ESKİŞEHİR METROPOLITAN MUNICIPALITY

SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN

Eskişehir Metropolitan Municipality
Department of Climate Change and Zero Waste

Serap Aylin ŞENER / Head of Climate Change and Zero Waste Department

Hale Senem ACAR / Climate Change and Energy Management Manager

Sinem ŞAYLAN / Environmental Engineer

Neşe KARAĞAÇ / Landscape Architect (MSc.)

Cemresu BANAR / Environmental Engineer

Dr. Vural YILDIRIM / Statistician

Murat ERKAPLAN / Biologist

Gürhan AKSOY / Electrical and Electronics Engineer

Mesut SARIOĞLU / Mechanical Engineer

Tolga DAVAZ / Electrical and Electronics Engineer

Consultants and Technical Experts:

Esra DEMİR / Demir Enerji / Senior Consultant

Caner DEMİR / Demi Enerji / Senior Consultant

Melda KARADEMİR / Demir Enerji / Senior Consultant

Dilan CENGİZ / Demir Enerji / Consultant

Buse ARAÇ / Demir Enerji / Consultant

Company:

DE SÜRDÜRÜLEBİLİR ENERJİ VE İNŞAAT SANAYİ TİC. LTD. ŞTİ.
Koşuyolu Mahallesi, Halili Sokak, No:7, 34718, Kadıköy /ISTANBUL
Phone: +90 (216) 428 76 69
E-mail: bilgi@demirenerji.com
Web address: www.demirenerji.com

This report was prepared by Demir Enerji.

2023

My esteemed citizens of Eskisehir,

Today, we are excited to have taken an important step together towards moving our Eskişehir to a greener, more sustainable, and healthier future. I am happy to share with you our Sustainable Energy and Climate Action Plan, which we prepared in line with Eskişehir's strategic plan decisions.

Eskişehir is a city full of culture, art and natural beauties. We have decided to implement this plan in order to protect these values, leave a more livable environment for future generations, and play an effective role in the fight against climate change. The Sustainable Energy and Climate Action Plan aims to increase energy efficiency, promote renewable energy sources, and reduce our carbon footprint by supporting the strategic goals of our city.

This plan was shaped with the contributions of not only the municipal administration, but also the business world, non-governmental organizations, and, of course, with you, the valuable residents of Eskişehir. I would like to thank you all for your interest, support and cooperation during this process. We have come together to build a more beautiful Eskisehir together with you and emerged this plan.

Sustainability is the common responsibility of the whole world. Therefore, we can only be truly successful through the efforts of each individual, institution and society. I would like to state that in the process of implementing this plan, we need all kinds of suggestions and contributions from you, my dearest residents of Eskisehir.

In conclusion, I would like to thank all of my fellow citizens of Eskişehir, my colleagues in the municipality, and all our stakeholders of public and private institutions with whom we work in cooperation that supported us in taking this important step. I believe that together we will make Eskişehir, which stands out with its cultural riches, an even more beautiful city with the principle of sustainability. Please accept my sincere love and respect to you all.

Prof. Dr. Yılmaz BÜYÜKERŞEN
Mayor of Eskişehir Metropolitan Municipality

CONTENT

FIGURE LIST

TABLE LIST

ACRONYMS

Acronyms	
AFAD	Disaster And Emergency Management Presidency
AR5	Fifth Assessment Report
BAU	Business-As-Usual Scenario
C40	C40 Cities Climate Leadership Network
CCAP	Climate Change Action Plan
CO_2	Carbon dioxide
CoM	Covenant of Mayors
COP	Conference of the Parties
EMM	Eskişehir Metropolitan Municipality
EMRA	Energy Market Regulatory Authority
EPDK	Energy Market Regulatory Authority
ESCO	Energy Services Company
ESKİ	Eskişehir Metropolitan Municipality General Directorate of Water and Sewage Administration
GHG Protocol	Greenhouse Gas Protocol
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
GWP	Global Warming Potential
ICLEI	Local Governments for Sustainability
IEAP	International Local Government Greenhouse Gas Emissions Analysis Protocol
IPCC	Intergovernmental Panel on Climate Change
MCA	Multi-Criteria Assessment
MEB	Ministry of National Education
MGM	Turkish State Meteorological Service
MoEUCC	Ministry of Environment, Urbanization and Climate Change
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined Contribution
NEEAP	National Energy Efficiency Action Plan
OSB	Organized Industrial Zone
SECAP	Sustainable Energy and Climate Action Plan
SPI	Standardized Precipitation Index
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

With the beginning of the Industrial Revolution, the use of fossil fuels accumulated underground over millions of years and their release into the atmosphere increasingly trigger climate change. Reports regularly published by the Intergovernmental Panel on Climate Change (IPCC) underscore the unequivocal nature of global climate changes, surpassing levels documented in the last millennium, particularly since the 1950s. Each decade of the last 30 years has been higher than any other decadal period of global temperatures recorded at the Earth's surface since 1850. It is a scientific fact that, with the industrial revolution, carbon dioxide emissions, especially from fossil fuels, have increased beyond the rate that can be absorbed by oceans and forests. Consequently, the perpetuation of prevailing practices is prognosticated to yield profound consequences of climate change, culminating in extensive environmental degradation, potential mass fatalities, and concomitant humanitarian crises.

Sustainable Energy and Climate Action Plan (SECAP) Process

Eskişehir Metropolitan Municipality has been a member of the Covenant of Mayors since 2011, committing to achieve the climate and energy goals of cities. The municipality's Sustainable Energy and Climate Action Plan (SECAP) process has been prepared in accordance with the Covenant of Mayors methodology. This process has followed the four main steps outlined below:

a) Preparation of greenhouse gas emission inventory and assessment of the current situation,
b) Establishing mitigation actions in accordance with international and national targets to reduce greenhouse gas emissions.
c) Risk and vulnerability assessment and determination of climate adaptation actions for areas and sectors affected by climate change
d) Making assessments and determining actions regarding energy poverty.

The implementation of these steps enables Eskişehir Metropolitan Municipality to effectively realize its sustainable energy and climate policies. In this context, the plan defines three main objectives:

- Reducing greenhouse gas emissions by 55% compared to the base year
- Increasing resilience against climatic disasters
- It is defined as carrying out studies to prepare the ground for combating energy poverty.

The action plan includes details about sub-actions and implementation processes to achieve these goals. This action plan aims to follow a broad strategy by adopting the principle of sustainability in different sectors and areas of the municipality.

Current Situation

For 2021, the energy consumption of Eskişehir city, including industry, is calculated as **18,564,139 MWh** and greenhouse gas emissions as **7,219,456 tCO_2e**. Greenhouse gas emissions from industry have a share of **48.2%** in the total. The share of emissions resulting from fuel and electricity consumption of buildings in total emissions is **19.3%.** While greenhouse gas emissions from transportation have a share of **17.1%,** greenhouse gas emissions from agriculture and livestock have a share of **13.9%**, greenhouse gas emissions

from solid waste and wastewater treatment have a share of 1.5%. Emissions from fugitive gases given under the title of other emissions have a share of **0.003%.**

The energy consumption of Eskişehir city, excluding industry, civil airport, illegal and industrial process emissions, is **10,154,392 MWh** and the greenhouse gas emission amount is **3,741,358 tCO_2e**. The share of emissions resulting from fuel and electricity consumption of buildings in total emissions is **37.2%**. While greenhouse gas emissions from transportation have a share of **33%**, greenhouse gas emissions from agriculture and livestock have a share of **26.8%,** greenhouse gas emissions from solid waste and wastewater treatment have a share of **3%.**

Mitigation

In the projections prepared for Eskişehir, greenhouse gas emissions excluding industrial sources are estimated to be **4,630,384 tCO_2e** by the year 2030 under the BAU (Business as Usual) scenario, which assumes the continuation of the current situation. In alignment with Eskişehir Municipality's commitment to a **55%** mitigation by the year 2030, the goal is to decrease the per capita greenhouse gas emissions from the baseline year of 2021, which was **4.16 tCO_2e**, to **1.87 tCO_2e**. *(Mitigation targets are specified on a per capita basis, excluding emissions from industry, the airport, fugitive emissions, and industrial processes.)*

Mitigation actions have been determined in line with Eskişehir's 55% mitigation target, and the main targets have been determined under the headings of buildings, renewable energy, transportation, waste and wastewater, agriculture and livestock.

Buildings | **Renewable Energy** | **Transport** | **Waste & Wastewater** | **Agricultural & Livestock**

These actions;

- Increasing the use of renewable energy resources,
- Installing renewable energy systems in public buildings and infrastructures,
- Raising energy efficiency standards in buildings and encouraging compliance with these standards in newly constructed buildings,
- Saving energy by modernizing lighting systems,
- Increasing the electric charging station infrastructure throughout the city and popularizing the use of electric vehicles,
- Diversifying rail system lines and increasing the usage rate by improving public transportation comfort,
- Optimization of traffic flow and signaling system by applying smart traffic methods,
- Organizing a city-wide campaign to reduce the amount of waste and separate waste,
  Improving the operating conditions of all wastewater treatment plants

- It has been shaped in line with goals such as ensuring sustainable production in agriculture and animal husbandry and raising awareness.

Adaptation

Eskişehir is a city that frequently confronts natural hazards such as floods, droughts, hailstorms, heatwaves, and forest fires. It is crucial to develop priority strategies to understand the city's risks and enhance its resilience and sustainability in the face of extreme weather conditions due to climate change. Assessing the city in terms of risks and vulnerability not only lays the groundwork for discussions within the community on how to address potential future challenges but also ensures the formulation of strategies. Through analyses and socio-economic evaluations, areas where the city is susceptible to climatic risks have been identified, and goals have been established accordingly.

The main goals within the scope of adaptation to climate change are;

- Protecting and increasing water resources
- Efficiency enhancing practices and pollution prevention
- Ensuring continuity and food security in agricultural production
- Protection of forest areas and biodiversity
- Increasing the amount and quality of green areas and reducing the heat island effect in urban areas
- Building resilience against climatic disasters and increasing the resilience of society to disasters
- Protecting public health against the dangers of climate change
- Increasing the resilience of the industrial sector against climatic disasters, especially drought
- Reducing the resource use of tourism facilities and increasing their resilience to climate hazards
- It has been determined as providing the administrative structure and technical tools that will enable the implementation and monitoring of mitigation, adaptation and energy poverty actions.

In line with these goals, actions that can be carried out in cooperation with various public stakeholders, especially Eskişehir Metropolitan Municipality, are included.

Energy Poverty

The measurement of energy poverty and its threshold values exhibit diversity depending on local characteristics. Considering local features such as geographical location, climate, housing structures, existing heating/cooling systems, energy prices, and other influencing factors, energy poverty can be evaluated through different definitions and observations. In this context, socio-economic elements examined at the household and individual levels, including factors such as age, health, and economic conditions, are significant variables in determining energy poverty.

In this context, actions have been identified under three main headings to initiate efforts in combating energy poverty, focusing on the development of buildings, households, and social assistance policies.

Eskişehir Metropolitan Municipality teams, along with all relevant stakeholders from the public, private, and civil society sectors of the city, extensively discussed mitigation, adaptation, and energy poverty actions in workshops. These actions have been meticulously prepared to integrate with national goals. Indicators have been established to monitor the city's progress in the upcoming period and to assess the success of the action goals.

This strategic action plan should be considered a significant step reflecting Eskişehir Metropolitan Municipality's commitment to achieving sustainability objectives. To successfully implement and monitor this plan effectively, collaborative efforts will be made among management, employees, and all stakeholders.

1. CLIMATE CHANGE AND CITIES

The level of danger posed by global warming, arising from increasing human activities since the Industrial Revolution and the escalating consumption of fossil fuels in energy production, can definitively be stated as of the 21st century. The impacts stemming from climate change are progressively affecting cities every day, primarily due to the rise in greenhouse gas emissions associated with industrial activities and the use of fossil fuels.

The continuation of current production and consumption habits that contribute to increased greenhouse gas emissions in the atmosphere is anticipated to lead to a worsening of climate change-related impacts. This is expected to result in the destruction of living spaces, deterioration of public health, and the potential for mass casualties due to disasters and intense pollution. The increase in extreme weather events in recent years, as evidenced by examples in our daily lives, underscores the severity of this destruction.

According to projections by the Intergovernmental Panel on Climate Change (IPCC), without mitigation measures, global greenhouse gas emissions could lead to a temperature increase of 4.1-4.8 °C by the year 2100 (Figure 1)[1].

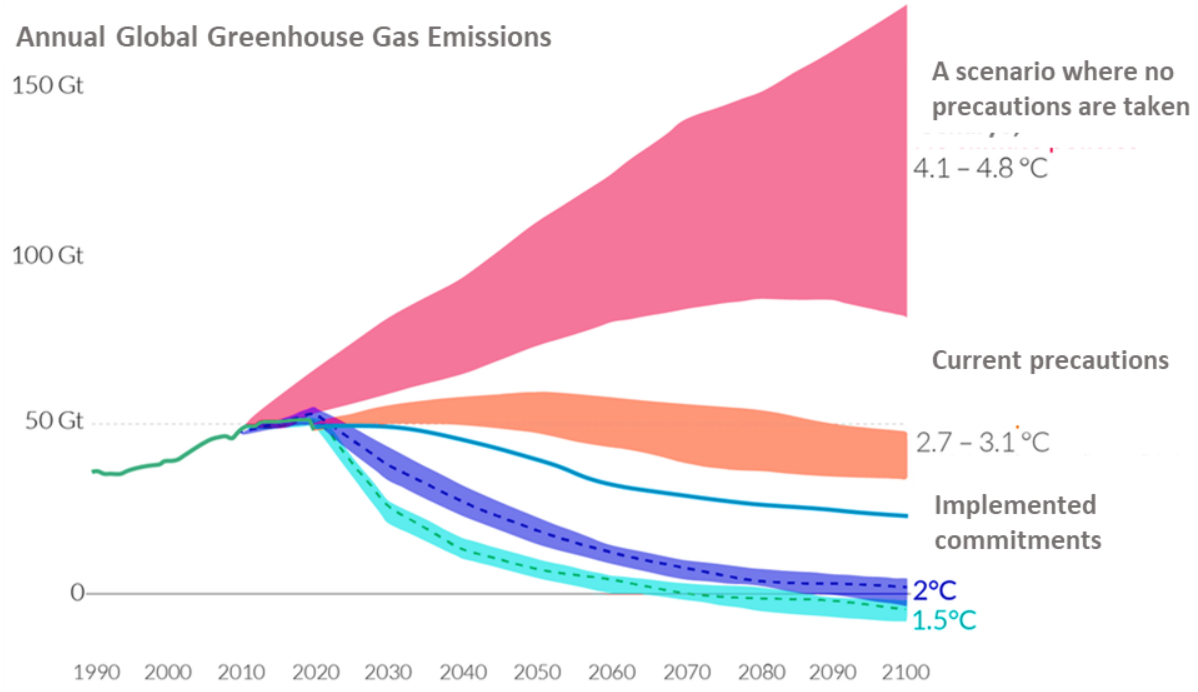


Figure 1: Annual global greenhouse gas emissions

The severe disruption of Earth's radiation balance, particularly since the 1990s, associated with rising temperatures and an accelerated pace of imbalance in recent years, is a well-established phenomenon in climate science. This imbalance is attributed to the greenhouse gas effect caused by the use of fossil fuels

[1] Our World in Data. (2020, August). CO_2 and Greenhouse Gas Emissions. https://ourworldindata.org

in energy production. Additionally, climate change, resulting from societal production and consumption habits, contributes to climate-related hazards.

Analyzing the distribution of natural disasters worldwide based on disaster types, there is a notable increase in the numbers of floods, storms, extreme temperatures, droughts, and wildfires in the 2000-2019 period compared to the disasters that occurred in the 1980-1999 period (Figure 2).

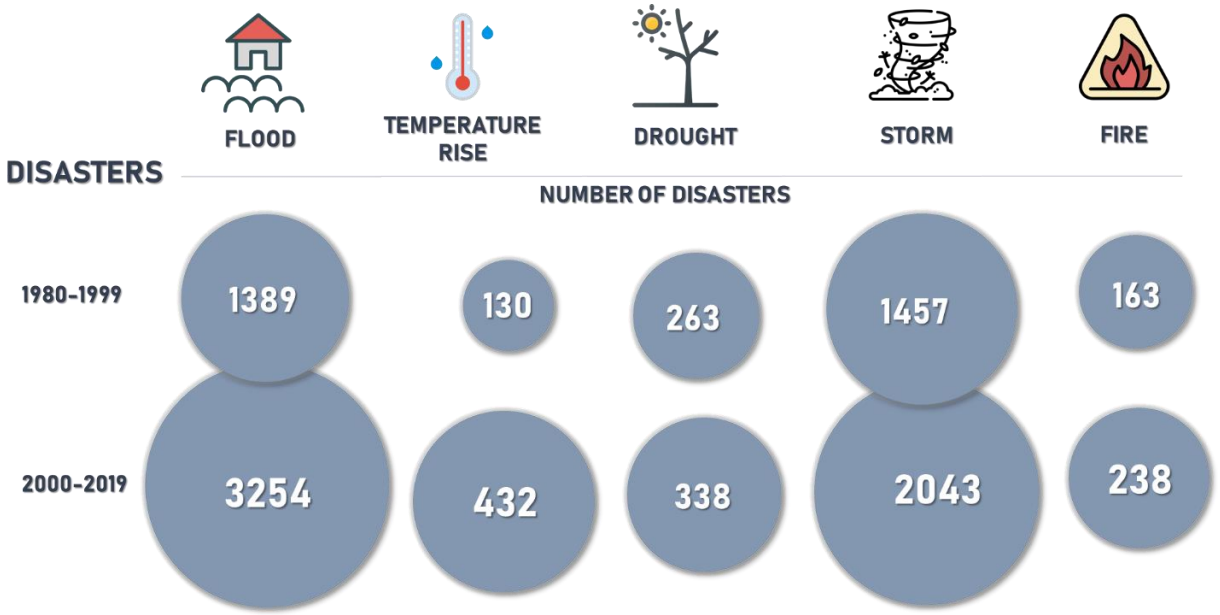


Figure 2: Distribution of natural disasters occurring worldwide according to disaster types [2]

This clearly evident and dangerous situation has directed the world's attention more towards the impacts of climate change, prompting action in cities. Global efforts, initiated with the signing of the United Nations Framework Convention on Climate Change in 1972, gained momentum with the influence of the Paris Agreement, signed by many countries in 2016. The Paris Agreement aims to ensure the fulfillment of commitments to align global temperature levels with a 1.5 °C target, urging all countries to accelerate their efforts within the scope of these mitigation policies.

In this context, local governments have increasingly become more involved in addressing this issue that closely concerns the quality of life and health of individuals. Unlike the decision-making processes of national governments, the regional problem-solving capabilities and the advantages of local governance in process management have allowed local governments to evaluate their position in the face of the adverse effects of climate change. Local governments and the partnerships and coalitions they have formed have, since the early 2000s, demonstrated their potential to set more ambitious goals in the fight against climate change than their national governments. This has made the position of local governments indispensable, showcasing that they can play significant roles in combating climate change.

The Eskişehir Metropolitan Municipality is a member of the Covenant of Mayors (CoM), an initiative by the European Commission aimed at encouraging, supporting, and promoting urban mitigation plans to decrease greenhouse gas emissions, increase the use of clean energy sources, and adapt to climate change. Within this framework, the primary commitment of Eskişehir Metropolitan Municipality is to

[2] It was created using the data in MGM's 2021 Meteorological Disasters Assessment.

mitigate greenhouse gas emissions by a minimum of 55% by the year 2030. Additionally, the municipality conducts assessments of the current situation to address climate-related disasters and energy poverty. It aims to identify action areas and implement initiatives to combat these challenges.

Eskişehir Metropolitan Municipality is also a member of various networks, including the Cities Race to Zero, Carbon Disclosure Project (CDP), Sustainable Urban Development Network, UNESCO Global Network of Learning Cities, and the European Commission's Climate Adaptation Mission. The municipality actively continues its comprehensive efforts and initiatives related to climate action, as illustrated in Figure 3.

Figure 3: Networks that Eskişehir Metropolitan Municipality is a member of

Under the Sustainable Energy and Climate Action Plan, following the development of the institutional and urban greenhouse gas inventory for Eskişehir, specific action areas are being identified with a focus on reduction, adaptation, and energy poverty. Action plans are being formulated for Eskişehir within these categories.

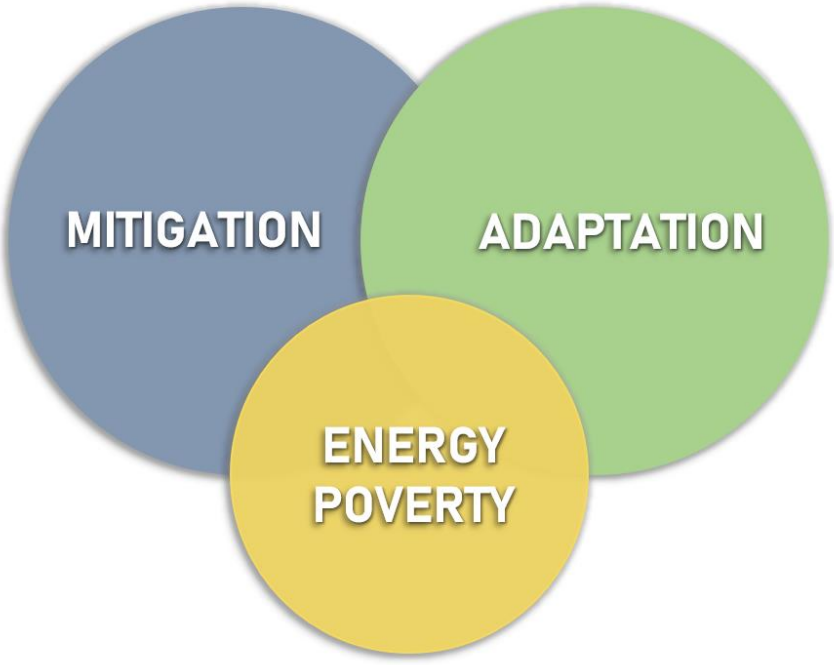


Figure 4: Main strategy areas under the Plan

MITIGATION is defined as strategies aimed at directly reducing carbon emissions in cities. These strategies typically encompass topics such as efficient energy use, increased utilization of renewable energy, sustainable mobility, and fuel efficiency.

ADAPTATION refers to strategies aimed at reducing the current and future impacts of climate change and enhancing the quality of life. These strategies include changes in land use in urban areas, smart growth in buildings and infrastructure, water management, public health, and awareness-building.

ENERGY POVERTY is a complex urban problem where households in cities are unable to meet their basic energy needs, lack access to clean energy, and face inefficiencies in heating and cooling due to inadequate insulation in buildings. Energy poverty necessitates the development of strategies encompassing various areas such as increased access to clean energy, energy efficiency, poverty alleviation and public health, similar to mitigation and adaptation efforts.

While these concepts necessitate three distinct main categories, in reality, all these main categories form a comprehensive set of intersecting strategies and goals on both horizontal and vertical axes, complementing each other.

1.1. INTERNATIONAL AGREEMENTS

Paris Agreement

The Paris Agreement was adopted on December 12, 2015, during COP 21 held in Paris, and it entered into force in November 2016. The main objective of the agreement is to limit the global average temperature increase to 2°C, preferably below 1.5°C. In addition to provisions for greenhouse gas reductions, the agreement also includes clauses related to countries taking action on climate change adaptation.

On September 21, 2021, Türkiye declared at the United Nations General Assembly that it would become a party to the Paris Agreement and commit to a Net Zero Emissions target by 2053. The Law Approving the Ratification of the Paris Agreement was unanimously accepted in the Grand National Assembly of Türkiye on October 6, 2021. Through Presidential Decree No. 85 published in the Official Gazette on October 29, 2021, the name of the Ministry of Environment and Urbanization was changed to the Ministry of Environment, Urbanization and Climate Change, and it became the Presidency of Environment, Urbanization, and Climate Change. [3]

Covenant of Mayors (CoM)

The Covenant of Mayors initiative was launched in 2008 by the EU to achieve climate and action goals. In 2014, the Mayors Adapt initiative was accepted by the EU, and in 2015, the Covenant of Mayors and Mayors Adapt were officially merged. Since then, cities signing the covenant have committed to supporting a 40% reduction in greenhouse gas emissions by 2030 and ensuring access to safe, sustainable, and affordable energy for everyone. After the EU announced the "Fit for 55" targets, the commitment of local governments signing the covenant was raised to 55%. Currently, there are 12,679 signatories from local governments in 57 countries worldwide. More than 60 municipalities from Türkiye, including Eskişehir Metropolitan Municipality and Tepebaşı Municipality, are signatories to the Covenant of Mayors.

[3] https://csb.gov.tr/tarihcemiz-i-7012 Date of access: November 2023

The European Green Deal

In December 2019, the European Union presented an initiative package that served as a commitment to take definitive and ambitious steps in addressing climate change, reducing greenhouse gas emissions and promoting topics related to environmental and social sustainability, with a focus on renewable energy usage. In 2021, the Republic of Türkiye Ministry of Trade published the Green Deal Action Plan, covering issues such as carbon border adjustments, green and circular economy, green financing, energy supply, sustainable agriculture, smart mobility, and the fight against climate change.

1.2. NATIONAL AND LOCAL CLIMATE POLICIES

In 2023, according to the revised Intended Nationally Determined Contribution (INDC) proposed by Türkiye to the UNFCCC, a 41% mitigation in greenhouse gas emissions from the business-as-usual scenario is suggested (the previous target was 21%). Türkiye supports its INDC targets with a series of national climate change policies, including:

- Environmental Law
- 12th Development Plan (2024)
- Strategic Environmental Assessment By-Law
- National Climate Change Strategy (2010-2023) and Action Plan (2011-2023) – under revision
- National Climate Change Adaptation Strategy and Action Plan (2011-2023) – under revision
- Energy Efficiency Strategy and National Energy Efficiency Action Plan (2017-2023)
- 2053 National Transportation and Logistics Master Plan
- Türkiye's Green Deal Action Plan
- Climate Council Final Recommendations
- Türkiye National Energy Plan
- Medium-Term Programme (2024-2026)

The primary legislation and policy documents being prepared to enhance Türkiye's climate action and targeted for completion as soon as possible are listed below:

- Climate Law
- Local Climate Change Action Plan By-Law
- Türkiye's Spatial Strategy Plan 2053
- 2053 Long-Term Climate Change Strategy
- Circular Economy Strategy and Action Plan
- Sustainable Smart Mobility Strategy and Action Plan
- Green Growth Technology Road Map
- Climate Financing Strategy

On the other hand, the Disaster and Emergency Management Presidency (AFAD) of the Eskişehir Governorship published the Provincial Disaster Risk Reduction Plan in 2021, which is directly related to climate change mitigation actions. The objectives and goals that could be associated with climate change are summarized below: [4]

[4] Eskişehir, Provincial Disaster Risk Reduction Plan, 2021

With the aim of **enhancing the disaster and emergency preparedness capacity** of Eskişehir province and **making it more resilient against disaster risks**, the following measures are being implemented:

- Implementing different practices at different points for flood control
- Rehabilitation efforts in streambeds in existing and new settlements, use of landscape elements
- Strengthening infrastructure (maintenance of bridges, culverts, pump stations)
- Creation of climate maps
- Storage of rainwater
- Inspections to prevent unauthorized use of groundwater
- Preventing excessive use of groundwater

With the aim of developing and implementing **early warning systems for disasters and emergencies**, and related methods, the following measures are being taken:

- Creation of protection strips around roads passing near forest areas in the city center and districts, with the aim of reducing the risk of fire, and placing warning signs
- Installation of water flow sensor and notification early warning systems

With the aim of **increasing collaboration by ensuring the sharing of data produced for disasters and emergencies with relevant institutions**, the following measures are being implemented:

- Extraction of building inventory information for existing units such as residences, education, health, hotels in the city center and districts
- Conducting training, drills, etc., to enhance inter-agency collaboration and coordination

With the aim of **creating a resilient community against disasters by increasing disaster awareness**, the following measures are being implemented:

- Conducting awareness training for technical personnel in public and local administrations in Eskişehir city center and affiliated districts
- Providing disaster awareness education in primary and secondary schools
- Increasing awareness activities on drinking water and network water usage and conservation with the participation of all public institutions and organizations
- Raising awareness among farmers about water usage

With the aim of considering **social vulnerability and including vulnerable groups in preparations before disasters and emergencies**, the following measure is being implemented:

- Identifying and registering the residences of vulnerable groups in advance, and pre-identifying individuals who will assist these groups during disasters

With the aim of **minimizing the adverse effects that threats from climate change can cause**, the following actions are being taken:

- Conducting meteorological and agricultural drought analysis studies throughout the province
- Implementing technological advancements in irrigation facilities for the benefit of producers

- Avoiding the conversion of agricultural, pasture areas, and water basins for settlement and considering them as areas that need protection
- Increasing forest assets through reforestation
- Giving importance to activities aimed at reducing water leakage rates in drinking water lines

The strategic plan of Eskişehir Metropolitan Municipality for the period 2020-2024 is guided by the vision of continuing to be a city with a sustainable urbanization approach, aiming for agricultural development, being sensitive to climate change, resilient to extraordinary situations, equal, accessible, peaceful, and happy for everyone. In this plan, 8 objectives and 24 targets are identified. To measure these targets, there are 90 performance indicators. The highlights from the strategic plan monitoring report are as follows:

- Target **H1.1.** "Increase Energy Efficiency and Renewable Energy Capacity, Combat Climate Change": The anticipated rate for 2022 was 100%, but the actual achievement was **53.1%**.
- Target **H1.2.** "Develop a Sustainable Waste Management System and Increase Environmental Awareness": The anticipated rate for 2022 was 100%, and the actual achievement was **96.1%**.
- Target **H1.3.** "Protect Existing Green Areas, Diversify Their Functions, and Create New Green Areas": The anticipated rate for 2022 was 100%, but the actual achievement was **59.8%**.
- Target **H2.1.** "Develop Alternative Urban Transportation Options": The anticipated rate for 2022 was 50%, but the actual achievement was **5%**.
- Target **H2.2.** "Increase the Usage Rate, Service Quality, and Environmental Sensitivity of Public Transportation Systems": The anticipated rate for 2022 was 100%, but there was **no actual achievement**.
- Target **H2.3.** "Enhance the Effectiveness of Traffic Management": The anticipated rate for 2022 was 100%, but there was **no actual achievement**.
- Target **H2.4.** "Develop Urban Transportation Infrastructure": The anticipated rate for 2022 was 100%, and the actual achievement was **70.8%**.
- Target **H7.2.** "Combat Material, Spiritual, and Social Deprivations": The anticipated rate for 2022 was 100%, and the actual achievement was **81%**.

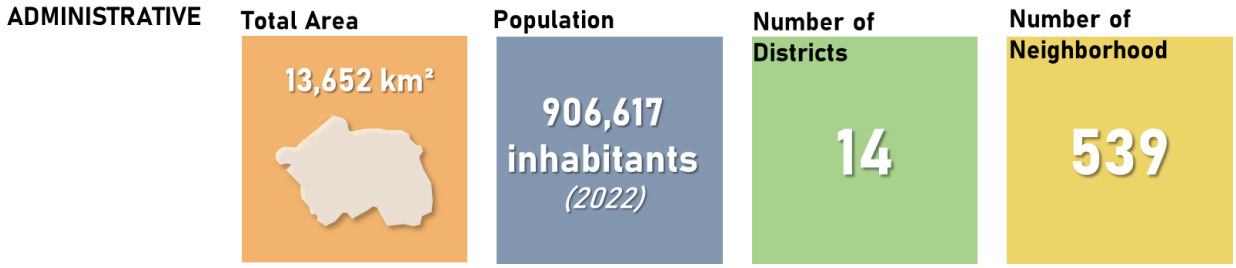
When determining climate change-related targets and actions, it is anticipated that new actions and targets will be identified/integrated based on target achievement rates and performance indicators.

2. ESKİŞEHİR CURRENT SITUATION ASSESMENT

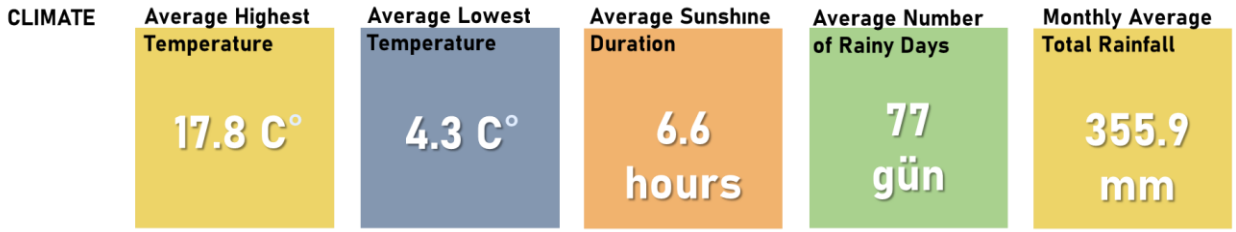
Eskişehir's history dates back to ancient times. It is one of the 30 metropolitan cities in Türkiye and is notable for having the country's second-largest organized industrial zone, with a prominent industry and rich underground resources. Eskişehir is also a city of universities and arts. This section will cover the current administrative, environmental, demographic, and socio-economic profile of Eskişehir. Current climate policies, greenhouse gas inventory results prepared under the SECAP, and profiles addressing current climatic risks and energy poverty will be evaluated.

2.1. ESKİŞEHİR IN NUMBERS

Eskişehir has an area of 13,652 km². According to the 2022 data from the Turkish Statistical Institute (TÜİK), its population is 906,617, making it the 25th most populous province in Türkiye. In terms of population density, it ranks 41st. Within the metropolitan boundaries, there are 14 districts and 539 neighborhoods linked to these districts.



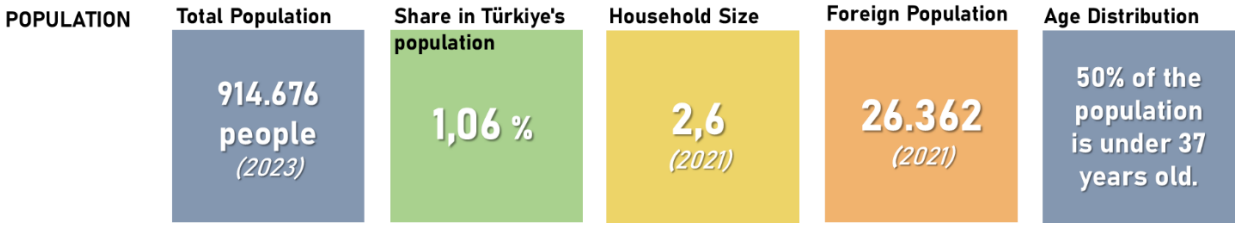
Eskişehir has a mixed climate type due to its location within the influence area of Central Anatolia, the Western Black Sea, and the Mediterranean climates[5]. According to data from the Turkish State Meteorological Service (TSMS), the average highest temperature in Eskişehir is 17.8°C, while the average lowest temperature is 4.3°C. The lowest temperatures are recorded in January, and the highest temperatures are measured in the summer months. The city has an average of 6.6 hours of sunshine per day. The average number of rainy days is 77, with the average annual total precipitation being around 355.9 mm. [6] July and August are dry months. However, they periodically experience the effects of the Black Sea summer rains.



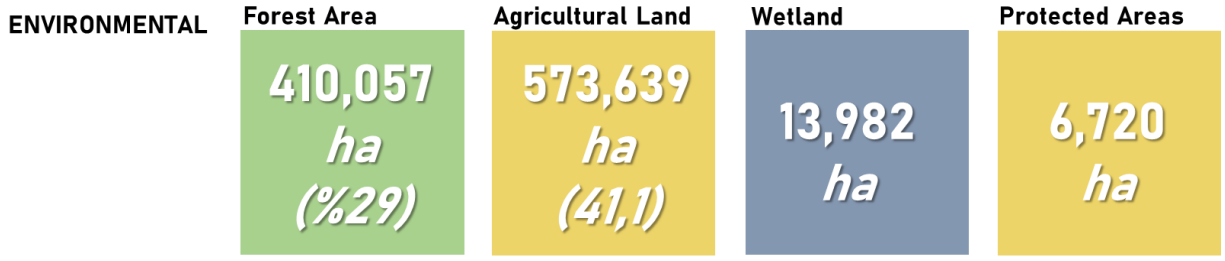
According to data from the Turkish Statistical Institute (TÜİK), Eskişehir's population makes up 1.06% of the total population of Türkiye. The average household size is 2.6, which is below the 2021 national average of 3.23 of the country. 49.8% of the population is male, while 50.2% is female. The foreign

[5] Tarım ve Orman Bakanlığı. (2022). Eskişehir İl Tarım ve Orman Müdürlüğü Genel Bilgiler. https://eskisehir.tarimorman.gov.tr/
[6] MGM. (2023). Resmi İstatistikler Eskişehir. https://www.mgm.gov.tr/

population living in Eskişehir is 26,362 people, making up approximately 2.9% of the total population. Looking at the age breakdown, it is observed that 50% of the population is younger than 37 years old, indicating that the majority of the population is young. [7]



Approximately 29% (410,057 hectares) of Eskişehir consists of forest areas, while 41.1% is comprised of agricultural lands. There are about 13,982 hectares of wetlands within the province. Additionally, there is a protected area of 6,720 hectares, significant for its biodiversity and historical characteristics. [8]



Eskişehir stands out as one of Türkiye's important cities in terms of socio-economic development. According to 2021 data from the Turkish Statistical Institute (TÜİK), the illiteracy rate is 1.5%. 43% of the population have primary and middle school education, while 48% have graduated from higher education institutions (high school and above, including bachelor's, master's, doctorate, etc.)[9] When looking at the sectoral distribution, the economy of Eskişehir comprises 54% from the services sector, 39% from the industrial sector, and 7% from the agricultural sector. [10] Eskişehir, one of the provinces with the highest technology intensity in Türkiye, also has a Gross Domestic Product (GDP) per capita of $10,158 in 2021, which is above the average for Türkiye.[11] According to the 2020 regional statistics for the TR41 Bursa Eskişehir Bilecik area, where Eskişehir is located, the unemployment rate is 9.6%, and the poverty rate is 9.2%, both of which are below the country average. [12]

[7] EMM. (2021). *İstatistiklerle Eskişehir.* Eskişehir: Eskişehir Büyükşehir Belediyesi Yayını.
[8] ÇED ve Çevre İzinleri Şube Müdürlüğü. (2022). Eskişehir İli 2021 Yılı Çevre Durum Raporu.
[9] TÜİK, 2021
[10] Sanayi ve Teknoloji Bakanlığı. (2020). Eskişehir Ekonomik Yapı. www.investineskisehir.gov.tr:
[11] BEBKA. (2022). Bursa Bilecik Eskişehir Kalkınma Ajansı - Eskişehir . https://bebka.org.tr
[12] EMM. (2021). *İstatistiklerle Eskişehir.* Eskişehir: Eskişehir Büyükşehir Belediyesi Yayını.

According to the Socio-Economic Development Ranking of Districts prepared by the Ministry of Industry and Technology, Odunpazarı district is in the 1st tier; Tepebaşı district in the 2nd tier; İnönü and Sivrihisar districts in the 3rd tier; Çifteler, Seyitgazi, Mahmudiye, Alpu, Beylikova, and Mihalgazi districts in the 4th tier; and Sarıcakaya, Günyüzü, Mihalıççık, and Han districts are also in the 4th tier. [13]

Table 1 Eskişehir districts socioeconomic development ranking

District	Rank (TR)	Tier	District	Rank (TR)	Tier
Odunpazarı	48	1	Alpu	557	4
Tepebaşı	84	2	Beylikova	570	4
İnönü	256	3	Mihalgazi	595	4
Sivrihisar	406	3	Sarıcakaya	653	5
Çifteler	437	4	Günyüzü	670	5
Seyitgazi	506	4	Mihalıççık	679	5
Mahmudiye	521	4	Han	776	5

2.2. ESKİŞEHİR GREENHOUSE GAS INVENTORY RESULTS

In the preparation of the greenhouse gas inventory and the setting of mitigation targets in the Sustainable Energy and Climate Action Plan, the methods and standards adopted by the Covenant of Mayors (CoM) are utilized. The following figure shows the steps followed in the preparation process of the Sustainable Energy and Climate Action Plan.

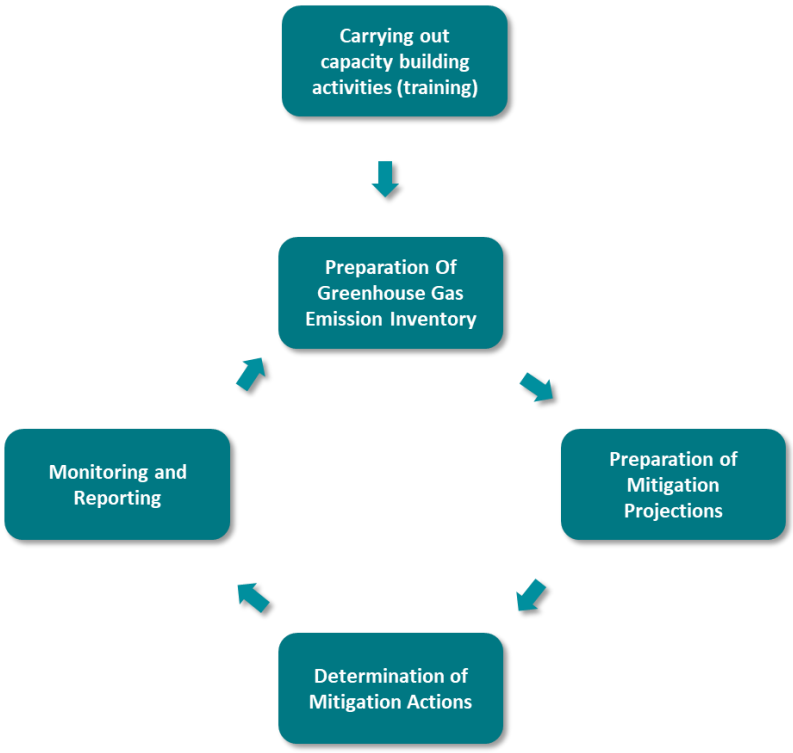


Figure 5: Greenhouse gas management process

[13] Sanayi ve Teknoloji Bakanlığı, İlçelerin Sosyo-Ekonomik Gelişmişlik Sıralamaları (2022)

a) Carrying Out Capacity Building Activities (Training): Providing training to municipal teams to enhance institutional capacity

b) Preparation of the Greenhouse Gas Inventory: Collecting consumption data of greenhouse gas sources specific to Eskişehir and identifying the major sources of greenhouse gas emissions in the city to prepare the greenhouse gas inventory

c) Preparation of Mitigation Projection: Creating actions in the greenhouse gas mitigation section of the Sustainable Energy and Climate Action Plan prepared for Eskişehir Metropolitan Municipality, focusing on buildings, renewable energy, transportation, waste, and wastewater management, agriculture and livestock.

d) Determination of Mitigation Actions: Determination and prioritization of actions in the Sustainable Energy and Climate Action Plan

e) Monitoring and Reporting: Monitoring and reporting changes in greenhouse gas sources and energy consumptions based on the specified base year.

2.2.1. Methodology

The Covenant of Mayors initiative allows newly participating municipalities to develop a mitigation action plan that fits their local conditions. For municipalities that have already established energy and climate actions, it enables the development of a mitigation action plan without significant changes to their approaches. Considering this principle, the Covenant has developed a flexible methodology based on existing standards and methods or adapted from them.

The International Council for Local Environmental Initiatives (ICLEI) has developed the International Local Government Greenhouse Gas Emissions Analysis Protocol (IEAP), which is an easily applicable guide containing common rules and standard approaches for local governments to concretely identify and make comparable mitigation in greenhouse gas emissions. Thanks to IEAP, greenhouse gas audit processes have been simplified, the achievements resulting from the activities of different communities have been aggregated and reported, and a reliable database has been established. ICLEI assists local governments in their efforts to reduce greenhouse gases that contribute to both climate change and deteriorating air quality. To date, it has provided analytical tools and methods for local governments to measure their emissions, set mitigation targets, and achieve these goals.

The most commonly used framework for creating corporate greenhouse gas inventories is the international Greenhouse Gas Protocol (GHG Protocol). For the preparation of city-scale greenhouse gas emission inventories, the 2014 IPCC National Greenhouse Gas Inventory Guidelines and the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) developed by the IPCC National Greenhouse Gas Inventories Programme are used as the basis.

Base Year

The base year is the year against which the emission mitigation target will be compared to when monitoring the results of proposed actions. The year is chosen taking into account a year with the most reliable data available and without extraordinary events (such as a pandemic, etc.). In this context, the base year for Eskişehir has been selected as 2021.

Scope

Within the boundaries of the Eskişehir Metropolitan Municipality, the selected sectors are buildings, energy, transportation, waste, and wastewater, agriculture and livestock and greenhouse gas emissions related to the industrial sector have also been calculated. The industrial sector, which can largely be characterized as private sector, is not under the enforcement authority of the Eskişehir Metropolitan Municipality. Therefore, when setting mitigation targets, industrial greenhouse gases have been excluded from the scope.

Method

In preparing the current greenhouse gas inventory, the activity-based approach, which is most commonly used by cities, has been employed. In this approach, all CO_2e (or greenhouse gas) emissions resulting from direct (through fuel combustion) or indirect (through electricity consumption) energy consumption in Eskişehir are included. While most of the greenhouse gas emissions are CO_2 emissions, CH_4 and N_2O emissions have secondary importance in terms of combustion processes in the residential and transportation sectors. All CO_2, CH_4, and N_2O emissions are calculated for all types of fuels, using the emission factors from the IPCC's Fifth Assessment Report (AR5), along with their global warming potentials (GWP).

- **Scope 1** – direct greenhouse gas emissions: These are emissions from all stationary and mobile greenhouse gas sources owned or directly controlled by the institution. Assets that are owned, leased, or acquired through financial leasing are included in these sources. The scope boundary encompasses all emission sources that can be controlled. This scope should include refrigerant gases of air conditioning systems used in operations.
- **Scope 2** – indirect greenhouse gas emissions from energy: These are the greenhouse gases resulting from the energy purchased for the institution's operations. This scope should include grid electricity used or other types of energy utilized for heating/cooling purposes.
- **Scope 3** – indirect greenhouse gas emissions: These are the greenhouse gas emissions caused by the institution's activities outside of indirect greenhouse gases scope and under its control. They can occur from activities before or after the institution's core operations or employee travel (Figure 6).

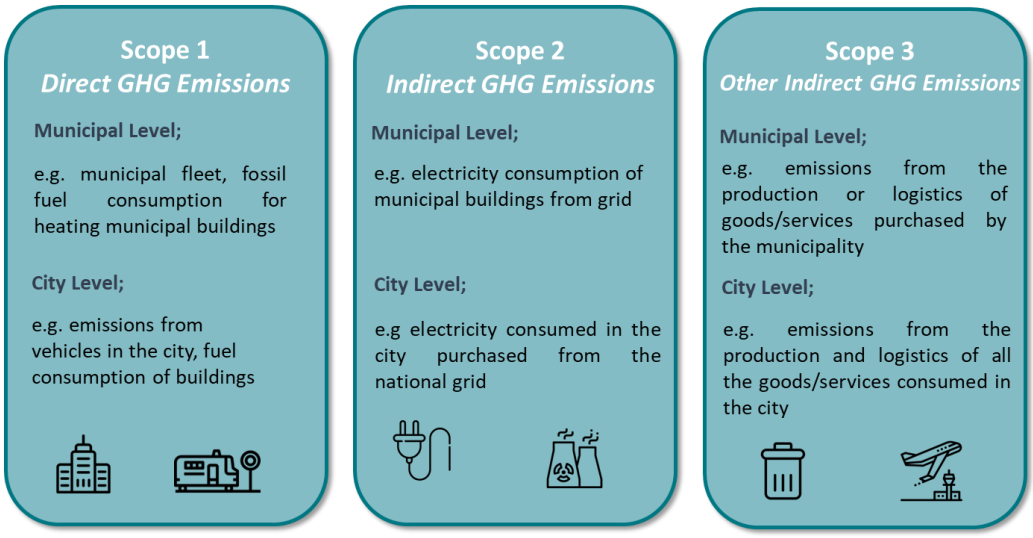


Figure 6: Greenhouse gas sources by their scopes

For the global warming potentials of different greenhouse gases, those specified in the Kyoto Protocol have been used, along with the greenhouse gases and global warming potentials that need to be included in greenhouse gas inventories. These are;

Table 2: Greenhouse gases and GWP values according to IPCC and Kyoto Protocol

Greenhouse Gases	Chemical Formula	Atmospheric lifetime (Years)	Global Warming Potential* (CO_2e) [14]
Carbon dioxide	CO_2	5-200	1
Methane	CH_4	12	28
Nitrous oxide	N_2O	114	265
Perfluorocarbons	PFCs	50.000**	6.630-9.200
Hydrofluorocarbons	HFCs	226**	148-12.400
Sulfur hexafluoride	SF_6	3.200	23.500
Nitrogen trifluoride	NF_3	740	16.100

* : It is time dependent.
**: The highest values are shown for this group of greenhouse gases.

2.2.2. Greenhouse Gas Inventory

In line with the data collected from Eskişehir Metropolitan Municipality and external stakeholders (electricity and gas distribution companies, EPDK, etc.), the greenhouse gas inventory for the city of Eskişehir for the year 2021 has been calculated. The inventory includes the sectors of buildings, energy, transportation, waste, and wastewater, agriculture and livestock which are selected within the boundaries of the Eskişehir Metropolitan Municipality. Since the Eskişehir Metropolitan Municipality has no enforcement authority in the industrial sector, two inventories have been prepared, including and excluding the industry.

As seen in Table 3, the energy consumption of the city of Eskişehir for the year 2021, including industry, is calculated as 18,564,139 MWh and the greenhouse gas emission is 7,219,456 tCO_2e. According to the table, the share of emissions from fuel and electricity consumption of buildings in the total emission is 58.1%. Greenhouse gas emissions from transportation account for 17.1%, while other emissions including solid waste, wastewater treatment, agriculture and livestock have a share of 24.7%.

Table 3: Eskişehir greenhouse gas emission amounts, 2021 (including industry)

Sector		MWh	tCO_2e	%
Buildings	Municipal Buildings and Facilities	98,604	39,164	0.5
	Commercial Buildings	1,230,159	368,045	5.1
	Residential Buildings	3,842,498	960,066	13.3
	Street Lighting	52,730	24,098	0.3

[14] https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values %20%28Feb %2016%202016%29_1.pdf

Sector		MWh	tCO_2e	%
	Industry	8,405,941	2,805,644	38.9
	Subtotal	**13,629,932**	**4,197,017**	**58.1**
Transport	Municipal Vehicle Fleet	21,413	6,092	0.1
	Public Transportation Municipal Buses	77,681	21,051	0.3
	Public Transportation Electric Systems	14,114	6,450	0.1
	City Vehicles	4,529,606	1,202,290	16.7
	Civil Airport	3,806	989	0.01
	Subtotal	**4,646,621**	**1.236.874**	**17.1**
Other Emissions	Solid Waste Disposal	-	31,786	0.4
	Wastewater Treatment Emissions	-	80,240	1.1
	Wastewater Treatment Process CH_4	-	*68,086*	*0.9*
	Wastewater Treatment Process CO_2	-	*8,650*	*0.1*
	Wastewater Treatment Process N_2O	-	*1,020*	*0.01*
	Wastewater Treatment Process Non-N_2O	-	*15*	*0.0*
	Wastewater Treatment Discharge N2O	-	*2,469*	*0.03*
	Fugitive Emissions	-	214	0.0
	Industrial Process Emissions	-	671,250	9.3
	Agriculture, Livestock and Land Use	-	870,649	12.1
	Agricultural Irrigation	287,586	131,427	1.8
	Subtotal	**287,586**	**1,785,566**	**24.7**
Grand total		**18,564,139**	**7,219,456**	**100.0**

Table 4 shows that the energy consumption of the city of Eskişehir, excluding industry, civil airport, fugitive, and industrial process emissions, is 10,154,392 MWh and the greenhouse gas emission amount is 3,741,358 tCO_2e.

Table 4: Eskişehir greenhouse gas emission amounts, 2021 (excluding industry)

Sector		MWh	tCO_2e	%
Buildings	Municipal Buildings and Facilities	98,604	39,164	1.0
	Commercial Buildings	1,230,159	368,045	9.8
	Residential Buildings	3,842,498	960,066	25.7
	Street Lighting	52,730	24,098	0.6
	Subtotal	**5,223,991**	**1,391,373**	**37.2**
Transportation	Municipal Vehicle Fleet	21,413	6,092	0.2
	Public Transportation Municipal Buses	77,681	21,051	0.6
	Public Transportation Electric Systems	14,114	6,450	0.2
	City Vehicles	4,529,606	1,202,290	32.1
	Subtotal	**4,642,815**	**1,235,884**	**33.0**
Diğer Emisyonlar	Solid Waste Disposal	-	31,786	0.8
	Wastewater Treatment Emissions	-	80,240	2.1
	Wastewater Treatment Process CH_4	-	*68,086*	*1.8*
	Wastewater Treatment Process CO_2	-	*8,650*	*0.2*
	Wastewater Treatment Process N_2O	-	*1,020*	*0.03*
	Wastewater Treatment Process Non-N_2O	-	*15*	*0.0*
	Wastewater Treatment Discharge N_2O	-	*2,469*	*0.1*

	Agriculture, Livestock and Land Use	-	870,649	23.9
	Agricultural Irrigation	287,586	131,427	3.5
	Subtotal	**287,586**	**1,114,101**	**29.8**
Genel Toplam		**10,154,392**	**3,741,358**	**100.0**

Buildings

In the city of Eskişehir, the share of the buildings sector, excluding industry, is 37.2%. This rate is the highest share within the total greenhouse gas emission inventory. Since buildings represent a large portion of total emissions, interventions in this sector are of great importance for achieving the mitigation target. The greenhouse gas emission amounts of the buildings sector are shown in a detailed breakdown.

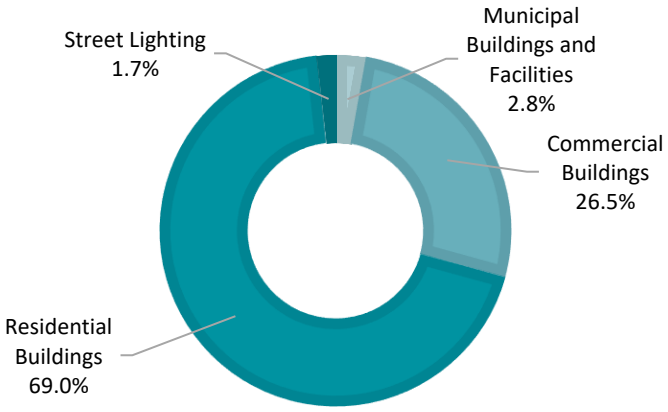


Figure 7: Greenhouse gas distribution of buildings, 2021

When we look at the breakdown of buildings sector, it is seen that 69.0% of GHG emissions are from residential buildings, 26.5% from commercial buildings, and 2.8% from municipal buildings and facilities. Figure 8 shows the breakdown of emissions from residential buildings according to the type of energy consumption source.

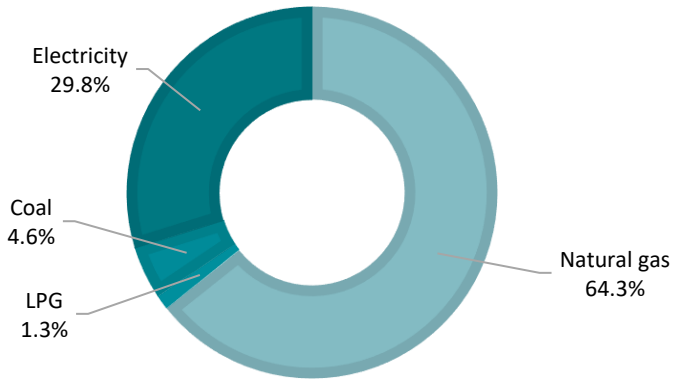


Figure 8: Breakdown of greenhouse gas emissions in residential buildings, 2021

When analyzing the GHG emissions by energy consumption sources in residential buildings it should be mentioned that natural gas has the highest rate 64.3% then it is electricity with a 29.8% rate, coal is third with 4.6% while LPG is in the last place with 1.3%.

Transport

In the 2021 GHG inventory, the transportation sector, which is the second highest source of emissions, accounts for 33.0% of the total inventory (excluding industry). In the transportation sector, emissions result from fuel and electricity consumption in the municipality's vehicle fleet, city vehicles, and public transport vehicles.

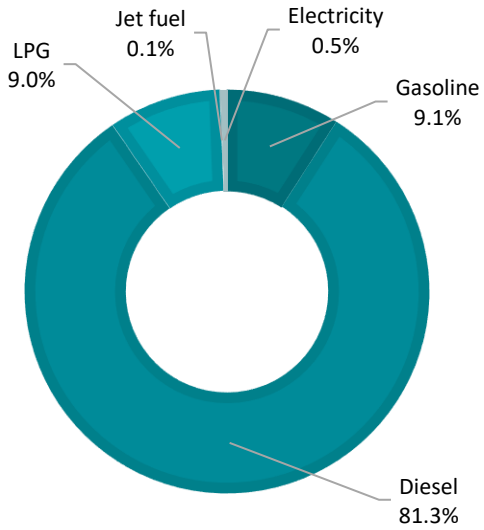


Figure 9: Transportation greenhouse gas distribution, 2021

In transportation-related GHG emissions, the largest share is from diesel with 81.3%. This is followed by emissions from gasoline consumption, which account for 9.1%, while a 9.0% share is due to LPG consumption. Emissions from electricity consumption hold a 0.5% share, and jet fuel has a 0.1% share.

Waste and Wastewater

In the 2021 greenhouse gas inventory of the city of Eskişehir, the share of the waste and wastewater sector in total emissions (excluding industry) is 3.0%. In addition to Eskişehir's Central Wastewater Treatment Plant, there are significant wastewater treatment facilities in the Sivrihisar and Çifteler districts, and many package wastewater treatment facilities operate in other districts of the city.

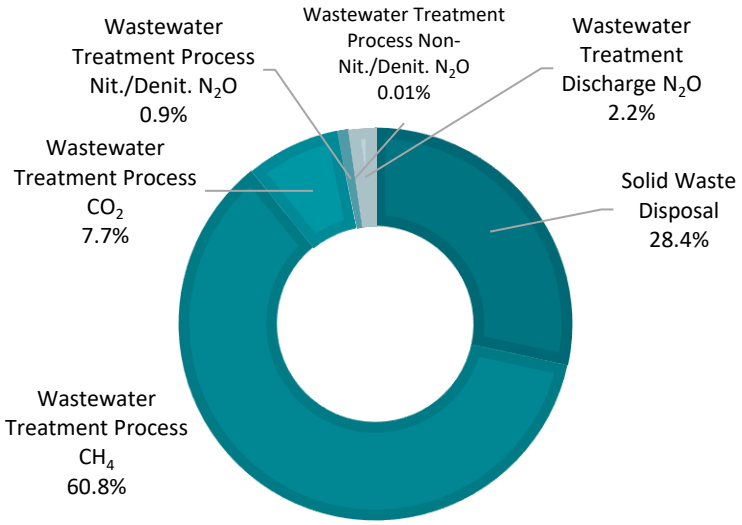


Figure 10: Greenhouse gas emissions from solid waste disposal and wastewater treatment, 2021

When analysing greenhouse gas emissions from solid waste disposal and wastewater treatment, the largest share, at 60.8%, is attributed to CH_4 emissions from wastewater treatment processes. This is followed by emissions from solid waste disposal, accounting for 28.4%, while CO_2 emissions from wastewater treatment processes make up a 7.7% portion.

Agriculture and Livestock

In the 2021 greenhouse gas inventory of the city of Eskişehir, the agriculture and livestock sector accounts for a share of 26.8%. Emissions from the use of chemical fertilizers and agricultural irrigation in agriculture, as well as emissions from enteric fermentation and fertilizer management in the livestock sector, have been included in the calculations.

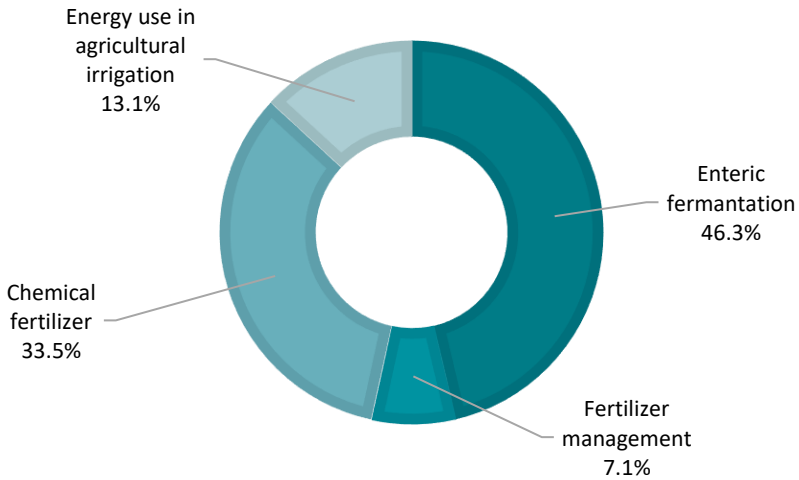


Figure 11: Agriculture and livestock greenhouse gas distributions, 2021

2.3. CURRENT CLIMATE CHANGE PROFILE

Detailed studies related to climate change in the context of Türkiye are included in the latest Türkiye's Eighth National Communication. This section also includes observations and research conducted by the General Directorate of Meteorology (MGM). Additionally, in this section, a summary of data related to the current situation of climate change in Türkiye and Eskişehir will be provided.

Table 5: Eskişehir basic climate indicators[15]

Eskişehir Basic Climate Indicators	Yearly
Average Temperature (°C)	11.0
Average Highest Temperature (°C)	17.8
Average Lowest Temperature (°C)	4.4
Average Insolation Time (hours)	6.6
Average Number of Rainy Days	72.6
Average Monthly Total Precipitation Amount (mm)	355.9
Maximum Temperature (°C)	40.6
Minimum Temperature (°C)	-28.6
Daily Maximum Total Precipitation Amount (mm)	65.7
Daily Maximum Wind Speed (m/s)	28.3
Maximum Snow Thickness (cm)	30

Temperature Values

According to the observations made by TSMS, as stated in the Eighth National Communication, it is expressed that precipitation has decreased and temperature has increased during the summer months across Türkiye.[16] According to the 2022 Report of the TSMS, with 14.5 °C; the average temperature of Türkiye, which was 13.9 between the years 1991–2020, has occurred 0.6°C above the average (Figure 12) The average temperatures have only been above the older averages since 2007 (excluding 2011). The year 2022, with 14.5°C, has been the seventh warmest year.[17]

[15] www.mgm.gov.tr, Resmi İstatistikler, İllere ait mevsim normalleri (1991-2020) Date of access: Kasım 2023
[16] Türkiye Sekizinci Ulusal Bildirimi ve Türkiye'nin Beşinci 2 Yıllık Raporu, 2023
[17] MGM. 2022 Yılı İklim Değerlendirmesi Raporu, (2023)

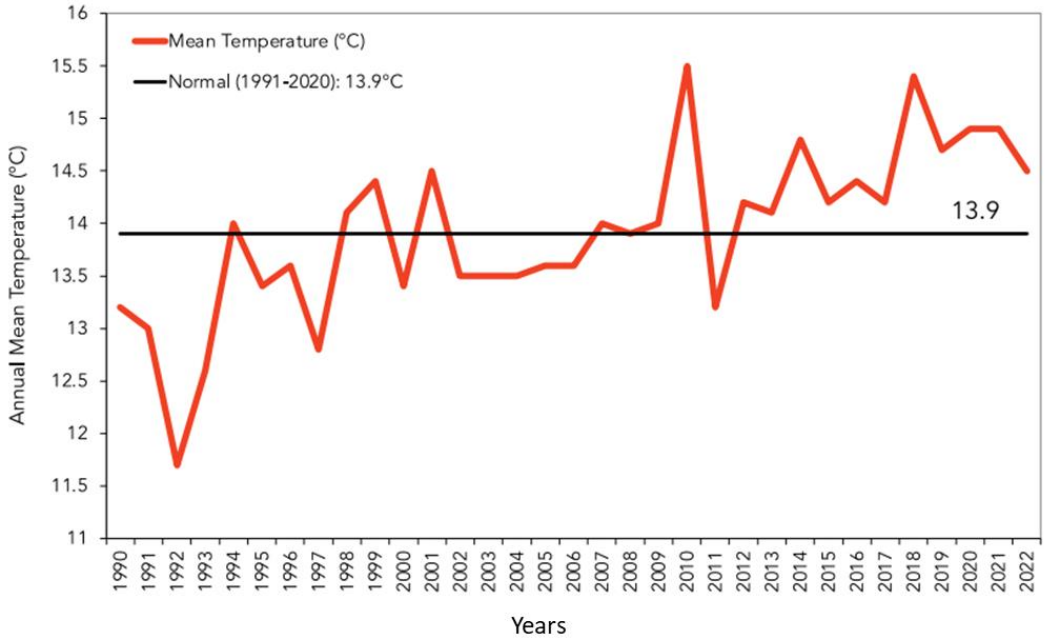


Figure 12: Change in average temperatures in Türkiye[18]

The average summer temperature in Türkiye for the years 1991-2020 is 24.0 °C. The average summer temperature for the year 2022 was 24.6 °C, which is 0.6°C above the seasonal norms. The summer of 2022 has been the eighth warmest summer in the last 52 years. Looking at regional assessments, temperatures in all regions have been above long-term averages. In the Central Anatolia region, where Eskişehir is located, the temperature difference between the long-term averages and the year 2022 is seen to be 0.4 °C (Figure 13).

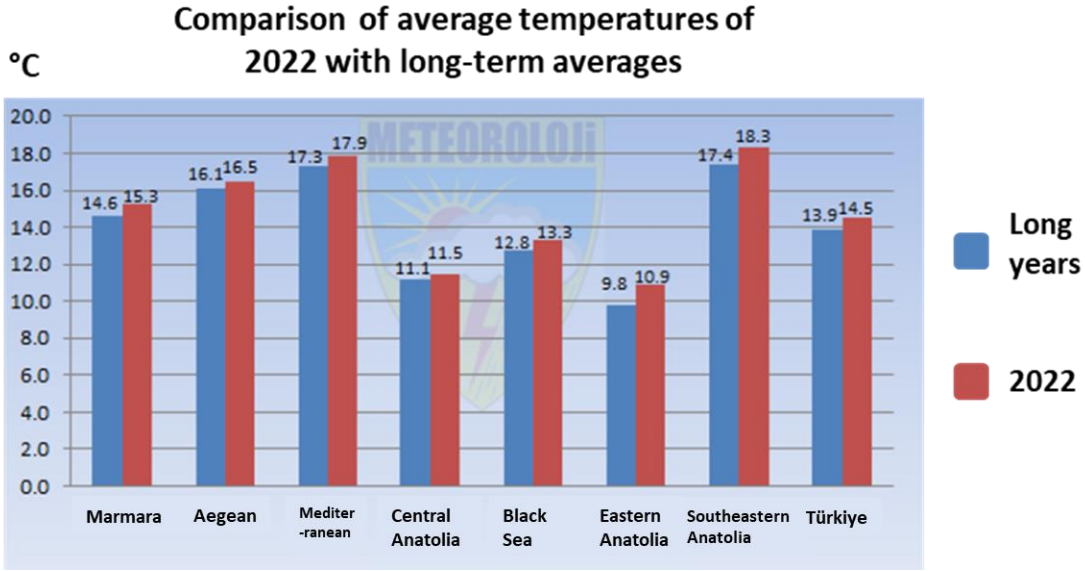


Figure 13: Comparison of average regional temperatures in 2022 with long-term averages

[18] Türkiye Sekizinci Ulusal Bildirimi ve Türkiye'nin Beşinci 2 Yıllık Raporu, 2023

Finally, according to the data from the General Directorate of Meteorology of the Ministry of Environment, Urbanization and Climate Change, it has been reported that the weather record of 49.1 measured in July of the previous year 2021, was recorded at 49.5 in the Sarıcakaya district of Eskişehir in the year 2023.

Precipitation Evaluations

The annual precipitation norms for Türkiye are 573.4 mm. In 2022, it was observed that there was a 21.1% decrease in precipitation and a 4% decrease compared to the precipitation in 2021. Across Türkiye, areal rainfall has shown a decrease in the months of April, May, July, September, November, and December compared to the averages. In 2022, precipitation in April and December showed a decrease of more than 50% compared to the seasonal norms, with the highest increase being 60% in June. Looking at the precipitation in Eskişehir in 2022, it is observed that there was an increase by 40-60% compared to the averages .(Figure 14).

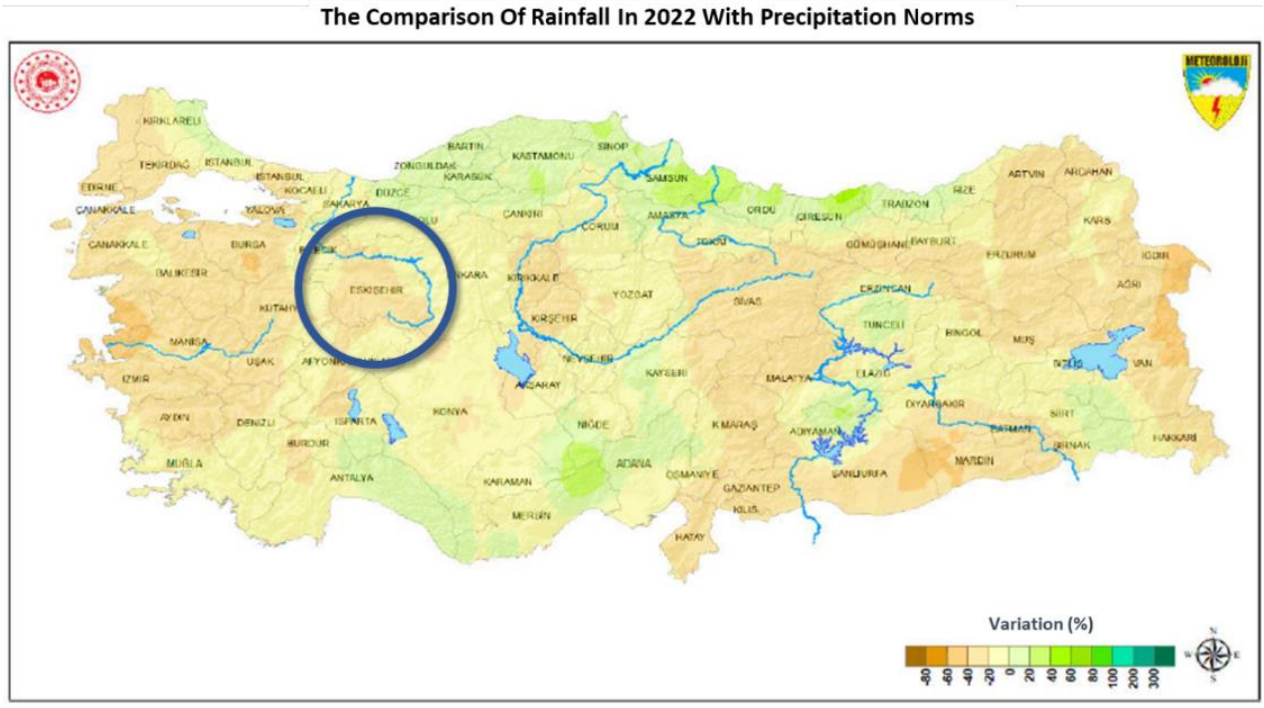


Figure 14: The deviation of Türkiye's 2022 rainfall from the normals

Drought

The definition of drought in the United Nations Framework Convention is described as "a natural event caused by precipitation significantly below recorded norms, adversely affecting land and water resources and disrupting hydrological balance." According to the Thornthwaite climate classification, it falls under the Semi-arid (D) and semi-arid to slightly humid (C1) region.

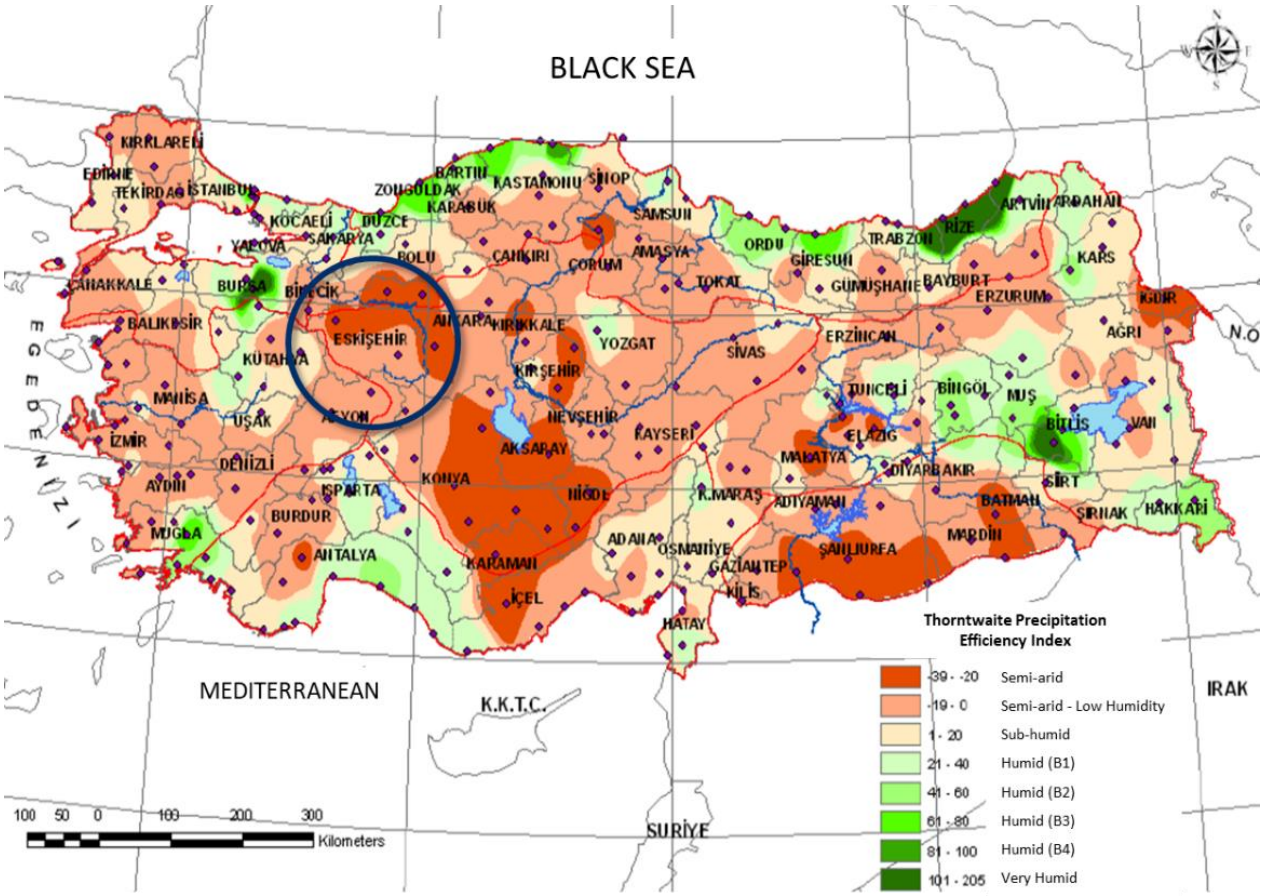


Figure 15: Türkiye's climate according to Thornthwaite climate classification[19]

[19] Tarım ve Orman Bakanlığı, Sakarya Havzası Taşkın Yönetim Planı, 2018

Meteorological Disasters

When analysing the distribution of meteorological disasters across Türkiye, a significant increase has been observed in the last 20 years. The highest increase has been in **severe precipitation and flooding**, followed by **storms and hail** events. In 2022, the extreme meteorological events consisted of severe precipitation and flooding (33.6%), storms (21.4%), hail (18.5%), lightning strikes (4.1%), and other meteorological events such as forest fires, landslides, and frost.

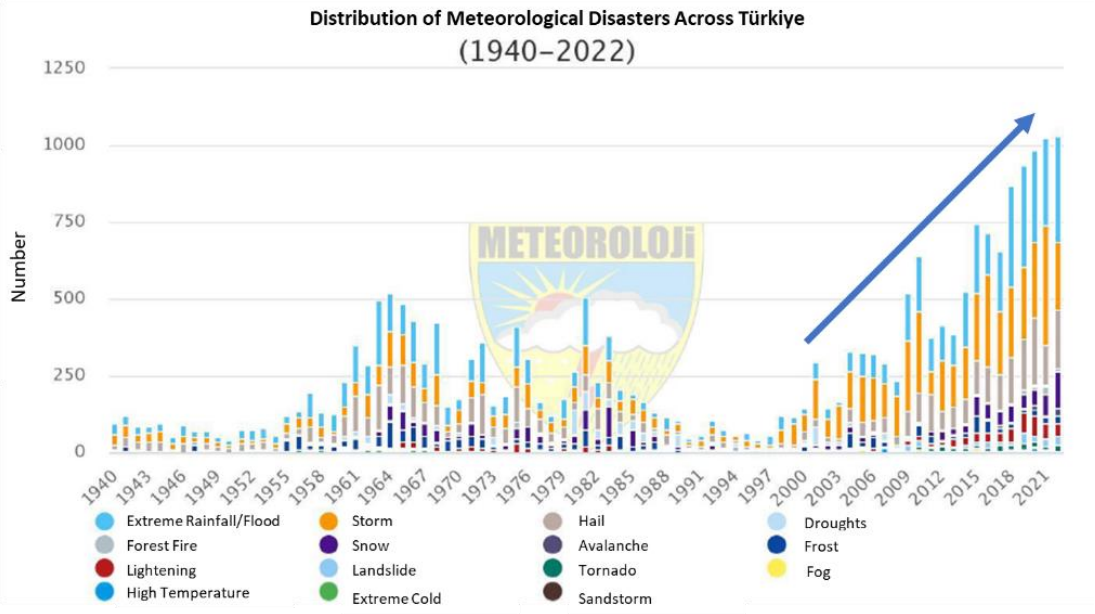


Figure 16: Meteorological disaster distribution throughout Türkiye (1940 - 2022)

In the Eskişehir province, landslides and floods are frequent disasters caused by excessive rainfall. According to the Disaster and Emergency Management Presidency report, the most significant triggering factor for landslides in the region is precipitation. In 2019, there were 19 instances of flooding/water inundation, and some of these areas have been declared Disaster-Prone Areas.

In Eskişehir, there are regions through which the Sakarya River, Sarısu Stream, Porsuk Stream, and Seydi Stream flow. The area is at risk of flooding due to its geological and topographic characteristics, as well as excessive precipitation and rapid snowmelt caused by climate change. Within the provincial boundaries, a total of 41 floods occurred between 1960 and 2012, but no fatalities were reported.

Recently, in June 2023, a flood occurred in Eskişehir following heavy precipitation, particularly affecting the Çatören and Yarbasan Streams in the Seyitgazi district. This event caused damage in some neighborhoods. The disaster resulted in the collapse of walls in some houses, trapping residents in certain areas, road closures, and harm to numerous animals.

Şekil 1: Flood event that occurred in Eskişehir in 2023 [20]

Forest Fires

Forests cover approximately 28.8% of Eskişehir's surface area. The forests in the province are located in the 1st, 2nd, and 3rd Degree fire-sensitive zones. When analyzing the forest fires that occurred between 2010 and 2019, it is observed that there were 208 forest fire incidents. In Eskişehir, an average of 57 hectares of land is damaged each year due to forest fires (AFAD, 2021). The most frequent natural disasters in Türkiye in 2020 and 2021 were reported in Türkiye's 8th National Communication Report. Data indicates that the number of forest fires occurring in Eskişehir is high. [21]

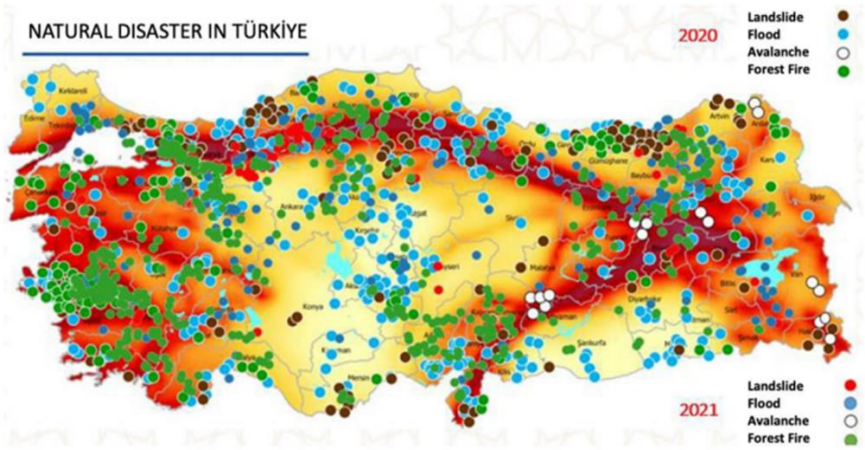


Figure 17: Map of natural disasters in Türkiye

[20] NTV Haber, Eskişehir'de kuvvetli yağış sele neden oldu (2 Haziran 2023) Date of access: Eylül 2023
[21] Türkiye Sekizinci Ulusal Bildirimi ve Türkiye'nin Beşinci 2 Yıllık Raporu

2.1. ENERGY POVERTY PROFILE OF ESKİŞEHİR

Energy poverty is a complex situation that is generally defined as the inability of households to meet their energy needs and is caused by the combination of many factors. This situation includes the household's inability to access energy/electricity for heating and cooling purposes, failing to sufficiently heat/cool when access is available, and the inability to affordably access energy-providing services. At the same time, the use of polluting fuels for heating and meeting other basic needs is also considered as one of the factors affecting both household and environmental health. [22]

The measurement of energy poverty and its threshold values vary according to local characteristics. It can be analyzed by examining specific features that differ by location, such as geographic position, climate, housing structures, existing heating/cooling equipment, energy prices, and the factors that influence them. In addition to all these, household and individual-specific socioeconomic factors such as age, health, and economic conditions also play a significant role in determining energy poverty.

It is important to offer a simplified approach based on three main foundations to understand the complex structure of energy poverty. The commonly identified basic causes are low-income levels, low energy-efficient buildings, and high energy prices. Identifying energy poverty is possible through analyses conducted under these three main factors which are fundamentally interconnected and vary at local and national levels. When measuring the factors causing energy poverty, a concrete approach can be outlined by considering the three main factors together.[23] (Figure 18).

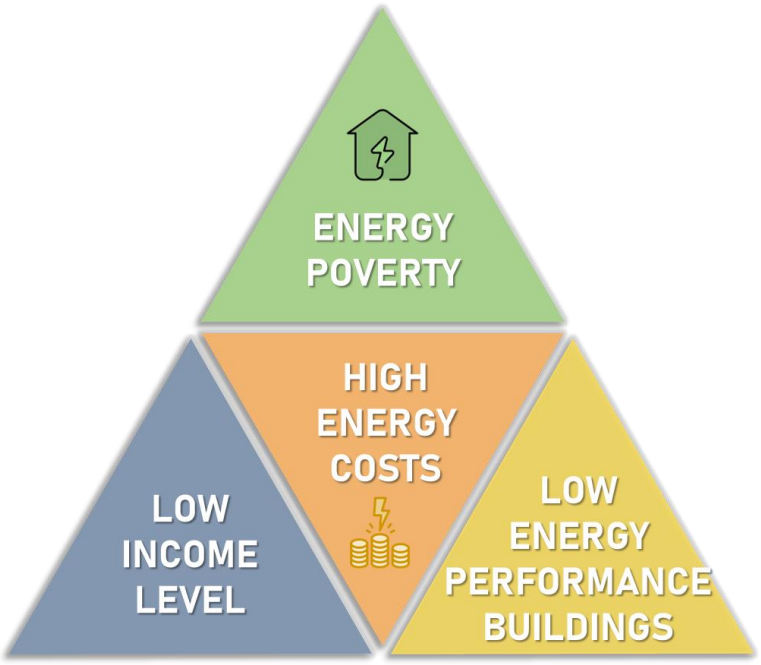


Figure 18: 3 basic factors of energy poverty

[22] EPAH, Introduction to the Energy Poverty Advisory Hub (EPAH) Handbooks: A Guide to Understanding and Addressing Energy Poverty, (2022)
[23] EPAH, Introduction to the Energy Poverty Advisory Hub (EPAH) Handbooks: A Guide to Understanding and Addressing Energy Poverty, (2022)

Buildings

Low-energy performance buildings are connected to low income; the need for minimum heating/cooling to maintain a comfortable and healthy life in low-performance and old buildings, the high energy expenditure required to retain heat, and the high proportion of the cost of the energy spent in household income can be defined as energy poverty. The presence of heating/cooling systems that make new buildings more energy efficient contributes to the increased energy efficiency of these buildings.

Looking at the building stock in Eskişehir, it is observed that 13% of the buildings are from 1980 and earlier, 24% are from the years 1980-2000. 63% of the buildings were constructed after the year 2000 and the average building age throughout Eskişehir is 21 years.[24] Odunpazarı district is the region where the oldest buildings are located.

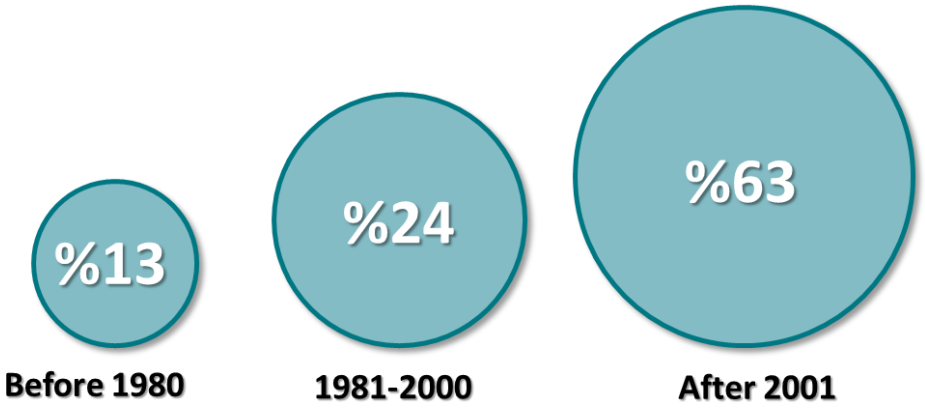


Figure 19: Distribution of building construction years

The types of heating fuels used in buildings provide important clues about their energy efficiency. Regions where polluting solid fuels like coal and wood are heavily used not only increase greenhouse gas emissions but also negatively affect public health. Reducing the use of coal for heating/cooking in households is one of the most important factors in combating energy poverty. Looking at the types of fuels used for heating/cooking in Eskişehir, it is seen that 16.8% of households are using solid fuels like coal and wood. Although this rate is below the Türkiye average (33.5%), carrying out efforts to minimize the use of solid fuels remains one of the important responsibilities of local governments. [25]

[24] TÜİK, Bina ve Konut Nitelikleri Araştırması, 2021
[25] TÜİK, Bina ve Konut Nitelikleri Araştırması, 2021

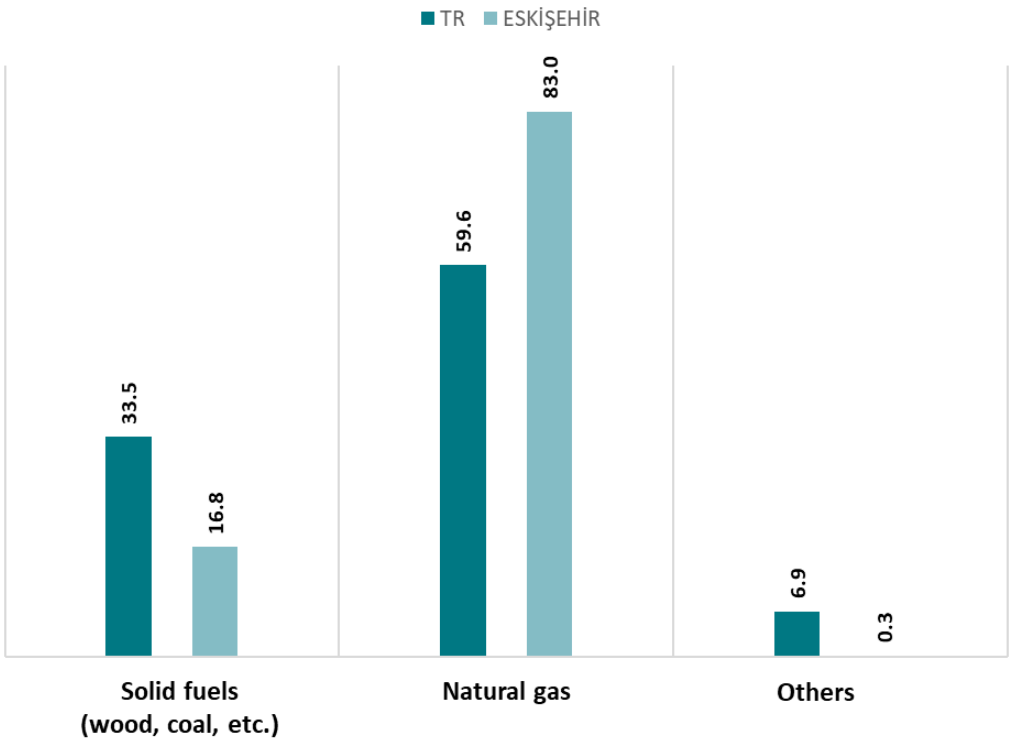


Figure 20: Heating Fuel Type Usage Distribution in Buildings (Eskişehir-Türkiye)

The use of central heating systems in buildings is beneficial in terms of energy efficiency, meeting heating needs and providing economic access to energy. In conditions with metered cost sharing in central heating, costs can decrease by 30-40%. Central heating systems are not very common in Türkiye, only 11.2% of households use central heating systems. In Eskişehir, this rate is 18.6%, which is above the national average.

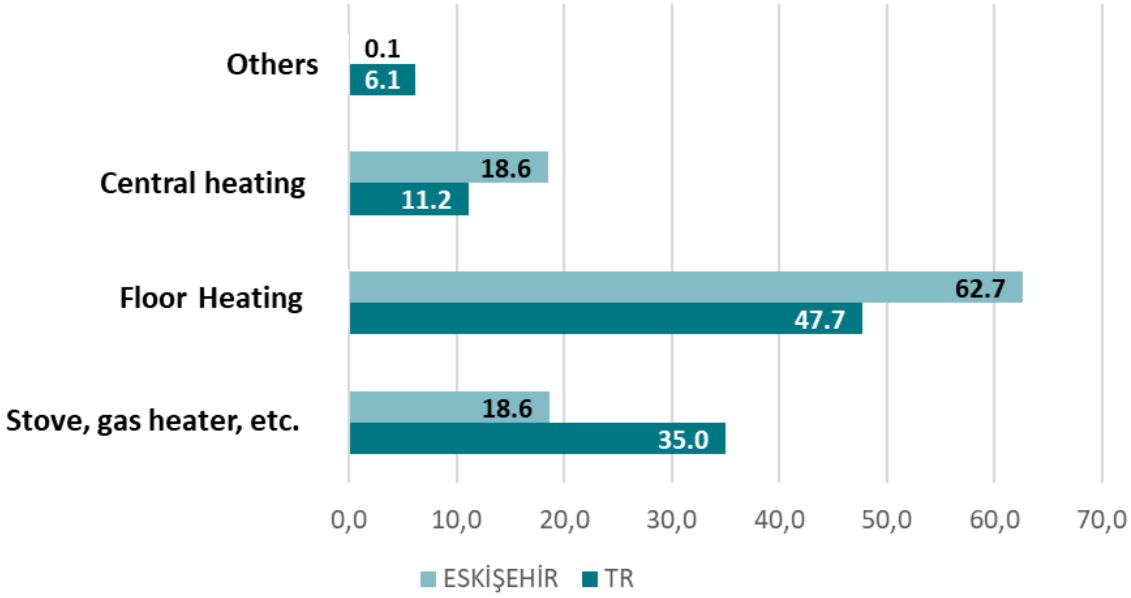


Figure 21: Heating systme usage distribution in buildings (Eskişehir-Türkiye)[26]

Households

In order to make assessments regarding energy poverty, it is necessary to analyse the socioeconomic status of households. Households with low socioeconomic standards are considered more vulnerable to increases in energy prices and sudden changes in air temperatures. According to an analysis based on the age breakdown, education, household size, spending habits, and property values in their areas, the population in Eskişehir that can be considered as having a low (vulnerable) socioeconomic status constitutes approximately 19.5% of Eskişehir's population.[27] According to data from the Department of Social Services of the Eskişehir Metropolitan Municipality, households requesting social support constitute 2.3% of the total households. [28]

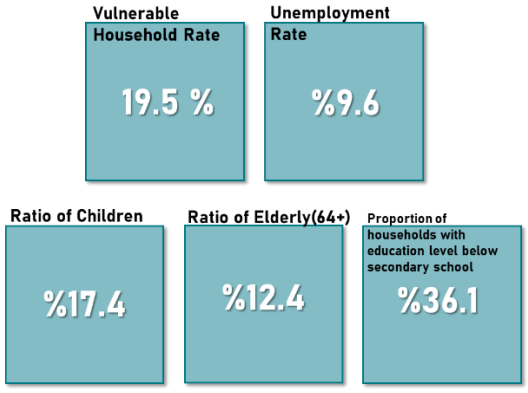


Figure 22: Socioeconomic indicators

[26] TÜİK, Bina ve Konut Nitelikleri Araştırması, 2021
[27] ENDEKSA, https://www.endeksa.com/tr/analiz/turkiye/eskisehir/demografi, Date of access:Ekim 2023
[28] Eskişehir Büyükşehir Belediyesi, Sosyal Hizmetler Daire Başkanlığı

Policy & Regulatory Framework

Like in many countries in the last 10 years, Türkiye has rapidly privatized its energy sector. General support to consumer groups through tariffs is not applied in the energy sector. Protecting low-income groups with social supports is seen as a complement to privatization. The first electricity support application for impoverished consumers is the Electricity Bill Cost and Uninterrupted Power Supply Support for needy households with patients dependent on devices due to chronic illnesses. Apart from this assistance provided to identified vulnerable households, a broader aid covering a larger number of poor households was adopted on February 28, 2019, and implemented on March 1, 2019, known as the Electricity Consumption Support[29]. Electricity Consumption Support covers Turkish citizens who are beneficiaries in households that continue to receive regular social aid under the Law No. 3294 on Social Assistance and Solidarity and the Law No. 2022 on Granting Monthly Allowance to Needy, Powerless, and Lonely Turkish Citizens Aged 65 and Over. The primary source of Electricity Consumption Support is the Social Assistance and Solidarity Promotion Fund. If the fund resources are insufficient, the required amount for payments will be covered by an additional allocation to be included in the budget of the Ministry of Family and Social Services.

In the context of energy poverty in Türkiye, another fuel type subject to social assistance is coal. In 2021, the number of households receiving General Directorate of Turkish Coal Enterprises-Turkish Hard Coal Enterprise coal assistance was 1,874,806; the value of the assistance was 1,225,402,000 TL[30] Coal assistance is provided once a year, before the winter season, in a minimum amount of 500 kg, at the discretion of the Board of Trustees of the Social Assistance and Solidarity Foundation. In 2017, 37.14% of households in Türkiye were using stoves for heating. In terms of fuel type, 28.59% of households used wood, 13.37% used coal, and 49.07% used natural gas. In households with low income, these rates were respectively 46.74%, 20.9%, and 26.89%. In light of the fact that natural gas has reached all provinces and approximately 60%31 of the districts in Türkiye, it can be said that households in urban areas that use coal despite having access to natural gas prefer it because they cannot afford natural gas, and thus fall into the category of energy poverty. Natural Gas Distribution Companies Association of Türkiye states that in cities where natural gas access is possible, the distribution companies are conducting efforts to provide natural gas assistance as an alternative to coal assistance for low-income households, citing examples from Bursa and Düzce. Under these aids, companies provide support to low-income consumers with access to natural gas, such as installation implementations, covering a part of the security deposit by the company, and fuel assistance. The specific purpose of electricity distribution companies in supporting public electricity assistance to poor households is to collect unpaid bills and reduce illegal usage, while the special aim of natural gas companies in assisting poor households is to increase the number of consumers by facilitating the transition to natural gas in areas where access is available.

[29] İhtiyaç Sahibi Hanelere Elektrik Tüketim Desteği Verilmesi Hakkında Karar'ın yürürlüğe konulmasına dair 795 sayılı Cumhurbaşka-nı Kararı. https://www.resmigazete.gov.tr/eskiler/2019/02/20190228-11.pdf

[30] 2023 yılı Cumhurbaşkanlığı Yıllık Programı https://www.sbb.gov.tr/wp-content/uploads/2022/11/2023-Yili-Cumhurbaskanligi-Yillik-Programi.pdf

[31] GAZBİR, 2019 Yılı Doğal Gaz Dağıtım Sektör Raporu

Table 6: Energy poverty summary table

FIELD TITLE	INDICATORS	UNIT	VALUE	YEAR
Climate	Frequency of heat waves	Annual average	6	2004-2022
	Number of heating degree days per year	Number	11	2021
Housing	Energy consumption (electricity+heating) per capita/ national energy consumption (electricity+heating) per capita	%	126	2021
	Households / persons connected to the gas grid / total households or persons	%	84	2021
	Households with centralised heating system / total households	%	18,6	2021
	Average age of the buildings	year	22	2021
	Dwelling ownership	%	61,7	2021
	Percentage of households / persons within the municipality with access to clean cooking fuels and technologies	%	59,6	2021
Socio-economic aspects	Vulnerable households or persons / total households or persons	%	19,7	2021
	Average price of electricity	€	0,08	2021
	Average price of gas	€	0,20	2021
	Citizens / households under poverty threshold / number of citizens / households	%	2,3	2021
	Unemployment rate	%	9,6	2021
	Persons aged under 12	%	17,4	2021
	Persons aged over 65	%	12,4	2021
	Persons with an education level under lower secondary school	%	36,1	2021
Policy and regulatory framework	Existence of energy poverty strategy	Yes/No	No	
	Existing rent regulation	Yes/No	No	
	Specific measures related energy poverty	Yes/No	No	
	Existing incentives for landlord's programs	Yes/No	No	
Participation / awareness-raising	Awareness-raising campaigns targeting vulnerable households	Yes/No	No	
	Engagement and cooperation with local stakeholders on energy poverty	Yes/No	No	

3. ESKİŞEHİR IN THE FUTURE

3.1. POPULATION PROJECTION

During the ten-year period from 2012 to 2022, the population of Eskişehir underwent significant changes due to both natural population growth and migration. Throughout this period, the city's advancements in education and industry played a crucial role in attracting young population, contributing to reshaping of its demographic structure significantly. Figure 23 illustrates the population changes over the decade.

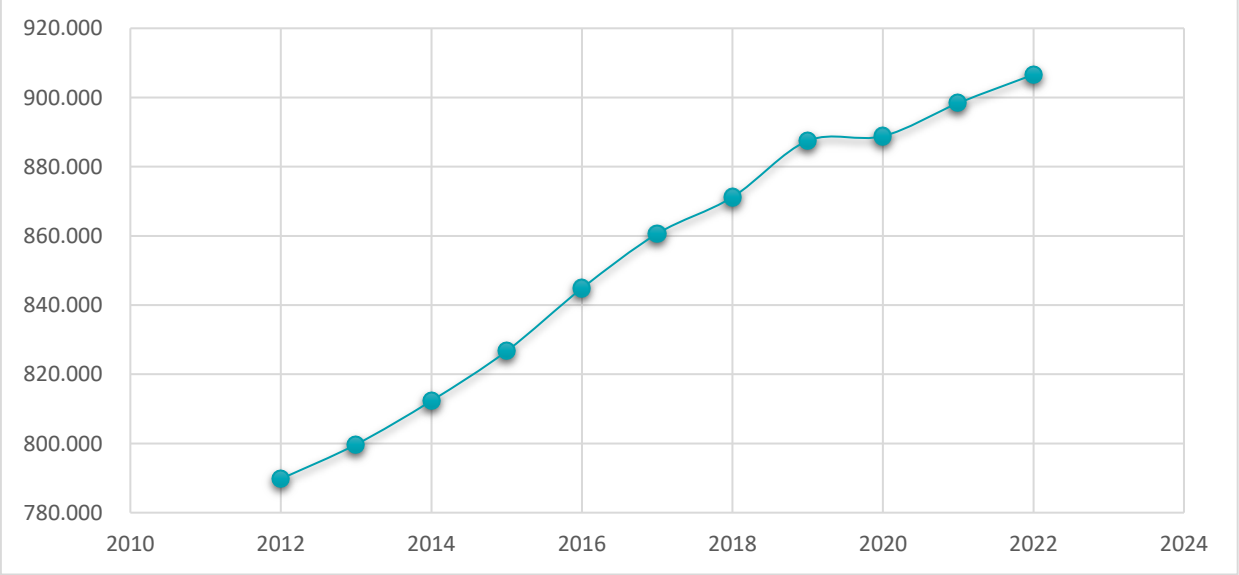
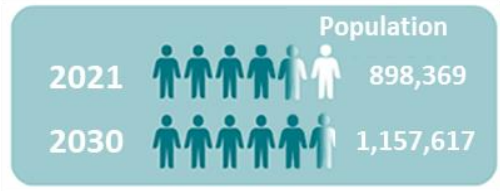


Figure 23: Population Change between 2012-2022[32]



Based on the average population growth rate of 3% between the years 2012-2022, the population projection is estimated to be 1,157,617 people by the year 2030.[33]

3.2. PROJECTION OF GREENHOUSE GAS EMISSIONS IN ESKİŞEHİR IN 2030

The 2030 projection of greenhouse gas emissions for Eskişehir is crucial for understanding the city's future environmental impact. This projection will play a critical role in guiding local governments in reducing carbon emissions, providing a roadmap for the city's strategies to achieve sustainable development goals and combat climate change. It will also be a key step for the city to comply with national and international environmental standards and move towards a green future.

[32] TUİK, 2022

[33] It was calculated within the scope of the report based on TUIK data between 2012 and 2022.

3.2.1. BAU and Mitigation Assumptions

The assumptions for greenhouse gas emissions for the targeted year 2030 take into account factors such as population growth rate, building and service sector growth rate, energy consumption trends in the last decade, and legislative changes within the jurisdiction of Eskişehir Metropolitan Municipality. The assumptions for calculating the city's greenhouse gas development under the BAU scenario, based on sector-specific considerations, are listed below.

Table 7: Assumptions for 2030 mitigation projections

	BAU Assumptions	Mitigation Assumptions
Population Projections		
Population	Based on the average population growth rate over the last 10 years, a 3% yearly increase rate has been taken into account. According to the 2030 projection, the population is estimated to be 1,157,617 in the year 2030.	
Building		
Residential Buildings	The breakdown of electricity consumption is anticipated as follows: – 10% for cooling, – 20% for heating, – 50% for other electrical devices, – 20% for lighting purposes. A proportional change is expected in correlation with population growth.	- A 55% mitigation is proposed for all existing residential, urban transformation buildings, and new constructions. Additionally, a 20% mitigation in electricity usage for cooling purposes in residences is targeted. - A 10% mitigation across all residentials is aimed through awareness-raising activities. - A 50% mitigation is expected by implementing energy efficiency in the lighting of all residentials. - A 100% mitigation is foreseen by transitioning all coal users in existing buildings to natural gas. - It is anticipated that 42% of electricity consumption in residential and commercial buildings will be met by solar energy-based renewable energy.
Tertiary Buildings	Natural Gas: An annual increase of 3% is projected. LPG: An annual increase of 3% is projected. Energy consumption increases are determined considering the trends of the last 5 years and the development status of the service sector.	- A 55% mitigation is foreseen by all commercial buildings with energy efficiency measures, and an additional 10% mitigation is expected through awareness-raising activities. - It is anticipated that 28% of electricity consumption in residential and commercial buildings will be covered by solar energy-based renewable energy.
Municipal buildings	Natural Gas: An annual increase of 3% is projected. Electricity: An annual increase of 3% is projected.	- A 55% mitigation is anticipated in all municipal buildings. - It is expected that 34% of the electricity consumption in municipal buildings will be covered by renewable energy, primarily solar energy.

	BAU Assumptions	Mitigation Assumptions
Transport		
Municipal fleet	Diesel: An annual increase of 1% is projected. Gasoline: No increase is projected.	- A 50% mitigation in all municipal vehicles is foreseen by replacing them with low-emission vehicles, and an additional 10% mitigation is foreseen through economic driving training programmes. - A 20% mitigation is foreseen by optimizing route planning to minimize fuel usage in all waste collection vehicles.
Public transport	Diesel: An annual increase of 4% is projected. Gasoline: An annual increase of 2% is projected. LPG: An annual increase of 1% is projected.	- The selection of electric vehicles in the city is expected to result in a 30% mitigation in the overall vehicle emissions. Additionally, economic driving training programs are anticipated to contribute to a 10% mitigation in logistics and all vehicles in the province.
Public transportation, cycling, and pedestrian transportation	The increase in fuel consumption of public transportation vehicles is projected to be 3% annually.	- An 80% mitigation in all public transportation vehicles is foreseen with the use of electric vehicles, along with a 10% mitigation in all vehicles due to the integration of the rail system and public transportation vehicles, and an additional 10% mitigation in all rail public transportation vehicles. - A 10% mitigation by increasing cycling and an additional 10% by increasing pedestrianization are foreseen.
Signaling systems		- A 20% mitigation is foreseen in 50% of the signaling systems.
Waste and Wastewater		
Waste	An annual increase of 3% is projected. Emissions related to waste have been projected for the year 2030 based on the anticipated population growth, as they are directly linked to the activities of the public.	- An 80% mitigation is foreseen in the entire solid waste disposal.
Wastewater	An annual increase of 3% is projected. Emissions related to wastewater have been projected for the year 2030 based on the anticipated population growth, as they are directly linked to the activities of the public.	- A 30% mitigation is foreseen in the entire wastewater treatment.
Agriculture and Livestock		
Livestock	An annual increase of 1% is projected.	
Fertilizer management	An annual increase of 1% is projected.	- A 40% mitigation is foreseen through the complete mitigation of animal waste by utilizing it as fertilizer.

	BAU Assumptions	Mitigation Assumptions
Chemical fertilizers	An annual increase of 1% is projected.	- A 40% mitigation is foreseen in the total current emissions by ensuring the use of organic fertilizers instead of chemical fertilizers.
Agricultural irrigation	An annual increase of 2% is projected.	- A 30% mitigation is foreseen in the entirety of agricultural irrigation.

3.2.2. Mitigation Projection

As a result of the assumptions, greenhouse gas emissions (excluding industry) in the city of Eskişehir for the year 2030 are calculated to be 4,630,384 tCO_2e under the Business-As-Usual (BAU) scenario. The per capita emission, which was 4.16 tCO_2e in 2021, is expected to decrease to 1.87 tCO_2e per capita by the year 2030, in conjunction with the implementation of actions within the plan.

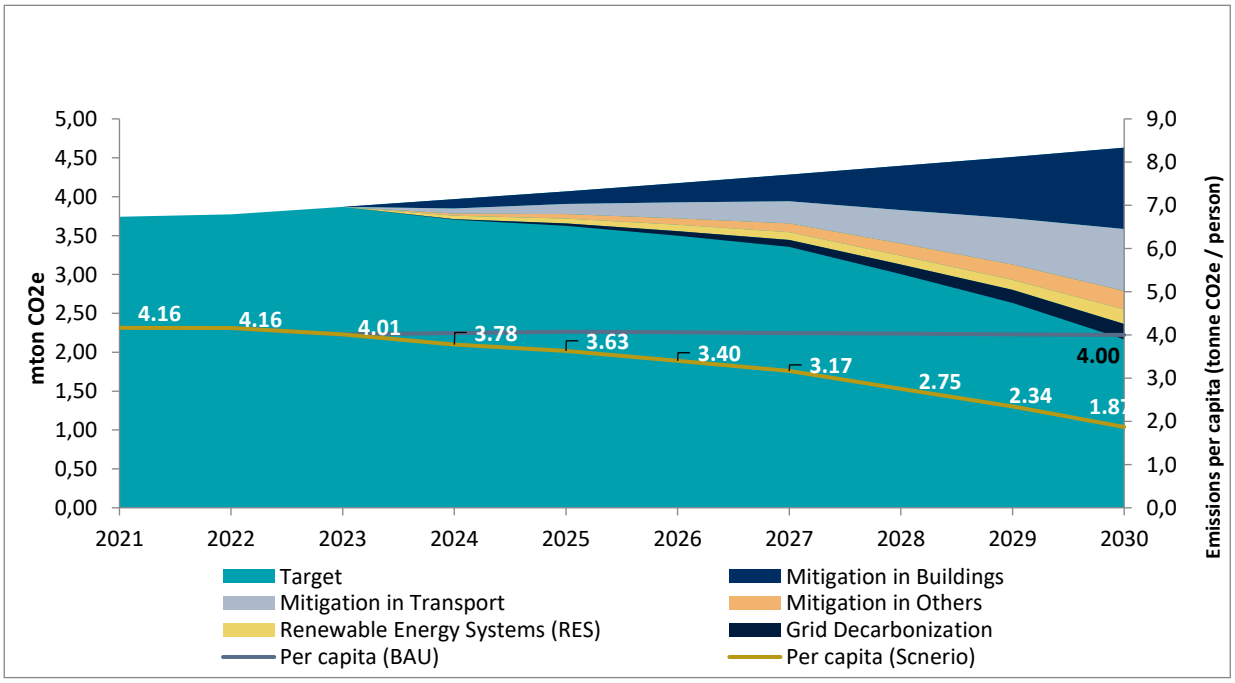


Figure 24: Eskişehir 2030 greenhouse gas BAU and mitigation scenario

When the emissions of the greenhouse gas inventory (excluding industry) are analysed, buildings in Eskişehir have the highest rate in the inventory with 37.2%. With the determined mitigation actions, a total mitigation of 1,229,081 tCO_2e is targeted in the buildings and energy sector by 2030.

The transportation sector is the sector with the second highest rate (33.0%).A mitigation of 795,240 tCO_2e is targeted in the transportation sector by 2030 with the measures identified in the plan

Mitigation actions have been envisaged for waste, wastewater and agriculture and livestock, which constitute the remaining 29.8% of the greenhouse gas inventory (excluding industry), Additional 241,810 tCO_2e mitigation is targeted with measures in these sectors by 2030.

In addition to all the mitigation actions, efforts are accelerating to reduce the emissions of the electricity grid by ensuring the integration of developing technologies in line with Türkiye's national targets. Taking into account the fact that targets such as reducing the use of coal in electricity generation and increasing the rate of renewable energy usage in electricity production continue to increase over the years,. In this context, an emission mitigation of 198,763 tCO_2e is envisaged until 2030 with national efforts. Table 8 summarizes the mitigation targets of all sectors.

Table 8: Sectoral mitigation targets for 2030

Sector	Mitigation (MWh), 2030	Mitigation (tCO_2e), 2030
Buildings	4,800,331	1,046,015
Renewable energy	525,000	183,067
Transport	2,234,315	795,240
Other (Waste and wastewater - Agriculture and livestock)	105,702	241,810
Grid decarbonization	-	198,763
Total Mitigation	**7,665,348**	**2,464,895**

3.3. CLIMATE SCENARIOS AND RISK ASSESSMENTS

3.3.1. Temperature Increase and Heat Waves

In the Eighth National Communication of Türkiye, the changes from the projection period to the 1971-2000 reference period are analyzed according to both the RCP4.5 scenario (optimistic) and the RCP8.5 scenario (pessimistic) within the scope of the Climate Adaptation Project.

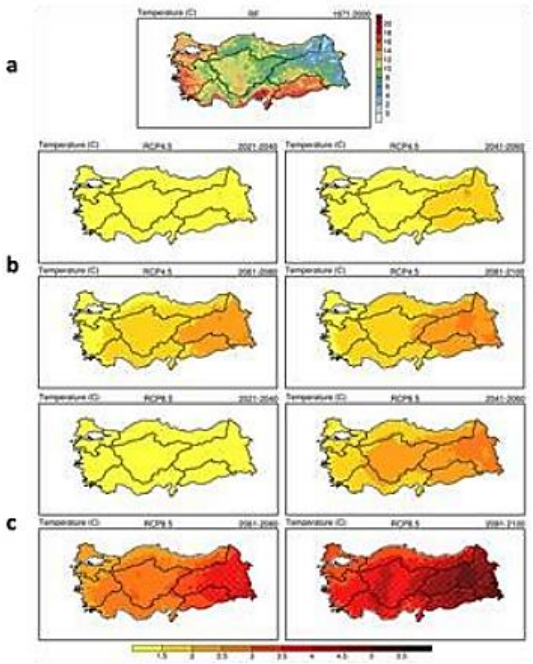
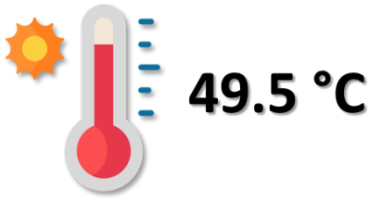


Figure 25: Change in average temperatures according to RCP4.5 and RCP8.5 scenarios compared to the reference period

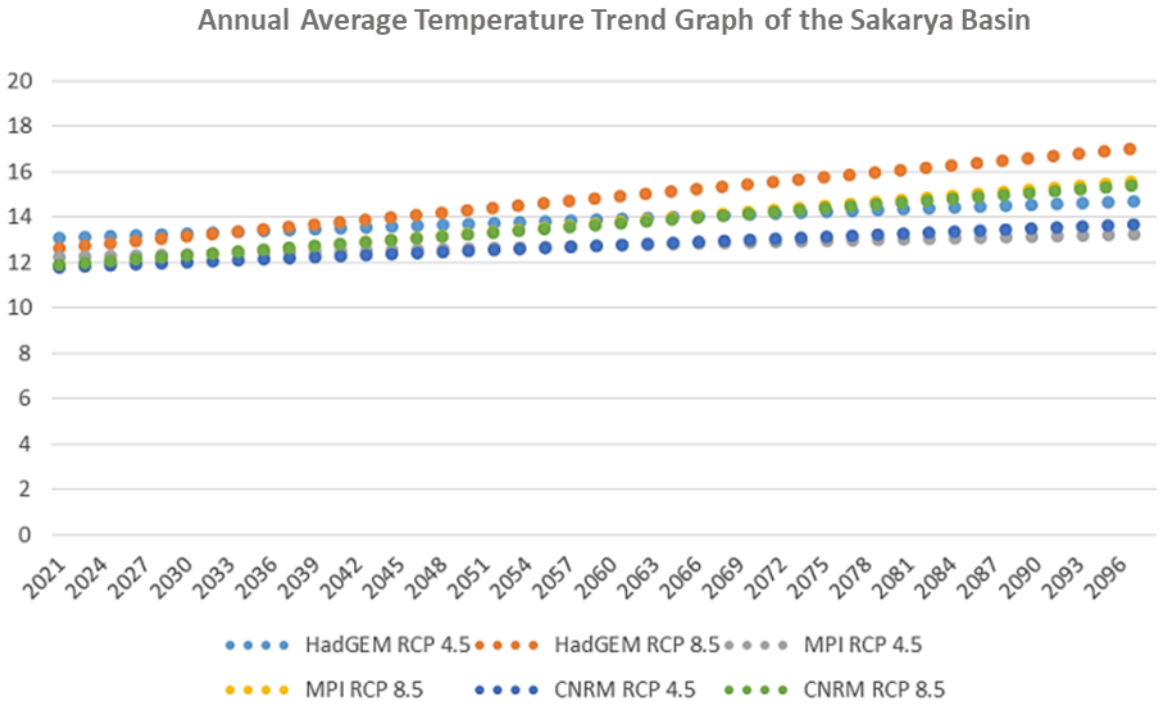
In the projections of temperature changes, both RCP4.5 and RCP8.5 scenarios foresee temperatures higher than the reference period. The RCP4.5 scenario predicts an increase of approximately 2.5°C in average temperatures in the eastern part of the country and at least 1°C in the rest of the country by the end of the century (Figure 25).

The RCP8.5 scenario forecasts an increase of approximately 2.5°C in average temperature across Türkiye by 2060s, and this increase is expected to exceed 5°C by the end of the century. .[34]



[34] Eighth National Communication of Türkiye, 2023.

In temperature projections for the Sakarya Basin, which encompasses the entire province of Eskişehir, average temperatures are expected to increase by approximately 1.5 degrees under the best-case scenarios and up to 4 degrees under the worst-case scenarios.[35]



Şekil 2: Sakarya Basin annual average temperature trend chart

When the current annual average temperature values of the districts located in Eskişehir are analysed, it is observed that Mihalıççık, İnönü, and Han districts have the lowest annual average temperature values, while Alpu, Beylikova, and Çifteler districts have the highest annual average temperature values. (Figure 26).

[35] Ministry of Agriculture and Forestry, Sakarya Basin Management Plan (2023)

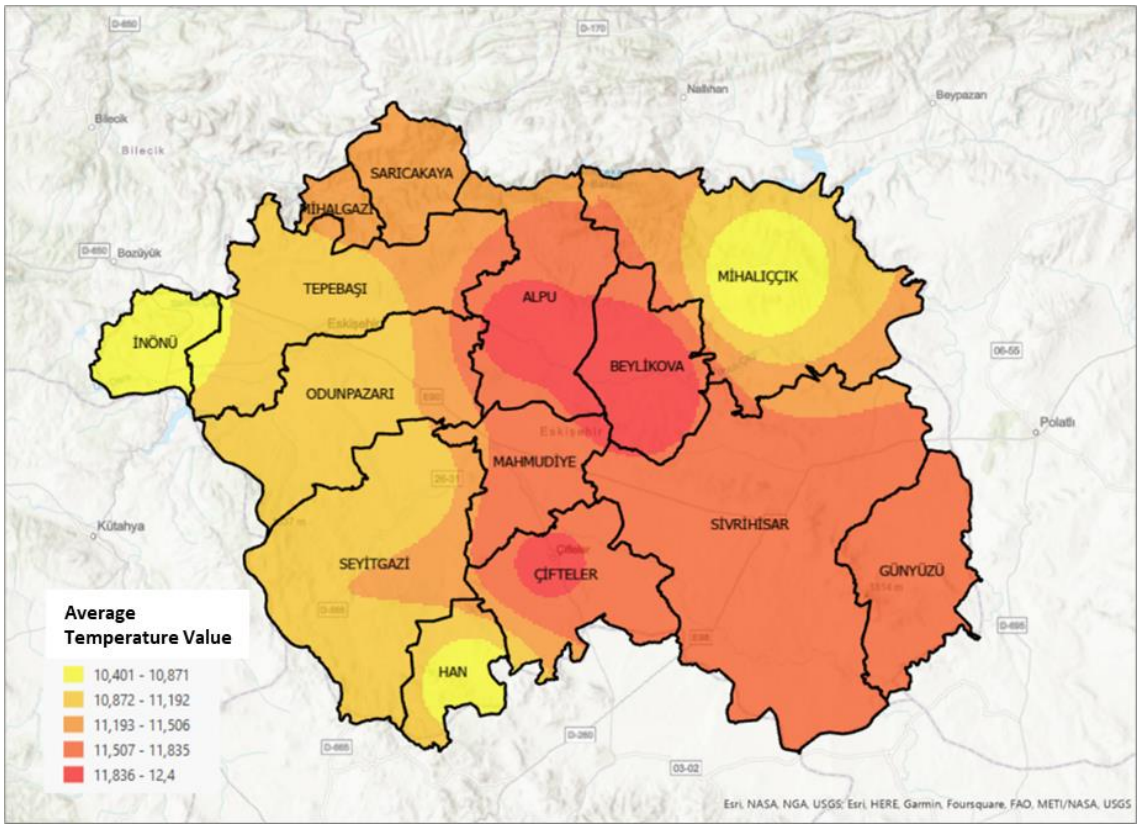
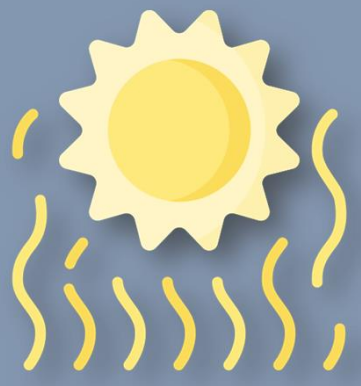


Figure 26: Current average temperature values distribution map of Eskişehir districts[36]

With the increasing temperatures in urban areas, the frequency, timing, intensity, and duration of extreme temperatures also vary. Changes in temperatures contribute to an increase in the number of heatwaves.



A heatwave is defined by the World Meteorological Organization (WMO) as the daily maximum temperatures persisting at least 5 days or more, with temperatures 3 to 5 °C above the seasonal averages. Heatwaves are among the most severe events associated with climate change, causing significant loss of life worldwide. In July-August 2010, a heatwave in Russia led to the unfortunate death of 55,000 people. Beyond the loss of lives, heatwaves also have adverse effects on various sectors, including public services, commerce, and agriculture.

[36] It was prepared within the scope of the study in ArcGIS environment, using district-based annual average temperature values obtained from https://en.climate-data.org.

Based on data obtained from the General Directorate of Meteorology, an analysis of the frequency of heatwaves in Eskişehir has been conducted. When analyzing the maximum temperatures between 2004 and 2022 in Eskişehir, based on the average of long-term (1991-2022) daily maximum temperatures, it was seen that an average of 6 heatwave events occurred annually. The evaluation indicates a particularly noticeable increase in the number of heatwaves, especially after the year 2010 (Figure 29). The months of July to September are the periods when heatwaves are most frequent.

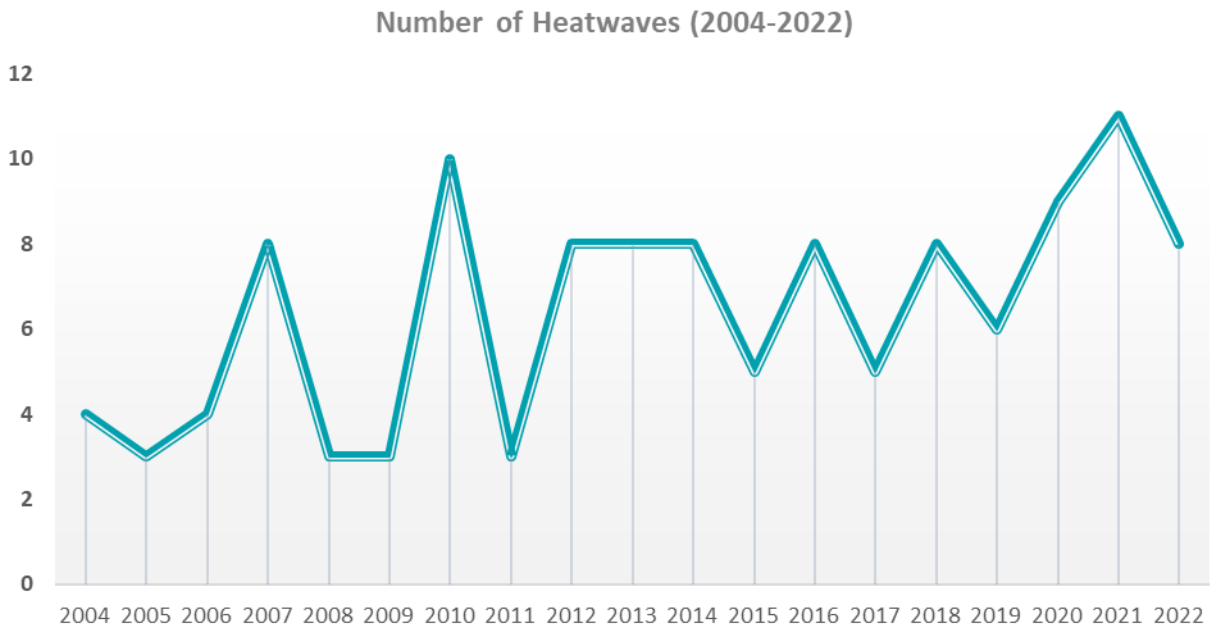


Figure 27: Number of heat waves in Eskişehir between 2004 and 2022[37]

3.3.2. Urban Heat Island Effect

The urban heat island effect is defined as urban areas that are exposed to higher temperatures compared to natural areas. Buildings, roads, concrete pavements, and other infrastructure absorb and radiate more solar radiation than natural landscapes such as forests and water. Urban areas with dense structures and limited green spaces become 'heat islands,' experiencing higher temperatures compared to their surrounding environmental areas. Temperature differences between daytime in urban areas and in outer areas can range from 2 to 6 degrees. These temperature variations are defined as the heat island effect.[38]

Urban land cover and land use directly influence surface temperatures. Buildings, concrete pavements, roads, metal, and all impermeable surfaces are emphasized as the primary reasons for the increase in surface temperatures in urban areas. The rising surface temperatures associated with urbanization particularly intensify the formation of urban heat islands, especially in densely built areas.

In recent years, remote sensing methods have been used to determine land surface temperatures. Using regional data from NASA's Landsat program dated July 17, 2022 (representing summer temperatures in

[37] It was prepared using the daily maximum temperature values between 2004 and 20022 obtained from the General Directorate of Meteorology.
[38] EPA, United States Environmental Protection Agency.

Eskişehir), surface temperature analysis was conducted for the central districts of Eskişehir through Geographic Information Systems (GIS). According to the data, the highest air temperature measured in Eskişehir on July 17, 2022, was 28.9°C. However, in many areas with dense urban structures especially in the Odunpazarı and Tepebaşı districts, surface temperatures are observed to vary between 32°C and 34°C (yellow). In areas with intense concrete pavements, these temperatures can exceed 36 degrees. Surface temperature values related to green area uses around the Porsuk River and its surroundings can go below daily temperature values (light green), indicating the cooling effect of green areas.

The increase in surface temperatures can lead to deterioration in air quality, an increase in sudden deaths due to extreme heat in cities, directly affecting public health. The most fundamental factors to reduce the heat island effect include the preference for surface coverings with high reflectivity and increasing tree and plant surfaces to create air corridors where the settlement/city can breathe.

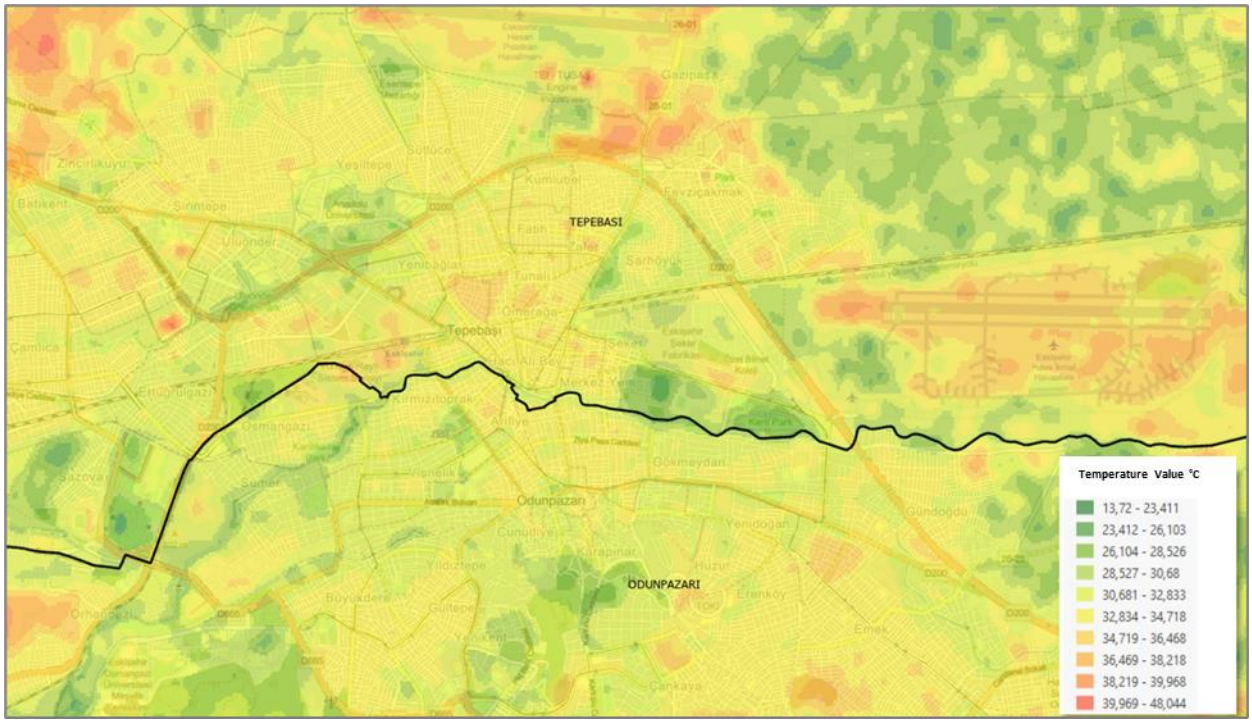


Figure 28: Surface temperature analysis of Odunpazarı and Tepebaşı centers[39]

3.3.3. Extreme Rainfall and Flood

Eskişehir is located in the Sakarya Basin, which is one of Türkiye's 25 basins. Covering approximately 8% of Türkiye's land area, the basin is the third-highest in terms of precipitation in the country. There were 499 flood incidents in 2019 in Türkiye, and 19 of them occurred in Eskişehir. When examining the annual average rainfall amounts of Eskişehir districts, the high-altitude areas in the northern part of the city, such as Mihalıççık, Sarıcakaya, Mihalgazi, and İnönü districts receive higher rainfall amounts topographically. Towards the south of the city the amount of rainfall decreases. (Figure 29).

[39] The report was created using Landsat data and ArcGIS program.

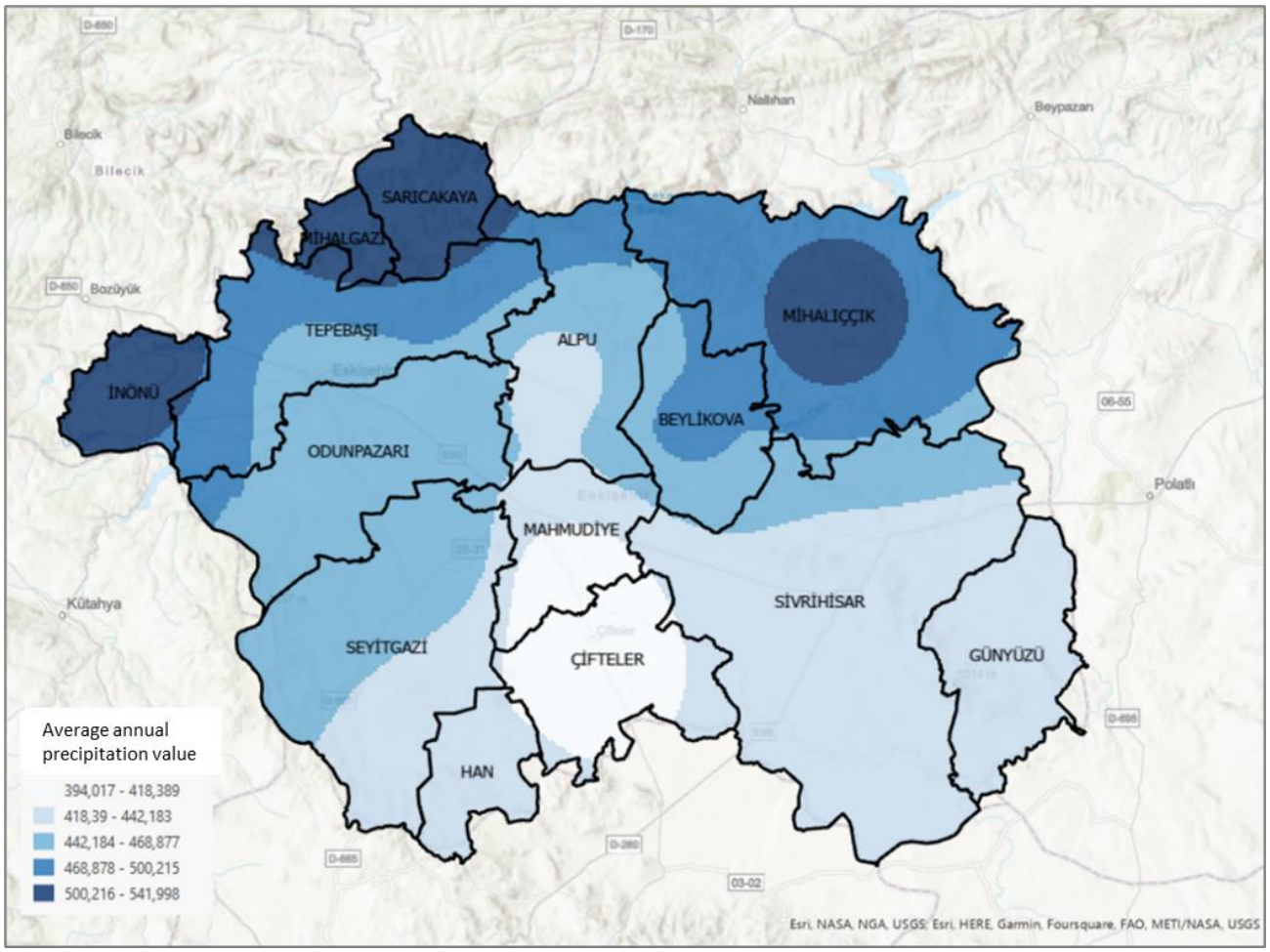


Figure 29: Annual average rainfall distribution in Eskişehir districts

The recent increase in flood events caused by extreme rainfall is attributed not only to the amount of precipitation but also to the irregularity of heavy rainfall occurrences. Sudden and extreme rainfall in urban areas, especially where infrastructure is inadequate and precautionary measures have not been taken, leads to flooding, particularly around undeveloped wetland areas.

In this context, the vulnerability of districts to floods has been assessed. Risk assessments were conducted by analyzing the vulnerability of sectors and the population in the district, considering the likelihood/frequency of climatic hazards. Based on the characteristics of the districts, the risk assessment resulted in the following:

- Very high risk: Odunpazarı
- High risk: Tepebaşı
- Moderate risk: Çifteler, Sivrihisar
- Low risk: İnönü, Alpu, Mihalıççık, Mahmudiye, Günyüzü
- Very low risk: Sarıcakaya, Mihalgazi, Seyitgazi, Han, Beylikova

The highest vulnerability to flood risk in Odunpazarı due to the potential flooding threat to the industrial zone within the district and the high population that could be affected.

The high population exposure to flooding in Tepebaşı increases its risk level.

The moderate risk level of Çifteler and Sivrihisar is attributed to the high amount of agricultural land vulnerable to flooding.

Risk assessments take into account the potential impact on sectors and the population, as well as the probability/frequency of climatic hazards occurring in the districts.

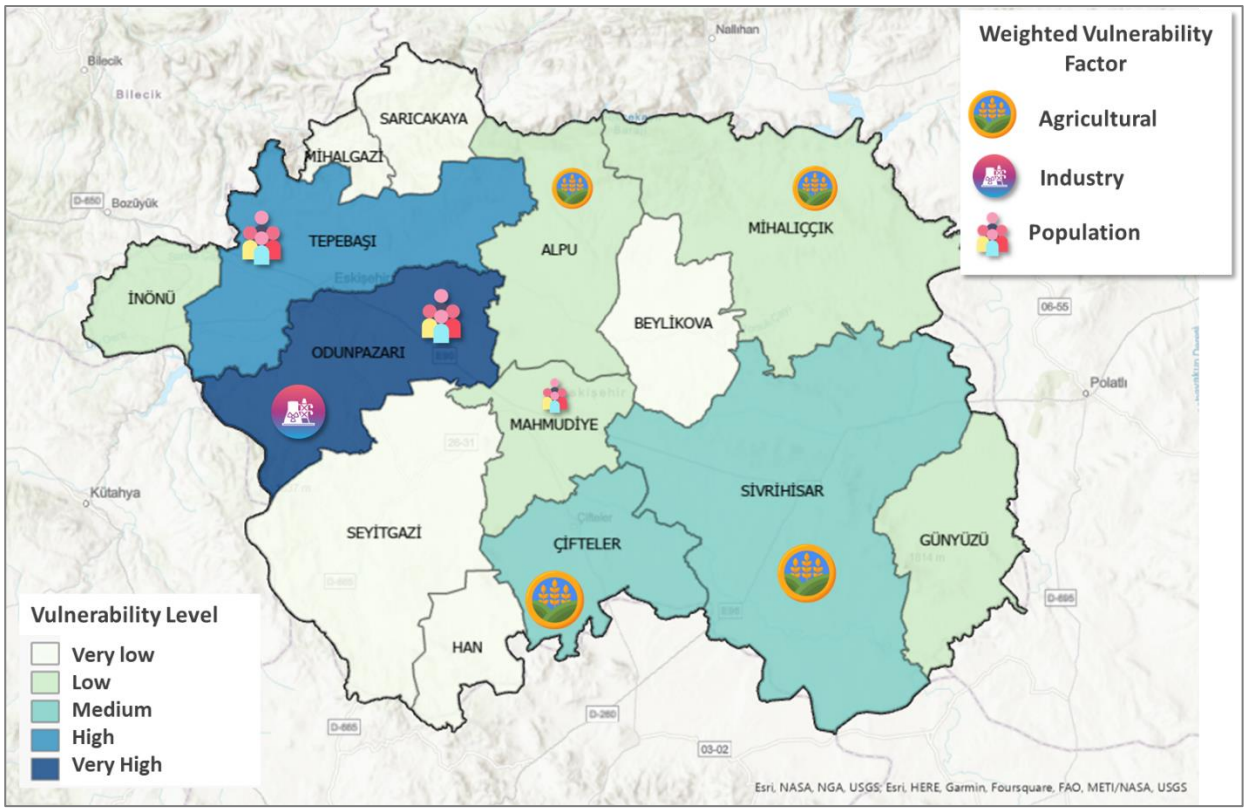


Figure 30: Eskişehir districts flood risk level map

3.3.4. Storm / Tornado / Hail

The number of extreme events occurring in the world and in Türkiye is increasing. 2022 was the year with the highest number of meteorological events in Türkiye, with 1030 extreme events. Considering the number of events experienced in 2022, storms ranked second with 21.4%, hail events ranked third with 18.5%, and tornadoes ranked third with 1.9%.[40] The tornado that occurred in Eskişehir in 2018 damaged approximately 2000 trees, [41] in 2022, rural areas were damaged.

In Türkiye, the increase in events such as storms, tornadoes and hail has begun to cause serious loss of life and property, and continues to cause long-term inefficiencies in regions where agricultural activities are intense. According to the information in the Natural Disaster Studies of Eskişehir Directorate of Agriculture and Forestry; only in 2022, 51,889 decares of land were damaged by hail, and between 2015 and 2022, a

[40] MGM, 2022 Yılı İklim Değerlendirmesi, Ocak 2023
[41] https://www.cnnturk.com/turkiye/eskisehirde-hortum-2-bin-agaci-devirdi Date of access: November, 2023

total of 482,905 decares of land were damaged. A total of 13,208 people were affected by these damages. In 2021, 11,621,105 TL of damage occurred due to floods, hail and storm events in agricultural areas.[42]

3.3.5. Forest Fires

Forest fires occur when flammable materials and favorable weather conditions come together. The risk of ignition increases depending on the presence of a suitable atmospheric environment when a combustible heat source is present. Drought is directly associated with the presence of flammable materials in forest areas, and as the severity and duration of drought increase, the probability of ignition increases. The continuity of flammable substances and the absence of empty areas in forests are critical factors in the expansion of fires.[43]

Between the years 2010 and 2019, there were 208 forest fires in Eskişehir, resulting in a total of 568.70 hectares of forest area being damaged. With the increasing temperatures in recent years, the spread of fires has intensified, and an average of 57 hectares of forest area has been affected annually [44]

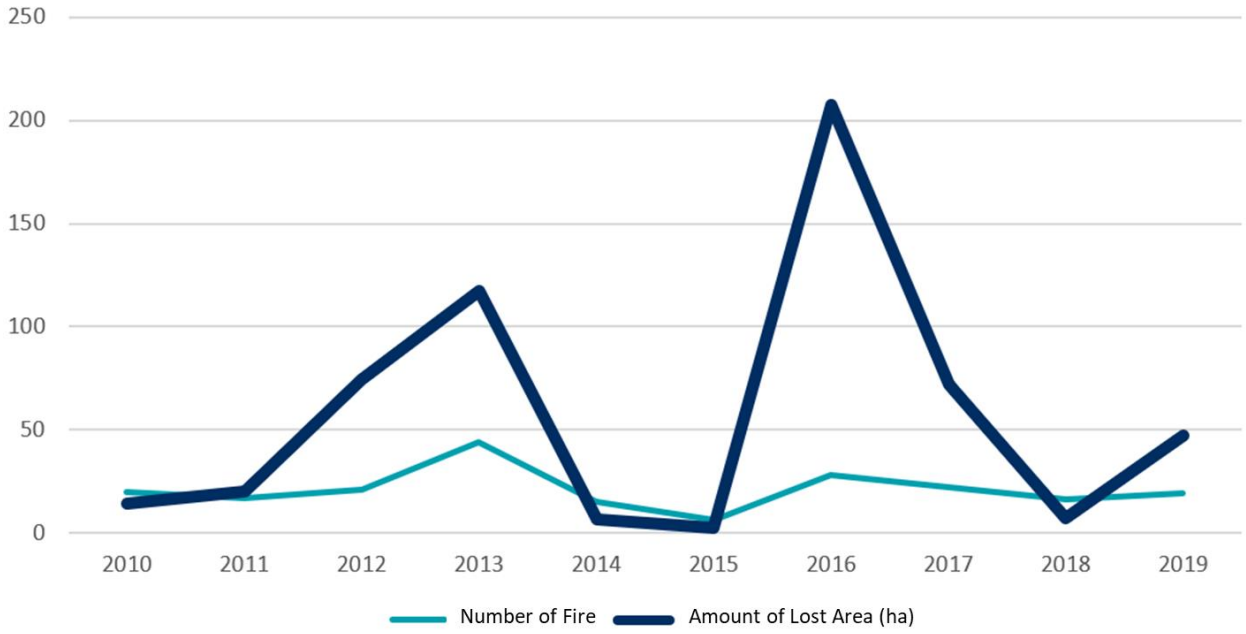


Figure 31: Forest fires in Eskişehir and the amount of area lost

Approximately 29% of Eskişehir's total area consists of forest areas. Approximately 36% of the forest areas are located in Odunpazarı, while 64% are in the Tepebaşı district. A significant portion of Mihalgazi and Sarıcakaya districts consists of forest and hollow forest areas. Due to the size of their forest areas, Mihalıççık and Mihalgazi districts also pose a risk of forest fires.

[42] Eskişehir Tarım ve Orman Müdürlüğü, 2022 Çalışma Raporu, 2022
[43] Dalabanlı, İsmail; İklim Değişikliği ve Artan Orman Yangınları İlişkisi, 2021
[44] AFAD, Eskişehir İl Afet Risk Azaltma Planı, 2021

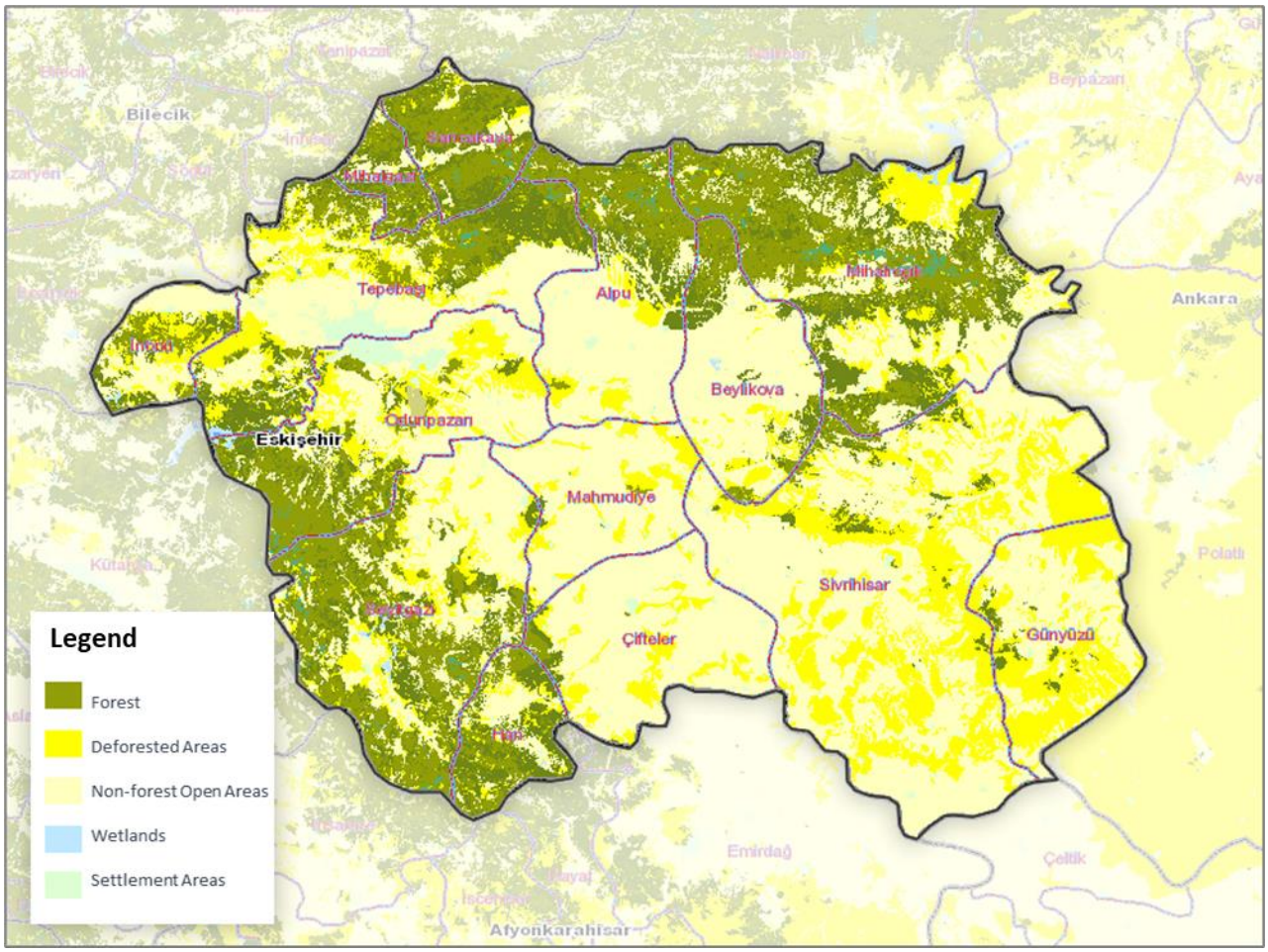


Figure 32: Eskişehir forest map[45]

3.3.6. Drought

Drought is defined as a natural event that occurs when precipitation falls significantly below recorded levels, leading to adverse effects on land and water resources and disrupting hydrological balance. Drought has three distinct types: meteorological, agricultural, and hydrological drought.[46]

Drought frequency, intensity, and impact levels vary based on the existing climatic, topographic, and hydrological characteristics of regions. The main factors influencing drought in Türkiye are atmospheric conditions, physical geography factors, and climate conditions.

The impact of climate change, leading to a decrease in rainfall, results in a decline in water levels in reservoirs. Societal awareness deficiency, population growth, and changes in consumption habits contribute to the competition among different sectors, leading to a reduction in water resources. This situation negatively impacts health, environment, energy production, agriculture, and the economy.

[45] It was prepared within the scope of the report using the base maps obtained from https://cbs.ogm.gov.tr/vatandas/.
[46] AFAD, Eskişehir İl Afet Risk Azaltma Planı, 2021

Eskişehir province is one of the 10 provinces located in the Sakarya Basin. Within the basin, there are sub-basins of Middle Sakarya, Porsuk, and Upper Sakarya. The Sakarya Basin Drought Management Plan prepared by the Ministry of Agriculture and Forestry, General Directorate of Water Management, includes analyses on drought exposure, water uses, and sectoral vulnerabilities. Looking at the water budget calculations, it is observed that, despite having a water potential significantly higher than the amount of water consumed in the current period, it begins to decrease in the near future (2020-2049) and falls behind water consumption in the long term (2075-2099).[47]

According to analyses conducted based on different vulnerabilities; economic value, and adaptive capacity parameters determined for various sectors, particularly for the agriculture sector with the highest consumption, it is observed that the vulnerability of the Porsuk sub-basin (north of Tepebaşı, Odunpazarı, İnönü, Alpu, Beylikova, and Sivrihisar districts) is low in the near and medium term, while the vulnerability of the Middle Sakarya sub-basin (Sarıcakaya, Mihalgazi) is high. (Figure 33).

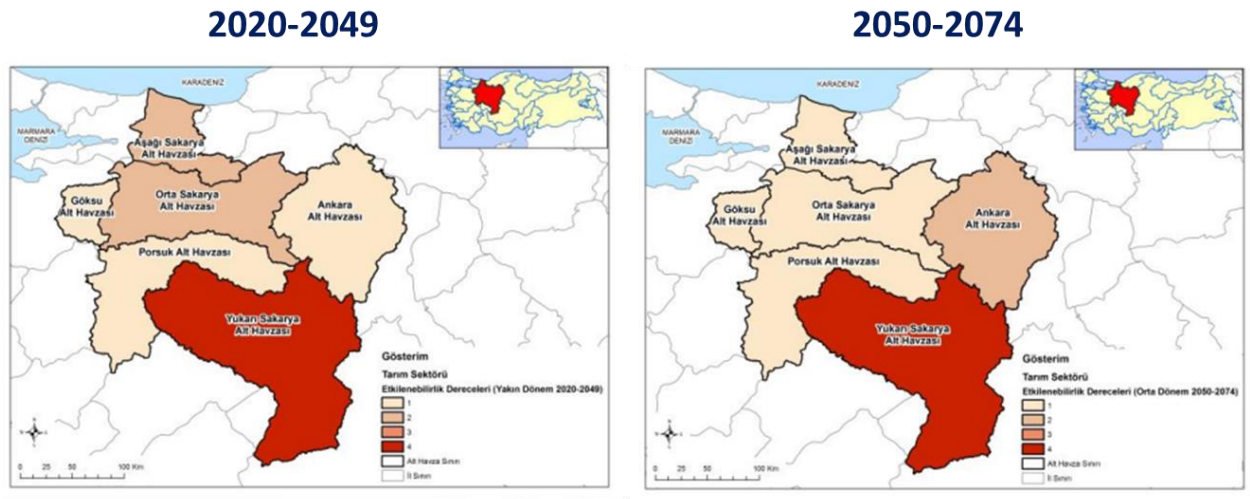


Figure 33:Sakarya Basin near (2020-2049) and medium (2050-2074) agricultural sector drought assessment

In analyses conducted for drinking-water use, it is observed that the vulnerability of the Upper Sakarya sub-basin (Sivrihisar (south), Günyüzü, Çifteler, Han, Mahmudiye, Seyitgazi) is high in the near and medium term. (Figure 34).

[47] SYGM Sakarya Havzası Kuraklık Planı

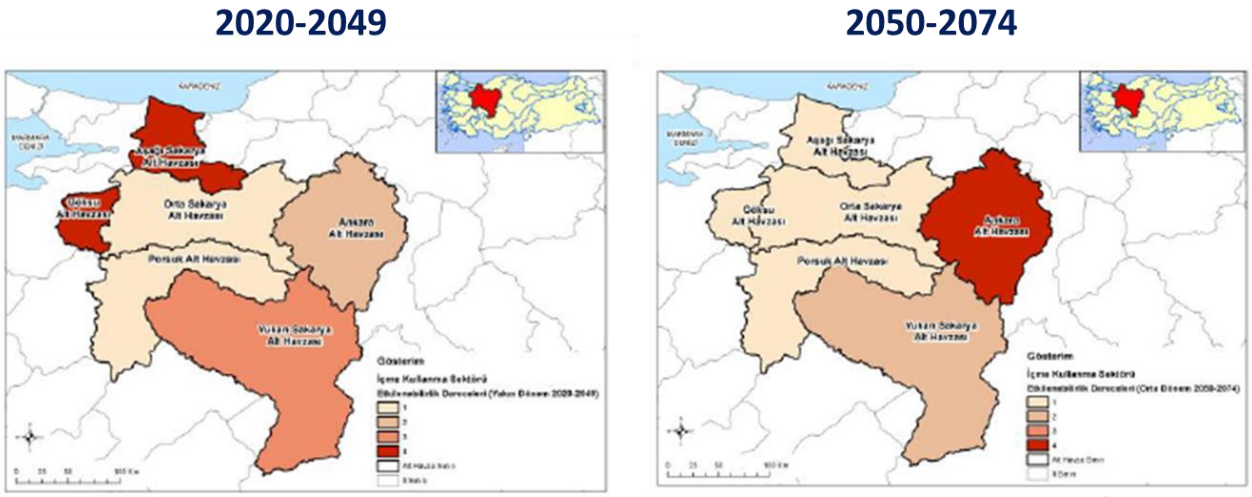


Figure 34: Sakarya Basin drinking and utility water near (2020-2049) and medium (2050-2075) drought assessment

Although the threat of drought is not considered high in Eskişehir province concerning sub-basins, projections in the Drought Basin Plan indicate a high risk of decrease in basin water potential. Therefore, any efforts or actions, especially in the efficient use of water, hold significant importance.

3.4. ASSESSMENT OF THE SOCIOECONOMIC SITUATION

Vulnerable populations, defined as groups with a higher risk of poverty and social exclusion which increases vulnerability to climate disasters. These vulnerable population groups include those living in poverty and deprivation, individuals with disabilities, children, youth, women, the elderly, unemployed, homeless, and similar demographic groups.[48] According to BEBKA (Bursa, Eskişehir, Bilecik Region) Regional Plan (2019-2023) data, the region Eskişehir is located, the unemployment rate is 9.6%; the poverty rate is 9.2%.[49] When the education data of Eskişehir province is analysed 43% of the total population is primary and secondary school graduates; 48% have high school graduation or above. One other vulnerable group is the elderly population over the age of 65 representing 12.4% of the population.

[48] TÜİK, 2015
[49] BEBKA, Bursa Eskişehir, Bilecik Bölge Planı (2019-2023)

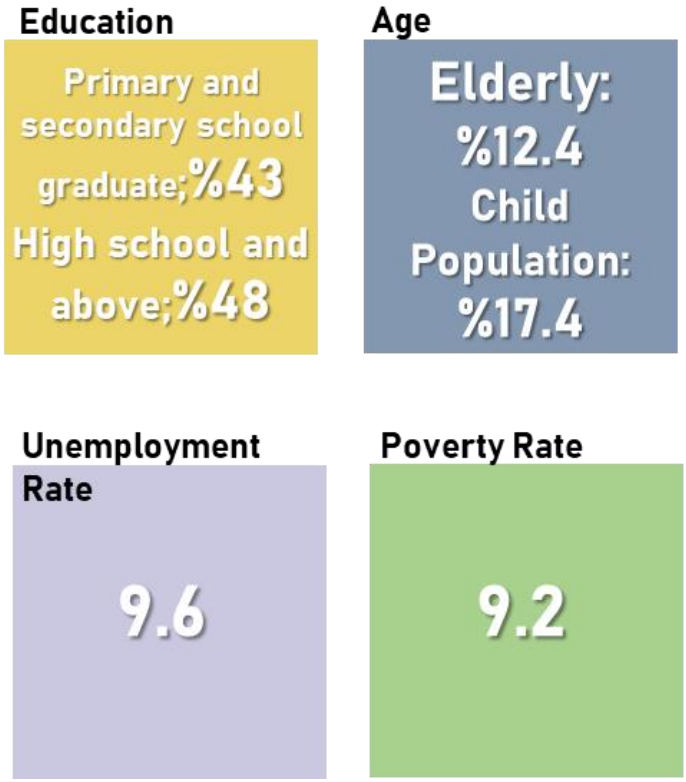


Figure 35: Indicators for vulnerability in Eskişehir

When determining rankings of development, variables related to demographics, employment and social security, education, health, finance, competitiveness, innovation, and quality of life are considered. Therefore, socio-economic development rankings provide clues about the well being and vulnerabilities of settlements.

In the province of Eskişehir, among the 14 districts:

- Sarıcakaya, Mihalıççık, Günyüzü, and Han are classified in tier **5,**
- Mihalgazi, Alpu, Beylikova, Mahmudiye, Çifteler, and Seyitgazi are classified in tier **4th,**
- Sivrihisar and İnönü are classified in tier **3,**
- Tepebaşı is classified in tier **2**, and
- Odunpazarı is classified in tier **1 district.**

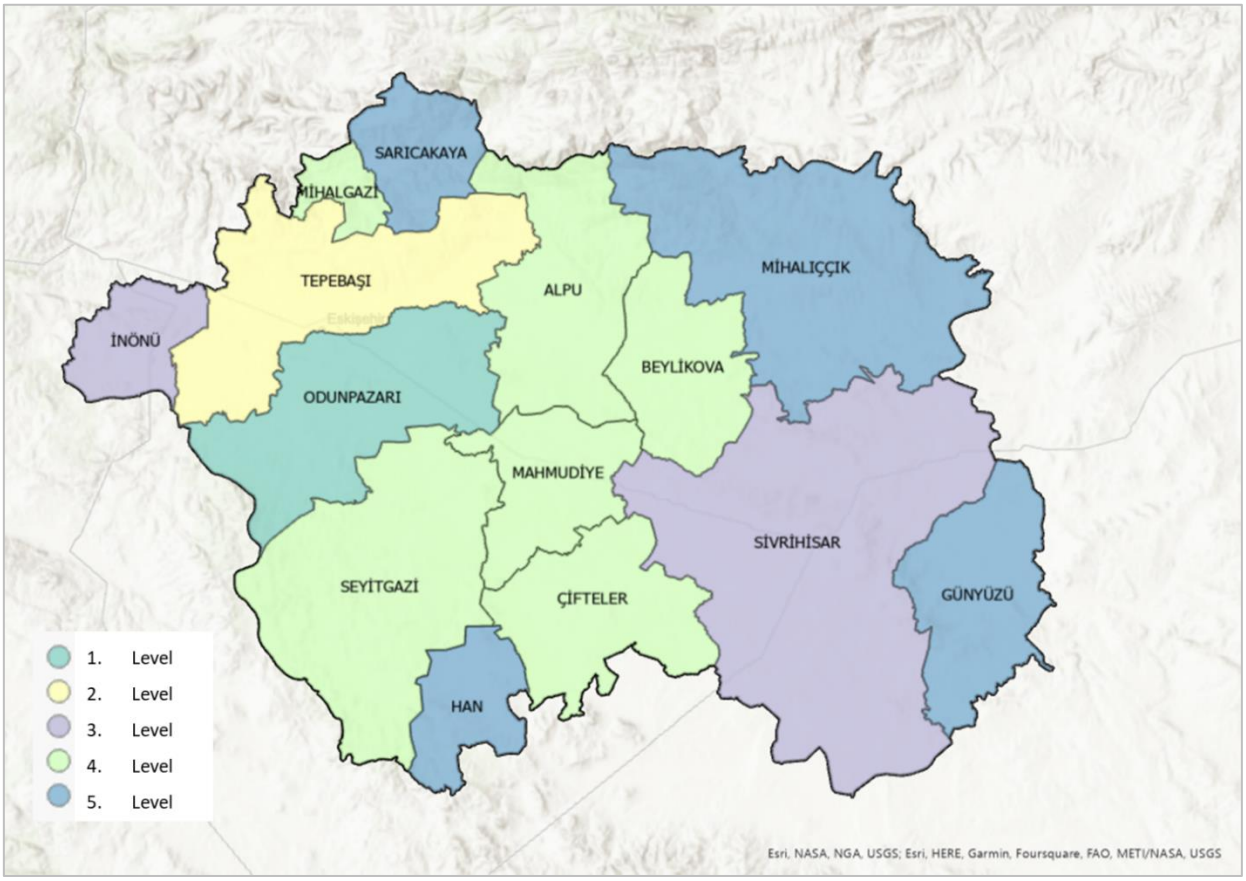


Figure 36: Socioeconomic development rankings of Eskişehir districts [50]

The rankings among districts might give an idea about more vulnerable areas with lower adaptive capacity (district of higher tiers). It gives the chance to prioritize the location of adaptation actions.

3.5. RISK AND VULNERABILITY ASSESSMENT

According to IPCC, the components of climate risk are hazard, exposure and vulnerability. In other words, when vulnerable communities are exposed to a certain danger, climate hazards become climate risks. By implementing climate adaptation actions, regions and cities will develop resilience against climate-related shocks and stresses that will develop in these areas and increase their adaptation capacity. However, before developing such adaptation actions, analyzes should be made regarding the risks of the region or city and a specific understanding of that area need to be developed.(Figure 37).

[50] Sanayi ve Teknoloji Bakanlığı, İlçelerin Sosyo-ekonomik Gelişmişlik Sıralaması Araştırması (SEGE), 2022 raporundan elde edilen veriler doğrultusunda hazırlanmıştır.

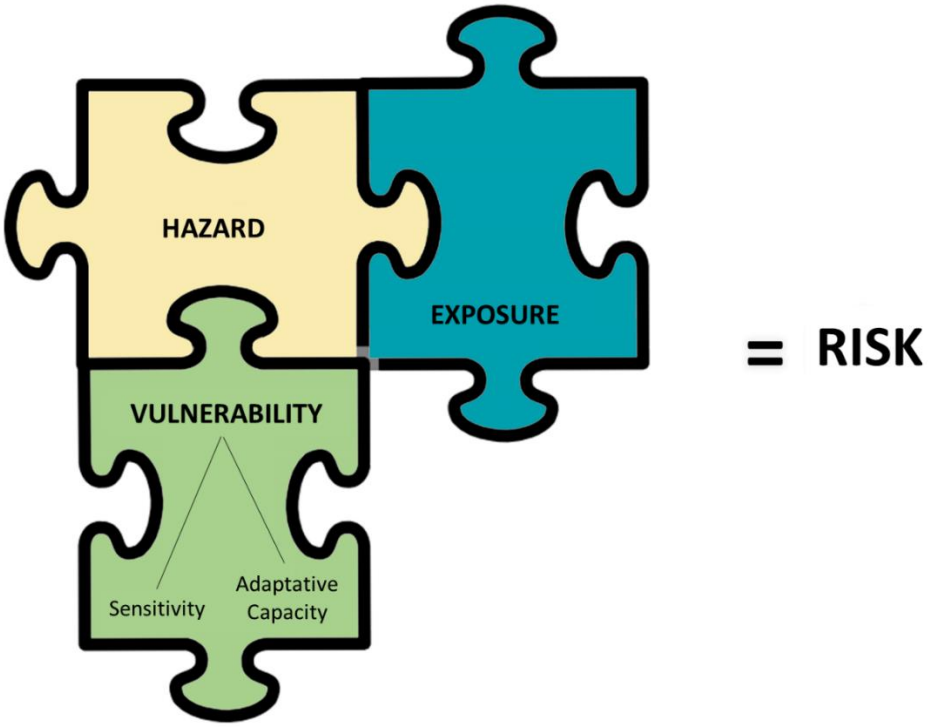


Figure 37: Components of risk definition

In conducting climate risk assessments for Eskişehir, state of the art has been analyzed, climate scenarios and hazards for the region have been assessed, the risks have been evaluated regionally, and workshops utilizing digital communication tools have been conducted to conclude expert opinions. According to future risk assessments based on expert opinions, the risk levels for temperature increase, heatwaves, extreme rainfall, floods, and flash floods, as well as severe wind, hail, storm, and tornado events, are considered moderate; while drought and forest fires are evaluated as high (Figure 38).

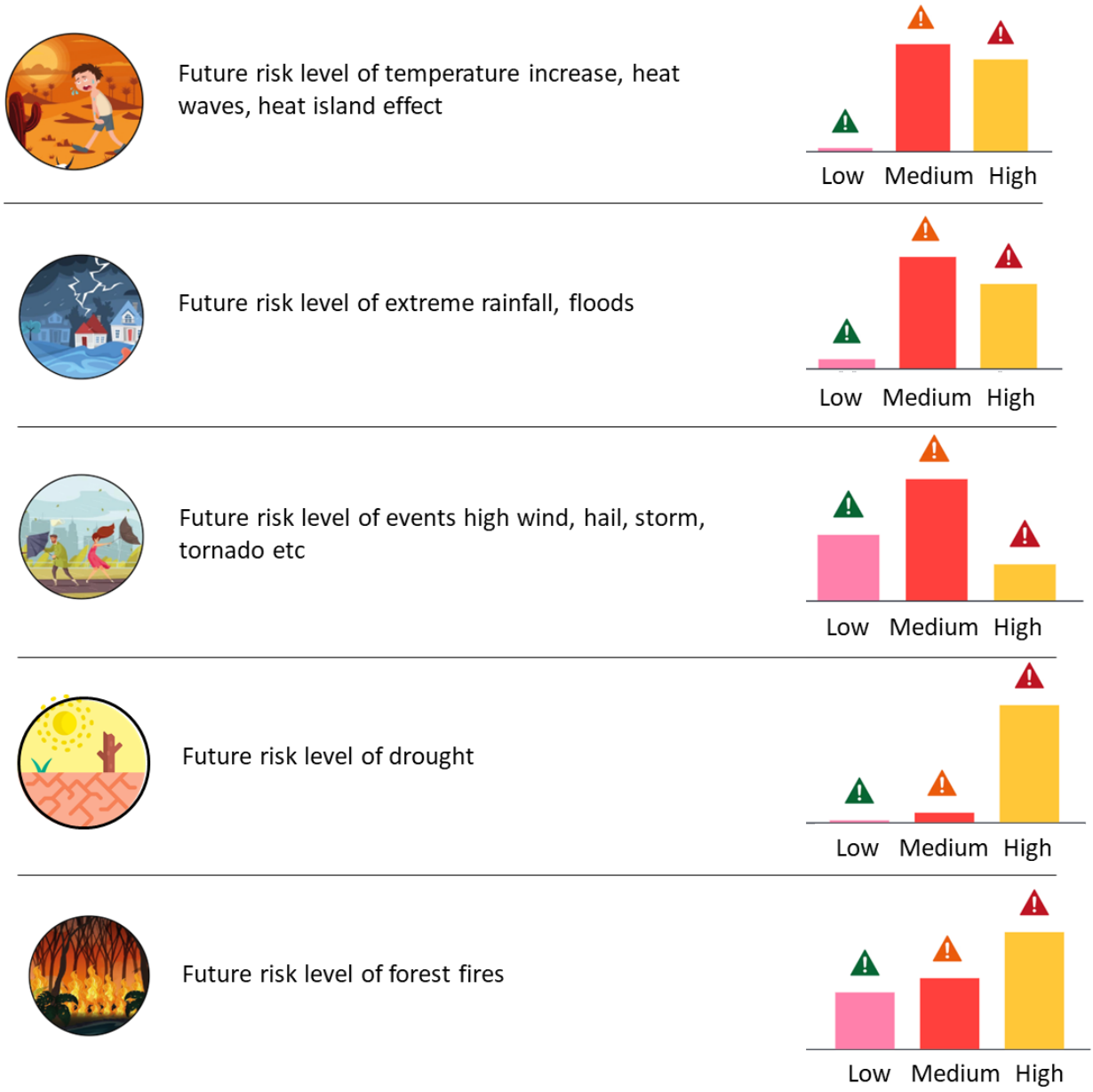


Figure 38: Expert risk assessments at the climate change adaptation workshop

In order to analyze the climate risks of Eskişehir, the city's risk and vulnerability assessments are made assessed using the methodology of the Covenant of Mayors (CoM) Risk and Vulnerability Assessment (RVA).

For Eskişehir, the current risks and vulnerabilities to climate hazards have been assessed based on analyses using precipitation and temperature data obtained from the Turkish State Meteorological Service (TSMS) (such as heatwaves, etc.), vulnerabilities identified through hydrological modeling prepared at the basin scale (vulnerable areas, population, economic damage, etc.), demographic characteristics of the settlement, provincial disaster plans, and information obtained from academic studies conducted at the provincial and district levels.

During the assessment of risks and vulnerabilities, it is important to understand the impact that existing risks and anticipated risks will have on the settlement and urban services for which the local government is responsible. In this context, the sectors that may be affected by climatic disasters identified specific to the settlement were detailed and the risks and vulnerabilities were determined using the Risk and Vulnerability Assessment methodology and indicators of CoM.

Accordingly, the urban services and sectors that are most vulnerable to the climate risks determined for Eskişehir are; agriculture & biodiversity, public health and water resources. However, urban infrastructure and transportation are also among the areas that can be severely affected.

Table 9: Eskişehir risk level assessment according to sectors

	Affected Areas							
Climate Hazards	Urban Infrastructure	Transportation	Waste Management	Industry	Agricultural & Biodiversity	Water Resources	Tourism	Public Health
Temperature Increase and Heat Waves								
Heat Island Effect								
Extreme Rainfall and Floods								
Storm / Tornado / Hail								
Forest Fire								
Dorughts								
Legend								
	Low Risk Level							
	Medium Risk Level							
	High Risk Level							

4. SUSTAINABLE ENERGY AND CLIMATE ACTION PLAN

4.1. PLAN VISION

The main vision of the 12th Development Plan, published in November 2023 aligned with Türkiye's 2053 targets; "Türkiye is determined as a stable, strong and prosperous Türkiye in the 21st Century that is environmentally friendly, resistant to disasters, produces high added value based on advanced technology, shares income fairly."

The vision of Eskişehir Metropolitan Municipality covering the years 2020-2024 has been determined as "To continue to be an accessible, peaceful, happy city that develops with the understanding of equality for everyone, sustainable urbanism; targets agricultural development, is sensitive to climate change, resistant to extraordinary events " which reveals its attitude towards combating climate change.

The vision of the Sustainable Energy and Climate Action Plan has been determined in line with international agreements, national targets and declarations, Eskişehir's current location, resources, strengths and weaknesses, threats arising from climate change, and stakeholders' expectations and needs.

“An Eskişehir that has increased energy and resource efficiency, contributes to sustainable transportation, healthy and livable city goals with green infrastructure investments, and is resistant to the negative effects of the climate crisis.”

Energy and Source Efficiency: Eskişehir aims to build a sustainable future by using energy and resources more effectively. It aims to optimize resource use by increasing energy efficiency, improving waste management and developing strategies for renewable resources.

Green Infrastructure Investments: It aims to protect and strengthen the natural ecosystems within the city with green infrastructure projects. It prioritizes harmonizing the city with nature and protecting biodiversity through parks, gardens, water management projects and afforestation efforts.

Sustainable Transportation: The Municipality supports sustainable transportation with measures such as strengthening public transportation systems, expanding bicycle paths, creating pedestrian-friendly areas and encouraging electric vehicles. These efforts aim to have a clean and efficienct city traffic by emissions.

Healthy and Livable City: Eskişehir is reviewing its urban planning strategies in order to create a healthy and livable city and supports the physical and mental health of city residents by increasing green areas. Facilitating access to health services, strengthening social facilities and promoting health standards in housing projects are part of this vision.

Resilience to the Climate Crisis: The city aims to protect the city from the future negative impacts by playing a leading role in the fight against climate change. It aims to create a city that is resistant to climate change by preparedness for water crisis, disasters, identification of vulnerabilities and all other hazards.

This holistic vision aims to make Eskişehir a city that meets the needs of both today's and future generations as always. The city will have a comprehensive sustainability model through sustainable energy, climate-friendly practices, healthy urban planning and making a resilient city.

4.2. STAKEHOLDER MAP

In order to cooperate in the preparation and implementation processes of the Sustainable Energy and Climate Action Plan (SECAP) and to ensure the effective implementation of the plan targets; It is important

to identify the stakeholders. Eskişehir Municipality Sustainable Energy and Climate Action Plan stakeholders are listed as internal and external. Intra-institutional stakeholders list the units involved in the administrative organization of the local government that are responsible for various urban services, planning and implementation. External stakeholders consist of public institutions and organizations such as provincial organizations of the central government and universities, private sector stakeholders, professional chambers, associations and NGOs.

In the process of Stakeholder Analysis study prepared with the aim of revealing the roles and importance of stakeholders, their impact and level of relevance to the subject is taken into account.

In the preparation of a holistic Sustainable Energy and Climate Action Plan (SECAP), the process with the contributions of various stakeholders, from the ministerial level to universities, guides local governments in terms of both data collection and ensuring cooperation for the feasibility of actions. If stakeholders already have a work in place regarding the relevant action, the feasibility of joint work will increase in parallel with the 2030 greenhouse gas reduction target. It can be said that the studies to be carried out on this subject are of great importance in terms of setting an example for other local governments.

According to the SECAP Stakeholder Analysis study, the provincial directorates of the central government have active duties within the currently updated national Climate Change Plans, wll be cooperated especially for monitoring the actions. These are the ones with higher interest on climate change. DSI, which has been working on climate change for many years, AFAD and ESKI, which play an active role in the preparation of provincial disaster plans, are institutions that are both interested in the subject and have high influence. In addition to planning, these institutions appear to be carry out implementations, especially on adaptation to climate change. In addition, the contribution of organizations such as investors and electricity and gas distribution companies encourage the use of renewable energy such as Solar Power Plants (SPPs), Wind Power Plants (RES) is important. Coordination within Eskişehir Metropolitan Municipality will be carried out by the Climate Change and Zero Waste Department, which is the team that will carry out the coordination on the subject. The internal units that are in close coordination are Departments of Environmental Protection and Control, Strategy Development, Real Estate and Expropriation, Zoning and Urbanization, Technical Affairs, Urban Transformation, Disaster Affairs, Parks and Gardens, and Agricultural Services.

Although universities and NGOs working on climate change have a high interest in the issue, their influence remains somewhat limited due to their resources. MGM, Agricultural Research Institutes, and Professional Chambers on different subjects stand out as institutions that work as knowledge institutions.

Public health is related to many areas of activity, it is a cross-cutting topic. Provincial and district health directorates and unions formed by health professionals such as the Medical Association are among the stakeholders recommended for cooperation in predicting and preparing for the effects of climate change on health and the extent of the risk that may occur in the future.

All units of the Local Government that make regulations for green areas, are responsible for land use planning and provide other related urban services are determined as stakeholders with high impact local service providers. Metropolitan Municipality, Disaster Affairs and Fire Departments are important stakeholders in terms of intervening in incidents caused by extreme weather events throughout the city. The reports kept by these units in their activities will provide data on the results of disasters occurring throughout the city. Also, it was emphasized that the action plans they prepared within the scope of combating disasters are important in terms of determining the needs of the built environment and

assessing the vulnerability to disasters. They have high impact on the planning and implementation processes of the Adaptation Plan activities

Provincial organizations of the Central Government are among the stakeholders with high influence because they are decision-making institutions with the authority to regulate, implement and control various relevant issues with SECAP. In this context, the Provincial Directorate of Environment Urbanization and Climate Change, the Provincial Directorate of Agriculture and Forestry, and the Provincial Directorate of Health are shown among the stakeholders with high impact. On the other hand, Development Agencies are known to be among the stakeholders with high impact in terms of supporting practices on relevant issues by offering funding sources in various fields in line with regional development strategies and targets.

Neighborhood Headmen's can raise public awareness and help understand the current situation on local basis. They are among high impact stakeholders on local scale in terms of identifying needs.

It was emphasized that construction companies and contractors should be considered as stakeholders of the process in order to raise awareness and adopt climate-friendly practices, especially since they have a significant impact on the practices by becoming associations.

Stakeholder Analysis is important for preparing an effective Sustainable Energy and Climate Change Plan and managing the implementation process. If the roles, responsibilities and needs are shared with the relevant stakeholders during the plan preparation, the management of the multi-sectoral and multi-stakeholder process can be carried out effectively.

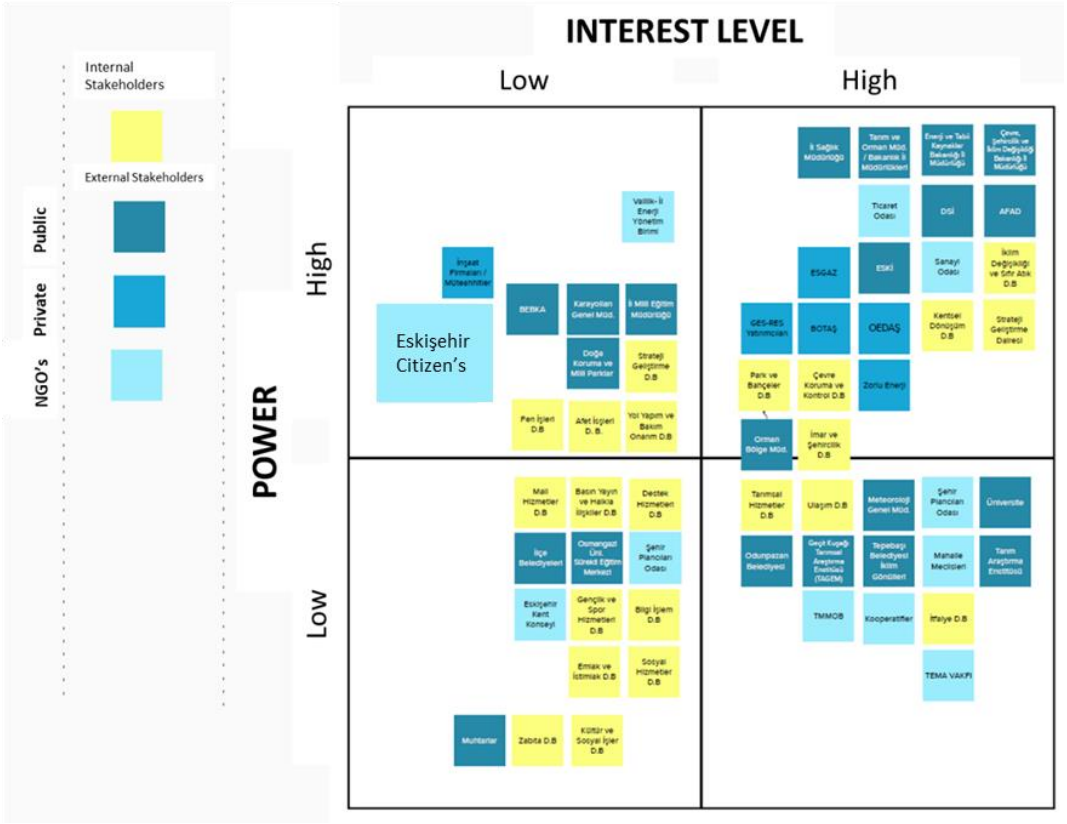


Figure 39: Stakeholder Analysis of SECAP implementation processes

4.3. ACTIONS

The preparation process of the Sustainable Energy and Climate Action Plan involves a series of multi-stakeholder and multidisciplinary activities. During the preparation of the action plan, the relevant units of Eskişehir Metropolitan Municipality, various external stakeholders, district municipalities, academics, NGOs and professional chambers participated in the process in order to ensure a participatory management approach.

Mitigation Workshop Results

The Multi-Criteria Assessment (MCA) Analysis was used to prioritize mitigation activities before the workshop to determine mitigation actions. Within the scope of the assessment, a number of criteria were considered for greenhouse gas reduction activities prepared with the main objectives of supporting the transition to sustainable energy and reducing greenhouse gas emissions: environmental, economic, social and institutional. The criteria in the four main categories were determined by Eskişehir Metropolitan Municipality in the light of strategic goals. The criteria to be used in the Multi-Criteria Assessment analysis were evaluated as "high", "medium" and "low" priority actions by a preliminary discussion with the relevant units under the leadership of the project implementing unit.

Figure 40: Mitigation workshop

On September 14, 2023, the workshop began with information on the Sustainable Energy and Climate Action Plan process and Eskişehir Metropolitan Municipality's current stage in the SEIEP process.

Afterwards, information was shared with the participants on the greenhouse gas inventory results of Eskişehir Metropolitan Municipality for 2021 and which key sectors will be focused on within the scope of the mitigation plan. Finally, the workshop methodology was shared with the participants and they were asked to separate into tables according to 5 main topic perspectives and express their opinions within the framework of the table topics. These topics are: Buildings, Energy, Transportation, Waste and Wastewater, and Agriculture, Livestock and Industry.

The main recommendations that emerged from the workshop according to the topics are listed below.

- **Buildings:** Planning an educational program for the development of concepts related to sustainable design (sustainable building standards, LEED, etc.) is highlighted on the agenda to facilitate the design of new residential areas. It has been emphasized that a comprehensive plan, in collaboration with universities, should be established for the transformation of registered buildings through energy-efficient practices. Understanding the existing building stock, ensuring the effectiveness of the regulatory inspection mechanism, and exploring best practices of other local governments are also emphasized, with a focus on discussing their applicability to Eskişehir. Additionally, the establishment of energy cooperatives throughout the province for the development of renewable energy investments has emerged as another prominent topic.
- **Energy:** The absence of a commitment across the city not to establish energy production facilities operated with fossil fuels is a notable issue. Efforts are highlighted to expand the biomass facility located in the Alpu district of Eskişehir for energy production from manure to cover extensive livestock areas. Other emphasized topics include the widespread installation of solar energy systems for communal spaces, the development of a municipal incentive mechanism through tax and fee reductions, and the implementation of energy-efficient upgrades for street and park lighting.
- **Transportation:** In municipal areas, the prioritized initiatives include the replacement of service and private vehicles with electric vehicles, the extension of rail systems along the north-south axis, and the expansion of rail system lines to the Organized Industrial Zone (OSB) located to the east of the city center. To promote the use of bicycles and e-scooters, there is an emphasis on conducting awareness campaigns through collaboration between the Ministry of National Education (MEB), the Police Department, and professional associations. Additionally, the creation of bicycle parking areas in pilot zones is highlighted.
- **Waste and Wastewater:** Among the highlighted topics in public institutions are the prohibition of single-use plastic or cardboard usage, the selection of electric vehicles for the logistics and transportation of solid waste, and the collaboration with the Ministry of National Education (MEB) to conduct awareness campaigns for waste segregation and disposal targeting citizens. Prioritizing separate teams for the collection and disposal of industrial waste by waste collection companies and encouraging compost production in rural areas through the creation of incentive mechanisms are emphasized. The development of a reward system for solid waste disposal for businesses and industrial facilities is also mentioned. Discussions with İlbank have taken place for the improvement of the existing wastewater treatment plant and the installation of new facilities. Planning facilities for districts without urban wastewater treatment plants, enhancing existing water infrastructure, and promoting the use of greywater are other crucial topics highlighted during the workshop.

- **Agriculture, Livestock, and Industry:** The forefront issues include the need for comprehensive agricultural policies, the development of support or incentive policies for farmers and producers, promoting water-efficient farming, following best practices, and developing projects in small-scale, pilot regions to encourage crops with high bioenergy production potential for biomass burning facilities. Discussions have taken place on projects aimed at deriving energy from manure. Emphasis is placed on conducting informative training sessions on composting, promoting the use of organic fertilizers, and increasing watershed and production pattern studies. In the context of livestock, there is a shift towards promoting small-scale livestock farming over large-scale livestock farming to reduce greenhouse gas emissions. Concerning industry, it is suggested to conduct a workshop to create an inventory of emission reduction practices currently implemented by industrial establishments and develop recommendations to reduce the energy consumption of the most energy-intensive businesses. Additionally, discussions have revolved around incentivizing the use of waste heat in industrial facilities and the importance of defining environmental criteria and sub-criteria under the Green Industrial Zone concept, with the sharing of information with businesses.

The workshop highlighted key topics, and main reduction actions have been identified in accordance with Eskişehir Metropolitan Municipality's 55% greenhouse gas reduction targets.

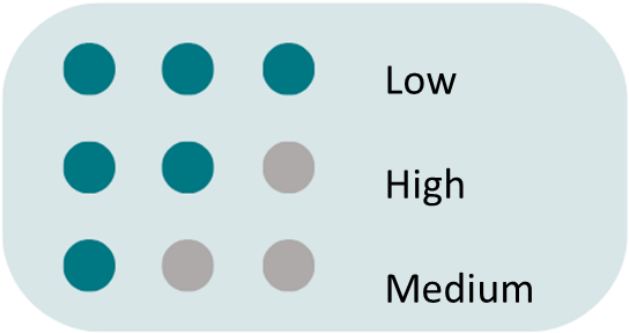
4.3.1. Mitigation Actions

Mitigation actions to be carried out in Eskişehir; It has been determined under four main headings: buildings and renewable energy, transportation, waste and wastewater, agriculture and livestock.

In the categories specified under the 'Action Type' in mitigation actions are as follows:

- Investment (public and/or private): Infrastructure investments that Eskişehir Metropolitan Municipality will undertake using its own resources or with grants/loans obtained from other institutions.
- Research: Conducting systematic studies that include the search for information or any research carried out for this purpose.
- Plan/Strategy: Providing a more detailed roadmap for improving performance in a specific sector or region (e.g., Climate Action Plan).
- Behavioural: Measures aiming to shift the community's behaviour, especially towards the targeted direction (e.g., promoting increased use of public transportation). While there may be a behavioural component in policy measures, activities in this category particularly focus on behaviour change, such as organizing awareness campaigns.

The priority level and impact on the mitigation target are defined as high, medium, and low, as seen in the table below.



Buildings and Energy

Buildings and renewable energy sectors play a critical role in achieving sustainability goals. While buildings constitute a large portion of energy consumption in Eskişehir, they also have a large impact (37.2%) in terms of greenhouse gas emissions. Eskişehir Metropolitan Municipality is working on a new zoning plan and building design standards update, developing methods to support its goals of increasing energy efficiency and reducing environmental impacts. This new approach aims to increase energy efficiency and reduce greenhouse gas emissions, based on sustainability principles. The action plan includes energy-efficient renovations in existing buildings, and various applications, especially in residential and commercial buildings whose building age is less than 10-15 years.

Within the scope of urban transformation projects, new buildings will be constructed in the first phase in 5 development project areas under the responsibility of Eskişehir Metropolitan Municipality. In addition, the transformation processes of buildings designated as "risky structures" under Law No. 6306 are carried out by the Ministry of Environment, Urbanization, and Climate Change of the Republic of Türkiye. In this context, it is envisaged that new buildings will be constructed with energy-efficient urban transformation and renewable energy integration. The municipality also aims to raise awareness in the society by informing the owners of residential and commercial buildings about energy efficient technologies and transformation processes. The main challenges in implementing mitigation actions in the buildings sector are inadequate prioritization of legislation and decision-makers, high investment costs, lack of technical capacity and lack of cooperation. In addition, other difficulties in urban transformation include compromise problems between owners and economic difficulties, and resistance to changing stereotypes and negative attitudes about energy efficiency.

According to the Building Sector Energy Efficiency Technology Atlas published by the Ministry of Environment, Urbanization and Climate Change in 2021 in the buildings sector for the mitigation actions targeted within the scope of Eskişehir Sustainable Energy and Climate Action Plan, a cost of 150 € per m2 is stated for energy efficient renovations, and an average of 100 m2 is required. 68% inflation was applied for the flat, taking into account 2023 construction costs. It is assumed that 15% energy efficiency will be applied in the Annex to the Real Estate Tax Law No. 81 of the Ministry of Environment, Urbanization and Climate Change. It is aimed to inform approximately 10% of the population about energy efficiency for those living in residences and commercial buildings. A cost of approximately 300,000 TL was calculated for Eskişehir, taking into account the organization and brochure printing within the scope of awareness-raising activities for approximately 10% of the population.

Eskişehir Metropolitan Municipality aims to reduce energy demand and greenhouse gas emissions by researching renewable energy, biomass energy and district heating systems throughout the city and integrating these systems into certain regions. In line with the increase targets in solar energy capacity emphasized in the National Energy Plan prepared by the Ministry of Energy and Natural Resources in accordance with Türkiye's net zero emission target by 2053, the priority targets are to expand solar power plants and develop energy efficiency practices in Eskişehir. In this context, it is planned to create various mechanisms to encourage solar panel installations. Additionally, it is aimed to enhance financial efficiency and reduce energy consumption by converting the city's street lighting systems to energy-efficient LED systems. Renewable energy mitigation actions involve significant risks and challenges, such as technical and infrastructural inadequacies, high investment costs, and difficulties in the level of social awareness and acceptance.

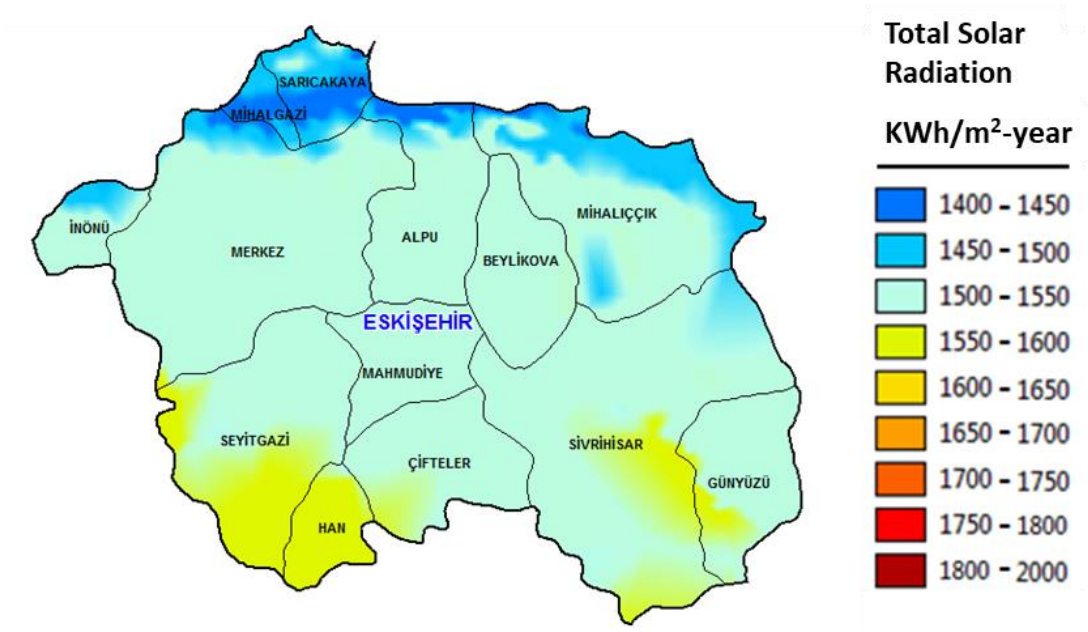


Figure 41: Solar Energy Potential Atlas of Eskişehir[51]

According to the Solar Energy Potential Atlas, which was created to determine the most suitable places for solar energy applications in our country and to determine solar energy-based electricity or heat energy production opportunities in these regions, the solar radiation value of all districts of Eskişehir appears as above. It has been mapped that the solar radiation value of Eskişehir city is mostly 1500-1550 kWh/m^2-year, 1400-1450 kWh/m^2-year towards the north of the city and 1550-1650 kWh/m2-year towards the south of the city. For the city of Eskişehir, there is a high potential for the use of solar energy-based renewable energy in the energy consumption of municipal buildings and residences.

Approximately €160 million for the installation of 275,000 kWp solar energy systems in residential and commercial buildings; A cost of over €6 million is anticipated for the installation of 5,000 kWp solar energy systems in municipal buildings. However, investment costs are expected to decrease over time. The private sector share is also important for costs.

[51] https://gepa.enerji.gov.tr/MyCalculator/pages/26.aspx

BUILDINGS

ACTION B1. Updating local level policies and plans regulations and guideliness regarding the municipality's new zoning works in line with sustainability principles

SUB-ACTIONS AND STEPS

- Planning capacity-building activities related to sustainable building design (sustainable building standards, LEED, etc.) within relevant municipal departments
- Updating plans, plan notes, and guidelines for the municipality's upcoming urban development projects in line with sustainability principles
- Creating a Sustainable Urban Design Guide for new settlement areas in accordance with sustainable design concepts

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Strategy development	Eskisehir Metropolitan Municipality District municipalities	Universities, Professional Chambers

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective B1.1, B1.4 NEEAP 2017-2023: Action B5, B11 EMM 2020-2024 Strategic Plan: Objective 1; Target 1.3 Building Energy Performance Regulation Planned Areas Zoning Regulation General Principles Article 20

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ●

BUILDINGS

ACTION B2. The implementation of energy-efficient measures in municipal buildings and the design of new buildings as net-zero energy

SUB-ACTIONS AND STEPS

Existing buildings:

- Implementation of energy-efficient measures in existing municipal buildings (such as insulation, green roofs, energy-efficient LED lighting, etc.)
- Utilization of renewable energy sources in municipal buildings
- Planning awareness and consciousness-raising activities on energy efficiency for municipal employees

New buildings:

- Designing all new municipal buildings as net-zero energy
- Assessment of embedded carbon values (throughout the supply chain), evaluating the carbon footprint of materials and preferring low-carbon materials (e.g., alternatives to cement; recycled aggregates, wood)

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public)	Eskisehir Metropolitan Municipality	Ministry of Energy and Natural Resources, Financial Institutions

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	Presidential Circular on Energy Saving in Public Buildings (dated November 3, 2023, no. 32359) CCAP 2011-2023: Objective B1.5, B2.1, B3.1 NEEAP 2017-2023: Action B1,B3,B10 EMM 2020-2024 Strategic Plan: Objective 8; Target 8.4.

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

BUILDINGS

ACTION B3. The renovation of existing buildings (residential and commercial) with sustainable and low-emission technologies

SUB-ACTIONS AND STEPS

Residences:

- Widespread implementation of energy performance certificates for residential buildings to collect information and conduct feasibility studies to reduce energy consumption
- Implementation of energy-efficient measures (especially insulation) to residential buildings and periodic monitoring of energy consumptions by district municipalities
- Coloring the roofs with white and green
- Installation of energy-efficient lighting systems (LED, etc.)
- Electrification of building energy systems
- Comprehensive research and planning for the transformation/renewal of registered buildings through energy-efficiency measures, development of collaborations with experts, particularly universities
- Monitoring of all additional measures by the municipality (data maintained by district municipalities will be supervised by the metropolitan municipality)

Commercial Buildings:

- Widespread implementation of energy performance certificates for commercial buildings to collect information and conduct feasibility studies to reduce energy consumption
- Feasibility studies for energy-efficient measures
- Promotion of nature-based solutions such as green roofs
- Monitoring of all additional measures by the municipality (data maintained by district municipalities will be supervised by the metropolitan municipality)

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (private)	District Municipalities, Property Owners	Eskisehir Metropolitan Municipality, MoEUCC, OEDAS, ESGAZ, EMO, TMMOB, Universities, Financial Institutions, Private Sector

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Informer, guider and supervisor	CCAP 2011-2023: Objective B1.1 NEEAP 2017-2023: Action B5, B6 EMM 2020-2024 Strategic Plan: Objective 3; Target 3.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ○

BUILDINGS

ACTION B4. The use of energy-efficient measures in urban renewal areas and new construction projects

SUB-ACTIONS AND STEPS

- Identifying of energy performance criteria in urban transformation projects
- Taking municipal council decisions by for the integration of green roof implementations (district municipalities)
- Conducting feasibility studies for meeting heating needs with district heating
- Doing research on financial resources to support the renovation of residencials to a higher and more environmental friendly energy standard
- Encouraging the use of heat-reflective glass in all new residential and commercial buildings
- Ensuring the integration of energy-efficient measures into new building permit projects, making at least B energy class mandatory in urban transformation areas to be undertaken by the metropolitan municipality (ensuring the maintenance of these data by district municipalities and reporting to the metropolitan municipality)
- Conducting circular economy assessments (focusing on waste management and recycling) in all renovation and demolition projects

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public and private)	Eskisehir Metropolitan Municipality, MoEUCC, District Municipalities, Property Owners	Construction Companies, Financial Institutions

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective 1.2 NEEAP 2017-2023: Action B9 EMM 2020-2024 Strategic Plan: Objective 3; Target 3.2 Planned Areas Zoning Regulation General Principles Article 40

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ●

BUILDINGS

ACTION B5. Planning Energy Efficiency Awareness Campaigns for Residential and Commercial Buildings

SUB-ACTIONS AND STEPS

Residences:

- Analysing the existing awareness levels of different socio-economic groups for the development of different communication campaigns (surveys, focus group meetings, etc.)
- Organizing periodic awareness-raising meetings for the entire community on energy efficiency and renewable energy technologies (meetings should include information not only on technologies but also on the environmental, health, and especially potential cost-saving aspects)
- Planning separate meetings with relevant building material manufacturers, contractors, financial institutions and bringing them together with citizens
- Improving the knowledge and skills of children and young people on renewable energy sources, energy usage, and their environmental impacts

Commercial Buildings:

- Sharing best practices with energy managers of commercial buildings, hospitals, shopping malls, and other commercial buildings in the city.
- Sharing information on possible measures with expert support (heat pump systems, various energy efficiency practices, etc.)

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Behavioral	Eskisehir Metropolitan Municipality, District Municipalities	TMMOB, Universities, Local Civil Society Organizations

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective B1.1 NEEAP 2017-2023: Action B1 and B5

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ○	● ● ●

RENEWABLE ENERGY

ACTION YE1. Analyzing and developing renewable energy and energy efficiency potantial

SUB-ACTIONS AND STEPS

- Collaborating with infrastructure companies (e.g., electricity, water) to understand capacity limits and support the transition to renewable electricity systems
- Analyzing the district heating capacity in the city
- Exploring the potential of wind and biomass energy in the city
- Conducting a feasibility study on district heating/cooling systems, with a focus on industrial areas, utilizing waste heat
- Conducting research on local microgrid options for renewable energy
- Supporting the transition to renewable or low-carbon energy sources (geothermal, electricity) in areas with high coal usage
- Promoting the widespread implementation of renewable energy in buildings
- Prioritizing the installation of solar energy and storage systems, especially in energy intensive sectors

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Research, Investment (public, private)	Eskisehir Metropolitan Municipality, District Municipalities	OEDAS, Universities, Professional Chambers, Renewable Energy Investors

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective E2.1, E2.3 NEEAP 2017-2023: Action E1 EMM 2020-2024 Strategic Plan: Objective 1; Target 1.1.

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ○	● ● ●

RENEWABLE ENERGY

ACTION YE2. Establishing incentive mechanisms for the dissemination of solar panels

SUB-ACTIONS AND STEPS

- Supporting the establishment of energy cooperatives to increase renewable investments
- Making tariff adjustments for municipal fees and licensing costs to encourage the dissemination of individual solar panels (district municipalities)

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Research, Policy	Eskisehir Metropolitan Municipality, District Municipalities	Renewable energy investors, Ministry of Energy and Natural Resources, EMRA

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective E2.1, E2.3 NEEAP 2017-2023: Action E1 EMM 2020-2024 Strategic Plan: Objective 1; Target 1.1.

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ○

RENEWABLE ENERGY

ACTION YE3. Implementation of energy-efficient street lighting systems

SUB-ACTIONS AND STEPS

- Taking inventory of street lighting systems
- Integration of energy-efficient street lighting systems
- Installation of lighting systems integrated with renewable energy in feasible areas, especially for illuminating open green spaces
- Establishing infrastructure to enable lighting poles to serve as charge for electric vehicles where possible

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Implementation	Osmangazi Electricity Distribution Inc.	Eskisehir Metropolitan Municipality

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Guider	CCAP 2011-2023: Objective E2.1, E4.1 NEEAP 2017-2023: Action E7

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ○	● ● ○

Transport

The transportation sector is one of the sectors that significantly contributes to greenhouse gas emissions. The share of transportation-related emissions in Eskişehir's inventory, excluding industry-based emissions, is 33%. One of the priority goals for the city of Eskişehir is to minimize the environmental impacts of transportation and create a more sustainable transportation network. Eskişehir Metropolitan Municipality prioritizes the purchase of electric public transportation vehicles starting in 2023 and the use of environmentally friendly vehicles in the municipal vehicle fleet. Expanding the rail system lines in line with EUAP and SKHP recommendations and increasing the comfort of public transportation aims to reduce greenhouse gas emissions by encouraging the use of public transportation. Eskişehir also aims to reduce fuel consumption through effective route planning of public transportation and waste collection services and training in economical driving techniques. Encouraging sustainable transportation methods, Eskişehir diversifies its transportation infrastructure by supporting the safe use of bicycle and pedestrian paths. In the Eskişehir Sustainable Transportation Master Plan, there are four categories of transportation modes: pedestrian, micro mobility, public transportation and private vehicle. The goals set in the plan include increasing the use of sustainable transportation modes (pedestrian, bicycle and public transport) and reducing the use of private vehicles. In addition, there is also the goal of improving the integration between transportation modes. Restriction of fossil fuel vehicles in European cities and tax advantages for electric vehicles in Türkiye encourage the widespread use of electric vehicles in Eskişehir. Additionally, a modern tram system has been built and integrated with other public transport systems. Additionally, there are 21 adaptive intersections within the scope of smart traffic management in Eskişehir. The main risks encountered in mitigation actions in the transportation sector are high investment costs, inadequacy of good practices, low interest in public transportation and bicycle paths, and difficulties in behavioural changes.

Due to the tax advantage provided for the widespread use of electric vehicles in the transportation sector, no additional costs are foreseen in this regard. According to the feasibility report published by the Ministry of Industry and Technology, the installation costs of fast charging stations in Türkiye in 2020 vary between $30,000 and $50,000. The cost for a bicycle path is between 4-6 € per m2. A cost of approximately 200,000 TL is estimated for awareness-raising activities to encourage public transportation. Waste collection vehicles, etc. belonging to district municipalities for economical driving training. A cost of 1,500 TL per training is envisaged, 150 TL if organized online, and a total budget of 15,000 TL is estimated for awareness-raising activities. The cost of converting from diesel to electric buses for municipal buses is estimated to be 250,000 € per bus. If purchasing a new electric bus is preferred, the cost per bus is approximately 500,000 €.

TRANSPORTATION

ACTION U1. Promotion of Low-Emission Vehicles for Public Transportation, Municipal Fleet, and Services

SUB-ACTIONS AND STEPS

- Conducting a feasibility study for the replacement of municipal fleet with low-carbon (electric, hybrid, etc.) vehicles
- Purchase/rental of municipal vehicles taking into account the low emission threshold values to be determined

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public)	Eskisehir Metropolitan Municipality	Ill Bank, Vehicle Manufacturers, Vehicle Maintenance Companies, District Municipalities

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective U3.1, U3.2 NEEAP 2017-2023: Action U1 EMM 2020-2024 Strategic Plan: Objective 2; Target 2.2 SUMP: Objective 4

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ○	● ● ●

TRANSPORTATION

ACTION U2. Increasing the Number of Electric Charging Stations Citywide and Promoting the Adoption of Electric Vehicle Usage

SUB-ACTIONS AND STEPS

- Analysing the potential for electric vehicle usage in the city
- Initiating discussions and collaborations with relevant private companies and public institutions to promote the dissemination of electric vehicles
- Establishing e-charging stations in central locations for electric vehicle usage (Parking areas may be prioritized for the integration of electric charging stations)
- Organizing events and activities to encourage electric vehicle usage in the city
- Providing information to citizens regarding the location and use of electric charging stations

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public and private) and Plan/Strategy	Eskisehir Metropolitan Municipality	Ministry of Transport and Infrastructure, Ministry of Energy and Natural Resources, Il Bank, Vehicle Manufacturers, E-charging Station Operators

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective U4.1 NEEAP 2017-2023: Action U1 SUMP: Objective 4

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ●

TRANSPORTATION

ACTION U3. Diversification of Rail System Lines and Improving the Comfort of Public Transportation to Increase the Use

SUB-ACTIONS AND STEPS

- Developing the mass transportation network and infrastructure to diversify modes of transportation
- Creating additional public transportation lines between new development/urban transformation areas and existing ones
- Conducting awareness and educational campaigns to increase the use of public transportation

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public and private) and Plan/Strategy	Eskisehir Metropolitan Municipality, ESTRAM	Ministry of Transportation and Infrastructure, MoEUCC, Ilbank Inc.

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective U4.1 NEEAP 2017-2023: Action U1 EMM 2020-2024 Strategic Plan: Objective 2; Target 2.2 SUMP: Objective 1 and 3

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ○

TRANSPORTATION

ACTION U4. Efficient Route Planning for Public Transportation Services

SUB-ACTIONS AND STEPS

- Conducting feasibility studies for additional public transportation routes
- Increasing integration between urban public transportation modes
- Creating alternative route simulations for public transportation

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public and private) and Plan/Strategy	Eskisehir Metropolitan Municipality	ESTRAM

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective U2.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

TRANSPORTATION

ACTION U5. Efficient Route Planning for Waste Collection Vehicles

SUB-ACTIONS AND STEPS

- Creating alternative route simulations for waste collection routes
- Optimization of waste collection routes for waste collection vehicles by district municipalities

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment (public) and Plan/Strategy	District Municipalities	Eskisehir Metropolitan Municipality

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Guider	CCAP 2011-2023: Objective U2.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

TRANSPORTATION

ACTION U6. Planning of Economic Driving Training

SUB-ACTIONS AND STEPS

- Identifying, grouping, and prioritizing the target audience (e.g., public transportation drivers, etc.)
- Conducting meetings for the target audiences
- Collaborating with relevant district municipalities to expand the scope of influence

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Behavioral	Eskisehir Metropolitan Municipality, District Municipalities	Ministry of National Education, Drivers' Chamber, NGOs, vehicle owners, private courses

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective U4.1

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ○	● ● ○

TRANSPORTATION

ACTION U7. Diversification of Transportation Infrastructure and Modes Considering Sustainable Transportation Methods

SUB-ACTIONS AND STEPS

- Conducting research to identify sustainable transportation methods suitable for local-specific requirements.
- Implementation of actions to increase non-motorized transportation modes outlined in the Sustainable Urban Mobility Plan (SUMP).
- Development of bicycle infrastructure, creation and expansion of parking areas and increasing the share in transportation.

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Implementation and behavioral	Eskisehir Metropolitan Municipality, District Municipalities	Financial institutions, Entrepreneurs, Citizens

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective U1.3, U2.1, U2.2, U3.1, U4.1 NEEAP 2017-2023: Action U4, U5 EMM 2020-2024 Strategic Plan: Objective 2; Target 2.1 SUMP: Objective 1 and 2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ●

TRANSPORTATION

ACTION U8. Optimization of Traffic Flow and Signal System through the increase of Implementation of Smart Traffic Methods

SUB-ACTIONS AND STEPS

- Increasing the number of smart intersection points.
- Adjustment of existing smart intersection signalization systems
- Collection and analysis of data obtained from traffic signalization systems
- Continuous monitoring of implemented systems, making necessary updates, and integrating innovative solutions

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Plan and Strategy	Eskisehir Metropolitan Municipality	Traffic Branch Directorate, Provincial Police Department

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer	CCAP 2011-2023: Objective U1.1

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

Waste and Wastewater

The amount of waste continuously increases due to population growth, industrialization, and changing consumption habits. Excluding emissions from industrial sources, the share of emissions from waste and wastewater in Eskişehir's inventory is 3%.

In Eskişehir province, sustainable waste management and improvements in wastewater treatment processes are being implemented to contribute to environmental sustainability. Solid waste transfer stations have been established in three different districts: Sarıcakaya, Mahmudiye, and Sivrihisar. These stations aim to reduce waste by implementing improvements in solid waste management. These steps aim to reduce environmental impacts by enabling more efficient collection and processing of waste. Additionally, anaerobic digesters in the wastewater treatment facility in the region provide 50-55% energy recovery, which is reused within the facility. Improvements in the processes of the wastewater treatment plant are targeted to reduce greenhouse gas emissions. These efforts contribute significantly to reducing environmental impacts and increasing resource efficiency in Eskişehir's waste management and water treatment processes. The primary risks encountered in mitigation actions in the waste and wastewater sector include businesses not implementing necessary improvements in waste management, insufficient increases in recycling and recovery rates, high costs, implementation challenges, and the inability to establish effective collaboration within the sector.

WASTE AND WASTEWATER

ACTION A1. Reducing Waste Amounts and Improving Waste Collection Processes

SUB-ACTIONS AND STEPS

- Organizing a citywide campaign to reduce waste and promote recycling
- Improving the Solid Waste Management Plan and implementing regulations for recycling
- Establishment of a Refuse Derived Fuel (RDF) plant
- Smart route planning for waste collection and transfer vehicles
- Conducting circular economy assessments (focusing on recycling) in all urban renewal and demolition projects
- Providing support for compost production, especially in rural areas
- Providing awareness training to the local community on compost production.

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Plan and Strategy	Eskisehir Metropolitan Municipality, District Municipalities	MoEUCC, Provincial Directorate of Environment, Urbanization and Climate Change, citizens

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	CCAP 2011-2023: Objective A1.1 EMM 2020-2024 Strategic Plan: Target 1.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ● ●	● ● ●

WASTE AND WASTEWATER

ACTION A2. Improvement of Operating Conditions in Wastewater Treatment Systems

SUB-ACTIONS AND STEPS

- Upgrading existing design and implementation standards to enhance the efficiency of new infrastructure lines
- Improving the existing water management infrastructure
- Enhancing the operating conditions of all wastewater treatment facilities
- Researching sustainable and environmentally friendly new technologies for integration into the wastewater treatment plant
- Collaborating with relevant institutions and organizations (universities, etc.) to improve the wastewater treatment plant
- Developing R&D project studies to ensure the continuity of improvements at the wastewater treatment plant
- Selecting pilot areas initially to increase awareness, providing training, and conducting awareness campaigns

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment project (public)	Eskisehir Metropolitan Municipality, ESKI	District Municipalities, Provincial Directorate of Environment, Urbanization and Climate Change, universities

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	National Waste Management Action Plan: 5.6 EMM Strategic Plan 2020-2024: Target 1.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

Agricultural & Lifestock

Eskişehir is a region with fertile agricultural lands, attracting attention with a 7% share of employment in the agriculture sector. In this context, the share of emissions from agricultural sources in Eskişehir's inventory, excluding emissions from industrial sources, is 26.8%.

The most commonly produced agricultural products in Eskişehir are sugar beets, sunflower, potatoes, wheat, and barley. Low-carbon emission practices are aimed to be promoted in agricultural activities in the region. According to the data system of the Ministry of Agriculture and Forestry, there are 23,824 farmers in Eskişehir. After providing training to relevant unit personnel on low-carbon emission farming techniques, the goal is to increase awareness by providing training to farmers through these personnel. There are approximately 8,110 agricultural irrigation subscribers in Eskişehir, and due to the high number of these subscribers, the number of special transformers is high. In this context, the aim is to increase the use of renewable energy in agricultural irrigation activities, thereby reducing greenhouse gas emissions. The main risks for mitigation actions in the agriculture sector include high costs, lack of education and information, infrastructure and support issues, and climatic factors.

Within the scope of training and awareness activities on low-carbon emission farming techniques in agriculture, organizing events and printing brochures incur a total cost of 300,000 TL. The cost of using renewable energy in agricultural irrigation is estimated to fall below 1 € per unit. Although there is significant uncertainty in the photovoltaic system installation market, recent price mitigations suggest that these values are likely to be much lower than the calculated value. Currently, the payback period is slightly above 8 years.

AGRICULTURE

ACTION T1. Conducting Training and Awareness Raising Campaigns on Low Carbon Emission Agriculture Techniques

SUB-ACTIONS AND STEPS

- Providing informative training sessions for farmers in schools or locations allocated by the municipality, with the support of academics teaching sustainability in agricultural high schools or relevant university departments
- Organizing media campaigns, seminars, and workshops to increase awareness in the community about significance of low carbon emission agriculture and its environmental impact

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Behavioral	Eskisehir Metropolitan Municipality	Ministry of Agriculture and Forestry, Provincial Directorate of Agriculture and Forestry, farmers, universities

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	Rural Development Action Plan: Objective 2 - Measure 2.1.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

AGRICULTURE

ACTION T2. Promotion of Low Carbon Agricultural Practices

SUB-ACTIONS AND STEPS

- Leaving fertilizer residues in the field to increase organic matter and using fertilizers based on soil analysis, promoting the use of organic fertilizers than chemical fertilizers
- Planning educational programs for farmers and using practical, on-the-job learning methods
- Raising awareness among farmers for delivering animal waste to fertilizer facilities by preparing brochures, etc.
- Encouraging the use of biomass incineration facilities for agricultural products or residues

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Plan and Strategy	Eskisehir Metropolitan Municipality	Ministry of Agriculture and Forestry, agro-industrial organizations, farmers

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Implementer and guider	Rural Development Action Plan: Objective 2 - Measure 2.1.2

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

AGRICULTURE

ACTION T3. Increasing Energy Efficiency and the Use of Renewable Energy in Agricultural Irrigation

SUB-ACTIONS AND STEPS

- Identifying regions and systems with high consumption in agricultural irrigation in Eskisehir, preparing crop patterns that align with the capacity of water resources
- Conducting feasibility studies for replacing identified systems with energy-efficient ones
- Promoting the use of photovoltaic systems in irrigation systems in Eskisehir province

ACTION TYPE	RESPONSIBLE INSTITUTIONS	ASSOCIATED INSTITUTIONS
Investment	Agricultural land owners	Eskisehir Metropolitan Municipality, Ministry of Agriculture and Forestry, agro-industrial organizations, farmers

MUNICIPALITY'S CONTRIBUTION	ASSOCIATED PLANS
Guider	Provincial Disaster Risk Mitigation Plan: Objective 10

IMPACT OF ACTION ON TARGET	PRIORITY LEVEL
● ○ ○	● ● ●

Adaptation Workshop Results

A method involving broad participation of internal and external stakeholders was followed in determining adaptation actions. In the workshop, initially, presentations were made to the participants regarding the assessments of the climate-related disasters awaiting Eskişehir. In the second stage, participants were divided into tables based on their areas of expertise, such as Water, Agriculture and Biodiversity, Urban, Disaster and Health, and Industry, Tourism, and Administrative Organization. With the assistance of moderators, the prioritization of actions on the boards was ensured.

Figure 42: Adaptation Workshop

The prominent suggestions according to the relevant topics of the workshop are stated below.

Water, Agriculture and Biodiversity: When analyzing the water consumption in the Sakarya Basin, where Eskişehir is located, it is known that agriculture is the most water-consuming sector, accounting for 70%, followed by drinking water with approximately 23%. In this context, water efficiency efforts in these two areas stand out for Eskişehir. During the workshop, participants emphasized the need for measures to increase efficiency that are consistent with existing policies and strategies, aiming to reduce water consumption. It was highlighted that coordinated awareness campaigns involving different institutions should develop distinct communication strategies for different sectors.

Agriculture, closely intertwined with water issues, requires specific solutions for some unique challenges. While rainfed agriculture is prevalent in the city, the irrigated area is also substantial. Among the issues emphasized by participants is the need for reversing the trend where farmers, facing increasingly

challenging economic conditions, lean towards high-value-added but more water-intensive crops. They stressed the necessity of increasing support and grants to alter this behavior. Simultaneously, there is an emphasis on enhancing research and development (R&D) efforts related to the anticipated impacts of climate change and investigating how agriculture will be affected.

The significant forest presence throughout the city and its richness in flora and fauna elevate the importance of biodiversity conservation. Specific areas in Eskişehir, such as Sivrihisar (around Karacaören Village), Tepebaşı (around Nemli Village-Karabayır), Tepebaşı (Turkmen Mountain, Efsunbaba Hill), Alpu (Bozan Town Afforestation Area), Sarıcakaya (around Mayıslar Village), and Sivrihisar (around Yeşilköy), are highlighted as ecologically important regions. Increasing the number of significant sink areas, such as forests, will become particularly crucial in the future, aligning with the National Climate Vision, and gaining added importance for cities aiming for a 'net-zero' target.

- **Urban, Disaster, and Health:** The primary focus of the discussion at the section was the increase of green areas, the most crucial tool for mitigating climate risks such as floods, and the heat island effect. Initiatives have already commenced in Tepebaşı district to create green corridors, ensuring the continuity of green spaces. It was noted that the main obstacle to increasing green areas is property issues. Additionally, challenges were highlighted in green area enhancement projects that include public spaces (such as schoolyards), as the institutions responsible for the maintenance of these green spaces often fail to fulfill their maintenance obligations. Pilot projects for integrating bike paths with green areas have been initiated in some areas (Tepebaşı). Rivers like Sakarya, Sarısu, Porsuk, and Seydi, despite some being regulated, still pose flood risks. The importance of preserving water lines and reclaiming their surroundings for the city, supported by landscape elements, was emphasized. Increasing the number of climate-resilient pilot areas/streets was suggested as beneficial for implementing these actions. Identifying vulnerable population groups susceptible to climate disasters emerged as one of the most critical issues. It was emphasized that working in coordination with the provincial health directorate is crucial for investigating/determining individuals with chronic illnesses at the provincial and district levels. The significance of developing early warning systems and issuing warnings, especially for vulnerable populations, during risky periods was highlighted.
- **Industry, Tourism, and Administrative Organization:** The importance of rain harvesting and reuse in the industry was emphasized. The discussion included the concept of utilizing the heat generated in the industry for water heating, even distributing it throughout the city. Collaboration between the organized industrial zones (OSB) and the Eskişehir Metropolitan Municipality was suggested in this regard. It was stressed that joint decisions, in collaboration with stakeholders, are necessary for practices such as water allocation, reuse, and harvesting in the industry. The importance of knowing the risks and threats to the preservation of historical and cultural areas and taking measures accordingly was highlighted. In Eskişehir, day-trip tourism was noted to be predominant in areas with urban tourism, particularly around Odunpazarı, Sazova, and Porsuk. It was emphasized that tourism should be expanded to rural areas alongside urban tourism. Due to the lack of diversified tourism, concerns were raised that any issues related to water could impact Eskişehir's tourism industry.

At the workshop, key adaptation actions were identified considering national and regional climate change adaptation plans, basin management plans, provincial disaster risk reduction plans, and Eskişehir's vulnerability to climate risks.

4.3.2. Adaptation Actions

Goals for adaptation; It has been determined as Water Management, Agriculture, Biodiversity, Green Areas, Disaster Management, Public Health, Industry, Tourism and Administrative Organization.

Actions for these topics have been determined to integrate with national climate change adaptation goals, climate projections, regional plans, Disaster Risk Reduction Plan, Basin Drought Management Plan, and municipal strategic plans. The implementation processes of adaptation actions are comprehensive efforts that require joint collaboration among various public sectors. Coordination and collaboration processes are crucial in this regard. Within this context, 47 actions under 12 targets have been identified for adaptation actions. Actions for which Eskişehir Metropolitan Municipality will play a key role in implementation and coordination are specifically marked with (*) symbols.

Water Management;

- Target 1. Protecting and increasing water supplies
- Target 2. Promoting water efficiency practices and prevention of pollution

Agricultural;

- Target 3. Ensuring continuity in agricultural production and food security

Biodiversity;

- Target 4. Protection of forest areas and biodiversity

Green Areas;

- Target 5. Increase in the quantity and quality of green areas
- Target 6. Reduction of the urban heat island effect in urban areas

Disaster Management;

- Target 7. Building resilience against climatic disasters
- Target 8. Increasing society's resilience to disasters

Public Health;

- Target 9. Protection of public health against climate change hazards

Industry and Tourism;

- Target 10. Increasing the resilience of the industrial sector against climatic disasters, especially drought
- Target 11. Reducing resource use of tourism facilities and increasing resilience to climate hazards

Administrative Organization

- Target 12. Providing administrative structure and technical tools to ensure the implementation and monitoring of mitigation, adaptation and energy poverty actions

Water Management

Climate change increases the pressure on water resources in cities. Increasing temperature, changes in precipitation regimes and extreme weather events make water resources even more fragile. In this context, sustainable protection of water resources is a fundamental element for adapting to climate change.

Climate change directly affects water resources. With the increasing risk of drought, decreases in water resources negatively affect agriculture, industry and domestic uses. At the same time, extreme rainfall and floods can cause sudden and harmful overflow of water resources. Water resources that are resilient to these variations have the potential to minimize the effects of climate change.

Protecting water resources is important in various aspects. First, it contributes to the preservation of biodiversity. Freshwater ecosystems provide ecosystem services and maintain environmental balance by providing habitat for many species. Secondly, effective management of water resources is vital for agriculture and food security. Decrease in water resources can negatively affect agricultural productivity and food production. Finally, management of water resources can increase communities' resilience to climate change impacts.

Water conservation and efficient use are one of the basic elements for sustainable management of water resources. It is critical that a wide range of stakeholders, from individuals to industry, are conscious of their water use. Ecosystem-based approaches play an important role in protecting and restoring natural aquatic ecosystems. Additionally, local governance and cooperation are important to ensure effective management of water resources. Strong collaboration between local communities, government agencies and non-governmental organizations can increase the sustainability of water resources.

Protecting water resources stands out as a fundamental strategy in adapting to climate change. Sustainable management of water resources has the potential to increase the protection of ecosystems, the sustainability of agriculture and the resilience of societies to the effects of climate change. Therefore, protecting water resources forms the basis of a sustainable future. There are some practices related to water management that can be done on an urban scale. These; many micro-scale applications such as the

increasing the number of rain gardens, the use of low-water consuming products in parks and gardens, and the expansion of rainwater retention and storage systems in buildings are among the applications that may be the responsibility of municipalities.

WATER MANAGEMENT

TARGET 1. Protecting and increasing water supplies

ACTIONS

Action 1.1:*
Assessment of the need for new plant species that require less irrigation in parks and gardens, traffic islands and intersections due to changing climate conditions.

Action 1.2:*
Integration of rainwater storage systems in buildings and urban areas, especially in public buildings, and increasing the use of graywater.

Action 1.3:*
Identification and prioritization of impermeable surfaces in public areas, and increasing permeable surfaces (sidewalks, roads, pedestrian zones, parks, etc.).

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality	All Public Institutions	

CHALLENGES

- **Lack of technical knowledge required for the construction of new implementations**
- **Citizens' different expectations regarding use of public spaces**
- **Failure to adopt the plan by other public institutions and organizations**

WATER MANAGEMENT

TARGET 2. Promoting water efficiency practices and prevention of pollution

ACTIONS

Action 2.1*:
Construction of wastewater treatment plants, improvement or renewal of existing systems, increasing the reuse rate to 30% by 2030.

Action 2.2:
Reducing the non-revenue water rate in municipalities (water loss) in accordance with relevant regulations.

Action 2.3:
Monitoring water quality and levels in regions where sectoral water extraction is carried out.

Action 2.4:
Promoting practices to increase efficiency in agricultural irrigation and closing open irrigation canals.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
EMM, ESKİ, Directorate of Agriculture and Forestry, Eskisehir Irrigation Associations	Organized Industry Regions	

CHALLENGES

- **Difficulties in cooperating with the private sector and public institutions**
- **Lack of financial resources**

Agricultural:

Climate change is significant threat to the productivity and sustainability of agricultural production. These threats increase the global food security risks. Changing precipitation patterns and extreme weather events significantly impact agricultural lands and vegetation. Decreasing water resources increasing the risk of drought, increasing the need for irrigation and negatively affecting agricultural lands. Eskişehir, being a city with intense agricultural production, is particularly vulnerable due to the drought risk for the future.

Various measures can be taken to address these challenges and protect agricultural production. Sustainable irrigation systems can support more resilient agriculture by ensuring efficient use of water resources in drought conditions. Soil management and conservation measures can prevent soil erosion and protect agricultural lands. Education and awareness campaigns can increase farmers' awareness of climate change.

Climate change policies are crucial for protecting the agricultural sector and taking necessary measures for a sustainable future. These policies can promote environmental sustainability, enabling agriculture to adapt to climate change and minimize its adverse effects. With comprehensive measures, the agricultural sector can become more resilient to the challenges posed by climate change, ensuring food security sustainably. In this context, prioritized agricultural practices that Eskişehir Metropolitan Municipality and various relevant public stakeholders can coordinate for the entire province have been identified.

AGRICULTURAL

TARGET 3. Ensuring continuity in agricultural activities and food security

ACTIONS

Action 3.1:
Widespread implementation of early warning systems and information campaigns for climate disasters, climate change-related diseases, and their impacts.

Action 3.2:
Implementation of methods to ensure efficient water use in agriculture, improvement drainage management in plains, prevention of surface irrigation, and losses due to evaporation.

Action 3.3*:
Protection, support, and dissemination of plant species and local breeds with high adaptive capacity.

Action 3.4:
Providing support to farmers to increase production diversity and quantity.

Action 3.5:
Development of special support mechanisms for farmers and production cooperatives, prioritizing women farmers and laborers, and increasing their adaptive capacities.

Action 3.6*:
Establishment of a current and dynamic information communication network for farmers and organizing training programs on climate-resistant agriculture.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Provincial Directorate of Agriculture and Forestry, Eskişehir Metropolitan Municipality	**Research Institutes, Universities, Agricultural Cooperatives, Chambers of Agriculture, Irrigation Associations**	

Biodiversity:

Eskişehir's biodiversity is at risk of exposure to the effects of climate change. Preserving its biodiversity should be a priority. Rising temperatures and changing precipitation patterns can impact local ecosystems, altering the distribution of native plant species and their habitats. The increasing risk of drought in aquatic ecosystems, in particular, can have negative effects on biodiversity. Additionally, climate change can exacerbate the spread of harmful organisms, leading to adverse impacts on vegetation.

Therefore, it is essential to implement sustainable measures to mitigate the potential effects of climate change on biodiversity in Eskişehir. Local authorities can identify factors threatening biodiversity across the province and engage in efforts to preserve forest ecosystems. Furthermore, promoting public participation through awareness campaigns and educational programs can encourage community involvement and strengthen conservation efforts to safeguard biodiversity.

BIODIVERSITY

TARGET 4. Protection of forest areas and biodiversity

ACTIONS

Action 4.1:
Identification and reduction of factors such as pollution, biopiracy, illegal hunting, and invasive species that threaten biological diversity.

Action 4.2*:
Establishment of safety strips within forest areas and between forests and settlement areas for combating forest fires.

Action 4.3*:
Raising awareness among citizens about forest fires, involving them in disaster management, and creating necessary improvement suggestions.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Provincial Directorate of Agriculture and Forestry, Eskişehir Metropolitan Municipality	Provincial Disaster and Emergency Management Presidency	

CHALLENGES

- **Lack of technical capacity**

Green Areas:

Green areas enhance carbon absorption, serving as a natural filter to absorb greenhouse gases in the atmosphere and thereby contributing to the fight against climate change. Additionally, shading provided by trees and plants helps prevent the urban heat island effect, maintaining local temperature balance. Green spaces also play a role in preventing erosion, conserving water resources, and supporting biodiversity. Therefore, increasing green areas in urban planning and overall environmental policies should be considered a significant strategy in combating climate change. Green spaces not only contribute to environmental sustainability but also enhance people's quality of life, creating healthy and resilient communities. In line with this, joint efforts among Eskişehir Metropolitan Municipality, district municipalities, and other public stakeholders have been outlined to increase green areas and set goals and actions for reducing the heat island effect.

GREEN AREAS

TARGET 5. Increase the quantity and quality of green areas

ACTIONS

Action 5.1*:
Increase the green space ratio and shaded areas to reduce the urban heat island effect.

Action 5.2*:
Develop green infrastructure plans that include arrangements such as ecological corridors in urban areas, and create plans and programs for green spaces, along with implementing exemplary practices.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality, Provincial Directorate of MoEUCC	District Municipalities	

CHALLENGES

- **Ownership structures**
- **Lack of financial resources**

GREEN AREAS

TARGET 6. Reduction of urban heat island effect in urban areas

ACTIONS

Action 6.1*:
Use reflective materials in surfaces in densely populated areas.

Action 6.2*:
Ensure the integration of bicycle paths and green corridors.

Action 6.3*:
Implement pilot street implementations for climate change adaptation.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality, Districts Municipalities	Provincial Directortorate of MoEUCC	

CHALLENGES

- **Lack of financial resources**
- **Challenges of maintenance and sustainability of green spaces**

Disaster Management:

Climate change increases the frequency of extreme weather events such as floods, storms, and droughts in urban areas, posing a threat to local governments and residents. Effective disaster management can enhance a city's resilience against risks arising from climate change and minimize the impacts of potential disasters. Disaster management should encompass comprehensive approaches, including proactive planning, rapid response, public awareness, and infrastructure strengthening.

The significance of disaster management lies in ensuring that cities are prepared for climate-related disasters. Preemptive risk analyses, disaster scenarios, and emergency plans provide a framework for addressing potential risks that urban areas may encounter, supporting effective disaster management. Additionally, the training of emergency teams and local communities is crucial for ensuring effective intervention during disasters. Taking steps such as strengthening infrastructure, implementing flood management systems, increasing green spaces, and transitioning to sustainable energy sources can help cities build resilience against climate-related disasters. These strategies are of great importance in minimizing the impacts of climate change-related disasters in urban areas, ensuring public safety, and promoting the sustainability of cities. In this regard, two main action areas have been identified in Eskişehir to build resilience against potential climate-related disasters and enhance community resilience in the face of disasters.

DISASTER MANAGEMENT

TARGET 7. Building resilience against climate disasters

ACTIONS

Action 7.1:
Identification of urban regions/buildings/infrastructure highly vulnerable to climate risks (floods, and heatwaves), and reduction of risks through spatial arrangements.

Action 7.2:
Protection and regulation of water surfaces and lines, take measures for covered riverbeds and water channels taking into account climate hazards, and even revitalizing the closed stream bed if needed

Action 7.3:
Prevention of urban sprawl and unauthorized land use.

Action 7.4:
Integration of climate-related disasters into the current disaster plans.

Action 7.5:
High-level understanding and commitment to existing climate risks in Eskişehir, and development of institutional capacity for climate and disaster resilience.

Action 7.6:
Ensuring the continuity of professional training for disaster and emergency response teams on climate emergencies and conducting exercises periodically.

Action 7.7:
Enhancement of infrastructure resilience in urban transportation, with evacuation pumps and culverts in multi-level intersections and designated underpasses where needed.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Provincial Directorate of Disaster and Emergency Management Presidency and MoEUCC	MGM, District Municipalities, Kızılay, Eskişehir Metropolitan Municipality	

DISASTER MANAGEMENT

TARGET 8. Increasing society's resilience to disasters

ACTIONS

Action 8.1:
Identification and mapping of vulnerable groups.

Action 8.2:
Identification and informating of areas where citizens can use as a shelter during heatwaves .

Action 8.3:
Designing protection methods (such as early warning systems) for agricultural lands and private properties against hailstorms.

Action 8.4:
Increasing the resilience of the private sector, business community, and professional organizations against climate hazards, ensuring occupational health and safety, and business continuity.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
EMM, Ministry of Agriculture and Forestry, General Directorate of Highways	**Ministry of Labor and Social Security and District Municipalities**	

Public Health:

Taking urgent measures to mitigate the adverse effects of climate change on public health is a critical necessity. Factors caused by climate change, such as rising temperatures, air pollution, decreasing water resources, and widespread natural disasters, pose threats to public health. Therefore, identifying emergency situations for the city, preventing epidemic diseases related to vector breeding, raising awareness among the public about climate change, and fostering participation in adaptation strategies are crucial for preserving the health of the community. These measures will help minimize the impact of climate change on health, contributing to healthier and more sustainable futures for communities.

PUBLIC HEALTH

TARGET 9. Protection of public health against climate change hazards

ACTIONS

Action 9.1*:
Determination and categorization of alarm situations related to the health impacts of climate change in Eskişehir, integration into the existing early warning system, and ensuring public's accessibility.

Action 9.2*:
Collaboration with the Provincial Health Directorate to investigate/identify individuals with chronic diseases at the provincial and district levels.

Action 9.3*:
Implementation of measures to prevent vector breeding.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality, Ministry of Health	District Municipalities	

CHALLENGES

- **Difficulty in accessing household data**

Industry:

The industrial production has a significant share in Eskişehir's GDP. Therefore, the industrial sector should take urgent measures to enhance its resilience against the challenges posed by climate change. While the powers of Eskişehir Metropolitan Municipality in this regard may be limited, collaboration with various public institutions and industrial zones to improve water efficiency and adopt sustainable water management practices is essential. This collaboration can particularly encourage applications aimed at preserving water resources, especially during periods of drought.

INDUSTRY

TARGET 10. Increasing the resilience of the industrial sector against climatic disasters, especially drought

ACTIONS

Action 10.1:
Determining climate risks as a criterion for water allocation and pricing in the industry sector.

Action 10.2:
Planning the reuse in the industry and in agricultural areas adjacent to industrial areas within the scope of updated regulations.

Action 10.3:
Planning for climate change adaptation from the establishment stage onward for facilities within Organized Industrial Zones (OSBs).

Action 10.4:
Monitoring and recording the use of surface and groundwater in industrial zones, ensuring the monitoring of water usage, and facilitating the reuse of water in industry and mining.

Action 10.5:
Evaluation of technological accident risks arising from climate change hazards and taking necessary precautions, priority given to facilities in industrial zones.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Ministry of Industry and Technology, Organized Industrial Zone, State Hydraulic Works	Eskişehir Metropolitan Municipality, Provencial Directorate of MoEUCC	

CHALLENGES

- **Not being prioritized**
- **Difficulty collaborating**

Tourism:

Eskişehir, with its rich history, cultural heritage, and natural beauty, stands as one of Türkiye's prominent tourist destinations. However, to cope with the impacts of climate change, the city should adopt sustainable tourism strategies. In this regard, various measures can be taken, such as assessing the vulnerability of tourism and cultural heritage to climate change, implementing sustainable practices in tourism facilities, limiting natural resource usage, and conducting initiatives to enhance tourists' environmental awareness. These practices can not only preserve Eskişehir's tourism potential but also contribute to building resilience against climate change.

TOURISM

TARGET 11. Reducing resource use of tourism facilities and increasing resilience to climate hazards

ACTIONS

Action 11.1:
Increasing the prevalence of sustainable tourism practices and certification in existing and newly established tourism facilities throughout the city, and increasing the number of green-starred hotels.

Action 11.2*:
Determining the levels of vulnerability and protective measures for cultural heritage from climate hazards through local and central institutions coordination.

Action 11.3:
Limiting the use of natural resources in tourism enterprises and facilitating collaborations among to protect the environment.

Action 11.4*:
Increasing environmental sensitivity in the city center during national and international meetings, conferences, and sports events, considering sustainable tourism principles.

Action 11.5:
Implementing practices across the province to encourage responsible tourism principles.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Provincial Directorate of Ministry of Culture and Tourism, State Hydraulic Works	Eskişehir Metropolitan Municipality, District Municipalities	

Administrative Organization:

The effective implementation of sustainable energy and climate action plans requires coordination and strong administrative organization. This involves strong collaboration and communication among various sectors, local governments, the private sector, and civil society organizations. Coordination ensures the seamless integration of each component of the plans and a focus on objectives. Administrative organization enables the efficient management of resources, ensuring that monitoring and evaluation processes are regularly conducted. This allows for tracking progress in plan implementation, swift issue resolution, and adjustments to strategies.

The establishment of coordination and administrative organization is crucial for the successful implementation of sustainable energy and climate action plans and achieving positive environmental impacts. In line with this, actions have been identified to support the management of the implementation and monitoring processes of reduction, adaptation, and energy poverty actions outlined in the Eskişehir Metropolitan Municipality's Sustainable Energy and Climate Action Plan.

ADMINISTIRATIVE ORGANIZATION

TARGET 12. Providing administrative structure and technical tools to ensure the implementation and monitoring of mitigation, adaptation and energy poverty actions

ACTIONS

Action 12.1*:
Establishing a governance model within the municipality that facilitates collaboration for the implementation of the Sustainable Energy and Climate Action Plan actions.

Action 12.2*:
Developing monitoring methods and tools (such as digital mapping, measurement, monitoring, communication, and coordination tools, etc.) and regularly monitoring Climate Mitigation and Adaptation Indicators.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality	District Municipalities	

4.3.3. Energy Poverty Actions

The assessment of energy poverty requires the analysis of numerous components within a complex structure. The existence of households that cannot adequately heat their homes during the winter months and use a significant portion of their income to cover energy expenses plays a crucial role in these assessments. Additionally, identifying households that use polluting solid fuels (such as coal or wood) for heating is directly related to energy poverty and public health.

In some European countries, support programs for families in need are implemented to combat energy poverty. These programs primarily address the affordability of energy prices, providing support in the form of tax reductions, social tariffs, or heating assistance. The recent Energy Poverty Alleviation Recommendation Report[52] published by the European Union emphasizes the importance of such actions during crisis times. However, it also warns that without structural improvements, these measures may pose obstacles to long-term efforts aimed at reducing energy consumption.

In Türkiye, professional chambers, unions, and consumer groups propose various solutions in various platforms, such as reducing taxes on energy, increasing the existing upper limit for electricity consumption support, replacing coal aids with natural gas, and providing employment opportunities in sectors with high unemployment rates. Considering the administrative structure of the Republic of Türkiye, a significant portion of these suggestions is related to central energy and social development policies and strategies.
As a local administration, the actions that Eskişehir Metropolitan Municipality can implement are outlined below. The actions are categorized under three main headings: buildings, households, and policy development. These actions are directly related to both mitigation and adaptation actions.

Buildings

The assessment of energy poverty encompasses various components, including buildings, energy prices, and income. Approximately 65% of the energy consumed in buildings is used for heating, cooling, hot water, and ventilation systems, while 20% is used for lighting. Constructing and retrofitting buildings to be energy-efficient helps reduce energy consumption and the amount of energy expended.

[52] Commission Recommendation on Energy Poverty (EU) 2023/2407, 20 October 2023

BUILDINGS

ACTION 1. Preparing an inventory of the heating systems and their current conditions for the buildings located in Eskişehir.

ACTIONS

The prioritized analyses include examining the energy consumption status, existing energy efficiency measures, and the use of polluting solid fuels (such as coal and wood) for heating purposes in buildings in Eskişehir.
These assessment studies should encompass:

- Construction years of the buildings
- Types of fuels used for heating
- Energy performance classes of the buildings
- Status of insulation/facade cladding
- Presence of central heating systems

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality, District Municipality	**All Public Institutions**	

CHALLENGES

- **The field studies covering the entire province and the compilation of the building inventory are extending over a long period**
- **Lack of human resources**
- **Lack of financial resources.**

Households

The existence of economically disadvantaged households unable to afford energy despite having access is expressed by the term energy poverty. Within this context, the identification of energy poverty encompasses various socio-economic analyses. The objective of this action is to identify households with limited access to energy, those unable to achieve sufficient heating/cooling even with access to energy, and those compelled to cover high energy costs.

HOUSEHOLDS

ACTION 2. Data collection to assess household energy poverty

ACTIONS

To carry out this action, a detailed survey should be conducted targeting households. Factors that increase the vulnerability of households, such as the comfort level of indoor temperature, the ratio of energy expenses to total household income, unemployment, and the presence of respiratory diseases will be assessed.

These studies will be analyzed using geographic information systems to conduct feasibility studies aiming to develop locally specific actions for energy-poor and/or at-risk households

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality, District Municipalities	Governorship, Ministry of Family and Social Services, Universities	

CHALLENGES

- **Need for high sample size**
- **Lack of human resources**

Politics

There are various strategies and preventive measures that municipalities can implement to deal with energy poverty. These strategies may differ based on local features, needs, and available resources.

POLICIES

ACTION 3. Creating awareness on energy efficiency and renewable energy; providing support for small-scale implementations

ACTIONS

- Conducting informative campaigns on the financial benefits achievable through energy efficiency applications (efficient devices, lighting, etc.)
- Organizing seminars and workshops to raise public awareness about energy savings
- Undertaking efforts to promote the transition to alternative energy sources and conducting cost-reducing initiatives
- Initiating research studies to pioneer the establishment of local energy cooperatives, creating social assistance programs (e.g. energy bill aid) for low-income families.

RESPONSIBLE INSTITUTIONS	RELEVANT INSTITUTIONS	PRIORITY LEVEL
Eskişehir Metropolitan Municipality	Governorship, Ministry of Family and Social Services, Districts Municipality, NGO's	

CHALLENGES

- **Lack of financial resources**
- **Lack of technical capacity**
- **Lack of collaboration between institutions**

4.4. MONITORING PLAN

The Covenant of Mayors emphasizes the importance of effective monitoring activities to support the commitments of local governments in the fields of climate change and sustainable energy. In this context, municipalities are expected to monitor their progress towards reducing greenhouse gas emissions, increasing energy efficiency, and expanding the use of renewable energy sources. The monitoring process involves regular data collection and analysis to assess the proximity to the set targets, record progress, and identify potential challenges. These activities play a crucial role in enhancing the effectiveness of municipalities in combating climate change and in continuously improving their policies. The timeline for the indicators to be monitored has been set to cover the years 2024-2026 and 2024-2030. It is recommended that for the first period, awareness campaigns in the building sector, the promotion of electric vehicle use in the transportation sector, planning effective routes for waste collection and public transportation services, and providing eco-driving trainings should be implemented. In the waste sector, efforts should focus on reducing waste quantities and improving processes.

Mitigation Indicators

Table 10: Indicators for monitoring mitigation actions

Action No	Indicator	Unit
Buildings and Renewable Energy		
Action B1.	Revised/added plan note related to sustainability	yes/no
	Sustainable Urban Design Guide	yes/no
Action B2.	Share of renewable energy usage in municipal buildings	%
	Number of zero-energy buildings owned by the municipality	number/year
	Share of zero-energy municipal buildings among total municipal buildings	%
Action B3.	Number of residential buildings with thermal insulation	number/year
	Number of residential buildings permitted for green/white roof applications	number/year
	Number of commercial (or residential and commercial) buildings permitted for green/white roof applications	number/year
Action B4.	Number of newly constructed buildings with energy class B or higher	number/year
	Number of buildings entering urban transfromation annually	number/year
	Number of buildings with green roof applications included in the building permit project	number/year
	Proportion of buildings in transformation with energy class B or higher	%
Action B5.	Number of awareness raising and awareness activities conducted	number/6 months
Action YE1.	Number of buildings using renewable energy sources	number/year

Action No	Indicator	Unit
	Share of renewable energy usage in total energy consumption	%
Action YE2.	Installed capacity of solar power plants	Kwh/year
Action YE3.	Percentage of street lighting with LED lighting systems	%
Transport		
Action U1.	Number of purchased/leased electric passenger vehicles	number/year
	Number of low-emission (electric, hybrid, etc.) vehicles used in the municipality	number/year
	Number of electric vehicles used in public transportation	number/year
Action U2.	Number of charging stations powered by renewable energy for electric vehicles	number/year
	Number of electric vehicles	number/year
Action U3.	Tram Line Length	hour/day
	Number of public transportation lines	number/year
	Number of public transportation vehicles	number/year
	Number of public transportation passengers	number/year
Action U4.	Fuel consumption of public transportation vehicles	liter/month
Action U5.	The time it takes for waste collection vehicles to reach the ıntegrated solid waste disposal and energy production facility	hour/day
Action U6.	Number of training sessions on economical driving techniques	number/year
Action U7.	Total length of bicycle paths	km/ year
Action U8.	Number of smart intersections	number/year
	Number of intersections with remote sensing systems installed	number/year
Waste and Wastewater		
Action A1.	Annual waste amount per person	ton/person
	Amount of fuel produced at Refuse Derived Fuel (RDF) plant	ton/year
	Number of trainings given on composting	number/year
Action A2.	Annual wastewater amount per person	number/year
Agriculture and Livestock		
Action T1.	Use of organic fertilizer	ton/year
Action T2.	Number of trainings given to farmers on low carbon emission agricultural techniques	number/year
	Awareness-raising activities conducted	number/year

Action No	Indicator	Unit
Action T3.	The share of renewable energy usage in agricultural irrigation	%

Adaptation Indicators

It is important to monitor climate change adaptation activities at specific intervals. This will allow for the assessment of success in these practices, the necessary improvements, and revisions for emerging needs. For monitoring adaptation indicators where data sources are not available, necessary data collection processes should be planned and prepared to support monitoring processes. Below, indicators have been identified to monitor the implementation status of actions determined for adaptation to climate change.

Table 11: Indicators for monitoring adaptation actions

Action No	Indicator	Unit
Water Management		
Action 1.1	Number of dry farming/landscaping applications	number/year
	Areas for dry landscaping including refuges and intersections	m^2/year
Action 1.2	Number of municipal buildings with greywater systems	number or %
	Amount of water used for park irrigation	m^3/year
	Amount of stored water used for garden irrigation by the metropolitan municipality	m^3/year
Action 1.3	Permeable surface ratio	%
Action 2.1	The ratio of treated wastewater to total water usage at the provincial level	%
	Number of facilities constructed/improved	number
	The reuse rate of treated wastewater at the provincial level	%
Action 2.2	Municipal water loss and leakage rates	%
Action 2.3	Presence of a monitoring system	yes/no
Action 2.4	The ratio of irrigation areas using modern irrigation methods at the provincial level	%
	Ratio of rehabilitated irrigation areas	%
Agriculture		
Action 3.1	Drought early warning system in pilot districts	yes/no
	Number of villages where the early warning system is used	number/year
Action 3.2	Number of improved/newly constructed drainage applications	number/year

Action No	Indicator	Unit
Action 3.3	Number of supported investments	number/year
	Number of protected races and plant species	number
	Number of relevant projects	number/year
Action 3.4	Number and amount of support mechanisms provided	number, €
Action 3.5	Number of female farmers/workers/cooperatives supported in pilot districts/villages	number
Action 3.6	Pilot application for farmer information flow	yes/no
	Number of farmer trainings	number/year
	Number of trainings for technical staff	number/year
	Number of trainings for children and youth	number/year
Biodiversity		
Action 4.1	Number of inspections	number /year
	Methodology for monitoring and combating invasive alien species	yes/no
	Number of research studies	number
Action 4.2	Length of forest safety lines	km
Action 4.3	Number of awareness-raising campaigns	number/year
Green Areas		
Action 5.1	The ratio of green space to the total urban area	%
Action 5.2	Number of green corridor/street arrangements	number
	Amount of green space per person	m^2/year
Action 6.1	Percentage of asphalt surface in urban centers	yearly %
	Permeable surface ratio	%
Action 6.2	Number of green certified buildings	number/year
	Number of trees planted in the urban area	number
	Size of green area integrated with bicycle paths	m^2/year
Action 6.3	Number of pilot projects	number/year
	Size of sample working area	hectar
	Number of buildings with green roofs and green facades	number

Action No	Indicator	Unit
	Amount of funding allocated/created for the pilot project	€
Disaster Management		
Action 7.1	Existence and number of risk maps	yes/no, number
	Existence of climate-resilient urban design guide	yes/no
	Number of transformation and improvement projects	number
	Size of the transformation area	hectar
	Existence of implementation guide	yes/no
	Existence of prioritization (short-medium-long term)	yes/no
Action 7.3	Number of urban planning revisions	number
	Size of the area revised	hectar
	Size of protected agricultural and pasture area	hectar
	Occupancy rate of developable areas	%
Action 7.4	Integrating climatic disasters into existing disaster plans	yes/no
	Evacuation routes	yes/no
	Early warning and information systems	yes/no
	Smart city application for climate hazards	yes/no
Action 7.5	Training guide	yes/no
	Number of awareness-raising meetings/sessions with key decision-makers and politicians	number/year
	Number of capacity-building training events conducted with implementers	number/year
	Number of capacity-building actions for members of the Disaster Risk Reduction Platform within the governorship	number /year
	Number of participants	number
Action 7.6	Number of training and drills	number /year
Action 7.7	Planning and design study	number
	Number of infrastructure interventions carried out	number
	Number of flood pumps installed for inundation exits	number
Action 8.1	Study conducted to identify vulnerable groups	yes/no
Action 8.2	Number of public areas designated as climate shelters	number

Action No	Indicator	Unit
	Citizen information platform	yes/no
Action 8.3	Hail protection measures	number
	Type and number of actions	number
	Size of protected areas	hectar
	Number of protected workplaces	number
Action 8.4	Guidance on resilience and business continuity	yes/no
	Types of commercial businesses and professional organizations, and the number of meetings	number/year
	Number of trainings	number/year
Public Health		
Action 9.1	Alarm status and staging form	number/year
	Number of warning stations	number
	Number of applications made to healthcare institutions related to warnings	number/year
Action 9.2	The carried out work	number/year
Action 9.3	Number of implementations	number/year
	Vector-borne disease control guide	yes/no
Industry		
Action 10.1	Annual sectoral water allocation	m^3
Action 10.2	Ratio of annual recycled water amount in industrial establishments to the total water usage amount	%
Action 10.3	Number of organizations conducting climate adaptation planning	number
Action 10.4	Number of businesses where monitoring studies related to surface and groundwater use at the provincial level	number
	The ratio of recycled waters in the industrial, energy, and mining sectors at the provincial level to the total water usage	%
Action 10.5	Ratio of the number of facilities with risk assessments to the total number of facilities	%
Tourism		
Action 11.1	Number of certifications	number/year
	Number of green-starred hotels	number/year
	Ratio of the number of green-starred hotels to the total number of hotels	%

Action No	Indicator	Unit
Action 11.2	Number of cultural heritage sites	number
	Total number of cultural assets inventoried	number
Action 11.3	The number of collaboration studies	number
Action 11.4	The number of events where environmental awareness is emphasized in their promotions	number/year
Action 11.5	The number of types of promotional materials created annually related to sustainable tourism practices	number
	The number of guides who have received training on the subject	number
	Number of informed tourists	number
Administrative Organization		
Action 12.1	Existence of a management plan	yes/no
Action 12.2	Existence of a monitoring tool	yes/no

The time plan for the actions to be implemented has been designed to cover the years between 2024-2026 and 2024-2030. It is recommended that the actions related to research, capacity building, awareness-raising, detection, and taking preventive measures be implemented in the first period **(2024-2026)**. These actions include;

Action 1.3: Identification and prioritization of impermeable surfaces in public areas and increasing permeable surfaces (sidewalks, roads, traffic-free zones, parks, etc.)

Action 3.3: Protection, support and dissemination of plant species and local breeds with high adaptive capacity

Action 3.6: Establishment of a current and dynamic information communication network for farmers and organizing training programs on climate-resistant agriculture

Action 4.3: Raising awareness among citizens about forest fires, involving them in disaster management, and creating necessary improvement suggestions

Action 7.1: Identification of urban regions/buildings/infrastructure highly vulnerable to climate risks (floods, and heatwaves), and reduction of risks through spatial arrangements

Action 7.5: High-level understanding and commitment to existing climate risks in Eskişehir, and development of institutional capacity for climate and disaster resilience

Action 7.7: Enhancement of infrastructure resilience in urban transportation, with evacuation pumps and culverts in multi-level intersections and designated underpasses where needed

Action 8.1: Identification and mapping of vulnerable groups

Action 9.2: Collaboration with the Provincial Health Directorate to investigate/identify individuals with chronic diseases at the provincial and district levels

Action 12.1 Establishing a governance model within the municipality that facilitates collaboration for the implementation of the Sustainable Energy and Climate Action Plan actions.

Energy Poverty Indicators

Monitoring energy poverty indicators in sustainable energy and climate action plans is of vital importance for ensuring social justice and inclusivity. Energy poverty refers to the challenges faced by many individuals and communities regarding access to energy, security, and sustainable use. These indicators are an important tool for assessing the impacts of plans, identifying disadvantaged groups, and more effectively guiding policy directions. Monitoring energy poverty contributes to the development of strategies aimed at reducing economic and social inequalities, taking into account the social dimension of sustainable energy practices. The indicators for assessing and monitoring energy poverty have been determined in line with the criteria developed by the Covenant of Mayors (CoM).

Table 12: Indicators for monitoring energy poverty actions

Indicator	Unit
Indicators for Climate	
Frequency of heat waves	average per year
Frequency of cold waves	average per year
Number of heating degree days	number/year
Number of cooling degree days	number/year
Indicators for Buildings	
F+G + H band (EPC) dwelling / total number of dwelling	%
Energy consumption (electricity + heating) per capita / national energy consumption (electricity + heating) per capita	%
Share of buildings renovated per year	%
Share of households or population with presence of leak, damp, rot in their dwelling / total households or population	%
Percentage of households or persons within the municipality experiencing heating discomfort	%
Percentage of households or persons within the municipality experiencing cooling discomfort	%
Households or persons connected to the electricity grid / total households or persons	%
Households or persons connected to the gas grid / total households or persons	%
Number of buildings with energy class higher than class B/total number of buildings	%
Ownership of heating and cooling systems	%
Households with centralised heating system / total households	%
Households with centralised cooling system / total households	%

Indicator	Unit
Low absolute energy expenditure	€
Number of households with only oil boilers, wood calefactions, conventional gas boilers	%
Average age of the buildings	years
Dwelling ownership	%
Percentage of households or persons within the municipality with access to clean cooking fuels and technologies	%
Indicators for Mobility	
Population or households not having access to essential services within 1 hour by walking, cycling or public transport / total population	%
People or households living more than one 1 km from nearest public transport station / number of population	%
The local public transport travel frequently enough, covering the essential necessities for the population	yes/no
Inhabitants or households receiving support to pay public transport services/public transport users	%
Socioeconomic Indicators	
Annual average household income	€
Average amount spent on energy annually	€
Vulnerable households or persons / total households or persons	%
Arrears on utility bills / total population or households	%
Inability to keep home adequately warm	%
Inability to keep home adequately cool	%
Average price of electricity	€
Average price of gas	€
Money spent to support energy poor households or persons / in relation to local GDP	%
Citizens or households under poverty threshold / number of citizens or households	%
At-risk-of-poverty rate	%
Citizens or households with social support	%
Unemployment rate	%
Persons aged under 14	%
Persons aged over 65	%

Indicator	Unit
Persons with respiratory and circulatory problems	unit
Persons with an education level under lower secondary school	%
Indicators for Policy and Regulatory Frameworks	
Existence of energy poverty strategy	yes/no
Existing rent regulation	yes/no
Specific measures related energy poverty	yes/no
Existing incentives for landlord's programs	yes/no
Indicators for Participation and Awareness Activities	
Awareness-raising campaigns targeting vulnerable households	number
Engagement and cooperation with local stakeholders on energy poverty	number

5. CONCLUSION

The Sustainable Energy and Climate Action Plan of Eskişehir Metropolitan Municipality outlines actions in three main categories. The "Sustainable Energy Actions" related to greenhouse gas mitigation present a roadmap for reducing emissions stemming from energy consumption in various sectors, identified with the participation of urban stakeholders. The starting point of this plan is the city-scale greenhouse gas inventory, relying on reports prepared or commissioned at both national and regional levels, considering the future visions of urban stakeholders and the city's history.

The Covenant of Mayors (CoM) grants local governments the freedom to exclude sectors in which they cannot intervene or do not have authority. Eskişehir Metropolitan Municipality does not have any sanctions on industrial establishments or national agricultural policies. However, considering rural development as an area of significance where local government is actively involved, it aims to address agricultural issues within the context of the climate action plan.

In the scope of the study for the preparation of the sustainable energy and climate change action plan for Eskişehir, the city's greenhouse gas emission sources were identified, and detailed calculations for greenhouse gas emissions were conducted for the reference year, which is 2021. The urban greenhouse gas emissions for Eskişehir in the reference year, 2021, excluding industrial, civil airport, leakage, and industrial process emissions, are approximately 3,741,358 tons of CO_2e. Of this, 73,488 tons result from the direct institutional activities of the Municipality (2.0%). Residential buildings, municipal buildings, including public and other commercial buildings, and street lighting account for 37.2% of Eskişehir's total greenhouse gas emissions; vehicle consumption, including public transportation, constitutes 33.0%; and waste and wastewater management along with electricity consumption for agriculture, livestock, and agricultural irrigation contribute to 29.8%.

Eskişehir has developed a Business as Usual (BAU) scenario using predictions from various institutions regarding population and sectoral growth. According to this scenario, emissions for 2030 are estimated to be approximately 4,630,384 tons of CO_2e. With measures taken in the built environment, transportation, waste and wastewater management, and agriculture, a mitigation of nearly 55% is anticipated by 2030, resulting in a mitigation of 2,464,895 tons of CO_2e. It is projected that total emissions can be reduced to 2,165,489 tons of CO_2e.

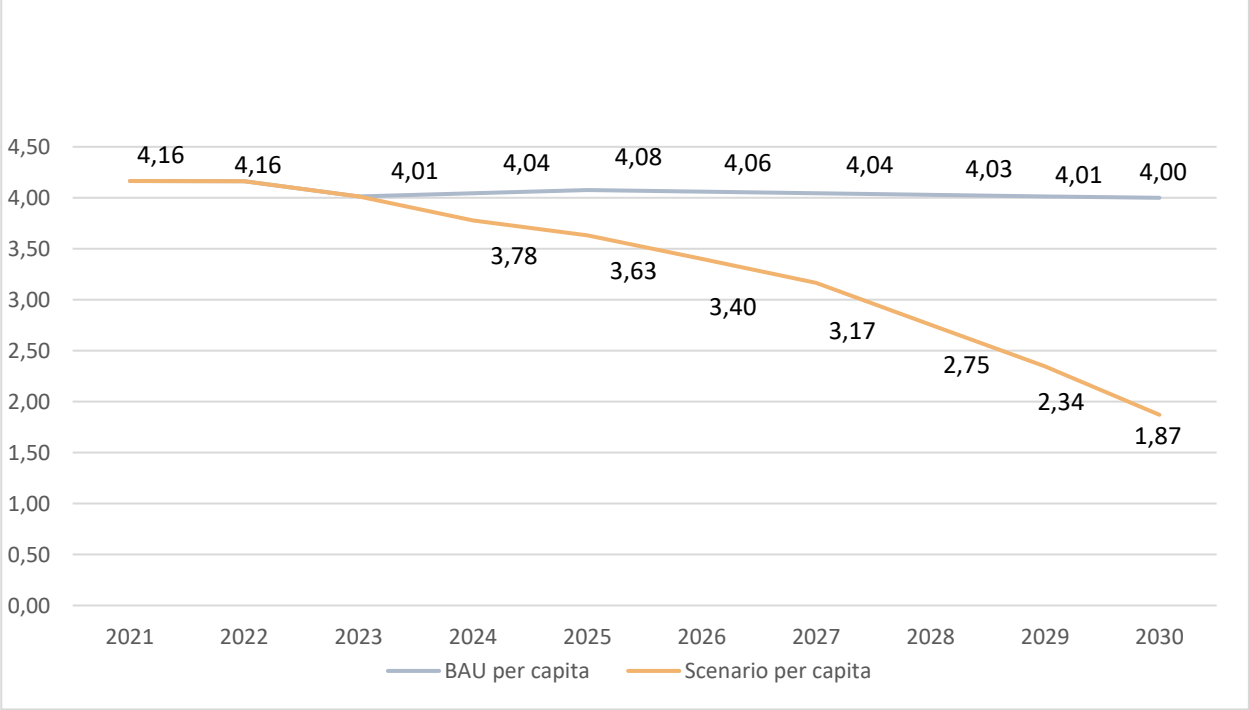


Figure 43: Greenhouse gas emissions per capita according to Eskişehir BAU and mitigation scenario (ton CO2e/pe capita)

Türkiye's urban growth rates, in terms of both qualitative and quantitative aspects, resemble those of developing countries rather than developed/industrialized countries. As it is not possible to discuss absolute emission mitigations at these growth rates, expressing emission mitigation targets in terms of per capita emissions would be more accurate. When looking at per capita greenhouse gas emissions for Eskişehir Metropolitan Municipality, it is projected that the emissions will be 4.00 tons CO_2e per person in 2030 under the Business as Usual (BAU) scenario, compared to 4.16 tons CO_2e per person in the base year of 2021. With emission mitigation actions, a 55% mitigation is expected to bring per capita emissions down to 1.87 tons CO_2e per person.

Additionally, within the scope of the scenarios, a total of 21 actions have been listed based on sectoral evaluations of mitigation measures. These actions include information about the responsible institutions for implementing each action, stakeholders contributing to the implementation, associated plans, priority levels, and the indicative impact of the action on the target. Monitoring indicators for these actions are discussed in the "Monitoring Plan" section. The mitigation amounts that will be achieved by 2030 under the reference scenario of 2021 are provided by sector in the table below.

Table 13: Mitigation amounts by sectors in 2030

Sector	Mitigation (MWh), 2030	Mitigation (Tonne CO_2e), 2030
Buildings	4.800.331	1.046.015
Renewable energy	525.000	183.067
Transport	2.234.315	795.240

Sector	Mitigation (MWh), 2030	Mitigation (Tonne CO_2e), 2030
Other (Waste and wastewater - Agriculture and livestock)	105.702	241.810
Grid decarbonization	-	198.763
Total Mitigation	**7.665.348**	**2.464.895**

It has been shown that local governments can be effective in energy efficiency and renewable energy applications both in existing buildings and in new buildings, through permit and license processes and plan notes methods.

Within the scope of Adaptation to Climate Change, which is the third component of Eskişehir Sustainable Energy and Climate Action Plan, an important step has been taken in line with the local government, sustainable and resilient Eskişehir vision, with the work carried out jointly with city stakeholders. Based on the historical data available and the studies carried out, in the light of the climate change scenarios created for Eskişehir, it makes a vulnerability analysis for the city, and sees the city as an ecosystem where anthropogenic activities are concentrated, as well as containing natural structures and systems, and the interaction of cultural and natural structures. It brings together suggestions for new planning practices with an accepting perception. In the thematic suggestions put forward through participatory processes; Urban green network/infrastructure, nature-based solutions and water management, which are discussed in outline, stand out as key concepts in the implementation of the stated multi-scale approach.

All findings obtained throughout the study indicate that the amount of green space in Eskişehir should be increased with many motivations such as reducing the urban heat island effect and improving air quality. Considering that most water consumption occurs in the agricultural sector, actions such as conducting research studies to increase water efficiency in agriculture and to develop agricultural products resistant to drought and possible climate change effects in terms of food security come to the fore. As is often stated, in this multidisciplinary process, local government needs the support of the central government and other stakeholders and it is very important to develop a working culture together. Creating green settlement practices in areas and adopting pedestrian-bicycle-public transportation priority development forms form the basis of the proposed strategy for climate adaptation.

In order to increase the sustainability and durability of cities, a good understanding of the functioning of different ecosystems, from natural to man-made structures, must be reflected in design decisions. For this reason, planning integration of design approaches and tools such as "water-sensitive urban design", "green infrastructure strategies" and "nature-based solutions", which consider the natural and cultural life form for city dwellers, is important in urban design applications. In this context, Eskişehir Climate Adaptation Strategy will be a guide in establishing design principles and directing implementations.


ESKİŞEHİR
METROPOLITAN MUNICIPALITY