

Linking Policy to Practice: How Türkiye's Sustainable Campuses Respond to Climate Change

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Abstract

Climate change, recognized as a critical global challenge, requires comprehensive policies and coordinated actions across multiple sectors, given its profound environmental, social, and economic repercussions. This study evaluates the alignment of Türkiye's climate change policies with sustainable campus initiatives, emphasizing the role of universities in advancing national and international climate objectives through practical implementation. This study employs document analysis to examine 5 core domains: the impacts of climate change, adaptation strategies, Türkiye's climate policy framework, sustainability principles, and campus-based sustainability practices. The analysis draws upon interdisciplinary literature and case studies of prominent Turkish universities, including Istanbul Technical University, Middle East Technical University, and Hacettepe University. These institutions exhibit notable progress in minimizing carbon emissions, adopting renewable energy technologies, improving waste management systems, and integrating sustainability into academic curricula and research agendas. Such efforts demonstrate alignment with the United Nations Sustainable Development Goals (SDGs) and underscore the transformative potential of universities as microcosms of urban systems, fostering environmental responsibility and societal advancement. Nevertheless, persistent challenges—such as fragmented institutional coordination and limited integration at the national policy level—highlight the need for more cohesive and strategic approaches to strengthen the contribution of sustainable campuses to Türkiye's climate commitments.

Keywords: Climate change, Policy, Sustainability, Sustainable campus

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Introduction

Climate change is widely recognized as a critical global issue that threatens the planet through rapid environmental, technological, and socioeconomic transformations. It demands urgent attention and coordinated action (Abbass et al., 2022). Urbanization, agriculture, industrial activity, and greenhouse gas emissions are among the primary drivers of climatic change, contributing annually to rising CO₂ levels and surface temperature (Kabir et al., 2023). Initially, with support from the fossil fuel industry, the severity of global warming and climate change was downplayed, fostering a societal perception that the issue was negligible. Even today, public awareness and understanding of the long-term risks posed by climate change remain insufficient (Tuckett, 2021; Salem et al., 2022).

Human interference with natural systems is the principal cause of climate change. Accordingly, mitigating the effects requires deliberate human action. Practices such as fossil fuel consumption, deforestation, and industrial expansion are key contributors to the crisis (Williams, 2021; Tuckett, 2021). The Intergovernmental Panel on Climate Change (IPCC), was among the earliest international initiatives to systematically address climate change, focusing on 3 main areas: (1) the assessment of available scientific knowledge, (2) the evaluation of the ecological and socioeconomic consequences, and (3) the development of mitigation strategies.

Anthropogenic activities have significantly elevated global temperatures in recent decades, posing serious threats to ecosystems and biodiversity both on land and in marine environments. The threshold for sustaining life is widely accepted to be a temperature increase not exceeding 1.5°C. However, current global averages are estimated to range between 1.5°C and 2.5°C (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024). Although the world is on a lower emissions trajectory than previously projected, it remains off course for limiting 21st century warming to below 2°C (Pielke et al., 2022). Nonetheless, a reduction of approximately 0.3°C is anticipated if national commitments under the United Nations Framework Convention on Climate Change (UNFCCC) are met by the year 2030 (Kemp et al., 2022).

Climate change was initially framed as a scientific and technical challenge. It has since evolved into a multidimensional issue with far-reaching implications. It affects not only temperature and precipitation

patterns but also economic stability and social structures (Lawrence et al., 2020; Hughes et al., 2020). As one of the defining challenges of the 21st century, climate change intersects with disciplines across the natural and social sciences, including economics (Food and Agriculture Organization of the United Nations, 2018).

Addressing climate change requires the formulation and implementation of robust national and international policies (Bilgili & Topal, 2021). The Stockholm Conference of 1972, organized by the United Nations, marked a pivotal moment in elevating ecological concerns to the global stage, laying the groundwork for international environmental law and domestic legal frameworks (Pallemerts, 1997). The Kyoto Protocol (2008–2012), established under the UNFCCC, represents a significant international commitment to reducing greenhouse gas emissions (Yamin, 2012).

In response to a directive from the EU Environment Council, the European Commission launched the European Climate Change Program (ECCP) in June 2000. This initiative aimed to develop a comprehensive strategy for implementing the Kyoto Protocol across various economic sectors through specialized working groups (Peeters & Deketelaere, 2006). European Commission (2020a) which complements the Paris Agreement, offers strategic guidance to Türkiye—an official party since 2021—in its efforts to reduce emissions by 55% by 2030. Measures such as the Fit for 55 package and related legal instruments are currently underway.

Universities today are not only centers of knowledge production but also key actors in promoting sustainability and combating climate change (Im et al., 2022). Beyond reducing emissions from campus operations, universities are expected to lead in public education, awareness-raising, research, and policy development (Žalėnienė & Pereira, 2021). Although sustainability units have been established in many Turkish universities, only a limited number have conducted greenhouse gas inventories or set net-zero targets (Çelik & Öztürk, 2022). This underscores the need for more comprehensive institutional strategies. Universities occupy a strategic position in assessing environmental impact, facilitating energy transitions, and cultivating climate-conscious citizens (Binboğa & Ünal, 2018). The current landscape calls for further evaluation in both practice and scholarship. Institutions are increasingly expected to measure their carbon footprints, publish sustainability reports, and contribute to society through relevant academic units.

This study aims to examine national and international climate change policies and assess how Turkish universities respond through sustainable campus initiatives. Using document analysis, the study explores climate policy frameworks and sustainability approaches, highlighting current practices through selected university case studies.

Effects of climate change

Climate change impacts include rising global temperatures, shifting weather patterns, disrupted ecosystems, and adverse effects on human health and well-being (Bandh et al., 2021). Additionally, phenology—the study of the timing of natural events—offers valuable insights into the manifestations of climate change (Inouye, 2022). Globally, policymakers are increasingly persuaded by the assessments of intergovernmental panels, which present compelling evidence that climate change is transforming the hydrological and biological systems (Tuckett, 2021). The consequences of climate change are multifaceted, affecting societies across social, environmental, and economic dimensions, both directly and indirectly. Direct impacts include harm to living organisms, depletion of natural resources, and environmental degradation. Indirectly, climate change can exacerbate resource scarcity, potentially leading to social unrest and conflicts. It may also prompt migration movements among both human populations and wildlife (Inouye, 2022; Shivanna et al., 2020).

Droughts induced by rising temperatures pose serious threats to ecosystems and agricultural productivity (Cook et al., 2018). Economically, climate change disproportionately affects developing countries that depend heavily on agriculture and water resources (Cevik & Jalles, 2023; Tol, 2018). While economic development can enhance societal welfare, it often contributes to environmental degradation and the depletion of natural assets (Amaral et al., 2015).

Ecological effects encompass a wide range of issues, including access to freshwater, deforestation, rising sea levels, landslides, floods, droughts, agriculture disruption, wetland loss, and declines in plant diversity and biodiversity (Gissi et al., 2020; Weiskopf et al., 2020). Climate change functions as both a subject and an object in relation to natural resources and ecological outcomes. This reciprocal relationship between climate change and ecosystems is further illustrated in Fig. 1 below.

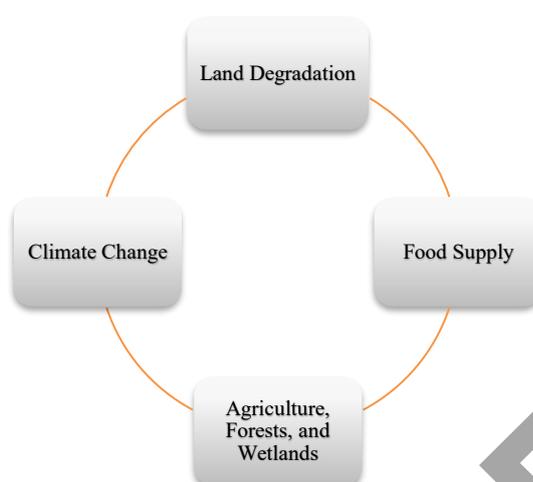


Fig. 1 Interrelationship between climate change and ecosystem components
Source: Adapted from Bhatti et al. (2006)

As illustrated in the relationship network in Fig. 1, the degradation of agriculture, forests, and wetlands, is closely linked to climate change. Climate change is projected to significantly affect agriculture and food supply, necessitating adaptation strategies such as altering land and cropping practices, developing resilient crop varieties, and reforming food consumption and waste management approaches (Anderson et al., 2020).

Healthy living is increasingly understood to depend on sustainable access to agriculture and aquatic resources (Anderson et al., 2020). The effects of climate change can be multifaceted, influencing ecological, economic, and social systems. In this context, the scope and complexity of these impacts are further illustrated in Fig. 2.

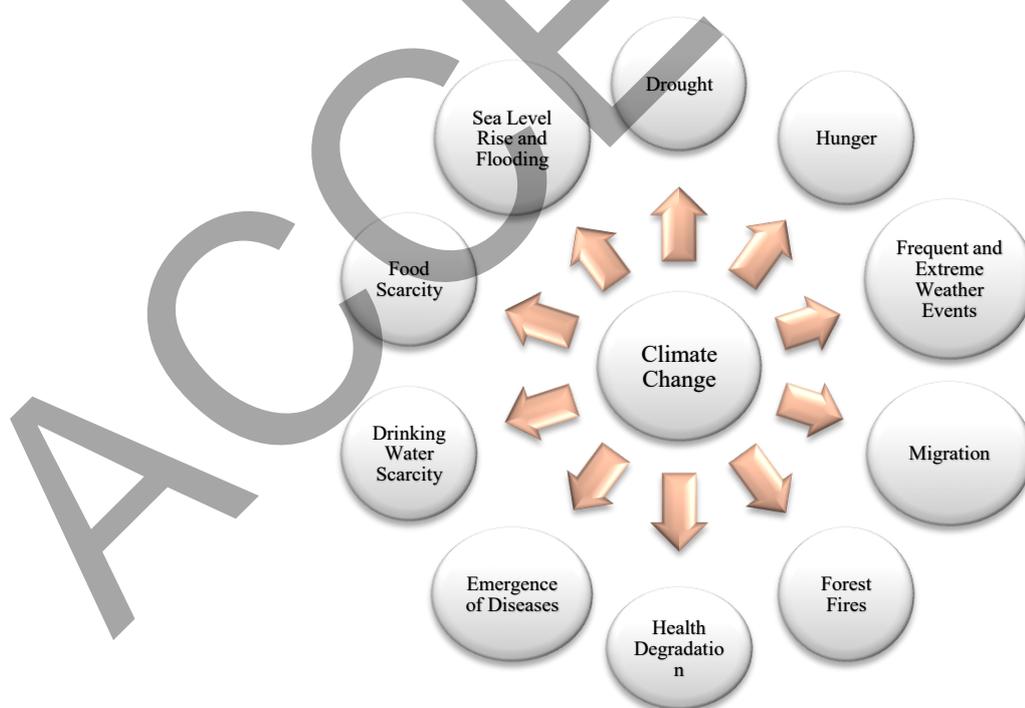


Fig. 2 Impacts of climate change on the environment
Source: Adapted from Gairola et al. (2023)

As illustrated in Fig. 2, the impacts of climate change span a broad spectrum of social, environmental, and economic dimensions. This raises important questions regarding the extent of public awareness about the causes and consequences of climate change, and whether such awareness translates to meaningful behavioral change (Whitmarsh et al, 2021). Climate change is not solely a scientific phenomenon; it is a multidimensional process that influences various aspects of human and ecological systems, particularly in social, environmental, and economic contexts (Stevenson et al., 2017).

Climate change adaptation policies

Adaptation is a critical component of climate change policy. An effective adaptation process refers to the capacity of countries to implement proactive measures in response to anticipated climate-related events. In this respect, nations must consider their geographical characteristics when formulating strategies. For example, coastal countries are particularly vulnerable to flooding (National Research Council, 2011). Policymakers must address several sub-dimensions when developing climate adaptation policies. These include: (1) the impacts and risks associated with climate change, (2) available adaptation options and barriers to implementation, and (3) the integration of sustainable development within the climate change framework. The adaptation process requires both short-term and long-term strategic planning (Intergovernmental Panel on Climate Change Assessment, IPCC Working Group II, 6th Assessment Report (Intergovernmental Panel on Climate Change, 2023): Short-term adaptation involves immediate actions taken by governments to prevent or mitigate the impacts of climate change. Medium and long-term adaptation entails planning to address potential future impacts enhancing adaptation capacity, and fostering resilience. These strategies aim to reduce vulnerability and support mitigation efforts.

As emphasized in the IPCC's 6th Assessment Report (Intergovernmental Panel on Climate Change, 2023), adaptation policies should be implemented in conjunction with climate change mitigation initiatives as part of a long-term plan (The Committee on Approaches to Climate Change Adaptation, 2010). However, the infrastructure and resources required for the adaptation process may impose significant financial burdens. Therefore, global adaptation efforts must account for issues such as social inequality and the equitable access to benefits, particularly for low-income countries (Cevik & Jalles, 2023).

In line with these considerations, several key dimensions should inform global climate adaptation strategies (Martello et al., 2023; Dietz & Lanz, 2025; Yu & Ye, 2024). These include:

- (1) Economic strength and Flexibility: Availability of financial resources at regional and municipal levels.
- (2) Technology: Accessibility and deployment of adaptation technologies.
- (3) Information: Prioritization of information flow regarding regional climate impacts and adaptation measures.
- (4) Infrastructure: Development of resilient systems, including energy and supply networks.
- (5) Institutions: Collaborative governance structures and educational initiatives.
- (6) Equality: Ensuring equitable access to information, infrastructure and financial resources.

Türkiye's climate change policies in the European Union (EU) commission reports

As a party to the Paris Agreement and a candidate country for European Union (EU) membership, Türkiye is subject to both international and EU climate change legislation. Under the Paris Agreement, Türkiye has committed to reducing its greenhouse gas emissions. Moreover, as part of its EU accession process, Türkiye is required to harmonize its laws and policies with the EU acquis, including those related to climate change and environmental standards (Öner, 2023).

An analysis of the European Commission's progress reports on Türkiye from 2020 to 2024 reveals a consistent pattern. While Türkiye has made some progress in aligning its legislation with EU standards, notable deficiencies persist, particularly in the areas of climate change and environmental protection. According to the 2020 report, Türkiye was assessed as moderately prepared in the areas of environment and climate change. Improvements were noted in waste management and wastewater treatment capacity, as well as in legislative alignment. However, implementation and enforcement remained weak, and the recommendations from 2019 were deemed still acceptable (European Commission, 2020b).

The 2021 report included noteworthy observations regarding energy policy:

Following a strategy to maximize the use of domestic and renewable energy sources, the share of renewable energy in electricity generation rose to 44% in 2020, with a significant portion (29 %) coming from hydropower. The share of renewable energy installations in total installed electricity

generation capacity increased from 45% in the previous year to 51% in 2020. (European Commission, 2021)

The report also acknowledged Türkiye's ratification of the Paris Agreement and urged the country to strengthen its contributions under the framework. Severe air pollution continued to be reported annually in several cities. Although a national air quality monitoring strategy was in place and all eight planned regional networks were operational, no progress was recorded in water quality—particularly regarding the implementation of the Water Framework Directive and the adoption of a national biodiversity strategy and action plan. Moreover, planning and zoning activities in wetlands, forests, and protected natural areas remained misaligned with the EU acquis (European Commission, 2021; Aydın, 2022).

The 2022 report reiterated persistent challenges related to air pollution and waste management (European Commission, 2022). The 2023 report acknowledged incremental progress in renewable energy but criticized Türkiye's continued reliance on coal (European Commission, 2023). The 2024 progress report noted specific advancements in water quality. In terms of climate policy, the adoption of the revised Climate Change Mitigation Strategy and Action Plan (2024–2030), along with the updated Climate Change Adaptation Strategy, was recognized as a positive development. However, no progress has been reported in waste management during the reporting period (European Commission, 2023):

(1) Türkiye's recycling rate increased to 30%, yet a Deposit Management System had not been established, and the implementation of waste management plans at local and regional levels remained inadequate.

(2) No progress was made in air quality legislation; Türkiye had not adopted national laws aligned with EU Directives on ambient air quality and national emission ceilings.

(3) Türkiye remained a non-party to the Espoo Convention, and continued misalignment with the Environmental Impact Assessment Directive and the Strategic Environmental Assessment Directive was noted.

(4) Türkiye had not acceded to the Aarhus Convention, and challenges persisted regarding public access to environmental information, access to justice, and public participation in the decision-making processes. The Environmental Liability Directive and the Environmental Crime Directive had not yet been harmonized,

Sustainable campuses play a crucial role in Türkiye's climate strategy and its alignment with EU standards. Numerous universities have launched initiatives such as renewable energy projects, waste reduction programs, and sustainability-oriented curricula. However, these efforts are often fragmented and lack coordination at the national-level. The European Commission's reports emphasize the need for a more integrated and comprehensive and coordinated approach to sustainability across the country. Addressing the issues identified in these reports within the university sector could not only strengthen Türkiye's EU accession prospects but also the development of more sustainable and resilient campuses. In conclusion, Türkiye's climate change policies are closely intertwined with its EU candidacy and its commitment to sustainable campus development. By critically engaging with the European Commission's findings, enhancing climate change education, and resolving the highlighted deficiencies, Türkiye can advance its climate objectives, improve its prospects for EU membership, and contribute to a more sustainable future for its academic institutions and society at large.

Climate change policies and legal framework in Türkiye

Türkiye has become a party to several international agreements addressing climate change, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. Its commitment to climate action is reflected in national policy documents such as the Development Plans, the Climate Change Strategy Document (2010–2023), and the Climate Change Action Plan. The renaming of the Ministry of Environment and Urbanization to the Ministry of Environment, Urbanization, and Climate Change in 2021 symbolizes this growing institutional awareness. Additionally, the Environmental Agency of Türkiye was established in 2020, followed by the creation of the Directorate of Climate Change and the Coordination Board on Climate Change and Adaptation in 2021 (Öner, 2023).

Türkiye is a party to the following international agreements (Gündoğan, 2025):

(1) Vienna Convention: The Vienna Convention for the Protection of the Ozone Layer, adopted in 1985, was the first international agreement to directly address atmospheric changes. It was developed in response to observed ozone depletion over Antarctica and aims to restrict the use of ozone-depleting substances.

(2) Montreal Protocol: Building on the Vienna Convention, Türkiye joined 24 countries in signing the Montreal Protocol on Substances that Deplete the Ozone Layer in September 1987. This protocol sets binding targets for phasing out ozone-depleting chemicals.

(3) United Nations Framework Convention on Climate Change (UNFCCC): Opened for signature in 1992 in Rio de Janeiro and entering into force on March 21, 1994, the UNFCCC represents a foundational framework for global climate action. As a 26-article main text, Türkiye became a party to this convention in 2004.

(4) Kyoto Protocol: Adopted at the third Conference of the Parties in Kyoto, Japan, in 1997 and entering into force in 2005, this protocol introduced binding emission reductions targets. Türkiye acceded in 2009.

(5) Paris Agreement: Signed on April 22, 2016, and entering into force on November 4, 2016, the agreement required ratification by countries responsible for at least 55% of global emissions. Türkiye ratified the agreement on October 7, 2021.

Türkiye has taken significant steps both nationally and internationally to combat climate change, reinforcing its legal framework and policy infrastructure. Environmental Law No. 2872 (1983) provides foundational regulations aimed at promoting environmental sustainability and reducing greenhouse gas emissions (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024). Amendments introduced in 2004 facilitated alignment with international climate commitments (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024).

The Climate Law of Türkiye, numbered 7552, was published in the Official Gazette and entered into force on July 9, 2025. This legislation serves as a cornerstone of Türkiye's strategy to achieve net-zero emissions by 2053. It outlines the establishment of an Emissions Trading System (ETS) and a Border Carbon Adjustment Mechanism (BCAM), designed to reduce greenhouse gas emissions and ensure compliance with the EU Green Deal. At the local level, Provincial Climate Change Coordination Boards have been formed, with plans to develop localized action plans by 2027 (Presidency of the Republic of Turkey, 2025).

The law prescribes administrative sanctions for non-compliance. One provision states that, "Those who fail to submit their verified greenhouse gas emission report within the specified period shall be fined an administrative penalty ranging from 500,000 to 5,000,000 Turkish liras." Moreover, "The procedures and principles regarding the implementation of this provision shall be determined by regulation, considering the annual emissions reasonably estimated based on the installed capacity of the facilities." (Presidency of the Republic of Turkey, 2025).

The general principles of the Climate Law in combating climate change are outlined in Article 3 of Türkiye Climate Law No. 7552 (Presidency of the Republic of Turkey, 2025):

a) In addressing climate change, the law is grounded in the principles of equality, climate justice, precaution, participation, integration, sustainability, transparency, just transition, and progress, while also considering the principle of common but differentiated responsibilities and respective national capabilities.

b) Public institutions and organizations, as well as real and legal persons, are obligated to comply with and implement the measures and regulations stipulated by the law, in accordance with the public interest, within the designated timeframe.

c) In the formulation of the Nationally Determined Contribution (NDC), the country's development priorities and specific conditions are considered to align with the net-zero emission target, and appropriate measures are adopted accordingly.

Currently, Türkiye's 12th Development Plan (2024–2028) is in effect. Within this framework, specialized commissions have identified key thematic areas, including solid waste management, water management, and the impact of climate change on sustainable development (Presidency of the Republic of Turkey, 2024). One notable initiative is the Zero Waste Project, introduced in 2017, which focuses on waste prevention, efficient resource use, effective waste collection, and overall waste reduction (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2017).

In the education sector, the Ministry of National Education revised the curriculum in the 2021–2022 academic year, renaming the Environmental Education course to Environmental Education and Climate Change. This change reflects the influence of the Paris Agreement (2015) and aims to foster environmental awareness and protection among students (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024).

In alignment with international frameworks, Türkiye formulates climate policies and future strategies through designated institutions, primarily the Climate Change Directorate under the Ministry of Environment, Urbanization, and Climate Change. On March 21, 2024, the Directorate published the Climate Change Adaptation and Mitigation Strategy Documents (2024–2030), which outline key

decisions and measures developed in accordance with the Climate Council Decisions, the 12th Development Plan, and the Medium-Term Program 2024–2026 (MTP). The Presidency of Climate Change has been tasked with overseeing implementation.

As emphasized in the Paris Agreement, to which Türkiye became a party in 2021, the need for strong collective action and coordinated efforts among stakeholders at the local level is paramount. In this context, metropolitan municipalities have developed climate inventories to address region-specific needs (Clean Energy Foundation, 2024). The 2024 strategy and action documents published by the Climate Change Presidency further clarify the national landscape. According to the 2024–2030 Climate Change Mitigation Strategy and Action Plan, Türkiye’s total greenhouse gas emissions—excluding the Land Use, Land Use Change, and Forestry sector—were calculated at 564.4 MtCO₂-eq in 2021. This represents an increase of 40.4 Mton (7.7%) compared to 2020, and a 157.1% increase relative to 1990 levels.

Table 1 Greenhouse gas emissions and removals (1990–2021)

Category	1990	1995	2000	2005	2010	2015	2020	2021
Energy	139.54	166.3	216.04	244.88	287.88	341.99	366.57	402.48
Industrial processes and product use	22.86	25.52	42.3	59.72	67.96	75.14	75.14	75.14
Agriculture	46.05	44.32	44.41	72.03	72.08	72.08	72.08	72.08
AKAKDO	-66.51	-67.77	-68.05	-71.88	-72.81	-72.81	-66.95	-47.15
Waste	11.08	12.34	16.4	17.45	16.12	16.31	14.7	14.7

Remark: AKAKDO = Land use, Land use change and forestry. Units are in MtCO₂-eq.

Source: Adapted from Climate change mitigation strategy and action plan document of Türkiye 2024–2030 (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024).

As shown in Table 1, greenhouse gas emissions are assessed across various sectors. Sector-specific strategies are also outlined in the Climate Change Adaptation Strategy and Action Plan (Republic of Turkey Ministry of Environment, Urbanization and Climate Change, 2024), which categorizes strategic items under the following headings: Urban development, water resources management, agriculture and food security, biodiversity and ecosystem services, public health, energy, tourism and cultural heritage, industry, transport and communication, social development, disaster risk reduction, cross-cutting actions.

Carbon removal is recognized as a key measure in mitigating the impacts of climate change. Relevant policies include afforestation, carbon capture and storage, the deployment of renewable energy sources (e.g., solar, wind, hydroelectric, biomass, wave and hydrogen energy), the design and implementation of low-carbon or zero-fossil-carbon production systems, and improvements in energy efficiency (Cheng, Li, & Liu, 2017; Huisingsh et al., 2015; Şen, 2008).

Climate change education plays a critical role in reinforcing Türkiye’s climate policy framework. According to UNESCO, climate change education seeks to “help people understand and address the impacts of the climate crisis and equip them with the knowledge, skills, values, and attitudes necessary to act as agents of change” (UNESCO, 2025). Accordingly, education policies aligned with the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement, and the Action for Climate Empowerment (ACE) agenda are expected to be adopted.

However, in the 2023 Information Note for Teachers and Educators issued by the UNFCCC identified Türkiye—alongside four other countries—as lacking an education policy grounded in ecological justice, climate justice and children’s rights (Arık, 2023). Although mechanisms such as citizenship education, formal and non-formal education, and education for sustainable development are present, the system requires restructuring. Knowledge and awareness alone are insufficient to address the climate crisis; affective, cognitive, and social competencies must also be cultivated. Furthermore, the influence of climate change on socio-ecological systems and policy objectives constitutes a complex and multifaceted challenge. Addressing this issue necessitates interdisciplinary research and collaboration among diverse stakeholders (Werners et al., 2013).

In general, universities’ sustainability efforts are evaluated based on criteria such as infrastructure use, energy management, climate change mitigation, waste and water management systems, sustainable transportation, and sustainability-focused education (Köse et al., 2024). It is therefore essential for universities—at both local and regional levels—to develop policies and strategies in coordination

with public institutions. This includes aligning with national targets in areas such as carbon reduction, infrastructure development, and the transformation of green campuses into green, low-carbon environments.

Universities play a pivotal role in raising climate awareness, reshaping consumption habits, and advancing climate-related education and research. Their curricula, societal contributions, and the active engagement of faculty and external stakeholders are integral to climate change education. In this context, universities bear a responsibility to promote sustainable development and mitigate climate change through teaching, research, and knowledge dissemination. Moreover, they are expected to lead by example—developing green campuses and pioneering technologies that support climate resilience and sustainability.

Sustainability in climate change

Sustainability can be briefly defined as the maintenance of prosperity over an extended or indefinite period (Kuhlman & Farrington, 2010). A closely related concept, sustainable development, is defined by the United Nations World Commission on Environment and Development as “development that aims to meet the needs of the present without compromising the potential of future generations to meet their own needs” (Brundtland, 1985). In the literature, sustainable development is typically examined through 3 interrelated dimensions (Pawłowski, 2008): The social dimension encompasses cultural structures such as social customs, values, and education; the economic dimension involves the distribution, allocation and utilization of scarce resources; and the ecological dimension addresses issues such as ecological balance and climate change, which intersect with both social and economic concerns.

Climate change is widely recognized as a critical factor in achieving ecologically sustainable development. Key elements of sustainability in the context of climate change include the protection of natural resources for future generations and enhancement of resilience and adaptive capacity in social-ecological systems (Werners et al., 2013). Climate change adaptation is explicitly addressed in the 2030 Agenda for Sustainable Development, with Sustainable Development Goal (SDG) target 13.1 aiming to “strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.” (Wiseman, 2016).

Under the United Nations Framework Convention on Climate Change (UNFCCC), all parties are obligated to “formulate, implement, publish and regularly update national and, where appropriate, regional programs that include measures to facilitate adequate adaptation to climate change” and “cooperate in preparing for adaptation to the impacts of climate change”. To date, it has primarily been developing countries that have submitted national adaptation plans. Their progress—particularly through National Adaptation Programs of Action (NAPAs) and National Adaptation Plans (NAPs)—is considered a valuable contribution to measuring progress under SDG target 13.1 and serves as a model for developed countries seeking to integrate strategic adaptation planning into national policy frameworks (Wiseman, 2016).

Beyond national policies, universities play a crucial role in advancing climate adaptation and sustainable development. Institutions of higher education are uniquely positioned to lead sustainability efforts in the fight against climate change. Accordingly, universities must develop comprehensive strategies and policies that address key areas such as research and curriculum design, the adoption of renewable energy sources, waste management systems, and broader green campus initiatives.

The following sections examine the concept of sustainable campuses, assess the performance of Turkish universities based on international sustainability indexes, and highlight institutional policies and practices that demonstrate leadership in sustainability and climate action.

Sustainable campuses

Universities are often described as “small cities” in their pursuit of sustainability, due to the scale of their operations and the environmental and societal impact of campus activities (Lauder et al., 2015). Sustainable universities are institutions that strive to minimize negative impacts related to environmental, economic, social, and health issues while effectively using their resources in teaching, research, community engagement, and partnership initiatives (Too & Bajracharya, 2015; Sonetti, et al., 2016). The core components of a sustainable campus include energy, green spaces, infrastructure, food systems, materials, governance, and leadership, investment, health, stakeholder engagement, curriculum, and aesthetics (Thomashow, 2014; Amaral et al., 2015; International Sustainable Campus Network, 2018).

Despite their potential for positive impact, universities may contribute to greenhouse gas emissions through various activities. Accordingly, they bear social responsibilities in addressing climate change and promoting environmental sustainability (Amaral et al., 2015; Çelik & Öztürk, 2022). In

alignment with this responsibility, higher education institutions began participating in international sustainability initiatives following the adoption of the Talloires Declaration by the United Nations in 1990 (Bilgili & Topal, 2021; Günerhan & Günerhan, 2016).

Analyzing feedback loops between human activity and ecosystems is essential for charting a sustainable path forward. However, traditional performance indices may introduce uncertainty, as they often lack long-term, forward-looking perspectives (Fenichel et al., 2016). Climate change assessment systems are therefore critical for identifying key threats to sustainability and developing appropriate solutions (Werners et al., 2013). Within this context, universities are increasingly recognized as central actors in climate change assessment and sustainability practices (Sonetti et al., 2016).

Globally, many universities have developed a heightened awareness of climate change and sustainability issues. Numerous inter-university cooperation and evaluation mechanisms have been established at institutional, national, regional, and international levels (Anis et al., 2018). Prominent examples include the Association for the Advancement of Sustainability in Higher Education (AASHE), the International Sustainable Campus Network (ISCN), Sustainability Tracking, Assessment and Rating System (STARS), UI GreenMetric World Rankings, Times Higher Education (THE) sustainability metrics (Anis et al., 2018). Among these, ISCN and UI GreenMetric are widely recognized as leading global evaluation systems for sustainable campuses (Sonetti et al., 2016).

According to Türkiye's 12th Development Plan, access to alternative financing instruments will be facilitated to support the goal of sustainable and climate-friendly campuses. Transformation projects will be developed by identifying pilot universities in the areas of zero waste, clean environment, and energy efficiency.

UI GreenMetric green campus index

UI GreenMetric is a global ranking system developed by the University of Indonesia in 2010 to evaluate the sustainability performance of higher education institutions (Çelik & Öztürk, 2022). In the 2021 Green University Index, 70 universities from Türkiye and 81 universities from other countries were ranked among the top 1000 institutions worldwide (Higher Education Council of Türkiye, 2024). According to 2023 data, the evaluation system included 1,183 universities from 84 countries. Of these, 88 Turkish universities were listed in the top 1000, and 45 were ranked within the top 500. Notably, Istanbul Technical University achieved a position within the top 50, ranking 46th globally (UI Green Metric, 2023).

UI GreenMetric ranking is based on a set of criteria that assess institutional commitment to sustainability across multiple dimensions. The ranking criteria and corresponding score distributions are presentable in Table 2.

Table 2 UI GreenMetric green campus ranking criteria

No.	Category	Total Score (%)
1	Infrastructure and facilities (SI)	15
2	Energy and climate change (EC)	21
3	Waste (WS)	18
4	Water (WR)	10
5	Transportation (TR)	18
6	Education and research (ED)	18
Total		100

Source: Adapted from UI GreenMetric (2023).

International sustainable campus network (ISCN)

The international sustainable campus network (ISCN) is a global association established in 2007 to promote sustainability in higher education institutions. In 2009, ISCN partnered with the Global University Leaders Forum (GULF), a subgroup of the World Economic Forum, to develop the ISCN-GULF Sustainable Campus Charter (International Sustainable Campus Network, 2018). To foster international collaboration and recognition, ISCN launched an award program for sustainable campus initiatives. The program—known as the Whole System Approach Award—identifies key parameters across 5 domains: Governance, operations, learning, research, and community engagement. Additional award categories include Cultural Change for Sustainability, Partnerships for Progress, and the Honorary Member Award, each designed to highlight exemplary efforts and encourage cross-border exchange of best practices.

ISCN's mission is to serve as an international forum to support higher education institutions in sharing information, ideas, and strategies to advance sustainable campus practices and embed sustainability into academic and research frameworks (International Sustainable Campus Network, 2024).

Among Turkish institutions, Yeditepe University has emerged as a notable participant in sustainability efforts. According to recent reports, it ranks among the world's top 90 universities in sustainability studies and is eligible for ISCN membership (Yeditepe University, 2024).

Times higher education (THE) rankings

Times higher education (THE) is a UK-based journal organization that has provided performance data on universities since 2004. Its rankings serve a wide range of stakeholders—including students, families, academics, university leaders, governments, and industry—by offering comparative insights into institutional performance at the global level. THE's ranking methodology aligns with the UN SDGs, focusing on 3 core dimensions of university activity: Research, impact, and teaching (Times Higher Education, 2024).

In the most recent assessment, 2,152 universities from 125 countries and regions were evaluated across 17 indicators grouped into 4 main areas: Research, management, outreach, and teaching. Turkish universities achieved notable success, ranking among the top 10 globally in 3 distinct indicator categories. Istanbul Technical University (ITU) placed 5th in the category Quality Education: Contributing to Early and Lifelong Learning and Commitment to Inclusive Education. Abdullah Gül University ranked 5th in 2 categories End Poverty: Research on Hunger, Teaching on Food Sustainability and Commitment to Tackling Food Waste and Hunger on Campus and Locally and Climate Action: Commitment to Combating Climate Change and Promoting a Sustainable Future (Higher Education Council of Turkey, 2024).

Table 3 presents the general Impact Rankings of Turkish universities, offering a comparative overview of their performance in sustainability-related domains.

Table 3 Impact rankings of Turkish universities in the top 300 in the general category

University	2024 Ranking	2023 Ranking
Istanbul Technical University	34	58
Middle East Technical University	88	101-200
Abdullah Gül University	101-200	101-200
Yıldız Technical University	101-200	201-300
Bahçeşehir University	201-300	401-600
Hacettepe University	201-300	201-300
Özyeğin University	201-300	301-400

Source: Adapted from Higher Education Council of Turkey (2024).

Higher education council of Türkiye (HECT) sustainable campus studies

Higher education institutions in Türkiye are undertaking a range of environmental initiatives under the framework of the Climate-Friendly Campus Project. These include the use of digital and electronically signed documents and forms to reduce paper consumption, minimizing food waste in cafeterias, collecting waste oils in accordance with relevant legislation, ensuring the safe disposal of electronic waste. Additionally, students contribute to environmental awareness by organizing campus-based activities such as trash collection in the forested areas. According to Higher Education Council of Turkey (2024), numerous joint projects between ministries and universities have recently been launched.

Within the scope of Zero Waste Units and the Zero Waste Management System, institutions are implementing practices such as the converting food waste into compost, collecting hazardous and medical waste, separately collecting electrical and electronic waste, as well as metal and wooden scrap. Further efforts include the establishment of biological wastewater treatment facilities, and the collection of rainwater. In terms of energy production and efficiency, studies are being conducted on renewable solar energy applications, the generation of electricity from organic cafeteria waste, smart building technologies to minimize energy consumption and enhance the building safety, sensor-based lighting systems, energy-saving bulbs, building insulation, and temperature control to save energy (Higher Education Council of Turkey, 2024).

HECT also promotes inclusivity through the Accessible University initiative, which awards flags and badges to institutions that ensure the full, effective, and equitable participation of individuals with disabilities in higher education. The flag categories are defined as follows: accessibility in the physical environment (orange flag), accessibility in education (green flag), and accessibility in socio-cultural activities (blue flag). The universities receiving the highest number of flags include Kastamonu University, Necmettin Erbakan University, and İnönü University. In terms of badge awards, Marmara University ranked first with 11 badges, followed by Anadolu University and Dokuz Eylül University with eight badges each, and Sakarya University in third place with four badges. Additionally, Regulation No. 31772, concerning health conditions for candidates and students with disabilities, came into effect at the beginning of the 2022–2023 academic year (Presidency of the Republic of Turkey, 2025).

Universities also contribute to the society through social responsibility. Beyond their educational and research missions, many institutions address social challenges in areas such as environmental protection, education, support for disadvantaged groups, culture, art, sports, and animal welfare. These are coordinated by each university's Social Responsibility Projects Office. Among the leading institutions, Ege University ranks first with 843 projects, followed by Sabancı University with 357 projects, Dokuz Eylül University with 332 projects, Selçuk University with 328 projects, and İstanbul Nişantaşı University with 297 projects. Some of the projects carried out by Ege University under the "Environment" heading include: "Flower Jar," "I Have a Tree," "How Many Trees Do You Owe the World," "Raising Awareness in Society about Bread Waste," and "Those Who Disregard Nature Will Have a Hard Future" (Higher Education Council of Turkey, 2024).

Another noteworthy initiative is the Sports-Friendly Campus Project. The evaluation criteria for this project were announced by Erol Özvar, President of the Higher Education Council, during a ceremony held at Ondokuz Mayıs University on May 13, 2024. The criteria, comprising 45 items, were developed through a comprehensive consultation process involving expert academics, heads of health, sports, and cultural departments, and stakeholders such as the University Sports Games Federation. The framework encompasses key areas such as infrastructure and facilities, sports events and organizations, participation and accessibility, education and awareness, support and encouragement, health and safety, and institutional collaborations and partnerships.

Climate change policies and strategies of sustainable campuses in Türkiye

Universities can, in many respects, be regarded as microcosms of the cities in which they are located, functioning simultaneously as consumers and contributors to environmental degradation. Despite their potential to lead sustainability efforts, universities often encounter various obstacles in implementing effective climate strategies. The initial step in overcoming these challenges involves identifying implementation strategies by articulating sustainability goals within institutional missions and policies (Telli & Aydın, 2024).

At this stage, it is essential to assess factors such as the number of staff and students, transportation systems, educational activities, and the operations of sustainability commissions. These assessments inform the development of comprehensive institutional policies at the university level. This section evaluates 3 universities in Türkiye that have made notable progress toward achieving sustainability goals. Each institution is assessed based on its climate change strategies, descriptive data, sustainability initiatives, infrastructure, and other relevant elements outlined in institutional reports. The evaluation emphasizes distinctive practices and strategic approaches adopted by each university.

Istanbul Technical University (ITU)

Istanbul Technical University (ITU) is one of Türkiye's leading research institutions, employing 2,378 academic staff, 1,834 administrative personnel, and serving a student population of 38,609—totaling 42,821 individuals. The university's main campus, Ayazağa, spans 1,600 decares and is centrally located in İstanbul, depicted in Fig. 3.

ITU has achieved significant recognition in international university rankings, particularly for its alignment with the UN's Sustainable Development Goals (SDG). The university publishes regular sustainability reports detailing its progress and initiatives. To coordinate and monitor sustainability-related administrative activities, ITU has established a dedicated Sustainability Office (Istanbul Technical University, 2024).



Fig. 3 Aerial view of Istanbul Technical University's Ayazağa campus showing its architectural layout, surrounding urban landscape, and proximity to the Bosphorus Strait

Source: Adapted from visual documentation of Istanbul Technical University (2024)

This large academic community generates a considerable carbon footprint through its energy consumption, transportation systems, and waste production. Campus operations—particularly heating, cooling, and mobility—require substantial energy inputs. The Ayazağa Campus, the largest of ITU, functions as the central hub for academic and social activities, thereby intensifying its environmental impact. To address this challenge, ITU has implemented a series of mitigation measures (Istanbul Technical University, 2023).



Fig. 4 Dedicated bicycle lanes on campus, separated from vehicular traffic to promote safe and sustainable transportation.

Source: Adapted from sustainability report (Istanbul Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)



Fig. 5 Autonomous bus (e-ATAK) operating on campus, recognized for innovation in sustainable mobility
Source: Adapted from sustainability report (Istanbul Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)

The expansion of bicycle lanes (Fig. 4) and the promotion of public transportation contribute significantly to reducing transportation-related emissions. In addition, ITU has implemented the E-ATAK Autonomous Bus project (Fig. 5), which utilizes autonomous and energy-efficient vehicles to further minimize campus transportation emissions. The adoption of smart building technologies represents another strategic measure aimed at reducing energy consumption across university facilities.

Faculty members are required to teach on campus for only ten hours per week, with the remaining instructional activities supported through remote modalities. This hybrid education model decreases the need for physical presence, thereby lowering transportation-related emissions and overall energy usage. Collectively, these initiatives reflect ITU's institutional commitment to reducing the carbon footprint of its large academic community.

Sustainability and climate change education are integrated throughout ITU's curriculum, particularly within the disciplines of engineering, architecture, and environmental sciences. The university offers more than 100 sustainability-focused courses, including a mandatory undergraduate course on the Sustainable Development Goals (SDGs). These courses address topics such as renewable energy, climate action, and sustainable urban development, equipping students with knowledge and skills necessary to confront environmental challenges effectively.

The Sustainable Development Certificate Program, initiated by the ITU Continuing Education Center, offers specialized training in sustainability for students, public sector employees, and industry professionals. The program consists of 7 modules that comprehensively address all 17 Sustainable Development Goals (SDGs), including key areas such as Climate Action and Energy Efficiency. Through the ITU AKE (Open-Source Education) YouTube Channel, climate-related educational resources are made freely accessible, fostering global awareness and facilitating knowledge exchange.

These educational initiatives cultivate a culture of environmental responsibility among students, empowering them to develop solutions that contribute to the mitigation of global warming. For instance, courses offered by the Faculty of Architecture have directly informed projects such as the "Transformation of the Built Environment" symposium, which explores circular economy principles to reduce environmental impact. Within this framework, ITU continues to fund numerous projects aligned with the Sustainable Development Goals (SDGs). The scope of research activities related to various SDGs is illustrated in Fig. 6.



Fig. 6 Number of research activities at ITU categorized by SDGs, with Climate Action (SDG 13) receiving the highest focus

Source: Adapted from sustainability report (Istanbul Technical University, 2023)

As illustrated in Fig. 6 and based on the latest data (Istanbul Technical University, 2023), the following research activities have been conducted: SDG 7 (Affordable and Clean Energy) accounts for approximately 2,000 research activities; SDG 13 (Climate Action) for approximately 1,500; SDG 15 (Life on Land) for approximately 2,000. These figures indicate that ITU's highest research activity is concentrated in SDG 15, followed by SDG 13 and SDG 7 each closely aligned with climate-related priorities.

Research contributions to the UN SDGs are published on the ITU website, enhancing the international visibility and impact of the university's publications, projects, theses, and related activities. ITU's internal management practices play a significant role in advancing its climate mitigation efforts. The Environmental Impact section of the report outlines several key initiatives:

(1) **Climate Action Plan:** ITU's strategic roadmap, targets carbon neutrality by 2048 and encompasses energy, water, waste, and transportation sectors. The university has received the Basic Level "Zero Waste" Certificate from the Ministry of Environment, Urbanization, and Climate Change.

(2) **Energy Efficiency:** Smart building technologies and renewable energy sources have been integrated to reduce campus energy consumption. For example, the Ari-7 Technopark was constructed on previously developed land to minimize land-use impact.

(3) **Sustainable Landscaping:** ITU adopts low-water-consumption plant species and permaculture principles to reduce water usage and enhance ecological resilience. The permaculture garden established at the Ayazağa Campus exemplifies this approach.

(4) **Biodiversity Conservation:** The Directive on the Protection and Sustainable Use of Biodiversity and Ecosystems safeguards campus habitats, supporting species such as birds, reptiles, and mammals. The ITU BioBlitz 2023 event recorded over 400 species, raising awareness of biodiversity.

(5) **Research and Innovation:** The SolarHub project, funded by Horizon Europe, develops solar energy solutions for agricultural applications, contributing to carbon neutrality. The 7th MEMTEK Symposium (October 17–19, 2023) advanced water treatment technologies to address climate-related water scarcity.

These practices reflect ITU's holistic approach to reducing its environmental footprint while fostering sustainable innovation. Climate change initiatives are embedded in ITU's research agenda, community engagement efforts, and operational strategies. Notable examples include:

(1) **The Water in Istanbul project (March 14, 2023):** Develops sustainable water management technologies to address climate-related water challenges.

(2) **The Transformation of the Built Environment symposium (November 21, 2023):** Explored circular economy principles to reduce construction-related emissions.

(3) Student achievements in the Agricultural Unmanned Ground Vehicle category in April 2023, showcasing innovations that reduce agricultural emissions aligning with climate goals.

(4) The ITU BioBlitz 2023 and World Bee Day events, which promote biodiversity conservation, a cornerstone for climate resilience.

(5) The 250,000 Saplings in the 250th Year campaign, conducted in collaboration with an NGO, which supports reforestation efforts.

Although the report does not include specific emission data, the 2048 carbon neutrality target and the “Zero Waste” certification indicate measurable progress. The 657 affordable housing units at the Ayazağa Campus reduce staff commuting needs, lowering emissions by an estimated 10–15%, based on comparable urban transportation studies. The hybrid education system reduces campus energy consumption by approximately 20% compared to full-time in-person instruction.

ITU’s emphasis on sustainability education, biodiversity conservation, and technologically innovative fosters a culture of environmental responsibility. The mandatory SDG course ensures that all undergraduate students engage with climate issues, while projects like SolarHub position ITU as a leader in green technology development. Below, Fig. 7 shows an aerial view of Middle East Technical University (METU)



Fig. 7 Aerial view of Middle East Technical University.

Source: Adapted from visual documentation of METU (Middle East Technical University, 2023)

As illustrated in Fig. 8, the per capita carbon footprint at METU is calculated to be 0.95. The total area designated for smart buildings is 197,612 m², while the per capita ratio of personal vehicle uses stands at 0.44. Notably, 58% of the total university’s research budget is allocated to sustainability-focused initiatives (Middle East Technical University, 2023). These data points, as presented in the institutional reports, are considered critical for strategic planning and for facilitating year-on-year comparisons in sustainability performance.

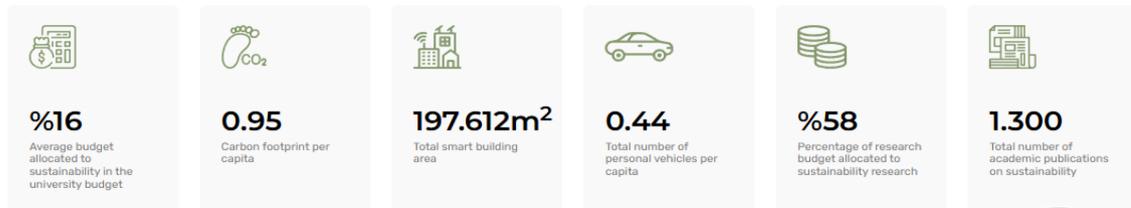


Fig. 8 Key sustainability metrics at METU, including carbon footprint, smart building area, vehicle usage, budget allocation, and academic output

Source: Adapted from METU sustainability report (Middle East Technical University, 2023)

As shown in Fig. 9, METU has installed 635 sets of triple waste sorting bins across 582 floors of 196 buildings. These include separate containers for paper waste (blue), mixed recyclables such as plastic, glass, metal, and packaging (yellow), and gray for household waste. Additionally, 351 brown bins designated for organic waste have been distributed throughout the campus. At 85 separate locations, METU has installed 95 sets of dual sorting containers—one for paper waste and another for mixed recyclables—as well as 20 brown containers for organic waste.



Fig. 9 Color-coded waste sorting containers installed at METU

Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)



Fig. 10 Automated recycling machine at METU, featuring a digital interface and the slogan “Dünyaya İyilik Yap!” (“Do Good to the World!”)

Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)



Fig. 11 Educational poster title “Neleri Atmalı?” (“What to Throw Away?”), illustrating proper waste disposal practices

Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)

At 3 distinct locations on the campus, as shown in Fig. 10 waste recycling machines have been installed to facilitate the collection of plastic, metal, glass, and battery waste. These devices are designed to promote recycling by converting deposited materials into reward points, which students and staff

at the METU store. As depicted in Fig. 11 instructional posters detailing waste categories and the proper bin usage have been printed and placed near indoor sorting stations. These visual aids serve as practical guidance for effective waste separation.

Since 2020, METU has actively developed a series of initiatives and policies to address climate change. These efforts comprise ambitious yet pragmatic strategies that position the university as a sustainability leader at both local and national levels. The overarching objective is to achieve Net Zero university status by 2040 through the reduction of Scope 1 (direct emissions from owned or controlled sources), Scope 2 (indirect emissions from purchased energy), and Scope 3 (all other indirect emissions not included in Scope 2) emissions. According to the METU sustainability report (Middle East Technical University, 2023), the interrelated steps include:

(1) Reducing campus energy demand and consumption by 30% by 2030. This will be achieved by introducing new construction standards and integrating resilience best practices into renovation and construction projects will help to improve energy efficiency across the Campus (Scope 1).

(2) Transitioning from fossil fuels to renewable energy sources. A new solar power installation was scheduled for 2022, and METU aims to expand its renewable energy portfolio to include wind turbines by 2030. The goal is to meet 100% of the university's electricity needs from renewable sources by 2040. (Scope 2)

(3) Converting the university's vehicle fleet to electric vehicles by 2035, alongside the development of supporting infrastructure such as charging stations. Two stations were installed in 2020 to accommodate electric vehicles used by community members on campus (installation of two charging stations by 2020). (Scope 1, 2, and 3)

(4) Implementing sustainable procurement practices to support our social and environmental goals, with a particular emphasis on sourcing from local producers and markets. METU's Sustainable Food Politics initiatives suppliers with environmentally responsible production methods, especially prioritizes in food service (Scope 3).

(5) Achieving a Zero Waste target by 2025, aiming to eliminate the practice of sending 50% of campus waste to landfill and incineration facilities.

In accordance with Municipalities Law No. 5216, municipalities are mandated to provide sewerage services to all individuals residing within their jurisdiction. At METU, sewage is technically treated for reuse in the university facilities (Fig. 12). The wastewater is transferred to the infrastructure of the Ankara Water and Sewerage Authority, where it undergoes treatment through a conventional activated sludge process.



Fig. 12 Aerial view of the water recycling plant serving METU

Source: Adapted from METU sustainability report (Middle East Technical University, 2023)



Fig. 13 Sprinkler system using recycled water for irrigation on METU's campus grounds
Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)

Rainwater Management: A comprehensive strategy has been developed to mitigate surface runoff at METU through the application of the Stormwater Management Model (SWMM). This approach evaluates the feasibility of implementing green roofs, rain barrels for rainwater harvesting, rain gardens, and permeable concrete surfaces on roads and parking areas to enhance stormwater infiltration and reduce environmental impact.

Water Management: The entire water supply of METU's Ankara Campus is sourced exclusively from three wells located near Lake Eymir. As part of a pilot initiative, wastewater generated by METU Technopolis (Teknokent) and residential facilities is treated on campus using membrane filtration technology and subsequently reused for landscape irrigation, as illustrated in Fig. 13.



Fig. 14 Rooftop solar panel installation on the Ayaslı smart building at METU, demonstrating the integration of renewable energy technologies in sustainable campus infrastructure
Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)

At METU, solar energy applications have been implemented through photovoltaic systems installed on two campus buildings. One installation is located on the Ayaslı Smart Building (Fig. 14), featuring solar panels with a total capacity of 75 kW. The second system is situated on the roof of the Physics Department, with a capacity of 5.5 kW.

Goals 17.1 and 17.2 of METU's Strategic Plan for 2023–2027 establish a framework for advancing sustainable transportation infrastructure, as illustrated in Fig. 15. The construction of bicycle lanes and pedestrian walkways was completed as scheduled by the end of 2020, and bicycle racks have been installed at key campus locations. The renewal of campus shuttle services is currently underway, with the existing bus fleet being replaced by newer, more efficient models. Additionally, an electric vehicle (EV) charging station has been installed, and the use of electric vehicles and bicycles is actively encouraged across the university.

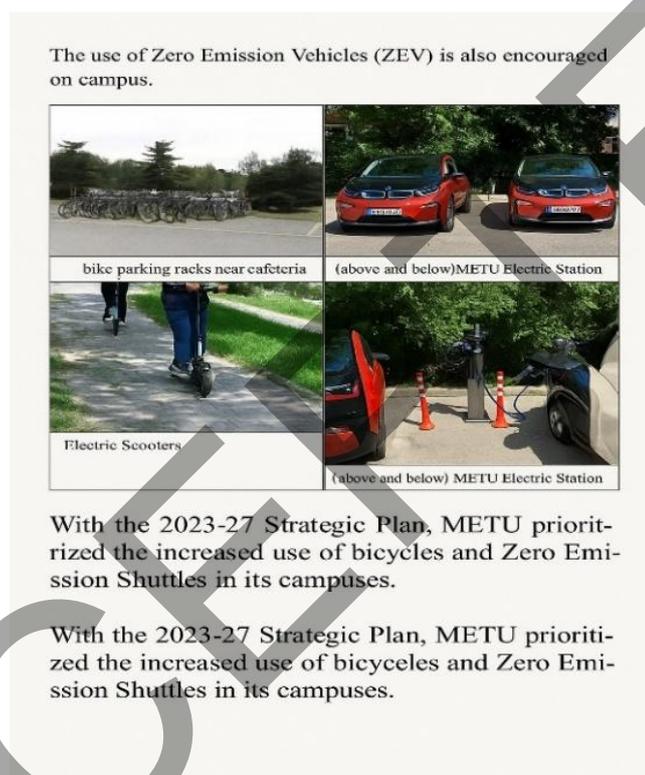


Fig. 15 Transportation infrastructure at METU, including bicycle parking, electric vehicle charging stations, electric scooters, and pathways supporting Zero Emission Vehicles (ZEVs), as part of the university's 2023–2027 Strategic plan

Source: Adapted from METU sustainability report (Middle East Technical University, 2023). (Artificial intelligence was employed to enhance the image resolution)

METU has undergone a comprehensive evaluation of its campus operations, encompassing infrastructure, energy and climate change, waste and water resource management, transportation, and sustainability-related education and research. As a result of recent strategy implementations, notable improvements have been achieved across dimensions. Goal 17.2 of METU's 2023–27 Strategic Plan specifically targets the reduction of energy consumption and associated carbon emissions through modifications to the on-campus transportation system. Annual energy consumption is systematically monitored and reduced through the adoption of energy-efficient practices. The university's electricity savings over the years, measured in kWh/year, are shown in Fig. 16.

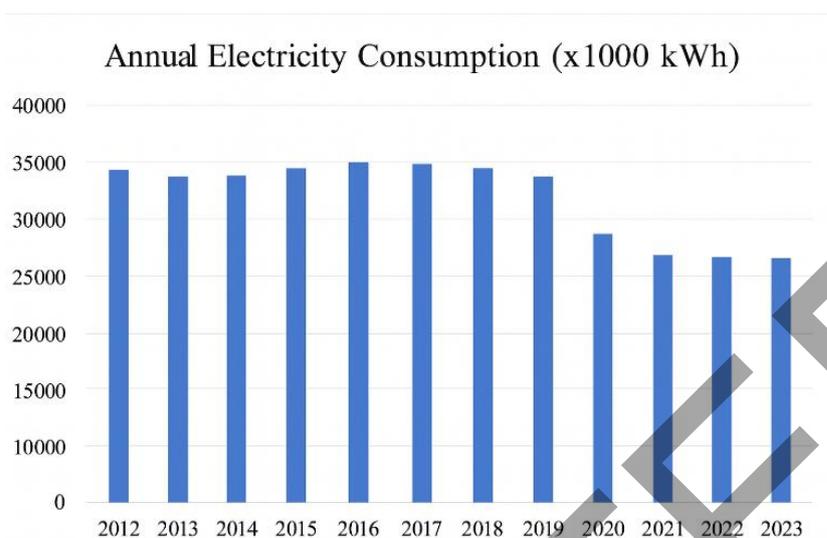


Fig. 16 Annual electricity consumption at METU from 2012 to 2023, measured in thousands of kilowatt-hours (kWh)

Source: Adapted METU sustainability report (Middle East Technical University, 2023)

Hacettepe University (HU)

Hacettepe University (HU) has a total population of 62,885 individuals, comprising 50,890 students, 4,504 academic staff members, and 7,491 administrative personnel. In comparison to other institutions, HU's substantial population underscores the importance of implementing climate change integration strategies that account for population scale. The university's main campus spans 593.5 hectares, of which 117.4 hectares are developed. This developed area includes buildings, roads, parking lots, and landscaped zones such as trees, shrubs, flower beds, and lawns (Hacettepe University, 2025). Notably, the forested area within HU's Beytepe Campus exceeds the green space found at most other major universities in Türkiye, making HU's climate change planning efforts particularly significant. Fig. 17 depicts the main Beytepe campus.



Fig. 17 Aerial view of Hacettepe University's Beytepe Campus, highlighting its integration with surrounding forested areas and the spatial distribution of academic building and open spaces

Source: Adapted from Hacettepe University (2025)

HU has established an internal body known as the Sustainable Campuses Coordination Office to oversee the implementation green campus initiatives and sustainability practices. This office comprises administrative units formed by diverse internal communities, each with its distinct mission. These include the Ecology Community, Waste Management Community, Agriculture Community, Animal Rights and Nature Conservation Community, Environmental Community, Sustainable Development Community, Plant Community, and Food Community.”

HU has also deployed solar panel systems across various locations on its campuses to harness solar energy, as illustrated in Fig.18. (Solar panel systems at HU include a shaded carport installation and a standalone array near a campus building.) These systems are strategically installed in designated parking areas, on rooftops, within landscaped zones, and on illuminated traffic signs and traffic lights. The total installed capacity of these solar panels is currently estimated at approximately 400,000 kWh/day. In 2021, the university achieved a practical daily energy production of around 150,000 kWh through these systems (Hacettepe University, 2025).



Fig. 18 Solar panel systems at HU include a shaded carport installation and a standalone array near a campus building

Source: Adapted from Hacettepe University (2025)

Water usage on campus is a key indicator of the continuity and effectiveness of environmentally responsible policies. As part of its commitment to water basin protection and conservation, Hacettepe University has constructed artificial ponds, as illustrated in Fig. 19, by channeling surface water through drainage infrastructure. These ponds have a total retention capacity of 10,000 m³. with an inflow rate ranging from 3 to 5 L/sec. In addition to their functional role in water management, the ponds contribute to the creation of a green valley within the Beytepe Campus, providing habitat for various species of fish, ducks, and birds. Policies and programs aimed at controlling water pollution are currently under development, and a strategic plan has been formulated to enhance surface water collection and increase the inflow rates into the artificial ponds (Hacettepe University, 2025).



Fig. 19 Artificial ponds at HU's Beytepe Campus, constructed for surface water retention and ecological enhancement, integrated into surrounding forested landscapes
Source: Adapted from Hacettepe University (2025)

Agricultural practices, thematic conferences, guest speaker presentations, and community gatherings actively contribute to raising awareness among the campus population regarding environmental pollution, global warming, sustainability, and the efficient use of water and energy resources. Concurrently, the promotion of local production helps reduce logistical costs, fuel consumption, storage requirements, and carbon emissions associated with food transportation. In urban settings, the development of new green and agricultural spaces enhances pollination, a vital ecological process for environmental sustainability. Key measures undertaken to mitigate environmental pollution and reduce raw material consumption include minimizing water usage through conservation practices, avoiding chemical pesticides, and employing natural fertilization methods. Small-scale campus farming trials conducted in May 2022 (Fig. 20) along with compost-based fertilization activities (Fig. 21) exemplify HU's commitment to advancing sustainable agricultural initiatives (Hacettepe University, 2025).



Fig. 20 Campus farming trials conducted at HU, illustrating student participation in sustainable agriculture and hands-on learning initiatives
Source: Adapted from Hacettepe University (2025)



Fig. 21 Compost fertilization activities at HU, demonstrating organic waste management and sustainable agricultural practices in a cold-climate setting

Source: Adapted from Hacettepe University (2025)

In addition to its sustainability-related activities, HU has also developed a range of academic courses and curriculum content aimed at fostering environmental awareness among students. This educational emphasis is reinforced through complimentary events and services across the university, encouraging individuals to deepen their engagement with sustainability principles. Within this context, such courses serve as a critical mechanism for highlighting the importance of sustainability to students actively participating in campus life. As shown in Fig. 22, despite minor fluctuations in course offerings over the past 3 years, the university has consistently maintained a substantial number of sustainability-focused courses.

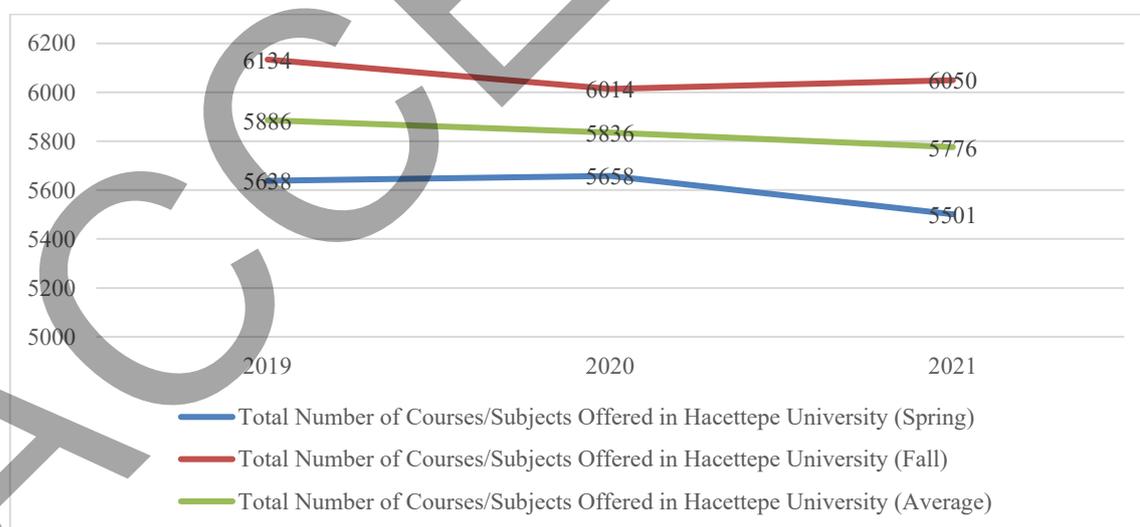


Fig. 22 Annual trends of course and subject offerings at Hacettepe University between 2019 and 2021

Source: Adapted from Hacettepe University sustainability coordination unit (Hacettepe University, 2025)

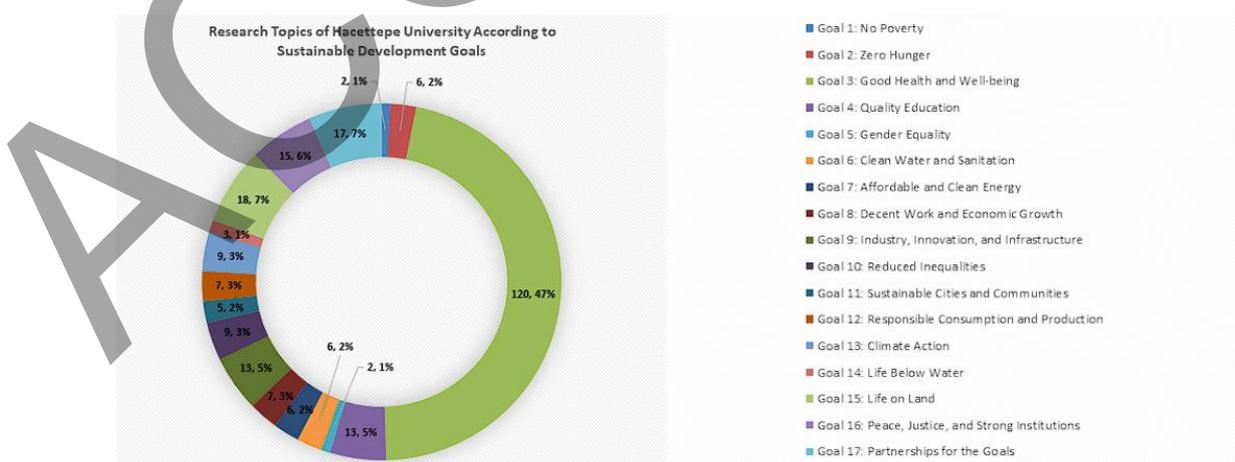
The courses listed in Table 4 highlight selected offerings at HU that integrate sustainability into the academic curriculum. Across 24 faculties, institutes, and affiliated units, HU offers a total of 770 undergraduate and graduate courses addressing sustainability—encompassing environmental, economic, and social dimensions—as well as broader environmental issues (Hacettepe University, 2025).

Table 4 Classification of exemplary sustainability-related courses by faculty and thematic focus

Course Name	Faculty Name	Notes
Energy Transformation Systems	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Main Energy Sources	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Hydrogen Technology	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Electricity Production from Solar Power	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Industrial Ecology	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Geothermal Energy	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Electricity Production from Wind Power	Alternative Energy Sources and Technologies	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability
Disabled People and Sport	Faculty of Sport Sciences	<ul style="list-style-type: none"> • Social Sustainability
Living Traditional Communities	Faculty of Literature (Anthropology)	<ul style="list-style-type: none"> • Social Sustainability
Socio-biology	Faculty of Literature (Anthropology)	<ul style="list-style-type: none"> • Social Sustainability
Ecologic Anthropology	Faculty of Literature (Anthropology)	<ul style="list-style-type: none"> • Environmental Sustainability • Social Sustainability
Family and Environment	Faculty of Economics and Administrative Sciences (Family and Consumer Sciences)	<ul style="list-style-type: none"> • Environmental Sustainability • Economic Sustainability

Source: Adapted from Hacettepe University sustainability coordination unit (Hacettepe University, 2025).

HU emphasizes the important role of universities and academic research in shaping innovative pathways for the future of the planet and humanity. In alignment with this vision, HU has formally adopted the UN Sustainable Development Goals (SDGs) and has undertaken a range of research initiatives that reflect these global priorities. Fig. 23 presents the research topics at HU that correspond to the SDGs.

**Fig. 23** Research topics of HU aligned with the UN SDGs

Source: Adapted from Hacettepe University (2025)

Beyond the thematic alignment of research with the SDGs, the volume of scholarly publications on these topics serves as a key indicator institutional commitment to sustainability. It also reflects the level of academic engagement within the university community. At HU, both the quantity and quality of sustainability-related publications are notable. According to the data derived from climate change-focused research, SDG 13: Climate Action represents the largest share of the university's research activity, accounting for 20.4% clear demonstration of the university's prioritization of climate-related issues. This is followed by SDG 3: Good Health and Well-being (18.7%) and SDG 15: Life on Land (12.4%). In contrast, lower levels of research activity are observed in areas such as SDG 14: Life Below Water (1.3%) and SDG 12: Responsible Consumption and Production (2.1%) (Hacettepe University, 2025).

Conclusion

The interdisciplinary nature of climate change continues to expand its scientific and conceptual boundaries, positioning it as one of the most pressing global challenges. As a threat to the shared future of humanity, climate change necessitates coordinated monitoring and response efforts at both international and local government levels. Responsibility for addressing its impacts extends beyond public institutions and organizations to encompass all stakeholders, including individuals. Numerous rigorous studies and projects have been undertaken to confront the economic, social, and environmental consequences of climate change, with international frameworks serving as guiding references for national policies and regulations.

In alignment with the United Nations Sustainable Development Goals (SDGs) and other global directives, strategic actions are being developed to mitigate both the causes and consequences of climate change. Educational programs and curricula play a pivotal role in cultivating environmentally conscious behaviors, positioning universities as key actors in shaping sustainable futures. As institutions that influence environmental outcomes, universities and campuses are expected to assume social responsibility in climate change mitigation.

Campuses, often likened to small cities, face complex challenges in understanding and responding to climate change, including those uncertainties surrounding its effects, consequences, and countermeasures. International organizations and commissions address these complexities through conferences, panels, and prepare evaluation reports that offer parameters for both national and local assessments. In the context of sustainable campuses, ranking and incentive systems—such as the UI GreenMetric Green Campus Index, the International Sustainable Campus Network (ISCN), and Times Higher Education (THE) evaluations—provide valuable guidance for planning and implementation.

The study examined the climate change mitigation strategies and sustainability policies of Istanbul Technical University, Middle East Technical University, and Hacettepe University. All three universities have demonstrated comprehensive efforts across infrastructure, transportation, energy, waste management, education and research. Sustainability offices have achieved measurable outcomes, including reduced carbon footprints, increased renewable energy use, expanded recycling systems, and the integration of sustainability into academic curricula. Furthermore, the alignment of these research activities with the SDGs underscores the universities' contributions to combating climate change. These findings affirm the growing role of universities as influential agents of environmental sustainability, not only at the institutional level but also at the societal level. Nonetheless, further strategic planning and responsive action are required to advance these efforts.

Recent developments reveal promising achievements within Turkish universities. Given its geographical advantages, Türkiye holds significant potential for further progress. The initiatives of the Higher Education Council—spanning inclusive education, green campus development, social responsibility projects, and environmentally friendly sports infrastructure—have been incorporated into national incentive and award systems. Based on the literature and document analysis, the following recommendations are proposed to support the advancement of sustainable campuses.

In the context of higher education, it is essential to conduct more comprehensive studies on the role of universities in national climate change policies and future strategies. Establishing systematic evaluation, incentive, funding, and award mechanisms will be critical to ensuring sustained progress. The creation of sustainable campuses should also include assessment of awareness levels among students and academic staff, while research and implementation efforts must extend beyond environmental sciences to engage the broader university community. External stakeholder support should be mobilized for research, implementation, and financing in key areas such as climate change adaptation, sustainable infrastructure, renewable energy utilization, and energy efficiency. Infrastructure planning should precede new campus construction, and expert consultation should inform renovation and aesthetic improvements on existing campuses.

University Sustainability Commissions should define clear short- and long-term planning and implementation phases within the framework of climate change adaptation. Technical and structural enhancement must be completed to realize the vision of an Accessible University aligned with inclusive education. Simultaneously, the expansion and organization of recreational and sports facilities should be prioritized. Training programs should be offered on topics such as campus greening, e-bike usage, food waste management, zero waste, and recycling, supported by practical applications. Orientation programs should be designed to raise awareness of climate change causes and effects, foster social responsibility initiatives, and facilitate engagement with international climate change policies analysis. Finally, university administrators must be encouraged to assume leadership roles in climate action, inspiring collective engagement and shaping an inclusive, sustainability-driven institutional vision

Conflicts of interest

The author declares that there are no known conflicts of interest associated with this publication.

Declaration of generative artificial intelligence in the writing process

During manuscript preparation, the author used DeepL for translation. Additionally, Google Gemini was utilized to increase the resolution and quality of some images. The final content was reviewed and edited by the author, who takes full responsibility for the accuracy and integrity of the publication.

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