BALTIC JOURNAL OF SPORT & HEALTH SCIENCES
No. 2(133); 2024; 13 –23; ISSN 2351-6496 / eISSN 2538-8347
DOI: https://doi.org/10.33607/bjshs.v2i133.1545

Sports, Environment and Climate Change: The Carbon Footprint of Sports Facilities Based on Energy Consumption in Turkey[1]

Ahmet Atalay[1], Sevdagül Demir[2]
[1]*Ardahan University, Faculty of Sports Science, Ardahan, Türkiye*
[2]*Ardahan Provincial Directorate of Youth and Sports, Ardahan, Türkiye*

ABSTRACT

In this research, it is aimed to make carbon footprint measurements related to energy consumption (electricity, natural gas) in sports facilities belonging to public institutions in Ardahan province in Turkey. Afterwards, it is aimed to discuss the suggestions for minimising the footprint of the type and characteristics of the facilities in the light of current literature. This research is limited to Ardahan province and conducted as a case study. In this context, the amounts of electricity and natural gas consumed in 10 sports facilities with different types and characteristics located in Ardahan provincial centre and districts for 12 months during 2023 were used as a data set. Carbon footprint calculations caused by electricity and natural gas consumption from fossil resources in sports facilities were carried out within the scope of Scope 1. In addition, it is frequently used in carbon footprint calculations due to the ease of access to the amount of energy consumed within the scope of Scope 1 and relatively simpler data sets. The total carbon footprint due to the amount of electricity consumed in sports facilities is calculated as 173,467 tonnes, while the carbon footprint due to natural gas consumption is calculated as 511,578.21 tonnes. In 2023, the total carbon footprint caused by the amount of energy consumed in sports facilities for a year is 685,045.21 tonnes. In this research where Ardahan is considered within the scope of case study, the results of carbon footprint from sports facilities can be attributed to 2 main reasons. The first one is climate conditions. The second one is the increase in participation in amateur and professional events and organisations held in sports facilities and the intensive use of sports facilities throughout the 12 months. As a case study, minimising the carbon footprint of sports facilities in Ardahan province and reducing their negative environmental impacts are very important in terms of sustainable environmental goals.

Keywords: carbon footprint, environment, sustainability, sports, sports facilities

INTRODUCTION

Climate change is one of the most important problems that human civilisation has to face today, and this situation is expressed as the biggest threat to the global community (Breithbarth, McCullough, Collins, Gerke, & Herold, 2023; Eichinger, 2019; Shahroh, Abdullah, & Mus, 2020). The reason why it is expressed as a threat is that half of the world's population lives in geographies directly affected by climate change (Intergovernmental Panel on Climate Change, 2022). Ironically, the most important factor contributing to climate change, which has come to the point of directly threatening people and their living spaces, is greenhouse gas emissions due to human activities (United States Environmental Protection Agency, 2022). It can be said that the human factor is both affected and influencing factor in the process of climate change. In the emergence of this situation, the intensification of human activities due to increasing population, economic

[1] This study has been prepared utilizing data derived from the project titled "Exploring Sustainability in Public Sports Facilities in the Eastern Anatolia Region: Carbon Footprint Measurement and Analysis", funded by the Ardahan University Scientific Research Office.

and technological developments is decisive (Elnour et al., 2022). Therefore, the climate change process, which is accelerated by greenhouse gas emissions, arouses intense interest in all segments of society, especially policy makers, academics, public and private sectors, and is closely followed and frequently discussed (Aklin & Mildenberger, 2020; Dietz, Shwom, & Whitley, 2020; Fiedler et al, 2021). One of these areas of discussion has recently been the sports sector. The sports sector has been one of the areas contributing to climate change, and the understanding of environmental sustainability and sports have become intertwined (Gandola & Asdrubali, 2024). It is known that studies in sports sciences have focused on the negative environmental impacts of the sports sector and comprehensive evaluations have been made on this issue (McCullough, Collins, Roberts, & Villalobos, 2023).

In recent years, the damages to the environment and natural resources caused by the increasing facilities and events and organisations in the sports sector have been frequently discussed in theory and practice. Especially in sports facilities, there is an intensive energy consumption and this energy need is met from fossil fuel sources. This situation causes carbon and greenhouse gas emissions and thus significant negative environmental impacts (Chard & Mallen, 2013). In addition, many factors such as the amount of energy used, the structure of the facilities, the presence of heating and cooling systems, garbage and waste production pose a risk to environmental sustainability (Atalay, 2021; Atalay & Švagždienė, 2023; Perkumienė, Atalay, & Labanauskas, 2024).

In this research, it is aimed to make carbon footprint measurements based on energy consumption (electricity, natural gas) in sports facilities belonging to public institutions in Ardahan province in Turkey. Afterwards, it is aimed to discuss the suggestions for minimising the footprint of the type and characteristics of the facilities in the light of current literature. In this research where Ardahan, one of the important and big cities of Turkey, is used as a case study, answers to the following research questions are sought:

- What is the carbon footprint based on the amount of energy consumed in sports facilities in the provincial centre and districts of the public institution?
- What are the recommendations for minimising the carbon footprint of these sports facilities?

This research was limited to Ardahan province and conducted as a case study. In this context, the amounts of electricity and natural gas consumed in 10 sports facilities with different types and characteristics located in Ardahan provincial centre and districts for 12 months during 2023 were used as a data set. Case studies offer an in-depth and detailed look at a phenomenon, situation, organisation or process (Hercegovac, Kernot, & Stanley, 2020; Priya, 2021). Therefore, it is aimed to reveal the negative environmental impacts of sports facilities in depth and in detail by obtaining data in a safe and healthy way.

The anticipated contributions of this study, which focuses on carbon footprint calculations based on energy consumption of sports facilities and minimisation of this footprint, can be expressed as follows: firstly, with an interdisciplinary approach such as sports sciences, environmental management and energy sustainability, it is envisaged to make a comprehensive evaluation of the carbon footprint and negative environmental impacts caused by sports facilities with a case study. By analysing the carbon footprint of sports facilities in the region in a concrete way, this case study can shed light on sustainability strategies across Turkey. This study aims to contribute to national sustainability goals by providing scientific bases for local governments and policy makers on energy management. Finally, it is aimed to contribute to the literature on environmental sustainability in sport with an interdisciplinary approach, to provide a reference for future studies and to enrich the literature in this field.

Relationship Between Energy Consumption and Carbon Footprint in Sports Facilities

Many studies and official and public institution reports reveal that climate change and environmental problems have become a vital issue on a global scale and the most important problem in the 21st century (Campagna & Fiorito, 2022; Eichinger, 2019; Hambira, Saarinen, & Moses, 2020; United States Environmental Protection Agency, 2022). Population growth, technological developments, acceleration of production and consumption, and intensification of human mobility are considered as the main sources of this problem (Acheampong, Adams, & Boateng, 2019; Maja & Ayano, 2021; Fawzy, Osman, Doran, & Rooney, 2020; Ding, Khattak, & Ahmad, 2021). One of the main causes of environmental degradation within the scope of climate change is carbon dioxide and greenhouse gas emissions called "carbon footprint" (Ruževičius & Dapkus, 2018). Carbon footprint is a concept

used to define the climate change problem (Scrucca, Barberio, Fantin, Porta, & Barbanera, 2021). Many sectors contribute to the carbon footprint and therefore to climate change due to the reasons mentioned above. One of these sectors is undoubtedly the sports sector (Wicker, 2019).

A special concern is emphasised in environmentally oriented scientific studies in sport sciences (Atalay & Švagždienė, 2023; Atalay, 2023; Atalay, Perkumiene, Labanauskas, & Perkumas, 2024). This concern is related to the damage to the environment with increasing amounts of waste, energy consumption and air pollution. However, this growing concern is not taken seriously enough by the sports sector (Bielanski et al., 2022; Happ & Schnitzer, 2022).

With the increase in the supply and demand curve in the sports sector and the increase in mass interest, human mobility has increased. This situation has caused a negative relationship between the environment and sports, and the sports sector has become one of the sectors where environmental measures should be taken (Atalay, 2023). Ecological balance is at risk due to the mobility in the sports sector.

The sports sector plays an important role in climate change and environmental degradation due to human mobility, and contributes to the carbon footprint. As a matter of fact, the research studies conducted reveal that the negative environmental impacts of sports are increasing and the carbon footprint is growing every day (Domański, 2024; Grofelnik, Perić, & Wise, 2023; Herold, Breitbarth, Hergesell, & Schulenkorf, 2024; McCullough, Collins, Roberts, & Villalobos, 2023; Uusitalo, Halonen, Koljonen, Heikkinen, & Claudelin, 2024). It can be said that intense consumption, mass participation and the behaviours exhibited due to the increasing number of tournaments and organisations do not represent an environmentally friendly understanding. The existence and operation of sports facilities (stadiums, sports halls, etc.) are very important in the healthy conduct of increasing tournaments and organisations. The negative environmental impacts caused by these facilities are of particular concern (Taks, 2013; McCool, 2015). This is because these facilities consume large amounts of energy in the process of these tournaments and organisations. A visual of the carbon footprint resulting from energy consumption due to heating, cooling, lighting, etc. in sports facilities hosting different types of tournaments and organisations is given below.

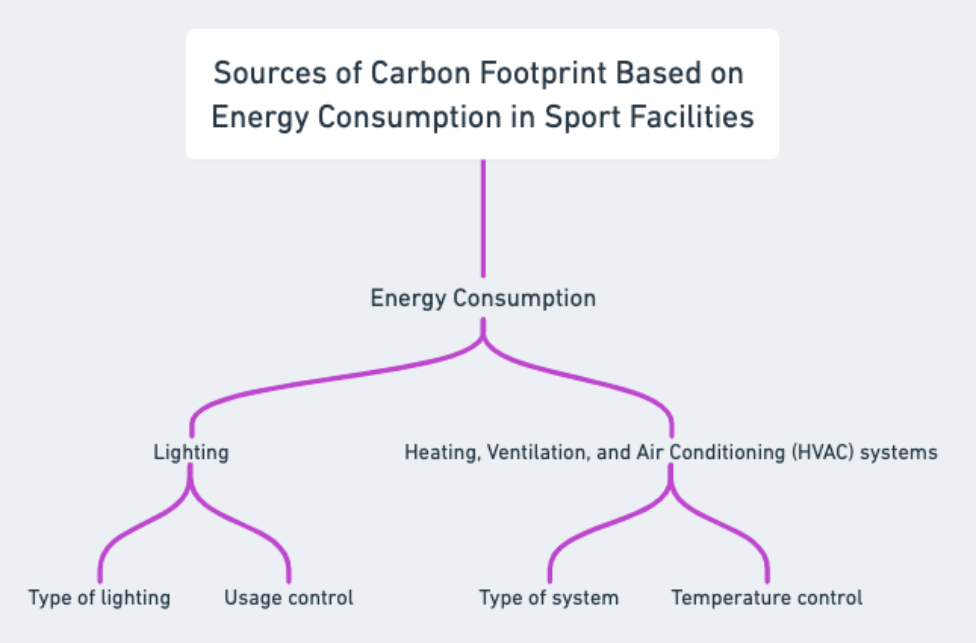


Figure 1. **Carbon footprint due to energy consumption in sports facilities (Prepared by the researchers).**

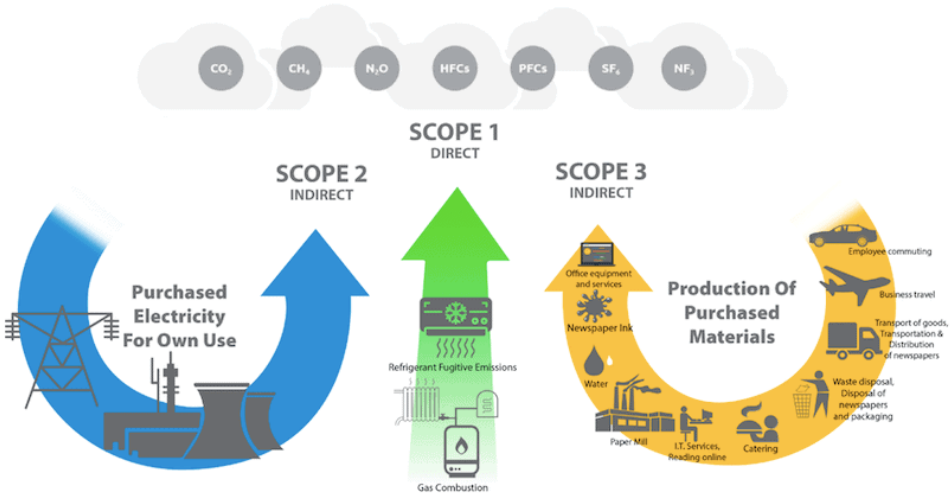
Many sectors, especially the sports sector, need to reduce greenhouse gas emissions by urgently putting carbon offset measures into effect in the process of combating climate change (Intergovernmental Panel on Climate Change, 2014). This is because the buildings and facilities used during the activities carried out in these sectors have particularly high energy consumption. It is known that energy consumption in buildings accounts for 39% of total greenhouse gas emissions (UN Environment Programme, 2019).

Buildings have an important share in environmental damage and carbon footprint production. The amount of energy consumed in buildings accounts for 40% of global consumption, and is 30% more than the carbon footprint caused by human mobility (Costa, Keane, Torrens, & Corry, 2013). A significant portion of this energy is used for heating and cooling buildings (Li et al., 2021). Sports facilities, especially stadiums, require a significant amount of energy for lighting, heating, cooling, and electronic equipment, leading to a high carbon footprint if renewable energy sources are not used (Collins & Flynn, 2018). The fact that the energy consumed is also met from fossil fuel sources increases carbon and greenhouse gas emissions from sports facilities day by day, and increases the carbon footprint (Mallen & Chard, 2011; de Vasconcelos & de Macedo Filho, 2020; O'Rourke, Smith, & Leary, 2021).

METHODOLOGICAL STRUCTURE

In this research, it is aimed to make carbon footprint measurements related to energy consumption (electricity, natural gas) in sports facilities belonging to public institutions in Ardahan province in Turkey. Afterwards, it is aimed to discuss the suggestions for minimising the footprint of the type and characteristics of the facilities in the light of current literature. As stated above, carbon footprint refers to the total amount of greenhouse gas emissions of a person, an organisation or a product in the atmosphere. These emissions are directly or indirectly caused by activities and contribute to climate change (Valls-Val & Bovea, 2021; Shi & Yin, 2021). In carbon footprint calculations, the calculation methodology put forward by the Intergovernmental Panel on Climate Change (IPCC) is utilised. Carbon footprint sources are divided into three, according to IPCC, and are expressed as Scope 1, Scope 2 and Scope 3 (Intergovernmental Panel on Climate Change, 2022). The scopes determined according to carbon dioxide sources are presented in Figure 2 below (Cronin, 2018):

Figure 2. **Sources and extent of carbon footprint (Cronin, 2018).**



Scope 1: Direct Emissions: Greenhouse gases emitted directly to the atmosphere by an organisation from sources under its control (e.g. company vehicles, energy consumed, emissions from facilities, etc.). For example, combustion of fossil fuels such as electricity, oil, natural gas in facilities, emissions from processes (chemical reactions, decay) and leaks (refrigerant gases, pipelines), etc. (Bush, Johnson, & Pioch, 2022).

Scope 2: Indirect Emissions: This refers to greenhouse gas emissions that occur during the production of energy sources such as electricity, heat or steam purchased by an organisation, for example, emissions caused by sources such as steam and

electricity used in production facilities (Heinonen et al., 2020).

Scope 3: Other Indirect Emissions (Value Chain Emissions): This refers to greenhouse gas emissions from all other sources outside the direct control of an organisation, but related to its activities. For example, purchased goods and services (raw material production, transport), invested assets (buildings, equipment) and the use phase of products sold, etc. (Klaaßen & Stoll, 2021).

In this research, carbon footprint calculations caused by electricity and natural gas consumption from fossil resources in sports facilities were carried out within the span of Scope 1. In addition, it is frequently used in carbon footprint calculations because it is easy to access the amount of energy consumed under Scope 1 and relatively simpler data sets (Clabeaux, Carbajales-Dale, Ladner, & Walker, 2020).

Case: Ardahan Province

Ardahan is one of the border provinces of Turkey, and borders Georgia. In 1992, Ardahan became a province, and sportive investments have been continuing since that time. There are 10 sports facilities in total in the province through public investment. Information on the purpose of use, capacity and characteristics of these facilities is presented in table 1 below (Ardahan Provincial Directorate of Youth and Sports, 2022):

Table 1. **Sports facilities in Ardahan**

Facility Name	Capacity (Number of Seats)	Type of Service
Kazım Karabekir Paşa Sports Hall	500	It serves many team and individual sports branches such as basketball, volleyball, futsal, boxing, badminton, gymnastics, wrestling, handball, arm wrestling, table tennis, folk dances. It is also equipped to host local and national competitions.
Ardahan Athlete Factory	----	The facility has 5 floors and there are multi-purpose sports halls. Table tennis, wrestling, judo, volleyball, basketball, volleyball and judo training is carried out. It is also equipped to host local and national competitions.
80. Yıl Cumhuriyet Stadium	2346	All four stadiums are capable of hosting local and national football events.
Halil Efendi 1 Nolu Semt Stadium	1000	
Halil Efendi 2 Nolu Semt Stadium	500	
Göle Stadium	500	
Damal Swimming Poll	-----	It is suitable for the recreational use of the people of the region. At the same time, it has the equipment and competence suitable for the training of swimming athletes in preparation for competitions.
Ardahan Spor Toto Swimming Pool	-----	It is capable of hosting local and national swimming competitions. It is also suitable for the recreational use of the people of the region.
Göle Sports Hall	500	It is capable of hosting local and national competitions in handball, basketball, volleyball, badminton, folk dances, short track branches. It is also suitable for the recreational use of the people of the region.
Halil Efendi Tennis Court	-----	It is capable of hosting local and national tennis competitions. It is also suitable for the recreational use of the people of the region.

Sports facilities in Ardahan are built in accordance with the healthy life understanding of the people. People from all segments of society can benefit from these facilities. However, it also hosts regional and national sports competitions. These facilities, which host many national competitions in individual and team sports, have an important role in both the popularisation of mass sports and the support of the professional. In addition, approximately 15000 licensed athletes in the city participate in competitions in different branches and continue their training in these facilities. In the sports facilities, coaches work in many sports branches, especially in Olympic branches, both contributing to the development of athletes and mediating the public to do sports. In addition, school sports activities, competitions and tournaments are organised in these facilities in accordance with bilateral agreements with the Ministry of National Education and the Ministry of Youth and Sports of the Republic of Turkey. In this way, it is aimed that children and young people gain the habit of doing sports and support their academic lives (Ardahan Provincial Directorate of Youth and Sports, 2022). These facilities are used intensively for 12 months of the year thanks to the competitions and events organised in both amateur and professional branches.

Collection and Compilation of Data Sets

In this research, the amount of energy (electricity and natural gas) consumed for a year in 2023 in 10 sports facilities of different sizes and purposes of use in Ardahan province in Turkey was used as a data set. The data were obtained from Ardahan Provincial Directorate of Youth and Sports by obtaining the necessary legal permissions for data collection, analysis and sharing of results in accordance with the circular published by the General Directorate of Education, Research and Coordination of the Ministry of Youth and Sports (Republic of Turkey Ministry of Youth and Sports, 2020). One-year energy consumption amounts of 10 sports facilities in the province are presented in Table 1 below:

Table 2. **One-year energy consumption amounts in sports facilities in Ardahan province**

Facility Name	Amount of Electricity Consumption (KWH)	Amount of Natural Gas Consumption (Cubic Metres)
Kazım Karabekir Paşa Sports Hall	25,373.24	37,522.00
Ardahan Athlete Factory	49,938.34	47,039.00
80. Yıl Cumhuriyet Stadium	72,085.23	28,928.00
Halil Efendi 1 Nolu Semt Stadium	22,318.96	8,272.00
Halil Efendi 2 Nolu Semt Stadium	352.19	100.00
Halil Efendi Tennis Court	4,694.26	19,806.00
Damal Swimming Pool	66,248.08	-------
Ardahan Spor Toto Swimming Pool	46,121.01	70,405.00
Göle Sports Hall	9,398.87	20,143.00
Göle Stadium	10,243.54	11,875.00
TOTAL	**306,773.72**	**244,090**

The electricity and natural gas consumption amounts of 10 sports facilities in Ardahan provincial centre and districts with different usage purpose and size for the year 2023 are visualised and presented in Table 1. According to this, the total amount of electricity consumed in 10 sports facilities in the province for one year in 2023 is 306.773,72 KWH and the total amount of natural gas consumed is 244.090 cubic metres.

Data Analysis and Carbon Footprint Calculation Method

Carbon footprint calculations based on the amount of electricity and natural gas consumption of 10 sports facilities with different intended use and size throughout 2023 have been carried out within the scope of Scope 1. In this context, carbon emissions released to the atmosphere depending on the energy consumed were calculated. The data analysis and calculation process consists of two steps. In the first step, carbon footprint calculations depending on the amount of electricity consumed; in the second step, carbon footprint calculations depending on the amount of natural gas consumed.

In the first step, the carbon footprint calculation based on the amount of electricity consumption in sports facilities was carried out. In this calculation,

the calculation value of 0.19338 kg/kWh for each unit, published by the UK Government GHG Conversion Factors for Company Reporting (GOV.UK., 2023) and accepted as the carbon dioxide emission factor for electrical energy, was used. The carbon footprint can be obtained by directly multiplying the amount of electricity consumed in sports facilities by this emission factor. The obtained calculation results are presented in tonnes in the findings section. The formula used in the calculation is given below:

Amount of Electricity Consumed * 0,19338 kg/kWh = CO2 Emissions

In the second step, the calculation of the carbon footprint resulting from the amount of natural gas consumed in sports facilities was carried out. In this calculation, the calculation value of 2.09672 kg/m³ for each unit, published by the UK Government GHG Conversion Factors for Company Reporting (GOV.UK., 2023) and accepted as the carbon dioxide emission factor for natural gas, was used. The carbon footprint can be obtained by directly multiplying the amount of natural gas consumed in sports facilities by this emission factor. The obtained calculation results are presented in tonnes in the findings section. The formula used in the calculation is given below:

Amount of Natural Gas Consumed * 2,09672 kg/m³ = CO2 Emissions

Carbon footprint calculations based on the electricity and natural gas amounts consumed for a year in 10 sports facilities with different characteristics and purpose of use in Ardahan province in Turkey have been carried out in the light of the formulae mentioned above. The results obtained include general and specific carbon footprint findings according to the type of facility. These findings are presented in detail in the next section.

FINDINGS

Carbon footprint calculations based on the electricity and natural gas consumption of 10 sports facilities with different types and characteristics located in Ardahan province were made. In addition to separate calculations for each sports facility, calculations for Ardahan province as a whole were also carried out. The findings obtained are presented in table 3 below:

Table 3. **Carbon footprint of sports facilities in Ardahan**

Facility Name	Carbon Footprint due to Electricity Consumption (tonnes)	Carbon Footprint due to Natural Gas Consumption (tonnes)	Total (tonnes)
Kazım Karabekir Paşa Sports Hall	14,818	78,673	93,491
Ardahan Athlete Factory	29,164	98,628	127,792
80. Yıl Cumhuriyet Stadium	42,098	60,654	102,752
Halil Efendi 1 Nolu Semt Stadium	13,034	17,344	30,378
Halil Efendi 2 Nolu Semt Stadium	0.206	0.210	0.416
Halil Efendi Tennis Court	2,741	41,528	44,269
Damal Swimming Pool	38,689	-------	38,689
Ardahan Spor Toto Swimming Pool	26,935	147,619	174,554
Göle Sports Hall	5,489	42,234	47,723
Göle Sentetik Stadium	5,982	24,898	30,880
TOTAL	**173,467**	**511,578.21**	**685,045.21**

Based on the calculation results, the total carbon footprint due to the amount of electricity consumed in sports facilities for one year in 2023 is calculated as 173,467 tonnes, while the carbon footprint due to natural gas consumption is calculated as 511,578.21 tonnes. In 2023, the total carbon footprint caused by the amount of energy consumed in sports facilities for a year is 685,045.21 tonnes. However, "Spor Toto Swimming Pool" is the facility with the largest carbon footprint with 174,554 tonnes in total. The swimming pool is followed by the "Ardahan Athlete Factory" (127,792 tonnes) and the "80. Yıl Cumhuriyet Stadium" (102,752 tonnes).

DISCUSSION

In the study, carbon footprint calculations based on energy consumption (electricity, natural gas) in sports facilities belonging to public institutions in Ardahan province in Turkey were carried out. Depending on the calculation results, the total carbon footprint due to the amount of electricity consumed in sports facilities for a year in 2023 was calculated as 173,467 tonnes, while the carbon footprint due to natural gas consumption was calculated as 511,578.21 tonnes. In 2023, the total carbon footprint caused by the amount of energy consumed in sports facilities for a year is 685,045.21 tonnes. However, "Spor Toto Swimming Pool" is the facility with the largest carbon footprint with 174,554 tonnes in total. The swimming pool is followed by the "Ardahan Athlete Factory" (127,792 tonnes) and the "80. Yıl Cumhuriyet Stadium" (102,752 tonnes).

The existence and accessibility of sports facilities are extremely important for the development and spread of amateur or professional sports branches in societies. Ardahan province is one of the provinces where sports facilities are used intensively with its young population and high sportive potential. Depending on the increasing interest in sports in the province, a significant increase is observed in electricity and natural gas consumption in sports facilities. However, the fact that all of this energy need is met by fossil fuel sources brings along negative environmental impacts.

In this research in which Ardahan is considered within the scope of case study, the results of carbon footprint from sports facilities can be attributed to 2 main reasons. The first one is climate conditions. The second one is the increase in participation in amateur and professional events and organisations held in sports facilities and the intensive use of sports facilities throughout the year.

The average height of Ardahan city centre is 1,827 metres (Çelik, Kopar, & Bayram, 2018). In Ardahan city centre, where the annual average temperature is 3.8°C, monthly average temperatures are below 0°C for 5 months. Minimum temperatures are below 0°C in all months. These values show that daily night temperatures can fall below 0°C even in summer (Öztürk & Kılıç, 2018). Therefore, it can be said that the winter season is quite long and harsh in a settlement centre at this altitude. Due to seasonal conditions, it causes a high amount of electricity, natural gas and consumption for heating, lighting and other operations in sports facilities. High energy consumption can lead to an increase in carbon footprint and negative environmental impacts. Chard & Mallen (2013) point out that energy needs such as oil, natural gas, electricity, etc. are met from fossil fuel sources, which causes greenhouse and carbon gas emissions and negatively affects the environment.

In recent years, there has been a growing demand for sports events and organisations across all segments of society due to the numerous benefits associated with sports. This rising interest has accelerated the development of sports facilities, leading to an increase in both the quantity and quality of such facilities in many countries (Fried & Kastel, 2020; Harger, Humphreys, & Ross, 2016). The expansion of facilities, coupled with increased participation in events and organisations, has resulted in significant consumption of electricity and natural gas in these venues, which is the focus of this study. In the province of Ardahan, 10 sports facilities are in continuous operation throughout the year, hosting amateur sports competitions and providing recreational services to children, youth, and the elderly. Regional football tournaments, other team sports, and individual sports such as tennis and swimming are held year-round (Ardahan Youth and Sports Provincial Directorate Activity Report, 2024). The full-capacity operation of these sports facilities throughout the year contributes to a growing carbon footprint due to high levels of electricity and natural gas consumption.

In sports facilities serving a wide range of disciplines, from winter sports to football, swimming, and athletics, energy needs are met through fossil fuels (Perkumienė, Atalay & Švagždienė, 2023). These types of fuels produce large amounts of carbon dioxide and other greenhouse gases as a result of combustion (Eweade, Hadj, 2021; Karlilar, Pata, Adeshola, & Olaifa, 2024; International Energy Agency, 2020; Yousaf, Ali, Aziz, & Sarwar, 2022).

For instance, the carbon footprint of the 2012 London Olympic Games was estimated to be around 3.4 million tonnes of CO2 equivalent. A significant portion of these emissions was directly related to the energy consumption of sports facilities (UN Environment Programme, 2022). The reliance on fossil fuels in sports facilities is considered an environmental threat. This situation highlights the necessity of taking measures to increase energy efficiency and reduce dependence on fossil fuels in sports facilities (Kellison & Mondello, 2012).

The widespread acceptance of sports in society and the large-scale participation have led to sports facilities operating at full capacity. While these facilities play a crucial role in the development of both amateur and professional sports, their environmental impacts must also be considered. This study, which examines the environmental effects of sports facilities in Ardahan as part of a case study, is expected to provide insights and shed light on the carbon footprint and environmental impact of sports facilities across Turkey.

CONCLUSION AND RECOMMENDATIONS

In this study, the carbon footprint calculations related to energy consumption (electricity and natural gas) in public sports facilities across Ardahan, Turkey, were conducted. According to the results:

- The total carbon footprint from electricity consumption in sports facilities over one year was calculated to be **173,467 tonnes.**
- The carbon footprint due to natural gas consumption was calculated to be **511,578.21 tonnes.**
- The total carbon footprint from energy consumption in sports facilities in 2023 amounts to **685,045.21 tonnes.**
- Among the facilities, the "Spor Toto Swimming Pool" had the largest carbon footprint, contributing **174,554 tonnes.** It was followed by the "Ardahan Athlete Factory" with **127,792 tonnes,** and the "80. Yıl Cumhuriyet Stadium" with **102,752 tonnes.**

These findings highlight the significant environmental impact of sports facilities, particularly those with high energy consumption, such as swimming pools. Based on these results, measures should be taken to reduce the carbon footprint of sports facilities by increasing energy efficiency, adopting renewable energy sources, and implementing more sustainable practices in facility management.

The carbon footprint results obtained in this study can be attributed to two main factors. The first is the altitude of the Ardahan settlement centre, which is at 1,827 metres above sea level (Çelik, Kopar, & Bayram, 2018). As a result, it is situated at a significantly high elevation, leading to considerably low average temperatures due to geographic conditions. Seasonal conditions, particularly the need for heating in the facilities, contribute to high natural gas consumption. The second factor is the year-round intense usage of the 10 sports facilities located across the province. The continuous use of these facilities by all segments of society for amateur, professional, and recreational purposes results in significant electricity consumption, primarily for lighting and heating. Local sports organisations, amateur leagues, and the public's use of sports facilities for a healthy lifestyle lead to increased energy consumption. This, in turn, can be associated with a higher carbon footprint and negative environmental impacts resulting from energy consumption.

As a case study, the reduction of the carbon footprint of sports facilities across Ardahan, and the mitigation of their negative environmental impacts, is crucial for achieving sustainable environmental goals. The operation and usage of sports facilities are vital for public health. However, it is essential to consider environmental concerns and reduce the carbon footprint during this process. In this context, the following recommendations are proposed to reduce the carbon footprint originating from sports facilities in Ardahan:

- Promotion and widespread adoption of clean, sustainable, and renewable energy sources: Encouraging the use of energy sources such as solar, wind, and geothermal in sports facilities.
- Consideration of geographic and seasonal conditions in the construction of new sports facilities: Ensuring that the design and construction of facilities account for local climate conditions to optimise energy use.
- Regular maintenance and repair of sports facilities: Ensuring facilities are well-maintained to prevent energy inefficiency and extend the lifespan of infrastructure.
- Prevention of heat loss in buildings through thermal insulation: Applying insulation in buildings to minimise energy consumption for heating, particularly in cold climates.
- Use of smart lighting systems in facilities:

Implementing smart lighting systems to reduce unnecessary energy consumption and improve efficiency.

- Greening the surroundings of sports facilities as part of carbon offset policies: Planting trees and creating green spaces around facilities to help absorb carbon emissions.
- Raising awareness among sports facility users about environmental sensitivity: Educating facility users on energy-saving practices and environmental responsibility to contribute to overall sustainability efforts.

The full capacity use of sports facilities is very important for public health and the spread of sports. However, in this process, both energy saving and reducing negative environmental impacts should be one of the priority targets of managers. The implementation of the suggestions mentioned above by facility managers can reduce the negative environmental impacts of sports facilities and contribute to sustainable environmental goals. It can be stated that this research, designed as a case study, is important in terms of shedding light on more comprehensive research in Turkey, and understanding the relationship between environmental sustainability and sports in the country.

Conflict of Interest Statement

There is no personal or financial conflict of interest between the authors of the article within the scope of the study.

Researchers' Contribution Rate Statement

As the author of this study, all contributions and responsibilities in the research design, data collection, analysis and preparation of the article belong to me.

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Received on October 25, 2024
Accepted on November 13 2024