TEXTE
105/2023

Sustainable mobility concept EURO 2024

Final report

by:
Felix Bittner, Max Eberhardt
MRK Management Consultants GmbH, Dresden

publisher:
Umweltbundesamt

German Environment Agency

Umwelt Bundesamt

TEXTE 105/2023

Project No. 175167

Report No. (UBA-FB) FB001181/ENG

Sustainable mobility concept EURO 2024

Final report

by

Felix Bittner, Max Eberhardt
MRK Management Consultants GmbH, Dresden

On behalf of the German Environment Agency

Imprint

Publisher
Umweltbundesamt
Wörlitzer Platz 1
06844 Dessau-Roßlau
Phone: +49 340-2103-0
Fax: +49 340-2103-2285
buergerservice@uba.de
Internet: www.umweltbundesamt.de

/umweltbundesamt.de
/umweltbundesamt

Report performed by:
MRK Management Consultants GmbH
An der Frauenkirche 12
01067 Dresden

Report completed in:
May 2023

Edited by:
Section I 2.1 Environment and Transport
Timmo Janitzek

Publications as pdf:
http://www.umweltbundesamt.de/publikationen

ISSN 1862-4804

Dessau-Roßlau, July 2023

Abstract:Sustainable mobility concept EURO 2024

The study "Sustainable mobility concept EURO 2024" deals with the promotion of sustainable mobility in the context of the European Football Championship 2024 (EURO 2024) in Germany. The transportation sector is one of the main sources of greenhouse gas emissions. For that reason, it is crucial to promote sustainable mobility as part of the fight against climate change. For major sports events such as the 2024 European Football Championship in Germany, the challenges in regards to sustainable mobility are particularly pronounced. Therefore, such events should integrate targeted measures to promote sustainable mobility during planning and implementation.

This study is based on a comprehensive literature review and the evaluation of relevant studies with a special attention on European sports events of the past 17 years. The measures identified are analysed in relation to the spatial dimension of traffic volume as well as the involvement of different stakeholder groups. Based on these results, recommendations for sustainable mobility solutions in the context of EURO 2024 are presented.

The results underline that a comprehensive cooperation between organizing committees, governments, transportation authorities, transportation companies and society is essential to achieve sustainable mobility at major sports events. Public participation in planning and decision-making processes and the integration of feedback loops can help to develop a shared vision and implement measures that are supported by all stakeholders. A comprehensive and integrated environmental strategy can help to reduce the environmental footprint of events while taking into account social and economic aspects.

The study shows that the promotion of sustainable mobility at major sports events is an important factor for reducing greenhouse gas emissions. Organisers of major sports events should integrate targeted measures to promote sustainable mobility into their planning and implementation. This will reduce the negative impact of transportation on the environment and quality of life in urban areas. It is important to implement these actions not only in short-term during the event but also long-term in the region in order to establish a sustainable mobility.

Table of contents

List of figures

List of tables

List of abbreviations

ARE	Federal Office for Spatial Development (Swiss Confederation)
BAFU	Federal Office for the Environment (Swiss Confederation)
BASPO	Federal Office for Sport (Swiss Confederation)
BMLFUW	Federal Ministry of Agriculture, Forestry, Regions and Water Management (Republic of Austria)
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
CO_2	Carbon dioxide
DFB	German Football Association
DOSB	German Olympic Sports Confederation
EURO 2024	2024 European Football Championship
FIFA	International Association Football Federation
FIS	International Ski Federation
GHG	Greenhouse gases
IOC	International Olympic Committee
ITS	Intelligent traffic systems
OC	Organising Committee
PtL	Power-to-Liquid
UEFA	Union of European Football Associations
UN	United Nations

Summary

Sustainable mobility refers to the implementation and use of transport modes and systems that ensure environmental, social and economic sustainability. This type of mobility is essential to reducing the negative impacts of transportation on the environment and the quality of life in urban areas while promoting economic development. The three core strategies to promote sustainable mobility are traffic avoidance, modal shift and traffic improvement. Since the transportation sector is one of the main contributors to greenhouse gas (GHG) emissions, promoting sustainable mobility is a crucial element of the fight against climate change. For major sports events, such as the 2024 European Football Championship in Germany, the challenges regarding sustainable mobility are especially important. Therefore, such events should integrate targeted measures to promote sustainable mobility during planning and implementation.

The study aims to identify approaches to promote sustainable mobility in the context of the 2024 European Football Championship in Germany. The event will be organised with a special focus on sustainability and social responsibility. It has been shown that conceptual support is needed in the mobility sector, as transportation is a major driver of environmental impacts at major sports events. The study examines innovative approaches to sustainable mobility and develops a strategy geared towards avoiding and reducing traffic emissions.

The study is based on a comprehensive literature review and the evaluation of relevant existing studies with a special focus on European sports events of the past 17 years. The identified measures are analysed in relation to the spatial dimension of traffic volume, the kind of transport concerned as well as the involvement of different stakeholder groups. Recommendations for sustainable mobility solutions in the context of EURO 2024 will be developed based on these results.

From the studies and concepts examined, various measures and approaches can be derived which contribute to sustainable mobility at major sports events. The most important findings and measures are summarised below.

1. Integrating sustainability into planning and organization phase: Environmental impact of large events can be minimised by taking sustainability aspects into account at an early stage, for example in objectives and guidelines or in cooperation with sponsors, especially in the area of mobility. This includes the integration of environmental and climate protection into the strategic planning and decision-making of events.
2. Improving the accessibility and use of local public transportation: Providing efficient and attractive public transportation services and promoting the use of public transportation through ticket combinations or reduced fares can increase the share of public transportation in the modal split and thus reduce transport emissions.
3. Park and ride facilities: The provision of park and ride lots near transport hubs or event venues can reduce the number of passenger vehicle (car) trips and thus reduce traffic and emissions in host cities.
4. Carpooling and carsharing: Promoting carpooling and carsharing services can help reduce the number of car trips and thus traffic and emissions in host cities.
5. Promoting cycling: The provision of cycling infrastructure such as cycle paths, bicycle parking facilities and bicycle rental systems can help to increase the share of cycling in the modal split and therefore reduce traffic emissions.
6. Use of renewable energies and energy-efficient technologies: The use of renewable energies and energy-efficient technologies in the transportation sector can reduce the environmental

impact of transport, for example in the electrification of public transportation or the use of electric vehicles.
7. Reduction of air travel: Avoiding air travel and promoting alternatives, such as rail or long-distance bus travel, can reduce emissions caused by international transport.
8. Communication and awareness-raising: Informing and raising the awareness about sustainable mobility options and behaviours among participants, visitors and other stakeholders can make an important contribution to reducing transport emissions.
9. Monitoring and evaluation: The collection and analysis of environmental data on a regular basis and the evaluation of measures and concepts can help to assess and continuously improve the effectiveness of environmental management approaches at major sports events. Monitoring and evaluation are crucial to achieve both short- and long-term goals and to minimise the environmental impact of events.

The key findings of the "Concept and Feasibility Study on a Climate-Neutral EURO 2024" (Öko-Institut e.V., 2022) show that the transport sector is the main source of greenhouse gas emissions at EURO 2024 with 84%. Aircraft (64%) and car transport (14%) are next in accounting for the largest shares. On the other hand, public transportation contributes less to the overall burden. This is indicating its potential as an environmentally friendly mobility alternative. The analysis of emissions caused by stakeholder group show that international stadium visitors account for the largest share of GHG emissions (57%), followed by fan zones (14%) and national stadium visitors (13%). Emissions from teams (0.6%) and other stakeholders (15%) are lower but can have a signaling effect because of their role model function. These results show the importance of promoting sustainable mobility at major sports events and offer starting points for targeted actions to reduce emissions for different groups of people and modes of transport.

The classification of measures in this study is based on the anticipated period of implementation. The spatial dimension of transport is also taken into account, including the subdivision into local and regional transport, national transport within Germany and international transport. Furthermore, affected groups of people and transport modes are included in the analysis. Based on the results of the ex-ante carbon footprint of the "Concept and Feasibility Study for a 'Climate Neutral' EURO 2024" (Öko-Institut e.V., 2022) the potential impact levers of the measures can be elicited via the following factors:

1. Affected modes of transport: Analysis of the affected modes of transport and their share in the projected greenhouse gas emissions.
2. Groups addressed: Investigation of the groups addressed and their share in the projected greenhouse gas emissions.
3. Spatial dimension: Inclusion of the spatial dimension of the action and its share of the spatial transport level in the projected greenhouse gas emissions.

In order to promote sustainable mobility at major sports events, measures should be adopted regarding spatial dimensions, stakeholder groups and modes of transport. These include the establishment of a coordination team, the integration of sustainable goals in sponsorship contracts, information and role model functions.

The reduction of environmental impacts in host cities requires the use of intelligent transport systems (ITS), green mobility and measures to reduce traffic. In order to use cars and buses more sustainably, environmentally friendly vehicle fleets, sustainable driver training and on-demand transport should be used. In the field of public transportation, shuttle buses, increased transport capacities, extended network plans, combined tickets and alternative propulsion systems are important. The promotion of cycling requires the expansion of cycle paths, secured

parking spaces, the offer of rental bikes, incentive schemes and cargo bikes. Pedestrian traffic can be supported by attractive "fan miles" routes.

National transport within Germany should be made sustainable through an intelligent match schedule design, the offer of on-demand transport, the expansion of public transportation and attractive pricing of the latter. For international transport, measures similar to those at national level are applicable, whereby rail transport should be particularly promoted.

In the medium- and long-term, or with regard to future major events, these measures represent starting points for making event traffic sustainable:

- anchoring of sustainable guidelines
- goals and legal regulations
- selection of the event location with regard to good accessibility and short distances
- the use of traffic control systems
- expansion of public transportation
- the infrastructure for means of transport of the environmental alliance
- the use of alternative propulsion systems and fuels, especially in air traffic.

The study shows that there are many measures to establish sustainable mobility at major sports events. However, the exact effects are difficult to quantify. This is why the measures taken should be analysed and evaluated after the event. In this way, insights can be gained for future events and measures taken can be adapted or especially promoted depending on their efficiency.

Overall, short-, medium- and long-term measures have been identified. Most of them are locally or regionally applicable and concern public transportation and spectators. Minimising air traffic and private transportation are the most effective levers to promote sustainable mobility. In general, cooperation with different stakeholders is necessary to ensure that as many measures as possible can be implemented effectively.

1 Introduction

1.1 Definition of sustainable mobility and its importance at major sports events

Sustainable mobility is generally understood as the use of transport means and systems that are viable in environmental as well as social and economic aspects.

Sustainable mobility plays a major role in reducing the negative impacts of transport on society and the environment, such as air pollution, greenhouse gas emissions, congestion, and accidents. Thereby it can help to improve the quality of life and promote economic development.

In order to make transportation more sustainable, in particular three approaches are available, the importance of which is arranged in descending order as follows: traffic avoidance, modal shift and traffic improvement. Traffic avoidance aims to avoid unnecessary journeys and thus reduce the amount of traffic. Modal shift aims to increase the share of sustainable transport modes such as walking, cycling, public transportation, and car sharing. Finally, the environmental impact of the remaining traffic can be minimised through measures such as the use of sustainable forms of propulsion.

It is important to promote sustainable mobility, as the transport sector is one of the largest emitters of greenhouse gases. In 2022, it accounted for 20% of Germany's total greenhouse gas emissions. Transport related greenhouse gas emissions in Germany by 2022 fell by only 9.4% compared to the reference year of 1990. During the same period, Germany's overall greenhouse gas emissions decreased by 40.4%. The comparison between the sectors shows that other sectors, such as energy and agriculture, were able to reduce their emissions significantly. That leads to the conclusion that the transport sector subsequently has the greatest need to catch up. (Federal Environment Agency, 2023)

The organisation of major sports events such as the 2024 European Football Championship in Germany poses a major challenge for sustainable mobility. A high number of visitors will lead to an increased volume of traffic and will result in high environmental pollution.

When planning and staging the 2024 European Football Championship, measures to promote sustainable mobility should definitely be taken. This study examines different approaches to promoting sustainable mobility at major sports events and discusses the applicability of these approaches to the 2024 European Football Championship in Germany.

1.2 Overview of the topic and motivation of the study

This study aims to contribute to the design of sustainable mobility in the context of the European Football Championship EURO 2024 in Germany. This event is organised by the Union of European Football Associations (UEFA) and the German Football Association (DFB) with a special focus on sustainability and social responsibility. The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) supports host cities and organisers with various measures and activities in the field of environmental protection. In exchange with the organisers and host cities, it became apparent that conceptual support is particularly necessary for the mobility sector, as transport is a major driver of environmental pollution at major sports events. Developing a strategy aimed at avoiding and reducing traffic emissions would make an important contribution to sustainable mobility. This will require innovative approaches.

2 Goals and methods

2.1 Aims of the study

The aim of this study is to provide conceptual support for the mobility sector as part of the preparations for EURO 2024. Previous discussions have only focused on individual aspects, such as the organisation of local public transportation, traffic guidance systems on motorways and the distribution of costs for a combined ticket. However, a holistic and sustainability-oriented strategy for the avoidance and reduction of traffic emissions is still needed. To close this gap, the study "Sustainable Mobility Concept EURO 2024" provides an overview of measures and their effects. In particular, an interlinking of local, regional, national and international transport in the sense of a sustainable mobility approach will be taken into account. Measures will be presented that can be implemented in the short-term until EURO 2024.

2.2 Methodology

This chapter describes the methodology of the presented study. The aim was to use existing studies and concepts that have dealt with the environmental impacts of past major sports events. In the evaluation of their results, only measures that mitigate impacts in the field of sustainable mobility were considered. For this purpose, a comprehensive literature search was conducted and a number of relevant studies and concepts were evaluated. Due to the data situation, the focus of these studies is on European sports events of the last 17 years. However, this circumstance is not seen as critical. Monitoring of sustainability has gained in importance especially in this period and the European perspective increases considerably for the upcoming EURO 2024 in Germany. Subsequently, the identified measures were analysed and classified. The measures and recommendations were differentiated on the basis of the spatial dimension of traffic volume and route relationships. In particular international arrival and departure to Germany, national traffic within Germany and regional and local traffic in the host cities were considered. In addition, the groups of people and their respective mobility, including teams, organisers, press, interest groups, spectators in stadiums and fan zones as well as service providers and suppliers, were taken into account. The results of this analysis form the basis for recommendations for the design of sustainable mobility in the context of EURO 2024.

2.3 Overview of existing research

The consideration of sustainability in major sports events is a relatively new development that has become increasingly prevalent in recent years. The idea of making major sports events more sustainable goes back to the United Nations' (UN) Agenda 21, which was adopted at the 1992 UN Conference on Environment and Development in Rio de Janeiro.

In the following years, awareness of sustainability and environmental protection at major sports events has slowly increased. The Olympic Games have taken a pioneering role in promoting sustainability in the sports world. For example, as early as 1997, the International Olympic Committee (IOC) published an environmental guide to provide a framework for environmentally friendly Olympic Games. (IOC, 2005)

Since then, many major sports events, such as the FIFA World Cup or the World Athletics Championships, have included sustainability as an important aspect in their planning. The ISO 20121 certification was developed specifically for sustainability management systems of events. It has been recognised worldwide in 2012 and plays a special role in promoting sustainability at sports events since.

The consideration of climate impacts of individual major sports events is also a new development and has become increasingly common in recent years. It stems from the growing urgency in dealing with climate change.

An important step in this direction was the adoption of the Paris Climate Agreement in 2015, in which the world's nations jointly agreed on the goal of limiting the global temperature increase to below 2 degrees Celsius compared to pre-industrial levels. This has also called on the sporting world and event management to do their share to reduce greenhouse gas emissions.

Since then, many major sports events, such as the Olympic Games or the Football World Cup, have started to consider their climate impact and take concrete measures to reduce their carbon dioxide (CO_2) emissions. For example, this can be achieved by the use of renewable energy, the reduction of transport and logistics emissions or the promotion of sustainable behaviours among participants and visitors.

It was recognised at an early stage that the transportation sector is the biggest source of greenhouse gases and other negative environmental impacts at major events. This is also reflected in the "Concept and Feasibility Study 'Climate Neutral' UEFA EURO 2024" published in July 2022 by the Öko-Institut e. V., in which the transportation related share of total GHG emissions for the EURO 2024 is estimated at 84%. (Öko-Institut e.V., 2022)

Studies examined

In 2007, the then Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) itself published a "Guideline for environmentally friendly major sporting events" entitled ***"Green Champions".*** The guide is based on experience gained at various international sports events such as the 2005 FIS Nordic World Ski Championships in Oberstdorf and the 2006 FIFA World Cup (with the "Green Goal" concept) as well as Leipzig's bid for the 2012 Olympic Games. It proposes environmentally friendly measures at major sports events and divides them into five phases: Application and concept, construction/modernisation/expansion of sports facilities, planning of the event, organisation and after-use/removal. Measures are presented for environmentally relevant areas such as water, waste, energy, transport and catering, whereby the importance of these areas depends on various criteria. For the guide, 154 major sports events in Germany in 2005 and 2006 were studied (including the Nordic World Ski Championships 2005 in Oberstdorf and the FIFA World Cup 2006). (BMU, DOSB, 2007)

Another study included is the ***"UEFA EURO 2008 Sustainability Report"***. The EURO 2008 in Austria and Switzerland was one of the first major sports events where environmental and sustainability aspects were included in the event concept. The event committee had set the goal for itself to keep the environmental impact as low as possible and reduce CO_2 emissions. Measures were adopted such as:

- The creation of a joint mobility concept for the two host countries and the eight host cities
- The provision of free or discounted public transportation for ticket holders and volunteers.
- The promotion of carpooling, bicycle rental and park and ride services
- The reduction of energy consumption and greenhouse gas emissions through efficient technologies and renewable energies, as well as
- Creating a positive legacy for host regions through investment in infrastructure, culture and tourism

The EURO 2008 was an important milestone for the consideration of sustainability aspects at major sporting events. (BMLFUW, ARE, BAFU, BASPO, 2008)

Under the title "***Green Goal",*** the environmental concept for the 2006 FIFA World Cup in Germany was developed. It had the aim of minimising the impact of the tournament on the environment. Measures included the use of renewable energy, improving energy efficiency in stadiums and accommodations, and promoting public transportation and cycling. The concept was part of the FIFA World Cup 2006 sustainability strategy and was intended to help reduce CO_2 emissions and energy consumption during the tournament. After the end of the event, a comprehensive evaluation of the concept and the achieved goals took place. For the mobility sector, the goals were to increase the modal split in favour of public transportation to 50% and to reduce the climate impact of the World Cup's arrival and departure traffic by 20% (with the exception of international traffic). As a result, the measures and adopted strategies increased the public transportation share to 57% and reduced CO_2 equivalents by 19% (equivalent to approx. 17,000 tons of CO_2 equivalents). (OC 2006 FIFA World Cup and BMU, 2006)

The 2013 "***Bundesliga Environmental Report"*** examined the environmental management of the professional clubs in the German Bundesliga. Club representatives were interviewed and relevant data on environmental activities were reviewed. In addition, selected stadiums and individual projects were visited on site. The ecological activities were structured according to four topics: Energy, Water, Waste and Emissions. The projects were assigned to three fields of observation: Club, Stadium and Fans/Partners. The study analysed which activities and projects are already being implemented in environmental management, which focal points exist and how the topic is promoted in the clubs. In the process, some recommendations for action for cross-club environmental management approaches were established, including:

- Increased cooperation between clubs and other organisations and participants in the field of environmental protection and sustainability.
- A clear anchoring of environmental management in the mission statement of the clubs as well as a stronger integration of the topics of environmental and climate protection in strategic planning and decision-making.
- The introduction of environmental management systems and the regular collection and evaluation of environmental data to measure and improve the effectiveness of environmental actions.
- Greater communication and transparency regarding clubs' environmental activities and achievements, including to fans and the public.
- Promote education and awareness-raising activities for fans and club staff to raise awareness of environmental protection and sustainability and encourage behavioural change.

The environmental report also serves as the basis for the Bundesliga's sustainability strategy. (DIE LIGA - Fußballverband e. V., 2013)

With its Green Goal environmental concept, the German Football Association (DFB) has set the standard for environmentally friendly major sporting events at previous World Cups and now also wants to organise UEFA EURO 2024 in the most climate-friendly way possible. With the "***Concept and Feasibility Study 'Climate Neutral' EURO 2024"*** (Öko-Institut e.V., 2022) practical climate protection measures were drawn up to achieve a climate-neutral organisation of the EURO 2024. The activities of the ten host cities are taken into account by the study. It is

intended to be applicable not only to EURO 2024, but also to other major sports events. The study includes an accounting of GHG emissions and provides concrete recommendations for actions to avoid, reduce and offset emissions. Costs and financing options are also considered. The study of the Öko-Institut e.V. on the "climate-neutral" EURO 2024 serves as the most important source of this study, as it presents and already quantifies a variety of measures and strategies for the sustainable realisation of a major sports event. The results are intended to be usable not only for EURO 2024, but also for other major sports events. (Öko-Institut e.V., 2022)

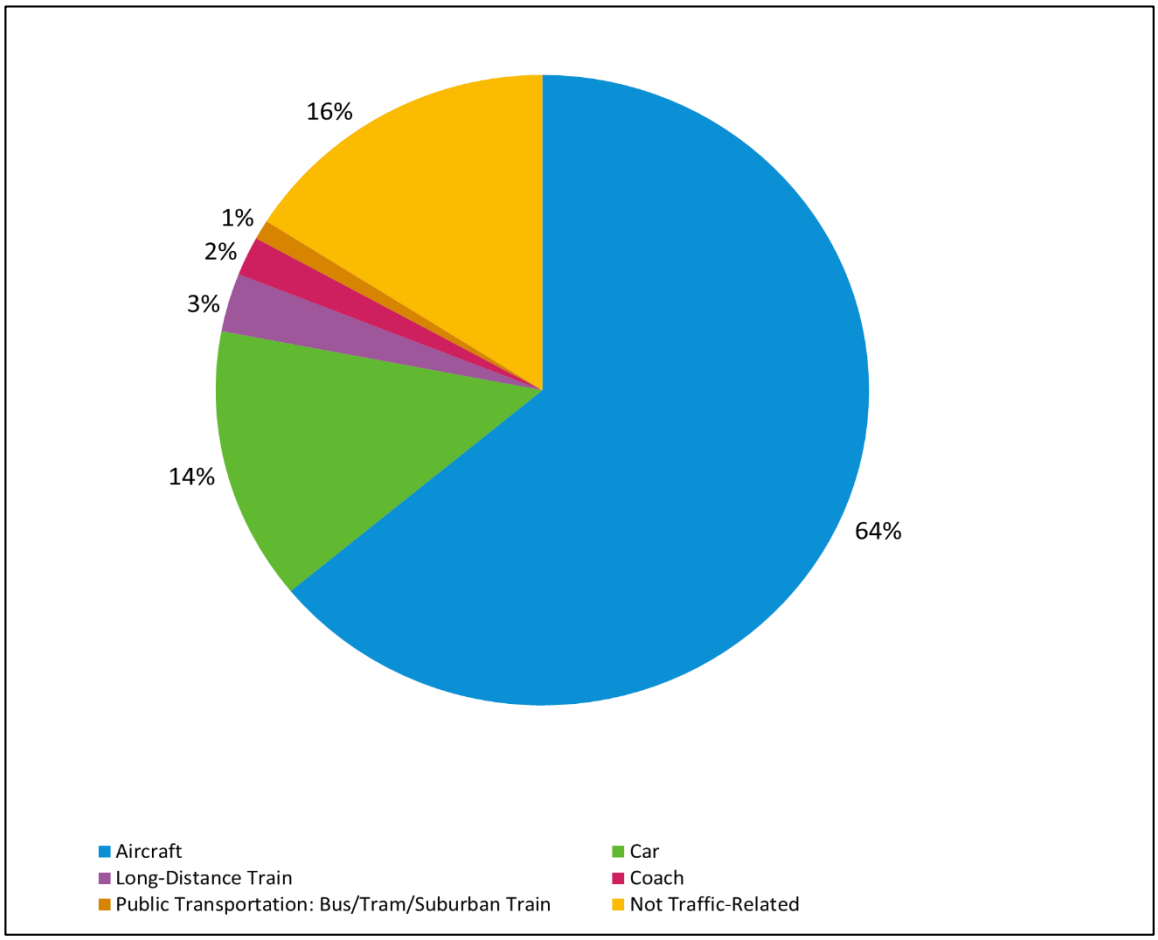
Despite the growing attention to sustainable mobility at major sports events, there are various limits to consider. Many concepts focus on technical solutions to reduce emissions, such as the use of electric vehicles or renewable energies. Indirect effects of measures are often insufficiently covered. In addition, only transport directly attributable to an event is usually included in the concepts. For example, the traffic generated by the numerous decentralised public viewing events is neglected, especially during World Cup and European Championships. In addition, the use of different indicators for sustainability and environmental compatibility in the studies makes direct comparison difficult. Therefore, a more in-depth analysis with increased comparability between studies is desirable in the future.

3 Results

3.1 Findings of the concept and feasibility study "climate-neutral" EURO 2024

As the "Concept and Feasibility Study for a Climate Neutral EURO 2024" is a main source for the present study, the central results of the study should be highlighted here. Beyond the measures described in chapter 3.2 and below, the ex-ante climate balance determined for EURO 2024 represents a solid starting point to explain the importance of targeted measures for different groups of participants and modes of transport. (Öko-Institut e.V., 2022)

Figure 1 **Shares of the transport modes in the total GHG emissions from of the ex-ante carbon footprint for EURO 2024**

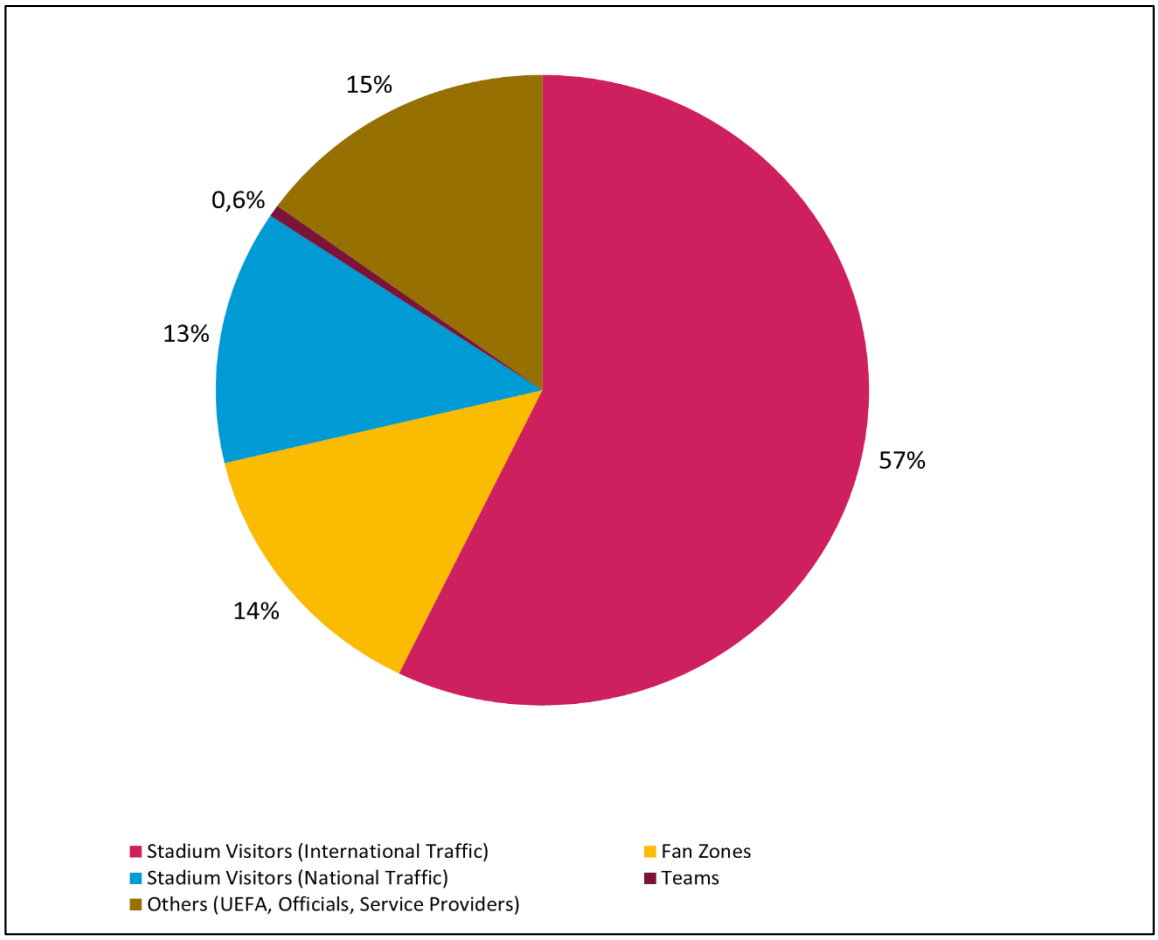


Source: (Öko-Institut e.V., 2022 p. 22)

The results (Figure 1) show that transportation will be the main source of greenhouse gas emissions at EURO 2024, accounting for 84% across all transport modes. This once again underlines the importance of promoting sustainable mobility at major sports events. Within the transportation sector, air travel is again the mode of transport responsible for 64% of the greenhouse gases emitted by the event. This means that the biggest lever for reducing emissions at UEFA EURO 2024 will be air transportation. Car traffic also contributes significantly to greenhouse gas emissions with 14%. Public transportation such as buses, trams and suburban trains (1%), long-distance trains (3%) or even coaches (2%) contribute only little to the overall

impact. This suggests that promoting these modes of transport as an environmentally friendly alternative to air travel and car transport can provide a positive impact on the climate balance.

Figure 2 **Shares of the groups of players in the transport related GHG emissions from the ex-ante carbon footprint for EURO 2024**



Source: (Öko-Institut e.V., 2022 p. 23)

The results of transport-related emissions by group (Figure 2) allow a number of conclusions. The largest share of transport related GHG emissions (57%) is caused by international transport of stadium visitors. This shows that the travel of visitors from abroad represents a significant environmental impact and is in line with the high share of air traffic, which is used to a large extent for international transport. Fan zones and national transport of stadium visitors also contribute significantly to emissions with 14% and 13% respectively. Here too, there is a lot of leverage in taking measures to reduce the environmental impact. Emissions from teams (0.6%) and other stakeholders such as UEFA personnel or officials (15%) are comparatively lower, but still relevant. This is because these transport groups can achieve a signal effect through their role model function and thus activate further groups of people for environmentally friendly measures.

3.2 Concept of measures for sustainable mobility at the EURO 2024

3.2.1 Methodology for describing the measures

The following subdivision groups the measures fundamentally according to their possible implementation period. Further, the measures are assigned to the spatial dimensions (1) local and regional transport in the host city, (2) national transport within Germany and (3) international transport to and from Germany. Within these categories, the groups of people and the types of transport affected by the measures are also named.

Furthermore, the measures can be linked to the results of the ex-ante climate assessment of the "Concept and Feasibility Study 'Climate Neutral' EURO 2024" by considering the following factors and questions:

- Means of transport concerned (see Figure 1)

  Which modes of transport are affected by the measure? Is there a link between the respective measure and modes of transport that account for a high share of total GHG emissions? How high is the share of the affected mode of transport in the projected GHG emissions of the event?

- Groups of people addressed (see Figure 2)

  Which groups are addressed by the measure? What share of transport-related greenhouse gas emissions does the respective group have? Are other actors subsequently influenced, for example by the signal effect of a certain measure?

3.2.2 Introduction to the presentation of measures

The design of sustainable mobility at major sports events such as EURO 2024 can be achieved through various approaches. The reduction of CO_2 emissions is the most important goal, as transportation accounts for a significant share of greenhouse gas emissions. One way to achieve emission reductions is to avoid traffic. However, in contrast to this, large sports events generate more traffic, which means that this transport design principle will be limited. As a result, shifting traffic to more environmentally friendly modes of transport such as walking, cycling or public transportation is a frequently applied principle at major events. In order to improve the climate balance of a large event, air traffic in particular (with a share of 64% of the event's total emissions) should be reduced to a minimum in return. (Öko-Institut e.V., 2022) In order to achieve a change in the choice of transport, it is essential to ensure that there are attractive options for using alternative means of transport. A lack of options for pedestrians, cyclists or public transportation will contradict a change in transportation mode. In addition to the general change of transportation modes, the use of motorised vehicles can also be made more environmentally friendly by use of alternative propulsion systems or fuels. The further development of these and the advancement of the associated infrastructure are also essential points in order to make partially unavoidable motorised transport more sustainable. This is referred to as transport improvement. (Öko-Institut e.V., 2022)

In addition to measures that directly lead to emission reductions, another approach is to raise awareness and inform all direct and indirect event participants. Comprehensive communication and information regarding the objectives, projects and offers as well as a final evaluation of the measures are crucial. In concrete terms information about the ecological impact of certain behaviours could be provided in order to actively involve participants in the process of reducing emissions. Training and workshops can also provide participants with practical

recommendations on how to live more sustainably in daily live. Information stands or areas during the event offer participants the opportunity to further inform themselves about emission reduction and sustainability. Finally, a comprehensive evaluation of the measures after the event is necessary to check to what extent the sensitisation and information of participants was successful and what improvements can be made for future events. The role model function of large sports events can contribute to raising people's awareness of sustainable mobility and climate protection. For example, if sporting events integrate measures for CO_2 reduction and sustainable mobility into their concepts and actively implement them, it can serve as a model for other events and also for the general public. In addition, organisers of major sporting events can raise awareness and interest in these issues through targeted communication and information about their sustainability measures, thus contributing to the promotion of more sustainable mobility. In addition to the approaches already mentioned, there is another way to achieve sustainable mobility at major sports events: climate compensation. This involves offsetting the resulting emissions by investing in climate protection projects. However, climate compensation alone is not sufficient to achieve sustainable mobility at major sports events. Although carbon offsetting is an important approach to neutralise the remaining emissions. Measures should first be taken to reduce emissions. Furthermore, climate offsetting is often controversial as it can be difficult to assess the actual benefits and effectiveness of carbon offset projects. It is therefore important that climate offset measures are carefully planned and monitored to ensure that they actually help to counter the generation of pollution and consequently climate change. Therefore, in the summary of appropriate measures, this approach is not considered in more detail. Ultimately, sustainable mobility in the hosting of major sports events can be achieved through a combination of emission reductions, awareness raising and climate compensation. (BMU, DOSB, 2007 p. 52) (Öko-Institut e.V., 2022) (OC 2006 FIFA World Cup and BMU, 2006 p. 23-24, 29)

3.3 Short-term measures

The study focuses on measures that can be implemented in short-term up to EURO 2024. Despite the potentially tight deadline for implementation, these measures can also be applied to other major (sports) events in the medium- and long-term.

For sake of clarity, the measures are differentiated according to the spatial dimension of traffic volume and route relationships. Some measures can be applied at several spatial levels, which is why they are mentioned several times in the respective sub-chapters. Starting with measures for local and regional transport in the host cities, those for national transport within Germany and international transport to and from Germany are listed.

3.3.1 General strategies for sustainable mobility at major sports events

General measures that can contribute to sustainable mobility can first be identified across spatial, group and transport mode boundaries. These measures are listed in Table 1.

Table 1 Measures that can be implemented in the short-term at the cross-regional transport level

Measure	Means of transport concerned	Group concerned
Establishment of a coordination team	Intermodal	UEFA, officials, service providers

Measure	Means of transport concerned	Group concerned
Integration of sustainable objectives or measures with their implementation in sponsorship contracts	Intermodal	UEFA, officials, service providers
Provision/communication of information and opportunities for mobility before and during the event	Intermodal	Stadium visitors (national traffic) and fan zones
Role model for sustainable mobility behaviour	Intermodal	Teams, UEFA, Officials, Press

Establishment of a coordination team

Sustainable mobility requires an integrative and coordinated cooperation of all persons involved, especially the organisation team, the transport companies as well as the local, regional and national authorities. To ensure effective cooperation, it is advisable to set up a coordination team that links all stakeholders with clearly defined targets. Key issues such as the organisation of responsibilities and teams, the selection and management of sponsors, contract management, environmental management, and the controlling and monitoring of project status can have a supporting effect and avoid misunderstandings and confrontations. (BMU, DOSB, 2007 p. 28, 37) (OC 2006 FIFA World Cup and BMU, 2006 p. 106-112)

Integration of sustainable objectives or measures with their implementation in sponsorship contracts

In order to achieve sustainable mobility at large sports events, it is crucial to define concrete and realistic objectives (for example, the reduction of CO_2 emissions, the increase of the share of environmentally friendly means of transport in the modal split or the reduction of the traffic load during the event). Then an action plan needs to be defined (for example, the integration of climate protection aspects in the planning and implementation of the event or the conversion of the vehicle fleet of the organisers and partners to alternative propulsion systems). Short-term as well as mid- and long-term measures should be taken into account. It is advisable to closely coordinate the goals and measures with the sponsors and to anchor them in the sponsorship contracts. For example, a car manufacturer could sponsor electric vehicles for the official UEFA fleet compound. Such an integration of sustainable objectives into the sponsoring contracts can help to ensure the implementation of measures, create awareness for sustainability among the sponsors and strengthen their function as role models. (BMU, DOSB, 2007 p. 54-55) (OC 2006 FIFA World Cup and BMU, 2006 p. 106-112) (DIE LIGA - Fußballverband e. V., 2013 p. 29)

Provision/communication of information and opportunities for mobility before and during the event

It is also essential to provide visitors with information on possible mobility alternatives. The information should include routes, available means of transport, accessibility, and timetables. It should be available and disseminated both before and during the event. It is advisable to provide this information as early as possible, for example when purchasing or sending tickets. This is needed in order to reach as many people as possible and to influence their mobility behaviour at an early stage. In addition to analogue media, modern technologies like mobile apps or digital information platforms can help. An app as a central access and information medium can

promote sustainable mobility solutions to a high degree and with a high penetration among fans. (BMU, DOSB, 2007 p. 54-55, 63, 73) (Öko-Institut e.V., 2022 p. 39-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 41) (OC 2006 FIFA World Cup and BMU, 2006 p. 75-76) (DIE LIGA - Fußballverband e. V., 2013 p. 46)

Role model for sustainable mobility behaviour

Teams, officials, UEFA and journalists should act as role models for sustainable mobility behaviour. They can use their position to gain publicity by practicing sustainable mobility and communicating this in order to raise awareness for sustainable mobility and support the implementation of corresponding measures. For example, national teams could commit to using only trains for international and national transport and buses for travel to accommodations and the venue. On the supply side, this could be positively designed and communicated to the public through the provision of special trains or attractive special compartments. (Öko-Institut e.V., 2022 p. 30, 33-38)

3.3.2 Local and regional transport in the host cities

Host cities play an important role in promoting sustainable mobility. While most greenhouse gas emissions are caused by travel to and from the host cities, a significant amount of emissions are caused by high volume of traffic in the city during the event itself. Teams with their coaches as well as officials, visitors and spectators travel from home and abroad. All these people are mobile at a local and regional level. They contribute considerably to a high volume of traffic, as the venue and the host city with its fan zones and public viewing locations are points of contact for all involved. In addition, there is the traffic generated by organisers, caterers, and service providers in the course of preparing, staging and following up the event. This leads to a considerable amount of emissions in the host city and the surrounding region. Thanks to the numerous mobility options such as buses, trains or bicycles that are available in the host cities, there are a number of measures that can be taken to reduce the environmental impact of traffic and make local and regional mobility more environmentally friendly and sustainable. (Table 2)

Table 2 Measures that can be implemented in the short-term at local and regional transport level

Measure	Means of transport concerned	Group concerned
Monitoring and control during the event by means of intelligent traffic systems	Intermodal	Organisers
Signage concept	Intermodal	Stadium visitors (national traffic) and fan zones
Traffic calming by closing off residential areas and restricting the drivable area	Car traffic	Stadium visitors (national traffic) and fan zones
Restricted parking for cars	Car traffic	Stadium visitors (national traffic) and fan zones
Increase of parking fees in the surrounding area	Car traffic	Stadium visitors (national traffic) and fan zones
Use of environmentally friendly vehicle fleets	Car and bus traffic	UEFA, officials, service providers

Measure	Means of transport concerned	Group concerned
Sustainable driving training	Car and bus traffic	UEFA, officials, service providers
Offering on-demand transportation	Car and bus traffic	Stadium visitors (national traffic) and fan zones
Establishment of shuttle buses	Public transportation	Stadium visitors (national traffic) and fan zones
Increase in transport capacity	Public transportation	Stadium visitors (national traffic) and fan zones
Expansion of the network	Public transportation	Stadium visitors (national traffic) and fan zones
Combiticket	Public transportation	Stadium visitors (national traffic) and fan zones
Use of passenger assistants	Public transportation	Stadium visitors (national traffic) and fan zones
Use of buses with alternative propulsion systems	Public transportation	Teams, others (UEFA, officials, service providers), stadium visitors (national traffic) and fan zones
Increase in bus stops near the stadium	Public transportation	Stadium visitors (national traffic) and fan zones
(Expansion) of cycle paths	Cycling	Stadium visitors (national traffic) and fan zones
Sufficient (secured) parking spaces for bicycles	Cycling	Stadium visitors (national traffic) and fan zones
Increase the number of rental bicycles	Cycling	Stadium visitors (national traffic) and fan zones
Charging stations for e-bikes	Cycling	Stadium visitors (national traffic) and fan zones
Campaigns/projects to promote cycling	Cycling	Stadium visitors (national traffic) and fan zones
Establishment of incentives for bicycle use	Cycling	Stadium visitors (national traffic) and fan zones
Establishment of (temporary) bicycle service/repair points	Cycling	Stadium visitors (national traffic) and fan zones
Offer cycle rickshaws	Cycling	Stadium visitors (national traffic) and fan zones
Use of cargo bikes	Cycling	UEFA, officials, service providers
Establishment of "Fan Miles" paths	Pedestrian traffic	Stadium visitors (national traffic) and fan zones

3.3.2.1 Measures concerning cross-modal transport

Monitoring and control during the event by means of intelligent traffic systems

To ensure smooth and targeted traffic management during the event, intelligent traffic systems (ITS) are essential. Through the use of ITS, traffic flows can be automatically monitored and controlled to avoid congestion and ensure a quick response to any problems that arise. This can be achieved by actively directing traffic or by providing traffic information via corresponding apps. ITS also offer the possibility to quickly identify and resolve serious incidents as well as insufficient capacities in shuttle buses or public transportation. ITS can be used for this purpose as part of a central situation in the host cities. However, a comprehensive data basis, corresponding structures and good coordination between public administration, mobility providers and security authorities are required. This is the only way to ensure an effective and timely response to emerging problems. (BMU, DOSB, 2007 p. 69-71)

Signage concept

One measure to promote environmentally friendly modes of transport at major events is comprehensive signage along the routes to the venues, including stadiums and fan zones. This signage should be installed especially along planned routes from hubs such as train stations or city centers. If the event is internationally in scope, as is the case with EURO 2024, consistent understandable signage should be used. It must take into account all modes of transport, including walking, cycling and public transportation, and provide clearly signposted routes to stops and bicycle parking. Clear signage ensures that visitors reach their destination quickly and safely, while encouraging the choice of environmentally friendly modes of transport. (BMU, DOSB, 2007 p. 42, 71) (Öko-Institut e.V., 2022 p. 39-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 39) (OC 2006 FIFA World Cup and BMU, 2006 p. 74)

3.3.2.2 Measures concerning car traffic

To ensure sustainable mobility, measures should be taken to make private motorised transport less attractive for visitors. There are different approaches to promote greener mobility and reduce traffic congestion around venues at regional and local level. Such measures are also called push factors, as they urge people to change their mobility behaviour. Fundamentally however, alternative means of transport and mobility options must also be available. The measures can help reduce traffic congestion in residential areas or city centers, lower CO_2 emissions and improve the quality of life in the city.

Traffic calming by closing off residential areas and restricting the drivable area

One possible measure involves closing nearby residential areas to private motorised traffic. This creates an incentive for the use of public transportation, cycling or walking, but also reduces traffic congestion in residential areas. This practice has already been applied at past major sports events such as the 2006 World Cup in Berlin, Leipzig, and Kaiserslautern and in Sydney for the 2000 Olympic Games. In addition, a more far-reaching approach is to comprehensively limit or restrict the passable area for car traffic. This could involve closing off a neighbourhood, the city center, an entire city, or an otherwise defined area to much of the visitor traffic. This area is called the traffic perimeter in the context of the host city concepts for the EURO 2024. This restriction will promote the use of other modes of transport. However, exceptions should be granted, for example for people with impairments or delivery traffic. (BMU, DOSB, 2007 p. 54-

55) (OC 2006 FIFA World Cup and BMU, 2006 p. 76) (Öko-Institut e.V., 2022 p. 30, 38-41) (DIE LIGA - Fußballverband e. V., 2013 p. 46)

Restricted parking for cars

Furthermore, the provision of parking spaces for cars can be limited to encourage the use of environmentally friendly means of transport. For example, parking spaces near the event location or in the city center can be reduced. (Öko-Institut e.V., 2022 p. 30, 38-41) (OC 2006 FIFA World Cup and BMU, 2006 p. 76)

Increase of parking fees in the surrounding area

Alternatively or complementarily, parking fees near the venue or in the city center can be increased to make car traffic less attractive. (Öko-Institut e.V., 2022 p. 30, 38-41)

3.3.2.3 Measures concerning passenger cars and buses

The use of cars and buses is indispensable for the preparation and implementation of large events. Cars are mainly needed for the organisation, supply and transport of individual persons and are therefore just as indispensable as buses. Although the latter have the highest emissions per person-kilometer among the means of transport of the environmental alliance, they are of particular relevance for passenger transport. (INFRAS AG, 2022) For example, 55 minibuses, 35 shuttle buses and 40 passenger cars were used for the 2005 Nordic World Ski Championships in Oberstdorf, and 912 minibuses and passenger cars were used for the 2006 World Cup in Germany. These figures give a rough idea of how important these means of transportation are. Despite the higher emissions of cars and buses compared to rail, cycling or walking, measures can be taken to use them efficiently and sustainably at a major event.

Use of environmentally friendly vehicle fleets

One possibility for the organisers, service providers and suppliers is to convert the vehicle fleets they operate to environmentally friendly propulsion systems. For example, electric or hybrid vehicles can be used, which have a lower environmental impact than conventional vehicles. However, attention should definitely be paid to the use of generally fuel-efficient vehicles that also meet high emission standards. The use of liquid gas or biofuel vehicles can also be an environmentally friendly alternative. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 38-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 42) (OC 2006 FIFA World Cup and BMU, 2006 p. 29, 76-77)

Sustainable driving training

In addition, sustainable driving training can be offered for drivers of cars and buses. Techniques and behaviours are taught that can contribute to a more environmentally friendly and fuel-efficient driving style. Potentially, 10% to 25% of fuel consumption can be saved, while CO_2 emissions are reduced at the same time. (BMU, DOSB, 2007 p. 55). In addition, single trips or empty runs should be avoided and the number of routes and distances travelled should be kept as low as possible. While this measure should primarily be implemented by the operators of vehicle fleets at the large sports event, it is also possible to promote the topic in the general

public. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 38-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 42)

Offering on-demand transportation

In order to increase sustainability of mobility at large events, visitors can also be offered on-demand transportation. This opens the opportunity to use cars or buses that have been booked in advance or made available on demand. These can be offered in the form of on-demand shuttle buses, carpooling or ridesharing services. The organisation and information about this offer can be provided via platforms and apps. On-demand transportation enables visitors to get to the event or to other hubs with better transport options even if they do not have their own car and have poor public transportation connections. Demand-responsive use can increase vehicle utilisation and reduce the number of trips and thus the environmental impact. Although this measure is not very widespread in practice so far and requires more effort than other measures, on-demand transportation can be implemented at least on a small scale in short-term. (Öko-Institut e.V., 2022 p. 30, 36-38)

3.3.2.4 Measures concerning public transportation

Public transportation is the most important factor for sustainable mobility at major sports events, as it can transport the majority of spectators and fans. The general availability and accessibility of buses and trains serves as a basic assumption for using public transportation. Measures that encourage people to choose more sustainable mobility by improving the quality of services are pull factors.

Establishment of shuttle buses

The promotion of sustainable mobility can be achieved by providing shuttle buses that take visitors from hubs or transfer points to the venue. Special concepts can be developed that are tailored to the needs of the visitors and ensure a fast and efficient connection. By using shuttle buses, not only the last mile can be bridged, but also incentives for intermodal means of transport such as bicycles or car sharing can be created. (BMU, DOSB, 2007 p. 42, 54-55) (Öko-Institut e.V., 2022 p. 30, 38-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38) (OC 2006 FIFA World Cup and BMU, 2006 p. 76)

Increase in transport capacity

It is advisable to increase the transport capacities in public transportation. This can be done by increasing the frequency or by using vehicles with higher passenger capacities. Particularly in the hours before and after the event, the increased visitor flows should be met with an increase in transport capacity. (Öko-Institut e.V., 2022 p. 30, 36-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38, 41) (OC 2006 FIFA World Cup and BMU, 2006 p. 72-73) (DIE LIGA - Fußballverband e. V., 2013 p. 45)

Expansion of the network

It may be useful to extend the existing network plan and to include more stops in order to meet the demand for people before and after the event. This applies in particular to bus transport. Another option is the offering of extended routes, perhaps more extensively at night. (Öko-

Institut e.V., 2022 p. 30, 36-38) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38) (OC 2006 FIFA World Cup and BMU, 2006 p. 72-73)

Combiticket

An already established and effective practice is the offer of a combination ticket. It allows spectators to use public transportation within a defined period of time and validity via their ticket and increases attractivity of travelling to and from the event by public transportation for ticket holders. This is especially true as they do not incur any visible additional costs, as the cost of the ticket is already included in the admission price. The combined ticket is a widespread measure and is regularly used at various sports events. At Bundesliga football matches it is regularly valid for a limited period of time before and after the matches and at the 2006 FIFA World Cup it even had an extensive validity of one day. It has been proven that the introduction of a combined ticket can increase the share of public transportation users. At the 2006 World Cup, 57% of visitors used public transportation to get to the stadium, while the average for Bundesliga matches is 40%. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 36-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38) (OC 2006 FIFA World Cup and BMU, 2006 p. 74) (DIE LIGA - Fußballverband e. V., 2013 p. 46)

Use of passenger assistants

In order to ensure a smooth journey to and from the event by public transportation, passenger assistants can be deployed to provide support and information and to simplify travel of visitors to and from the event location. At events with an international dimension, multilingual passenger guides should be deployed wherever possible. Multilingual announcements can also be made at railway stations to provide visitors with useful information on changing trains. It also makes sense to point out environmentally friendly mobility options. (BMU, DOSB, 2007 p. 71)

Use of buses with alternative propulsion systems

As already described, the use of vehicle fleets with alternative propulsion systems can help to reduce emissions and make mobility more sustainable. This applies to car fleets as well as bus fleets. The use of electric buses or buses with alternative combustion engines can be used as a measure to reduce the environmental footprint of public transportation, the transport of teams and other participants. It can also make the overall mobility of a large sports event more environmentally friendly. (Öko-Institut e.V., 2022 p. 30, 38-41)

Increase in bus stops near the stadium

The attractiveness of bus transport can also be increased by transporting spectators and other users as close as possible to the venue. In this way they have short distances to travel afterwards. In order to ensure this proximity, sufficient bus stops and parking spaces should be provided near the stadium. In combination with the use of electric buses, the installation of charging infrastructure at these parking spaces is an additional sensible option. (BMU, DOSB, 2007 p. 54-55) (OC 2006 FIFA World Cup and BMU, 2006 p. 76)

3.3.2.5 Measures concerning cycling

Cycling is a particularly environmentally friendly form of transportation, which should be promoted as part of the goal of sustainable mobility. As cycling is mainly used on a local and partly regional level by spectators and fans. The measures to promote it are concentrated on the host city level. As a basis for a functioning and pronounced cycling traffic, the geographical conditions must first be right, in the sense that flat or hilly terrain can be found in the local and regional area. An above-average mountainous terrain will not be able to motivate the majority of people to cycle, regardless of other conditions. Furthermore, certain basic infrastructural conditions should exist. This concerns the availability of cycle paths, bicycle parking facilities and rental bicycles. Accordingly, the infrastructural conditions, along with other starting points, offer a lever for promoting cycling. Unfortunately, it is not always possible to implement these measures in the short-term until 2024. That is especially the case for larger projects such as the construction of cycle paths or cycle lanes. Extensive changes may also be needed to the existing road infrastructure, which requires additional time and resources.

(Expansion) of cycle paths

As already described, cycling can be promoted through the inner-city and regional expansion of cycle paths and the improvement of infrastructure. More cycle lanes, better development and signposting can expand the cycle network and accessibility and increase travel speed, comfort and safety. All these factors can encourage people to switch to cycling and increase the number of cyclists. The construction of cycle lanes can be done in the short-term by building so-called temporary pop-up cycle lanes. However, the planned and permanent construction in coordination with cycling and overall traffic concepts for the sustainable establishment of cycling is desirable. When a major sports event is being held, promotions of already planned construction projects can be considered at short notice. If that is possible, they may be already available when the event takes place. At this point, the cooperation of neighbouring cities and municipalities is desirable in order to strengthen not only urban but also regional cycling. (BMU, DOSB, 2007 p. 42) (Öko-Institut e.V., 2022 p. 38-39) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38)

Sufficient (secured) parking spaces for bicycles

In addition to the cycle path infrastructure, it is also important to provide sufficient and partially secured parking spaces for bicycles near the event location and at other intersections. This enables easier parking for bicycles and prevents or restricts theft. Bicycle parking facilities can range from mobile, short-term bicycle parking systems to the construction of bicycle parking garages or underground garages. (BMU, DOSB, 2007 p. 42, 54-55) (Öko-Institut e.V., 2022 p. 38) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38) (OC 2006 FIFA World Cup and BMU, 2006 p. 76) (DIE LIGA - Fußballverband e. V., 2013 p. 46)

Increase the number of rental bicycles

Increasing the number of rental bikes can also help to promote cycling at major events. It is important that the rental bikes are available at different stations in the city as well as at the event location and that booking, pick-up and return are simple and straightforward. The availability of e-bikes can further increase the number of users of rental bikes. (Öko-Institut e.V., 2022 p. 38)

Charging stations for e-bikes

In line with the provision of bicycle parking spaces and the (rental of) e-bikes, another measure is the provision of charging stations for e-bikes. Even if the installation of the corresponding charging infrastructure is only feasible to a limited extent in short-term, it would open the possibility for visitors who have to travel longer distances to use the bicycle as an environmentally friendly alternative to the car. (Öko-Institut e.V., 2022 p. 38)

Campaigns/projects to promote cycling

Another strategy to promote cycling is the implementation of campaigns and projects. These can vary in form and content, from pure information and advertising to integrating people. A common project, for example, is the "Stadtradeln" (city cycling), which is exercised in some cities in Germany. This project could also be used during the EURO 2024, for example to create an internal competition between the host cities or to achieve a total mileage that would be a reference value for future major sporting events. (Öko-Institut e.V., 2022 p. 40)

Establishment of incentives for bicycle use

Cycling at a major sports event can be encouraged by other incentives with direct event-related rewards. For example, the distribution of drink coupons at guarded bicycle parking areas or raffle tickets could be mentioned. (Öko-Institut e.V., 2022 p. 39) (DIE LIGA - Fußballverband e. V., 2013 p. 29)

Establishment of (temporary) bicycle service/repair points

Temporary bicycle service and repair points can still be set up on the way to or at the event location. Cyclists can carry out minor repairs or have their bikes serviced for the duration of the event. This creates an incentive to use bicycles, but also ensures that the bicycles are in good condition and that the cyclists arrive safely and without problems at their destination. (Öko-Institut e.V., 2022 p. 38)

Offer cycle rickshaws

Cycle rickshaws can also be offered as a tourist transportation alternative. They are environmentally friendly and also offer a special experience to visitors. (Öko-Institut e.V., 2022 p. 38)

Use of cargo bikes

Apart from the pure transport of people, especially spectators, there is also the possibility to use bicycles for transport purposes. Organisers, suppliers or service providers can use cargo bikes to transport goods and materials during the planning, preparation, implementation and post-event follow-up of EURO 2024. After the event, the cargo bikes can be transferred to municipal or private ownership for further projects. (Öko-Institut e.V., 2022 p. 38)

3.3.2.6 Measures concerning pedestrian traffic

Walking is a highly sustainable form of transport as it produces no emissions and therefore is particularly environmentally friendly. It is also a cost-effective and healthy way of getting

around, as it encourages physical activity. Walking is also often the most direct way to get to certain venues, especially in urban areas with heavy traffic and limited parking. Promoting walking as a form of mobility at a major sports event can also help to reduce traffic and the associated congestion and emissions. In addition, improved walking infrastructure can also help spectators and fans to get to know the city better and have a better experience by moving to different venues in a pleasant way.

Establishment of "Fan Miles" paths

This can be done by setting up "fan miles" or "red carpets" for spectators and visitors leading from hubs such as the city center, train stations or fan zones to the venue. These should be planned well in advance and have already proved successful at past events, such as the 2006 FIFA World Cup, where pedestrian traffic was promoted. When designing the route, care should be taken to ensure that it is designed as attractively as possible along green spaces, landmarks and attractive neighbourhoods. It is also worth considering the needs of pedestrians and offering food, drinks, free drinking water, seating, shade, entertainment and information. In addition, pedestrian safety needs should be taken into account and the paths should be clearly demarcated. If there is no clear or already implemented route, citizen participation can be encouraged to identify and design one. (BMU, DOSB, 2007 p. 42, 54-55) (Öko-Institut e.V., 2022 p. 40-41) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38) (OC 2006 FIFA World Cup and BMU, 2006 p. 76)

3.3.2.7 Summary of sustainable mobility in the host cities

The measures to promote sustainable mobility that are used at major events in host cities can also be of great benefit in the long-term for everyday life, at other events in the cities and in other regions. For example, infrastructural improvements have an impact long after the event, if designed for the long-term. The created infrastructure and the implemented practices can be used in the future for other events, especially those with a local or regional reference, such as Bundesliga matches. In addition, the implemented measures can act as a role model for other cities and municipalities. As a result, the measures at the host city level for sustainable mobility at a major sporting event and beyond are to be rated with high significance.

3.3.3 National traffic within Germany

National transportation within Germany is of decisive importance for environmentally friendly mobility and the sustainable staging of a major sporting event such as EURO 2024. Due to the arrival of many visitors from abroad and from different regions within Germany, there will be a large number of longer transport routes, which will cause correspondingly high greenhouse gas emissions. The amount of national transport depends on various factors, including the size of the host country, the number of fans travelling to the event, and the number and distances between venues in the country. Accordingly, as the volume of expected traffic increases, measures to reduce greenhouse gas emissions become even more important. The traffic volume, i.e. the number of traffic movements in turn, depends on the interest in the major sporting event and the visitor capacities of the venues and cities. With regard to EURO 2024, a high level of interest can be expected. Therefore, it is of great importance to keep the traffic generated as low and sustainable as possible by taking appropriate measures. (Table 3)

Table 3 Measures that can be implemented in the short-term at national transport level

Measure	Means of transport concerned	Group concerned
Intelligent game plan design	Intermodal	Stadium visitors (national and international traffic), fan zones, UEFA, officials, service providers and teams
Sustainable driving training	Car and bus traffic	UEFA, officials, service providers
Offering on-demand transportation	Car and bus traffic	Stadium visitors (national traffic) and fan zones
Increase in transport capacity	Public transportation	Stadium visitors (national traffic) and fan zones
Use of special and night trains	Public transportation	Stadium visitors (national traffic), fan zones and teams
Combiticket Plus/ international special tickets	Public transportation	Stadium visitors (national traffic) and fan zones
Attractive pricing of (special) public transportation tickets	Public transportation	Stadium visitors (national traffic), fan zones and teams
Use of passenger assistants	Public transportation	Stadium visitors (national and international traffic) and fan zones

3.3.3.1 Measures concerning cross-modal transport

Intelligent game plan design

An important contribution to reducing national traffic can already be made by UEFA's organisers through the scheduling of matches. When drawing up the match schedule, care should be taken to ensure that teams, fans and officials have to travel as short a distance as possible to play or watch their matches. This applies in particular to the planning of the group phase, which is easier to plan than the knock-out phases of the tournament because the participating teams are already known. Taking Germany as an example, care should be taken to ensure that tournament participants do not have to travel too long distances, such as between Hamburg and Munich. Since it is not possible to generally avoid long distances between venues, the game or event schedule should nevertheless be intelligently planned in advance, taking distances into account. This applies not only to the staging of the major sports event but also to the travel to and from it. In this way, the need for and volume of traffic can be fundamentally minimised, which in turn translates positively into lower greenhouse gas emissions. For the EURO 2024, the preparation of the match schedule and the choice of venues has already been completed, which means that implementation in the short-term is possible to a limited extent at best. (Öko-Institut e.V., 2022 p. 30, 36-38)

In order to reduce the environmental impact of transport, one should not only minimise the distances to be covered, but also focus on environmentally friendly means of transport in order to make transportation more efficient. At the national level, it is particularly desirable to increase the use of public transportation. Nevertheless, there are also car-specific starting points for making transportation more environmentally friendly.

3.3.3.2 Measures concerning car and bus transport

Sustainable driving training

If cars or buses are used for longer journeys at a national level, offering sustainable driving training is a good idea. As already noted at the host city level, this can save a considerable 10% to 25% of fuel. The driving training measure can be applied specifically to drivers for passenger transport, but also to service providers and suppliers with longer journeys. It is also worth considering releasing the information on driving behaviour to the public in order to reach spectators and fans and to convince them to drive in an environmentally friendly way or at least to draw their attention to this if they travel by car. (BMU, DOSB, 2007 p. 54-55) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 42)

Offering on-demand transportation

On-demand transportation can also be set up and carpools formed for groups of people who are poorly connected to public transportation or to fill gaps in services at short notice. These can bring spectators and fans either directly to the venue or to hubs from where other means of transport can be used. In terms of environmental friendliness, the use of buses is particularly desirable in order to combine as many journeys as possible and thus save money. A platform or app should be set up for the measure, which simplifies the organisation among the participants. In practice, this measure has not yet been fully established, which is why the organisation of the measure is more elaborate on a large scale and should rather be considered in the long-term. In short-term, on-demand transportation can be used sporadically. As far as the possibility for on-demand transportation is existing. It should be advertised by the organising persons. As already described in the Host City chapter of the measures, the use of on-demand transportation is an efficient and easily applicable action to reduce greenhouse gases, especially within cities. (Öko-Institut e.V., 2022 p. 30, 36-38) (DIE LIGA - Fußballverband e. V., 2013 p. 29, 46)

3.3.3.3 Measures concerning public transportation

As already emphasised, it is crucial to promote environmentally friendly and sustainable transportation at the national level. In this context, the focus should be on public transportation in particular, as it offers an environmentally friendly form of transportation due to lower greenhouse gas emissions. Rail transport in particular is an important component of public transportation. In the following, measures at the national level are mentioned that can help to promote public transportation.

Increase in transport capacity

In principle, the transport capacities of public transportation should be sufficiently large to be able to serve the increased traffic volume caused by a major sports event. Since regular services will not be sufficient for this purpose, at least on selected routes at national level, transport capacities should be increased. This applies in particular to the days before and after events as well as to the days of the event itself, so that people arriving early and at short notice as well as those departing early and later can be transported by public transportation. In order to increase transport capacities, it is advisable to use vehicles with higher capacities or to use additional vehicles which at the same time increase the frequency of the route offered. (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38, 41) (OC 2006 FIFA World Cup and BMU, 2006 p. 73)

Use of special and night trains

Special trains and night trains can be offered as special forms of capacity increase, which can transport spectators, fans, teams or press representatives between or to the respective venues. In this way, the respective groups of players could be transported individually or in combination, depending on the event or match. For example, the team, press representatives and fans of a specific team could be transported from the venue of one match to that of the next match. The use of additional trains has already shown positive effects at past events. For example, at the 2005 Nordic World Ski Championships in Oberstdorf, a 26% reduction in car traffic was recorded. This resulted in a saving of 10% of greenhouse gas emissions. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 33-36) (OC 2006 FIFA World Cup and BMU, 2006 p. 74) (DIE LIGA - Fußballverband e. V., 2013 p. 29, 46)

Combiticket Plus/ international special tickets

The Combiticket, which is already widely used at local level, could be extended to a national level of validity. The resulting Combiticket Plus would allow spectators to use their ticket additionally for travelling to and from the host city. The validity of the ticket should be limited to a reasonable period of time, for example 1 or 2 days. The introduction of this ticket should be communicated to the ticket holders and advertised so that as many people as possible take advantage of the offer. (Öko-Institut e.V., 2022 p. 30, 33-38) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 38)

Attractive pricing of (special) public transportation tickets

In general, attractive prices for public transportation tickets are preferrable in order to encourage as many visitors, press representatives and other people to switch to public transportation wherever possible. For this purpose, special event-related offers could be set up, like an EURO 2024 Bahncard 100 or a discount on certain routes. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 36-38) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 41) (OC 2006 FIFA World Cup and BMU, 2006 p. 75)

Use of passenger assistants

To support passengers travelling by public transportation, passenger assistants can be deployed in the vehicles and at junctions to provide information and answer questions. As already described at the host city level, in the context of an international event, they should be multilingual and supported by multilingual announcements at transfer points or junctions. The service provided by the passenger assistants can have a positive impact on the travel experience of spectators and fans to simplify the journey. This measure can have a positive long-term effect on the use of public transportation. (BMU, DOSB, 2007 p. 71)

3.3.4 International arrival and departure to Germany

International transport plays a crucial role in promoting environmentally friendly, low-emission and sustainable mobility. It accounts for a large share of total greenhouse gas emissions. According to the Öko-Institut's ex-ante carbon footprint for EURO 2024, greenhouse gas emissions from international fans are more than five times higher than from national fans. Air travel in particular contributes enormously to the total emissions of the event with a share of 64%. (Öko-Institut e.V., 2022 p. 21-22) With the aim of environmental friendliness and

sustainability of transport, air traffic in particular should be avoided and public transportation and especially rail transport should be strengthened instead. Measures can be applied to achieve this, which are largely similar to those at the national level. (Table 4)

Table 4 Measures that can be implemented in the short-term at international transport level

Measure	Means of transport concerned	Group concerned
Increase in transport capacity	Public transportation	Stadium visitors (international traffic)
Use of special and night trains	Public transportation	Stadium visitors (international traffic)
Combiticket Plus/ international special tickets	Public transportation	Stadium visitors (international traffic)
Attractive pricing of (special) public transportation tickets	Public transportation	Stadium visitors (international traffic)

3.3.4.1 Measures concerning public transportation

Increase in transport capacity

In order to successfully transport as many internationally arriving and departing persons as possible, such as spectators, fans, teams, officials or press representatives, sufficient capacities must be available. If the existing standard capacities on the routes offered are not sufficient, capacity increase by use of additional vehicles or higher-capacity vehicles is needed. This is particularly useful during the peaks of arrival and departure. At a major sports event such as EURO 2024 this is expected approximately 2 to 3 days before and after the event. (Öko-Institut e.V., 2022 p. 30, 36-41) (OC 2006 FIFA World Cup and BMU, 2006 p. 74)

Use of special and night trains

An individually adapted offer is the use of special trains. These can be used to target specific groups of people. For example, teams, press representatives, officials or certain fan groups can be transported to the country of the event on separate trains or on regular trains with separate compartments. Depending on the concept for the respective special trains, it may be advisable to mix passenger transport from different countries in order to jointly move them to the country of the event. As a special form of special trains, Night trains can also be offered as a special form of trains which enable overnight travel. This appears to be a suitable means of transport, especially on longer routes. (Öko-Institut e.V., 2022 p. 30, 33-36) (OC 2006 FIFA World Cup and BMU, 2006 p. 74)

Combiticket Plus/ international special tickets

Similar to the introduction of the Combiticket or Combiticket Plus on the local/regional and national level, it is possible to offer tickets on international level for special conditions. Whether or not the introduction of an internationally valid Combiticket is sensible and purposeful should be carefully examined. Nevertheless, there are a variety of ticket solutions that can make

international travel by public transportation attractive. One example could be the automatic combination with the Combiticket Plus in the country of the event or the reduction of the price of this ticket when travelling internationally by public transportation. It would also be conceivable to introduce an international EURO 2024 ticket. This would allow travel to the event country and back on defined routes within a limited period of time. It is important that both neighbouring countries and countries further away are equally included. (Öko-Institut e.V., 2022 p. 30, 33-36)

Attractive pricing of (special) public transportation tickets

Along with the offer of tickets, an attractive pricing structure for public transportation should be implemented. There is a multitude of possible implementation points. From special tickets to special offers or discounts, a broad repertoire of options exists. It has been proven that price is an effective lever to induce people to change their choice of transport mode. (BMU, DOSB, 2007 p. 54-55) (Öko-Institut e.V., 2022 p. 30, 36-38) (BMLFUW, ARE, BAFU, BASPO, 2008 p. 41) (OC 2006 FIFA World Cup and BMU, 2006 p. 75)

3.4 Medium- and long-term measures

The measures that can be implemented in the medium- and long-term presented below refer to an implementation time horizon after EURO 2024. The implementation of these measures requires a longer time and therefore started or should have been initiated at an earlier point in time. However, a subsequent and short-term implementation until EURO 2024 should not be written off as impossible. In addition, some of the measures mentioned refer to the follow-up to EURO 2024 or other major sports events. Despite the different time horizon, the measures presented in this chapter can help to make mobility at major sports events more sustainable and environmentally friendly. Especially with regard to future events they can prove to be valuable.

It is important to emphasise that the short-term measures described in chapter 3.3 are not only relevant to the current event. They remain applicable to other events in the medium- and long-term. Therefore, these measures are not mentioned again here.

3.4.1 General strategies for sustainable mobility at major sports events

Basically, the following measures can be formulated, which have a cross-spatial, cross-participant and cross-modal effect. (Table 5)

Table 5 Measures that can be implemented in the medium- and long-term at cross-regional transport level

Measure	Means of transport concerned	Group concerned
Formulation of guidelines and goals	Intermodal	All
Setting legal/binding regulations as a basis	Intermodal	All
Selection of venues and buildings	Intermodal	All
Reuse of resources	Intermodal	-
Analysis, assessment, and evaluation of the measures	Intermodal	-

Formulation of guidelines and goals

One measure to promote a sustainable event is the early definition of guidelines and goals. This creates a clear orientation for further planning, development and implementation of the event. In the course of the EURO 2024, this has already been done and laid down in the *strategy for a sustainable event for* UEFA EURO 2024. At this point, the guideline of sustainable mobility for the major sporting event can be formulated. Goals such as transporting as many people as possible by public transportation can be mentioned as specific measures to implement the goal. (BMU, DOSB, 2007 p. 37, 54-55)

Setting legal/binding regulations as a basis

In order to organise a large-scale event successfully and sustainably, legal regulations should be established or existing regulations should be linked to the objectives in order to create a binding and mandatory obligation to comply. Such a commitment creates incentives to pursue the objectives more closely. (BMU, DOSB, 2007 p. 37)

Selection of venues and buildings

As part of the planning and application process for a major sports event, special attention is paid to the selection of venues and event locations. Various factors like size and duration of the event as well as the expected number of spectators and timing of the event are decisive factors in the selection of one or more venues. Further consideration should also be given to infrastructural accessibility and factors like noise pollution or nature conservation. The measure of intelligent game plan design, distances between different venues should also be taken into account, as already pointed out. The first steps towards lower greenhouse gas emissions, especially from transport, can already be taken by selecting venues on the basis of shorter distances. (BMU, DOSB, 2007 p. 35)

The in chapter 3.4.1 mentioned measures have already been taken into account for the EURO 2024 and therefore particularly relate to consideration for future events. For the follow-up of major sports events and also of the EURO 2024, the following measures are also suitable.

Reuse of resources

The event should be planned and implemented in a way that as many materials and objects as possible can be reused. In the context of infrastructure and transport, this concerns in particular the continued use of the event venue, the infrastructure created and used and also the means of transport. In a broader sense, this also concerns accommodation, building materials, signage, promotional items and much more. (BMU, DOSB, 2007 p. 77)

Analysis, assessment, and evaluation of the measures

An additional crucial step for the success of future events is the monitoring of the ongoing event and the measures implemented. An evaluation to assess them is needed. Practices that work well and those that are less successful can be highlighted, as well as strengths and weaknesses. In addition, an evaluation of the achievement of objectives can be carried out. It is advisable to record the evaluation and assessment of the measures taken and objectives set in a written

report at the end of the large-scale event. The resulting knowledge base helps to adopt measures that have worked and to use any potential for improvement that has been uncovered for future major events. Measures and projects that have been implemented particularly successfully can also be used in the media in order to present the successful implementation and the results to the public and to encourage imitation. (BMU, DOSB, 2007 p. 78)

3.4.2 Local and regional transport in the host cities

For local and regional transport, a large number of measures for sustainable mobility can be implemented in the short, medium- and long-term. The large number of mobility options and the relatively short distances to be travelled lead to a wide range of possible approaches for making transport more environmentally friendly and reducing emissions. (Table 6)

Table 6 Measures that can be implemented in the medium- and long-term at the local and regional transport level

Measure	Means of transport concerned	Group concerned
(Expansion) construction of infrastructure, signage, lighting for future relevant venues	Intermodal	All
Choice of location for fan zones based on accessibility (walking, cycling, public transportation)	Intermodal	Fan zones
Intelligent parking management system	Car traffic	Stadium visitors (national traffic) and fan zones
Systems for directing traffic to parking spaces	Car traffic	Stadium visitors (national traffic) and fan zones
Permanent rededication of parts of the parking areas of the venue/stadium	Car traffic	Stadium visitors (national traffic) and fan zones
Expansion (construction or extension) of the public transportation network (routes and stops)	Public transportation	Stadium visitors (national and international traffic) and fan zones
Regional cycle route concept to the host city and event venues	Cycling	Stadium visitors (national traffic) and fan zones

3.4.2.1 Measures concerning cross-modal transport

(Expansion) construction of infrastructure, signage, lighting for future relevant venues

It is important to provide infrastructure for transportation across all modes of transport. This applies to future relevant event locations or to expand existing infrastructure. It will strengthen the means of transport of the environmental network in the mid and long-term. Pedestrian and cycle paths between junctions and the event venues should be available and sufficiently developed. The pedestrian and cycle facilities should have sufficient capacity to accommodate an appropriate number of pedestrians and cyclists during peaks of event traffic. In addition, the pedestrian and cycle routes to and from the venue should be as direct, continuous, barrier-free, safe, clearly demarcated, signposted and adequately lit as possible. The connection to public transportation should be provided by the existence of sufficiently developed stops, with regard to the integration into the network plan and by sufficient passenger transport capacity. The

provision of the necessary infrastructure creates the basic prerequisite for increased use of the respective modes of transport by event visitors. (Öko-Institut e.V., 2022 p. 39)

Choice of location for fan zones based on accessibility (walking, cycling, public transportation)

In addition to the location of the event venue, the location of the fan zones is also crucial for the degree of utilisation of pedestrian, bicycle and public transportation. These should already be carefully selected in the planning phase of the event. Attention should be paid to sufficient connections and infrastructure for walking, cycling and public transportation. This applies to the routes to the fan zones and to connections between the fan zones and the actual venue. By intelligently selecting these locations, spectators, fans, organisers and service providers can be encouraged to use lower-emission means of transport.

3.4.2.2 Measures concerning car traffic

Several measures that can be implemented in the medium- to long-term are available to minimise motorised private transport. These have an impact to direct traffic flows away from the venue and encourage visitors from other regions or countries to park at certain points and use other means of transport for the last few journeys or to avoid the use of cars completely.

Intelligent parking management system

Another measure is to set up an intelligent parking management system. This can contribute to reduce the search for parking spaces and make the intermodal use of transport more attractive in various ways. Permanent and temporary park and ride facilities can be made available and advertised. These should be well connected to public transportation. The security of the parking facilities could be increased by precautions like video surveillance, barriers or specially deployed parking attendants. This creates trust. By using modern information technology like apps, arriving visitors can also be offered the opportunity to book parking spaces in advance. (BMU, DOSB, 2007 p. 54-55)

Systems for directing traffic to parking spaces

In addition to an intelligent parking management system, traffic guidance systems can be installed to direct drivers to the nearest or next available parking space. These can also be used to screen off certain areas during an event. (BMU, DOSB, 2007 p. 54-55)

Permanent rededication of parts of the parking areas of the venue/stadium

Along with the reduction of motorised private transport at major sports events, some of the parking spaces that were previously intended for this purpose and which are in the immediate vicinity of the event location, can be permanently converted. The space gained can then be converted into parking spaces for buses or bicycles. In addition, charging infrastructure could be provided or even photovoltaic systems installed on these spaces. (Öko-Institut e.V., 2022 p. 30, 38-41)

3.4.2.3 Measures concerning public transportation

Expansion (construction or extension) of the public transportation network (routes and stops)

One measure that can strengthen public transportation in the medium- and long-term is the expansion of the rail and bus transport network. A differentiation must be made between new construction and the expansion of existing infrastructure, also considering stops and routes. Such construction projects are usually associated with an extensive planning and implementation process. This is why they should be considered long-term measures and started well before a major sports event is held. It is also important to judge the sustainability of an expansion. The capacity created by the expansion of public transportation should be needed outside the event as well. The resulting improved connection of neighbourhoods or adjacent cities must be useful for the local population outside the venue. In places where the expansion of rail transport does not appear to be beneficial, bus transport can be expanded. (BMU, DOSB, 2007 p. 42) (OC 2006 FIFA World Cup and BMU, 2006 p. 72-73)

3.4.2.4 Measures concerning cycling

Regional cycle route concept to the host city and event venues

For a medium- to long-term strengthening of cycling, it is recommended to create a regional and local cycle path concept if it does not already exist. Such a concept could improve the connection of surrounding communities of the venue via cycle paths and possibly cycle expressways. The cycle route concepts of the host city and the surrounding region should be coordinated. In order to best prepare for an upcoming major sports event construction projects relevant to connectivity could be specifically promoted. Improved regional cycling connections can increase the proportion of spectators who cycle to the event venue as longer distances are easier to cover. (Öko-Institut e.V., 2022 p. 39)

3.4.3 National traffic within Germany

For national transport, there are only few measures that can be implemented in the medium- and long-term to design sustainable mobility for major sports events. (Table 7) As already mentioned in chapter 3.3 a large proportion of the short-term measures are also suitable for the medium- or long-term. For national transport within Germany, rail transport supplemented by long-distance buses plays a central role, as both transport modes generate low GHG emissions per passenger kilometer. (Gores, et al., 2017)

Table 7 Measures that can be implemented in the medium- and long-term at national transport level

Measure	Means of transport concerned	Group concerned
Use of alternative fuels for aircrafts	Air traffic	Stadium visitors (national traffic) and fan zones

3.4.3.1 Measures concerning air traffic

Use of alternative fuels for aircrafts

Another option is to reduce the environmental footprint of the resulting air traffic if avoidance is not possible. The progressive development of power-to-liquid fuels (PtL) could help to ensure aircraft operation with alternative fuels. However, it is unlikely that a complete replacement of

the kerosine consumption will be possible in the next few years. (Öko-Institut e.V., 2022 p. 30, 33-36)

3.4.4 International arrival and departure to Germany

At the international transportation level, there are few measures for the implementation of sustainable mobility at major sports events that are congruent with measures which can be implemented in the medium- and long-term in national transport. (Table 8) Reference should be made to the short-term measures described in chapter 3.3, which are also applicable to medium- and long-term planning. International travel to and from the event is of particular importance due to the high proportion of GHG emissions. In the long-term, environmentally friendly rail transport and connections to neighbouring countries should be promoted and planned as an alternative.

Table 8 Measures that can be implemented in the medium- and long-term at international transport level

Measure	Means of transport concerned	Group concerned
Use of alternative fuels for aircrafts	Air traffic	Stadium visitors (international traffic) and fan zones

3.4.4.1 Measures concerning air traffic

Use of alternative fuels for aircrafts

The use of alternative fuels, such as power-to-liquid fuels, can also be an action for more environmentally friendly mobility in international air traffic. The complete operation of aircraft with alternative fuels is not yet foreseeable in the near future. (Öko-Institut e.V., 2022 p. 30, 33-36)

4 Conclusion and discussion

The present study shows that there is a multitude of measures to establish sustainable mobility at major sports events. The measures can be differentiated and classified according to various aspects. In this study the measures were classified according to the possible implementation period, the spatial transport dimension, the means of transport involved, and the stakeholder groups addressed.

With regard to the implementation period, the focus of the study was on measures that can be implemented in short-term and can be applied until EURO 2024. Accordingly, the majority of measures identified can be implemented within a short period of time. With regard to the mode of action, a distinction can be made in the short-term between emission-reducing and awareness-raising measures as well as climate compensation. A clear demarcation, especially with regard to the sensitising effect, is not always possible. The medium- and long-term measures tend to be aimed at infrastructural and organisational measures, which generally have a longer implementation horizon.

On the spatial level it is evident that most of the measures are applicable on the local or regional level of a host city. This is mainly due to its function as an event location and the fact that a high number of participants are localised there. Due to the relatively short distances within the host cities, the dense traffic can usually be accommodated by a much more diverse portfolio of available means of transportation compared to national or international level. On this level fewer mobility options and alternatives can be offered due to longer distances and increasingly complex route relationships. This multitude of mobility options at a local and regional level implies that there are many starting points for improving sustainability of mobility in the course of the EURO 2024. Although the volume of traffic in the host cities is high, a large part of the traffic is generated by national and international transport. This is caused by individual arrivals and departures as well as domestic travel between the venues. Accordingly, the ex-ante carbon footprint of the Öko-Institut e.V. (2022, p. 21-23) determines that international transport will be responsible for 57% and national transport for 13% of the transport related greenhouse gas emissions at EURO 2024. Concluding from this, the measures for international and national transport that should be pursued with special prioritisation for EURO 2024. The diverse measures at the host city level should not be neglected despite their smaller impact on overall emission. In addition to reducing emissions, they often also have a sensitising effect. A large number of the event's stakeholders are travelling within the host city and are confronted with the issue of sustainable mobility. Many of the measures at the host city level have a high potential for a positive effect, even outside the event. The importance of measures at local and regional level also increases for smaller events due to lower national and international traffic. As smaller events take place more frequently than large events such as EURO 2024, measures at the host city level cannot be neglected.

In terms of means of transport, most of the measures are related to public transportation. This is due to its universal applicability for regional, national and international transport. Intensive use of public transportation is also desirable, as it has a high transport capacity and can therefore achieve low emissions per passenger kilometer. This is particularly applicable as it is the main mode of transport for major events such as EURO 2024. The Öko-Institut e.V. (2022, p. 22) points out that air transport is the main driver of greenhouse gas emissions when looking at the specially determined total greenhouse gas emissions for EURO 2024. This is followed by car traffic with 14%, while only 16% of the event's total greenhouse gas emissions are not transport related. This leads to the conclusion that the qualitatively most effective lever for promoting sustainable mobility is the minimisation of air and car traffic. The alternative for these modes of

transport is again public transportation. For reasons outlined above, this should be strengthened in a prioritised manner via appropriate measures.

Among the different groups, most of the measures concern the spectators and visitors of the major sports event. Spectators are clearly the group of participants with the highest number of people. At the same time, they provide a large proportion of the transportation services. Consequently, they are responsible for a considerable proportion of the emissions. As already mentioned, 57% of transport emissions are caused by international transport by spectators, while UEFA officials, VIPs and employees account for 15% and teams for 0.6%. Together with national transport by spectators, these emit a total of 70% of transport-related greenhouse gas emissions. Measures relating to spectator traffic can be particularly environmentally effective due to the potential scope of their impact. (Öko-Institut e.V., 2022, p. 16, 21-23)

Cooperation with different stakeholders should be established for the implementation of actions, as in most cases they need joint implementation. Transport companies, regional, state or federal administrations, police, security companies, sponsors and many other entities have to be integrated into the processes. Therefore, a well-functioning cooperation is essential.

It is important to note that a large number of measures are event specific and therefore do not have an impact beyond the event period. Long-term measures, such as infrastructural changes, should be particularly sustainable. They are able to efficiently serve the high utilisation during the event period and also the demands outside of the major event.

It is imperative that an evaluation of the major event and the measures taken be implemented in the aftermath. This will help to analyse successes and less effective measures in order to learn from the experience and highlight effective practices for future major events.

5 List of references

BMLFUW, ARE, BAFU, BASPO. 2008. *sustainability report UEFA EURO 2008.* berne, vienna : s.n., 2008.

BMU, DOSB. 2007. *Green Champions in Sport and the Environment - Guidelines for Environmentally Compatible Major Sporting Events .* Berlin, Frankfurt am Main : s.n., 2007.

DIE LIGA - Fußballverband e. V. 2013. *Bundesliga Umwelt Report: Die ökologischen Aktivitäten der Clubs.* Frankfurt/Main : s.n., 2013.

Gores, Sabine and Graichen, Jakob. 2017. *Ansätze zur Bewertung und Darstellung der nationalen Emissionsentwicklung unter Berücksichtigung des EU-ETS.* s.l. : Umweltbundesamt, 2017.

INFRAS AG. 2022. *Handbuch für Emissionsfaktoren des Straßenverkehrs Version 4.2. .* s.l. : Umweltbundesamt, 2022.

IOC. 2005. *Manual on Sport and the Environment.* Lausanne : International Olympic Committee, 2005.

OC 2006 FIFA World Cup and BMU. 2006. *Green Goal Legacy Report.* Frankfurt/Main, Berlin : s.n., 2006.

Öko-Institut e.V. 2022. *Concept and Feasibility Study for a "Climate Neutral" Hosting of the European Men's Football Championship 2024 (UEFA EURO 2024).* Darmstadt : s.n., 2022.

German Environment Agency. 2023. Climate Protection in Transport. [Online] 15 March 2023. https://www.umweltbundesamt.de/themen/verkehr-laerm/klimaschutz-im-verkehr.

A Appendix

A.1 Table of measures

Measure	Time horizon	Spatial dimension	Means of transport concerned	Group concerned
Establishment of a coordination team	Short-term	Cross-room	Intermodal	UEFA, officials, service providers
Integration of sustainable objectives or measures with their implementation in sponsorship contracts	Short-term	Cross-room	Intermodal	UEFA, officials, service providers
Provision/communication of information and opportunities for mobility before and during the event	Short-term	Cross-room	Intermodal	Stadium visitors (national traffic) and fan zones
Role model for sustainable mobility behaviour	Short-term	Cross-room	Intermodal	Teams, UEFA, Officials, Press
Monitoring and control during the event by means of intelligent traffic systems	Short-term	Local and regional transport	Intermodal	Organisers
Signage concept	Short-term	Local and regional transport	Intermodal	Stadium visitors (national traffic) and fan zones
Traffic calming by closing off residential areas and restricting the drivable area	Short-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones
Restricted parking for cars	Short-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones
Increase of parking fees in the surrounding area	Short-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones
Use of environmentally friendly vehicle fleets	Short-term	Local and regional transport	Car and bus traffic	UEFA, officials, service providers
Sustainable driving training	Short-term	Local and regional transport	Car and bus traffic	UEFA, officials, service providers

Measure	Time horizon	Spatial dimension	Means of transport concerned	Group concerned
Offering on-demand transportation	Short-term	Local and regional transport	Car and bus traffic	Stadium visitors (national traffic) and fan zones
Establishment of shuttle buses	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
Increase in transport capacity	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
Expansion of the network	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
Combiticket	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
Use of passenger assistants	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
Use of buses with alternative propulsion systems	Short-term	Local and regional transport	Public transportation	Teams, others (UEFA, officials, service providers), stadium visitors (national traffic) and fan zones
Increase bus stops near the stadium	Short-term	Local and regional transport	Public transportation	Stadium visitors (national traffic) and fan zones
(Expansion) of cycle paths	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Sufficient (secured) parking spaces for bicycles	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Increase the number of rental bicycles	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Charging stations for e-bikes	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones

Measure	Time horizon	Spatial dimension	Means of transport concerned	Group concerned
Campaigns/projects to promote cycling	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Establishment of incentives for bicycle use	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Establishment of (temporary) bicycle service/repair points	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Offer cycle rickshaws	Short-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Use of cargo bikes	Short-term	Local and regional transport	Cycling	UEFA, officials, service providers
Establishment of "Fan Miles" paths	Short-term	Local and regional transport	Pedestrian traffic	Stadium visitors (national traffic) and fan zones
Intelligent game plan design	Short-term	National transport	Intermodal	Stadium visitors (national and international traffic), fan zones, UEFA, officials, service providers and teams
Sustainable driving training	Short-term	National transport	Car and bus traffic	UEFA, officials, service providers
Offering on-demand transportation	Short-term	National transport	Car and bus traffic	Stadium visitors (national traffic) and fan zones
Increase in transport capacity	Short-term	National transport	Public transportation	Stadium visitors (national traffic) and fan zones
Use of special and night trains	Short-term	National transport	Public transportation	Stadium visitors (national traffic), fan zones and teams
Combiticket Plus/ international special tickets	Short-term	National transport	Public transportation	Stadium visitors (national traffic) and fan zones
Attractive pricing of (special) public transportation tickets	Short-term	National transport	Public transportation	Stadium visitors (national traffic), fan zones and teams

Measure	Time horizon	Spatial dimension	Means of transport concerned	Group concerned
Use of passenger assistants	Short-term	National transport	Public transportation	Stadium visitors (national and international traffic) and fan zones
Increase in transport capacity	Short-term	International traffic	Public transportation	Stadium visitors (international traffic)
Use of special and night trains	Short-term	International traffic	Public transportation	Stadium visitors (international traffic)
Combiticket Plus/ international special tickets	Short-term	International traffic	Public transportation	Stadium visitors (international traffic)
Attractive pricing of (special) public transportation tickets	Short-term	International traffic	Public transportation	Stadium visitors (international traffic)
Formulation of guidelines and goals	Medium-/ long-term	Cross-room	Intermodal	All
Setting legal/binding regulations as a basis	Medium-/ long-term	Cross-room	Intermodal	All
Selection of venues and buildings	Medium-/ long-term	Cross-room	Intermodal	All
Reuse of resources	Medium-/ long-term	Cross-room	Intermodal	-
Analysis, assessment, and evaluation of the measures	Medium-/ long-term	Cross-room	Intermodal	-
(Expansion) construction of infrastructure, signage, lighting for future relevant venues	Medium-/ long-term	Local and regional transport	Intermodal	All
Choice of location for fan zones based on accessibility (walking, cycling, public transportation)	Medium-/ long-term	Local and regional transport	Intermodal	Fan zones
Intelligent parking management system	Medium-/ long-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones

Measure	Time horizon	Spatial dimension	Means of transport concerned	Group concerned
Systems for directing traffic to parking spaces	Medium-/ long-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones
Permanent rededication of parts of the parking areas of the venue/stadium	Medium-/ long-term	Local and regional transport	Car traffic	Stadium visitors (national traffic) and fan zones
Expansion (construction or extension) of the public transportation network (routes and stops)	Medium-/ long-term	Local and regional transport	Public transportation	Stadium visitors (national and international traffic) and fan zones
Regional cycle route concept to the host city and event venues	Medium-/ long-term	Local and regional transport	Cycling	Stadium visitors (national traffic) and fan zones
Use of alternative fuels for aircrafts	Medium-/ long-term	National, international traffic	Air traffic	Stadium visitors (national and international traffic) and fan zones