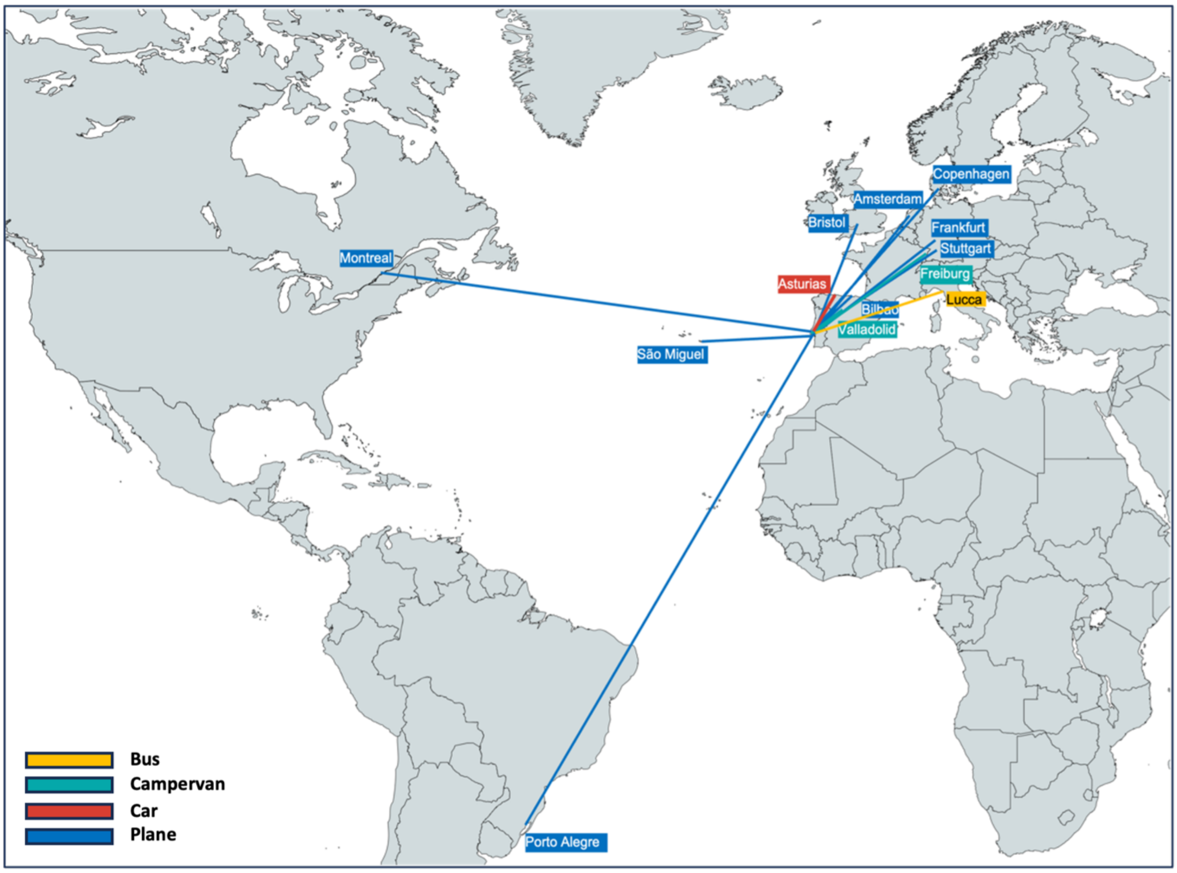
CO2 Distribution by Transport (round trip, in tonnes, for 150.000 visitors)



The travel by the mentioned transportation means is illustrated in the following two maps, showing the destinations which participants travelled from to Portugal and Peniche as well as showing the corresponding transportation means of plane, bus, campervan, and car. Figure 11 displays international travel and shows that some visitors arrived from Montreal, Canada and Porto Alegre, Brazil as the only intercontinental travellers. Furthermore, the majority of international travel originated from within Europe, with Central Europe being the primary region for international travel. Furthermore, as displayed the dominant travel means in the international dimension was plane travel with only two cases of travel by campervan and one case by car.

Figure 11

International Travel & Transport Mode

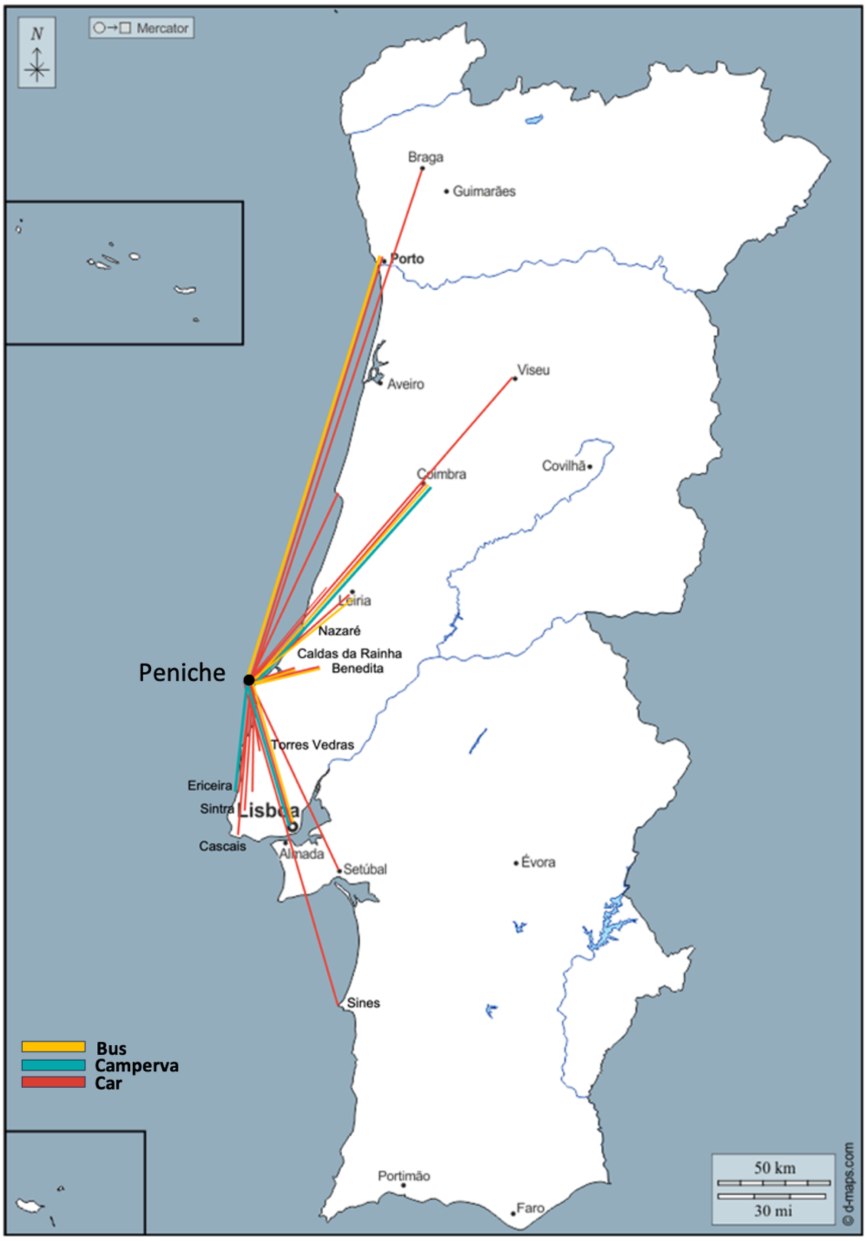


Note. *Adapted from „World Map: Simple", by mapchart, n.d., Retrieved from https://www.mapchart.net /world.html, Copyright 2023 by MapChart*

Figure 12 shows the national travel within mainland Portugal in which the highest concentration can be observed in Central Portugal which is at the same time the region closest to the events' location. The main cities where travel originated from are Peniche, Lisbon, and Coimbra. As the figure shows, transportation by car was dominant.

Figure 12

National Travel & Transport Mode



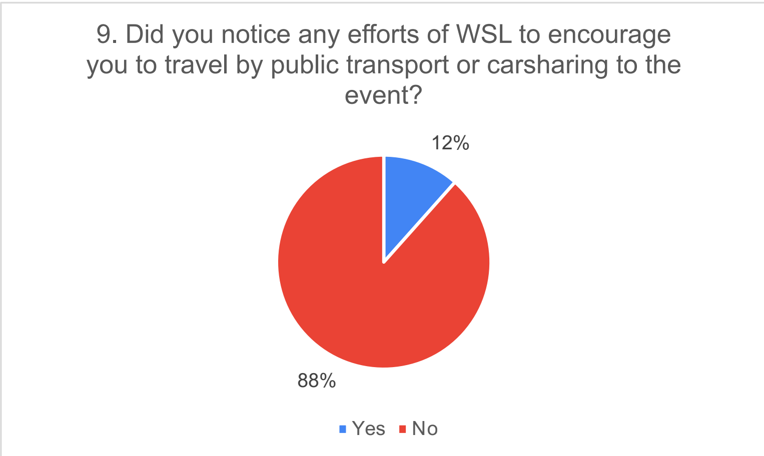
Note. Adapted from "Portugal : main cities", by d-maps, n.d., Retrieved from <u>*https://d-maps.com/carte.php?num_car=61186&lang=en*</u>*, Copyright 2007-2023*

4.2 Awareness of Promotion of Environmental-Friendly Travel

Figure 13 displays the perception of the events' visitors about any efforts of WSL to encourage travel to the event by environmental-friendly transportation options, such as public transport or car sharing. Among the participants, 88% stated that they did not notice any such efforts by WSL, while 12% reported noticing such initiatives. 7% of the participants provided an evaluative response when asked what they noticed and mentioned the provision of shuttle buses for the event as the observed effort.

Figure 13

Awareness of Promotion of Environmental-Friendly Travel

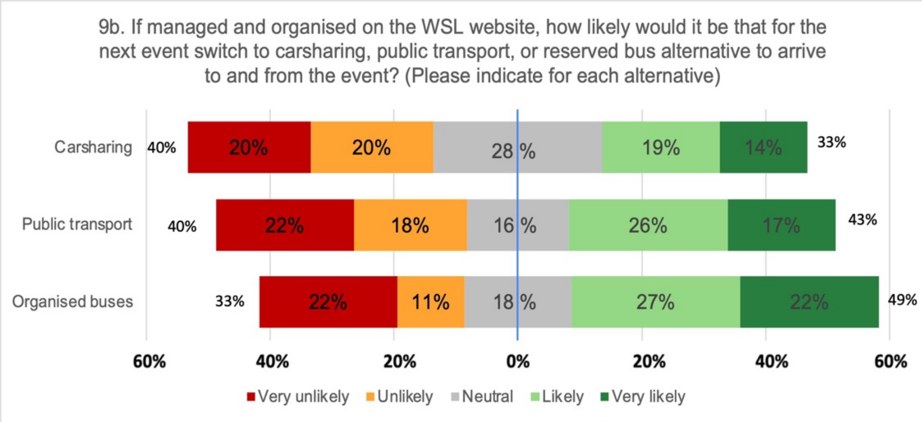


4.3 Openness to More Environmental-Friendly Transportation

Figure 14 illustrates the participants' likelihood of switching to Carsharing, Public transportation, or a reserved bus alternative for travelling to and from the next event if organised and managed on the WSL website. The figure visually demonstrates participants' general tendency towards each transportation option for the next event and the extent of their likelihood or unlikelihood to choose each option. Respondents show the highest openness towards the use of Organised buses which is followed by Public transportation and lastly by Carsharing.

Figure 14

Openness to more Environmental-Friendly Transportation



Considering the responses represented in Fig. 14, it was studied the scenarios in which everyone who answered positively or neutral to the possibility of switching to more eco-friendly transportation mode would actually do it. In 3.1.3 it was explained in detail how these calculations were done.

Figure 15 shows the potential decrease in the overall CO2 footprint of the sample group when using the conservative calculation in which only participants who answered with "Likely" or "Very likely" were considered. From a total of 112 participants, 58% that answered with "Likely" or "Very likely" would therefore reduce the total CO2 footprint of the sample by 10% or by 0,6682 tonnes of CO2.

Figure 15

Decrease of overall CO2 Emission (conservative calculation)

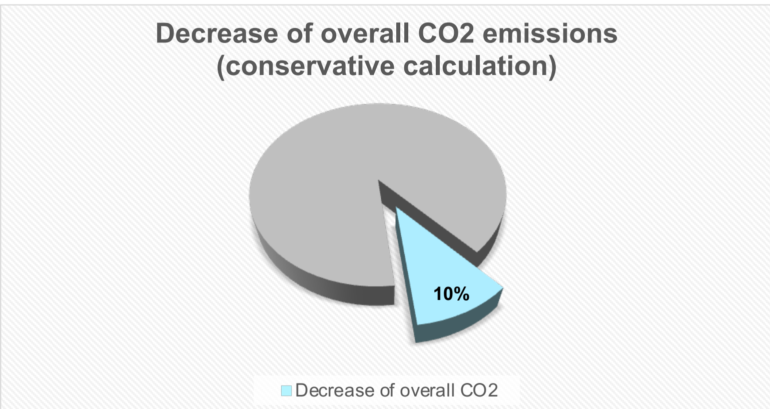
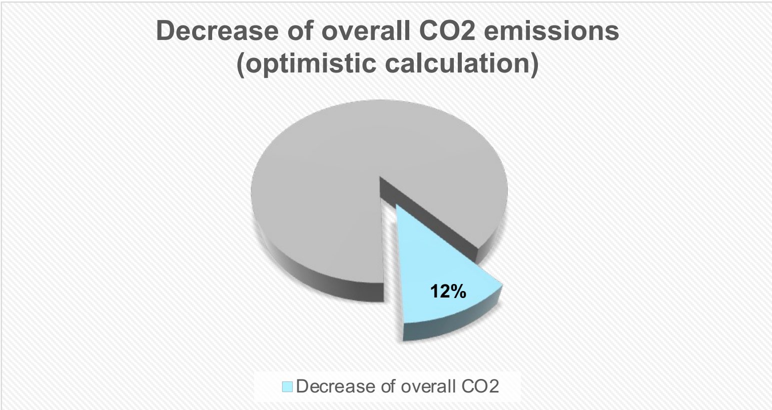


Figure 16 demonstrates the potential decrease in the overall CO2 footprint of the sample group when using the more optimistic calculation. Considered were participants that responded with “Very Likely”, “Likely”, and “Neutral”. Also here, the least emitting transportation means were always used when the options were rated with the same score. According to this calculation, the travel-related CO2 footprint of the visitors would be reduced by 12%.

Figure 16

Decrease of Overall CO2 Emissions (optimistic calculation)

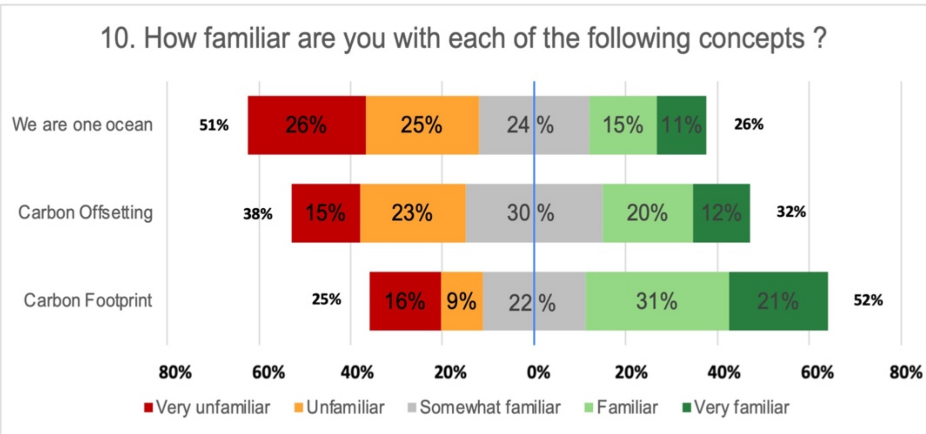


4.4 Familiarity with Environmental-Related Concepts

Figure 17 presents the participants' familiarity with the concepts of "We Are One Ocean", "Carbon Offsetting", and "Carbon Footprint". The most familiar concept with a clear majority is “Carbon Footprint”, followed by “Carbon Offsetting”. It is also shown that “We are ocean” is relatively unfamiliar to the participants.

Figure 17

Familiarity with Environmental-Related Concepts



4.5 Offsetting CO2 Emissions

Figure 18 shows the distribution of participants based on their willingness to financially contribute to offset their travel to and from the event by supporting programs of "We Are One Ocean" if WSL would offer this opportunity at the event. The data reveals that the majority of the participants, accounting for 52%, expressed their readiness to contribute funds to partially or fully offset their travel-related CO2 footprint if given the chance at the event. On the other hand, 13% of participants chose not to contribute any money towards offsetting. Additionally, 35% of respondents indicated that they were not familiar with the concept of carbon offsetting and, as a result, decided not to allocate any funds.

Figure 18

Availability for Offsetting CO2 Emissions

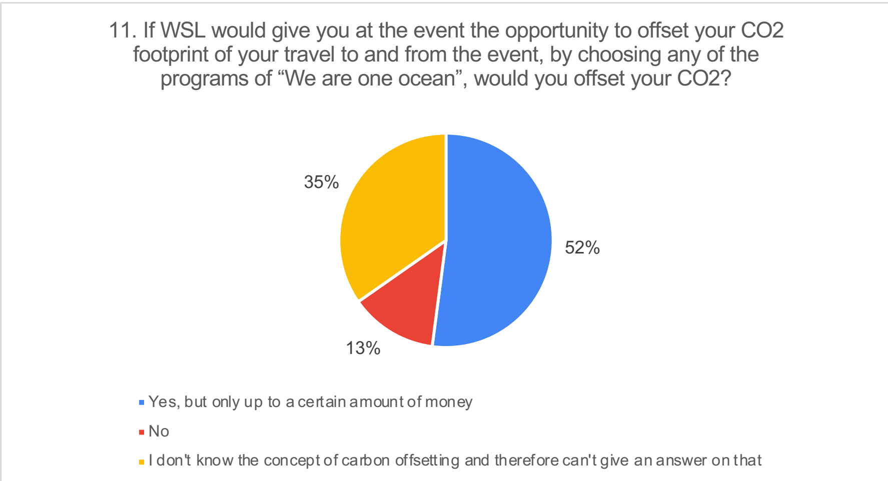


Figure 19 presents the participants' contributions to offset their travel-related carbon footprint and the amount they would contribute if WSL matched their contributions. An average individual contribution of 22.53€ would be contributed to partially or fully offset their travel-related carbon footprint. Furthermore, if WSL matches their contributions, the average individual contribution would increase by 11% to reach 24.92€ per person.

Figure 19

Total CO2 Offsetting Contribution

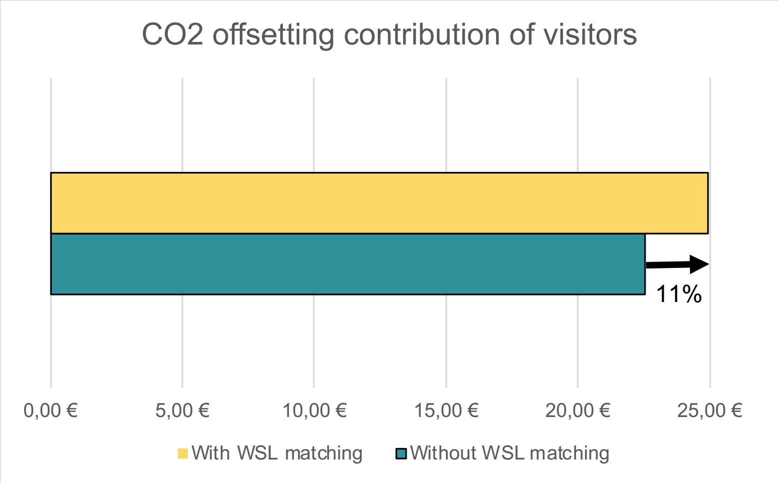


Figure 20 outlines the participants' behaviour considering their contributions when WSL is willing to match their contributions. The figure reveals that 75% of participants would maintain the same amount of contribution, even if WSL matched it. Only 3% would decrease their contribution in such a scenario. However, 22% of participants would increase their contribution if WSL matched their amount.

Figure 20

Participants Willingness to Contribute with WSL Matching

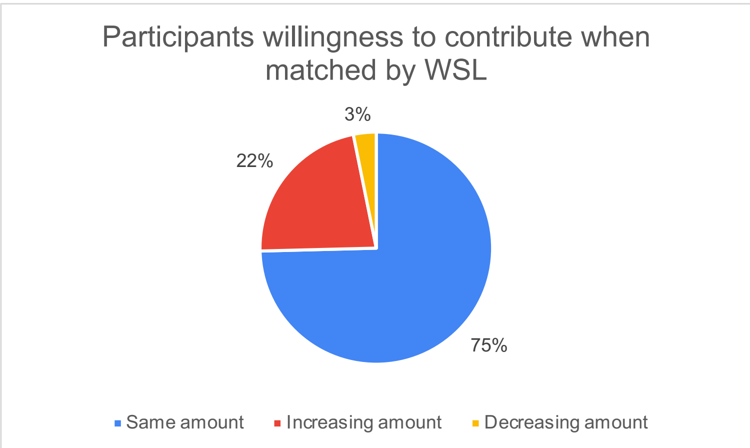


Figure 21 displays the extent to which this group (22%) would increase their contribution if WSL would match their amount. This figure was created to understand whether participants would be willing to make a significantly higher contribution when WSL matches their amount. Without WSL matching, the total contribution amounts to 13,93€ per person.

However, if WSL were to match their amount, the participant's willingness to pay would increase to 29,64€ per person, representing a substantial 113% increase.

Figure 21

Degree of Increase of Contribution per Contributor

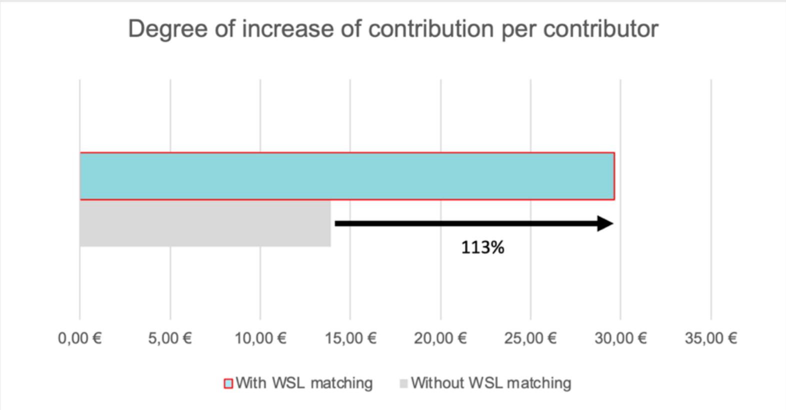


Figure 22 shows the participants' preferences concerning their support of a local project, that benefits the environment in the event's location or of an environmental project in any other location.

Figure 22

Participants' Preference for local or non-local Project

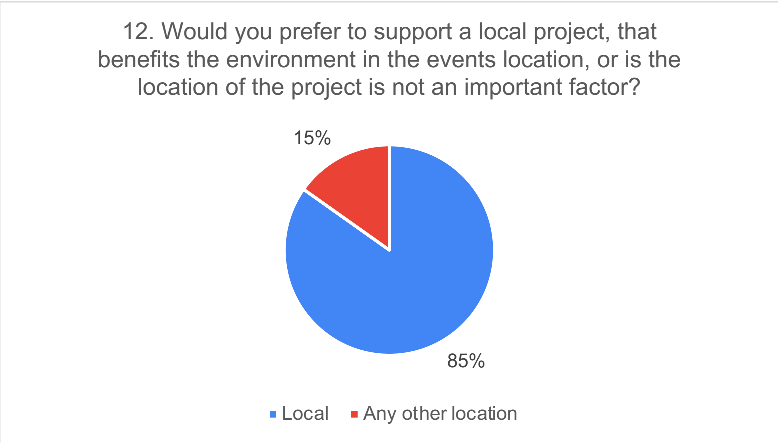
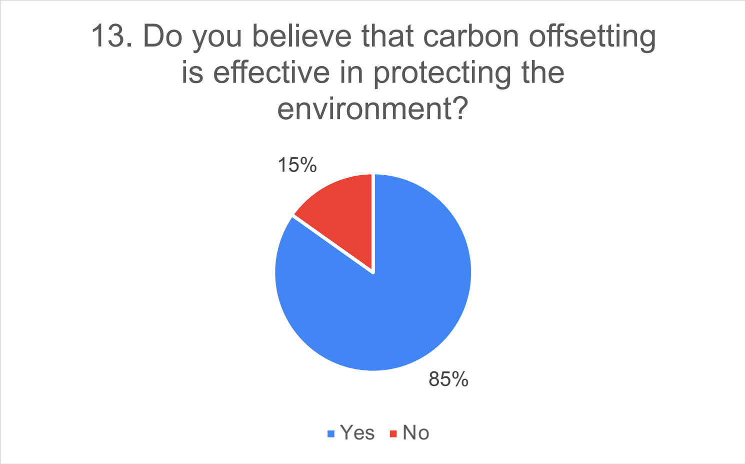


Figure 23 displays the beliefs of participants who responded in Question 11 with either “Yes…” or “No” about the effectiveness of carbon offsetting in protecting the environment. It shows that 85% of these participants believe in the effectiveness of carbon offsetting, while 15% do not.

Figure 23

Participants' Perception about Effectiveness of Carbon Offsetting



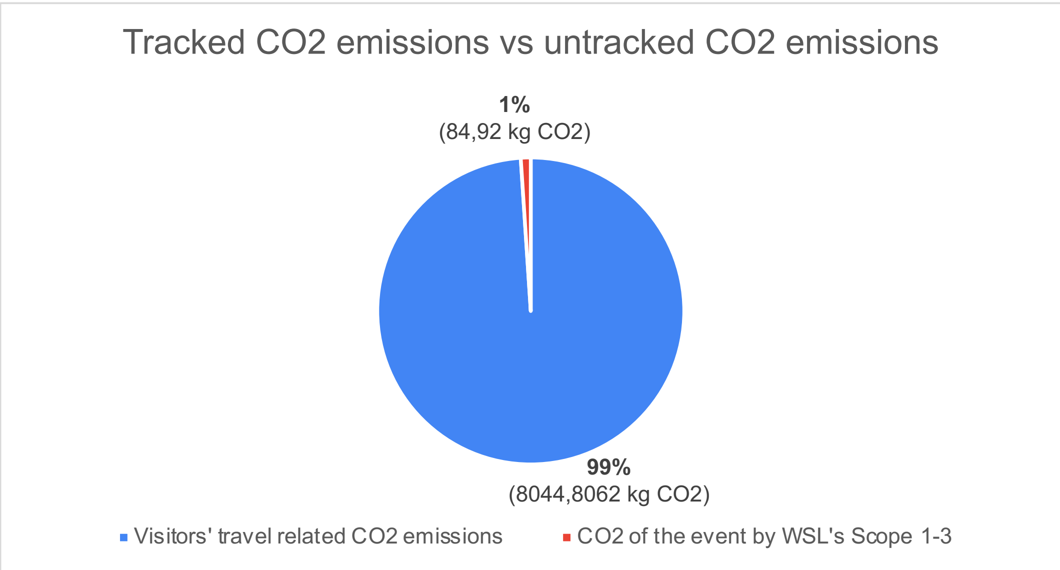
4.6 Calculation of Event's Total CO2 Footprint tracked by WSL

The travel-related CO2 emissions of staff and athletes were estimated at around 64,92 tonnes of CO2. Therefore, the total CO2 footprint of the surf event in Peniche which is calculated by WSL is suggested to be at around 84,92 tonnes of CO2.

Figure 24 illustrates the sum of all Scope 1,2,3 emissions of the surf event in Peniche that are tracked by WSL (1%) in relation to the travel-related CO2 emissions of the event's visitors as part of Scope 3 that are not tracked by WSL (99%), calculated in this work.

Figure 24

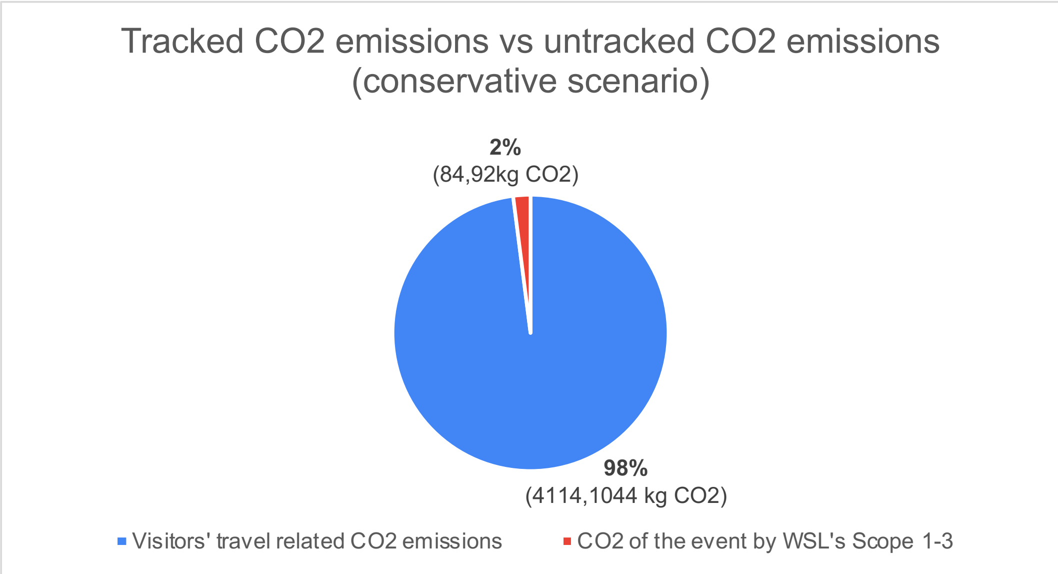
Tracked CO2 Emissions vs. untracked CO2 Emissions



In Figure 25, the distribution of the tracked and untracked CO2 emissions, using the conservative calculated CO2 footprint (see Table 4), of the surf event are presented. It illustrates the sum of all Scope 1,2,3 emissions of the surf event in Peniche that are tracked by WSL (2%) in relation to the travel-related CO2 emissions of the event's visitors as part of Scope 3 that are not tracked by WSL (98%), calculated in this work.

Figure 25

Tracked CO2 Emissions vs. untracked CO2 Emissions (conservative scenario)



5. Analysis and Discussion in Form of a Comprehensive Carbon Footprint Reduction Plan

5.1 Discussion

In the previous chapters, it was given a comprehensive explanation of why it is important to include the CO2 emissions caused by visitors' travel to events in the total CO2 footprint of an event. This was especially illustrated by the detailed calculation and estimation of the visitors' CO2 footprint in Chapter 4.1. Therefore, the travel-related CO2 emissions of the 150,000 visitors to the surf event reached 8044,8062 tonnes of CO2. On the other side, the total CO2 emissions of the event in Peniche (including staff and athletes) that is assumed to be estimated by WSL is at around 84,92 tonnes of CO2.

It can be concluded that the established travel-related CO2 footprint is significantly higher than the combined CO2 emissions of WSLs' definition of Scope 1,2,3 of the GHG Protocol. Therefore, Figure 24 represents the most important statistic that results from the analysis of the gathered information of the event.

As can be seen, WSL only tracks around 1% of the total CO2 emissions that are being emitted as a result of the MEO RIP CURL PORTUGAL PRO. That means 99% of CO2 emissions of the event are not tracked. Consequently, it is suggested, that WSL is effectively offsetting just 1% of the total CO2 emissions of its event. This distribution would change insignificantly to 98% untracked CO2 emissions and 2% tracked CO2 emissions when considering the conservative calculation of the travel-related CO2 footprint of visitors (see. Fig. 25).

The results of the analysis prove the statements of Pereira, R. et al. (2017) and Collins et al. (2009) considering the extremely high CO2 impact of spectators' traveling when compared with the other components of the event. Furthermore, the results showcase the importance of including Scope 3 emissions as stated in the GHG Protocol (Ranganathan et al., 2004) and Corporate Value Chain (Scope 3) Accounting and Reporting Standard Supplement to the GHG Protocol Corporate Accounting and Reporting Standard GHG Protocol Team (Callahan et al., 2011). Interestingly, the results do not only confirm that the travel-related emissions "*are large (or believed to be large) relative to the company's Scope 1 and Scope 2 emissions"*, but they contribute with 99% as the clear majority of the total CO2 footprint of the event and are the main emission contributor of all three Scopes. Given this high impact, it is suggested that WSL addresses this issue by increasing their eco-awareness and their responsibility for what CO2 emissions they feel accountable for. It is therefore also very important that WSL might consider reflecting on their way of promoting their CO_2 neutrality since that only applies to around 1%-6% of their carbon emissions (regarding the surf event in Peniche). This requires WSL to establish full transparency of their carbon emission impact. These initiatives could offer multiple advantages. Firstly, they would provide WSL with valuable insights into which emission sources to prioritise for reduction efforts. Secondly, such initiatives could contribute to enhancing WSL's public image, offering transparency, and ensuring a strong commitment to environmental responsibility. Another advantage is that WSL could also play a central role in raising the awareness of its visitors of issues like climate change, which has a positive effect on fans' willingness to embrace environmental initiatives, actively participating in endeavours to minimise ecological footprints (Bas et al., 2022). Finally, WSL can be an example showcasing how environmental and climate issues can be effectively integrated into sports (Stahl et al., n.d.). This would improve and develop a better understanding of stakeholders and other organisations of the eco ambitions of WSL.

If WSL wants to be the leader in environmental sustainability in the sports industry, the organisation has the chance to take this role and lead the way by considering fully accounting for all CO_2 emissions with a focus on travel-related CO_2 emissions from its visitors. With this initiative WSL would also fulfil its obligation of being signatory of the United Nations Sports for Climate Action, which advocates for demonstrating climate leadership and taking responsibility for their climate footprint (United Nations, n.d.). Thus, as one of the two objectives of Sports for Climate Action, WSL should fulfil their obligation, by making commitments in form of measuring, reducing, and reporting greenhouse gas emissions.

Moreover, the analysis has shown that there is an openness of spectators to adopt environmental-friendly transportation to get to and from the event if that would be managed and organised by WSL. According to the results of this study, this has the potential to reduce the overall carbon footprint of the sample by 12%.

As it has been established by Dolf & Teehan (2015), Stahl et al. (n.d.), and Bas et al. (2022) sports enjoy a special reputation for how effectively they influence people and on how they can empower responsible and environmental behaviour of sports fans. Thus, such as all sports organisations, WSL is in an advantageous position to advocate and promote true environmental responsibility.

5.2 Reducing Travel-Related CO2 Footprint of Visitors

This chapter focuses on solution-oriented approaches as well as recommendations in the form of a comprehensive carbon footprint reduction plan. Unlike Dolf & Teehan (2015) which work did not examine the feasibility of their recommendations and rather showed the potential to reduce CO2 emissions, the objective of this work was to present the potential of CO2 reduction as well as to give recommendations that can be implemented, and so provides prototypes that can be used by WSL and other sports managers (Dolf & Teehan, 2015). This plan is structured in two parts. The first part involves the avoidance of carbon emissions from human activities, which is the most important and effective way to reduce the CO2 footprint of the event, as it was also addressed by Stahl et al. (n.d.), Collins et al. (2009), Pereira, R. et al. (2017), and (Clarke et al., 2022). The second part focuses on the already created CO2 emissions, that could not have been avoided in part one. Thus, a concept to offset CO2 emissions will be presented, which is very easy to integrate and adaptable in the already existing WSL One Ocean initiative.

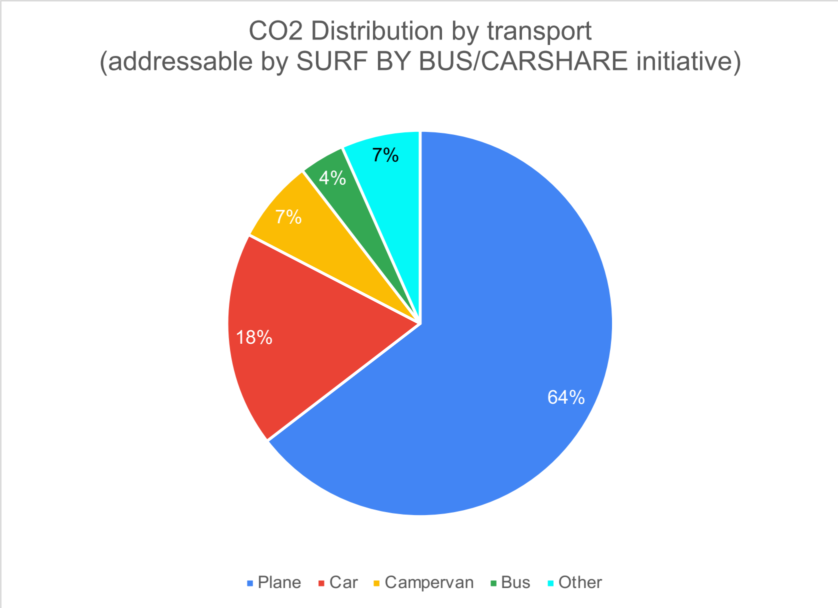
This plan has the aim to effectively eliminate the majority of CO2 emissions of the event making it a truly CO2-neutral event.

5.2.1 SURF BY BUS Platform

Through the analysed data of Chapter 4.3 it was established, that the travel-related CO2 footprint of visitors could be reduced by 12% if there was an offer for Organised buses managed and organised on the website of WSL. It must be emphasised that with the following recommended initiatives, WSL can only address the CO2 footprint of visitors who use transportation means from within mainland Portugal. As shown in Figure 26, that excludes all plane travel (64%) and some camper van and car travel (7%) that originated from outside Portugal, bringing the total carbon footprint that can be reduced from car, campervan, and bus to only 29%. The reason is that WSL can only offer alternatives within mainland Portugal because of the complexity of organising buses or carsharing from other countries. However, when taking into account, that WSL could therefore only improve on 29% of the total travel-related CO2 emissions, a decrease of 12% would imply that around 41% of the total CO2 emissions from car, campervan, and bus could be reduced, which is a promising prediction.

Figure 26

CO2 Distribution by transport (addressable by SURF BY BUS/CARSHARE Initiative)

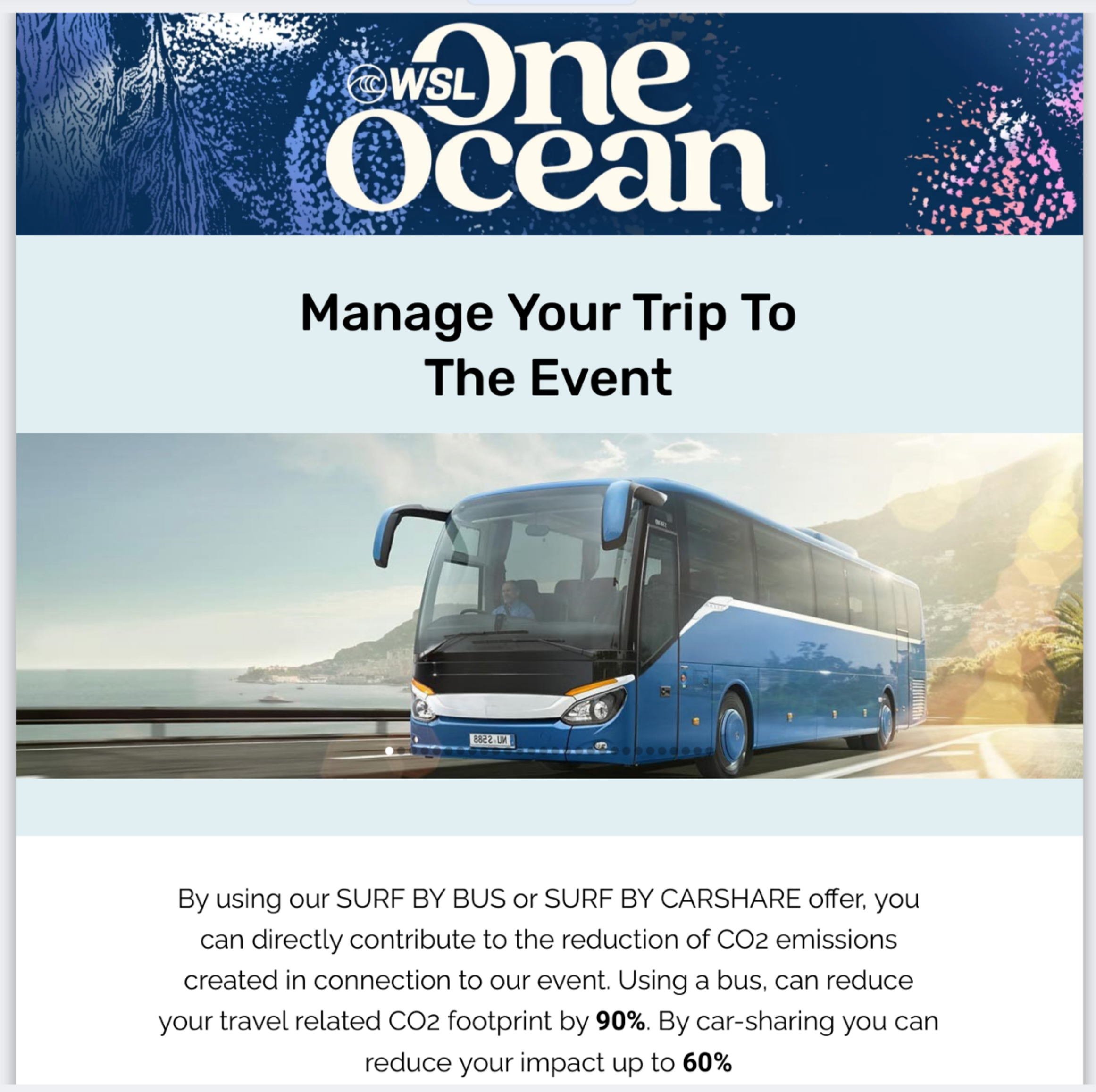


As a result of the established potential for improvement to reduce the CO_2 emissions of visitors, an appropriate concept was created that aims to reduce these CO_2 emissions.
In the following the SURF BY BUS and SURF BY CARSHARE platforms will be presented, as part of the comprehensive carbon footprint reduction plan, to reduce the CO_2 footprint of the event. The platform was created with the website builder tool “Wix.com”.

The objective of the website is to give recommendations to WSL but also other sports event organisers and event management on how to take the initiative and address and include the CO_2 footprint of its event visitors in the efforts to reduce the overall CO_2 emissions of the event. Therefore, as a result of the already identified lack of promotion of environmental-friendly transportation for visitors, the platform offers the possibility for visitors, to fulfil their part to reduce their CO_2 footprint.
At the beginning of the website (see Fig. 27), it is important to explain the most important reason why visitors should use the offer. Thus, providing them with a comparison of how much CO_2 they could save by using either the SURF BY BUS or SURF BY CARSHARE platform, allows them to understand, that their decision has a significant impact on the environmental footprint of the event. As it is stated on the website, the use of a bus reduces the CO_2 footprint by 90% and using a shared car option up to 60%.

Figure 27

Prototype SURF BY BUS/SURF BY CARSHARE (1)

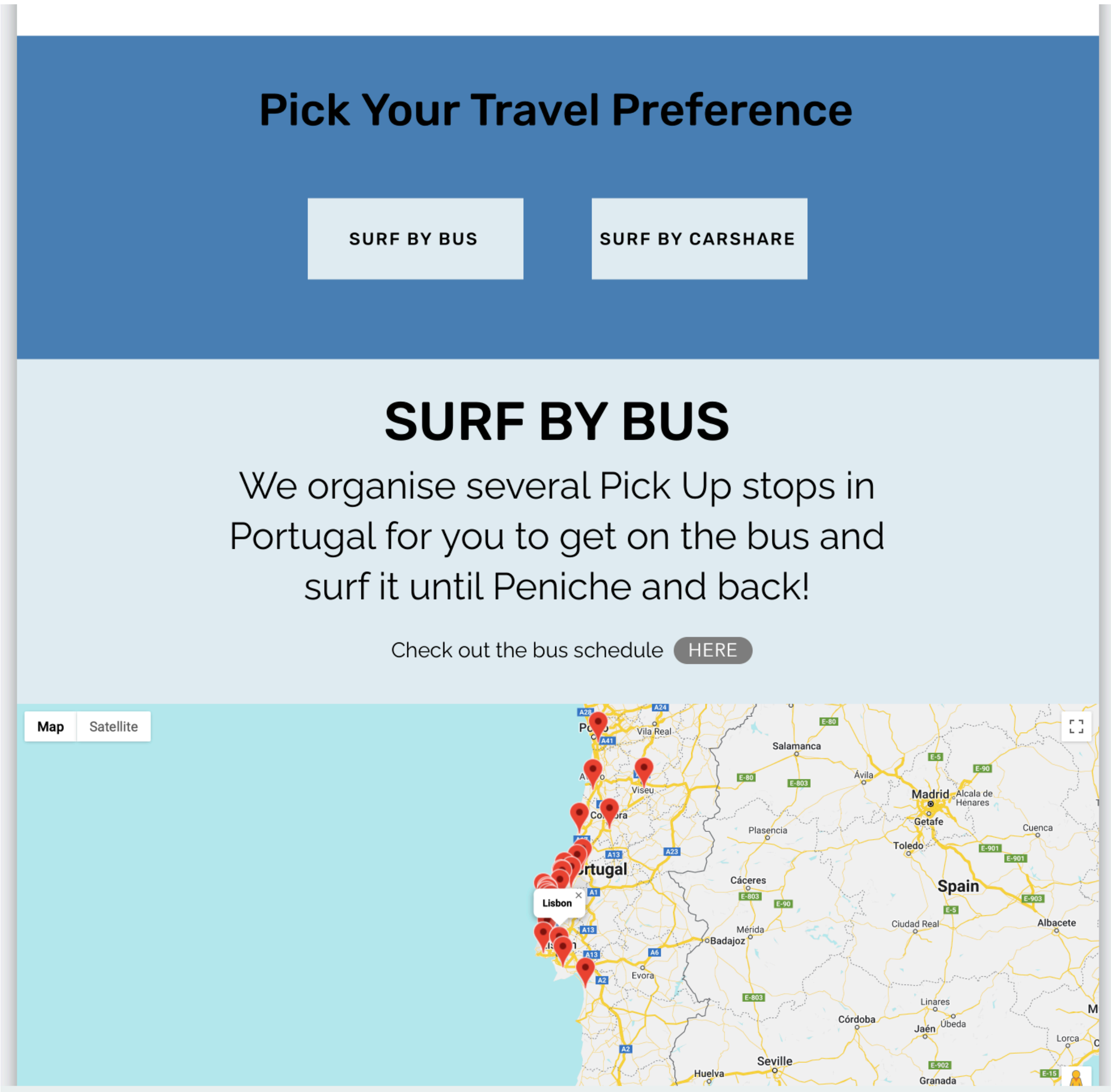


Note. Retrieved from https://www.2tservices.de/nl/images/banniere2.jpg, https://www.worldsurfleague.com/wsloneocean Copyright World Surf League 2023

In the next section, (see Fig. 28) the website provides a map with all the bus stops specified as well as a schedule section in which 5 Routes can be found (see Fig. 29,30). When creating the SURF BY BUS platform, the focus was to recommend a cooperation initiative between WSL and bus travel providers such as Rede Expressos and Rodoviaria do Oeste. By cooperating with these companies, WSL can profit by using already existing infrastructure, such as Route 1A,1B&3, and capacities more efficiently, resulting in a reduction of CO2 emissions. Furthermore, if the capacities of the already existing routes (Route 1A,1B&3) are reached, additional bus offers can be increased for the period of the surf event. Besides the already existing routes 1A,1B&3, it was decided to provide Route 2&4, which are responsible for offering busses in other regions that were specified in the survey by participants. One of the most crucial parts of this idea is that people should book their trip in advance of the event, which makes the planning phase much easier. By promoting the SURF BY BUS option way ahead of the event, WSL and the bus providers have enough time to organise an appropriate number of buses.

Figure 28

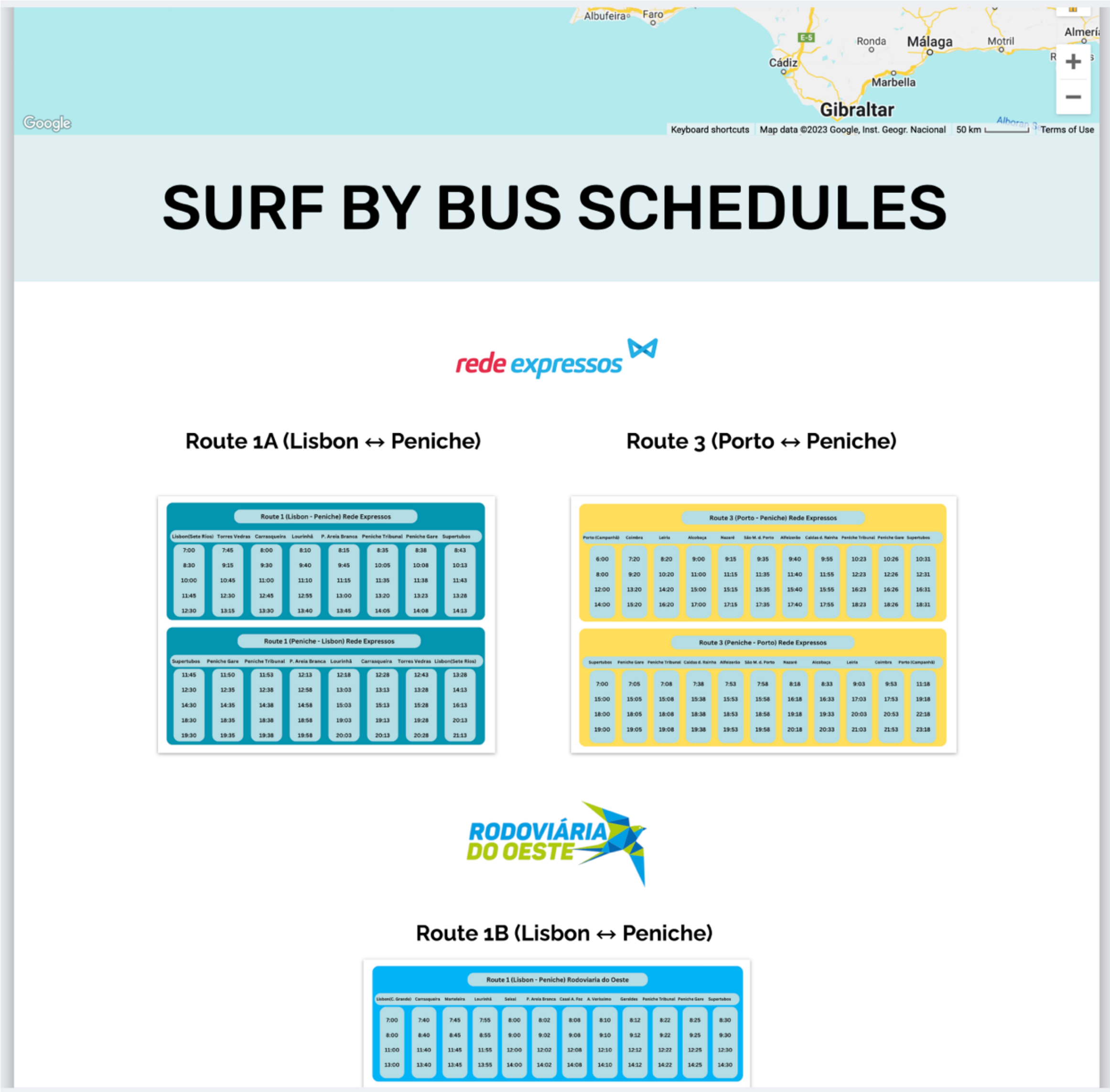
Prototype SURF BY BUS/SURF BY CARSHARE (2)



Note. *Retrieved from* *https://www.google.com/maps/@39.7493591,-7.9389692,6.89z?entry=ttu, Copyright by Map data Google 2023*

Figure 29

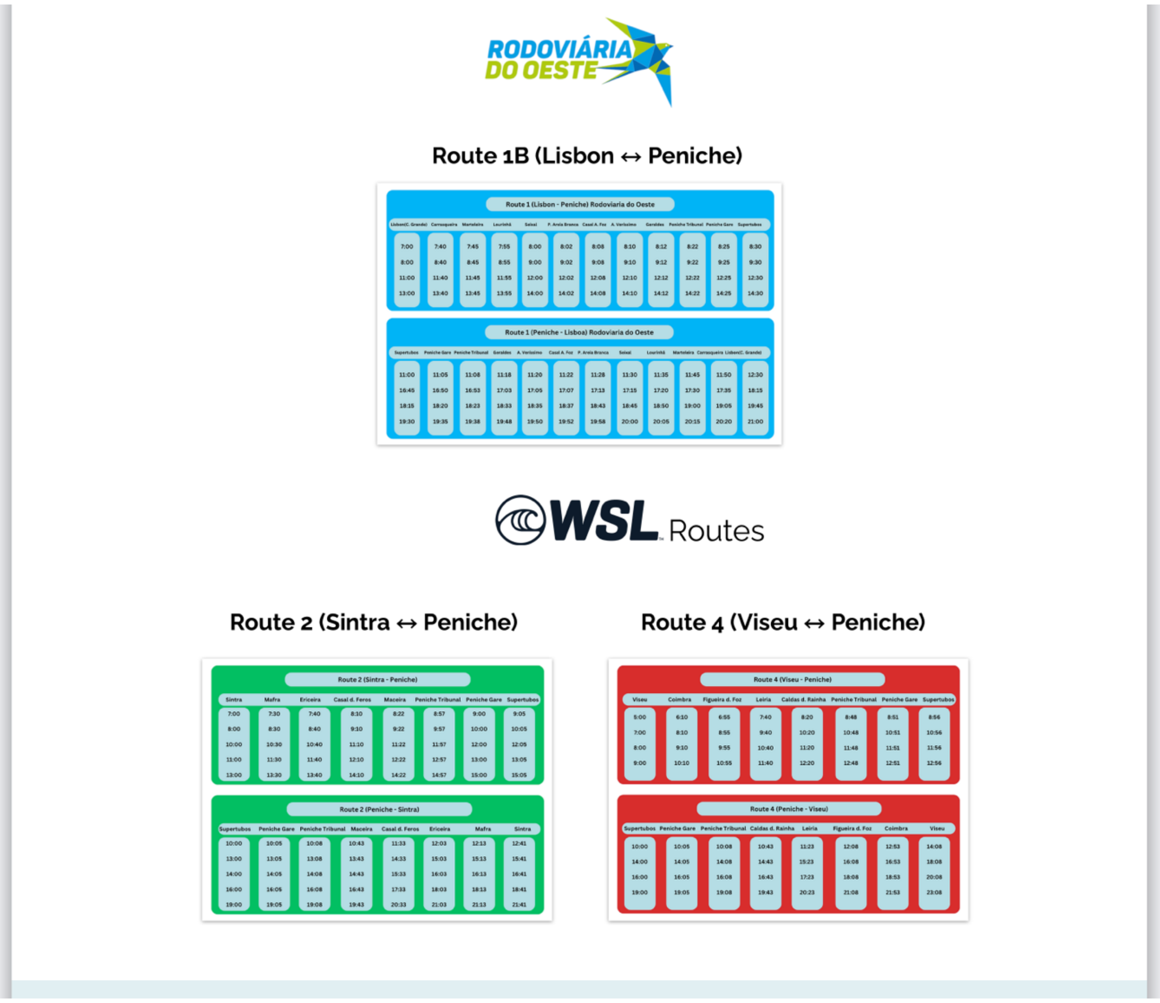
Prototype SURF BY BUS/SURF BY CARSHARE (3)



Note. *Retrieved from* *https://www.google.com/maps/@39.7493591,-7.9389692,6.89z?entry=ttu*, *http://rodoviariadooeste.pt/a-partir-de-julho-mudamos-a-nossa-imagem-no-oeste/*, *https://www.busbud.com/pt-pt/empresa-deautocarros/rede-expressos* *Copyright by Map data Google 2023, Rodoviária do Oeste 2023, Busbud Inc. 2023*

Figure 30

Prototype SURF BY BUS/SURF BY CARSHARE (4)



Note. *Retrieved from http://rodoviariadooeste.pt/a-partir-de-julho-mudamos-a-nossa-imagem-no-oeste/, https://www.wslstore.com.br Copyright by Rodoviária do Oeste 2023, LPO - LOJAS DE PRODUTOS OFICIAIS LTDA. - CNPJ: 19.704.841 /0001-08*

In the following, the bus schedules of all Routes are displayed in full view, providing a comprehensive illustration of actual travel times and total durations. A significant effort was invested in sourcing actual travel times and calculating recommended travel times, which are derived from Google Maps data, in order to provide a realistic view of the recommendations that are given in this work. It was also paid careful attention to recommend realistic departure times to Peniche, so visitors have the chance to see the surf competition that sometimes starts as early as 8:00 AM in the morning as well as realistic departure times from Peniche, offering most of the buses in times in which the day event would finish. Furthermore, it was decided to add to all the Routes the stops of Peniche Tribunal, Peniche Gare, and Supertubos Beach, so that these bus offers would also meet

the needs of Peniche residents. Since there will be regular arrival and departure times of buses, people from Peniche can use this offer instead of their car. Adding these stops could significantly reduce the CO2 emissions of Peniche residents since it was derived from the analysis, that 93% of residents used a car to get to and from the event.
In the following, each route is presented.

Route 1A (Lisbon ↔ Peniche) by Rede Expressos

Priority for Route 1A is the already existing bus offer from Rede Expressos. A full view of the bus schedule (see Fig.31) times is possible by clicking on the image displaying that buses of Rede Expressos would stop in Lisbon (Sete Rios), Torres Vedras, Carrasqueira, Lourinhã, Praia da Areia Branca, and Peniche (duration: 1:43h).

Figure 31

Prototype SURF BY BUS/SURF BY CARSHARE Schedule 1

Route 1 (Lisbon - Peniche) Rede Expressos

Lisbon(Sete Rios)	Torres Vedras	Carrasqueira	Lourinhã	P. Areia Branca	Peniche Tribunal	Peniche Gare	Supertubos
7:00	7:45	8:00	8:10	8:15	8:35	8:38	8:43
8:30	9:15	9:30	9:40	9:45	10:05	10:08	10:13
10:00	10:45	11:00	11:10	11:15	11:35	11:38	11:43
11:45	12:30	12:45	12:55	13:00	13:20	13:23	13:28
12:30	13:15	13:30	13:40	13:45	14:05	14:08	14:13

Route 1 (Peniche - Lisbon) Rede Expressos

Supertubos	Peniche Gare	Peniche Tribunal	P. Areia Branca	Lourinhã	Carrasqueira	Torres Vedras	Lisbon(Sete Rios)
11:45	11:50	11:53	12:13	12:18	12:28	12:43	13:28
12:30	12:35	12:38	12:58	13:03	13:13	13:28	14:13
14:30	14:35	14:38	14:58	15:03	15:13	15:28	16:13
18:30	18:35	18:38	18:58	19:03	19:13	19:28	20:13
19:30	19:35	19:38	19:58	20:03	20:13	20:28	21:13

Route 1B (Lisbon ↔ Peniche) by Rodoviaria do Oeste

Priority for Route 1B (see Fig. 32) is the already existing bus offer from Rodoviaria do Oeste. Buses from Rodaviaria do Oeste stop in Lisbon (Campo Grande), Carrasqueira, Marteleiria, Lourinhã, Seixal, Praia da Areia Branca, Casal do Alto Foz, Alto do Veríssimo, Geraldes, Peniche Tribunal, Peniche Gare (duration:1:30h).

Figure 32

Prototype SURF BY BUS/SURF BY CARSHARE Schedule 2

Route 1 (Lisbon - Peniche) Rodoviaria do Oeste

Lisbon(C. Grande)	Carrasqueira	Marteleira	Lourinhã	Seixal	P. Areia Branca	Casal A. Foz	A. Veríssimo	Geraldes	Peniche Tribunal	Peniche Gare	Supertubos
7:00	7:40	7:45	7:55	8:00	8:02	8:08	8:10	8:12	8:22	8:25	8:30
8:00	8:40	8:45	8:55	9:00	9:02	9:08	9:10	9:12	9:22	9:25	9:30
11:00	11:40	11:45	11:55	12:00	12:02	12:08	12:10	12:12	12:22	12:25	12:30
13:00	13:40	13:45	13:55	14:00	14:02	14:08	14:10	14:12	14:22	14:25	14:30

Route 1 (Peniche - Lisboa) Rodoviaria do Oeste

Supertubos	Peniche Gare	Peniche Tribunal	Geraldes	A. Veríssimo	Casal A. Foz	P. Areia Branca	Seixal	Lourinhã	Marteleira	Carrasqueira	Lisbon(C. Grande)
11:00	11:05	11:08	11:18	11:20	11:22	11:28	11:30	11:35	11:45	11:50	12:30
16:45	16:50	16:53	17:03	17:05	17:07	17:13	17:15	17:20	17:30	17:35	18:15
18:15	18:20	18:23	18:33	18:35	18:37	18:43	18:45	18:50	19:00	19:05	19:45
19:30	19:35	19:38	19:48	19:50	19:52	19:58	20:00	20:05	20:15	20:20	21:00

Route 2 (Sintra ↔ Peniche) by WSL Routes

This south route (see Fig. 33) would be organised by WSL and starts in Sintra and stops in Mafra, Ericeira, Casal dos Feros, Maceira, and Peniche Praia de Supertubos (duration: 2:05h). The route would address a high demand from the metropolitan region of Lisbon and provide possibilities for people living on the coast near regions such as Ericeira, Casal dos Feros, and Maceira to get to Peniche in a more ecological way.

Figure 33

Prototype SURF BY BUS/SURF BY CARSHARE Schedule 3

Route 2 (Sintra - Peniche)

Sintra	Mafra	Ericeira	Casal d. Feros	Maceira	Peniche Tribunal	Peniche Gare	Supertubos
7:00	7:30	7:40	8:10	8:22	8:57	9:00	9:05
8:00	8:30	8:40	9:10	9:22	9:57	10:00	10:05
10:00	10:30	10:40	11:10	11:22	11:57	12:00	12:05
11:00	11:30	11:40	12:10	12:22	12:57	13:00	13:05
13:00	13:30	13:40	14:10	14:22	14:57	15:00	15:05

Route 2 (Peniche - Sintra)

Supertubos	Peniche Gare	Peniche Tribunal	Maceira	Casal d. Feros	Ericeira	Mafra	Sintra
10:00	10:05	10:08	10:43	11:33	12:03	12:13	12:41
13:00	13:05	13:08	13:43	14:33	15:03	15:13	15:41
14:00	14:05	14:08	14:43	15:33	16:03	16:13	16:41
16:00	16:05	16:08	16:43	17:33	18:03	18:13	18:41
19:00	19:05	19:08	19:43	20:33	21:03	21:13	21:41

Route 3 (Porto ↔ Peniche) by Rede Expressos

Priority for Route 3 (see Fig. 34) is the already existing bus offer from Rede Expressos. The exact bus schedule times can be viewed by clicking on the images displaying that busses would start in Porto (Campanhã) and stop in Coimbra, Leiria, Alcobaça, Nazaré, São Martinho do Porto, Alfeizerão, Caldas da Rainha, and Peniche (duration: 4:20h).

Figure 34

Prototype SURF BY BUS/SURF BY CARSHARE Schedule 4

Route 3 (Porto - Peniche) Rede Expressos

Porto (Campanhã)	Coimbra	Leiria	Alcobaça	Nazaré	São M. d. Porto	Alfeizerão	Caldas d. Rainha	Peniche Tribunal	Peniche Gare	Supertubos
6:00	7:20	8:20	9:00	9:15	9:35	9:40	9:55	10:23	10:26	10:31
8:00	9:20	10:20	11:00	11:15	11:35	11:40	11:55	12:23	12:26	12:31
12:00	13:20	14:20	15:00	15:15	15:35	15:40	15:55	16:23	16:26	16:31
14:00	15:20	16:20	17:00	17:15	17:35	17:40	17:55	18:23	18:26	18:31

Route 3 (Peniche - Porto) Rede Expressos

Supertubos	Peniche Gare	Peniche Tribunal	Caldas d. Rainha	Alfeizerão	São M. d. Porto	Nazaré	Alcobaça	Leiria	Coimbra	Porto (Campanhã)
7:00	7:05	7:08	7:38	7:53	7:58	8:18	8:33	9:03	9:53	11:18
15:00	15:05	15:08	15:38	15:53	15:58	16:18	16:33	17:03	17:53	19:18
18:00	18:05	18:08	18:38	18:53	18:58	19:18	19:33	20:03	20:53	22:18
19:00	19:05	19:08	19:38	19:53	19:58	20:18	20:33	21:03	21:53	23:18

Route 4 (Viseu ↔ Peniche) by WSL Routes

This north route (see Fig. 35) would be organised by WSL starting in Viseu and going to Coimbra, to address the high demand, that could be seen through the survey. The next bus stops would be in Figueira da Foz, Leiria, Caldas da Rainha, and Peniche Praia do Supertubos (duration: 3:42h).

Figure 35

Prototype SURF BY BUS/SURF BY CARSHARE Schedule 5

Route 4 (Viseu - Peniche)

Viseu	Coimbra	Figueira d. Foz	Leiria	Caldas d. Rainha	Peniche Tribunal	Peniche Gare	Supertubos
5:00	6:10	6:55	7:40	8:20	8:48	8:51	8:56
7:00	8:10	8:55	9:40	10:20	10:48	10:51	10:56
8:00	9:10	9:55	10:40	11:20	11:48	11:51	11:56
9:00	10:10	10:55	11:40	12:20	12:48	12:51	12:56

Route 4 (Peniche - Viseu)

Supertubos	Peniche Gare	Peniche Tribunal	Caldas d. Rainha	Leiria	Figueira d. Foz	Coimbra	Viseu
10:00	10:05	10:08	10:43	11:23	12:08	12:53	14:08
14:00	14:05	14:08	14:43	15:23	16:08	16:53	18:08
16:00	16:05	16:08	16:43	17:23	18:08	18:53	20:08
19:00	19:05	19:08	19:43	20:23	21:08	21:53	23:08

How to Book a Bus?

Step 1: Click on the travel hour of the Route and the direction you want to go

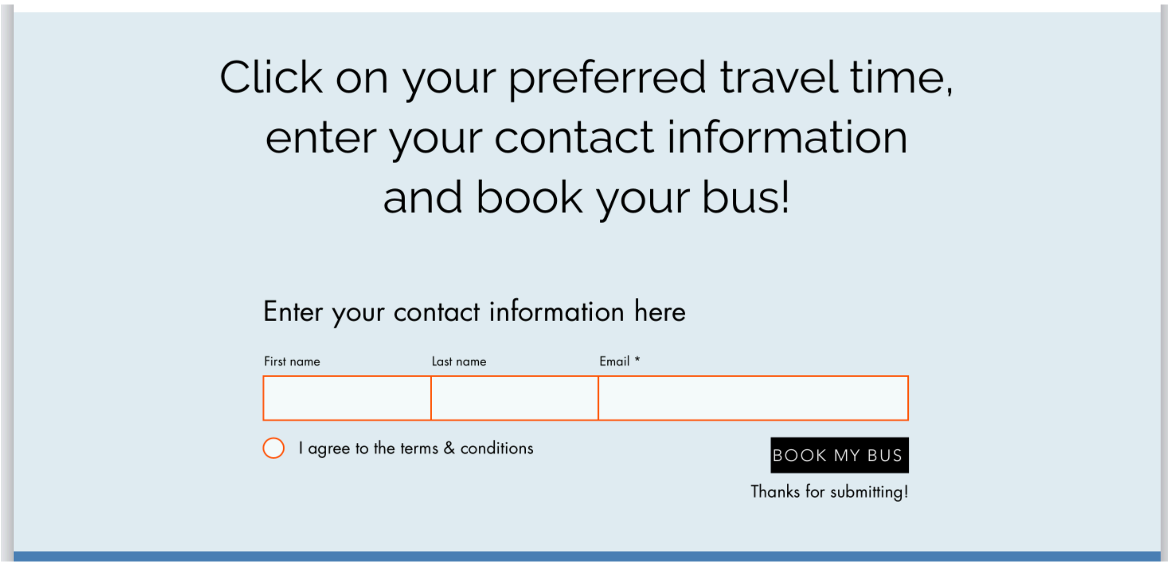
Step 2: Fill in your information in the registration section and click on BOOK MY BUS

Step 3: When chosen Route 1A,B or 3 you will be directed to the website of Rede Expressos or Rodoviaria do Oeste to finalise your payment and booking. When chosen Route 2 or 4 a window opens to finalise your payment and booking with WSL Routes

In Figure 36, the registration section is displayed, in which visitors need to fill out their information to book their busses to and/or from Peniche.

Figure 36

Prototype SURF BY BUS/SURF BY CARSHARE (5)

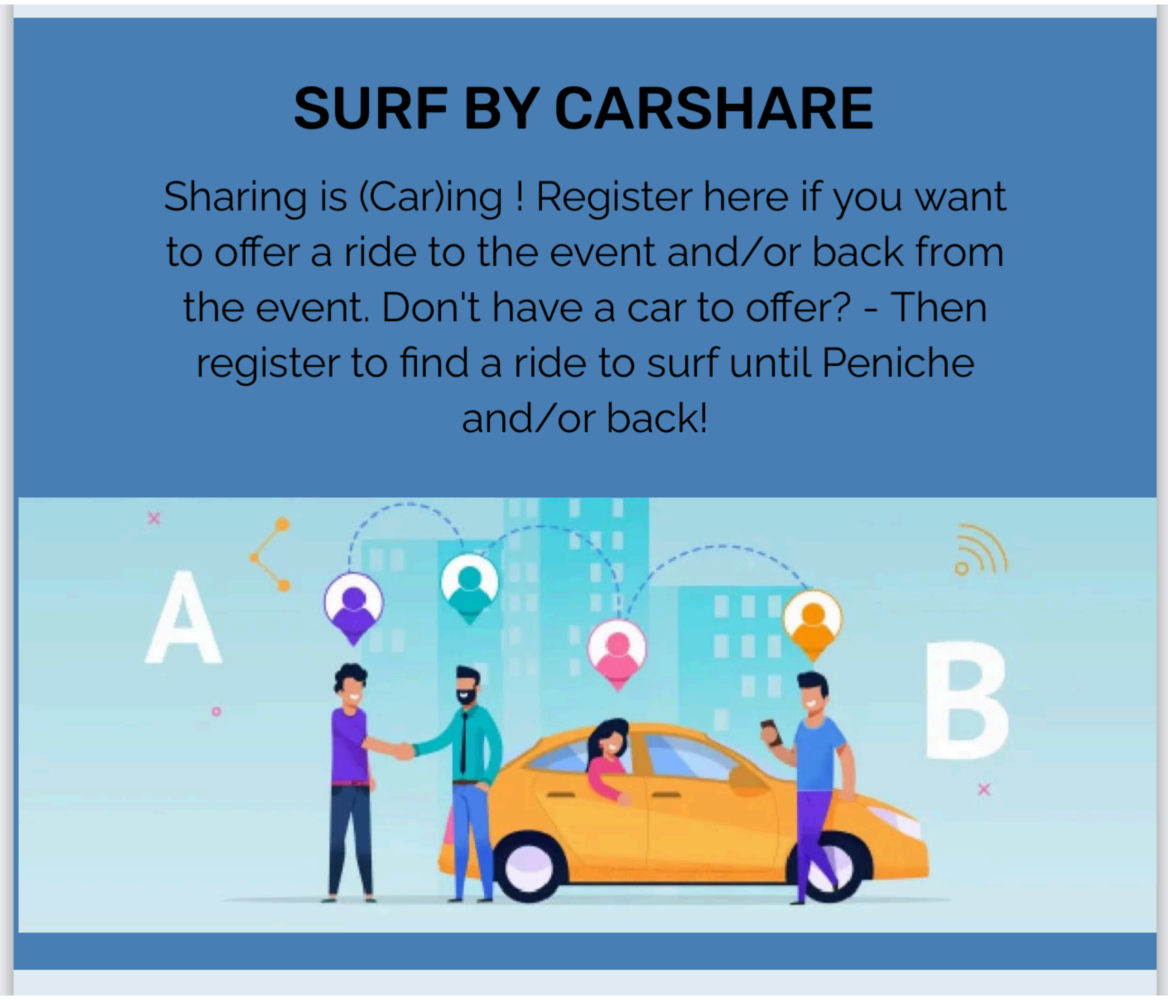


5.2.2 SURF BY CARSHARE Platform

In the following (see Fig. 37) the SURF BY CARSHARE platform will be presented, as part of the comprehensive carbon footprint reduction plan, to reduce the CO2 footprint of the event. The SURF BY CARSHARE platform follows on the website after the SURF BY BUS platform.

Figure 37

Prototype SURF BY BUS/SURF BY CARSHARE (6)



Note. Retrieved from https://ideausher.com/blog/ridesharing-and-carpooling-app-development/ Copyright by Idea Usher 2023

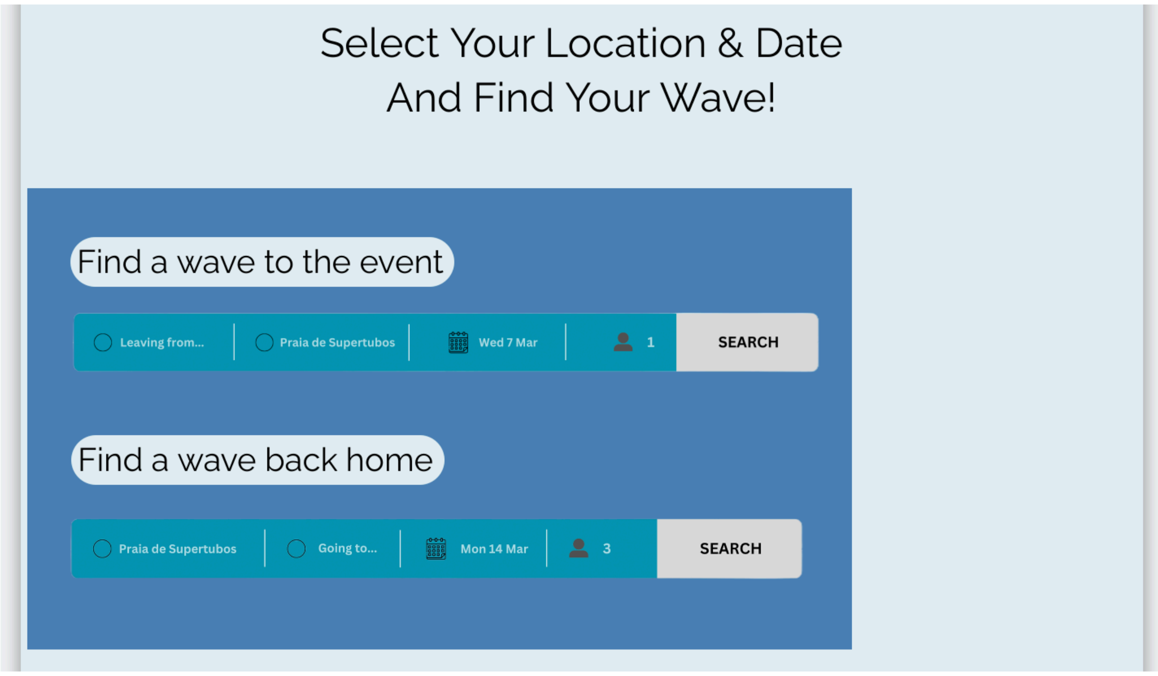
In the first section, the SURF BY CARSHARE offer is promoted in which the visitor can either search for a carshare or offer a carshare. It is also explained, that the carshare offer can be used one way or both ways.

Find a Carshare

The next section (see Fig. 38) addresses people, who would like to use a carshare offer. Therefore, the visitor needs to fill in his/her location where she likes to get picked. It is recommended, that visitors preferably choose a location that is easily accessible and that is close to a main national street so that pick-ups can be made trouble-free. The destination is automatically set to Praia dos Supertubos. Then the date and time need to be specified as well as the number of people, that want to be picked up from that location. In the next step, the visitor needs to press SEARCH after which a window will open showing potential matching options of people who offer a carshare as well as the corresponding price. To choose that carshare option, the visitor can confirm the booking, paying right away or after the journey, as well as use a chat for communication purposes. For the return journey from Praia dos Supertubos, the procedure is almost the same. Here the visitor needs to indicate the destination as well as the date and time, and the number of passengers. It is possible to book the return journey for another day, making it likely having a different person offering the carshare than for the first journey.

Figure 38

Prototype SURF BY BUS/SURF BY CARSHARE (7)

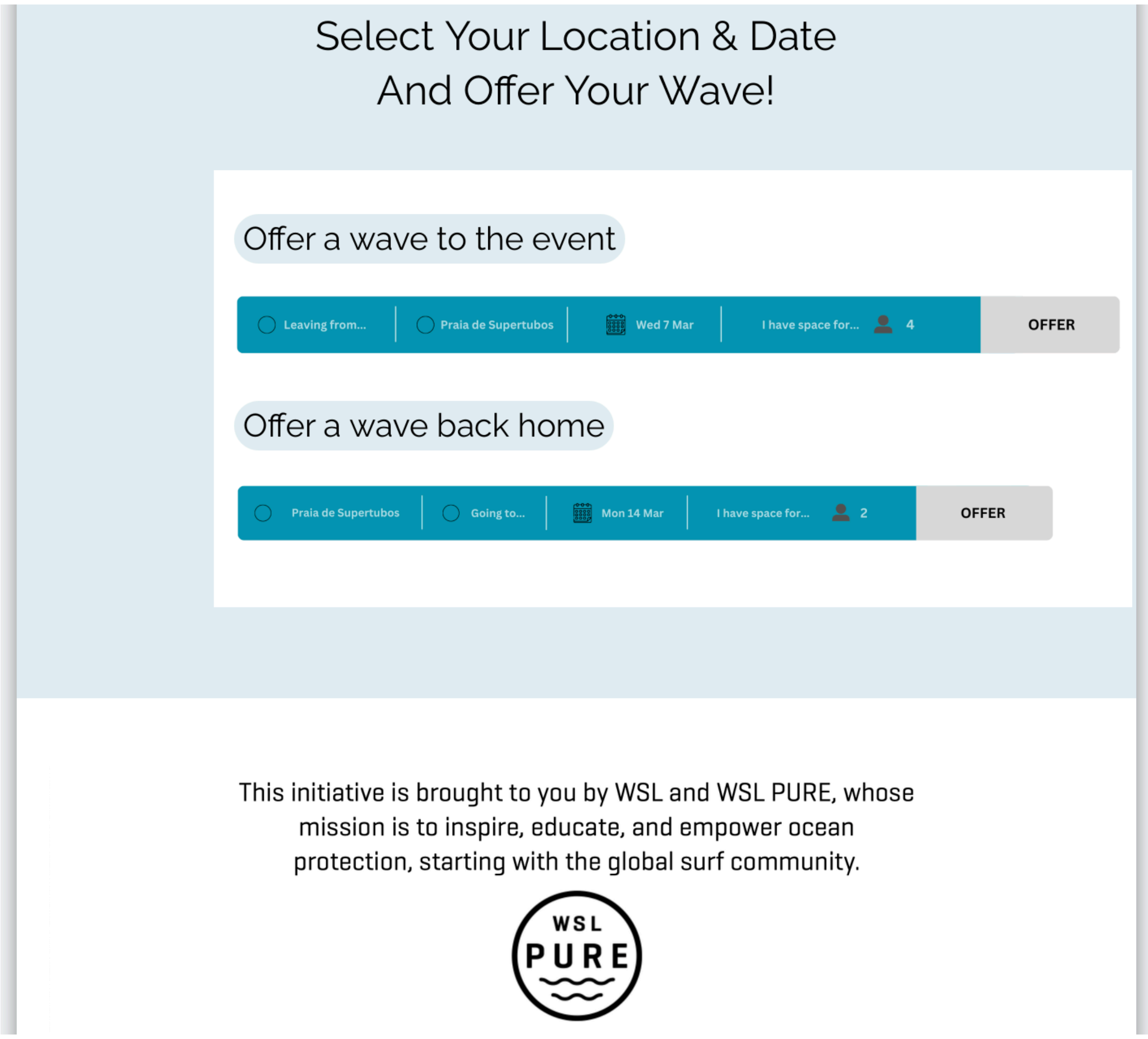


Offer a Carshare

In the section (see Fig. 39), visitors who plan to go by car and want to utilise their available space to reduce their CO_2 footprint while also obtaining monetary compensation can offer a carshare. The way it works is very similar to the previously described option. Visitors need to specify from where they will start driving to the event as well as the date and time they leave from that location. Furthermore, they need to indicate the number of passengers they can take in their car. After clicking on SEARCH, a window opens, that shows different routes, that are calculated by an algorithm, passing through locations, in which people who want to use a carshare offer and have indicated their pick-up location. The visitor who offers the carshare can then confirm a route and automatically gets connected to the people who will be picked up on that route via the previously mentioned chat. The algorithm works constantly and updates regularly in order to provide every new carshare search and carshare offer with the most recent data. Furthermore, the algorithm consistently determines the most environmentally friendly routes by continuously assessing whether there are alternative carshare offers that optimise the travel distance to Praia dos Supertubos. If someone wants to offer a carshare from Praia dos Supertubos, they can fill out the destination and specify the date and time as well as the number of seats that are available. Here, the algorithm works in the same way as with the journey to Praia dos Supertubos, ensuring the most environmentally friendly routes by continuously assessing whether there are alternative carshare offers that optimise the travel distance to the indicated destination.

Figure 39

Prototype SURF BY BUS/SURF BY CARSHARE (8)



Note. Retrieved from *https://www.worldsurfleague.com/wsloneocean* *Copyright by World Surf League 2023*

5.2.3 Promotion of More Environmental-Friendly Travel

As established previously, the travel-related CO2 footprint of visitors of the event is much more significant than the CO2 footprint that is calculated by WSL. This suggests that the most effective way to reduce the majority of the CO2 footprint is to focus on the biggest part – the visitors' travel to and from the event. The only option event managers have, to reduce the travel-related CO2 footprint of the event is to make the transportation of visitors more efficient. This means that an increase of the occupancy rates of transportations will have a reduction effect of the CO2 footprint. The recommended concepts SURF BY BUS and SURF BY CARSHARE that were presented previously, aim to make the travel of visitors as carbon efficient as possible and provide a more environmentally friendly travel option. It is therefore important, that these concepts are advertised in advance of the event so as many people as possible are informed, that there is a carbon-reducing initiative managed by WSL. The early advertisement of the initiative is crucial for the success of the initiative, giving people enough time to plan their trip to and from the event. It is suggested to start with the promotion of the initiative 6 months before the event (Norman, 2023). WSL needs to include the SURF BY BUS and SURF BY CARSHARE initiatives in their conventional channels for advertisements such as national television ads, radio channels, and YouTube ads. Furthermore, it is suggested that WSL advertise via social media such as Instagram, Facebook, and TikTok to especially reach younger age groups. Demographics (see Fig. 6) have shown that 72% of visitors were between the ages of 18 and 34 and therefore the optimal target group to address through the mentioned social media platforms. Moreover, print ads could also support the promotion of the schedule, especially posters in the region around the event.

Although the focus should lay on the promotion of the SURF BY BUS and SURF BY CARSHARE initiatives months before the event starts, it would also be beneficial to promote the initiative onsite at the event, so visitors that travel daily to and from the event can be informed that there are eco-friendlier offers that can be used. Print ads like posters and flyers could be set up in the event area to promote the bus schedules as well as the carshare initiative.

At this point, it is important to mention that for the MEO RIP CURL PORTUGAL PRO, a free bus shuttle service was provided for the city of Peniche, Baleal and Ferrel (see Fig. 40). However, as the results of the survey show, only 7% of the participants noticed that WSL offered a shuttle bus service for the event. This low number shows that promotion and advertisement of the service were not sufficient and can potentially be explained by the fact that the service was promoted only by a single Facebook post from the municipality of Peniche. Furthermore, besides social media, the service was promoted on the municipalities' website and on the website of Rodoviaria where a very low outreach can be assumed. Additionally, the promotion of the service from the municipality on the 7th and from Rodoviaria do Oeste on the 9th was done far too late, since the event officially was supposed to start on the 8th of March. The late timing of the promotion resulted in a low reach of people. A representative of the municipality also confirmed that when asked if the schedule should have been posted way ahead of the event. In the case of the local shuttle bus service, it is suggested that the schedule should be promoted at least 3 weeks prior to the event, so WSL can make sure that it provides enough time for locals to receive this information and plan their trip to the event. Although WSL couldn't provide data about the occupancy rate of this service, the low rate of participants who were aware of the shuttle bus service suggests that occupancy rates were rather low than high. Additionally, through personal exploration and use of the free shuttle bus services to get to the event, it was noticed, that busses were mostly driving with just a few visitors. If these suggestions are being implemented, there is a good chance, that more locals will use the free service. Furthermore, Dolf & Teehan (2015) suggest that the education of local spectators to prioritise eco-friendly travel beyond the event can have an overall positive impact on the environment which makes the offer of these transportation means very important.

Figure 40

Shuttle Bus Schedule MEO RIP CURL PORTUGAL PRO 2023

Note. *Retrieved from* *[https://www.facebook.com/photo/?fbid=57904418092 3455&set =a.314203120740897&locale=de_DE]*

5.2.4 Awareness Campaign of Sustainability for Visitors

The previous chapters suggested different opportunities to actively reduce the travel-related CO2 footprint of the event, with practical and realistic examples to have a direct impact. Besides direct examples to reduce the CO2 emissions of the event, WSL can also take the initiative onsite and advertise an awareness campaign about sustainability and take on an educational responsibility to inform visitors about sustainability practices and how important it is to keep the environment clean, reduce waste, and respect natural habitats and especially beaches that make events like MEO RIP CURL PORTUGAL PRO possible. These suggestions are also supported by the results of the survey regarding the topic of the familiarity with environmental-related concepts (see Fig. 17), in which 25% were not familiar with the Carbon Footprint. Furthermore, 38% of the participants indicated that they were not familiar with Carbon Offsetting and 52% were not familiar with the sustainable initiative We Are One Ocean. These data show that WSL could use the opportunity on-site to help visitors understand common subjects about sustainability and educate the people who are interested in these topics. This can be implemented by making this awareness campaign not only informative but also interactive and participatory, engaging visitors in activities that animate them to participate. Here it is suggested to motivate visitors with giveaways or prices which can be won when participating in one of the several interactive and participatory workshops, quizzes, games, and simulations or virtual reality experiences.

5.3 Compensating Travel-Related CO2 Footprint of Visitors

In the previous chapters, the CO2 footprint reduction was addressed with two very comprehensive and effective recommendations using the SURF BY BUS and/or the SURF BY CARSHARE offer. As the analysis has shown, the presented recommendations have the potential to lead to a considerable reduction of the carbon footprint of spectators. However, spectators' traveling will still be a source of carbon impact and therefore in this work it is also discussed how this impact can be compensated.

This part of the comprehensive carbon footprint reduction plan addresses mainly the 71% of CO2 emissions, and the percentage, that remains despite the SURF BY BUS and/or the SURF BY CARSHARE offer which addressed 29% of the CO2 emissions. It needs to be emphasised, that this part of the comprehensive carbon footprint reduction plan should only be considered when all other possibilities to reduce CO2 emissions, have been utilised to a feasible extent. In this case, the priority in the comprehensive carbon footprint reduction plan is the avoidance of carbon emissions that was described in Chapter 5.2.1 and 5.2.2. After the effort to bring the CO2 emissions to a minimum, the second phase of the plan focuses on an effective way to address the remaining emissions of the event. The concept is called “Renewable Offsetting” and aims to neutralise the remaining carbon emissions that were created, enabling WSL to achieve true CO2 neutrality for their events.

The need for this concept to offset the emissions that could not have been reduced in the previous concept is crucial to show the full accountability of an organisation and fully mitigate the total emissions. This is also recognised by the law firm Osborne Clarke which says that on one side the key to reducing travel-related emissions for sports organisations lies in adopting more sustainable forms of transport, which could involve investing in electric vehicles and mandating the use of sustainable aviation fuels (Clarke et al., 2022). On the other side, however, the company says that "*it is likely that investment into carbon offsetting schemes will be required to fully mitigate the industry's emissions in this area.*" (Clarke et al., 2022). Furthermore, (Gao & Souza, 2022) argue that there are some Scope 3 emissions that are beyond the control of organisations and thus another frequently used way to reduce its carbon footprint is to voluntarily purchase offset credits.

Prior to delving into the detailed explanation of the concept and its prototype, it is crucial for the reader to comprehend the underlying reasoning behind the utilisation of a distinct approach instead of relying on traditional carbon offsetting methods such as *"investing in and supporting projects such as VCS (Verified Carbon Standard) and REDD+ (reduce emissions from deforestation and forest degradation) certified carbon offset projects"* (WSL, 2019b) as it is used by WSL to nearly 100% to achieve CO2 neutrality.
Carbon offsetting methods such as investing in projects that include the restoration and protection of natural ecosystems are in general seen as critical because of their lacking additionality, permanency, and vague predictions (Broekhoff et al., 2019; Kajosaari, 2023). WSL is using mostly offsetting projects that are REDD+ certified in which the majority of the projects focus on protection and conservation of forests. Unfortunately, as described previously, these projects lack the crucial element of additionality, which is the most important when it comes to carbon offsetting. Furthermore, it is not sure what will happen with some projects that WSL is investing in after their lifetime of 30 years. If the protected forests are logged or burned down by wildfire, the carbon will be released back into the atmosphere. Additionally, the overall critical view on carbon offsetting by the protection and conservation of forests suggests many risks, which can be also seen in the case of the 2014 World Cup held in Brazil, in which a stadium was certified as carbon-neutral by a program that was yet to aim to plant 1.4 million trees in order to mitigate the negative impacts of the construction. However, only 70,000 trees were actually planted, and the

nursery was abandoned after achieving a mere 5% of the required planting for a positive impact (Cerezo-Esteve et al., 2022).

To reduce this risk, the concept that is presented and recommended in this work focuses on another method of carbon offsetting which is the investment and creation of renewable energy sources or "Renewable Offsetting". At this point, it needs to be explained that Carbon offsetting by the development of renewable energy is seen as critical for example by Friends of the Earth which states that since it is currently the most cost-effective energy source, it becomes challenging to perceive how offsetting in this manner would be considered additional to what would happen (*Why Offsetting Will Worsen the Climate and Nature Emergencies*, n.d.). This method of offsetting used to be a valid measure when prices of wind turbines and solar panels were still very high. However, it is argued that just because the development of renewable energy is planned by governments doesn't automatically mean at which pace the development of renewable energy will happen. Unsurprisingly, statistics show that the development of renewable energy is still very slow and that the energy mix of Portugal consists of only 29% renewable energy of which wind accounts for 13,49% and solar for 3,11% (Ritchie et al., n.d.). This suggests that the investment in renewable energy is still effective because it increases the percentage of renewable energy that is desperately needed as fast as possible. Here the private sector can be animated to act individually and support the increase of renewable energy in the energy mix on a local or regional level. On the national level, the development doesn't seem to be fast enough. Furthermore, this initiative should benefit the regional communities around Peniche which would profit from it. This would also improve socio-cultural sustainability. Unlike the carbon offsetting method of reforestation and protection of forests, the investment from CO2 offsetting in renewable energy sources considers the element of additionality because the creation of new renewable energy sources such as wind turbines and solar panels contributes as an additional renewable energy source, that would not have been created without the CO2 offsetting. Renewable energy sources contribute to the reduction of future GHG emissions, by substituting energy from fossil fuels. Furthermore, the investment in renewable energy sources also fulfils the element of permanency. By generating renewable energy, the project effectively avoids the CO2 emissions that would have been produced by fossil fuels. Unlike current carbon offset projects that WSL invests in that have a limited lifespan of 30 years and could potentially face the risk of reversibility, renewable energy projects have the potential for long-term emissions reductions, contributing to the ongoing mitigation of GHG emissions. Moreover, unlike the issue of vague predictions that reforestation and forest protection projects have, renewable energy projects generally have the potential to provide more accurate calculations of avoided CO2 emissions. Thus, the avoided CO2 emissions can be easily calculated by determining the CO emissions that would have been emitted by a gas or coal plant, minus the CO2 emissions of the renewable energy source during processes like the manufacturing and installation of the renewable energy source (Schmidt-Achert et al., 2022). The emission data of conventional fossil fuels can be determined exactly.

The "Renewable Offsetting" concept is also suggested because it can speed up the sustainable energy transition, increasing the percentage of global renewable energy usage and simultaneously reducing carbon emissions from fossil fuels. From the 10 publicly promoted carbon offset projects on WSLs' website, only one incorporates a renewable energy development project. Therefore, it is recommended, that WSL should offset their CO2 emissions with more projects that favour the creation of renewable energy sources like the "Renewable Offsetting" concept of this work.

It is clear that "Renewable Offsetting" as it was explained requires financial investments to offset the created carbon footprint. These investments are suggested to be generated from the visitors of the surf event. As the results of Chapter 4.5 clearly demonstrate, there is a significant support of the visitors, to financially contribute to offset their travel-related carbon footprint. These results are consistent with the conclusions that have been made by Van Tonder et al. (2013) and Saayman et al. (2016) about event visitors' willingness to pay for offsetting in order to reduce the carbon footprint of sport events. It needs to be mentioned, that in this question of the survey, the visitors were asked to contribute to any of the projects of WSLs' We Are One Ocean initiative, and hence the general willingness to contribute to an environmental project it is assumed that visitors' willingness to contribute would be also unchanged for the "Renewable Offsetting" concept. The interesting discovery was that around one third of participants would not decide to contribute because they were not familiar with the concept of carbon offsetting. This shows that WSL has the opportunity to inform and educate this group onsite, about the concept of carbon offsetting which eventually could increase the support for it. Here it is important to refer to the previously recommended Awareness Campaign for visitors in Chapter 5.2.4, which would be the ideal framework for WSL in which the education of these topics could be integrated. Furthermore, with only 13% of opponents that would decisively not contribute to offset their travel-related carbon footprint this group of participants is relatively small and suggests rather a minimal opposition to the concept of carbon offsetting. However, considering the 52% of supporters, their financial openness to invest their money to offset their carbon footprint reaches a surprisingly high level. Therefore, an average contribution of 22,53€ would result in a total contribution of 1,420€. It needs to be emphasised that this amount only represents the sample group and is estimated to be a lot higher when doing the projection of the total population of the event. This amount of potential investments to offset the travel-related carbon footprint of the visitors supports the recommendation for the concept of "Renewable offsetting", from a financial point of view. Furthermore, analysis of the data about the availability of participants to raise their contribution when matched by WSL did not show a significantly high number of people and showed only an 11% increase in contributions. However, the 22% of people that would contribute more when WSL would match their amount, would increase their contribution by 113% to more than double which is a significant increase. This willingness to contribute significantly more by a fifth of the visitors can be interesting for WSL to think about getting financially involved in the "Renewable Offsetting" concept.

The recommended concept and its prototype will be presented in the following.

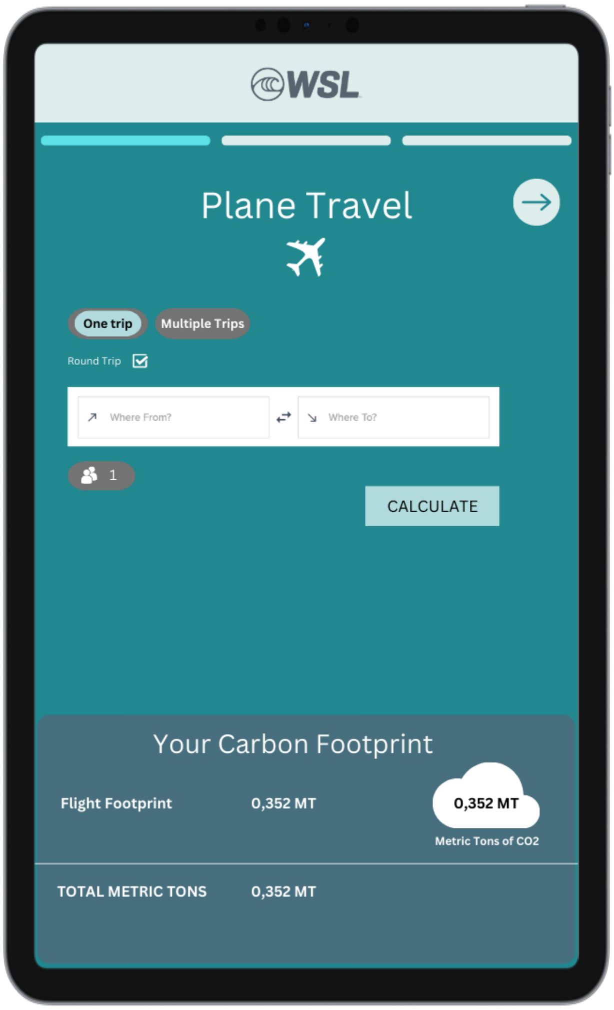
The implementation of the "Renewable Offsetting" concept requires the active involvement of event visitors, which calls for proactive measures by WSL. To facilitate this, it is recommended that WSL establishes a booth at the event. This dedicated booth will serve as a platform for WSL staff to promote the concept of "Renewable Offsetting", engage in conversations with visitors, and provide education and guidance on the offsetting process. By having a physical presence and direct interaction with attendees, WSL can effectively communicate the importance of the concept of "Renewable Offsetting" and encourage active participation in reducing the event's carbon footprint. After educating and explaining the concept of "Renewable Offsetting" to the visitors, they can start.

The designed prototype is an interactive application, that has the purpose to estimate the carbon footprint of the visitors' travel journey to and from the event as well as calculate the corresponding renewable offset price. The application includes five interfaces and can be run on any type of tablet that will be provided by WSL.

Interface 1 (see Fig. 41) asks the visitor to fill out their travel journey made by plane, in order to get to the event. The visitor needs to fill out the origin airport and the destination airport. If several flights were taken, the visitor needs to click on “Multiple Trips” and fill out further flights. Moreover, if the travel journey by plane is a round trip, the visitor needs to check that box. It is also important to indicate how many people are travelling together. After all the information has been filled in, the carbon emissions of the plane travel can be calculated. Therefore, the bottom section of the interface shows the CO2 in metric tonnes. To proceed, the arrow on the top right corner needs to be pressed.

Figure 41

Prototype Offsetting Application (1)



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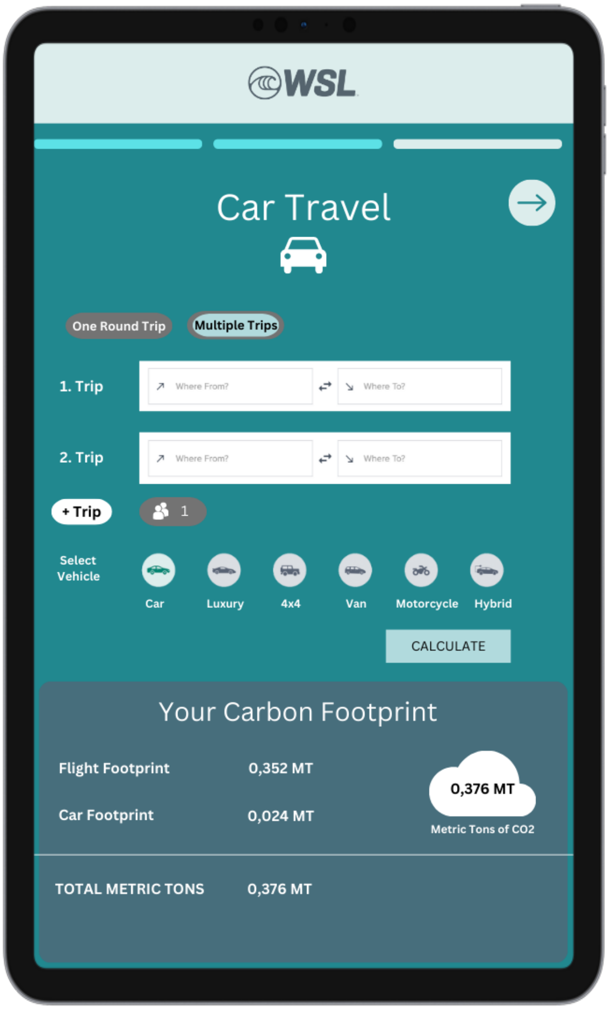
Interface 2 (see Fig. 42) collects information about the travel journey made by car. If a simple round trip is made, then the visitor needs to indicate the starting place and the destination, that is Praia dos Supertubos. If multiple trips were taken, meaning that between the starting position and Praia dos Supertubos a layover was made, it needs to be specified by stating several journeys. As an example: If someone starts in Lisbon to get to Praia dos Supertubos, but wants to make a stop in Ericeira, then it needs to be filled out as (1. Trip: Lisbon-Ericeira; 2. Trip: Ericeira-Praia dos Supertubos). By clicking on the "+ Trip" button, more trips can be added. As with plane travel the number of travellers needs to be indicated. Next, the car type needs to be selected, making the carbon footprint calculation more accurate. After clicking on CALCULATE, the carbon footprint of the car will be added to the plane's carbon footprint displayed at the bottom of the interface. To proceed, the arrow on the top right corner needs to be pressed.

Figure 42

Prototype Offsetting Application (2)



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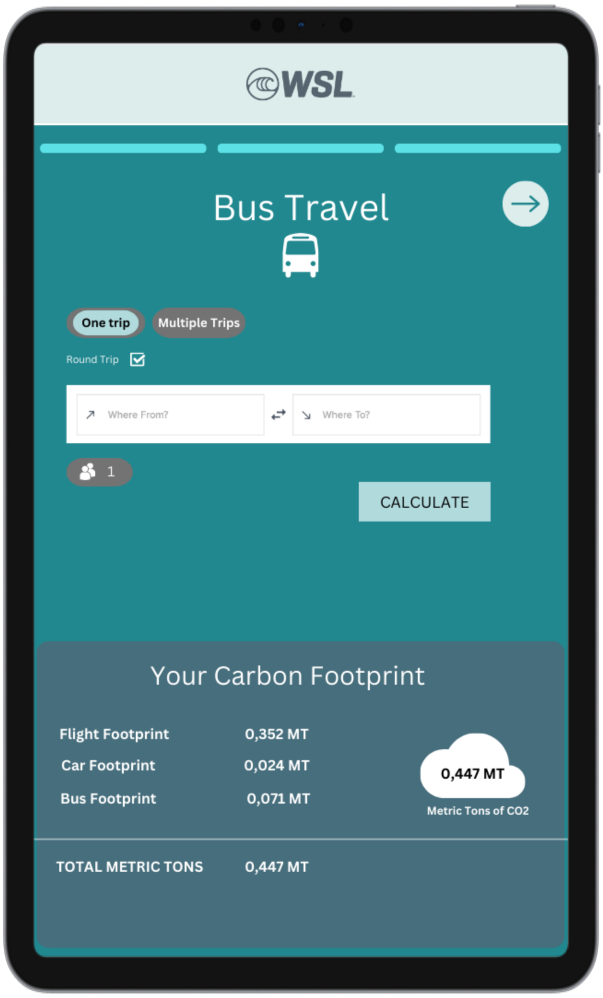
Interface 3 (see Fig. 43) aims to calculate the CO2 footprint of bus travel that was taken in order to get to and/or from the event. The visitor needs to indicate the origin from where the bus started and the destination. If several bus trips were taken, the visitor needs to click on “Multiple Trips” and fill out the additional trips by bus. Moreover, if the travel journey by bus is a round trip, the visitor needs to check that box. It is also important to indicate how many people are travelling together. To calculate the carbon footprint of the bus journey, the button CALCULATE needs to be pressed and the application will display the amount on the bottom, listed with the other CO2 footprints. After completing this interface, the calculation of the travel-related CO2 footprint of the visitor will be concluded. To proceed, the arrow on the top right corner needs to be pressed.

Figure 43

Prototype Offsetting Application (3)



Note. Retrieved from https://www.wslstore.com.br Copyright by LPO - LOJAS DE PRODUTOS OFICIAIS LTDA. - CNPJ: 19.704.841/0001-08

Interface 4 (see. Fig 44) shows the total carbon footprint along with a comparison of the amount of renewable energy that needs to be produced, to balance out the carbon emissions. As already mentioned previously the renewable technologies of wind turbines and solar panels are recommended to use for the “Renewable offsetting” concept. In the given example the estimated carbon footprint of 0,447 tonnes of CO2 would equal 600kw/h of electricity or approximately 13 days of wind energy generated by a 10kW wind turbine, assuming the wind turbine operates at a speed of 5m/s.

Figure 44

Prototype Offsetting Application (4)

Note. Retrieved from https://www.wslstore.com.br Copyright by LPO - LOJAS DE PRODUTOS OFICIAIS LTDA. - CNPJ: 19.704.841/0001-08

In order to indicate the equivalent kW/h of electricity that needs to be produced to offset the created carbon emissions the CO2 converter of the German website Bundesverband Windenergie (BWE) was used (Bundesverband WindEnergie e.V., n.d.). The converter calculates how much CO2 can be saved when producing a certain amount of wind energy. Additionally, the calculation of how many days a 10kW wind turbine needs to operate to produce 600kW/h of electricity can be comprehended by taking the table of the annual yield of wind turbines in Figure 45, showing that a 10kW wind turbine can have a yearly maximum of 17.000 kW/h of electricity in very good wind conditions of 5 m/s (Jüttemann, n.d.).

Figure 45

Annual Yields of Small Wind Turbines of Different Capacities

Nennleistung (kW)	Windverhältnisse	Jahresertrag (kWh)
1,5	Schwach (3 m/s)	480
1,5	Gut (4 m/s)	1.270
1,5	Sehr gut (5 m/s)	2.250
3,5	Schwach (3 m/s)	770
3,5	Gut (4 m/s)	2.400
3,5	Sehr gut (5 m/s)	4.700
6,0	Schwach (3 m/s)	2.000
6,0	Gut (4 m/s)	5.800
6,0	Sehr gut (5 m/s)	10.000
10,0	Schwach (3 m/s)	3.000
10,0	Gut (4 m/s)	9.000
10,0	Sehr gut (5 m/s)	17.000

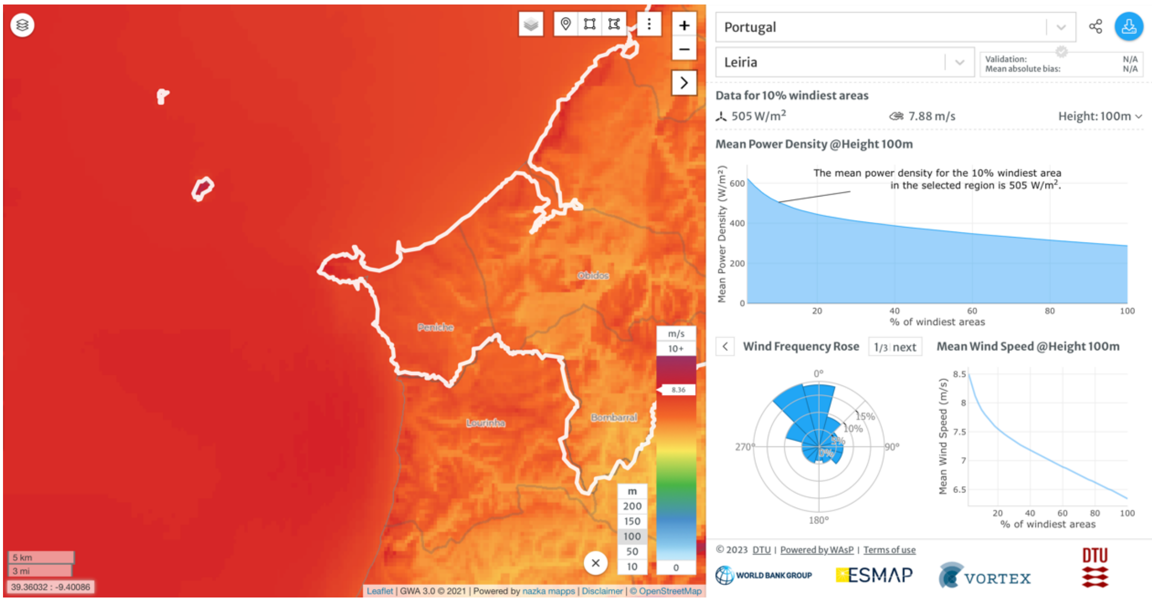
Note. Retrieved from https://www.klein-windkraftanlagen.com/strom-leistung-ertrag-kleinwindkraftanlage/ Copyright by Patrick Jüttemann 2023

It needs to be emphasised, that this table shows wind speeds that are below wind speeds near Peniche. As a matter of fact, the wind speed of Peniche and its surroundings reaches a maximum of 8 m/s (see Fig. 46) (DTU, 2023). This means that the anticipated 600kW/h of electricity is likely to be reached before the mentioned 13 days.

The carbon footprint of 0,447 tonnes of CO2 would also equal 713kW/h of electricity or around 17 Days of solar energy generated by a 10kW solar panel. As with the example of wind energy the CO2 equivalents of solar energy generated were established. Therefore, 1 kW/h generated solar energy equals 0,000627 tonnes of CO2 and so 0,447 tonnes of CO2 would require 713kW/h of solar energy to be offset (Harms, 2020). To calculate how many days a 10kW solar panel needs to operate to produce 713kW/h of electricity an annual yield of 15.000 kW/h was estimated, resulting in 17 days (Solvasto, 2021).

Figure 46

Wind Atlas (Region Peniche)



Note. *Retrieved from* *https://globalwindatlas.info/en/area/Portugal/Leiria* *Copyright by DTU 2023*

Interface 5 (see. Fig. 47) displays the costs in Euro to offset the carbon emissions of 0,447 tonnes of CO_2. Furthermore, it provides a live view of the current offsetting donations, showing how much money is still needed to invest in one 10kW wind turbine or one 10kW solar panel. It is also explained at the bottom of the interface how the investment of one wind turbine can benefit the local community. A 10kW wind turbine could power 5 Portuguese households of each 3 persons for an entire year. A 10kW solar panel could power 3,5 Portuguese households of each 3 persons for an entire year. The visitor can then decide if the contribution (11,18€) should be invested in a wind turbine or a solar panel, by clicking on either of the symbols of wind turbine or solar panel and then on CONTRIBUTE.

Figure 47

Prototype Offsetting Application (5)

Note. *Retrieved from* *https://www.wslstore.com.br* *Copyright by LPO - LOJAS DE PRODUTOS OFICIAIS LTDA. - CNPJ: 19.704.841/0001-08*

The product price of a 10kW wind turbine is estimated at around 7.700€ as shown in the example and can be found online (amazon, n.d.). A 10kW solar panel would be estimated at costs of around 12.500€ (photovoltaik4all, n.d.). Numbers about the energy consumption of an average Portuguese household with 2.5 persons were calculated based on (Fundação Francisco Manuel dos Santos, 2023a) showing the number of an average household in 2022 and the yearly domestic consumption of electricity per capita in 2021 (Fundação Francisco Manuel dos Santos, 2023b).

It should be noted that during the work of this research there were encountered several limitations. One potential limitation is the sample size, which made it more difficult to make accurate projections to the population. Thus, it had to be used evaluation methods such as bootstrapping in order to project from the sample to the population. Another important limitation to consider is the calculation of individual carbon footprints. In terms of the actual travel route and the exact vehicle model that was used, it was necessary to make assumptions which might have influenced the carbon footprint. However, to prevent a to high extrapolation of the carbon footprint, it was always used the shortest distance travelled and the least emitting vehicle.

6. Conclusion

This current research aimed to calculate the ecological footprint of the MEO RIP CURL PORTUGAL PRO 2023 with focus on the travel-related CO2 emissions of the visitors as well as putting it into relation to the from WSL calculated CO2 footprint of the event. The primary aim was to scientifically confirm the assumption that the travel-related CO2 emissions of an event are mainly caused by the travel of its visitors. Based on the quantitative analysis of the survey it can be concluded that the CO2 footprint of travel from visitors of the surf event is at 99% significantly higher than the from WSL communicated total CO2 footprint of the event at 1%. It has been concluded that these results proof that travel-related CO2 emissions for an event (Scope 3), as by the GHG Protocol are crucial to be included in the total carbon footprint of an event. It has also been shown that the exclusion of these emissions would drastically distort the CO2 footprint of one's organisation. Additionally, it can be said that the estimation of the travel-related CO2 footprint of the surf event makes it possible to understand their dimensions of impact on the environment in relation to other areas of the event. This allows organisation to change their approach of how they prioritise ecological impactful areas of their core business and give them the chance to protect the climate in a dedicated and uncompromising way.

The second aim of this work was to provide WSL with solution-oriented approaches as well as recommendations which they can implement to reduce the travel-related carbon footprint that has been revealed. A comprehensive carbon footprint reduction plan was established with two main prototypes. The SURF BY BUS/CARSHARE platform was based on survey data and its detailed analysis in Chapter 4.3, giving WSL realistic data about the willingness of the sample group to change to a bus or carshare alternative. In the optimistic scenario WSL would be able to reduce the CO2 footprint by 12% and the overall results of the sample group are significantly positive and suggest a high willingness of participants to travel more sustainable to and from the event. Thus, the SURF BY BUS/CARSHARE platform was created for both bus and car users, enabling it to reduce CO2 emissions per person significantly. The platform is supported by a promotion strategy which ensures a much more improved organisation and promotion of environmental-friendly transportation than it was done for the event. Analysing the demographics of the sample group in which 72% of visitors were between the ages of 18 and 34, made it clear to use social media platforms such as Facebook, Instagram, and TikTok, and regionally used print media to promote the SURF BY BUS/CARSHARE initiative at least 6 months before the event.

Moreover, an awareness campaign of sustainability for visitors is proposed which WSL is suggested to implement. This should encourage WSL to be more active onsite during the event and take on an educational responsibility to inform visitors about sustainability practices. Analysed data about the familiarity of environmental-related concepts suggests that there is high potential of the sample group to learn more about environmental topics. In concrete, this could be implemented by WSL interactively engaging with visitors in activities such as games or workshops that involve giveaways or prices.

The second prototype "Renewable Offsetting" addresses all remaining CO2 emissions, that couldn't have been avoided and serves as a last resort. This concept should only be considered when all other measures to avoid and reduce CO2 emissions have been stressed completely. "Renewable Offsetting" differentiate itself from WSL's offsetting projects by fulfilling important criteria such as Additionality, Permanency, and providing more accurate calculations of avoided CO2 emissions. The "Renewable Concept" is also based on statistics that were made with the survey data. Therefore 52% of the sample had a high willingness to contribute for offsetting their travel to and from the event and would contribute an average of 22.53€ per person. The financial potential of this concept is assumed to be high when projecting to the whole population of 150.000 visitors.

This research can be seen as a pioneer study focusing on the environmental sustainability of WSL events, which brought up questions and recommendations for future studies. Therefore, further research might concentrate on environmental concepts in sports organisations that enable visitors to offset their carbon emissions and whether their willingness and attitude is high or low. This could give crucial answers on the actual behaviour of visitors when offered carbon offsetting possibilities. Moreover, in the pursuit of more comprehensive insights about the inclusion of travel-related CO2 emissions of event visitors in the carbon footprint, it is recommended that researcher explore the attitude of other sports organisations and event industry towards the inclusion of these emissions.

This research has shown that the environmental responsibility of organisations should be extended to the areas that have a significant impact on the environment. Furthermore, it brought to the attention that organisations should rethink about how they define their boundaries and scopes when it comes to carbon footprint calculations. In conclusion it can be said that, although it seems that the inclusion of travel-related CO2 emissions as part of the carbon footprint is a very rare practice, organisations should decide for themselves whether they strive to be carbon-neutral for its stakeholders or for the world's environment.

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Appendix A: Survey Questionnaire

5 Minute Survey of MEO Rip Curl Portugal Pro in Peniche

Thank you for taking my survey that
is in the scope of my Master dissertation of Sustainable Tourism Management at Polytechnic of Leiria. The survey is about getting estimates about the CO2 footprint of spectators of the event. The survey is anonymous and I guarantee the confidentiality of the data. To find out about the results of this research, please contact chris.z77711@gmail.com.

* Indicates required question

1. 1. Please name the city from which you started your travel journey **knowing** that you will vis the MEO Rip Curl Portugal Pro.

   (City and country)

   ____

2. 2. Are you staying in a **temporary accommodation** in Peniche, Baleal, Consolação, Atouguia da Baleia or around **specifically for the event**?

   Mark only one oval.

   - Yes *Skip to question 3*
   - No *Skip to question 4*

Temporary accommodation

3. 2a. How many days are you staying?

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- Other: ____________________

Plane travel

4. 3. Did you use a plane in order to get to the event? *

Mark only one oval.

- Yes *Skip to question 5*
- No *Skip to question 7*

Plane travel

5. 3a. From where to where did you travel by plane? (Please state all your travel journeys) *

____

6. 3b. Why did you use plane? Please select all options that were reasons for you to choose traveling by plane.

Tick all that apply.

- ☐ Limited information on public transport
- ☐ Limited information on car sharing offers
- ☐ Limited access to public transportation
- ☐ Trip duration/travel time (due to number of connections and connection waiting time)
- ☐ Comfort
- ☐ Reducing CO2 emissions
- ☐ More autonomy/flexibility
- ☐ Other: ____________________

Car travel

7. 4. Did you use a car in order to get to the event? *

Mark only one oval.

- ◯ Yes *Skip to question 8*
- ◯ No *Skip to question 11*

Car travel

8. 4a. From where to where did you travel by car? *

____

9. 4b. When traveling by car, how many people did you take with you to the event? *

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- 6
- 7

10. 4c. Why did you use the car? Please select all options that were reasons for you to choose traveling by car.

Tick all that apply.

- [ ] Limited information on public transport
- [ ] Limited information on car sharing offers
- [ ] Limited access to public transportation
- [ ] Trip duration/travel time (due to number of connections and connection waiting time)
- [ ] Comfort
- [ ] Reducing CO2 emissions
- [ ] More autonomy/flexibility
- [ ] Other: ____________________

Camper van travel

11. 5. Did you use a camper van in order to get to the event? *

Mark only one oval.

- Yes *Skip to question 12*
- No *Skip to question 14*

Camper van travel

12. 5a. From where to where did you travel by camper van? *

____

13. 5b. Why did you use camper van? Please select all options that were reasons for you to choose traveling by camper van.

Tick all that apply.

- [ ] Limited information on public transport
- [ ] Limited information on car sharing offers
- [ ] Limited access to public transportation
- [ ] Trip duration/travel time (due to number of connections and connection waiting time)
- [ ] Comfort
- [ ] Reducing CO_2 emissions
- [ ] More autonomy/flexibility
- [ ] Other: _______________________

Bus travel

14. 6. Did you use a bus in order to get to the event? *

Mark only one oval.

- ( ) Yes *Skip to question 15*
- ( ) No *Skip to question 17*

Bus travel

15. 6a. From where to where did you travel by bus? *

____

16. 6b. Why did you use bus? Please select all options that were reasons for you to choose traveling by bus.

Tick all that apply.

- [ ] Limited information on public transport
- [ ] Limited information on car sharing offers
- [ ] Limited access to public transportation
- [ ] Trip duration/travel time (due to number of connections and connection waiting time)
- [ ] Comfort
- [ ] Reducing CO2 emissions
- [ ] More autonomy/flexibility
- [ ] Other: _______________________________

Train travel

17. 7. Did you use a train in order to get to the event? *

Mark only one oval.

- ( ) Yes *Skip to question 18*
- ( ) No *Skip to question 20*

Train travel

18. 7a. From where to where did you travel by train? *

____

19. 7b. Why did you use train? Please select all options that were reasons for you to choose traveling by train.

Tick all that apply.

- [ ] Limited information on public transport
- [ ] Limited information on car sharing offers
- [ ] Limited access to public transportation
- [ ] Trip duration/travel time (due to number of connections and connection waiting time)
- [ ] Comfort
- [ ] Reducing CO2 emissions
- [ ] More autonomy/flexibility
- [ ] Other: ____

Bicycle or walk

20. 8. Did you use a bicycle or walked from Peniche, Baleal, Consolação, Atouguia da Baleia o around to the event?

Mark only one oval.

- Yes *Skip to question 21*
- No *Skip to question 22*

21. 8a. Why did you use bicycle or walked? Please select all options that were reasons for you to choose traveling by bicycle or walked.

Tick all that apply.

- [ ] Limited information on public transport
- [ ] Limited information on car sharing offers
- [ ] Limited access to public transportation
- [ ] Trip duration/travel time (due to number of connections and connection waiting time)
- [ ] Comfort
- [ ] Reducing CO_2 emissions
- [ ] More autonomy/flexibility
- [ ] Other: ______________________

22. 9. Did you notice any efforts of WSL to encourage you to travel by public transport or carsharing to the event?

Mark only one oval.

- Yes *Skip to question 23*
- No *Skip to question 24*

Did you notice any efforts of WSL to encourage you to travel by public transport or carsharing to the event?

23. 9a. Which efforts did you notice? *

____
____
____
____
____

Skip to question 24

24. 9b. If managed and organised on the WSL website, how likely would it be that for the next event switch to carsharing, public transport, or reserved bus alternative to arrive to and from the event? (Please indicate for each alternative)

Mark only one oval per row.

	Very unlikely	Unlikely	Neutral	Likely	Very likely
Public transport	⬭	⬭	⬭	⬭	⬭
Carsharing	⬭	⬭	⬭	⬭	⬭
Organised busses	⬭	⬭	⬭	⬭	⬭

25. 10. How familiar are you with each of the following concepts: *

Mark only one oval per row.

	Very unfamiliar	Unfamiliar	Somewhat familiar	Familiar	Very familia
Carbon Footprint	⬭	⬭	⬭	⬭	⬭
Carbon Offsetting	⬭	⬭	⬭	⬭	⬭
Environmental projects supported by WSL focusing on coastal restoration and conservation. ("We are one ocean")	⬭	⬭	⬭	⬭	⬭

26. 11. If WSL would give you at the event the opportunity to offset your CO2 footprint of your travel to and from the event, by choosing any of the programs of “We are one ocean”, woul you offset your CO2?

Mark only one oval.

- No *Skip to question 27*
- Yes, but only up to a certain amount of money *Skip to question 28*
- I don't know the concept of carbon offsetting and therefore can't give an answer on that *Skip to question 34*

No

27. 11a. If WSL would match the amount of money that people contribute to offset their carbon footprint, how much would you contribute? (1 metric tonne CO2 = 25€ and 1 metric tonne CO2 = 4.900km by middle class gasoline car)

(example: X EURO)

____

Skip to question 30

Yes, but only up to a certain amount of money

28. 11b. Please indicate until how much you would be available to contribute. (1metric tonne CO2 = 25€ and 1 metric tonne CO2 = 4.900km by middle class gasoline car)

(example: X EURO)

____

29. 11c. If WSL would match the amount of money that people contribute to offset their carbon footprint, how much would you contribute? (1 metric tonne CO2 = 25€ and 1 metric tonne CO2 = 4.900km by middle class gasoline car)

(example: X EURO)

30. 12. Would you prefer to support a local project, that benefits the environment in the events location, or is the location of the project is not an important factor?

Mark only one oval.

- Local
- Any other location

31. 13. Do you believe that carbon offsetting is effective in protecting the environment? *

Mark only one oval.

- Yes *Skip to question 32*
- No *Skip to question 33*

Yes

32. 13a. Please explain why.

Skip to question 34

No

33. 13b. Please explain why.

____
____
____
____
____

Skip to question 34

Demographic Questions

34. 14. Please indicate your gender. *

Mark only one oval.

- Female
- Male
- Other

35. 15. What is your age? *

Mark only one oval.

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 or over

36. 16. What's your highest level of education? *

Mark only one oval.

- No formal education
- High school diploma
- Bachelor's degree
- Master's degree
- Professional degree
- Doctorate degree
- Other

Appendix B: QR-Code of Survey Questionnaire

POLITÉCNICO DE LEIRIA | ESCOLA SUPERIOR DE TURISMO E TECNOLOGIA DO MAR

SURVEY
QUESTIONÁRIO

MEO RIP CURL PRO PORTUGAL 2023

ENGLISH

PORTUGUESE