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Soccer and CO^2: Air Travel at International Football Tournaments from 1990 to 2024

Thesis presented by

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Conor

1. INTRODUCTION

1.1 Outlining the research question

This research explores the impact of football air travel on the environment for all men's World Cup and UEFA European Football Championships hosted between 1990-2024. These tournaments required qualifying teams to travel to a host country and attract tens of thousands of supporters to stadiums throughout the host country. The supporter of teams and players travel across the host nation during their stay in the competition. Depending on the success of the team this can range from about 10 days up to 5 weeks.

The environmental damage caused by air travel is widely known and research and is having a significant impact on the environment. The global football industry is part of this problem. The decision of where to host major international competitions is an important element of this as both UEFA and FIFA have radically altered their traditional hosting methods in recent years. FIFA has tended to use more remote locations (further from Europe) such as Korea, Japan, South Africa, and Qatar, and has abandoned the policy of hosting the event in a UEFA member every 8 years. Furthermore, countries of great geographic size – for example the United States of America (USA) and Russia – have both hosted the FIFA World Cup since 1994, with the USA set to host the event again in 2026. FIFA has also commenced co-hosting the World Cup, a policy adopted by UEFA first in 2000, and continued in 2008 and 2012. In 2021, UEFA abandoned the traditional of a host nation, in favour of multiple host cities spread throughout Europe.

Coupled with the great geographical spread of host cities and larger host nations, both the FIFA World Cup Finals and UEFA European Championships Finals have expanded substantially. In 1992 just 8 UEFA members competed at the Finals in Sweden, while 24 countries headed to

the USA for World Cup 1994. In 2022, 32 countries competed at the World Cup in Qatar and 24 countries appeared at the delayed 2020 UEFA European Championships. The World Cup in 2026 will consist of 48 qualifying teams. This means the World Cup Finals will have expanded by 100% since 1994, while the European Championship Finals will have increased in size by 200%.

Given the increased travel of this increase, and the impact of CO^2 emissions on the sustainability of the planet it is both timely and important to examine the impact that these tournaments are having on the environment. The lack of monitoring and implementation of sustainability policies for managing the environmental conditions are influencing the overall actions of the leading authority of football. Proper intervention and planning are essential for the leading authorities for minimizing the level of carbon footprint due to travelling for major events in international football (Paché, 2020). Specifically, explore whether smaller or more central (in or close to Europe) host nations are better placed to host these major sporting events from and environmental perspective? This work is only important in the context of both FIFA and UEFA and their commitment to sustainability as both federations are signatories on the United Nations' Sport for Climate Action Framework and are aiming to achieve net-zero carbon emissions by 2040 (United Nations, 2023; Goldblatt, 2020).

1.2 Rationale for research

There are several strands of literature on the World Cup and other football tournaments which focus on the event and their economic impact. Yet, to date, there are few studies to date that explore the importance of sustainability. It is very important for every individual and business entity to maintain effective emission control over travel and other services to sustain an effective environmentally friendly atmosphere. This is particularly true for both FIFA and

UEFA who are committed to reaching net carbon neutral soon. Therefore, this work is an attempt to see of their current practices and actions make the words that they express. It also seeks to highlight the importance of environmentally friendly changes that can be introduced so that European and the world football associations can maintain sustainable environmental standards.

The environmental impact of international soccer tournaments centres around the benefits of hosting such an event and the resulting carbon emissions. Major tournaments like the FIFA World Cup or UEFA European Championships are often showcases as having significant economic benefits for the host country. Host routinely argues that an influx of tourists and investments can boost local businesses, create jobs, and raise the host country's profile on the international stage. The literature on such economic benefits very much questions this logic. Furthermore, any benefits that are realised must be weighed against the environmental impact of the tournament, particularly in terms of carbon emissions. This is something this is routinely overlooked.

One critical factor is the distance between the participating teams and the host country. The further away the teams are, the greater the amount of air travel required to transport them to the host country. This, in turn, leads to higher carbon emissions. The Stockholm Environmental Institute estimates that the 2014 World Cup in Brazil produced over 2.7 million tons of CO2, primarily due to air travel (Andersson and Garcia, 2014). Smaller countries with efficient transportation systems and a smaller population may be better equipped to manage the logistical challenges of hosting a significant event, leading to lower carbon emissions. In addition, smaller countries may prioritize sustainability and environmental concerns in their decision-making and planning.

1.3 Main contributions and preview of findings.

This research makes several contributions to the current body of literature and are listed as follows:

1. A new database on distance travelled at major tournaments since 1990, for all qualifying countries is created.
2. An index measuring of the of CO^2 emissions for each game is created for all Finals matches. The index is at the most conservative measure and is the first to quantify the environmental impact that air travel from these games has on the environment.
3. A comparison of tournaments is made within the same hosts countries to assess whether these tournaments are improving through time. Holding the host constant allow for comparisons that are not readily available when the hosts change.
4. The environmental impact of changing competition design e.g., non-traditional hosts, co-hosting, and expansion of competing team, can be considered through time to measure the impact that these changes is having on CO^2 emissions from air travel.

Despite many advancements in jet fuel economy over the past thirty years, both FIFA and UEFA do not appear to be minimizing their carbon footprint from team travel at major tournaments. We have assessed a total of 895 football tournament matches between June 1990 and June 2024. Over the course of that timeline there has been significant changes to the amount of qualifying teams, the locations of tournaments and the landscape of these competitions. By creating a CO^2 emissions index, we have shined a light on the evolution of tournament hosting from a CO^2 emissions perspective. Our results show that the decision of where to host the World Cup and the European Championships results in fluctuating levels of emissions**.** Total travel was greatest at the 2002 World Cup in Korea and Japan, and this resulted in an average of 31.5 tonnes of CO^2 being emitted per game. The emissions created

by World Cup competitions in South Africa (2010) and Brazil (2014) were strongly affected by travel to the event. The host country's location is obviously crucial, since tournaments in Italy and France resulted in comparatively low average emissions per game.

In contrast to the World Cup, the European Championships produce much lower CO^2 emissions per game due to them being intra continental competitions. Tournaments hosted in England (1996) and Belgium/Netherlands (2000) produced two of the lowest emissions with 3.88 tonnes and 3.03 tonnes emitted respectively. However, an outlier exists as the 2020 European Championships was held across 11 different countries, and this resulted in 9.66 tonnes of CO^2 being emitted per game. It is anticipated that the upcoming 2024 European Championships in Germany will produce one of the lowest average emissions due to their European locations. Hosting a major tournament near most qualifying teams significantly reduces CO^2 emissions.

1.4 Overview of the remaining sections in the thesis.

This thesis continues as follows; Section 2 explores the literature connected to the evolution of environmental issues in sport while also providing an overview of sustainability related research. Section 3 provides an overview of major tournaments from 1990 to 2024, focusing on how these competitions have expanded in scope. Section 4 delves into various sources of collected data from The Rec. Sport. Soccer Statistics Foundation, European Environmental Agency, and Distance Calculation. Section 5 displays the findings from the data we have collected. We have analysed the results carefully and established a strong link to the literature. Section 6 discusses the implications of the results and where exactly it can be placed within the literation. We further make recommendations based on the results. Section 7 summarises the data, method and results in the context of literature. The thesis is concluded by suggesting some potential avenues for future research.

2. CONTEXT AND LITERATURE REVIEW

2.1 Introduction

On the 2nd of June 2002 Paraguay and South Africa met in their opening game of the FIFA World Cup in Busan, South Korea. While most football fans will struggle to recall this game as it was largely uneventful, it does hold a significance. It is likely the FIFA World Cup's highest CO^2 emitting game of all time. The teams travelled a combined distance of greater than 31,000 kilometres to meet in South Korea and produced more than 170 tonnes of carbon dioxide (CO^2) from travel alone. This is approximately the electricity usage of 33 homes for an entire year or nearly 20,000 gallons of gasoline (Environmental Protection Agency, 2023). While FIFA recently communicated, for the first time, its responsibility towards the environmental impact of the construction and operation of stadia at the 2022 World Cup in Qatar (O'Rourke & Theodoraki, 2023), little attention has been placed on international travel to or during tournaments.

The importance of travel and the impact the sports industry has on the environment is acknowledged by the United Nations' Sport for Climate Action Framework which calls for the halving of emissions by 2030 and the achievement of net-zero emissions by 2040 (United Nations, 2023). This is an ambitious target, and one football federations needs to consider seriously. CO^2 emissions from travel have been calculated to contribute up to 83% of total emissions from a World Cup tournament (FIFA, 2013). Goldbatt (2020) notes that there is little sense of urgency to address this given the actions of individual sports' federations. Instead, sports' stakeholders are criticised as appearing to rely on carbon offsetting and innovation to reduce climate change rather than focusing on the source of the problems (Wilson & Millington, 2015; Goldblatt, 2020; Gammelsæter & Loland, 2023).

Given that major sports events attract a range of stakeholders (athletes, officials, media outlets, commercial enterprises, and spectators) contributing significantly to transport emissions in a concentrated period, a reduction in transport emissions is an important step towards the delivery of environmentally sustainable major sports events. To achieve this objective, there is first a need for increased monitoring and measurement of sustainable practices in sport (McCullough et al., 2019).

2.2 Context and Theory

The management of sporting events, by their very nature, are dependent on the natural world. Yet these sports often contribute to environmental degradation (McCullough et al., 2016). This does not just apply to elite level sports and all levels of sport should examine how human behaviour in relation to the environment can be managed to protect the environment (Thibault, 2009). The admission that sport plays a part in environmental degradation is now widely accepted (Inoue and Kent. 2012; Pfahl, 2013) but only in recent years. As recently as the early 1990s, little or no effort was made by sporting association or federations to manage the impact had on the natural world. It is only since the 1990s that strategies have begun to emerge – from federations such as the International Olympics Committee and FIFA – to address issues and concerns around the environment. Two environmental initiatives have largely been targeted. The first is reducing the ecological footprint of sporting events. The second is attempting to raise awareness of environmental awareness at a global level. While the implementation of such policies is admirable, the success of these – particularly reducing the ecological footprint – is very much debatable.

The origins of planning and organizing a major sporting event with environmental issues in mind can be traced to the first two Winter Olympics during the 1990s in Albertville, France

(1992) and Lillehammer, Norway (1994) (Kietlinski, 2021). This was greatly assisted by the International Olympic Committee (IOC) adoption of the environment as the 'third pillar' of Olympism to mark the 100-year anniversary of the foundation of the movement at the Centennial Olympic Congress, Congress of Unity, in Paris 1994 (Chappelet, 2013). This pillar now placed the management of ecological concerns beside the original goals of the Olympic movement - the unity of sport and culture. By 1996 the "Olympic Charter included the sentence "[The IOC's role with respect to the environment is:] to encourage and support a responsible concern for environmental issues, to promote sustainable development in sport and to require that the Olympic Games are held accordingly" (International Olympic Committee, 2014).

Prior to the Lillehammer event, concerns were raised about the construction of sports facilities and the negative impact theses could have on the environment. As a result, carefully planning went into preparation and planning for the games, which were unprecedented at the time. The consequences of this new form of sport management have had far reaching effects and acted as the catalyst in creating a culture in major sports events that has had a legacy. For example, in 1999 the ratification of Agenda 21 by the IOC, led to the creation of sustainable development principles which were essential to host a Summer or Winter games (Chappelet, 2013). In 2006 FIFA developed the Green Goal programme for the World Cup held in Germany. This programme has become the driving force behind the bidding, preparation, hosting and evaluating the success of the World Cup (McCullough et al., 2016). The United Nations Environmental Programme (2009) claims that the Summer Olympic Games in Beijing resulted in spending of more than US$17 billion to address environmental issues from 2001 to 2007. The United Nations' Sport for Climate Action Framework outlines specific climate goals such as aiming to achieve net-zero carbon emissions by 2040 (United Nations, 2023) and the IOC,

FIFA and UEFA are signatories (Goldblatt, 2020). On the surface at least, sustainability and climate action appear to be essential parts of the management of these sports events.

While the promotion of environmental and sustainability goals should be celebrated, McCullough et al. (2019) note the paradox that now exists between the goals of global sporting organisations and actions in the management of major sporting events on a global level. The motivation to earn financial rewards – the primary objective of international sporting federations – can cause the underestimation of the negative environmental effects of an event. This is coupled with overestimation of the economic benefits to the host, who attempt to maximise the environmental benefits of the same event to generate revenue (Kellison & Mondello, 2014). A more holistic approach to the management of these event is required, if competing interests are to be managed.

As noted by McCullough et al. (2019) consideration of the environmental impact of major sporting tournaments requires the identification of both direct and external effects of the entire life cycle of the event. These need to be evaluated at both a production and consumption level to the full account of the direct impact of hosting events e.g., planning, production, ticket sales and transportation, as well as externalities that are created such as crowding out and environmental effects. Such an assessment would move international federations away from simple consideration of the 'bottom line' and instead of tokenism, place sustainability and environmental concerns, at the center of the planning and management of sporting events.

The role of the environment in sports is increasingly gaining attention due to the profound impact of climate change and other environmental factors on athletic activities. From affecting athletes' performance to influencing the infrastructure of sports venues, the environment plays a crucial role in shaping the world of sports.

One significant aspect is the climate crisis's effect on sports facilities. Stadiums and arenas are facing challenges due to rising sea levels, extreme weather events, and changing environmental regulations. Research by Kellison and Orr (2021) highlights how climate vulnerability has become a catalyst for early stadium replacement. This not only impacts the financial aspects of sports organizations but also raises questions about the sustainability of sports infrastructure in the face of environmental changes.

Moreover, specific sports are directly impacted by environmental shifts. Orr (2020) discusses the potential impacts of climate change on sports such as baseball and cross-country skiing. For baseball, changing weather patterns could affect playing conditions and scheduling, while warming temperatures can significantly impact winter sports like skiing, threatening their viability in certain regions.

These examples underscore the interconnectedness of sports and the environment. As the climate crisis continues to unfold, athletes and governing bodies must adapt and innovate to mitigate environmental risks and ensure the long-term sustainability of sports participation and infrastructure. Collaboration between environmental experts and the sports industry is crucial in developing resilient strategies that can withstand the challenges posed by environmental changes.

2.3 Football Governing Bodies and Hosting Major Tournaments

To host major tournaments prospective host countries must making bidding applications to both FIFA and UEFA respectively. Would-be hosts often view this as a very effective medium to showcase the features of their culture, boast national pride and happy and demonstrate their capabilities as a host nation by attracting international visitors to their country. (Chams and García-Blandón 2019). These relevant federation then score then vote on the applicants and anoint the winners. Geeraert (2017) note that governments have largely refrained from regulating the sport, instead leaving football association self-managed and free from strict regulations. This has resulted in governments invested taxpayers' money into events that are not necessarily climate-friendly, as well as the emitting of CO^2 for the construction of infrastructure that is not effectively utilised after the events. Many examples of this can be found across the world following major events in countries such as South Africa, Russia, Brazil and Qatar in recent years. This, even though, hosting major events is often considered a public good, as it affects society, and it should be carefully managed.

From 1958 to 2006, FIFA adopted a rotation policy for hosting, with every second tournament held in Europe (once every eight years). The leading nations that have won and hosted the football World Cup are Brazil, Germany, France, Italy, and England, with prize money of the tournament now worth around $800 million (Porter, May, and Kiernan, 2018).The policy of rotation was abandoned after the 2006 World Cup in Germany and in recent years, more remote locations (further from most qualifying teams) such as Korea, Japan, South Africa, and Qatar have been used. Furthermore, countries of greater geographic size have been selected as hosts, such as the United States of America (USA) and Russia. Both countries have hosted the FIFA

World Cup since 1994, with the USA set to host the event again in 2026. Three reasons are cited for this change in policy. Broadcasting revenue is now more important than ticket sales (Deloitte, 2016; Wallrafen et al., 2020). The desire to spread the game globally (FIFA, 2023a). And the suggestion that FIFA is trying to diminish the influence UEFA has on world football (Ahmed & Agini, 2021).

FIFA has also commenced the co-hosting of the World Cup by more than one country, a policy adopted by UEFA first in 2000, and continued in 2008 and 2012. In 2021, UEFA chose in favour of multiple cities spread throughout Europe hosting the European Championships. Additional changes of note include expanding tournament sizes with just 8 UEFA members competing in the European Championship finals in Sweden in 1992 and 24 teams qualifying for the World Cup in the USA in 1994. These numbers have risen considerably with 24 teams competing at the delayed 2020 UEFA European Championships and 32 countries competing at the World Cup in Qatar in 2022. The World Cup in 2026 will consist of 48 qualifying teams (FIFA, 2023b) which means that the number of European Championship matches has tripled since 1994, while the number of World Cup matches will have doubled.

Despite growing the number of teams travelling to major tournaments and dispersion of venues, both UEFA and FIFA state that they wish for their sport to be environmentally sustainable. The UEFA Mission Statement highlights their objective of a ‘reduction in direct and indirect carbon emissions related to UEFA’s operations and events’ which they calculate on a per live spectator basis (UEFA, 2023a). Raising awareness for saving the environment, reducing the use of single-use plastics, planting trees, zero burning of fossil fuels, and other measures have also been introduced by smaller host nations like Austria and Poland (Nogueira, 2022). UEFA has also taken the aim of recycling every good and product in a proper and effective manner

so that the environment flourishes, making people aware of avoiding plastic materials, cleaning the places, purchasing products with less packaging, and going for the afforestation methods for helping in the development of a sustainable and friendly environment (Dantas *et al.* 2020). FIFA has committed to reducing emissions by 50% by 2030 and to reaching net-zero by 2040 according to the UN Framework Convention on Climate Change Sports for Climate Action Framework principles and the Paris Climate Agreement (FIFA, 2023c). Our study assesses the validity of these commitments by comparing the travel emissions of both World Cups and European Championships from 1990 to 2022. We also project the CO^2 emissions that are likely to occur from team travel at the 2024 UEFA European Championships.

2.4 Air Travel and the Environment

Air travel refers to as the particular or specific form of traveling that occurs primarily in the form of airplanes, helicopters, jet aircraft, gliders, parachutes, or any such modes of transformation that can help in sustaining flight (Gössling and Dolnicar 2023). It can be both domestic and international depending on the network, aim, and objectives of this medium of transportation. Air travel mainly helps in shortening long journeys, carrying on to international countries, helping in economic development and upliftment, helps to create job opportunities by opening the advantages of international tourism and trade opportunities (Bhushan, 2023).

Aviation produces about 2% of all human-induced emission per year (Agarwal et al. 2020). Not only is CO^2 emitted by aircraft as greenhouse gas but so too is water vapor and Carbon nitrogen oxide, carbon monoxide and sulphur oxides, not burned hydrocarbons, compounds of nitrogen and traces of hydroxyl family, and elements of soot particles are emitted from aircraft. All these emitted elements are responsible for air pollution, land or soil pollution, depletion in the Ozone layer, formation of acid rain, and soil erosion also. Nearly 92.5% of aircraft engines

do emit or exhaust normal atmospheric nitrogen and oxygen (Bösehans et al. 2020). Contrails of water vapor that are formed by aircraft along with Carbon Dioxide, are mainly responsible for the warming up of the Earth's surface. Cirrus clouds are formed with it, lastly resulting in climate change (Dursun, 2022).

Despite the obvious environmental costs of aviation, this form of travel is preferred by many people, as it provides high speed with the supreme or utmost advantage of air transportation by saving time. There are no such physical barriers to air transportation, clearance is done in a very quick and precise manner. Easy of access to connectivity and other transportation services offers means this form of travel is often chosen over other alternatives (Heiets *et al.* 2022).

While the negative effects of air travel on the environment are accepted, the situation could be worse. For example, airplanes and helicopters have reduced the reliance on fossil fuels overtime. While the release of harmful CO^2 gases into the atmosphere can be observed in the sky – due to the vapor trails of harmful nitrogen oxides (Chen *et al.* 2022) – these omissions have reduced through time due to improvements in technology and environmental practices. However, these improvements are being offset by the rapid increase in the demand for travel. Emissions from aviation are growing very faster that other modes of transportation simply due to the increased demand for aviation. Improvements in fuel efficiency are improving by about 1% per year but the number of flights is increasing by 7% (Agache et al. 2022).

The contribution of air travel to climate change must be recognised. According to Thakur (2021), the aviation industry is responsible for the fastest-growing carbon dioxide generators in the environment. A rise in the total rates of fuel combustion also increases the carbon emission amount, and it is directly related to the erosion of the ozone layer and have resulted

in global warming (Kovacikova *et al.* 2021). Other emissions such as nitrogen oxides and water vapor, had added additional warming effects. The mixture or the combination of all these gases had resulted in an increase in the rate or density of CO^2 emissions that are mainly generated by airplanes and air travel. This has increased air pollution quickly with some estimates placing this at around rises by 5% per year (Lührs *et al.* 2020).

2.5 Othe Issues with Air travel

Air travel, mainly in the tourism and traveling industry has risen by a huge amount from 1990 to 2022. In 2022, aviation accounted for 2% of global energy-related CO2 emissions (International Energy Agency, 2023). According to the International Civil Aviation Organization (ICAO), with the engagement of more and more airplanes and with the activation of carbon emissions of industry, pollution will rise by 75% in the upcoming years. At this rate, apart from the carbon budget, global warming will rise by 1.5 degrees Celsius (Borras *et al.* 2022). By the year 2035, the total number of flyers or passengers will also increase by 7.2 billion all over the world.

It can be clearly observed that, during the time of the Covid-19 virus, global pandemic, and lockdowns there was a mass flight grounding from the year 2020 to the initial months of 2022. It has resulted in the reduction of carbon dioxide emissions from air travel by a rate of 61%, as per the reports of the Global Carbon Project. This result shows that while flights were not grounded, there was a huge rise in carbon dioxide and nitrogen oxide emissions that even resulted in global warming and depletion in the ozone layer. But, when the flights were grounded during the time of the global pandemic, CO^2 emissions were reduced. This proves that air travel negatively impacts the environment in many ways (Barczak *et al.* 2022).

Aside from air pollution other negative externalities exist. Noise pollution is an issue often overlooked (Mouter et al. 2019). Radiation of harmful high sound often gives rise to disturbances in the air, damages the life of the natural kingdom and affects the human (Gelb and Apparicio 2021; Ma et al. 2020).

2.6 Tournament Organisation and Emissions

According to Clarkson and Philippou, (2022), sustainability and proper analysis of the environmental conditions and management of waste is playing an every-increasing role in organizing such major sporting events. Daddi et al., (2021) provide a framework for sustainability management in football, developed in 2015, and seeking to unite a wide range of sports organizations behind a set of 5 priorities to meet the goal of net zero carbon emission by 2050. The major priorities that have been undertaken through this framework involve the systematic efforts to promote the greater environmental responsibilities, reduce overall climate impact, education for climate action, promote sustainable and responsible consumption of resources and advocate for climate action through communication. FIFA has designed a three-pronged program for sustainability with project to address climate, waste, and water as well as the biodiversity (Brochado et al., 2021).

Such steps are now required given the evolution of major football tournaments. For example, a return flight between Lisbon and New York generates approximately the same level of emissions per passenger as an average person in the EU does by heating their home for a year (European Commission, 2023). Therefore, each flight sacrificed can significantly reduce the football industry's carbon footprint. As international football is a global sport, aviation travel is an inherent part of its operations. Goldblatt (2020) finds that athlete and spectator travel accounted for 67 percent of emissions at the 2010 World Cup in South Africa (Econ Poyry,

2009), 83 percent at the World Cup in Brazil in 2014 (FIFA, 2013) and 74 per cent at the World Cup in Russia in 2018 (FIFA, 2016). Collins et al. (2009) also offer a quantitative impact assessment of environmental externalities. In addition to emissions, travel also bears a social cost. Wicker (2020) highlights that travel for competitions generates stress for athletes and reduces their enjoyment from participation, which is vital to sustaining the recreational and health benefits of football.

The travel emissions generated by major tournaments is influenced by the distance between the participating teams' home country and the host country, and the distance between the host nation's stadia. Effective management of this is now required as these tournaments have grown in scale and size. It logically follows those smaller countries, in terms of land mass, with efficient transportation systems should be better equipped to manage the logistical challenges of hosting a significant event, leading to lower carbon emissions. However, countries with large populations and a competitive national league may already have stadia and infrastructure in place for the tournament which eliminates the need to emit further emissions in their production. Such countries may also be better placed to benefit from leverage which Schulenkorf et al. (2022) describe as the strategic planning of an event for the maximization of business, social, or other benefits.

An example of successful event leverage is the Los Angeles Olympics in 1984 where existing venues and infrastructure were used in the hosting of the Games to avoid significant urban change (Azzali, 2020). This contrasts to the Sochi Winter Olympics where all facilities were newly built with no set agreements made for their use afterwards, resulting in their abandonment (Azzali, 2020). Similar legacy issues are evident from the 2014 World Cup in Brazil. Bek et al. (2019) call for a bottom-up approach to creating a legacy from major sporting

events. This argument lends to the use of host cities that already contain infrastructure for large sporting events.

Many organisations justify their CO^2 emissions by promising to off-set them with positive environmental practices to sink carbon (Gammelsæter & Loland, 2023), such as growing trees. However, offsetting is contentious (Watt, 2021) and carbon markets have been described as a way of supporting "a 'fossil forever' agenda while avoiding the mistake of openly advocating it." (Lohmann, 2013:298). Crabb (2016) studied one of several carbon offsetting programmes for the 2014 FIFA World Cup and showed how Cuiabá, illustrated in numerous FIFA outlets as an example of a 'green' city, was acquired by regional business and politicians to improve the environmental reputation of the region but this was to the detriment of the local population and the environment (Gammelsæter & Loland, 2023)

Another example of ineffective CO^2 emissions off-setting occurred during the 2022 World Cup in Qatar. FIFA promoted the event as being carbon neutral and European countries submitted complaints against FIFA's claims to the Swiss Commission for Fairness in late 2022. The Commission concluded that it should not be claimed that sustainability goals have been achieved by the 2022 World Cup if there are no definitive and accepted methods for measuring sustainability or ensuring sustainability measures have been implemented (Themen, 2023). The Commission advised FIFA to refrain from making unsubstantiated claims in the future and claims of this nature could only be made if the body could fully substantiate the calculation of all CO^2 emissions caused due to the tournament and provide proof that these have been fully offset (Themen, 2023).

2.7 Conclusion

The environmental impact of hosting international tournaments has become a major concern today. Air travel is a major contributor to greenhouse gas emissions, and the question of whether smaller countries are more sustainable hosts for international soccer tournaments has been a topic of debate. Smaller countries generally have a smaller population, which means less energy consumption and fewer carbon emissions. For example, the 2018 World Cup was held in Russia, a massive country with a population of over 144 million. The tournament resulted in an estimated 2.1 million tonnes of CO2 emissions, according to the organizers (BBC, 2018). In contrast, the 2016 European Championship was held in France, a country with a population of around 66 million, resulting in significantly fewer carbon emissions. The sustainability of the tournament largely depends on the host country's ability to mitigate these impacts using renewable energy, waste management practices, and sustainable transportation. Ultimately, international football tournaments should be held in countries that are committed to reducing their environmental impact and promoting sustainability.

3 AN OVERVIEW OF MAJOR CHAMPIONSHIPS: 1990 TO 2024

3.1 Introduction to Major Tournaments.

The chapter delves further into the significant international football competitions that FIFA and UEFA have organised over the previous 33 years. These competitions have expanded in scope and importance, leaving the usual football hotspots to take place in nations like South Africa, Ukraine, and Qatar that have only sporadic historical ties to football (Gaur, 2023). Each FIFA World Cup and UEFA European Championship since 1990 are summarised in Table 3.1 below.

Table 3.1: An Overview of Major International Tournaments 1990-2022

Year	Competition	Location	Stadia Used	New Stadia	Countries	Players
1990	World Cup	Italy	12	2	24	528
1994	World Cup	USA	9	0	24	528
1998	World Cup	France	10	1	32	704
2002	World Cup	Korea and Japan	20	4	32	736
2006	World Cup	Germany	12	0	32	736
2010	World Cup	South Africa	10	5	32	736
2014	World Cup	Brazil	12	6	32	736
2018	World Cup	Russia	12	9	32	736
2022	World Cup	Qatar	8	5	32	832
1992	European Championship	Sweden	4	2	8	160
1996	European Championship	England	8	0	8	176
2000	European Championship	Belgium/Netherlands	8	0	16	352
2004	European Championship	Portugal	10	0	16	368
2008	European Championship	Austria/Switzerland	8	0	16	368
2016	European Championship	France	10	0	24	552
2020	European Championship	Various	11	0	24	624

Significant international football competitions have seen a rise in the number of countries and players since 1990. The FIFA World Cup has included 32 countries since 1998. From eight countries in 1992 to sixteen in 2000 and twenty-four in 2016, the UEFA European Championship has grown. The growing popularity of football on a worldwide scale, the rising financial rewards for participating teams, and the political desire to include more countries in

these big games may all be contributing factors to the growth in participation. Significant international football competitions have multiplied considerably since 1990. This change is primarily attributable to the worldwide popularity of football, the increasing financial incentives for participating teams, and the political desire to include more nations in these significant competitions.

3.2 FIFA World Cup

3.2.1 Italy 1990

The 1990 FIFA World Cup was the 14th World Cup held from the 8th of June to the 8th of July 1990. The Italians became only the second country (after Mexico) to host the tournament for a second time, having previously hosted the tournament in 1934. A total of 116 national football associations attempted to qualify for the Finals, which commenced in April 1988. Italy (hosts) and Argentina (defending champions) were automatically granted spotted at the finals. At the completion of qualification 13 UEFA members, were joined by countries from AFC (2), CAF (2), CONCACAF (2) and CONMEBOL (3), joining the hosts and champions to make 24 countries in total. The tournament would consist of a group stage of six groups, followed by a knockout stage commencing with 16 teams. The winners of the Round 16 would progress to the Quarter Finals, with subsequent winning teams progressing to a Semi-Final and Final.

Twelve host cities were used during the Finals across mainland Italy, as well as the islands of Scilly and Sardinia. Six matches were played in the Stadio Olimpico (Rome) and San Siro (Milan) while Stadio San Nicola (Bari), Stadio San Paolo (Naples), and Stadio delle Alpi (Turin) each hosted five matches. Other host cities included Florence, Bolonga, Genoa, Cagliari, Udine, Verona, and Palermo. Both Stadio San Nicola and Stadio delle Alpi were completely new venues opened for the 1990 World Cup. The remaining ten stadia were all

upgraded in the led up to the Finals. Following the 52 games, West Germany emerged as winners, beating Argentina 1-0 in the Final in Rome. The 1990 World Cup was infamous for a record low goals-per-game average and poor discipline. In total, 16 red cards were issued during matches, a record high at the time. Time wasting was also a major issue, resulting in significant rule changes following the tournament. This included the introduction of the back-pass rule and the awarding of three point, rather than two, for winning a match. The latter was introduced to encourage attacking player, while the former rule change was to prevent excessive timewasting.

3.2.2 FIFA World Cup USA 1994

In 1994, the 15th edition of the FIFA World Cup, the United States hosted it for the first time. The World Cup, held from June 17th to July 17th, 1994, was largely responsible for the sport's meteoric rise in popularity throughout North America. Football gained popularity in a country where it had previously lagged behind other sports as a result of the influx of tourists who flocked to watch the games. Qualification concluded with 13 UEFA members qualifying for 94 World Club, they were joined by countries from AFC (2), CAF (2), CONCACAF (2) and CONMEBOL (3), joining the hosts and champions to make 24 countries in total. Three new entrants made their World Cup debuts in Saudi Arabia, Greece and Nigeria. 9 different locations were used around the United States to host games. These included San Francisco (Stanford Stadium), Michigan (Pontiac Stadium), New York (NY Giants Stadium), Washington (JFK Stadium), Orlando (Citrus Bowl Stadium), Dallas (Cotton Bowl Stadium), Chicago (Soldier field) & Boston (Foxboro Stadium). Due to the large area of continental America, this caused various problems for the competing teams. Teams in groups A and B had to travel distances of circa 2,400 miles (Boston to Dallas & back). This made playing conditions very difficult to adapt the coolness of Boston to the intense humidity of Dallas. This was in stark contrast to

Teams in groups E & F who played exclusively on the east coast where every game played was in the same time zone.

The World Cup final was contested between Brazil & Italy in the Rose Bowl in Pasadena, California. Following a scoreless draw and extra time, the game went to penalties, where Brazil ultimately prevailed 3-2. Brazil became the first nation to win the World Cup for the fourth time after this victory. The 1994 FIFA World Cup was a turning point for American football, impacting the growth and popularity of the sport for years to come (Gaur, 2023).

3.2.3 FIFA World Cup France 1998

From June 10th to July 12th 1998, France hosted the FIFA World Cup for the second time in their history. 174 teams from 6 confederations attempted to qualify for World Cup. Along with the hosts, France, 14 nations from the European region qualified. Nine group winners and the best second-place team were chosen following group games, while the remaining eight group runners-up were assigned to pairs of four-team play-off matches, with the winners advancing to the finals as well. Thirty members of CONCACAF competed for three berths in the final tournament, while CONMEBOL and CAF each received five spots. This World Cup continued the trend of an improved format and the number of participating teams increasing from 24 to 32. Croatia, Jamaica, Japan and South Africa were four of the new entrants playing in their first World Cup.

Ten host cities were used during the Finals across mainland France. The most used stadium throughout the tournament was the Stade de France hosting a total of nine matches. Paris St Germain's Parc de Princes also hosted six matches bringing the total amount of games held in the French capital to fifteen. Seven matches were held in the Stade Velledrome (Marseille), six

in the Stade DeGerland (Lyon) and six in Stade Felix-Bollaert (Lens). The first golden goal in World Cup history was scored by France in a round of 16 match versus Paraguay. The match finished goalless, sending it into extra time. The golden goal rule applied such that France were the first nation to score in extra time and immediately win the match. France would continue to win the first World Cup. 'Les Bleus' defeated Brazil 3-0 at the Stade de France in Paris. Zinedine Zidane, widely considered one of the all-time greats of the game, scored twice.

In many ways, the 1998 World Cup changed France. A sense of national pride was fostered as people from all walks of life flocked to watch the game and support the French side. The victory enhanced French culture and outlined its sporting goals.

3.2.4 FIFA World Cup South Korea and Japan 2002

The 17th FIFA World Cup was held in 2002 in South Korea and Japan between May 31st and June 30th, 2002. 32 teams competed in the 2002 World Cup with Slovenia, Ecuador, Senegal and China making their World Cup Debuts. European teams competed for 14 spots, followed by CAF, CONMEBOL, AFC, and CONCACAF teams competed for five, four, and three spots, respectively. The first Asian edition of the competition was a turning point in Asian football. 10 South Korean and 10 Japanese venues hosted twenty matches with many of the stadiums being purposely built for the World Cup. This gave both nations the chance to exhibit the globe their football traditions and infrastructure.

Tokyo made history by becoming the first host nation's capital without a World Cup venue. Groups A through D played every game in South Korea, while Groups E through H played every game in Japan. The other 16 stadiums each hosted 3 matches, while Daegu, Suwon, Yokohama, and Saitama each hosted 4 matches.

The 2002 World Cup was exciting and unexpected. Underdogs won as conventional football powerhouses lost early. The defending champions (France) were eliminated in the group stage along with the much fancied Argentina. South Korea shocked everyone by reaching the Semi-finals and impressing their ardent home supporters (2002 Korea Japan FIFA Football World Cup History, Winners, Runners-Up, 2022).

Brazil were victorious once again for a record-breaking firth time in their history defeating Germany 2-0 at the International Stadium in Yokohama. Asian football's popularity soared and the groundwork for its future development was created during the 2002 World Cup in South Korea and Japan. The victory of the competition and the fervour of the supporters enhanced football's standing across the world.

3.2.5 FIFA World Cup Germany 2006

From June 9th to July 9th, 2006, Germany hosted the 18th FIFA World Cup. Germany hosted its first World Cup tournament since reunification. 198 teams made an attempt to qualify. The remaining 31 finals spots were distributed among the continental federations, with Germany, the host country, receiving automatic qualification. Czech Republic, Ghana, Ivory Coast, Togo, Ukraine, Serbia, Montenegro and Trinidad and Tobago all made their World Cup debuts. Teams from UEFA competed for 13 spots, CAF for 5, CONMEBOL for 4, AFC for 4 and CONCACAF for 3. The World Cup in Germany marked the first time since 1984 that six confederations were represented.

12 locations across the mainland were utilised for hosting games. Olympiastadion (Berlin) Signal Iduna Park (Dortmund), Allianz Arena (Munich) and the MPH Arena (Stuttgart) each

hosted six matches. The remaining eight stadia staged five matches each. Modern stadiums made it possible for football fans from all over the world to appreciate the magnificent game. The 2006 World Cup marked the return of the footballing powerhouses. Unlike the 2002 World Cup in South Korea and Japan where unconventional teams made it deep into the competition, none of the 2006 quarter finalists were from outside Europe or South America. Throughout the competition, numerous up-and-coming young athletes emerged. On the global stage, Cristiano Ronaldo, Lionel Messi, and Franck Ribéry launched their careers.

Italy were crowned World Cup Champions after defeating France in a dramatic final held in Olympiastadion in Berlin. Following a scored 1-1 draw, Italy were victorious 5-3 in a penalty shootout. Although Germany were not successful in winning the World Cup, the tournament was widely considered as a great success. The tournament victory boosted national prestige and the significance of football in the country's sports scene.

3.2.6 FIFA World Cup South Africa 2010

The 2010 FIFA World Cup was the first time an African nation hosted the event. UEFA only opened the bidding process to African nations due to a rotation policy. This enabled football confederations to rotate hosting the event and re-enforce its message that football is a worldwide game. South Africa proudly hosted the event in eleven sites from June 11th to July 11th, 2010. Unlike previous tournaments, the defending champions were not awarded automatic qualification. Italy, just like the other 12 UEFA teams had to participate in qualification. At the completion of qualification the 12 UEFA members, were joined by countries from AFC (4), CAF (6), CONCACAF (3), OFC (1), CONMEBOL (5), joining the hosts and make 32 countries in total.

Five new stadiums were purposely built in Johannesburg, Cape Town, Pretoria, Port Elizabeth & Durban. The three stadiums with the most matches played were FNB Stadium (Johannesburg), Cape Town Stadium (Cape Town) and Nelson Mandela Bay Stadium (Port Elizabeth). 8 matches were hosted at each venue. Matches were also hosted at Ellis Park Stadium in Johannesburg (7) and Moses Mabhida Stadium in Durban (6). Six games each were played at Loftus Versfeld Stadium (Pretoria), Free State Stadium (Bloemfontein) and Royal Bafokeng Stadium (Rustenburg). The 32 teams played in cutting-edge settings that showcased South Africa's culture and customs. The country's bright and diverse atmosphere was remarkable for worldwide football enthusiasts.

The traditional South African horn called a vuvuzela, which fans blast throughout matches, contributed to the 2010 World Cup's unique atmosphere. The vuvuzela was emblematic of the distinctive mindset of the tournament. Spain emerged as the victors of the 2010 World Cup. In the final held at Soccer City Stadium in Johannesburg, they emerged victorious with a 1-0 win over the Netherlands after extra-time. Spain established itself as a formidable force in the realm of football following its inaugural victory in the World Cup. The hosting of the 2010 World Cup in South Africa significantly contributed to fostering unity and instilling a sense of pride within the nation. The competition also acted as a source of inspiration for a new generation of African athletes and supporters.

3.2.7 FIFA World Cup Brazil 2014

The 20th FIFA World Cup was held for second time in Brazilian history between June 12th and July 13th ,2014. At the conclusion of qualification, 32 countries in total —including the hosts— were added to the 12 UEFA members by countries from the AFC (4), CAF (5), CONCACAF (4) and CONMEBOL (6). Brazil's footballing heritage was expected to result in the hosts

reclaiming the World Cup. Twelve host cities were carefully chosen for the tournament, including seven new and five renovated stadiums. The Maracanã (Rio) and Estadio Nacional (Brasilia), which each held seven games, were the most utilised stadiums. The least-used stadiums, which each hosted four matches, were the Arena Da Baixada (Cuiabá), Arena Da Amazônia (Manaus) Arena das Dundas (Natal) and Arena Pantanal (Curitiba).

Brazil's World Cup dream ended in disaster as they were beaten by eventual champions Germany 7-1 in the Semi-Final – the nation's biggest football defeat since 1920. At the Maracanã Stadium, Germany defeated Argentina 1-0 to win their fourth World Cup. Mario Gotze's goal in extra time gave Germany a historic victory. The 2014 World Cup was infamous for the use of goal-line technology. In an effort to combat a team being wrongly awarded a goal if the whole ball had not crossed the line, referees were equipped with a watch that would vibrate and showed a message if the ball had crossed the line. Goal-line technology was first used in a group match featuring France and Honduras where it was needed to confirm if a goal should be given.

3.2.8 FIFA World Cup Russia 2018

The 21st FIFA World Cup was held in Russia from June 14th to July 15th , the first time the tournament was held in Eastern Europe and eleventh time the event was held in Europe. Another first for the World Cup was that all 209 member associations applied to enter the qualifying process for 31 spots – excluding already qualified hosts, Russia. 12 UEFA members qualified and they were joined by countries from AFC (5), CAF (5), CONCACAF (3) , CONMEBOL (5). Twelve stadiums in eleven Russian cities were renovated or built for the World Cup. Of the twelve stadiums, the Luzhniki Stadium (Moscow) and the Saint Petersburg Stadium (Saint Petersburg) were used most (7). Other host cities included Sochi, Kazan,

Nizhny Novgorod and Samara with each hosting the same quantity of matches (6) while the Otkritie Stadium (Moscow) and the Rostov Stadium (Rostov-on-Don) each hosted five matches. Volgograd, Kaliningrad, and Saransk were completely new venues opened for 2018 World Cup. In the final on the 15th of July at the Luzhniki Stadium in Moscow, France defeated Croatia 4-2 to claim their second World Cup and become the fourth European team to win the World Cup consecutively – Italy 06', Spain 10' and Germany 14'.

The World Cup in Russia was the first time Video Assisted Referees (VAR) was used in a tournament. The use of VAR checks a referees on-field decision under four reviewable categories. These categories include Goal/No Goal, Direct Red Card, Penalty/no Penalty and a case of mistaken identity. A video operation room in Moscow was tasked with all game-related VAR activities during the tournament, receiving a live feed of the matches and communicating with the referee, linesmen and fourth officials through radio. Information was also communicated to broadcasters, while stadium fans watched the replays on big screens to understand decisions. There was a record number of penalties awarded at the 2018 World Cup.

3.2.9 FIFA World Cup Qatar 2022

The 22nd FIFA World Cup was held in Qatar from November 20th to December 18th, 2022. The Qatar World cup was unique in the fact that it was the first World Cup staged in the Middle East and it was held during the months of November and December. It would not have been possible to host the event during the traditional months of June and July due to Qatar's extreme hot climate. A total of 211 national football associations attempted to qualify for the Finals. Qatar (hosts) became the first team since Italy in 1934 to make their tournament debut as hosts. Previous World cup hosts Russia were disqualified due to Vladimir Putin's invasion on Ukraine. At the completion of qualification 13 UEFA members, were joined by countries from AFC (6),

CAF (5), CONCACAF (4) and CONMEBOL (4), joining the hosts and to make 32 countries in total. Teams competed in eight stadia in five Qatari host cities. The Qatari government invested billions of dollars in infrastructure and technology for the World Cup. The stadiums were equipped with air conditioning to ensure that players, staff and fans were kept cool. The Lusail Stadium (Lusail) was the most frequently used venue, hosting 10 fixtures, including the World Cup Final. There were nine matches played in the Al Bayt Stadium (Al Khor). These were played within a 20-mile radius of Doha's centre. The Khalifa (Al Rayaan), Al Thumama (Doha), and Education City (Al Rayaan) stadiums were also popular hosting eight. The 974 (Doha), Al Janoub (Al Wakrah), and Ahmad bin Ali (Al Rayaan) stadiums played host to seven matches.

The World Cup final was contested between Argentina and France on 18th December. After a scored 2-2 draw at the end of normal time, the game was decided by a penalty shootout in which Argentina prevailed 4-2. This marked their third World Cup win.

3.3 UEFA European Championship

3.3.1 UEFA European Championship Sweden 1992

Euro 1992 was the ninth European Championship held by UEFA. Sweden hosted the event from June 10th to June 26th, 1992. In contrast to succeeding editions, the tournament began with eight teams rather than sixteen. War in the Balkans and Yugoslavia's exclusion reduced the number of teams. The seven remaining teams were divided into two divisions, and the competition was reorganised. Teams who finished in the first two positions in the group, progressed while the remaining teams exited the tournament. Only two points were awarded to the winning team of a match.

Some of the stadia used for staging the tournament included the Rasunda Stadium (Stockholm), Ullevi Stadium (Gothenburg), Malmo Stadion (Malmo), and Idrotsparken (Norrkoping). the Rasunda Stadium and the Ullevi Stadium hosted 5 matches each while the stadiums in Malmo and Norrkoping hosted 3. Denmark, who replaced Yugoslavia in the 11th hour, faced Germany in the Ullevi Stadium. Denmark defeated Germany 2-0 to claim the 1992 European Championship. Euro 1992 demonstrated that football is unpredictable. Underdog teams all around the world were inspired by Denmark's surprising win.

3.3.2 UEFA European Championship England 1996

The tenth UEFA-hosted European Championship was Euro 1996. The event took place in England from June 8th to June 30th, 1996. Forty-seven teams battled it out during qualification for fifteen final spots, excluding hosts England. Four groups of four country's made-up Euro 1996, expanding the tournament from eight teams. The winner and best-runner up automatically qualified. Play-off matches between the eight other runner-ups were played to make up 16 spots in total. Three points were awarded for a win as opposed to previous tournaments where only two points were awarded for a win. Matches were held in eight different stadiums in eight English cities including the home of world-renowned club sides Manchester United (Old Trafford) and Liverpool (Anfield). Wembley Stadium (London) hosted the greatest number of matches during Euro 96 with 6 matches. This was closely followed by Old Trafford (5) and Anfield (4). Games were also held in cities such as Birmingham, Sheffield, Leeds, Nottingham, and Newcastle. Germany and the Czech Republic squared off in the European Championship final at Wembley Stadium in London. Germany prevailed 2-1 courtesy of a golden goal. The golden goal rule was unique such that the first nation to score in extra time would immediately win the match. 27 years later, the golden goal experiment is still very much part of history.

3.3.3 UEFA European Championship Belgium/Netherlands 2000

In 2000, the eleventh UEFA European Championship took place. It was held in Belgium and the Netherlands from June 10th to July 2nd, 2000. Forty-nine teams competed in nine different groups with the hope of claiming one of 16 spots. The winner and best-runner up automatically qualified. Play-off matches between the eight other runners-up were played to make up 16 spots in total. The top two teams from each of the four groups, proceeded to the quarter-final, semi-final, and final.

There were eight venues used in total across both countries with four in Belgium and four in the Netherlands. Belgium hosted matches in the King Baudouin Stadium (Brussels) and Jan Breydel Stadium (Bruges) while Holland hosted matches in the Amsterdam Arena (Amsterdam) and Feijenooed Stadion (Rotterdam). All four of these venues proved to be the most popular with each venue hosting five matches. Less popular venues included the Stade du Pays de Charleroi (Charleroi) and the GelreDome (Arnhem) with these venues hosting only three matches each. The final took place at Rotterdam's De Kuip Stadium between France and Italy. After extra time, France won 2-1 with the requirement of another golden goal to claim the title. For the second time, the Golden Goal Rule was applied. Belgium and the Netherlands' successful staging of Euro 2000 demonstrated their readiness to play host to major international sporting events.

3.3.4 UEFA European Championship Portugal 2004

The 2004 tournament was the 12th edition of the UEFA European Championship. From June 12th to July 4th, 2004, it took place in Portugal. Similarly to Euro 96 and Euro 00, the

tournament was contested by sixteen nations. Fifty nations were split into ten groups of five teams and played each other both home and away to determine qualification. Following the conclusion of qualification, Latvia were the only country to make its tournament debut. Several cities in Portugal hosted games, including Lisbon, Porto, Faro, and Coimbra. The Estadio da Luz and the Estadio Jose Alvalade in Lisbon were the most popular venues with both venues staging five matches. Stadiums such as the Estádio Dr. Magalhães Pesso (Leria) and the Estádio D. Afonso Henriques (Gumaraes) were the least popular venue with both hosting just two matches each.

There were several close games and surprising results during the tournament. The traditional football powerhouses of Spain, France and Germany all exited the competition early. The fierce clash demonstrated the growing strength and team potential of Europe's football league. Portugal and Greece squared off at Lisbon's Estádio da Luz for the title. In an unexpected outcome, Greece defeated hosts, Portugal, 1-0. Portugal made history for the wrong reasons as they became the first host nation to lose a Euro's final. However, it raised the country's profile as a football powerhouse and sparked interest in the sport among a new generation.

3.3.5 UEFA European Championship Austria and Switzerland 2008

In 2008, the 13th UEFA European Championship took place. It took place in Austria and Switzerland from June 7th to June 29th, 2008. Equally, Euro 08 included sixteen countries. However, qualifying took on a different format. Teams that finished outside of the top two spots, did not participate in a play-off to qualify, they simply did not qualify. Nations who finished runners up in the groups – qualified. Hosts, Austria, were one of two teams making their European Championship debut with the other country being Poland. The top two teams from each of the four groups, proceeded to the quarter-final, semi-final, and final. Ernst Happel

Stadion (Vienna) hosted the most amount of matches (7). This was closely followed by St Jacob-Park stadium in Basel (6). The remaining 6 stadiums all hosted an equal 3 matches each in host cities such as Geneva, Bern and Zürich. Germany and Spain competed in the final at the Ernst Happel Stadium in Vienna. Spain maintained their unbeaten run and defeated Germany on a score line of 1-0.

3.3.6 UEFA European Championship Poland and Ukraine 2012

In 2012, the 14th UEFA European Championship took place. It was held between June 8th and July 1st in Poland and Ukraine. This was the first time in Polish and Ukrainian history to host such an event. Qualifying matches were played between August 2010 and November 2011. 51 countries battled it out over this period for one of 14 remaining spots, the two host countries automatically qualified. Euro 2012 was the last European tournament of its kind to feature 16 teams. Following the tournament, the format would be changed to 24 participants. Four stadiums in Poland and four stadiums in Ukraine played host to Euro 2012. Five brand new stadiums were built for the tournament. Of these new stadiums, Stadion Narodowy w Warszawie (Warsaw) and the Arena Gdansk (Gdansk) hosted the greatest number of matches with 5. Host cities such as Lviv, Wroclaw and Poznan all hosted 3 matches each throughout the tournament. Kiev's Olympic Stadium hosted the European Championship Final between Spain and Italy. Spain won their third European Championship title with a 4-0 victory, their second straight title. Euro 2012 was brilliantly carried out and was outstanding in terms of energy, skill, and sportsmanship.

3.3.7 UEFA European Championship France 2016

The UEFA European Championship took place for the fifteenth time in 2016. It was held in France from June 10th until July 10th, 2016. France served as the host nation for the European

Championship three times, in 1960, 1984, and 2016. As aforementioned, the number of participating teams increased from sixteen to twenty-four countries. During qualification, fifty-three national sides competed for twenty-three places in the tournament to join automatically qualified France. The winners of each group of six teams and one group of five routinely qualified for the tournament, along with the runners-up and the best 3rd placed team. The eight 3rd placed teams entered into a home and away play-off to determine the remaining 4 spots. Matches were held in ten different stadiums in ten different cities across the French mainland. Twelve matches in total were held in the French capital with the Stade de France hosting seven and the Parc des Princes hosting five. Stade De Lyon (Lyon), Stade Pierre Mauroy (Lille) State Velodrome (Marseille) all hosted six matches each. Four brand new stadiums had been built specifically for Euro 2012 in Lille, Lyon, Nice and Bordeaux. Extra time and penalty shootouts were used in a number of games during the tournament. With more teams participating, the competition became more unpredictable and tense. Portugal and France squared off in the Euros final at Saint-Denis' Stade de France. Portugal won the European Championship for the first time with a 1-0 win after extra time.

3.3.8 UEFA European Championship 2020

The 16th UEFA European Championship was originally scheduled to take place between the 12th of June and 12th of July 2020, however, as a consequence of COVID-19, the tournament was postponed to the 11th June – 11th July 2021. To commemorate the 60th anniversary of The European Championships, UEFA announced that matches would be staged across eleven different stadiums in eleven different European cities. UEFA viewed this one-off event as an opportunity to showcase European unity through football. Unlike previous editions where the hosts were guaranteed qualification, this was not the case for Euro 2020. All 55 countries had to battle it out to claim one of 24 final berths. The format for qualifying remained the same

where both the group winners and runners up from the five groups of five and five groups of six teams automatically qualified. A new competition introduced by UEFA called the Nations league had a direct correlation to European Championship qualifying. Teams that had not already qualified, were given a second chance of qualifying by entering into a play-off. The play-offs for each group featured four. The 20 teams that had already qualified for the tournament were joined by the winners of the play-offs for each group, which were determined by two one-off semi-final matches, both of which were played at the homes of higher-ranked teams.

London, Rome, Amsterdam, Munich, Baku, Seville, Budapest, Saint Petersburg, Amsterdam, Copenhagen, Bucharest, and Glasgow were the major cities selected to host the European Championship. These venues hosted three group matches and one match in the knockout phase. There were two outliers in the form of the Krestovsky Stadium (Saint Petersburg), which hosted six group games and Wembley Stadium (London) which hosted two matches in the knockout phases. Wembley Stadium also played host to Euros final between England and Italy. After a scoreless extra time, a penalty shootout resulted in Italy's second European Championship title since 1968. Euro 2020 demonstrated how resilient and committed football fans can be in the face of tremendous adversity. Fans of the beautiful game of football from every corner of Europe came together for this event.

3.3.9 UEFA European Championship Germany 2024

Only two major European countries declared their intentions to host the 17th edition of the UEFA European Championships. Germany & Turkey both presented to UEFA's Executive Committee for hosting rights with Germany ultimately prevailing by 12 votes to 4. The 2024 European Championships are scheduled to take place from the 14th June - 14th July 2024. This

will be the third time that European Championship matches will be played on German soil. Four matches were held in Munich during the multi-national Euro 2020 while Germany also played host to the event in 1988. The event will also return to its four-year cycle, after EURO 2020 was postponed a year due to COVID-19. The qualifying format will remain the same as Euro 2020. As hosts, Germany receive automatic qualification for the tournament. Twenty of the twenty-three berths will be awarded via direct qualification to the winners and runners-up of the ten qualifying groups; the final three berths will be decided via play-offs. Countries who perform best during the 2023 UEFA Nations League and have not yet qualified through the main qualifying competition will receive spots in the play-offs. Notably, Russia has been refused the right to qualify for the Championships due to their war against Ukraine.

UEFA's minimum capacity requirement of 30'000 seats for European Championship matches is not a problem for a traditional football powerhouse such as Germany. There have been nine venues selected for Euro 24 that have previously hosted matches during the 2006 World Cup, these include Olympiastadion (Berlin), Signal Iduna Park (Dortmund), Allianz Arena (Munich), MPH Arena (Stuttgart), RheinEnergie Stadion (Cologne), Red Bull Arena (Leipzig), Waldstadion (Frankfurt), Volksparkstadion (Hamburg) and the Veltins-Arena (Gelsenkirchen). The only arena that had not been used is the Merker-Spiel Arena in Düsseldorf, which has since been added as the tenth venue. The European Championship final will take place on the 14th of July in the Olympiastadion (Berlin).

3.4 Future Tournaments – 2026 to 2032

The FIFA World Cup and UEFA European Championship Finals hosts have been announced out to 2032. All four tournaments – 2026, 2028, 2030 and 2032 – have a common theme – more than one host country. The World Cup in 2026 will be shared by Canada, Mexico, and

the United States of America. Euro 2028 will be shared by the United Kingdom and Republic of Ireland, while Euro 2032 will be co-hosted by Italy and Turkey. World Cup 2030 will take the unprecedented step of being hosted on three continents and six countries. The three opening games will be held in held in Argentina, Paraguay, and Uruguay to commemorate the 100th anniversary of the first World Cup (FIFA, 2023d) while the remainder of the tournament will be hosted by Morocco, Portugal, and Spain. This approach, by both FIFA and UEFA, clearly demonstrates that mitigation of international travel is not a priority. Rather, the unprecedented step of hosting tournaments across multiple countries and continents appears to be preferable to any attempts to reduce the carbon emissions associated with air travel. Former England international striker and World Cup semi-finalist Gary Lineker recently said "I'd like to see FIFA worry more about climate change. With the World Cup coming up, you can see certain problems ahead. There's a lot of travel between three countries – three countries which are spread over an enormous area as well." (BBC Sport, 2022).

4 SOURCES OF DATA

4.1 Introduction to the sources of data

The data are divided into three groups and are drawn from a variety of sources. The first group includes information on participation at the FIFA World Cup Finals and the UEFA European Championship Finals between 1990 and 2022. Data from both competitions are extracted from The Rec. Sport. Soccer Statistics Foundation (RSSSF, 2023a; RSSSF, 2023b). These sources include all teams playing at the finals, squad sizes, dates, locations, and number of games played during the tournament. To estimate the 2024 European Championships in Germany, locations are extracted from the UEFA website (UEFA, 2023b). The tournament is then simulated using EA Sports FIFA 2023. Using this software, the top ranked teams in FIFA as measured by August 2023 FIFA/ Coca-Cola World Ranking were entered into a simulated tournament. While the actual tournament in 2024 may vary from the simulated tournament, the only difference is captured by distance travelled to the 2024 Finals. Once in Germany, the internal travel from the simulated tournament is identical to the actual competition, regardless of which teams compete, as the venues are confirmed. Therefore, the internal distances component and CO^2 emissions calculated for Euro 2024, are not a forecast but an actual representation of travel.

4.2 Description of data and statistics.

In total, we assess data from 895 football tournaments matches held between June 1990 and June 2024. Our data includes players and their management team who travel to and within host location. We refer to these individuals as the overall 'team.' We do not include spectator travel. While it may be possible to estimate the number of fans travelling, it is impossible to know

each spectator's origin and whether later games at tournaments are populated by fans engaged in internal travel or those travelling from their country of origin. We therefore know with certainty that the estimates we calculate are conservative. Fans often travel thousands of miles to support teams, meaning long-haul journeys and the use of wide-body aircraft.

Table 4.1 presents data on stadia, teams competing, the number of games and the total number of players at these major tournaments. Over time, the number of players allowed to compete at major tournaments has risen. In 1990 and 1992, only 22 and 20 players, respectively, could be named in country squad lists. This increased to 22 players for all tournaments until 2002 and this number further increased to 23 squad players from 2002 to 2018. In 2020, the number of players allowed in a squad rose to 26.

Table 4.1. Major Football Tournaments Between 1990 and 2024

Year	Competition	Location	Stadia	Teams	Games	Players	All
1990	World Cup	Italy	12	24	52	528	768
1992	European Championship	Sweden	4	8	15	160	240
1994	World Cup	USA	9	24	52	528	768
1996	European Championship	England	8	8	31	176	256
1998	World Cup	France	10	32	64	704	1,024
2000	European Championship	Belgium/Netherlands	8	16	31	352	512
2002	World Cup	Korea and Japan	20	32	64	736	1,120
2004	European Championship	Portugal	10	16	31	368	560
2006	World Cup	Germany	12	32	64	736	1,216
2008	European Championship	Austria/Switzerland	8	16	31	368	608
2010	World Cup	South Africa	10	32	64	736	1,216
2012	European Championship	Poland/Ukraine	8	16	51	368	608
2014	World Cup	Brazil	12	32	64	736	1,312
2016	European Championship	France	10	24	51	552	984
2018	World Cup	Russia	12	32	64	736	1,312
2020	European Championship	Various	11	24	51	624	1,104
2022	World Cup	Qatar	8	32	64	832	1,504
2024	European Championship	Germany	10	24	51	624	1,104

Source: The Rec. Sport. Soccer Statistics Foundation (2023)

Between 1990 and 2000, when a maximum of 22 players could play, we account for 10 staff members travelling with each team. This includes a manager/coach, assistant, goalkeeping

coach, physio, kitman, doctor and other coaching staff. From 2002 to 2012, we raise this number to between 12 and 15 individuals as sports science and data analysis became more important to the game. From 2014 to 2018, this is raised to 18 travelling staff members, and we account for 20 travelling staff members for the tournaments in 2020, 2022 and 2024. It is important to note that these estimates and increases through time are based on intuition. However, marginal changes have a tiny impact on overall emissions. National team websites often listed backroom staff, which regularly including 15 to 20 staff, however we believe this number would have been lower historically. The increases are used to capture the role of performance analysts, data analysts, additional physio and coaching staff, scouting/opposition performance analysts, social media and communication staff and equipment managers.

Again, we believe these estimates are conservative and do not include other supporting staff who may travel to matches, such as the Chief Executive Officer, Association President, secretarial staff, or honorary members. The final column "All" attempts to measure all players and staff at these tournaments. There are also examples of "second" chartered aircraft travelling to tournaments to deliver equipment.

The second group of data is the CO^2 emissions from air travel. Data are sourced from the European Environmental Agency and are triangulated with other open sources such as Our World in Data (2023) and Carbon Independent (2023). The data gathered cover the years 1990 to 2022 and estimate average long haul flight CO^2 emissions per passenger, per kilometre, so that our analysis controls for the improvements in fuel efficiency of planes in this period. Advances in technology, changes in airline fleets, and efforts to improve fuel efficiency may have led to a reduction in emissions as airlines and aircraft manufacturers are continually working to reduce their environmental impact.

It is important to note that considerable variation can exist when attempting to measure the amount of CO^2 emissions per passenger in this context. The amount of carbon dioxide emissions produced by a plane per passenger, per kilometre, can vary depending on several factors, including the type of aircraft, the distance of the flight, the load factor (how full the plane is), and the specific airline's fuel efficiency. Short-haul flights tend to have slightly higher emissions per passenger-kilometre, while long-haul flights can be more efficient due to the higher cruise altitude and longer distances travelled.

The third data source is calculated using a Distance Calculator (see https://www.distance.to/). For consistency purposes, we assume all travel is completed by airplane. A team is assumed to leave their capital city and travel, by plane, directly to the destination of its first match and, subsequently, travel directly to its next match. When the team of a host country is playing, we do not include travel to the first match as it is assumed the team is in this city for pre-tournament training and media duties. An overview of distances travelled at these major football tournaments is provided in Table 4.2. As expected, countries further away from Europe, and those of larger geographic areas, report higher travel distances, with Brazil, South Korea/Japan and South Africa reporting the highest scores.

As one would expect, most travel made by countries competing in the FIFA World Cup or UEFA European Championship is often incurred when travelling to the host destination. Traditionally, as most finalists are from UEFA member countries and Western Europe hosted the tournament one in every two competitions, the burden of travel on most countries travelling to the finals was small once every eight years.

Table 4.2. Distances Travelled (Kilometres) at Major Football Tournaments

Year	Location	Total	Mean	Median	Minimum	Maximum
1990	Italy	112,130	2,156	488	123	15,821
1992	Sweden	10,406	694	513	241	2,021
1994	USA	307,684	5,917	3,573	306	22,157
1996	England	25,641	827	163	50	4,411
1998	France	169,753	2,652	832	9	20,837
2000	Belgium/Netherland	20,756	670	233	97	3,684
2002	Korea/Japan	368,393	5,756	1,010	98	31,337
2004	Portugal	38,760	1,250	317	0	5,745
2006	Germany	183,506	2,867	734	313	25,955
2008	Austria/Switzerland	24,459	789	268	95	3,770
2010	S Africa	334,715	5,230	1,603	215	22,945
2012	Poland/Ukraine	40,989	1,322	876	246	5,313
2014	Brazil	379,576	5,931	3,386	698	30,705
2016	France	70,663	1,386	1,114	188	3,907
2018	Russia	284,661	4,448	2,402	634	18,565
2020	Various	119,010	2,334	1,907	0	7,647
2022	Qatar	223,006	3,484	72	5	20,226
2024	Germany	45,622	895	669	148	3,928

Source: The Rec. Sport. Soccer Statistics Foundation (2023) and Distance.to (2023)

This changed in 2010, when South Africa became the first Confederation of African Football member to host the World Cup Finals. Since then, the tournament has not returned to Western Europe and will not arrive back until 2030. Consequently, competing finalists often face greater travel distances when travelling to the finals in destinations such as Brazil, Russia, and Qatar. To account for these differences and the changing landscape of host countries over more than a decade, Table 4.3 measures the volume of internal travel once teams have arrived at the host country. This allows for comparisons to made across time, without the need to consider where the host country is located globally. Some useful insights can be made when internal tournament travel is compared to total travel. Most notably, 99% of team travel during the 2022 World Cup in Qatar was associated with arriving at the Middle East state. This is due to the concentration of the stadia used at the finals, with spectators often able to see more than one game per day during the group stage of the competition.

Table 4.3. Internal Distances Travelled (Kilometres) at Major Football Tournaments

Year	Location	Total	% of Total Travel	Mean	Median	Minimum	Maximum
1990	Italy	18,005	0.16	360	227	123	1,114
1992	Sweden	4,150	0.40	277	266	241	513
1994	USA	104,851	0.34	2,621	2,606	306	6,544
1996	England	3,319	0.13	144	131	50	483
1998	France	35,108	0.21	731	746	9	1,530
2000	Belgium/Netherland	4,931	0.24	214	222	97	349
2002	Korea/Japan	37,148	0.10	774	649	98	1,638
2004	Portugal	6,402	0.17	207	119	0	963
2006	Germany	30,681	0.17	639	636	313	1,046
2008	Austria/Switzerland	9,030	0.37	393	235	95	1,412
2010	S Africa	61,592	0.18	1,283	1,315	215	2,798
2012	Poland/Ukraine	17,556	0.43	763	592	246	2,096
2014	Brazil	131,268	0.35	2,735	2,678	698	5,727
2016	France	39,317	0.56	1,008	995	188	1,557
2018	Russia	99,223	0.35	2,067	2,156	634	3,849
2020	Various	92,279	0.78	2,366	2,598	0	6,206
2022	Qatar	3,017	0.01	63	66	5	144
2024	Germany	20,046	0.44	542	579	148	902

5 Source: The Rec. Sport. Soccer Statistics Foundation (2023) and Distance.to (2023)

On the contrary, Euro 2020 experienced the greatest portion in internal travel due to UEFA's decision to host games across the European continent. This is followed by France 2016 where the organisers moved teams around the country when playing during both the group and knock-out stages of the competition. The 2002 FIFA World Cup in Korea and Japan is another interesting case. While long distances were required by many to reach east Asia, once on the ground, internal travel at the tournament accounted for just over 10% of all travel.

4.3 Summary and conclusion

It is no secret that over the past 30 years, both the World Cup and European Championships have evolutionized. The number of competing teams, players and staff has increased exponentially. There is now more than ever an increased dependency on air travel. Consequently, this leads to a significant amount of carbon dioxide emissions produced by a plane per passenger. Using three groups of data, we have arrived at the following conclusion; the tournament location and stadia location of the host country is absolutely crucial. Going forward, there simply cannot be a repeat of the likes of South Africa (2010) and Brazil (2014). Teams are travelling vast distances to arrive at tournament but then also having to travel across the country to compete due to the sheer geographical size of the country. That is considered as a lose-lose situation, both for the competing teams and the environment. FIFA and UEFA are dedicated to growing the game globally but there must be a trade-off. Hosting these showpiece competitions in peripheral locations must be coincided with a concentration of stadia in close proximity.

5 FINDINGS AND ANALYSIS

5.1. Introduction to findings

The objective of this section is to present the results from the data we have collected. The results are broken down into three sub-sections; Estimated CO^2 emissions of total team travel, estimated CO^2 emissions of internal team travel only & estimated CO^2 emissions per game at both World Cups and European Championships. Using our calculations from the CO^2 emissions index, we will be able to shine a light on the difference between a tournament with a low carbon footprint and a high carbon footprint. By a method of comparison, we will be able to compare and contrast France (1998/2016) and Germany (2006/2024) as two countries who have hosted, or will host, both the World Cup and European Championships. We will further be able to highlight just how important a role both FIFA and UEFA play in the awarding of these major competitions. It is abundantly clear that footballs governing bodies need to take more responsibility in minimizing the carbon footprint of teams travelling for major sporting events.

5.2. Team Travel and CO2 Emissions from 1990 to 2024

By combining the three discussed sources of data, it is possible to create a CO^2 emissions index from 1990 to 2024. This allows us to understand how the evolution of hosting tournaments have impacted CO^2 emissions from team travel. As mentioned, significant changes have occurred with the expansion of qualifying teams, the movement to locations further from UEFA member teams, and the co-hosting of these tournaments, changing the landscape of these competitions. Our analysis is a first attempt to demonstrate the CO^2 emissions cost of these decisions, at a most conservative level.

Despite improvements in aeroplane fuel efficiency over the course of the past three decades, FIFA and UEFA do not appear to be reducing their carbon footprint from team travel at major tournaments. Tables 5.1 and 5.2 present the total emissions from both competitions between 1990 and 2022. As shown in Table 5.1, the greatest number of kilometres travelled by teams at a World Cup was during the 2002 version hosted by Korea and Japan, leading to the greatest volume of CO^2 being emitted at this tournament. Table 5.2 shows that emissions at UEFA European Championships are far lower than at World Cups and this can be attributed to the shorter distances travelled by teams to the host location.

Table 5.1. Estimated CO^2 Emissions (Metric Tonnes) of Total Team Travel

Year	Location	Games	Total	Mean	Median	Min	Max
World Cup							
1990	Italy	52	664.11	12.77	2.89	0.73	93.71
1994	USA	52	1,537.92	29.58	17.30	1.66	120.34
1998	France	64	785.21	12.27	3.85	0.04	96.39
2002	Korea/Japan	64	2,015.81	31.50	5.53	0.53	171.48
2006	Germany	64	948.43	14.82	3.79	1.62	134.15
2010	S. Africa	64	1,742.91	27.23	8.34	1.12	119.48
2014	Brazil	64	1,525.14	23.83	13.60	2.80	123.37
2018	Russia	64	1,073.74	16.78	9.06	2.39	70.03
2022	Qatar	64	923.24	14.46	0.30	0.02	83.74
European Championship							
1992	Sweden	15	55.32	3.69	2.73	1.28	10.74
1996	England	31	120.27	3.88	0.76	0.23	20.69
2000	Belgium/Netherlands	31	94.03	3.03	1.05	0.44	16.69
2004	Portugal	31	220.62	7.12	1.80	0.00	32.70
2008	Austria/Switzerland	31	104.13	3.36	1.14	0.40	16.05
2012	Poland/Ukraine	51	167.46	5.40	3.58	1.00	21.70
2016	France	51	272.34	5.34	4.29	0.72	15.06
2020	Various	51	492.70	9.66	7.89	0.00	31.66
2024	Germany	51	188.88	3.70	2.77	0.61	16.26

The 2020 tournament was held across 11 countries resulting in the highest travel distances and CO^2 emissions. Figures 1 and 2 display the mean and median distances travelled by teams within tournaments from 1990 to 2024. The mean and median CO^2 emissions are also displayed.

Table 5.2. Estimated CO^2 Emissions (Metric Tonnes) of Internal Team Travel Only

Year	Location	Games	Total	Mean	Median	Min	Max
World Cup							
1990	Italy	52	94.85	2.50	1.84	0.73	6.43
1994	USA	52	557.21	14.29	14.45	1.66	35.54
1998	France	64	162.39	3.38	3.45	0.04	7.08
2002	Korea/Japan	64	225.25	4.69	3.83	0.53	25.12
2006	Germany	64	158.57	3.30	3.29	1.62	5.41
2010	S. Africa	64	320.72	6.68	6.85	1.12	14.57
2014	Brazil	64	527.43	10.99	10.76	2.80	23.01
2018	Russia	64	374.27	7.80	8.13	2.39	14.52
2022	Qatar	64	12.49	0.26	0.27	0.02	0.60
European Championship							
1992	Sweden	15	22.06	2.01	2.11	1.28	2.73
1996	England	31	15.57	0.68	0.61	0.23	2.26
2000	Belgium/Netherlands	31	22.34	0.97	1.00	0.44	1.58
2004	Portugal	31	36.44	1.58	1.57	0.00	5.48
2008	Austria/Switzerland	31	38.44	1.67	1.00	0.40	6.01
2012	Poland/Ukraine	51	71.72	3.12	2.42	1.00	8.56
2016	France	51	151.53	3.89	3.83	0.72	6.00
2020	Various	51	382.04	9.80	10.76	0.00	25.69
2024	Germany	51	82.99	2.24	2.40	0.61	3.73

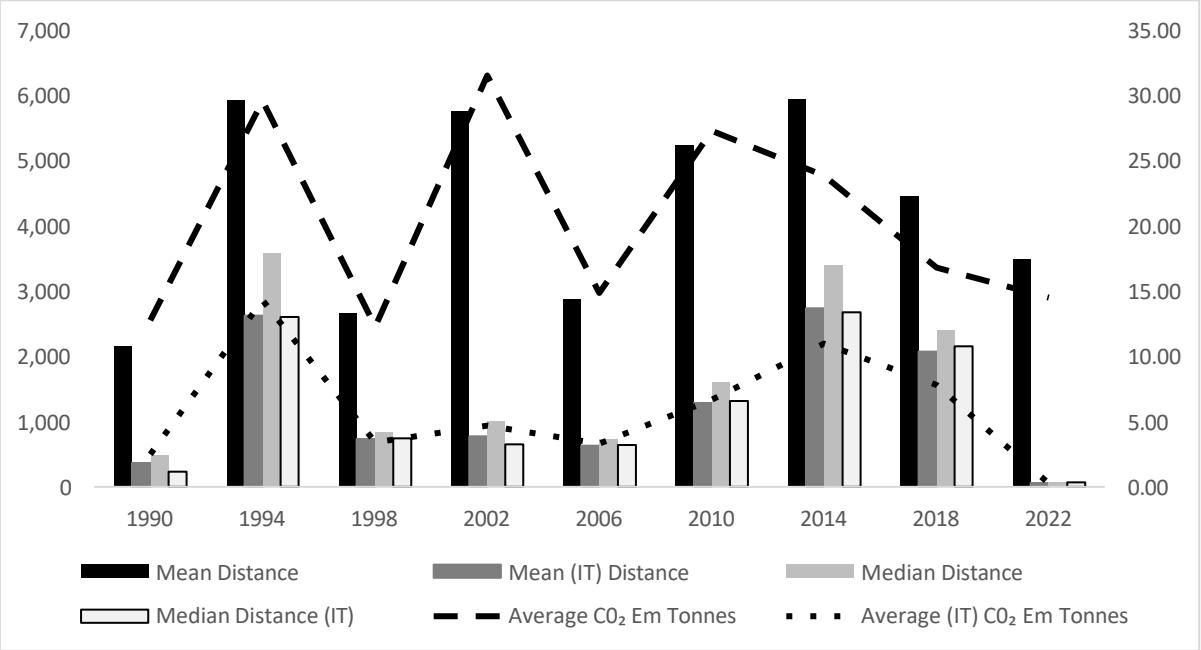
For each of these variables, two figures are reported. One is based on total team travel and emissions, including travel to the tournament, and travel within the host location. The second, referred to as internal travel (IT), solely relates to travel undertaken during the rounds of the tournament. Using two metrics allows us to determine whether the location of the host venue, or the size of the host venue (i.e., the distance between stadia), has the greatest influence on CO^2 emissions. All figures are reported on a per game basis.

From an environmental perspective, it would be most beneficial if the average CO^2 emissions (grey line) trended downwards to reflect the improvements in fuel efficiencies over this period. However, it is clear from Figure 5.1 that the decision of where to host the World Cup has resulted in fluctuating levels of emissions. Total travel was greatest at the 2002 World Cup in Korea and Japan, and this resulted in an average of 31.5 tonnes of CO^2 being emitted per game.

15% of these emissions were due to travel between the 20 stadia, and the remainder was due to travel to and from the host location. This was influenced by the location being outside Europe and a significant distance from many of the qualifying teams.

The emissions generated by the World Cup tournaments in South Africa (2010), Brazil (2014) and Qatar (2022) were also heavily influenced by the travel to the tournament for the same reason. The location of the host country is clearly an important factor as the tournaments in Italy, France and Germany resulted in relatively low average emissions per game due to their European location. The 2022 World Cup in Qatar resulted in the lowest within tournament emissions due to the proximity of stadia in a small country.

Figure 5.1. Team Travel (Kilometres) and CO^2 Emissions (Metric Tonnes) per Game at World Cups

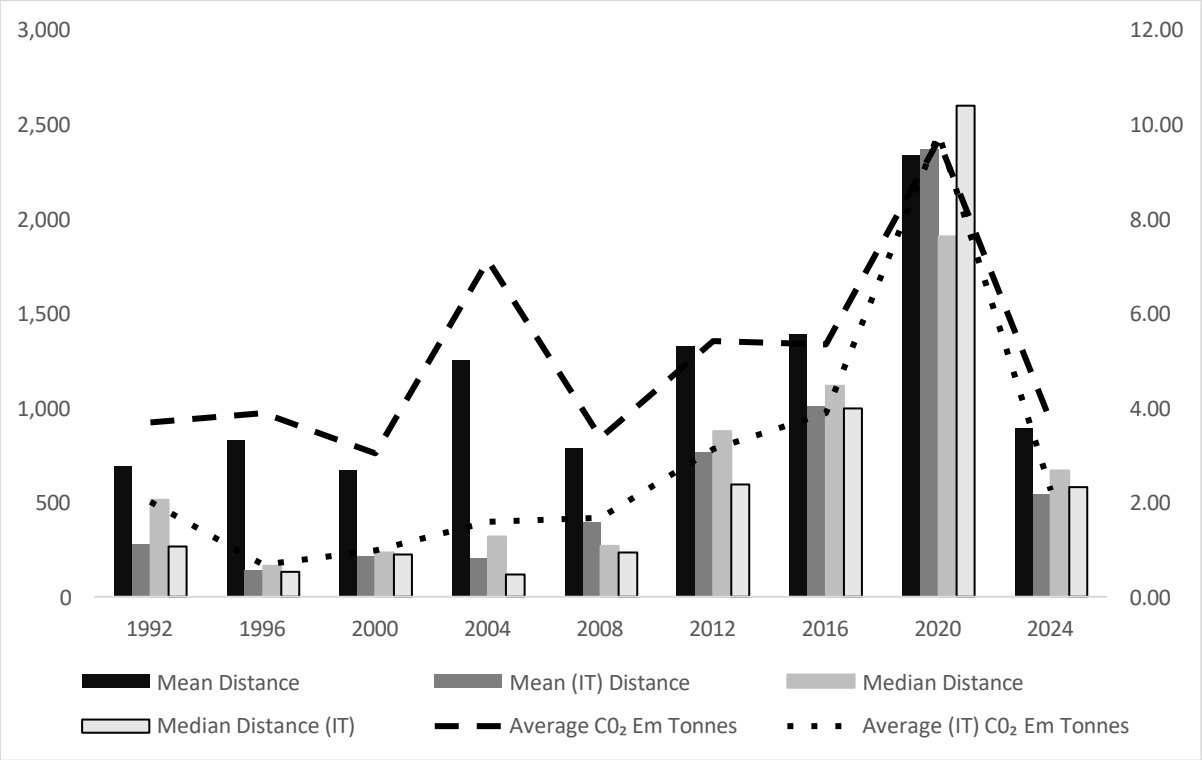


***** Average emissions values (metric tonnes) correspond to right-axis.

Figure 5.2 illustrates that average CO^2 emissions per game are far lower for European Championships compared to World Cups due to them being intra-continental competitions. Within tournament travel represents a greater portion of total travel when compared to World Cups. The 2020 tournament spread across 11 countries was the highest emitting tournament and 78% of team travel emissions came from within tournament travel. While hosting of the

tournament across multiple cities may help to promote the sport, it is not an environmentally friendly practice. The 2004 tournament in Portugal had the second highest average team travel emissions per game due to its peripheral European location. With the upcoming 2024 European Championships in Germany, it appears that this tournament will produce relatively low CO^2 emission from travel, owing to the central European location and the fact the stadia are relatively close to each other.

Figure 5.2. Team Travel (Kilometres) and CO^2 Emissions (Metric Tonnes) per Game at European Championships (1990 - 2024)



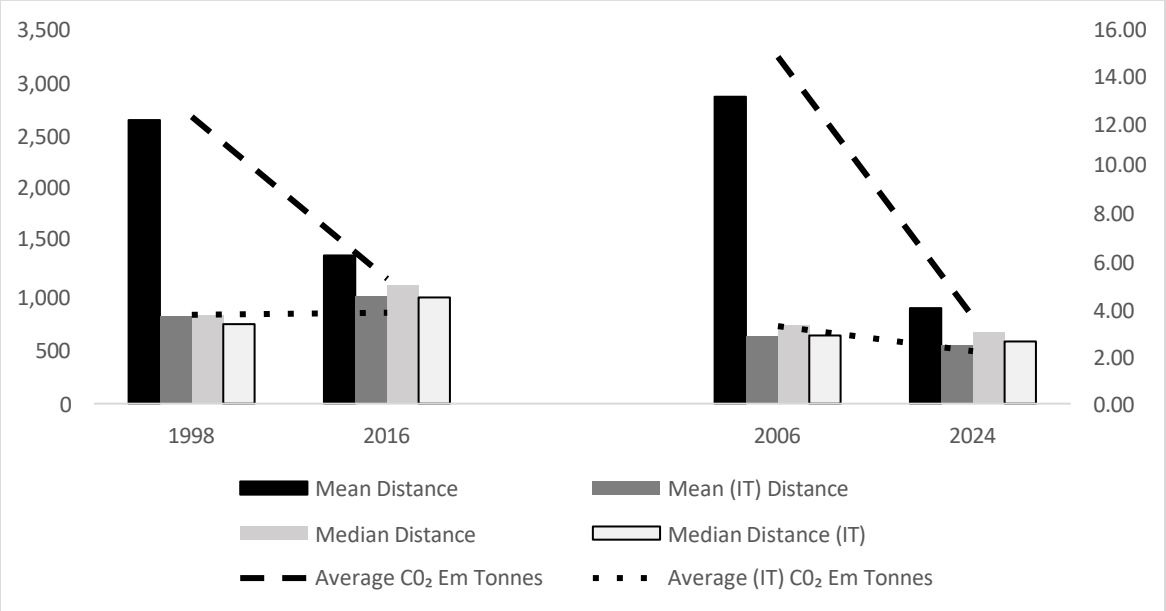
* Average emissions values (metric tonnes) correspond to right-axis.

5.3 Comparing France and Germany's Tournaments in 1998/2016 and 2006/2024

During the period of examination, both France and Germany hosted, or will host, the tournament twice. France hosted the FIFA World Cup in 1998 and the European Championships in 2016. Germany hosted the FIFA World Cup in 2006 and will host the UEFA European Championships in 2024. Based on observed and predicted movement of teams, Figure 5.3 presents comparisons across both tournaments when each acted as the host. Again,

data is presented on all team travel and internal team travel only. It is worth noting that when only internal travel is examined, CO^2 emissions at the 2016 European Championships in France are higher than the FIFA World Cup hosted there in 1998, with an identical number of competing countries (24).

Figure 5.3: Comparing Tournaments – France (1998/2016) and Germany (2006/2024)



* Results for Mean Distance and Median Distance for Germany 2024 are based on a simulation. This simulation was generated using EA Sports FIFA 2023 in September 2023 when all match locations for the Finals were known. This was before the 24 teams that qualified for the Finals was known. The simulation included all the highest ranked teams in FIFA as measured by the FIFA/Coca Cola Men's World Rankings for UEFA members. Countries were assigned to groups based on these rankings and movements were then tracked. **Average emissions values (metric tonnes) correspond to right-axis.

The difference in Germany is negligible despite eight fewer countries competing at Euro 2024 compared to FIFA World Cup in 2006. This evidence suggests while air travel is becoming more environmentally friendly, gains are eroded by increasing numbers of players, staff and countries competing, even in Western European hosts. The increased mean and median travel distance in France during the 2016 competition, when compared to 1998, demonstrates that teams are required to travel further distance during the tournaments' rounds.

To highlight some of these distances that teams travel, Tables 5.3 and 5.4 present data on games that required excessive travel distances. Table 5.3 includes all games that required a combined

distance of 20,000 kilometres to be covered by competing teams. Table 5.4 considers internal travel only where countries, having played at least one match in the host country, were required to travel a combined distance of more than 5,000 kilometres to play their next fixture. Table 5.3 demonstrates that 5 fixtures, all of which were at the 2002 FIFA World Cup in Korea and Japan, led to more than 140 tonnes of CO^2 emissions from air travel by the team.

Table 5.3: FIFA World Cup Matches with Greater than 20,000 Kilometre Travel Requirements

Year	Team 1	Team 2	Host	City	Combined Distance	$C0_2$ Emissions
2002	Paraguay	South Africa	Korea	Busan	31,337	171.48
2002	Argentina	Nigeria	Japan	Ibaraki	31,328	171.42
2002	Uruguay	Denmark	Korea	Ulsan	27,453	150.22
2002	England	Sweden	Japan	Saitama	25,668	140.45
2002	Brazil	Turkey	Korea	Ulsan	25,630	140.24
2006	Australia	Japan	Germany	Kaiserslautern	25,955	134.15
2002	Italy	Ecuador	Japan	Sappaoro	23,100	126.40
2014	Russia	South Korea	Brazil	Cuiabá	30,705	123.37
2002	France	Senegal	Korea	Seoul	22,084	120.84
1994	Cameroon	Sweden	USA	Los Angeles	22,157	120.34
2010	Honduras	Chile	South Africa	Mbombela	22,945	119.48
2002	USA	Portugal	Korea	Suwon	21,646	118.45
2010	England	USA	South Africa	Phokeng	21,910	114.09
2002	Croatia	Mexico	Japan	Niigata	20,319	111.19
1994	Nigeria	Bulgaria	USA	Dallas	20,417	110.88
2010	Brazil	North Korea	South Africa	Johannesburg	20,302	105.71
2010	New Zealand	Slovakia	South Africa	Phokeng	20,124	104.79
1998	Argentina	Japan	France	Toulouse	20,837	96.39
2022	Uruguay	South Korea	Qatar	Al Rayyan	20,226	83.74
2014	Ivory Coast	Japan	Brazil	São Lourenço da Mata	20,634	82.91

Table 5.4: Internal Travel – Matches with Combined Distance > 5000 km.

Year	Team 1	Team 2	Host Country	City	Total Distance	$C0_2$ Emissions
1994	Sweden	Russia	USA	Detroit	6,544	35.54
2021	Czech Republic	Denmark	Azerbaijan	Baku	6,206	25.69
1994	Spain	Switzerland	USA	Washington	4,554	24.73
2021	Belgium	Portugal	Spain	Seville	5,935	24.57
2014	Cameroon	Croatia	Brazil	Manaus	5,727	23.01
2021	England	Denmark	England	London	5,414	22.41
2014	USA	Portugal	Brazil	Manaus	5,375	21.60
2014	Honduras	Switzerland	Brazil	Manaus	5,344	21.47
2014	Uruguay	England	Brazil	São Paulo	5,061	20.34

* Due to Covid-19 Euro 2020 was held in 2021.

The data presented in Table 7 lists the most environmentally damaging games that took place after the teams had arrived at the destination. It also highlights the impact of hosting the 2020 European Championships across 11 different countries as three observations are from this tournament. These include the 2nd, 4th and 6th biggest CO2 emitting games. The host nations of the USA and Brazil make up the remainder of the list due to their expansive geographic size and wide distribution of stadia. The decision at the 1994 World Cup for Sweden and Russia to travel a combined distance of 6,544 kilometres from Texas and California respectively, to meet in Pontiac, Michigan less than a week later, is not a scheduling strategy that is consistent with achieving environmental goals. One can only hope this will not be repeated at World Cup 2026.

5.4 Summary and conclusion

It is clear from the displayed data that team travel and CO^2 emissions over the past 30 years has increased exponentially. There seems to be little doubt that this is owed to the expansion of qualifying teams, hosting tournaments in peripheral locations and the co-hosting of these showpiece events. As technology continues to develop and aeroplane efficiency come to the fore, FIFA and UEFA have not moved to reduce their carbon footprint from team travel at major tournaments. The 2002 World Cup in Korea & Japan produced a mesmerising 31.5 tonnes of CO^2 emissions per game on average. Other World Cup locations such as South Africa and Brazil generated similar emissions due to the travel required to arrive at the location. The buck doesn't stop there with teams required to travel large distances to compete after they had arrived at the location, owing to the sheer geographic size of the host country.

The CO^2 emissions per game for European Championships make for much better reading. This is mainly due to the fact that this event is generally hosted in a central European location. However, an outlier exists as the 2020 tournament was hosted in 11 different country's across the continent producing the highest level of team emissions. Promoting the game in 11 different

countries was a romantic gesture by UEFA but it has come at a big cost to the environment in the form of greenhouse gases. It comes as a stark reminder to UEFA that if the planet is broken, it is not possible to play football.

6 DISCUSSION OF FINDINGS

6.1. Introduction to discussion

It is worth emphasising that the total travel emissions generated at these tournaments are far greater than these team-level estimates. Our calculations do not include spectator, commercial and broadcasting related travel and equipment/logistical travel. Nor do we consider teams travelling to and from warm-up camps or training bases before or during group games[1]. Furthermore, national associations frequently charter flights from their national airline – this implies that these aircraft will have to return at zero capacity. These considerations mean that the differences between a tournament with a low carbon footprint and a high carbon footprint will be much greater, especially when the emissions are multiplied by thousands of travelling fans. While we only assess measurable components of travel, the findings still serve to highlight the important role sport's governing agencies play when awarding the host of a major event to a country.

6.2. Implication of findings

The environmental impact of major football tournaments in recent years has been exacerbated by four key factors of such decision-making. We discussed these in detail and offer some recommendations to both federations considering this.

[1] This regularly occurs for example, in the 2022 World Cup the Spanish National Team charted a flight from Madrid to Amman and then flew on to Qatar.

6.2.1 Tournament Expansion

The expansion of both tournaments in the number of finalists teams has increased the number of games and travel journeys. This is acutely true of the UEFA European Championships which have increased from just 8 teams in 1992 to 24 teams today. FIFA World Cup 2026 will also witness further expansion, from 32 to 48 qualifying countries. The format of the tournament will mean that the expansion will result more than 100 matches at the next FIFA World Cup, an increase in games by about 60%. The impact of these changes will further increase CO^2 emissions as further travel will be required during both group and knock-out rounds. This expansion of the game imposes an environmental cost, and this trade-off should be carefully considered when FIFA and UEFA establish future strategic goals.

The FIFA World Cup and UEFA European Championship Finals hosts have been announced out to 2032. All three tournaments – 2028, 2030 and 2032 – have a common theme – more than one host country. Euro 2028 will be shared by the United Kingdom and Republic of Ireland, while Euro 2032 will be co-hosted by Italy and Turkey. World Cup 2030 will take the unprecedented step of being hosted on three continents and six countries. The three opening games will be held in held in Argentina, Paraguay, and Uruguay to commemorate the 100th anniversary of the first World Cup (FIFA, 2023d) while the remainder of the tournament will be hosted by Morocco, Portugal, and Spain.

Saudi Arabia look all but set to host the World Cup in 2034, having being confirmed as the only sole bidder for the process (McInness, 2023). Australia had previously been given an extension to launch their bid to host the event but ultimately decided against it. Over the course of the past 5 years, Saudi Arabia has taken major steps forward in hosting major sporting events. Sports such as boxing and Forumla One have staged showpiece events in cities such as

Riyadh and Jeddah. The Saudi Public Investment Fund continue to pour investment into other sports such as LIV golf and the Saudi Pro League – the latter has seen a vast amount of football stars play their trade in the Saudi Arabia, including Cristiano Ronaldo and Sadio Mané. Hosting footballs showpiece event in 2034 would represent a significant sporting milestone for Saudi Arabia. It is believed that they will try to emulate Qatar as being the second country to host footballs showpiece in the Middle East. Concerningly, the travel distances needed for teams to reach Saudi Arabia would be just like Qatar, if not more.

6.2.2. Movement of Tournaments to non-Traditional Hosts

For the bets part of a century FIFA World Cup were held in Western Europe or South America, with UEFA European Championships were largely held in Western Europe. A single host was used by both competitions for the entirety of the 20th century. This has now changed and brought with it environmental implications. The expansion of team numbers, discussed in section 6.2.1 is not the sole driver of increased travel emissions. If the number of teams were the only source of increased emissions, the most recent tournaments would be the highest emitters. Tables 5.1 and 5.2 show that this is not the case. The movement to countries away from the traditional European base has increased travel distances. This is acutely true when travelling to arrive at the host country for the start of the tournament and when one considers The median values presented in Table 5.1 and Table 5.2. For example, the median value CO^2 at Italia ’90 was just 2.89 tonnes of emissions. This is much lower to the mean value of 12.77 and a total CO^2 emission of 664.11 tonnes. This is replicated throughout Table 5.1 and demonstrates the considerable role that geographic outlier countries play when travelling to the Finals. The differences are exacerbated as European countries become geographic outliers, when the World Cup Finals are hosted in Asia, Africa, and the American continents – both north and south.

Thus, there are two parts to consider. Hosting tournaments in peripheral locations such as Japan, Korea, South Africa, and Qatar require long travel distances for many qualifying countries (Table 5.1). However, when located in the host country, travel distances for games were largely consistent with European hosts (Table 5.2). The 2022 World Cup in Qatar reported the lowest CO^2 emissions per game when only internal travel is considered. This tournament generated relatively low mean emissions per match, due to short travel distance between stadia. This contradicts much criticism about some of the socio-cultural implications of Qatar hosting the event (Al-Emadi et al., 2016).[2] The same cannot be said of USA, Brazil, and Russia. Long-haul flights required to arrive to the host location are then matched by further lengthy trips during the tournaments.

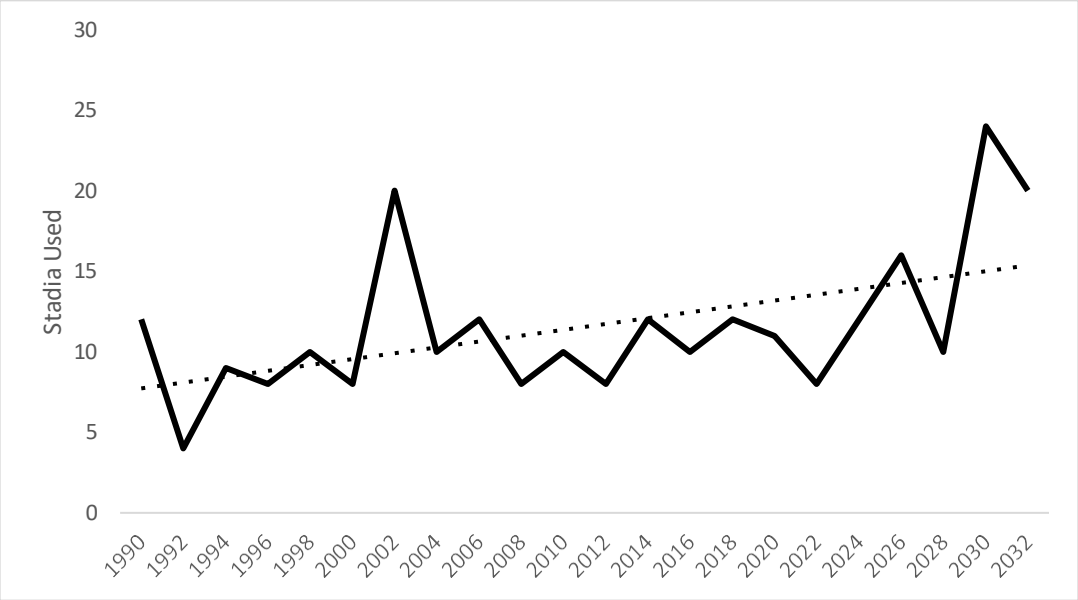
6.2.3 Stadia Used During Tournaments

The number of stadia used within a tournament is also affecting emissions. Ignoring the construction of these stadia, which are environmentally damaging due to the need for mass production of concrete, UEFA have increased the number of stadia used within their Championships, thereby increasing team travel. The 2020 tournament was held across 20 stadia resulting in the highest level of travel emissions ever reported at a UEFA European Championship. FIFA decreased their use of stadia in recent years which contributes to the decline in emissions at World Cups. Sensibly, the strategy to use 20 different stadia in 2002 has never been repeated, with between 8-12 stadia now used to host games. The most recent World Cup in Qatar used just 8 venues, the lowest of any World Cup host since 1990. One must go back to the 1978 World Cup in Argentina, when just 16 teams competed in the Finals across 6 different stadia, to find a lower number used at the tournament.

[2] One caveat, however, is that that unprecedented infrastructural investment was required for this tournament, and we do not measure any carbon emissions related to construction.

However, this trend will now continue into 2026 and beyond. 16 stadia will be used across Canada, Mexico, and the USA, making the tournament the most geographically spread in the history of the World Cup. 24 different stadia – a record number for a FIFA World Cup – will be used at World Cup 2032. 2 are in Portugal, 3 in South America, 6 in Morocco, and the remaining 14 in Spanish territory, including 1 on the island of Gran Canaria. So, despite a shift since 2002 away from increased stadia usable, the next decade will see a reversal of this, with increased air travel an essential element of getting to these locations. Given the approach that both FIFA and UEFA are committed to from at least 2026 to 2032, their actions seem to be different to the words expressed in sustainability goals. This is demonstrated in Figure 6.1.

Figure 6.1: Stadia Used at Major Tournaments 1990 to 2032



Source: The Rec. Sport. Soccer Statistics Foundation (2023). 2026 to 2032 figures are estimated from Wikipedia pages for the relevant tournaments.

The trend is the use of stadia is worrying and will continue into the next decade. The sustainability targets set out by the United Nations cannot be assisted by the increased use of stadia. This is true for both the construction/redevelopment f venues and the travel required between these venues.

6.2.4 Co-hosts and Multi-city Hosts

Lastly, the European Championships in 2020 took a unique step of locating the tournament across multiple ten European cities and one Asian city to celebrate 60 years of the tournament. As shown by Figure 5.1 and Figure 5.2, this created CO^2 emissions from travel that were far greater than when a single country or co-hosts were awarded the tournament. The tournament resulted in considerable air miles and dramatically increased average CO^2 emissions at the tournament. Serious consideration needs to be given to this approach. If organisers are serious about reducing their carbon footprint, this competition format should not be used again.

6.3. Recommendations to FIFA and UEFA

Based on the findings in sub-section 6.2 this sub-section lists recommendations to both FIFA and UEFA to improvement the sustainability of these major events.

6.3.1 Measuring Carbon Footprint

A first step in managing any organisation's carbon footprint is to conduct a detailed measurement of emissions. This research is an attempt to do this for one input – team air travel. The consequence of this research is that one can evaluate if FIFA and UEFA are awarding the hosting of major sporting events to locations that can minimise the carbon footprint of team travel. Given that environmental sustainability is cited as one of their core missions, hosting decisions can be benchmarked from our analysis. We show that hosting a major football tournament in a smaller host nation, with shorter within tournament travel distances, significantly reduces CO^2 emissions. This should become part of the scoring process when evaluating national associations bids for these tournaments.

6.3.2 Selection of Geographically Peripheral Hosts and Fixture Design

We also show that locating a tournament close to most qualifying teams also significantly reduces the CO^2 emissions from team travel. Thus, there are clear scheduling implications for sustainability strategies. The findings generalise and are relevant for other major events that require international travel to an event with subsequent domestic travel as a tournament progresses. As noted by Paché (2020), proper intervention and planning are essential for the leading authorities to minimise the carbon footprint of travel for major events in international football.

However, given that one of the missions of football authorities is to spread the game, it is not reasonable, or fair, to expect countries in geographic isolation from Western Europe or South America not to be allowed to hosting major tournaments. Should they win the rights, careful planning should then go into fixture scheduling and the movement of teams. A good example of this can be seen from the 2023 FIFA Women's World Cup in Australia. The Republic of Ireland qualified for the first time. After travelling 17,204 kilometres from Dublin to Syndey to play the hosts Australia, the team then travelled 3,209 kilometres to the western city of Perth to play their second game. Their final group game was in Brisbane, requiring travel back to the east coast of Australia of some 3,607km. Is such travel necessary? Particularly given Australia's huge landmass and peripheral location? These issues could be readily solved by locating teams in one city or cities near one another.

6.3.3 Altering Competition Design

Sport governing bodies have many objectives other than protecting the environment, which include developing the sport, ensuring inclusivity and being financially stable. However, a balance must be struck in terms of managing these aims without damaging the environment.

Proposed solutions include holding group stage matches in locations that are close to the playing teams. These groups are determined in advance of the tournament which limits any reduction in ticket sales and protects revenue generation. The teams who qualify for the knockout stage could then travel to a host location that includes stadia which are close together. This approach would reduce some of the travel to and from the host location for teams at the early stage of the tournament and reduce within tournament travel at the later stages. This is how the 2019-20 UEFA Champions League ended, with the quarterfinals, semi-finals and final all played in Lisbon, Portugal from the 12th to the 23rd of August due to Covid-19.

6.4. Limitations of the work.

This work is a preliminary attempt to track and track the CO^2 emissions that international football teams have generated through time. It is by no means the final word on the matter given the limitations in the data and difference in airplane technology through time. We take only the most obvious travel events – playing matches – and map these against known information on team locations. We exclude spectator travel and travel to training camps and other events as the data does not allow this to be done easily. Further investigations may prove to be fruitful in this area.

The inclusion of spectator data – probably using survey data – could further develop this research agenda. It may be possible to see whether fans have become sustainable in their travel options through time and see if it is possible to incentivize sustainable travel options at an international competition, similar to the work of Thormann and Wicker (2024) in the German Bundesliga.

Future research could consider hypothetical CO^2 emissions based on alternative competitions designs and scheduling constraints. Clearly, we offer the most conservative estimates, additional data on fans and their travel patterns could build upon this attempt and add greater precision to observed emissions.

6.5. Summary and Conclusion.

Sustainability in football has become an increasingly critical aspect as the sport acknowledges its environmental impact and strives for responsible practices. Reducing carbon emissions at major sporting events has become a paramount goal as football tournaments aim to align with sustainable practices. By prioritizing environmental considerations in the planning and execution of both the World Cup and European Championships, football authorities are not only enhancing the overall experience for fans but also setting a precedent for future large-scale sporting events to prioritize environmental stewardship. As we have seen throughout the paper, our analysis demonstrates the CO^2 emissions cost of these decisions, at a most conservative level. We do not include spectator, commercial and broadcasting related travel and equipment/logistical travel. These consideration show that the distinctions between a tournament characterized by a low carbon footprint and one marked by a high carbon footprint will be more pronounced, particularly when the emissions are magnified by the thousands of traveling fans. We demand that a balance must be struck if the football authorities are serious about protecting the environment. we strongly recommend that these major sporting events are held in a smaller host nation, with shorter distances for travel within the tournament. This has the knock on effect of significantly reducing CO^2. Additionally, our study demonstrates that situating a tournament in proximity to the majority of qualifying teams also results in a noteworthy decrease in CO^2 emissions arising from team travel.

7 CONCLUSION

7.1. Summary of the research

As outlined at the start of this work, this research explores the impact of football air travel on the environment at two major international football tournaments over a 34-year period and considers both the FIFA World Cup and UEFA European Championships tournaments, for male players. As both FIFA and UEFA are committed to reaching net carbon neutral by the end of the next decade, this work attempts to measure if the words of both are matched by their actions. Furthermore, it also seeks to highlight the importance of environmentally friendly changes that can be introduced so that European and the world football associations can maintain sustainable environmental standards.

From the creating of a conservative CO^2 index of emissions we find that these tournaments are not becoming more sustainable and that longer travel distances to host, more competing teams and competition design are all resulting in an upward trend in CO^2 emissions, despite an awareness of this and improvements in airplane technology over the past thirty years. By creating this CO^2 emissions index, we have demonstrated how the evolution of tournament hosting had negatively impacted upon the environment and that the selection if the host and scheduling of games needs to be considered for future tournaments.

It would seem that competition expansion, and locating these tournaments in non-traditional areas/hosts, appears to be the priority of both FIFA and UEFA over the next ten years, with tournaments in 2026 and beyond little to be the highest emitters to date, given the geographic location, dispersion of venues and expansion in competition size. Greater consideration should be given to fixture scheduling and the movement of teams, as well as the including a carbon

audit in the bidding process to ensure hosts are attempting to meet sustainability goals from the outset.

7.2. Avenues for future research.

As stated earlier in the thesis, future research could consider hypothetical CO^2 emissions based on alternative competitions designs and scheduling constraints. This could be developed into a scenario analysis where organisers can compare alternative competitions designs. It might also be possible to understand fan travel at these tournaments. If one could access data on fan travel plans and location, and their movement during the competition, it would be possible to do a preliminary analysis on how fans impact the environment of the host country. This would be both useful and timely. To date, almost all research explores spectator arrivals into host country's focuses on the positive – economic impact – with little or no attention focused on the downside risks or environmental impact. As stated, this work offer the most conservative estimates, additional data on fans and their travel patterns could build upon this attempt and add greater precision to observed emissions.

7.3. Conclusion of thesis.

Various sporting events have been hosted and are continuing to be hosted around the world. These sporting events are having big social and cultural impacts on the host nation. Football tournaments such as the World Cup and the European Championships are viewed as one of the major sporting events that contribute significantly to the economic growth of a nation. More and more developed and developing nations are actively putting their hand up to be host of these significant events. Increased tourism, infrastructure development and increased merchandise sales all lead to increased revenue for the host country and lead to a big boost to the local economy. However, there are also drawbacks to hosting major sporting competitions.

The greatest cost of hosting a major tournament is the potential environmental damage it causes to the world we live in. As discussed throughout the paper, the environmental damage caused by air travel is having a significant impact on the environment. We have analysed the decision of where to host major international competitions as being an important element of this as both UEFA and FIFA have dramatically changed their traditional hosting methods in recent years. The common theme we have seen throughout is that smaller countries with efficient transportation systems and a smaller population may be better equipped to host a significant event, which in turn leads to lower carbon emissions. We have found that there needs to be more responsibility from footballs governing bodies to minimize the carbon footprint of teams travelling for major football events.

As shown above, we analyse data from a total of 895 football tournament matches conducted between June 1990 and June 2024. Our dataset encompasses players and their management teams who travel to and within host locations, collectively referred to as the 'team.' Over the time span of 33 years, we have seen that the number of players allowed to compete at major tournaments has risen. In 1990, only 20 players could be named in a squad list. In 2020, 26 players were allowed to compete. Similarly, this is matched by an increase in travelling staff members. we account for 10 staff members in 1990 but almost as many as 20 staff members in 2020. The next set of data pertains to CO^2 emissions resulting from air travel. The compiled data span from 1990 to 2022 provides estimations for the average CO^2 emissions per passenger on long/short-haul flights. As anticipated, countries more distant from Europe and those with larger geographic expanses disclose greater travel distances, with Brazil, South Korea/Japan, and South Africa recording the highest figures. By integrating the three aforementioned data sources, we formulated a CO^2 emissions index. We assessed how the changes in hosting tournaments have influenced the CO^2 emissions associated with team travel. Our analysis represents an initial endeavour to illustrate the CO^2 emissions implications of these decisions.

Our results from the data and method are clear – the decision where to host the World Cup and European Championships results in fluctuating levels of emissions. From a World Cup point of view, the highest team travel distance recorded in a World Cup occurred in the 2002 edition hosted by Korea and Japan, resulting in the highest CO^2 emissions for that tournament, producing 31.5 tonnes of CO^2. As displayed above, we do not appear to see a pattern of downward trending CO^2 emissions. From an environmental perspective, this is certainly not the picture we want to be painted. The emissions produced during the World Cup tournaments in peripheral locations such as South Africa (2010), Brazil (2014), and Qatar (2022) were significantly impacted by team travel to the tournaments. The host country's location is evidently a crucial factor, with tournaments held in Italy, France, and Germany resulting in relatively low average emissions due to their European locations. In contrast to the World Cups, the CO^2 emissions emitted at European Championships are much lower. As we have seen, this is owning to them being intra-continental competitions. The tournament held in 2020 spanned 11 countries and ranked as the most environmentally impactful, with 78% of team travel emissions originating from within the tournament itself. Although hosting the event in multiple cities aligns with UEFA's objectives to 'grow the sport', this practice is not environmentally suitable. The environmental cost of the game's expansion should be carefully examined when FIFA and UEFA set their future strategic objectives. Up until 2032, the FIFA World Cup and UEFA European Championship Finals hosts have been revealed. The three tournaments (2028, 2030 and 2032) are all related by having several host nations, which again, does more harm than good to the environment.

When just domestic travel is considered, the 2022 World Cup in Qatar was found to have the lowest CO^2 emissions per game. Due to the short travel time between the stadiums, this tournament produced comparatively low mean emissions each match. This runs counter to a

lot of concerns over some of the socio-cultural ramifications of Qatar serving as the host nation. Regarding the USA, Brazil, and Russia, the same cannot be stated. The extensive journeys needed to get to the host location are followed by longer ones throughout the competitions. It does not seem that FIFA and UEFA are lowering their carbon impact from team travel at key tournaments, despite advances in jet fuel efficiency over the last thirty years. The combined emissions from the two competitions between 1990 and 2022 clearly displayed in Figure 2 & Figure 3 above.

The main goals of host nations are financial gain and international economic stability. Throughout this paper we have suggested that European football rivalry raises employment standards and improves a nation's economic standing. Because of this, football federations must host football competitions. The study also emphasises the detrimental effects of large crowds and air travel during football games. When it comes to sustainability, it becomes a debatable topic as larger and more developed nations are investing a higher amount in facility development in different cities and providing them with the opportunity to host world-class event that helps to develop them as international tourist location but the improvement in the travelling and management of people and facilities is increasing the travelling and affecting the CO2 emission. Therefore, the small nation will be a better option for hosting football events and maintaining effectiveness in environmental conditions as well and it will also contribute to the economic empowerment of such nations.

According to the discussion findings, the improvement in air travelling and local transportation for long journeys during major football events is having a significant impact on the overall environmental conditions. Small nations can be good options for maintaining sustainability during such events that minimize the travelling and emission of CO^2 which is more important for the world. Moreover, support from the developed and leading nations in this industry is also needed for managing the resources as small nations do not have such capabilities and

infrastructure for hosting the events solely. Hence, it is recommended to encourage the small nations to host the leading football events.

In conclusion, we believe that FIFA and UEFA are not doing enough to properly reduce the carbon footprint at major football tournaments. If footballs governing bodies committed to economic stewardship, we could see a big increase in global awareness for climate change. As a major sports organisation with a wide-reaching influence, UEFA must recognise its global responsibility. Taking steps to reduce its carbon footprint promotes a sense of responsibility among fans, participants, and partners. Reducing the carbon emissions associated with air travel during major football tournaments should be at the forefront of both UEFA and FIFA's strategies to minimize the environmental impact of teams.

8 REFERENCES

Agarwal, A., Agarwal, K. and Misra, G., 2020. Is internet becoming a major contributor for global warming-the online carbon footprint. *Journal of Information Technology and Digital World*, 2(4), pp.217-220

Ahmed, M. and Agini, S. (2021) The battle to control football: FIFA versus UEFA, Financial Times. Available at: https://www.ft.com/content/268989a1-5299-473e-adc4-ed02d247cd3c (Accessed: 28 August 2023).

Al-Emadi, A. et al. (2016). 2022 Qatar World Cup: Impact Perceptions among Qatar residents, *Journal of Travel Research*, 56(5), pp. 678–694.

Azzali, S., (2020). Challenges and key factors in planning legacies of mega sporting events: Lessons learned from London, Sochi, and Rio de Janeiro. International Journal of Architectural Research, 14 (2), pp.203-218.

BBC Sport. (2022). Heat Will Be Tough. Available at https://www.bbc.com/sport/av/football/66808120.

Bek,D., Merendino,A., Swart, K. & Timms, J. (2019) Creating an enduring developmental legacy from FIFA2010: the Football Foundation of South Africa (FFSA), *European Sport Management Quarterly,* 19:4, 437-455,

Brochado, A., Brito, C., Bouchet, A. and Oliveira, F., 2021. Dimensions of football stadium and museum tour experiences: The case of Europe's most valuable brands. *Sustainability*, 13(12), p.6602.

Butler, R., & Massey, P. (2019). Has competition in the market for subscription sports broadcasting benefited consumers? The case of the English Premier League. *Journal of Sports Economics*, 20(4), 603-624.

Carbon Independent. 2023. Carbon footprint calculator. https://www.carbonindependent.org

Chappelet, J. L. (2013). *Olympic environmental concerns as a legacy of the Winter Games. In Olympic legacies: Intended and unintended* (pp. 1-19). Routledge.

Clarkson, B. and Philippou, C., 2022. Gender diversity and financial sustainability in professional football: a competitive strategy and proposed interdisciplinary research agenda. *Managing Sport and Leisure*, pp.1-5.

climatechangenews.com/2013/03/11/formula-one-the-petrolheads-driving-the-greeneconomy/

Collins, A., Jones, C., & Munday, M. (2009). Assessing the environmental impacts of mega sporting events: Two options?. *Tourism Management*, 30(6), 828-837.

Crabb, L. A. H. (2016). Elites and carbon offsetting in Brazil: A critique of the 2014 FIFA World Cup in Mato Grosso [PhD-thesis]. Essex Business School. http://repository.essex.ac.uk/id/eprint18620

Cury, R., Kennelly, M., & Howes, M. (2023). Environmental sustainability in sport: a systematic literature review. *European Sport Management Quarterly*, 23(1), 13-37.

Daddi, T., Rizzi, F., Pretner, G., Todaro, N., Annunziata, E., Frey, M. and Iraldo, F., 2021. Environmental management of sport events: a focus on European professional football. *Sport, Business and Management: An International Journal*.

Dantas, F., Borges, A. and Silva, R., 2020. Impact of UEFA Champions League and UEFA Europa League on Financial Sustainability—Case Study of Two Small Football Portuguese Teams. *Sustainability*, 12(21), p.9213.

Deloitte. (2016). Annual review of football finance. Deloitte.

Econ Pöyry (2009). Feasibility study for a carbon neutral 2010 FIFA World Cup in South Africa, https://www.environment.gov.za/sites/default/files/docs/carbonneutralwc_feasibility_study.pdf

Environmental Protection Agency (2023). Greenhouse Gas Equivalencies Calculator. Available at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results.
European Commission, (2023). Reducing emissions from aviation. https://climate.ec.europa.eu/eu-action/transport-emissions/reducing-emissions-aviation_en.
Faccia, A., Mataruna-Dos-Santos, L.J., Munoz Helù, H. and Range, D., 2020. Measuring and monitoring sustainability in listed european football clubs: A value-added reporting perspective. *Sustainability*, 12(23), p.9853.
Fahy, R., Butler, D., & Butler, R. (2023). Broadcasting demand for Formula One: Viewer preferences for outcome uncertainty in the United States. *Managing Sport and Leisure*, 1-12.
FIA. (2020). FIA introduces sustainable fuel into Formula 1 and commits to becoming carbon
FIFA (2013) Summary of the 2014 FIFA World Cup Brazil™ Carbon Footprint, https://resources. fifa.com/image/upload/summary-of-the-2014- fifa-world-cup-brazil-carbon-footprint-2835150. pdf?cloudid=kcvvlnivbq3gs9ksnagy; FIFA (2016) Greenhouse Gas Accounting Report: 2018 FIFA World Cup; https://resources.fifa.com/image/ upload/greenhouse-gas-accounting-report. pdf?cloudid=bs36nsonccbtfs5v7ppu
FIFA (2016) Greenhouse Gas Accounting Report: 2018 FIFA World Cup; https://resources.fifa.com/image/ upload/greenhouse-gas-accounting-report. pdf?cloudid=bs36nsonccbtfs5v7ppu
FIFA, (2023a). About FIFA. https://www.fifa.com/about-fifa
FIFA, (2023b.) FIFA World Cup 26. https://www.fifa.com/fifaplus/en/tournaments/mens/worldcup/canadamexicousa2026.
FIFA, (2023c.) Environmental Pillar Greenhouse Gas Emissions. https://publications.fifa.com/en/sustainability-report/environmental-pillar/greenhouse-gas-emissions/greenhouse-gas-emissions-overview/.
FIFA, (2023d.) FIFA Council takes key decisions on FIFA World Cup™ editions in 2030 and 2034. https://www.fifa.com/about-fifa/organisation/fifa-council/media-releases/fifa-council-takes-key-decisions-on-fifa-world-cup-tm-editions-in-2030-and-2034.
Gammelsæter, H. and Loland, S. (2023) Code Red for Elite Sport. A critique of sustainability in elite sport and a tentative reform programme, *European Sport Management Quarterly*, 23:1, 104-124,
Geeraert, A. (2017). A little green. The European union's efforts to promote environmental sustainability in sport. In B. P. McCullough & T. B. Kellison (Eds.), Routledge *Handbook of Sport and the Environment* (pp. 393–403). Routledge.
Giampiccoli, A. and Nauright, J., 2019. Beyond the reach of FIFA: Football and community 'development'in rural South Africa, towards a politics of inclusion and sustainability. *Soccer & Society*, 20(2), pp.288-306.
Goldblatt, 2020. Playing Against the Clock: Global Sport, the Climate Emergency and the Case for Rapid Change. Rapid Transition Alliance. https://rapidtransition.org/wpcontent/uploads/2020/06/Playing_Against_The_Clock_FINAL.pdf
Hautbois, C., & Desbordes, M. (2023). Sustainability in Sport: Sport, Part of the Problem… and of the Solution. *Sustainability*, 15(15), 11820.
Inoue, Y., & Kent, A. (2012). Sport teams as promoters of proenvironmental behavior: An empirical study. *Journal of Sport Management*, 26(5), 417–432. doi:10.1123/jsm.26.5.417.

International Energy Agency, 2023. Aviation. https://www.iea.org/energy-system/transport/aviation.
International Olympic Committee. (2014). Factsheet The Environment and Sustainable Development Update - January 2014. https://stillmed.olympic.org/Documents/Reference_documents_Factsheets/Environment_and_substainable_developement.pdf.
Jalil, E.E.A., Liau, S.H., Ku, E.N. and Lee, K.F., 2019. Event logistics in sustainability of football matches. *International Journal of Supply Chain Management*, 8(1), pp.924-931.
Kellison, T. and Orr, M. (2020) 'Climate vulnerability as a catalyst for early stadium replacement', International Journal of Sports Marketing and Sponsorship, 22(1), pp. 126–141. doi:10.1108/ijsms-04-2020-0076.
Kellison, T.B., & Mondello, M. (2014). Civic paternalism in political policymaking: The justification for no-vote stadium subsidies. *Journal of Sport Management*, 28(2), 162–175. doi:10.1123/jsm.2012-0210
Kietlinski, R. (2021). 'A Strong, Sustainable Legacy': The Environment and Japan's Winter Olympics. *The International Journal of the History of Sport*, 38(13-14), 1476-1493.
King, E. (2013). Formula One: The petrolheads driving the green economy. https://www.
Lohmann, L. (2013). Beyond Patzers and clients: Strategic reflections on climate change and the 'Green Economy'. *Development Dialogue*, June, p. 295–326.
Mallen, C., Stevens, J., Adams, L. & McRoberts, S. (2010) The Assessment of the Environmental Performance of an International Multi-Sport Event, *European Sport Management Quarterly*, 10:1, 97-122.
McCullough, B. P., Orr, M., & Watanabe, N. M. (2019). Measuring externalities: The imperative next step to sustainability assessment in sport. *Journal of Sport Management*, 34(5), 393-402.
McCullough, B. P., Pfahl, M. E., & Nguyen, S. N. (2016). The green waves of environmental sustainability in sport. *Sport in Society*, 19(7), 1040-1065.
McInnes, P. (2023) Saudi Arabia confirmed as sole bidder for 2034 Men's World Cup, The Guardian. Available at: https://www.theguardian.com/football/2023/oct/31/saudi-arabia-2034-mens-world-cup-human-rights.
Miller, T. (2016). Greenwashed sports and environmental activism: Formula 1 and FIFA, Environmental Communication, 10(6,) 719-733.
Mohajan, H.K., 2018. Qualitative research methodology in social sciences and related subjects. Journal of economic development, environment, and people, 7(1), pp.23-48.
neutral from 2021 and net zero by 2030. https://www.fia.com/news/fia-introduces-sustainablefuel-formula-1-and-commits-becoming-carbon-neutral-2021-and-net-zero.
Newman, M. and Gough, D., 2020. Systematic reviews in educational research: Methodology, perspectives and application. *Systematic reviews in educational research*, pp.3-22.
Orr, M. (2020) 'On the potential impacts of climate change on baseball and cross-country skiing', Managing Sport and Leisure, 25(4), pp. 307–320.
O'Rourke, A., & Theodoraki, E. (2022). The FIFA World Cup Qatar 2022 sustainability strategy: human rights governance in the Tripartite Network. *Frontiers in Sports and Active Living*, 4, 809984.
Our World in Data (2023). Transport. Available at https://ourworldindata.org/transport.
Paché, G., 2020. Sustainability challenges in professional football: The destructive effects of the society of the spectacle. *Journal of Sustainable Development*, 13(1), pp.85-96.
Parent, M. M., & Ruetsch, A. (2020). *Managing major sports events: Theory and practice*. Routledge.

Pereira, R. P., Camara, M. V., Ribeiro, G. M., & Filimonau, V. (2017) 'Applying the facility location problem model for selection of more climate benign Mega Sporting event hosts: A case of the FIFA World Cups', *Journal of Cleaner Production*, 159, 147–157.
Pfahl, M. (2011). *Sport and the natural environment: A strategic guide*. Dubuque, IA: Kendall Hunt.
Porter, C., May, A. and Kiernan, A. eds., 2018. *Football, Community and Sustainability*. Routledge.
Schulenkorf, N., Welty Peachey, J., Chen, G., Hergesell, A., 2022. Event leverage: A systematic literature review and new research agenda', *European Sport Management Quarterly*, pp. 1–25.
The Rec. Sport. Soccer Statistics Foundation (RSSSF), 2023a. European Championship. https://www.rsssf.org/tablese/eurochamp.html.
The Rec. Sport. Soccer Statistics Foundation (RSSSF), 2023b. World Cup 1930-2022. https://www.rsssf.org/tablesw/worldcup.html.
Themen, A., 2023. Swiss Commission for Fairness upholds complaints against FIFA. Swiss Commission for Fairness. https://www.faire-werbung.ch/de/swiss-commission-for-fairness-upholds-complaints-against-fifa/.
Thibault, L. (2009). Globalization of sport: An inconvenient truth. *Journal of Sport Management*, 23(1), 1–20. doi:10.1123/jsm.23.1.1
Thormann, T. F., & Wicker, P. (2024). Environmentally-Friendly Stadium Travel of Football Fans: A Stated Preferences Study. *Journal of Sports Economics*, 25(1), 3-29.
Trendafilova, S., McCullough, B., Pfahl, M., Nguyen, S.N., Casper, J. & Picariello, M. Environmental sustainability in sport: Current state and future trends*, Global Journal on Advances in Pure & Applied Sciences*. 2014, 03, 09-14.
UEFA, 2023a. Strength Through Unity Football Sustainability Strategy 2030. https://editorial.uefa.com/resources/0270-13f888ffa3e5-931c597968cb-1000/uefa_football_sustainability_strategy.pdf.
UEFA, 2023b. UEFA EURO 2024 fixtures: When and where are the matches? https://www.uefa.com/euro2024/news/0275-151eb1c333ea-d30deec67b13-1000--uefa-euro-2024-fixtures-when-and-where-are-the-matches/.
United Nations Environmental Programme, 2009. Independent Environmental Assessment Beijing 2008 Olympic Games. https://wedocs.unep.org/bitstream/handle/20.500.11822/7882/BEIJING_REPORT_COMPLETE.pdf?sequence=3&isAllowed=y#:~:text=Some%2090%20per%20cent%20of,encourage%20cleaner%20public%20transport%20systems.
United Nations, 2023. Sports for Climate Action. https://unfccc.int/climate-action/sectoral-engagement/sports-for-climate action#:~:text=The%20Sports%20for%20Climate%20Action%20Initiative%20will%20provide%20sports%20organizations,collaborating%20on%20areas%20of%20mutual
Urdaneta, R., Guevara-Pérez, J.C., Llena-Macarulla, F. and Moneva, J.M., 2021. Transparency and Accountability in Sports: Measuring the Social and Financial Performance of Spanish Professional Football. *Sustainability,* 13(15), p.8663.
Wallrafen, T., Deutscher, C. and Pawlowski, T. (2020) The impact of live broadcasting on stadium attendance reconsidered: Some evidence from 3rd Division football in Germany', *European Sport Management Quarterly*, 22(6), pp. 788–811. doi:10.1080/16184742.2020.1828967.
Watt, R. (2021). The fantasy of carbon offsetting. *Environmental Politics*, 30(7), 1069–1088.

Wicker, P., (2020). The impact of participation frequency and travel distances for different sport participation purposes on subjective well-being: the ‘unhappy commuter’ and the happy sport tourist?, *European Sport Management Quarterly*, 20:3, 385-402.
Wilson, B., & Millington, B. (2015). Sport and environmentalism. In R. Giulianotti (Ed.), *Routledge handbook of the sociology of sport* (pp. 366–376). Routledge.