Climate City Contract

2030 Climate Neutrality Action Plan of the City of Miskolc

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Summary

In January 2022, the Municipality of Miskolc MJV submitted its application for the European Union's "100 Climate Neutral and Smart Cities Mission" program, as part of the European Green Deal, to be implemented within the framework of Horizon Europe. The European Commission selected Miskolc County Municipality as one of 99 other cities to participate in the program. In addition to 100 cities from EU Member States, 12 non-EU cities from other European countries are also part of the mission. As part of the mission, Miskolc aims to become net zero carbon by 2030. To achieve this, a City Climate Contract will be signed with the European Commission. However, this goal can only be achieved through a broad partnership and stakeholder involvement. In addition to the Municipality of Miskolc MJV, the commitment of the main urban emitters is also needed, as only a joint effort can achieve a net emissions value.

To sign the climate agreement, the city had to prepare a Climate Neutral Action Plan 2030 and an Investment Plan showing how the activities set out in the plan will be financed.

Miskolc MJV has been one of the most committed cities in Hungary in the last decade to continuously improve the quality of life of its inhabitants, to develop activities that have an impact on the quality of life, and to improve infrastructure. The development of an action plan for climate neutrality and the implementation of climate-aware awareness-raising as widely as possible is in the city's fundamental interest. In line with EU directives, local authorities must also contribute to reducing greenhouse gas emissions and to climate protection efforts.

- ✓ In September 2011, the Municipality of Miskolc MJV signed a cooperation agreement with the Nonprofit Ltd. for Greener Cities. In the cooperation agreement, the city undertook to follow the principles of Green City Movement, to respect the points of the Green Charter of Milan, to apply the Green City Accreditation Point System in the initiation and implementation of development in the city.
- ✓ In 2013, Miskolc MJV, within the framework of the ATTAC project, prepared the Sustainable Urban Transport Plan (SUMP) of the city, led by Miskolc Holding Zrt. and MVK Zrt., of which two positive examples have been implemented, without claiming completeness: the extension of the tram network for the development of public transport has been completed, and 75 CNG buses strengthen the environmentally friendly urban transport.
- ✓ In 2013, the city also prepared a Sustainable Development Strategy (2013), which aims to "offer the city's population the opportunity to choose sustainability, to offer the development of a sense of identity in Miskolc based on the values of sustainability."
- ✓ In 2015, it joined the European Covenant of Mayors, committing to reduce its CO_2 emissions by at least 20% (compared to the base year of 2008).
- ✓ In 2016, it prepared the SEAP, in 2019 the SECAP and in 2020 the City Climate Strategy, which already set a target of 43% emission reduction.
- ✓ Miskolc is involved in a number of international collaborations and initiatives to support the urban green transition.

In 2021/2022, Miskolc prepared its Sustainable Urban Development Strategy (SDS) for the programming period 2021-2027. In the process of planning the strategy, the city redefined its vision, objectives and action plan based on the changed challenges and needs, thus the SDS will also form the basis for the city's future strategic documents, including the CCC Action Plan.

The current Action Plan is a constantly evolving strategic document, and it is important that it is regularly reviewed and updated in the light of the challenges and needs facing the city. It provides a good basis and guidance for the development of further sectoral plans. The present **Action Plan** has been prepared **with a comprehensive planning approach**, taking into account the **full** extent of the scale required to meet the **emission targets.**

The constantly and rapidly changing economic environment, the pandemic that reached the whole world in just a few months and changed our habits, the Russian-Ukrainian war that started in February 2022 and has been ongoing since then, and the accelerated climate change have caused significant problems in economic and social processes, but together they pose completely new challenges for all actors in a community, including urban management and urban development.

Although cities cover only a few percent of a country's surface area, they consume 60-80% of all energy produced and are responsible for 75% of total carbon emissions, making cities the most important arena of our daily lives, and meaningful results can only be achieved with the involvement of cities.

Hungarian municipalities, including the city of Miskolc, in addition to having to respond to the challenges of climate change, the rapid technological development offered by digitalisation, and unexpected external situations, unlike the vast majority of cities in the world, are not facing the use of infrastructure caused by overpopulation, but the fact that the population is drastically decreasing (which is not yet accompanied by a decrease in consumption and emissions). Despite (or even with) the problems in the municipality, Miskolc has a number of assets and strengths that give it the potential to reverse this negative trend and move in a positive direction. In the short term, it is possible to address some of the problems (for example, reducing car use and hence emissions by improving public transport), but to make Miskolc a sustainable city and a liveable home for its residents, fundamental changes are needed.

Based on demographic trends, it was a clear objective that all planned interventions in all cities should contribute directly or indirectly to increasing the retention capacity of the city's population, in addition to reducing emissions.

The use of **resilience** and **urban adaptability** as a horizontal aspect of the design was a key priority.

Miskolc **is well positioned to** build on existing developments and processes to achieve the planned climate-neutral urban operation, i.e. to minimise greenhouse gas emissions and to be able to absorb nearly as much carbon dioxide as the urban infrastructure emits. An outstanding achievement over the last decade is that the district heating company has been able to provide more than 50% of its primary energy needs from renewable geothermal energy sources. In 2021, the renewable share in the Avas urban area was already 68.28% and in the city centre 60.31%, which is also outstanding at European level.

In Miskolc, the urban environment will become sustainable by minimising environmental pressures, reducing air, carbon and water pollution, eliminating water and heat losses from the networks, while relying mainly on renewable energy sources to minimise energy use, and reducing the urban heat island effect in densely populated inner-city areas, thereby improving the quality of life for city dwellers. Efforts should be made to reduce waste production and increase waste recycling, and to strengthen the circular economy. In addition to energy, it is important to help improve the city's self-sustainability in the food supply sector, by empowering local (city and county) economic actors, strengthening short supply chains and playing a greater integrating and supporting role.

The green transition, and the possibility and pace of the transition, will of course be strongly influenced by both **national and international developments.** The experience of the past shows that it will take decades before there is a significant positive change in energy use and energy mix. It is also worth bearing in mind that the emergence of new technologies and the increasing use of renewable energy sources have not, on the whole, led to a reduction in the use of fossil fuels (and not at all to their replacement), but rather to the servicing of growing energy demand.

Economic growth will determine emissions growth, but the growth trajectory of recent decades will not be sustainable (completely contrary to decarbonisation objectives). Urban systems will therefore have to adapt to an increasingly changing environment. But one could also ask whether there can be a sustainable economy at the current rate of economic growth (given our current knowledge of technology), or whether any economic growth can be made sustainable. We also have to take into account in the planning process that the green transition will require for some time a specific increase in the extraction of necessary raw materials (including copper, lead, zinc, aluminium, iron, lithium, copper, cobalt) in certain areas, and that although the resulting emissions will not be directly felt in the city, they will have a negative impact on the achievement of climate neutrality goals.

Cities can initiate and sustain positive processes **by transforming** and **regulating their own infrastructure,** but for a complex urban ecosystem, this process can only be advanced at a significant social cost. The emissions from the operation of municipal infrastructure and services are a relatively small part of the total city emissions, so the municipality can only have a direct impact on this segment, but stimulating and influencing other areas will be an important task in the next decade. In addition to the need for **industry to make the green transition**, the **public will** also need to play an active role, firstly **by reducing consumption** and improving **private property** and energy **efficiency** (which will require significant resources and manpower), and secondly by changing attitudes, which should also be a priority for the city.

For the city of Miskolc, the largest greenhouse gas emission segment is the building sector, followed by the transport sector and then the energy used by industry. Waste management is in line with the national average, and the agricultural sector has much lower emissions than the national average**. Total urban emissions in the 2021 base year were 588,034 tCO_{2e}, with annual emissions per capita of 3.9 tCO_{2e}.** Assuming no change in current social and economic trends, the calculated value of urban greenhouse gas emissions **in 2030 would be 516 $ktCO_{2e}$.**

At the level of the whole urban system, two major segments will come to the fore. For the **building sector,** in addition to deep renovations, the phasing out of natural gas will be important. Buildings currently account for half of total energy use in Hungary, two thirds of which could be saved through renovation. Today, virtually any building can be modernised to minimise its energy use. To reduce gas use gradually but intensively, a detailed timetable and deadlines should be set to encourage decoupling. Our goal is to phase out gas supply by 2028 where it is used only for cooking and baking, and to phase out gas connections in new build properties from 2028 onwards.

The key to decarbonising **transport**, alongside electrification, is to reduce private car use and shift individuals to public transport. In parallel with the decarbonisation of the electric bus fleet, it is of paramount importance to improve the quality of service so that it can offer a real alternative to those who currently choose private transport. In addition to a number of transport-related improvements, a package of interventions to develop 16 district centres (important for reducing the need for private transport and covering the whole city) in support of the "15-minute city" concept will be launched from 2024. The replacement of the 55,000 cars and more than 7,000 trucks in the city must be accelerated as much as possible (with incentives) and their mileage must be significantly reduced to make progress towards the targets.

The two key strategic priorities that can be highlighted in terms of climate neutrality **are** therefore the **decarbonisation of the building sector** (through deep renovation and the phasing out of natural gas) **and the decarbonisation of transport** (mainly through the reduction of private car use).

The development of national regulators and national energy mix will have a significant impact on the decarbonisation of **electricity** use, which is expected to increase due to electrification. To further increase the urban share of solar energy, grid development is necessary. This is largely covered by the Hungarian Recovery and Resilience Plan.

By implementing these processes, it will be possible to create a liveable and environmentally resilient urban environment that will help retain the current population and attract the young, working-age population that is attached to the city. **Achieving climate-neutral urban operations** alongside a prosperous economy that makes the green transition **could be a breakout point for the city, differentiating it from other large cities in the region** and creating good practice within Europe.

Miskolc has a long-standing commitment to protecting the urban environment and striving to create a more carbon-neutral city. This process has been given a new impetus and perspective by the city's accession to the 100 Climate Neutral Cities Mission.

Miskolc, February 2024

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Abbreviations and acronyms

Abbreviations and acronyms	Definition
GHG	Greenhouse gases
IPPC	Intergovernmental Panel on Climate Change
KSH	Central Statistical Office
MEKH	Hungarian Energy and Public Utility Regulatory Office
MVM	Hungarian Electricity Works
Miskolc MJV	City of Miskolc with County Rights
MVK Zrt.	Miskolc Municipal Transport Ltd.
MIHŐ	Miskolc Heating Company
MVM MIFÜ	Miskolci Heatingplant Kft.
MIVIZ	Miskolc Waterworks
ME	University of Miskolc
FVS	Sustainable Urban Development Strategy
SUMP	Sustainable Mobility Plan
NEKT	National Energy and Climate Plan
ETS	Emissions trading scheme

1 Introduction

Geographical, social, economic context

Geographical location

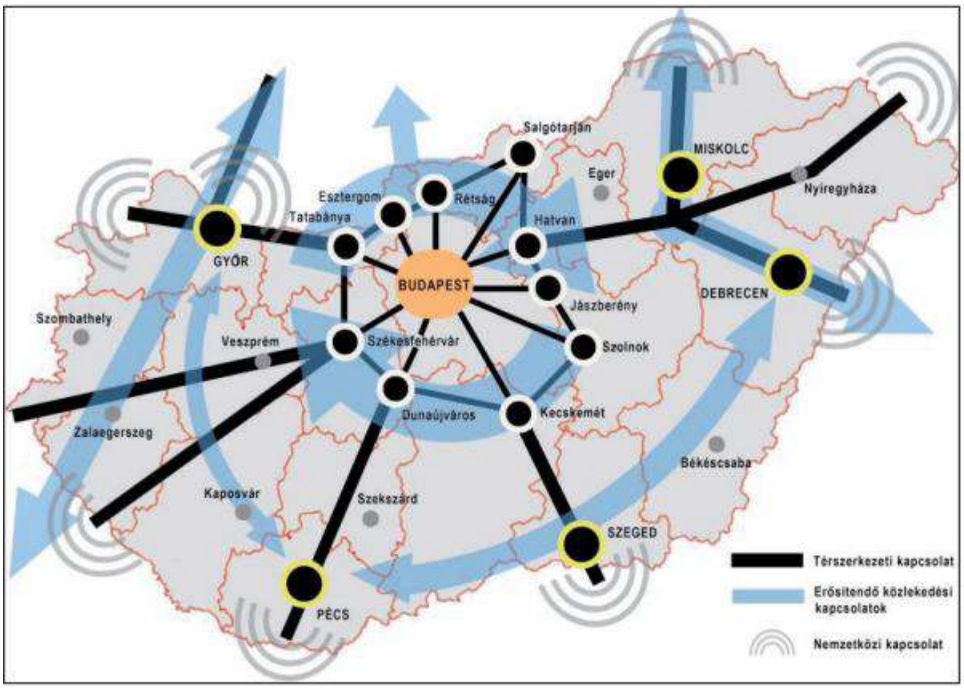
The city of Miskolc with County Rights was built on the eastern side of the Bükk Mountains, in the valley of the Stream Szinva, the Stream Hejő and the River Sajó, at the junction of the lowland and the northern central mountains, at the intersection of the north-south and east-west trade axes. Miskolc has an area of 236.68 km2, of which 58.02 km2 is internal and 178.66 km2 is external. The width of the inner area is 19 km east-west and 10 km north-south.
It is the most populous town in the North-Hungarian region, the economic, administrative, cultural, educational and health centre of the region.

Due to its size and geographic location, Miskolc plays a key role in the region's economy, being the seat of several county administration and regional institutions and offices.

Miskolc is classified as a regional centre according to the municipal hierarchy and as a large city according to the urban category.

In the spatial structure of Borsod-Abaúj-Zemplén county, the distance from Miskolc, the main transport routes and border crossings is one of the most important factors shaping the spatial structure and the spatial distribution of functions.

Map 1: Structure of strategic links



Source: OFTK

The National Development and Spatial Development Concept lists Miskolc among the border regions to be reassessed in terms of spatial structure and transport links: the integrated development of the **Miskolc-Kassa** region can act as a pulling force for the entire eastern, problem-ridden section of the border. The region's many higher education institutions are an important strength. They provide quality education and serve as a base for research and development. However, the level of cooperation between universities and between universities and businesses is still low. The natural environment of the border region is twofold: on the one hand, there are many protected areas on both sides of the Hungary-Slovakia border, but on the other hand, there are also many areas with serious environmental damage and pollution as a result of past heavy industrial activities. The border area has a significant cultural heritage value, the use of which as a social and economic resource is an area that still needs to be developed.

Demography

Table 1: Population by main age groups

(thousand persons)								
	2011				2022			
	0-14 years	15-64 years old	65 years and over	total	0-14 years	15-64 years old	65 years and over	total
City of Miskolc with County Rights	23	115	30	168	19	92	34	144
other cities	37	162	39	239	34	135	45	215
municipalities	52	185	43	280	50	166	44	260
Total Borsod-Abaúj-Zemplén County	112	462	113	686	103	393	123	619

Source: HCSO - preliminary census data 2022.02.

Between 2011 and 2022, the city's population decreased by 14.29% (-9.8% at county level), with domestic and international migration -5.4% and natural increase and decrease - 4.4%. Over the last 30 years, the population of Miskolc has decreased by almost 50,000, or almost a quarter. Further modelling the trends of the last 20 years suggests that **by 2035 there will be as many people of working age in the city as inactive and the population will not be much more than 130,000.** This poses huge challenges for the organisation and maintenance of public services. This negative demographic trend has not yet been reflected in consumption and energy use data, which shows both the emergence of energy-intensive sectors in the city and the significant overconsumption by households, which is also observed here, as almost everywhere in Europe. The year 2022 has already brought a change in this respect, with residential gas consumption falling sharply as a result of significantly higher overheads above average consumption. Nationally, gas consumption has already fallen by 25% compared to 2021.

Housing stock

Table 2: Change in the number of dwellings

	2011 (thousands)	2022 (thousands of units)	Housing stock in 2022 as a percentage of 2011
City of Miskolc with County Rights	77	79	102,5
other cities	95	98	102,8
municipalities	112	110	97,7
Borsod-Abaúj-Zemplén County	284	286	101,0

Source: HCSO -census data 2022.

Less than 2,000 new dwellings have been built in 10 years, an increase of 2.5%, with negative demographic trends already having an impact on the supply side.

There has been minimal change in the number of households in recent years. According to the 2022 census data, there are 79 051 dwellings in the municipality, of which 25% are under 50m² (19 644), 32% 50-59m² (25 544), 20% 60-79m² (15 485), 8% 80-99m² (6 363), 15% over 100m² (11 742). The average floor area of an apartment is 65m².

Table 3: Total number of dwellings in Miskolc

Period	Total number of dwellings at the beginning of the year (units)
Year 2017	76.772
Year 2018	76.807
Year 2019	77.114
Year 2020	77.251
Year 2021	77.352
Year 2022	79 051

Source: KSH - Annual settlement statistics, 2022 KSH census

Demographic and housing data for the 2022 Census are presented in the table below. The table includes 2011 data (where available) and is supplemented with a projected 2030 dataset based on trends over the past 10 years (not including measures in this Action Plan).

Table 4: Comparison of census data

Census data	2011	2022	2030
Population number (persons)	167 754	145 735	131 162
Number of dwellings	76 539	79 051	81 423
Occupied dwelling	69 381	66 548	63 886
Unoccupied dwelling	7 158	12 503	17 536
Number of households with wood heating (number)	9 767	8 258	7 019
Number of households heating with coal, lignite (number)	2 282	564	141
Number of dwellings with district heating (units)	31 669	33 216	
Heating one or more dwellings with central heating, boiler or other means (units)		25 960	18 172
Mains (piped) gas heating (pcs)	38 459	39 608	31 686
LPG (cylinder, tank) gas fired (pcs)	211	130	0
Number of dwellings with electric heating (units)	609	4 501	31 507
Number of households with solar panels (number)		2 106	10 530
Number of households with heat pump heating (pcs)		960	4 800
Number of households with solar collectors (number)		570	2 850

Number of households with air conditioning (number)		14 291	21 437

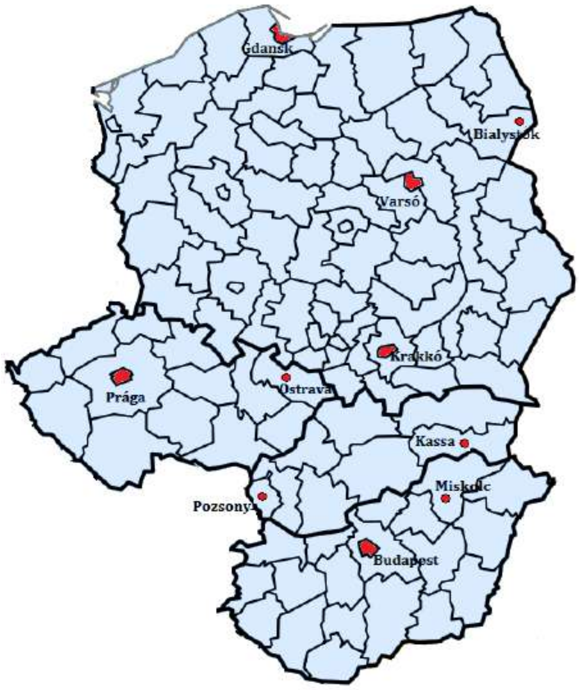
Source: KSH - 2022 Municipal census data series

The data series have also been used in the determination of consumption trends and associated emission values, with the difference that the population decline has been calculated at a lower rate than would be expected from the trend in previous decades. For some renewable energy technologies (heat pumps, solar PV) the trend is expected to be much higher, and this is indicated in the Economic model.

Economy

In order to briefly describe the economic environment, economic prosperity and competitiveness will first be briefly contextualised, based on research at the University of Miskolc. In the following, the city of Miskolc (and the region of Northern Hungary) is compared with 9 other cities (and their NUTS2 regions).

Figure 1: Scope of cities examined in terms of competitiveness



In the case of the Czech Republic Prague and Ostrava are two metropolitan areas as classified by ESPON (2005). For Poland, Warsaw, Krakow, Gdansk are metropolitan areas and Bialystok is a metropolitan city, while for Slovakia, Bratislava is a metropolitan area and Košice is a metropolitan city. In Hungary, Budapest is a metropolitan area and Miskolc is a city.
The cities were selected based on the availability of qualitative data and indicators measured on a qualitative scale, using the Urban Audit Perception Survey list of cities.

Of the cities and regions included in the study, only the capital regions can be said to be moderately developed according to the Regional Competitiveness Index, the others being in the low developed category in 2022. This also highlights the disparities between metropolitan and rural regions.

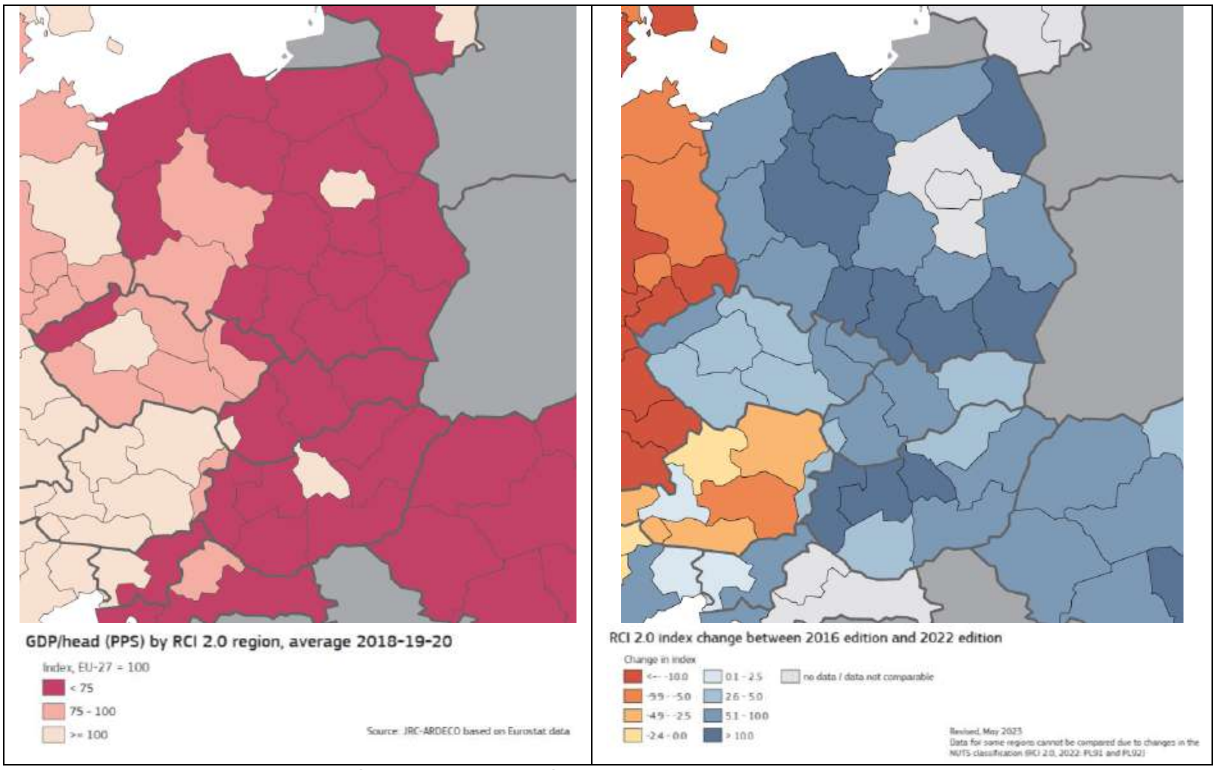
Table 5: Results of the regional competitiveness ranking for the cities and regions included in the study (NUTS2)

City	NUTS2 region	Ranking	Basic indicators sub-index	Efficiency subindex	Innovation subindex
Prague	Prague	46	104.2	117.1	122.4
Bratislava	Bratislavský kraj	50	89.8	120.0	125.8
Budapest	Central Hungary	93	83.0	116.4	107.6
Ostrava	Moravskoslezsko	118	93.9	98.3	90.9
Kraków	Malopolskie	127	89.7	100.7	78.2
Bialystok	Pomorskie	140	92.4	93.0	72.6
Warsaw	Mazowieckie	177	84.0	86.4	50.0
Gdansk	Podlaskie	181	86.7	78.9	57.8
Kosice	Východné Slovensko	193	69.7	73.1	70.1
Miskolc	North Hungary	207	64.4	68.6	56.8

Source: Regional Competitiveness Index (2022)

The competitiveness rankings of Hungarian cities lag behind their regional competitors, with Budapest and the Central Hungary region lagging far behind Prague and Bratislava, ranking 93rd (compared to 46th in Prague and 50th in Bratislava). Miskolc and the North Hungary region are the worst placed of the cities and regions surveyed, ranking 207th out of 234 regions. In the case of Miskolc and Northern Hungary, it is also a negative phenomenon that the change in the competitiveness index (2016-22) lags behind the development of the Visegrad Four regions.

Table 6: Change in GDP per capita (PPS, EU27=100%, average 2018-2020) and regional competitiveness index (2016-2022, %)

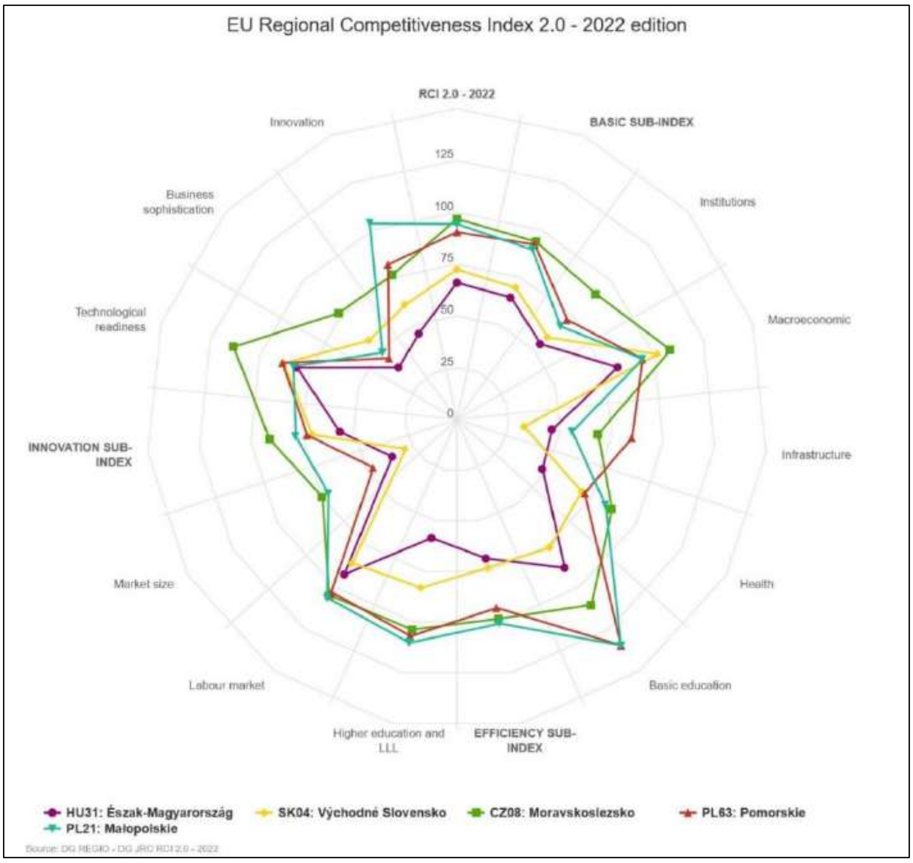


Source: Regional Competitiveness Index (2022)

In terms of GDP per capita at purchasing power parity, of the regions included in the study, only the capital regions are above the EU average, the others are below 75% of the EU average.

When comparing the Northern Hungary region with the city regions of Ostrava, Košice, Krakow and Bialystok, the performance of the home region is below the others in almost all but one or two pillars.

Figure 2: Main components of the Regional Competitiveness Index of the North Hungary region in a regional comparison (2022)



Source: Regional Competitiveness Index (2022)

Further results of the EU Regional Competitiveness Index show that there are still large differences between EU regions (the North-South, East-West divide is still very much in evidence), although less developed regions have also improved their competitiveness compared to previous years. In almost all Member States, with a few exceptions, metropolitan regions stand out significantly.

The **Northern Hungary region has a** significant industrial heritage, having been a centre of the iron and steel industry before the change of regime. Northern Hungary was the biggest loser of the regime change, with the collapse of the heavy industry and agriculture hitting the region the hardest. Its GDP used to exceed the national average, but is now less than two-thirds of the national average. With a GDP per capita of HUF 3,936,000 (~EUR 10,906), it is one of the poorest regions in the European Union, with a GDP per capita at purchasing power parity (PPP) of 52% of the EU average, while GDP per capita at market prices is only 34% of the EU average (Eurostat 2022). After the socio-economic shock of regime change, manufacturing and services became dominant. However, the rural areas of the region are characterised by a fragmented settlement structure, with agriculture remaining the only source of livelihood in many settlements.

In Miskolc, the last 10-15 years have seen a clear **change in the economic structure**, with an increase in the number of registered business organisations, most of which are individual, micro and small enterprises. The distribution of local enterprises by economic sector shows that the weight of construction and retail trade has decreased in recent years. Of the top 10 companies with the highest turnover in the city, the top five are four mechanical engineering companies (Robert Bosch Energy and

Body Systems and Robert Bosch Power Tool Kft., Joyson Safety System Hungaria Kft. and Starters Automotive Hungary Kft.) and one utility company (MVM ÉMÁSZ Hálózati Kft.).

Looking at the structure of the exporting sectors, it is also clear that the machinery industry plays a central role, and the concentration of Miskolc's economy is clearly visible, as the machinery industry accounts for 83% of export turnover in the county seat of Borsod, and the city's concentrated industrial structure has made it highly vulnerable to crises, especially when the most important sector is directly linked to vehicle production.

Through the **University of Miskolc,** the city is a **major R&D&I centre in the region**, cluster cooperation related to the key sectors (chemicals, automotive, mechanical engineering, IT) helps economic growth, and it is important to further strengthen dual training. The further strengthening of the **IT sector** in the municipality **could be a starting point for the creation of high added value jobs**.

Transport

Miskolc is an important logistical hub on the Via Carpatia road and rail transport corridor linking Europe's northern and southern borders. The city is located at the intersection of the main transport corridors of Central Europe and thus plays an **important role in the region's transport**.

The city's road network, formed by a hierarchical structure of primary and secondary arterial roads, collector roads and secondary roads, is essentially an offset cross-shape, with a ring structure and few circular elements.

The length of the road network of the City of Miskolc with County Rights is 527 km. The total length of state roads in the administrative area is 42 km, which is maintained by the Hungarian Public Road Nonprofit Zrt.

Road infrastructure developments in recent decades have sought to reduce urban transit traffic. This arterial road network should carry some of the transit traffic, pendulum traffic as well as local traffic. Road congestion in the city centre is one of the biggest problems in road transport.

With a combination of multi-motivated traffic, the access sections of trunk roads are congested, inland areas are under capacity, causing congestion and consequently increasing environmental pressures (mainly air pollution along the trunk road network), and further deterioration is expected in the absence of intervention.

The public transport network of the city of Miskolc adapts to the structure of the city, so more than half of the passengers travel along the two axes (North-South and East-West). The shopping centres are located along the east-west axis (at the eastern end of the city); slightly south of this is the city's main passenger railway station, the Tisza Station.

The public transport network, based on the socialist metropolitan system, needs a major overhaul. There is a need to improve the tramway network on the north-south axis, and to connect Búza Square and possibly Gömöri Station to the network. The bus network should be adapted to the tram lines. It is important to create competitive public transport corridors that are independent of other motor traffic.

A more detailed analysis of the transport sector (as a major emitting sector) is presented in the individual chapters.

Public utilities

A major problem in the town is the **deteriorated technical condition of the** existing **basic utility networks and in two parts of the city (Martinkertváros, Miskolc-Szirma) the drainage of rainwater is not solved**. Currently, the length of the public drinking water network is 685.44 km, and due to its age and technical condition, it is in need of continuous renewal.

The city's water supply is mainly based on the karst waters of the Bükk Mountains. Water from 8 water production plants is stored in 47 drinking water reservoirs with a capacity of 29,505 m3. The average daily water consumption of the city in 2021 was 42,000 m^3, with a peak daily demand of nearly 49,000 m^3. Almost all residential buildings are supplied with piped drinking water (99%). However, the network water loss is significant, estimated at 44-45%.

In Miskolc, there are 7 thermal wells, of which 3 are currently out of operation. The Miskolctapolca Thermal Spring provides thermal water for the Miskolctapolca Cave Bath and the Miskolctapolca Adventure Bath and is a reserve drinking water source. The thermal wells of the Selyemréti Outdoor Baths supply the Selyemréti Outdoor Baths. The Fonoda Street thermal well supplies heating and drinking water for the central office building of MIVÍZ Ltd.

The heat production and heat supply activities of MIHŐ Miskolci Hőszolgáltató Kft. cover the administrative territory of Miskolc, providing district heating and hot water services for 32 thousand residential and nearly a thousand other public users. The proportion of residential properties connected to the district heating system is 42%. The **age of the equipment owned by the heating company is very high, averaging over 30 years, while the average age of the network is unfortunately even higher, over 40 years.**

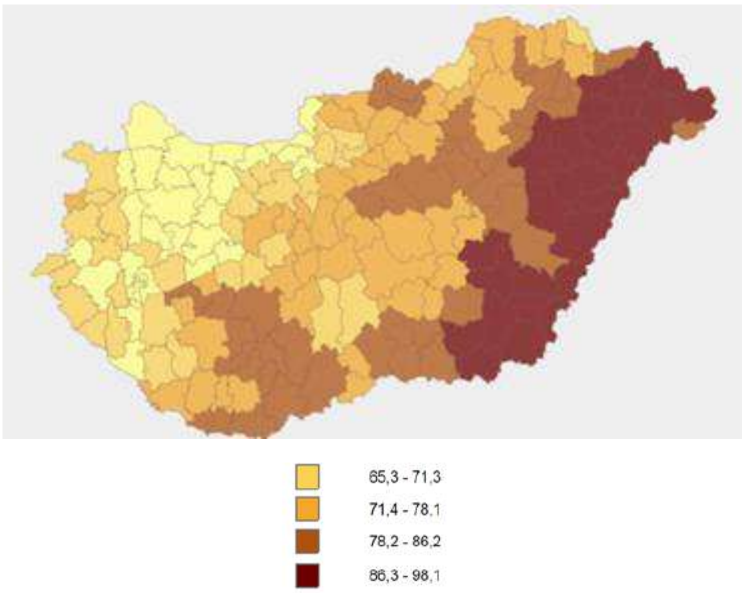
The electricity supply and distribution network of Miskolc is operated by MVM Émász Áramhálózati Kft. The city's street lighting is provided by around 21,700 energy-saving luminaires; the passive and active elements of the street lighting network are in mixed ownership. Of the passive elements, the cables and poles are owned by ÉMÁSZ Nyrt.; the active elements (luminaires) are also mixed ownership.

The gas supplier in the administrative territory of the city of Miskolc is NKM Földgázszolgáltató Zrt. In Miskolc, the gas pipeline network is 708 km long, with a 100% completion rate.

Adapting to climate change

In terms of adaptation to climate change, a key factor is that Miskolc is exposed to a continuous increase in temperature and annual sunshine, with warming accompanied by more frequent temperature extremes, fewer frosty days, more hot days and longer periods of dry, hot weather.

Figure 3: Exposure - Frequency of heatwave days, 2021-2050



Source: Miskolc City Climate Strategy 2020, NATér (https://map.mbfsz.gov.hu/nater/)

A sharp increase in heat is a high risk factor for agriculture, environment and diversity, health, energy, transport and water management, and its impacts need to be mitigated in all sectors concerned. Based on current climate models, the frequency of heatwave days in the city region will increase by 71.4% to

78.1% between 2021 and 2050. During prolonged heat waves, mortality among vulnerable population groups will increase, with a very high average annual excess mortality of 166.3 - 182.0%/year.

Increasing the size and extent of green spaces is a key priority for cooling the city, because it increases the size of evaporative surfaces. The city's green and blue infrastructure is a natural resource in mitigating the effects of climate change. Green space coverage is high, but the network is fragmented in many places and the condition of green spaces and green areas needs to be improved and their extent can be further increased. There are many developments in this direction, and they are increasingly being consciously implemented, and their effectiveness can be further enhanced by adopting international best practices.

The natural ecosystems in the area of the Bükk National Park bordering the city are considered to be in a good condition with little disturbance, while in the city area they are in a poor condition, especially in the ruderal, poorly managed areas, giving room for invasive species. Control of invasive species is needed along the Stream Szinva and the River Sajó and in disturbed areas where large areas of construction debris are present. Ecosystem services are only to a lesser extent in inland areas. The Szinva streambed has been revegetated at several points, the former cover has been removed and the total bed encroachment has been reduced.

The streams Szinva and Hejő flowing through the city are clean and in good ecological condition. The River Sajó has a 12.5 km long course. The largest lakes in the municipality are Lake Hámori and Lake Csorba. Natural water retention solutions are not common in the city, although there is a need and potential for them.

Pollution prevention and reduction

Miskolc's air quality is improving, with particulate matter (PM10; PM2.5) being the only problem in winter. The most significant source of air pollution in the city is residential heating, with many households using unfavorable fuel mix. Residential open-air burning of waste and fallen leaves is a major source of conflict, and the municipality has launched a campaign against it. Airborne particulate matter is very high at certain times of the year. The number of exceedances of the health limit values is significant, especially in the areas of Búza Square and Martinkertváros part of the city. At the same time, the level and duration of PM10 pollution is decreasing and has been below the limit value in recent years. Serious health problems are caused by pollen spraying from allergenic plants (e.g. ragweed), which is expected to increase due to climate change.

In 2022, in the HungAIRy LIFE integrated project, the Municipality of Miskolc and the University of Miskolc installed measuring units in more than sixty locations across the city. The sensors installed in the measuring units measure the amount of solid particles - colloquially known as particulate matter - in the air. Up-to-date pollution information is available free of charge on the website pmmonitoring.hu and in the PMMONITORING app.

Noise and vibration from traffic is particularly high along the main roads 3 and 26, but inland roads are also congested during the day. Traffic management measures are already in place to reduce these impacts. Industrial areas have little impact on residential areas and noise pollution is low.

Soil contamination is severe in the old industrial sites of DAM, "Slag Pile" and DIGÉP, where particularly high concentrations of heavy metal slags, cadmium, arsenic, lead and zinc are present. Other sources of soil pollution are traffic and illegal dumping of municipal waste.

In terms of pollution emissions, modern industrial plants in the city's industrial parks comply with emission limits and are considered to be low emitting.

GHG emissions of the city of Miskolc

In Miskolc, as in the country as a whole, five sectors are responsible for greenhouse gas emissions: energy production and management (including buildings), industrial production, transport, waste management and agriculture. The natural carbon sink capacity (a collective term for land use, land use change and forestry) to offset emissions was also examined.

In the case of the city of Miskolc, the building sector is the largest emitting segment, followed by the transport sector. The waste management sector is in line with the national average and the agricultural sector has much lower emissions than the national average. **Total urban emissions are 588,034 tCO_{2e} , with annual emissions per capita of 3.9 tCO_{2e} .**

Table I-1.1: Climate Neutrality Target by 2030 (kton CO)$_{2e}$			
Sectors	**Scope 1**	**Scope 2**	**Scope 3**
Stationary energy	33	19	-
Transport	37	1	-
Waste/wastewater	-	-	5
IPPU	8	-	-
AFOLU	-	-	-
Other	-	-	-
Geographical boundary	**Same as city administrative boundary**	**Smaller than city administrative boundary**	**Larger than city administrative boundary**
	x	Scope 2 emissions from final energy purchases, indirect emissions from electricity	x
Specify excluded/additional areas	not relevant	not relevant	not relevant
Map			
Attached as an annex.			

The overall reduction of 470 kt CO_{2e} from the total emissions (588 kt CO_{2e}) is needed to reach the 80.1% target. Using the calculations of the NetZero Economic model, taking into account current trends (Business as Usual 2030), emissions of 516 kt CO_{2e} need to be reduced by 80%, as the model assumes that some reduction would occur even without the measures in the Action Plan, but only the difference is taken into account. Accordingly, the interventions have been defined in terms of 516 kt CO_{2e} and the Investment Plan will use this as a baseline. The 2030 reduction target based on the model is 412 kton CO_{2e}, after savings of 103 kton CO_{2e} is the residual. The distribution of this residual is shown in the table above.

The emission segments and their detailed data series are presented in chapter 2.1.

2 Part A - Current State of Climate Action

2.1 Module A-1 Greenhouse Gas Emissions Baseline Inventory

In order to reach the 80% decarbonisation target for 2030 for climate neutrality, the city intends to address all greenhouse gases (GHGs) and sectors in the iterative process to be implemented, and to increasingly define the data on them. Taking into account the data currently available, the 2021 GHG inventory considers the emissions of three GHGs: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The GHG inventory covers the entire administrative boundary of the city.

Mandatory GHG emission areas to be assessed according to the Cities Mission's definition of climate neutrality:

1. Direct GHG emissions within the city boundary (Scope 1) from stationary energy use (buildings/facilities/equipment), transport, waste/wastewater disposal and treatment, industrial processes and product use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU).
2. Indirect GHG emissions within the city boundary (Scope 2) from electricity consumption supplied from the grid and heating/cooling energy consumption supplied from the district heating network.
3. GHG emissions outside the city boundary (Scope 3) resulting from the disposal and treatment of waste/wastewater generated.

In cases where the building sector is included as a separate category, be it consumption or emission, the gas and electricity consumption (and the corresponding emission) related to industrial production (manufacturing only, machinery, construction, industrial heating, waste water treatment) is reported in the IPPU category.

Miskolc's industrial structure is highly concentrated, with 80% of its industry based on mechanical engineering, a highly energy-intensive sector. The inventory has taken into account that the electricity and natural gas consumed by industry is almost entirely related to manufacturing and production processes, with a much smaller share of consumption in the classical sense in buildings. For the industrial segment, therefore, the phasing out of fossil fuels is essentially not possible through building energy interventions, but through technology changes in the manufacturing processes and the use of local renewable energy sources. The growth in electricity use is driven by the expansion of industrial activity, which is significant (around 1.5% per year on average) and is unlikely to slow down in the near future, but will change in structure with the decarbonisation of transport and heating and the associated electrification. This is why it is also worth looking separately at the amount of energy used by industry in Miskolc and its GHG emissions. Accordingly, it is considered necessary to treat it separately from the building sector. This will be indicated in the data series in all relevant cases.

In the cases where the energy system as a whole is considered (Table I-1.1: Climate Neutrality Target by 2030), the energy systems include the consumption and emissions of energy used by industry. In this case, no emissions have been identified for the IPPU, as there is no industry (e.g. cement production, glass production) operating in the city to justify this.

A-1.1: Final energy use by source sectors				
Base year				
Unit	MWh/year			
	Scope 1	Scope 2	Scope 3	Total
Buildings	**1 076 106**	**584 810**		**1 660 916**
electricity		283 883		
natural gas	811 296			
district heating		300 927		
firewood and coal	264 810			
Transport	**731 964**	**8 158**		**740 122**
public transport - diesel	22 725			
public transport - electricity		8 158		
public transport - CNG	28 350			
private transport - diesel	116 956			
private transport - petrol	290 389			
Transport/freight transport- diesel	270 013			
Transport/ freight transport- petrol	3 532			
Waste*				
Industrial Process and Product Use (IPPU)**	**334 634**	**222 282**		**556 916**
electricity		222 282		
natural gas	120 700			
district heating (gas used to generate heat)	213 934			
Agricultural, Forestry and Land Use (AFOLU)	**447**	**1 716**		**2 163**
electricity		1 716		
natural gas	447			

**Energy use for waste management is included in the transport and buildings sector data, emission values are given in Table A-1.4.*

*** IPPU includes the amount of gas and electricity used in industrial processes*

A-1.2: Emission factors applied

In the case of electricity generation, the specific CO_2 emissions of electricity generation in Hungary based on the national energy mix were used in the calculations.

Emission factors are calculated values per MWh energy content

Methodologies used: association of mayors, IPCC, Ember-Climate

Primary energy/ energy source	Carbon Dioxide (CO_2)	Methane (CH_4)
electricity	0.236 tCO_{2e}/MWh	
natural gas	0.202 tCO_{2e}/MWh	
diesel	0.267 tCO_{2e}/MWh (0.01096 MWh/l)	
petrol	0.249 tCO_{2e}/MWh (0.00961 MWh/l)	
biomass	0.007 tCO_{2e}/MWh	
landfill	0.337 tCO_{2e}/MWh	0.05 tCH_4*
Forest	-12 tCO_{2e}/year/ha	
green space	-9 tCO_{2e}/year/ha	

**1CO_2 = 21 CH_4 ; one methane molecule is equivalent to 21 carbon dioxide molecules.*

A-1.3: GHG emissions by source sectors				
GHG emissions based on the use of electricity, fossil fuels and district heating energy, and consumption and use data provided by each supplier, using the emission factors provided (Table A 1.2).				
Base year	2021			
Unit	**CO_2 equivalent/year**			
	Scope 1	Scope 2	Scope 3	Total
Buildings	169 335	67 077		236 412
Transport	188 339	1 925		190 264
Waste	9 167		33 781	42 948
Industrial Process and Product Use (IPPU)*	67 596	47 809		115 405
Agricultural, Forestry and Land Use (AFOLU)	2 600	405		3 005
Total	437 037	117 216	33 781	588 034
* *IPPU includes the amount of gas and electricity used in industrial processes*				

A-1.4: Activity by source sectors			
Buildings: consumption data based on the Hungarian Energy and Public Utility Regulatory Office (MEKH) and the Hungarian Central Statistical Office (KSH), as well as data provided by the local district heating provider (MIHŐ Kft.). Transport: based on data provided by the Ministry of Interior, Hungarian Public Roads, KSH, Miskolc Transport Company (MVK), Hungarian State Railways (MÁV Zrt.) and Volánbusz. Waste: based on data provided by KSH, local service provider (MiReHu Nkft.). Industry and agriculture: consumption data based on data from MEKH and KSH.			
MWh/year		Base year: 2021	
	Scope 1	Scope 2	Scope 3
Sector: Buildings	**1 076 106**	**584 810**	
Residential buildings	791 834	375 303	
Commercial buildings	170 539	132 681	
Institutional buildings	113 734	76 826	
Sector: Transport	**731 964**	**8 158**	
Community transport	51 075	8 158	
Individual transport	680 890		
Sector: Waste*			
Solid waste management			
Waste water treatment			
Sector: Industrial Process and Product Use (IPPU)**	**334 634**	**222 282**	
Sector: Agricultural, Forestry and Land Use (AFOLU)	**447**	**1 716**	
*Energy use for waste management is included in the transport and buildings sector data, emission values are given in Table A-1.4. ** *IPPU includes the amount of gas and electricity used in industrial processes*			

Graphics and charts

Figure 4: Miskolc aggregated GHG inventory by sector

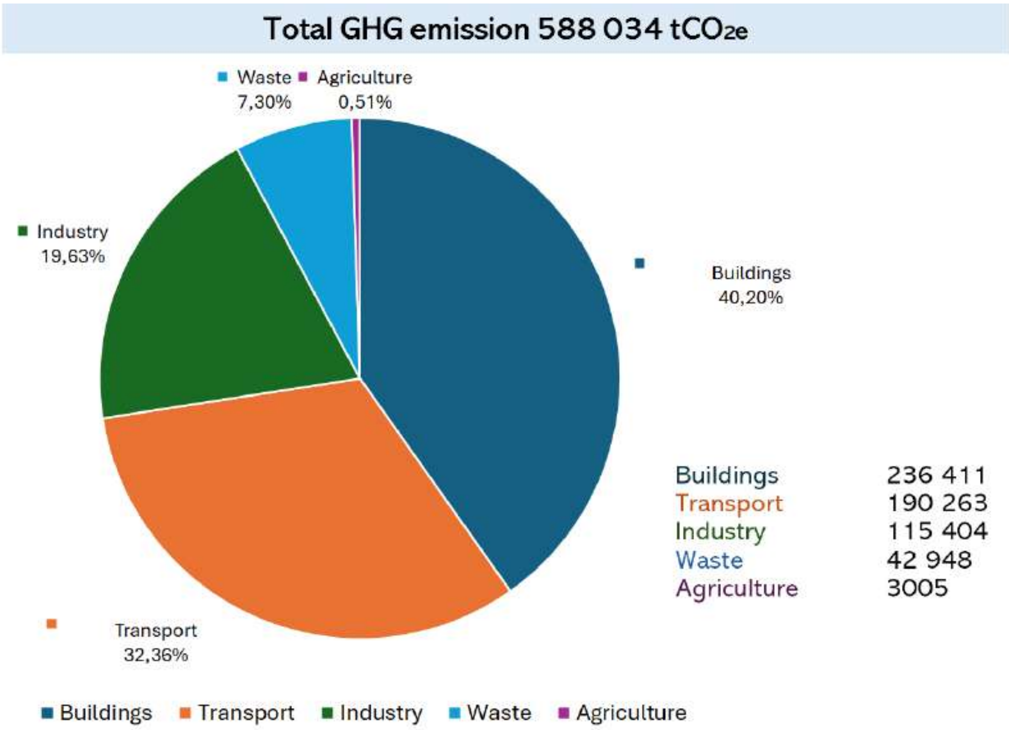


Figure 5: Miskolc aggregated GHG inventory by SCOPE 1-2-3

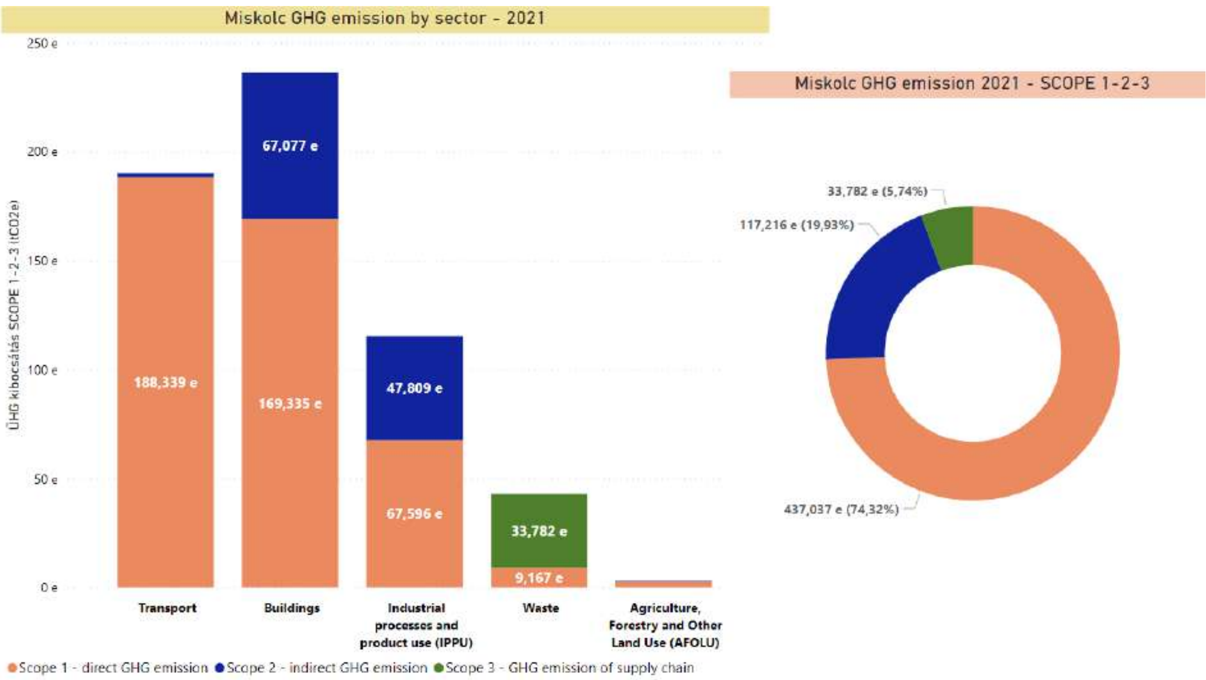
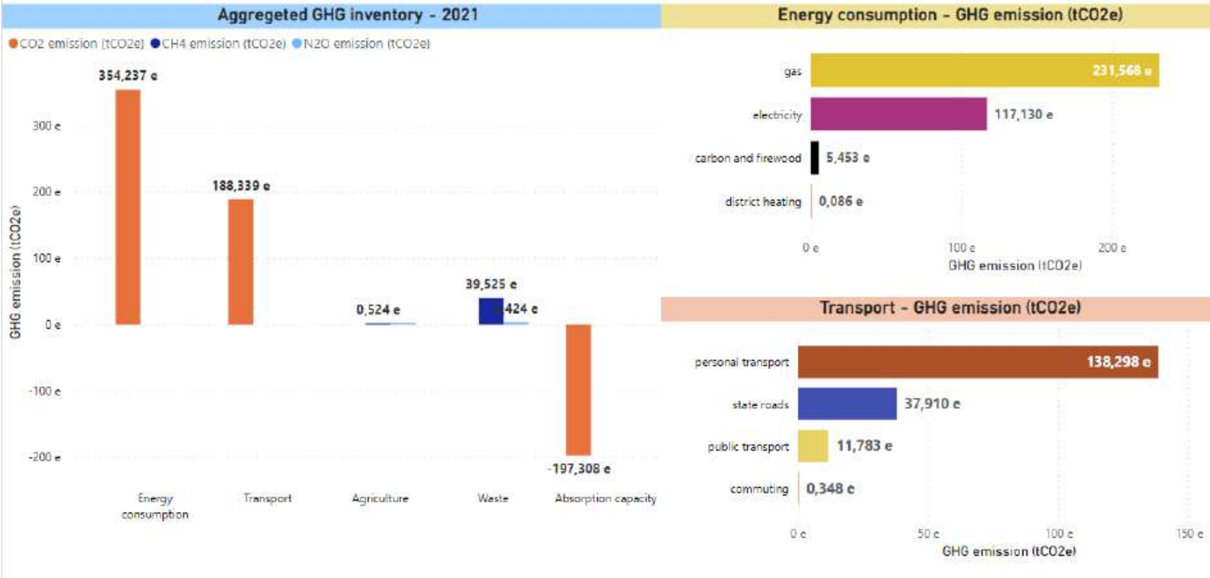


Figure 6: Miskolc aggregated GHG inventory by sector



In the case of the city of Miskolc, the largest emission segment is the building sector, followed by the transport sector and then energy use related to industrial processes. Waste management is in line with the national average, and the agricultural sector has much lower emissions than the national average.

Total urban emissions are 588,034 tCO_{2e}, with annual emissions per capita of 3.9 tCO_{2e} .

Description and assessment of GHG baseline inventory

Country outlook

According to the National Clean Development Strategy (2020-2050), the energy sector is by far the largest contributor to GHG emissions in terms of gross emissions by sector, accounting for 72% in 2018. However, the positive trend in the use of fossil fuels is that the share of coal has decreased from 30% to 10% over the last 30 years. By 2018, transport had become the largest emitter not only within the energy sector but also among all subsectors, accounting for 22% of Hungarian emissions. Road transport dominates transport emissions, which have increased by nearly 40% in the last five years.

Agriculture contributes 11% of total emissions and the waste sector 5.7%.

Emissions per capita were around 6.4 tCO_2 in 2020, below the EU average. Hungary's per capita emissions of around 6 tons are lower than the European average of over 8 tons per capita, largely due to low per capita energy consumption and the dominance of nuclear and relatively low specific emissions of natural gas in energy production.
The situation is less positive for GHG emissions as a share of GDP: Hungary is a larger emitter than the EU average (as are other Eastern European countries), while the Scandinavian countries or France are much further ahead.

Basis for the greenhouse gas inventory

The greenhouse gas inventory, like the carbon footprint, expresses in tons of carbon dioxide equivalent how much greenhouse gas the city has directly and indirectly emitted into the air for a given inventory year. According to the calculation model, the emissions were examined for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). According to the Intergovernmental Panel on Climate Change (IPCC), the emission factors identified for impact are:

- the value of carbon dioxide is taken as a base unit (1),
- the greenhouse gas factor of methane is twenty-one times that of carbon dioxide (21),
- nitrous oxide has a greenhouse gas factor of three hundred and ten times that of carbon dioxide (310),

Data retrieval

For some of the regional levels and for the emitting sectors studied, we worked with published data, but it was also necessary to obtain data that are not publicly available. In preparing the Action Plan, data published by the Hungarian Central Statistical Office (KSH) were retrieved, and KSH was contacted to obtain other unpublished data and to discuss methodological issues. In addition, the GHG inventory also required data obtained through direct contacts with the industrial companies, public service providers and member companies of Miskolc Holding Zrt. The Hungarian Energy and Public Utilities Regulatory Office (MEKH) was contacted separately in order to map detailed (sectoral) consumption data.
The aggregation of the data received also clarified the discrepancies between the data published by the HCSO and the detailed data requested by the target, so that there are sectors (e.g. energy management - electricity consumption data supplied to the city) where the data provided by the specialised institution/service provider responsible for the area were used instead of the data published by the HCSO. These are shown separately in the analysis.

Sectors assessed in terms of consumption and emissions

In Miskolc, as in the country as a whole, five sectors are responsible for greenhouse gas emissions: energy production and management (including buildings), industrial production, transport, waste management and agriculture. The natural carbon sink capacity (a collective term for land use, land use change and forestry) to offset emissions was also examined.

1. Energy management, energy consumption
    a. electricity
    b. natural gas
    c. district heating
    d. domestic firewood

2. Large industrial consumers

3. Transport
    a. Local urban public transport (MVK Zrt.)
    b. Local urban long-distance transport (bus)
    c. Local urban rail passenger transport (MÁV)
    d. Car traffic on individual municipal roads
    e. HGV traffic on individual municipal roads
    f. Individual public roads affected by car traffic
    g. Individual public roads affected by lorry traffic

4. Waste management, waste water treatment

5. Agriculture

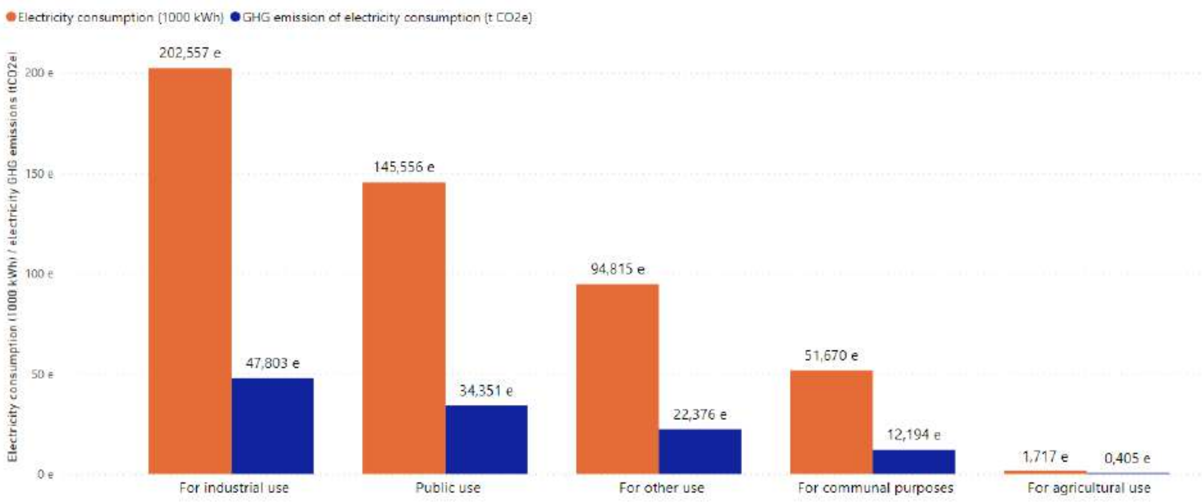
6. Urban absorption capacity

A detailed GHG inventory analysis is part of a separate study, and the main indicators and findings are presented in this chapter for 2 sectors - energy (including electricity and natural gas) and transport.

Energy management - electricity

Statement of electricity consumption (broken down by HCSO categories, based on MEKH data.)

Figure 7: Electricity consumption and related GHG emissions in Miskolc - 2021



Source: HCSO and MEKH

In terms of the electricity consumed by each sector and the associated CO_2 emission value, the use of electricity for industrial purposes is the most significant in the city.

Electricity supplied for industrial purposes is 202 560 MWh, with emissions of 47.8 thousand tons of CO_{2e} , total urban electricity consumption in 2021 is 497 151 MWh, with emissions of 117 130 tCO_{2e}.

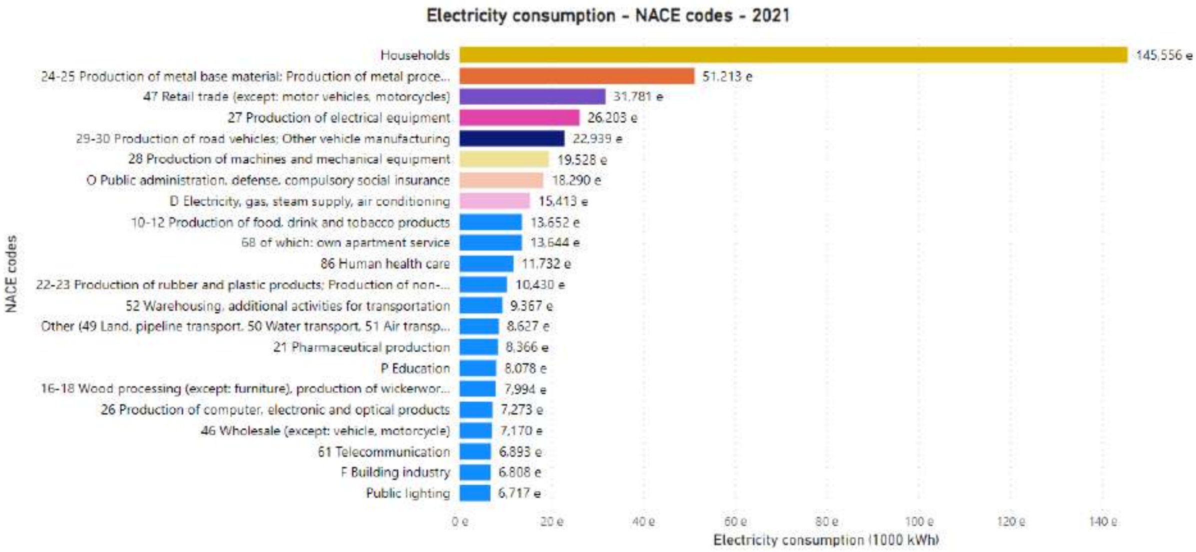
Based on the value of electricity supplied to households, the per capita electricity consumption is 998 KWh/capita, compared to 804 KWh/capita in 2017 in the previous SECAP (the population forecast for 2017 at the time of data collection was used, which was probably already lower, so the per capita consumption may have been higher in 2017)
If we look at households only from the consumption side, there has been a steady increase since 2017, but from this perspective, especially 2020 (and partly 2021) should be treated with caution due to COVID.

Table 7: Electricity supplied to households

	2017	2018	2019	2020	2021
Electricity supplied to households (1000 kWh)	128 891	131 631	131 150	140 496	145 557

Source: KSH

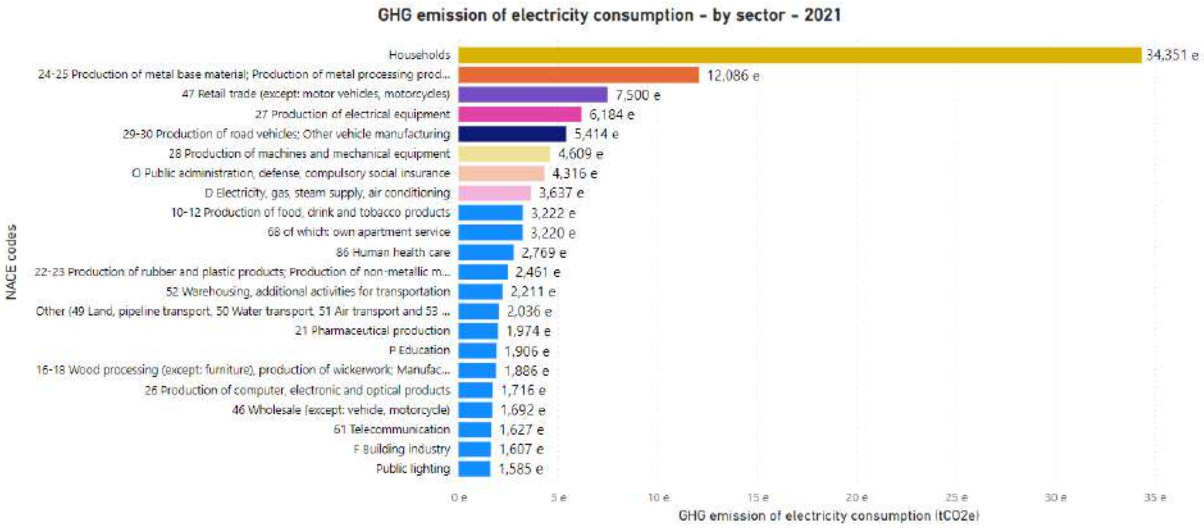
Figure 8: Electricity consumption by sector in Miskolc - 2021



Source: MEKH

If we look at the sectors by sector, the largest consumers are households (145 557 MWh). However, apart from the sectoral breakdown, it can be seen that overall, industrial consumers (mainly mechanical engineering sectors) consumed a larger amount on an annual basis (202 557 MWh). The total consumption of other consumers (service sector) is 94 815 MWh, and the electricity consumed by municipal consumers (44 952 MWh) is about one third of household consumption.

Figure 9: Electricity GHG emissions by sector in Miskolc - 2021



Source: MEKH

The CO_2 emissions of each sector can be measured according to consumption, and the potential for savings is mainly in the replacement of industrial and household consumption with green electricity, while electrification processes make it unrealistic to expect a drop in consumption.

Energy management - Natural gas

An analysis of gas consumption data over the last 5 years shows that the distribution between sectors is rather uneven. The annual gas consumption for residential buildings has varied between 32-38% over the last 5 years, while the consumption of the electricity, gas and steam supply sector (which includes gas supplied to district heating) has varied between 20-28%.

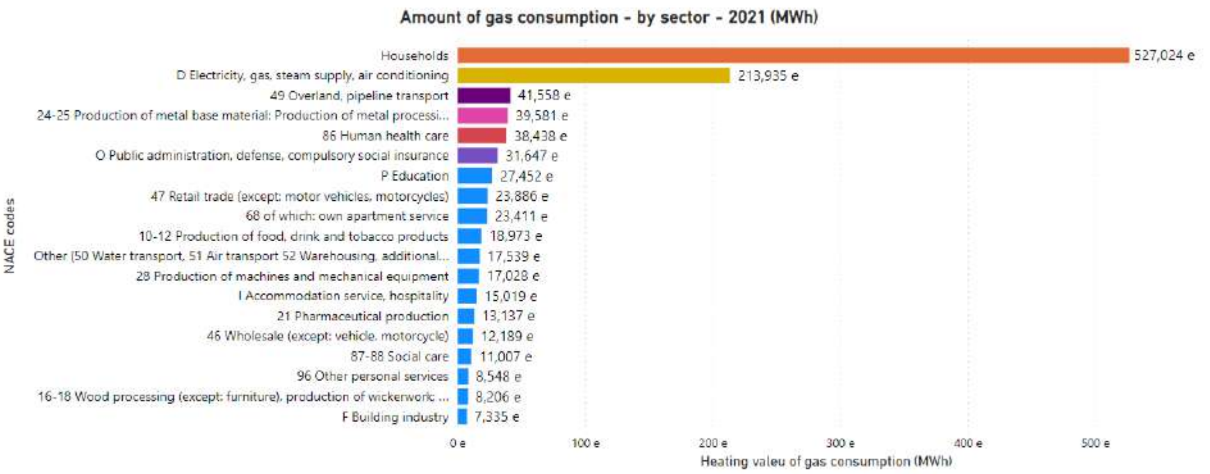
Figure 10: Annual consumption of natural gas by HCSO category - 2021

Source: KSH

The gas consumption of the electricity, gas and steam supply sector also needs to be examined separately. According to the relevant data provided by the MHŐ, in 2021, 770 174 GJ of the total heat energy produced was generated from fossil sources (including own boilers and fossil-based heat energy purchased from MVM MIFÜ and MVM Balance), which is 22.480.000 m3 of gas consumption (calculated at 34,26 MJ/m3 energy content). Based on these figures, the remaining amount was used by MVM MIFÜ Ltd. and MVM Balance Zrt. for electricity generation (this amount is no longer included in the urban GHG inventory due to ETS).

For the year 2021, a detailed set of data on gas consumption has also been requested from MEKH and is presented below.

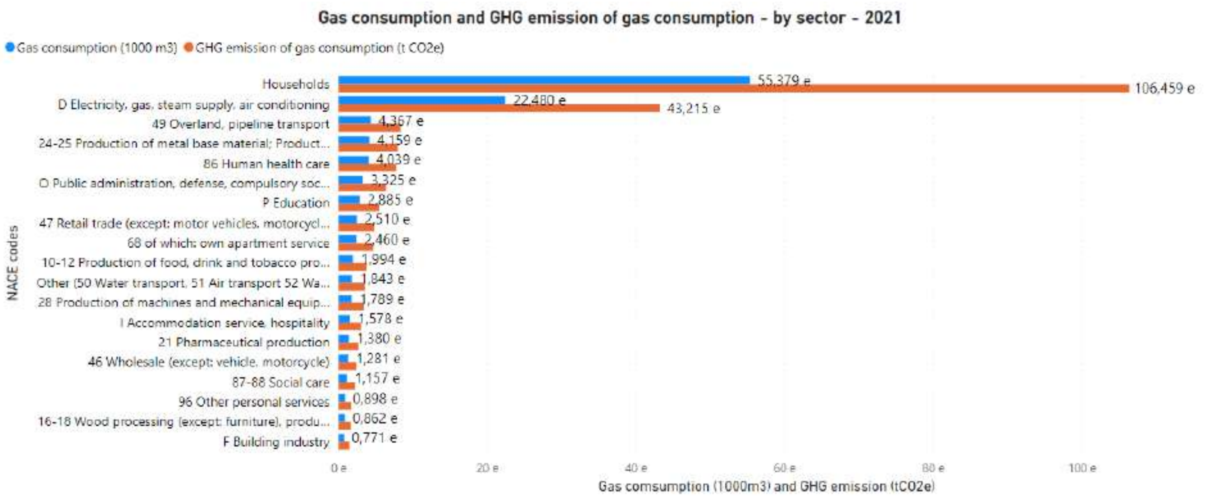
Figure 11: Energy content of natural gas consumed, broken down by TEÁOR - 2021



Source: MEKH

Since the residential sector, i.e. total household consumption (527 024 MWh) is almost equal to the annual gas consumption of all other sectors (619 360 MWh), no significant savings in gas consumption can be achieved without upgrading the residential stock. In contrast to electricity consumption, the consumption of natural gas by the industrial sector as a whole is much lower than the consumption for residential purposes, at around 24% overall.

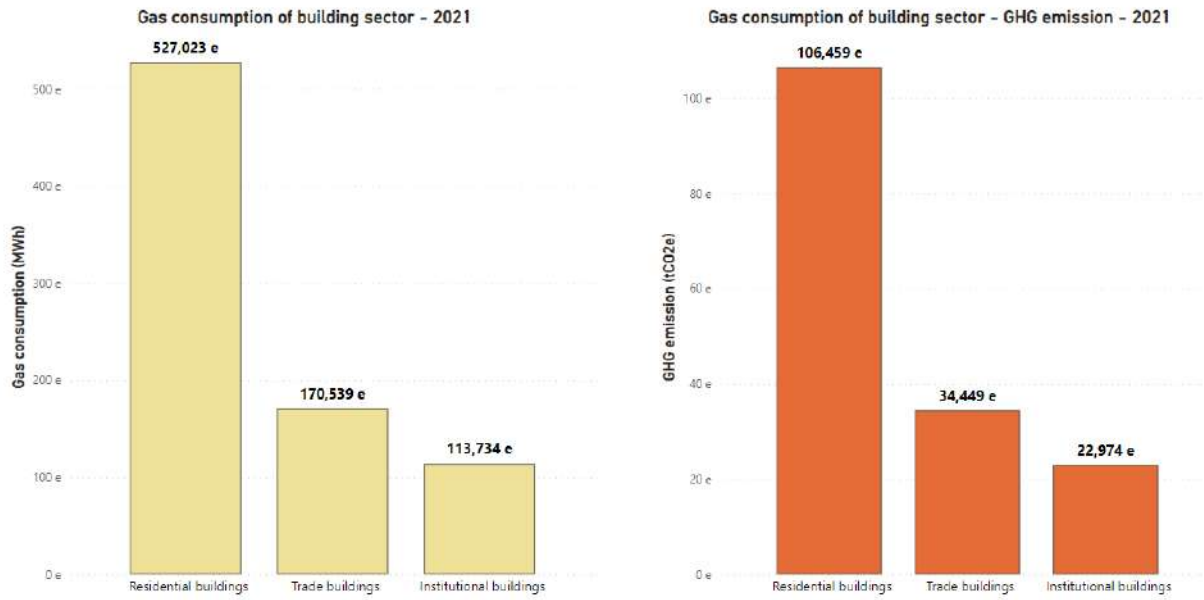
Figure 12: Annual natural gas consumption and GHG emissions by TEÁOR - 2021



Source: MEKH

GHG emissions from residential buildings for natural gas use are 106,459 tCO_{2e}, emissions from the total building sector are 163,881 tCO_{2e} , with residential buildings accounting for 65%. The most significant savings potential lies in a large reduction in household natural gas use.

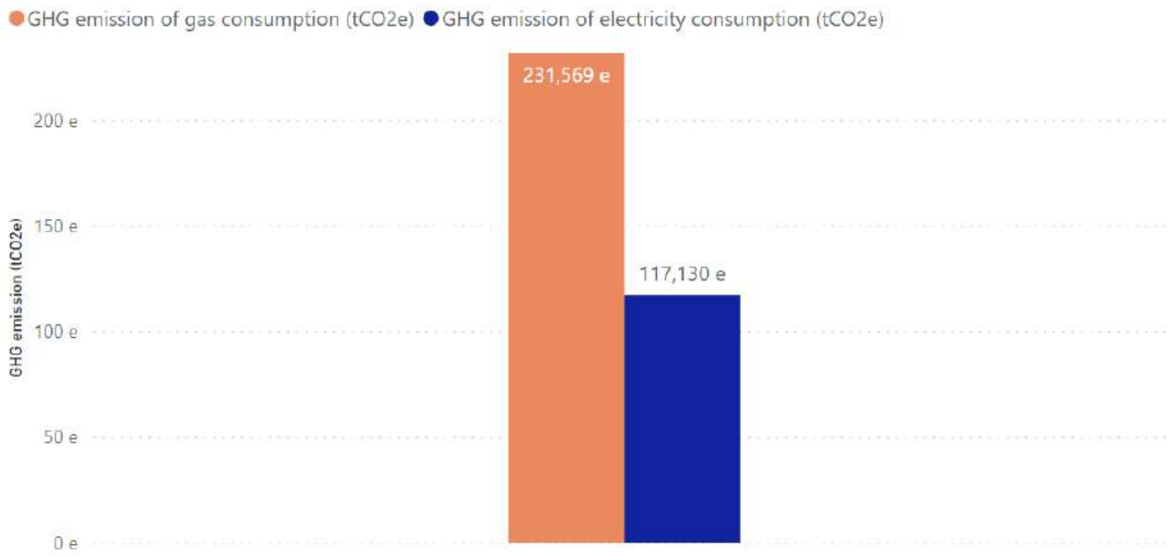
Figure 13: Building sector natural gas consumption and GHG emissions - 2021



Source: MEKH

Based on aggregated data, the GHG emissions from natural gas use are 231,569 tCO_{2e} , and 117,130 tCO_{2e} for electricity use.

Figure 14: Aggregated statement of GHG emissions from electricity and natural gas consumed at city level - 2021



Source: MEKH

The largest emission segment is the use of natural gas in cities, with GHG emissions from natural gas consumption being 2 times higher than from electricity consumption.

Transport

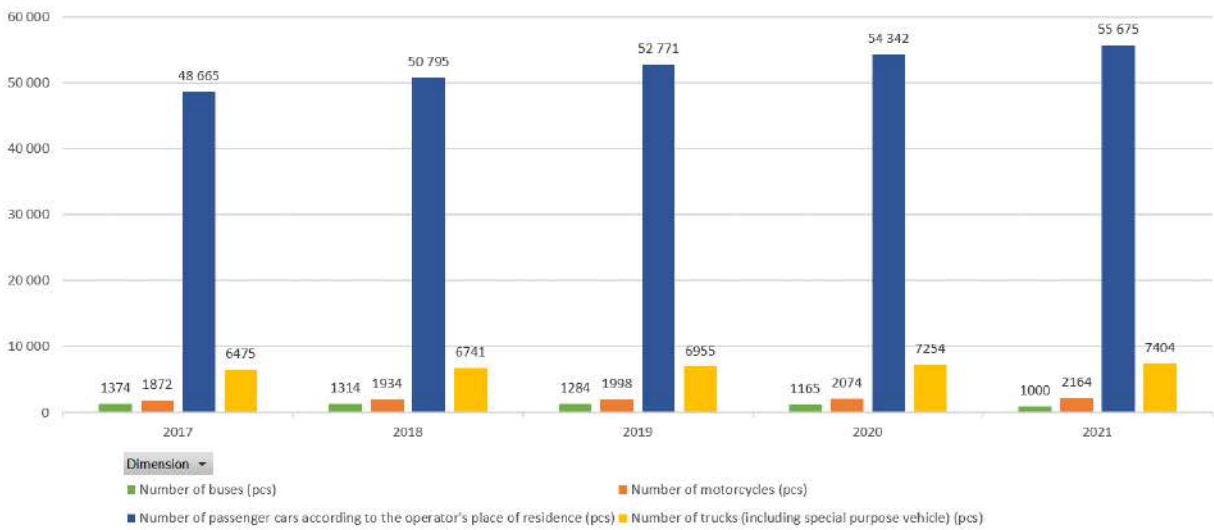
For most travellers today, travelling by private car by road seems to be the most fluid and seamless way of getting around - even for short distances. However, the increasing demand for transport and the growing number of cars in Miskolc, in line with economic development, are also causing serious environmental and sustainability problems, posing a major challenge to urban planners and operators. Therefore, one of the strategic challenges for cities in the near future, recognised both at EU level and in Hungary, is to influence (ultimately, reduce if possible) transport needs from a sustainable development perspective, and to shift transport to public transport, alternative modes of transport and/or environmentally friendly vehicles.

When examining GHG emissions from the transport sector, several segments were examined.

1. Individual car and lorry traffic on 527 km of municipal roads. The emissions data are calculated from the number of vehicles registered, mileage and the amount of fuel sold.
2. Individual car traffic and lorry traffic on 42 km of state-maintained roads (of which 37 km are inland roads). Emission data for this segment were derived from traffic counts on the given traffic segments of the Hungarian Roads.
3. Local public transport. Based on data and decarbonisation plans of MVK Zrt.
4. Long-distance public transport. Based on data provided by Volánbusz Zrt., using only the mileage within the administrative territory of the city.
5. MÁV passenger transport. Based on the data provided by MÁV Zrt., using only the mileage within the administrative territory of the city.
6. Commuter vehicle traffic emissions data derived from CSO data.

In Miskolc, the number of cars has been growing steadily despite the negative demographic trends of the last 10 years. Based on 2017 data from SECAP and the current base year 2021, 7,000 new vehicles were registered, an increase of 14.4% over 5 years.

Figure 15: Number of vehicles registered in Miskolc (2017-2021)

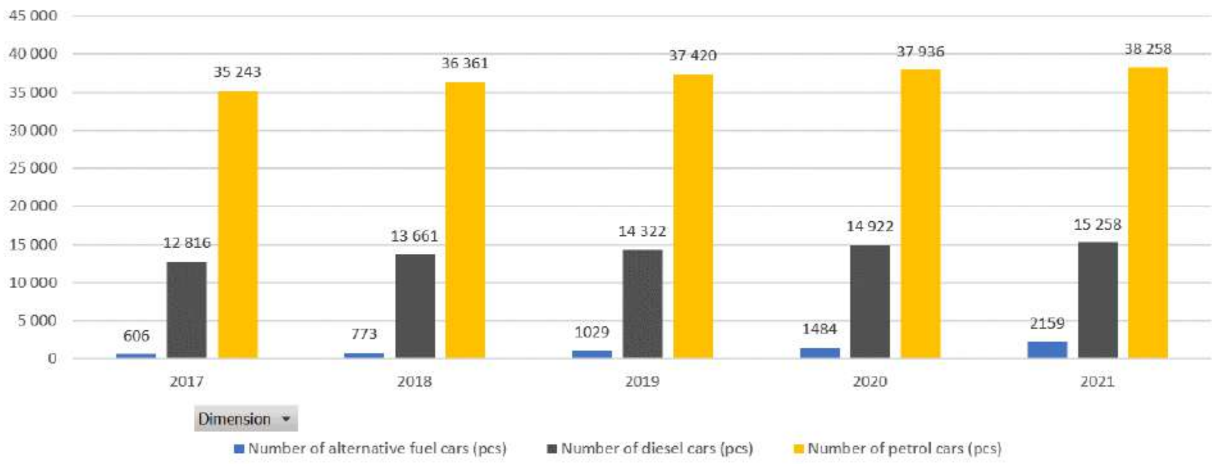


Source: BM/KSH - vehicle registration data

In 2021, 55,675 cars and 7,404 trucks were registered in the city. 68% of the passenger cars were petrol-powered, representing 38,258 cars, and a further 15,258 diesel-powered vehicles were registered, with no change in the proportions over the last 5 years. In 2021, 223 pure electric cars and

25 pure electric trucks were on the road, up from 19 and 3 registered in 2017, with a significant increase in electric cars, but still below 0.5%.

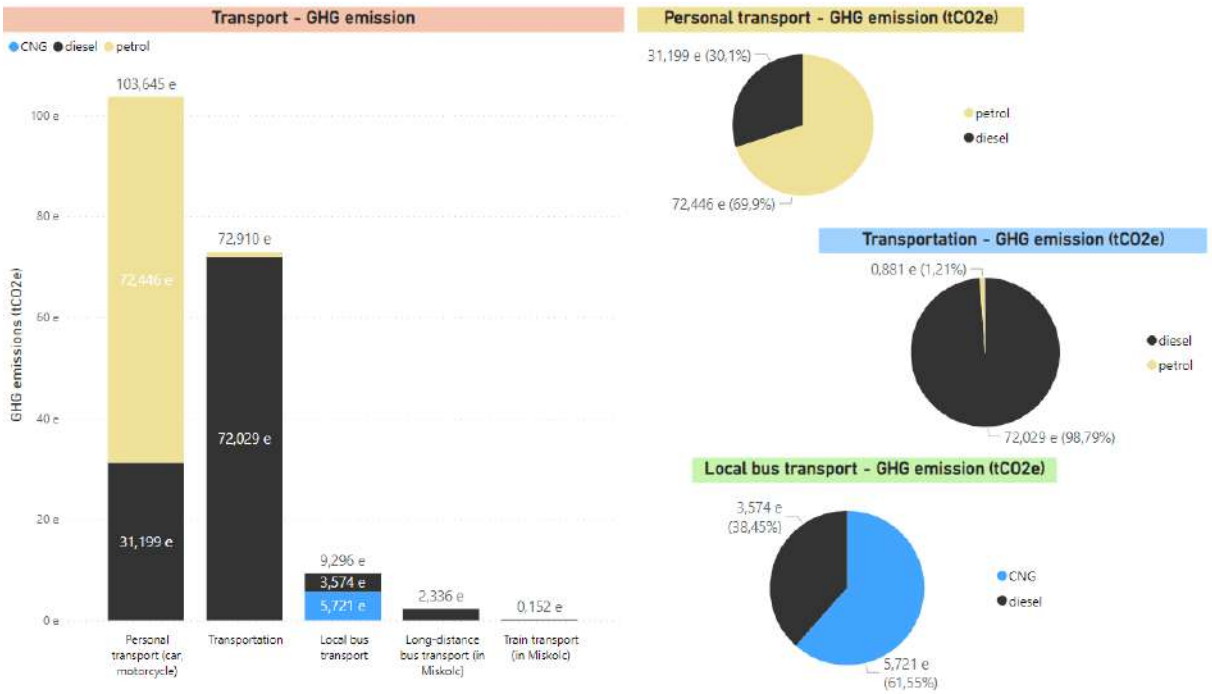
Figure 16: Stock of passenger cars in Miskolc (20217-2021)



Source:BM/ KSH - motor vehicle traffic data

The total emissions from the transport sector are 188 338 tCO_{2e} (including electricity consumed by trams 190 264 tCO_{2e}), which is 32% of total urban emissions. Transport and haulage in this segment is almost entirely carried out by diesel vehicles, while electrification of other modes of transport (private, public) is underway, but still lags far behind.

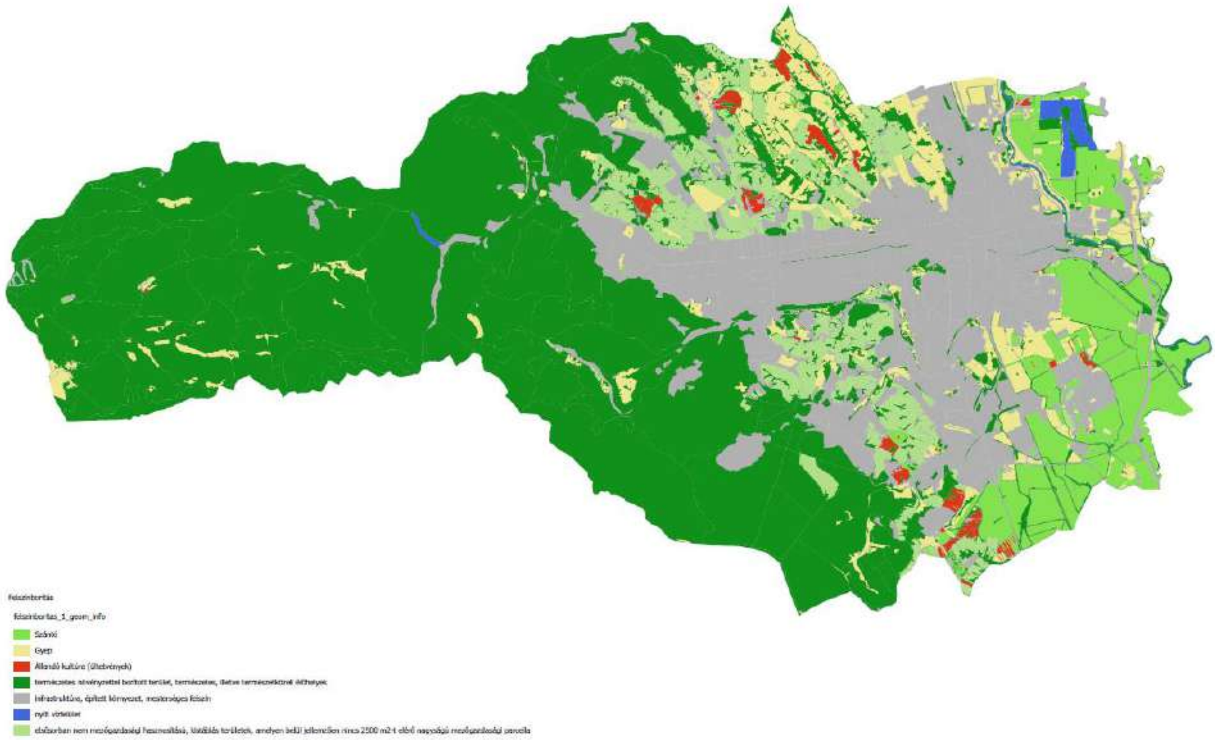
Figure 17: Total GHG emissions from the transport sector in 2021



Absorption capacity

Miskolc has a very good environmental location. The proximity of the Bükk Mountains provides the city with significant green space capital, but it cannot replace the role of green spaces within the city.

map 2: surface cover in the administrative area of Miskolc



Source: Lechner Knowledge Centre

Miskolc's green spaces are adequate, but their condition needs constant improvement due to the high use. For forests, green spaces, tree-lined areas, green strips, institutions with large green areas, the green coverage is 740.31 m^2 /person. The addition of water management areas increases the figure to 1166.07 m2 /person.

The value for public parks and gardens is 10.38 m^2 /person. This figure is corrected for the large garden zones, where each inhabitant has his own garden but very few public parks.

There is no precise data on the extent of biologically active surfaces. The proportion of biologically inactive surfaces is 8-16% of the municipality's area, reaching 30-40% in the interior. This is a very high value in itself, which is realistic at 50% when corrected for the area. Accordingly, the proportion of biologically active surfaces may be around 50%.

Municipal green area: 6.952 ha.

Miskolc has a negligible amount of inland forest compared to the size of the forest outside. The current ratio is about 3% (inland forest/land area), which is to be increased to about 7% in the current regulation plan, partly by including existing forests in the areas to be included in the inland area (e.g. Hejőcsaba), partly by providing for significant afforestation (Hejőcsaba, Görömböly), and partly by increasing the forest area in the current inland area (Diósgyőr, Sajó mente).

Size of the fortified areas in the administrative territory of Miskolc: 11.228 ha

In terms of GHG inventory, the municipality has a significant absorption capacity (-197,308 tCO_{2e}), but in terms of livability and quality of life, there is still much to be done in the inner city areas.

(The absorptive capacity calculation is based on the guidelines of the Ministry of Finance's Sustainable Urban Development Strategy Methodology Manual and the Climate Resilience Guidelines 2021-2027 published by the Prime Minister's Office. One newly planted tree has a CO_2 sequestration capacity of about 0.008 tCO_2/year/ tree (8 kilograms); 1 ha of afforested area has a CO_2 sequestration capacity of about 12 tCO_2/year/ha; 1 m2 of grassland has a CO_2 sequestration capacity of about 0.00163 tCO_2 /year/m^2; extensive green areas have a CO_2 sequestration capacity of about 9 tCO_2/year/ha)

2.2 Module A-2 Current Policies and Strategies Assessment

The policies at local level are summarised in the table below.

A-2.1: List of relevant policies, strategies & regulations					
Type	Level	Name & Title	Description	Relevance	Need for action
Action Plan	municipal	Sustainable Energy and Climate Action Plan (SECAP) 2019	The 2019 Action Plan reviewed the baseline situation, presented baseline inventories, took stock of CO_2 emission reduction measures, and included a climate risk and sensitivity analysis of the city. It also provided an overview of the financing options for the implementation of the action plan and made recommendations for monitoring and indicators. It also identified the actions and milestones for implementation and described the process for providing publicity.	The Action Plan identified specific CO_2 emission reduction measures in the following areas: buildings, installations and equipment; transport; energy production and land use. The SECAP GHG inventory revealed urban emissions in less depth than the 2021 GHG inventory for the CCC. It dealt comprehensively with energy systems and in many cases only covered the municipal scope. Due to lack of continuous review had limited input into the development of the CCC.	A review is needed. The coordination and monitoring of the implementation of the new SECAP needs to be clarified and human resources allocated to it.
Strategy	municipal	Climate Strategy of the City of Miskolc, 2020	Based on the situation analysis and assessment, the 2020 climate strategy set 5 mitigation objectives and 7 adaptation and	Mitigation measures set out in the strategy: Reducing energy consumption (energy	A review is needed. A single monitoring system is needed to

			preparedness objectives with 2030 targets. It proposed measures to achieve the targets and set out a framework for implementation.	saving), increasing energy efficiency Increasing the share of renewable energy sources Promoting sustainable/climate-friendly transport modes, improving air quality Reducing GHG emissions from the waste sector. It has also looked at expanding natural GHG sinks. The Climate Strategy GHG methodology and package of measures provided a good basis for the development of the CCC, but monitoring has not been implemented in recent years.	manage these strategies (SECAP, Climate Strategy, SUMP)
Plan	municipal	Miskolc Sustainable Mobility Plan (SUMP) Review, 2016	The document sets out the expectations for the transport sector, defines the vision, the 4 overarching objectives and the measures proposed to achieve them. The set of objectives is broken down by sector.	24 measures support new urban design, 19 measures support less energy use, 7 measures support continuous progress and 14 measures support networking. All of these have an emission reduction effect.	Under review.

				The planned measures in the transport area of the CCC have integrated measures planned but not yet implemented under the SUMP.	
Plan	municipal	Green Infrastructure Development and Maintenance Plan of Miskolc City of County Rights (ZIFFA), 2018	The plan identifies 8 main objectives: Designation of green zones Building a coherent green infrastructure system; Linking human transport routes and green infrastructure Providing urban ventilation; Increasing urban water surfaces; Alleviating clogging; Tailoring human functions to the green infrastructure strategy; Complex rehabilitation of brownfield sites	The implementation of the plan will help to increase the city's CO_2 absorbing capacity. By its nature, it is not designed with a GHG inventory approach, it indirectly helps to increase absorption capacity in the future, but it does not include specific targets.	A review is needed.
Strategy		Sustainable Urban Development Strategy 2021-2027 (2022)	It sets out 2 overarching objectives, 4 strategic objectives and 4 horizontal objectives along 5 planning dimensions (Prosperous City, Sustainable City, Serving City, Digital Transition, Green Transition).	As a sustainable urban development strategy, it has several sub-objectives towards CO_2 emissions, such as sustainable transport development, networked infrastructure development, sustainable energy supply, green and blue infrastructure development, energy renovation of buildings, sustainable waste management, public awareness, creation of	In 2024, a review is needed for the 2022 national census. A monitoring system for the indicators in the strategy is planned to be developed by the end of 2024, which will also be integrated with the indicators measured in the other strategies. A green financing framework should be developed as part of the strategy by the end of

				an RDI ecosystem, sustainable tourism development, circular and local agriculture development. Strategic Objective S3 is Urban Climate Adaptation and Decarbonisation. Specific GHG emissions have only been calculated for municipal building energy interventions.	2024, already based on the CCC.

Successful implementation of the strategies requires the development and expansion of human capacities on the part of the municipality and the allocation of support policy instruments to specific measures at national level. The processes initiated under the CCC have a key role to play in this. The pathways identified by the CCC need to be further integrated into all sectoral planning and reviews. As the emission reduction impact of previous strategies is difficult to measure, the CCC has been fully designed to integrate all measures needed to achieve the 80% emission reduction.

A-2.2: Description & assessment of policies

Policy at local level has been reviewed above, and now we will look at the national policies that influence the implementation of the Action Plan.

Hungary's National Energy and Climate Plan (NEKT) (revised in 2023)

In Act XLIV of 2020 on Climate Protection, Hungary set the goal of achieving full climate neutrality by 2050. The path to achieving climate neutrality is set out in the National Clean Development Strategy.

- To achieve climate neutrality, Hungary plans to reduce its gross greenhouse gas emissions by at least 50% by 2030 compared to 1990. This means that emissions in 2030 should not exceed 47.5 million t CO2eq gross, a reduction of 16.7 million t CO2eq compared to 2021.
- Hungary to increase the share of renewable energy to at least 29% of gross final energy consumption by 2030.
- Hungary has significant geothermal potential, which is increasingly being exploited. In view of our country's endowments, the aim is to exploit geothermal thermal energy more intensively and for a wider range of uses.
- Under the draft Renewable Energy Directive, Hungary must ensure that renewable energy accounts for at least 29% of total energy consumption in the transport sector by 2030. The share of advanced biofuels and renewable fuels of non-biological origin will be increased to 1% by 2025 and 5.5% by 2030.
- For energy-intensive industries, the use of technologies to capture CO_2 is being stepped up.
- The National Hydrogen Strategy identifies the industrial use of hydrogen as one of the priority areas for intervention. Hydrogen production needs to be significantly reduced from the currently dominant natural gas-based production. In order to promote green hydrogen production, the Strategy foresees the installation of at least 240 MW of electrolysis capacity by 2030.
- Hungary aims to reduce GHG emissions from agriculture through the adoption of good agricultural practices, including the promotion of adaptation to a changing climate, and through various support instruments, including increasing the share of renewable energy production in agricultural energy use.
- GHG reduction measures that can be applied to waste management will be set out in the new waste strategy. However, the introduction of waste concessions is also intended to increase the share of reused or recycled waste, thereby reducing the amount going to landfill.
- To increase CO_2 absorption capacity, the aim is to significantly increase the proportion of land covered by forests and other wooded land, in line with the National Forest Strategy.

The NEKT is currently under review, which includes raising and modifying all of Hungary's 2030 climate and energy policy targets. The Government is due to adopt the final version of the revised NREAP in June 2024. Based on the recommendation, more ambitious and concrete commitments should be included in the plan (e.g. increase the share of renewables from 21% to at least 23%; significantly increase the share of Hungary's contribution to the EU energy efficiency target; define more detailed energy subsidies; significantly increase both final and primary energy consumption reduction targets by 2030).

Second National Climate Change Strategy (NÉS-2)

The Second National Climate Change Strategy (NÉS 2), which was prepared for the period 2017-2030 (with a view to 2050), is a strategic document setting out the framework of the Hungarian climate policy, its objectives and main lines of action, and is therefore an important cornerstone for the CCC of Miskolc. The objectives, structure and all measures of this document are in line with the NÉS2.

The NÉS-2 is based on 2 visions in line with the mitigation and adaptation objectives:

Decarbonisation vision - "transition to sustainability":
- reducing dependence on fossil fuels
- the rise of material and energy-saving technologies
- the spread of clean energy sources

Adaptation vision - "prepare for the inevitable, prevent the avoidable!"
Hungary is one of the countries in Europe most affected by climate change. Measures to address the natural, economic and social consequences are already included in national action plans in the short term.

The climate policy principles of the NÉS-2 are:
- The precautionary principle and the principle of prevention
- Principle of avoiding congestion
- The principle of common but differentiated responsibilities
- The principle of transition towards sustainability

Overall objectives:
- Survival and development in a changing world. The aim is to ensure the continued and sustainable maintenance of habitability, the preservation of our resources (drinking water, arable land, biodiversity), our cultural treasures and natural values, and the protection of human health. It also aims at sustainable development and the sustainable use of resources.
- Identifying assets, opportunities and constraints. The aim is to reduce emissions and adapt cost-effectively through appropriate innovation activities.

Specific objectives:
- Decarbonisation: shifting to a low-carbon economy, reducing greenhouse gas emissions and increasing natural sinks.
- Geospatial underpinning of the spatial assessment of climate vulnerability: establishment and operation of a data system for decision preparation.
- Adaptation and preparedness: preserving the quality and capacity of national natural, economic and human resources. Responding appropriately to problems.
- Ensuring climate partnership: raising awareness and public confidence in climate change, prevention and adaptation measures. In addition to public funding, it is important to involve other frameworks, including churches, charities, NGOs, chambers of commerce, local authorities and business stakeholders.

The strategy contains 3 main sections that correspond to the main areas of intervention:
- Domestic Decarbonisation Roadmap (HDÚ)
- National Adaptation Strategy (NAS)
- "Partnership for Climate" Awareness Plan, horizontal instruments

National Energy Strategy 2030, looking ahead to 2040

The National Energy Strategy 2030, adopted in 2020, sets out a long-term vision for Hungary's energy supply
determines the provision of. The key elements of the document are:
- Energy efficiency measures throughout the supply and consumption chain;
- Increasing the share of low CO_2 intensity electricity generation - based mainly on renewable energy sources;
- Expanding renewable and alternative heat production;
- Increasing the share of low CO_2 emission transport modes.
- Reducing the share of natural gas imports to around 70% by 2030 (below 70% by 2040),
- reduce the use of natural gas for district heating to below 50%,

- Domestic installed photovoltaic capacity will exceed 6,000 MW by 2030 and approach 12,000 MW by 2040 (reducing the electricity import ratio to below 20%),
- By 2035, at least 200,000 households should have an average of 4 kW of roof-mounted solar panels
- The number of residential heat pumps and their installed capacity should reach 410-420 MW (about 100 000 units)
- 1 million smart meters installed,
- The share of carbon-neutral domestic electricity generation will increase to 90% by 2030,
- Final energy consumption must not exceed 2005 levels (while maintaining economic growth), and if final energy consumption increases after 2030, it can only come from carbon neutral energy sources,
- The share of renewable energy use in final energy use increases to at least 21%,
- GHG emissions will be reduced by at least 40% compared to 1990 (93.7 million tCO_{2e}). This means that (gross) emissions excluding land use, land use change and forestry will not exceed 56.19 million tCO_{2e} in 2030.
- There is also significant potential for energy savings in the energy efficiency improvement of the building stock of some 12-15 thousand public institutions (about 960 thousand public buildings) in Hungary. Based on experience from abroad, energy savings of around 15-30% can be achieved in public buildings within 5 years

National Energy Strategy for Buildings - NES

The policy objectives of the National Strategy for Energy in Buildings adopted in 2015 are closely linked to the National Energy Strategy's targets. The targets relate to the following activities:

- Harmonisation with EU energy and environmental objectives;
- Building modernisation as a means of reducing the overheads of the population;
- Reducing budget expenditure;
- Reducing energy poverty;
- GHG emission reductions.

Climate protection is given a prominent place in the NEEAP's objectives, through the formulation of GHG emission reductions. The NEEAP states that the greatest energy savings and hence GHG emission reductions in the building sector can be achieved through the energy renovation of existing buildings.
"In Hungary, buildings account for approximately 40% of the country's primary energy consumption, including heating, cooling and hot water. A significant proportion of domestic buildings are in an outdated technical and thermal condition, which means that there is significant potential for energy savings in reducing the energy use of buildings. Natural gas accounts for more than 50% of the energy use in the building sector. Consequently, energy savings in buildings have a significant impact on the development of natural gas imports. The vast majority of energy use in buildings is for space heating, and therefore there is a strong seasonality of use."

EU directive on the energy performance of buildings

Key findings of the Directive:
- Aim for full decarbonisation of the building stock by 2050.
- Measures to improve the energy performance of buildings should not only focus on the building envelope, but also include all relevant elements and technical systems of the building, e.g. passive technical elements to reduce energy demand: heating or cooling, lighting and ventilation.
- Well-designed street vegetation, green roofs and walls to insulate and shade buildings help reduce energy demand by limiting heating and cooling demand and improving the energy performance of buildings.
- In existing buildings, it is recommended to install self-regulating devices for separate temperature control in each room or, where justified, in the designated heated zone of the

building unit, where this is economically feasible, for example where the cost is less than 10% of the total cost of the replaced heat generators.

Energy and Climate Awareness Action Plan (ECAP)

The primary aim of the plan is to spread the idea of energy and climate awareness. In addition, the long-term aim of the measures is to ensure that consumers, beyond economic actors, develop energy consumption for sustainable development, recognising both their individual interests and their individual responsibilities, and that their consumption decisions are based on environmental and community interests, as well as on cost considerations.
The strategy identifies energy savings as one of the direct benefits of improving the attitudes of the population, which can be achieved by upgrading building energy systems and replacing electrical household appliances. The combined effect of equipment and behavioural changes can achieve significant savings of almost 0 percentage points in household energy consumption.

The actions in the Action Plan cover 5 main thematic areas:

1. Energy efficiency and energy saving
2. Renewable energy use
3. Energy savings and emission reductions in transport
4. A resource-efficient and low-carbon economy and society
5. Climate adaptation

National Forest Strategy

The conservation of local green spaces and the management of forest assets will be implemented in support of the overall objectives of the national forest strategy.

Forests contribute to climate change mitigation through their significant atmospheric carbon sequestration, their temporary or permanent storage of carbon dioxide, their replacement of fossil fuel use, and their beneficial micro-, meso- and macro-climatic effects. The following aspects are important in this context:
The carbon dioxide used by forests is permanently sequestered in wood and forest soils, reducing the carbon dioxide content of the atmosphere. Increasing the area and the amount of wood in forests increases the removal of carbon dioxide from the atmosphere. In developed countries (including Hungary), both forest area and the amount of carbon sequestered in forests are steadily increasing. Therefore, it is important for climate protection to preserve and further improve the quantity and quality of existing forests, and to increase forest area through afforestation, which is one of the most effective climate protection measures. In our country, the afforestation programme should be continued alongside sustainable forest management.
Proper forest management can ensure adequate soil shading, which reduces soil and atmospheric warming.
A key issue for the sequestration of atmospheric carbon dioxide in forests is the proportion of harvested wood that is permanently incorporated into forest management and the amount of fossil fuel that can be replaced. The broadest possible, multi-stage, sustainable use of harvested wood in the form of wood products and their energy recovery at the end of the wood product life cycle therefore serves to mitigate the effects of climate change. In the long term, replacing fossil fuels with wood is advantageous, as the regeneration of harvested forests gradually removes carbon dioxide from the atmosphere, making wood energy use climate-neutral in the long term. The positive micro- and mesoclimatic effects of forests are enhanced by afforestation and reforestation, other agricultural greening practices (e.g. field protection, wooded pastures) and the avoidance of large areas of continuous felling or end-use.
Within the framework of the international emissions trading system, part of the revenue from carbon dioxide quota trading should also be used for natural sequestration of carbon dioxide, afforestation and increasing forest cover in the forestry sector, and it is important to examine the carbon cycle of forest stands and determine carbon absorption.

The National Forest Strategy sets the following general objectives:

- Ensuring the long-term environmental, economic and social services of forests through multifunctional, sustainable forest management, with an appropriate balance between the multifunctional roles of forests in different areas
- Increasing energy and resource efficiency to promote renewable energy use, reduce the impact of climate change, prevent climate change and meet the needs of the manufacturing sector.
- The organisation and community-based development of biomass-based renewable energy use at predominantly regional level
- Supporting the development of the forest exploration network to improve access to forests, with a view to ensuring at the same time the sparing management of forests while maintaining continuous forest cover, market access, protection of forests and cultural recreation for the population
- Ensuring the biological basis of forest management in a sustainable manner, targeted protection and enhancement of forest biodiversity, with a particular focus on protected and high nature value forests
- Conserve and restore forest potential by promoting forest management practices that protect soil and erosion.
- Improving forest water management
- Sustainable development of forestry functions, expanding the range and added value of forest benefits: in particular through agro-forestry systems, further processing of wood and the use of local biomass for energy ("bio-economy")
- Increasing the country's forest area covered with indigenous tree species, afforested areas and other forest tree species for economic purposes, taking into account local conditions
- Strengthening the public welfare and tourism potential of forests.

In addition, it sets the following strategic objectives:

- Strengthening forestry, forestry services and the processing and marketing of forest products and by-products
- Better use of rural development funds
- Increasing the number of forestry workers, improving working conditions and job security, and ensuring stable employment in rural areas
- Amendments to the legal framework for the organisation, administrative obligations and taxation of forestry

Jenő Kvassay Plan–National Water Strategy (NWSS)

The Kvassay Jenő Plan– National Water Strategy adopted in 2016 sets the following interrelated objectives
long-term targets for the future:

- All water users have access to enough healthy water at the same opportunity, and efficient use of our water potential and measures to combat water damage are in harmony with the natural environment.
- As a result, the quantity and quality of domestic usable water resources will be improved until they reach good status, and then the conditions for maintaining them will be met in changing circumstances.
- The focus will be on preventing water damage rather than protecting it today, protecting human life and national assets at a level commensurate with the risk, and adapting water management systems and land use patterns in a coordinated way so that the harmful abundance of water can be used to reduce water scarcity.

The link can also be identified at other levels of the hierarchy of the NFP target system:

Long-term goals until 2030:

- Water retention for better use of our waters.
- Delivering quality water and sanitation services and stormwater management, with a tolerable burden on consumers.

- Improving the relationship between society and water (at individual, economic and decision-making levels).

European Union Transport Policy - White Paper (Roadmap to a Single European Transport Area)

Key cornerstones of EU transport policy:

- By 2030, 30% of road freight over 300 km will have to be carried by other modes, such as rail or waterways, and 50% by 2050, thanks to efficient green freight corridors.
- optimising the performance of multimodal logistics chains, including increased use of inherently more resource-efficient modes of transport;
- making transport and infrastructure use more efficient through information systems and market-based incentives (including full application of the "user pays" and "polluter pays" principles);

Act II of 2021 amending certain laws on energy and waste management (Waste Management Code)

It contains provisions on the prevention of waste generation, the elimination of illegal dumping (waste abandonment), strict penalties for waste abandoners, a compulsory return fee system, waste concessions, public management of waste and the creation of the legal basis for the transition to a so-called circular economy.
It sets a binding target to reduce the proportion of municipal waste going to landfill to 10% or less of the total municipal waste generated by 2035.
The amount of municipal waste prepared for re-use and recycled shall be increased to at least 55 % by weight by 2025, 66 % by weight by 2030 and 60 % by weight by 31 December 2035, compared to the amount of municipal waste generated nationally in the reference year.
The amount of municipal waste prepared for re-use and recycled shall be increased to at least 50 % by weight of municipal waste generated at national level by 2025, 55 % by weight by 2030 and 60 % by weight by 31 December 2035.

3. National Biodiversity Strategy

The National Strategy for Biodiversity Conservation to 2030 is Hungary's comprehensive strategy for the conservation and sustainable use of biodiversity. The document analyses the status and situation of biodiversity and, with the national vision for 2030 in mind, identifies 3 strategic areas within which 19 objectives focus on addressing domestic biodiversity conservation challenges.

1. Reducing threats to biodiversity
2. Sustainable use of biodiversity and benefit sharing
3. Tools and solutions to support implementation

The strategy focuses on issues such as the network of protected areas, the control of invasive alien species that damage natural and semi-natural ecosystems, and sustainable agriculture, forestry, game and fisheries management. Other priorities include halting the decline of pollinators, improving the resilience of ecosystems to climate change, developing elements of the green infrastructure network and reducing pollution that threatens biodiversity.

Biodiversity is the diversity of living things, and the long-term conservation of our country's diverse natural assets is essential for the well-being of present and future generations. Biodiversity is also the basis for food production, and is key to ensuring soil fertility and pollination, purifying water and air, while providing us with raw materials for medicines and timber. It also plays a key role in preventing and mitigating the effects of disasters, epidemics and disease, and in regulating global and regional climate.

Hungary's unique and rich natural assets, its diverse and increasingly visited national parks, its wild and protected plant and animal species and their natural and semi-natural habitats, its indigenous farm animals and plants, its unique Hungarian landscape and its natural and cultural values all contribute to the country's image.

The protection and wise management of natural resources is a principle to be followed to ensure the long-term preservation of Hungary's rich and valuable natural environment and biodiversity, which is essential for the quality of life of the Hungarian population.

Setting an emission target and an emission gap

	(1) Baseline emissions 2021	(2) Emissions Reduction Target 2030		(3) Emission reduction through other Action Plans		(4) Emissions gap		(5) Emissions reduction through the CCC Action Plan to address the Gap		(6) Residual emissions	
	(absolute) tCO_{2e}	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)
Buildings	236 412	198 566	84,0	0	0	198 566	84,0	198 566	84,0	37 846	16,0
Transport	190 264	144 940	76,2	0	0	144 940	76,2	144 940	76,2	45 324	23,8
Waste	42 948	31 464	73,3	0	0	31 464	73,3	31 464	73,3	11 484	26,7
Industrial Process and Product Use (IPPU)	115 405	94 466	81,9	0	0	94 466	81,9	94 466	81,9	20 939	18,1
Agricultural, Forestry and Land Use (AFOLU)	3005	1 540	51,2	0		1 540	51,2	1 540	51,2	1465	48,8
Total	588 304	470 976	80,1	0	0	470 976	80,1	470 976	80,1	117 058	

Aggregated by energy system category, the emissions are as follows:

	(1) Baseline emissions 2021	(2) Emissions Reduction Target 2030		**(3) Emission reduction through other Action Plans**		**(4) Emissions gap**		**(5) Emissions reduction through the CCC Action Plan to address the Gap**		**(6) Residual emissions**	
	(absolute) tCO_{2e}	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)	(absolute)	(%)
Stationary energy	351 816	293 032	83,2	0	0	293 032	83,2	293 032	83,2	58 785	16,7
Transport	190 264	144 940	76,2	0	0	144 940	76,2	144 940	76,2	45 324	23,8
Waste/wastewater	42 948	31 464	73,3	0	0	31 464	73,3	31 464	73,3	11 484	26,7
Industrial Process and Product Use (IPPU)	-	-	-	-	-	-	-	-	-	-	-
Agricultural, Forestry and Land Use (AFOLU)	3005	1540	51,2	0	0	1 540	51,2	1 540	51,2	1465	48,8
Total	588 034	470 976	80,1	0	0	470 976	80,1	470 976	80,1	117 058	19,9

When developing the NetZero Economic model, the **Buildings** category is included in the Buildings ***and Heating*** category and the city-wide electricity consumption and emissions are calculated in a separate ***Electricity*** row. This row also includes the emission value of electricity used by industry, and the ***Other*** row includes the Scope 1 emissions associated with industry, which is the emission value of natural gas used by industry largely for production and power generation. Accordingly, the values in the table above are as follows, based on the urban GHG inventory. In the Economic model, the table for the Baseline has been supplemented with a BAU 2030 value used in the model, which is already the result of running the model. Accordingly, the values in the table above are derived as follows based on the urban GHG inventory:

	Baseline emissions (BAU 2030)	Emissions Reduction Resulting from CNAP		Remaining issues		Residual Emissions Offsetting		Emissions gap (amount necessary to achieve net-zero)	
	kton CO_{2e}	kton CO_{2e}	% of BAU 2030	kton CO_{2e}	% of BAU 2030	kton CO_{2e}	% of BAU 2030	kton CO_{2e}	% of BAU 2030
Buildings & Heating	170	137	80%	33	20%	33	20%	0	0%
Electricity	124	106	85%	19	15%	19	15%	0	0%
Transport	131	93	71%	38	29%	38	29%	0	0%
Waste	5	1	13%	5	87%	5	87%	0	0%
Other	84	76	90%	8	10%	8	10%	0	0%
Total	516	412	80%	103	20%	103	20%	0	0%

These values have been used in the Investment Plan in accordance with the methodology.

2.3 Module A-3 Systemic Barriers and Opportunities to 2030 Climate Neutrality

A-3.1: Description of systemic barriers and opportunities - textual elements

Achieving climate neutrality is a highly complex task, requiring the continuous cooperation of almost all disciplines. As the natural sciences come to the fore, the role of the social sciences and economics is becoming increasingly important. The situation itself is characterised by a high degree of complexity, with seemingly distant fields being interlinked and the problems and obstacles encountered being complex. There is also no clear view at the scientific level that all the technological support and knowledge is available to make the green transition feasible. Further technological developments will have a major impact on the application of the tools chosen. One of the key issues for the feasibility of urban scenarios will be the involvement of individuals and the shaping of their attitudes, which can only be achieved as a result of a long and sustained process.

There will be many factors in the transition process that will not be decided and shaped at the city level (e.g. national energy mix, public support programmes, regulatory environment), and their evolution will also influence the achievement of the city's goals. The fact that, so far, emerging renewable energy sources have not replaced part of the fossil fuel-based consumption, but have been superimposed on it to meet a steadily increasing energy demand, needs to be faced.

As shown in the GHG inventory, when looking at direct emissions, the share of emissions related to energy systems is the highest and the transport sector is the second largest GHG emitter. These 2 segments are also highlighted when examining systemic barriers. The analysis is complemented by green and blue infrastructure and waste management, which are crucial for quality of life, mainly because of the potential of the circular model to facilitate the green transition.

These were the areas in which the climate neutrality working groups were set up during the preparation of the action plan, with the participation of the relevant service providers, scientific institutions and NGOs. The working groups were set up and the organisations and experts involved in them were invited to participate in the co-creation process with the aim of involving all relevant stakeholders.
The working groups are also responsible for identifying systemic barriers, which are summarised below.

In addition to these areas highlighted later on, emissions related to construction and agriculture will also be addressed in the urban area. Within the administrative boundaries of the city these are not currently relevant, there is no concrete and steel production, but there is significant use in the creation of infrastructure, and food production and transport are also significant emissions, here too the city as a regional centre will need to play a role.

Energy systems

Barriers to own generation and storage capacity

- Under-utilisation of peak power potential in Miskolc (not government-subsidised, worth using in case of negative stock market energy price).
- There is a lack of exploitation of the potential of the biogas system.
- The capacity to receive energy from solar power is missing from the energy supply system. Tight grid capacity is a barrier to exploiting more renewable potential.
- There is a lack of energy recovery from existing storage basins in the urban water management system. This takes better account of natural aspects than peaking power plants.

Strategic and organisational gaps in municipal energy policy

- Many energy management programmes that have already been prepared are not actually implemented. There is a lack of ex-post evaluation and feedback from the strategies.
- No urban energy manager is employed, no organisation or department has been set up to provide a platform for the overall coordination and planning of urban energy management.
- Lack of metropolitan cooperation on issues where state-level advocacy can be achieved by joining forces (knowledge-sharing platform with Pécs, Budapest on the efficiency of energy communities)
- The efficient distribution of the energy produced is not sufficiently emphasised compared to energy storage.
- There is no platform for urban energy procurement, and the city often enters into unfavourable energy procurement contracts.
- The CO_2 emissions of the population are not priced in, without consequences.
- There is no uniform urban social firewood storage, drying and preparation system. Properly selected and prepared fuel could serve as a model for the population.
- Miskolc does not have a building-type based register of the use, energy condition, renovation or demolition of individual properties.
- Unfavourable brownfield investment climate, preference for new build properties. The subsidy system does not encourage the re-use of existing buildings.
- With a declining population, the settlement is expanding and the use of zoned areas for residential purposes is also common. This induces the need for infrastructure improvements and an increase in GHG emissions.

Regulatory barriers

- Areas where we have influence at local level are not properly identified. A decomposition of national and local regulation is needed when assessing local problems.
- A city centre with a special structure. Energy investments and the use of renewable energy on listed buildings are limited in terms of urban design and heritage protection.
- There is a lack of regulation to ensure that the installation of a photovoltaic system does not in any way negatively affect the soil protection of plant cover.

Information flow and awareness-raising gaps

- The public is less informed about energy efficiency and energy renovation, although the biggest energy savings can be achieved through residential property renovation.
- Energy awareness among the population is low (e.g. widespread "warmth at home" comfort feeling in heating habits, overheating of residential properties is still prevalent, although 2022 has brought a shift in this.)
- There is no single point of information on energetics. There is no public will if the details of access and support are inaccessible, opaque, without a single, customer-friendly platform and trained staff to help them find their way. Such key points include access to application systems, the steps and conditions for applying, the planning and construction phases, access to specialists, etc. (sample of Budapest street information points)
- Lack of smart meters in urban energy, only partially deployed smart grid and smart metering.
- Energy poverty is associated with high levels of waste incineration for heating purposes, mainly due to low income, but also due to a high level of ignorance.
- The nodes and opportunities for potential energy communities are unidentified.
- People are not aware of their options and the limits of energy use. The first step should be information, not punishment. In addition to awareness-raising campaigns, there is a lack of continuous and conscious education.
- There is a lack of awareness-raising programmes and alternatives to conversion.
- Consumption-promoting communication from the service sector.
- Lack of visualisation at the individual level of how much extra resources and work is needed to achieve a set energy improvement or goal.
- Lack of user knowledge in the operation of heating systems.
- Low emphasis on training energy professionals, even at the sales level.

- There is a lack of basic energy knowledge in education.
- Lack of information on technological innovation hinders decarbonisation of the energy sector and the transition to renewable energy sources

Gaps in support schemes for energy development

- Low energy potential of residential building stock: lack of energy efficiency improvement programmes
- There is a lack of widely available residential energy subsidy schemes with a minimum subsidy intensity of 30%.
- There is a lack of formulation of energy improvements for the population at individual level. This specific information should be integrated into support programmes.
- There is no incentive system to switch to an environmentally friendly heating system.
- There is a lack of property-specific development opportunities and the modernisation proposals are too universal and general.
- Too slow return on energy investments in buildings - lower willingness to invest.
- For the vast majority of people, most applications are inaccessible.
- The prefab programme has been discontinued, and comprehensive programmes can only be launched with the involvement of the state.
- Lack of available green financing models (green bond).
- There is a lack of energy efficiency principles in public procurement procedures. There is a growing commitment to green public procurement, but it is still difficult to apply in practice.

Lack of energy communities

- Lack of public awareness. (Point out that not everyone may be able to use energy as, when and how much they want. They may have to be forced to use electricity at night or have a centrally controlled energy supply. You may have to join an energy community, etc. the most appropriate education platforms are workplaces)
- Missing ownership partnerships.
- The legal and financing structure of energy communities is not resolved.

Unused district heating capacity

- Access to district heating capacity is not sufficiently incentivised.

Obstacle to stand-alone geothermal energy recovery

- Miskolc currently has no geothermal wells of its own.

Inclusivity

- The public is not effectively involved in the design of energy management systems, which would be a prerequisite for eradicating energy poverty and achieving energy justice.

Opportunity to exploit geothermal potential

Following the energy renovation of the building stock, a system upgrade could achieve 90% of the total heat demand from geothermal energy. This systemic transformation would not threaten existing jobs, but would rather stimulate additional job creation.

The focus of the energy transition, based on our survey, is the replacement of gas heating in the identified building types. There is also a governmental strategy to reduce the use of natural gas in the energy mix and increase the share of alternative energy sources, which could well be linked at city level. Geothermal energy is available and geothermal heat pump systems can be installed, and the share of geothermal in district heating can be further increased, but this will require building energy upgrades.

Lack of data is an important limiting factor in the energy transition. Modelling the transition of the building sector would require the development of a comprehensive database for the whole city in real time.
In Miskolc, electricity is mainly generated by combined heat and power plants (which produce both electricity and district heating) and solar panels. However, the current system used to calculate electricity emissions takes into account the national electricity mix, rather than the electricity actually produced within the city limits. This means that urban electricity generation does not have a significant impact on total emissions, but unused "string electricity" does. However, the installation of solar panels on urban buildings reduces the amount of electricity purchased from external sources. It is not feasible to install wind power within the city due to safety and disturbance to residential areas. Alternative forms of local electricity generation should be explored, such as the expansion of biogas production and utilisation or the production and use of local hydrogen fuel.

Transport

System barriers

- Lack of systemic thinking and action in the areas of urban planning and development (e.g. reducing transport needs in the city through urban planning and economic development, importance of prevention: the most effective way to reduce GHG is to avoid getting in the car or building the road in the first place)
- Lack of a cross-cycle transport concept and strategy.
- There is a lack of consensus at the decision-making (and professional) level on the overall planning tasks, and a lack of shared vision.
- Lack of ownership of unpopular decisions: lack of political and decision-making commitment, responsibility and will (e.g. local regulation, parking fees, awareness-raising could reduce private car use)
- Infrastructure gaps in the road network.
- Shortcomings in smart transport elements/infrastructure.
- The lack of an urban transport system plan based on a system approach to the integration of different modes of transport and related means (road transport, parking, public transport, bicycle, scooter, pedestrian)
- The expansion of transport infrastructure is constrained by the morphology and settlement structure of the city.
- The public transport network is seemingly complete, covering most of the city, but not independent of other modes.
- City dwellers shift their responsibilities to the community, they do not feel ownership of the city, individuals shift the responsibility for change to the community (lack of time and capacity of younger generations as a barrier to change).
- Gaps in information and public awareness.

Community transport

- Public transport dispreferences at the national level of decision making.
- Lack of resources, underfunding, poor financial situation of public transport - The quality of public transport services does not serve the objectives.
- The state of public transport infrastructure (outdated transport, traffic management systems, information services).
- In the values of local society, the prestige of private motorised transport is higher than public transport.
- On the periphery of the city, using public transport is both a "sociological adventure" and a challenge. Many people are discouraged from using it (they would rather take on a public transport operator than let their child ride the bus alone).
- Parallel bus and tram lines (to be maintained due to different destinations).
- Lack of skilled labour. Difficulties in training, education, vocational training, maintenance, management, etc.

Individual motorised transport and transport by motor

- Urban dwellers see cars as a status symbol, and both forced and unjustified car use is common.
- In a city with a declining population, the number of private cars, both residential and company cars, is steadily increasing.
- There is morning and afternoon congestion on the roads, and constant pressure from residents to expand road and parking infrastructure, typically at the expense of green spaces.
- The majority of cars are also stored on the roads by those who have access to a yard or garage.
- A typical negative tendency is to pave or gravel the green lanes next to the roads to allow parking in front of the house.
- In Miskolc, there is currently no alternative to road transport and logistics.

Individual non-motorised transport

- Non-motorised transport is in a subordinate position in the city, even though there is a need for it. Poor infrastructure and poor prestige (cycling and walking)
- Workplaces, institutions and schools do not encourage the use of bicycles and scooters to get around.
- The expansion of cycling infrastructure is typically at the expense of green spaces

Parking

- The parking system is not used as a traffic management tool, it currently operates as a separate entity.
- Lack of unified political will to abolish rent-free zones and enforce concepts
- Lack of coordination between parking and public transport: lack of P+R systems or under-utilisation of existing ones.
- The expansion of parking spaces is typically at the expense of green spaces
- An obstacle is that national policy does not allow municipalities to differentiate charges based on environmental performance and to maintain on-street parking spaces in city centres for high occupancy vehicles (car-sharing) or electric vehicles.

Opportunities in transport development

- More than half of passengers travel on the two axes (North-South and East-West), which could be developed to provide a viable alternative for more city dwellers

Make a distinction between need and want, and in the planning process, the needs of road users should be the primary constraint, not the needs of road users. In the case of private transport, relying only on electromobility may not be a good solution either, instead we should plan better cities with less transport demand!

Traffic congestion is particularly high in the city centre and areas adjacent to city centres. Alternative mobility systems, traffic flow reduction and optimisation are key challenges. Systemic improvements are needed, as the city centre would be transformed into a protected pedestrian zone, so traffic and parking issues need to be addressed. The aim is to create a mixed zone between the city centre and the suburbs, limiting vehicular traffic through traffic engineering and architectural solutions, making it more pedestrian-friendly. To achieve this and to optimise traffic management tasks as a whole, a modern intelligent traffic management system is needed, the lack of which is currently a major limiting factor.

A key issue in public transport is the lack of intermodal ticketing and payment systems (to encourage modal shift). The most important aspect of the attractiveness of public transport is the number of transfers required. The lower the number, the more attractive the alternative. The share of public transport in terms of emissions ranges between 6-7% (1.5-2% of total urban emissions) and therefore, while decarbonisation of the vehicle fleet is important, it is even more important to develop and maintain an adequate level of service. As the largest emitter within transport modes is private car use, the clear objective is to shift private car users to public transport. This can only be achieved through passenger-oriented public transport that can provide a full service.

Another aspect to be examined is the time and economic constraints people face when using public transport. To this end, a 15-minute city concept has been launched for all 16 of the city's district centres.

Green and blue infrastructure

Design and systemic barriers

- An effective regulatory framework for the protection of green spaces is lacking.
- Shortcomings in the conscious management of green spaces.
- The use of public spaces, their functional designation is not optimised, and there is a lack of a comprehensive concept of public space zoning.
- Systematic planning of green spaces is hampered by wasteful land use.
- Over-regulation often leaves no room for systemic management of green spaces.
- Missing green assets and tree inventory, inventory of green infrastructure assets.
- Uncoordinated data sharing and information flow between professional and social representatives, sectoral actors.
- Missing urban information system and monitoring.
- Vertical and roof surfaces in the city are underused.
- Tendering-driven development is operational, leaving no room for comprehensive development.
- Professional differences of opinion on the absorption capacity of green spaces.
- Lack of social, decision-maker and company knowledge, indifference, prevailing conventional attitudes.
- Lack of awareness-raising and awareness-raising among the public and decision-makers.
- The behaviour of the population is not environmentally aware, environmental knowledge is lacking.

Operational and maintenance obstacles

- Persistent shortages of professionals, resources and technical equipment.
- Public spaces are underfunded to maintain and improve them.
- The dominance of a technocratic approach to the management of public spaces and green areas.
- The species/species selection is not done with sufficient care.

Green space systems, natural state

- The low proportion of living topsoil in the city.
- Infrastructure development is typically at the expense of biologically active surfaces.
- The preference for paved surfaces is also prevalent at the residential level.
- Over-enveloping of private properties, heat island effect.
- In terms of design and construction, green spaces are not treated as an asset.
- The plant population is poorly resilient to climate change and has a low adaptive capacity.
- Negative impacts of climate change on municipal and surrounding green infrastructure, cost overruns.
- Strong anthropogenic impact and pollution of existing natural assets.
- Buffer areas for green and blue infrastructure elements are scarce and incomplete.
- The connection between the Szinva and the surrounding green spaces is not resolved.
- The management of green spaces is not ecological.
- The spread of invasive species is transforming green spaces (e.g. the spread of Japanese bitter-grass along the Szinva).

Surface water and groundwater

- There is no complex climate and environmentally sound water management system, and the necessary approach is lacking.
- In water engineering and construction, the old drainage, concrete construction approach is typical.

- Surface water, groundwater and stormwater are not kept in place, either by the population or by institutions. There is a lack of knowledge and attitude.
- There is a lack of knowledge of the specificities and potentials of water management due to the geographical location, and a lack of complex monitoring.
- The state of the utility network does not allow water conservation measures to be taken.
- The Sina River is a drainage channel, its technical and ecological condition is degraded, and its connection to green spaces is not resolved.
- The karst aquifer is vulnerable to extreme weather events, which could threaten the city's water supply.

The potential of existing green and blue infrastructure

- A significant part of the urban area is covered with natural vegetation, which represents a significant carbon sink capacity that needs to be preserved.
- The city also has an abundance of water. In addition to supplying water to green infrastructure, these also have a carbon-absorbing capacity themselves, albeit to a lesser extent, especially if stream beds are restored to their near-natural state to a greater extent.

Waste management, circular economy

Systemic barriers in cross-sectoral waste management and disposal

- From 1 January 2023, waste management will become a state responsibility, and the powers of local authorities will be reduced.
- Inefficient recycling processes are currently in place.
- Slow behaviour change, including cultural barriers.
- Insufficient data collection, limited community involvement and support.
- Lack of infrastructure for circular economy measures.

Non sector-specific systemic barriers

- Lack of consolidated monitoring, reporting and control procedures.
- Fragmentation of responsibilities.
- Difficulties in developing cooperation between the public and private sectors.

Opportunities in the transition to a circular economy

In line with EU requirements, separate collection of bio-waste will be mandatory from 2024.By 2035, nearly two thirds of municipal waste will have to be recycled, which cannot be achieved without effective separate collection of bio-waste. Between 17% and 29% of domestic municipal waste is biodegradable, of which a significant proportion is food waste.
Green and food waste from kitchens will soon be recycled in biogas plants, contributing to the circular economy by generating electricity and heat as a renewable energy source. In addition, the residue from the biogas plant is an excellent compost material for agriculture due to its high nutrient content. MOHU MOL Waste Management Ltd (MOHU), the concessionaire for waste management, and its contracted partners are gradually and continuously introducing door-to-door collection of green and food waste from kitchens. In a first round, small areas have been designated, typically in condominium environments. MOHU will provide voluntary access to the service in 14 municipalities across the country, in Budapest, Miskolc, Debrecen, Székesfehérvár, Szolnok, Kecskemét, Cegléd, Zalaegerszeg, Békéscsaba, Nagykanizsa, Tatabánya, Kaposvár, Gyula and Békés in condominium areas from January 2024.[1]
The new system also includes the complete collection, processing and recycling of recyclable beverage packaging materials under the auspices of MOHU MOL Waste Management Ltd. This will be done in two ways: in stores larger than 400 m², MOHU Zrt. will install beverage packaging return machines, but stores with a floor area between 200 m² and 400 m² can also request this solution.

[1] Source : MOHU (https://mohu.hu/media/hirek/januartol-elindul-a-konyhai-zold-es-elelmiszerhulladek-hazhoz-meno-gyujtese-is.html)

Mobile metal, plastic and glass reverse vending and processing equipment is planned for smaller grocery stores and other service providers - petrol stations, tobacconists and other retail outlets.[2]

For all sectors, the human and financial resources needed to build the infrastructure are a major challenge. Developing the business models for this is a task for the respective governments, city leaders, financial institutions and the businesses involved.

[2] Source : MOHU (https://mohu.hu/media/hirek/a-legkisebb-boltokba-is-elmennek-avisszavaltott-aludobozokert-uvegekert-pet-palackokert.html)

A-3.2: Systems & stakeholder mapping				
System description		Stakeholders involved	Influence	Interest
Energy systems	regulation and policy	Hungarian State MVM ÉMÁSZ Áramhálózati Kft. MVM Green Generation Ltd. MVM Next Energy Trading Ltd. Municipality of Miskolc MJV Miskolci Hőszolgáltató Kft.	Shaping the regulatory environment Determining energy prices Operation of energy systems	Consumer retention Using a profitable business model Guaranteeing security of supply
	Infrastructure	Hungarian State MVM ÉMÁSZ Áramhálózati Kft. MVM Green Generation Ltd. MVM Next Energy Trading Ltd. Municipality of Miskolc MJV Miskolci Hőszolgáltató Kft. Miskolc Geothermal Energy Ltd. businesses citizens	Transforming the national energy mix System-wide network developments Developing renewable energy systems, increasing the share of renewables Implementation of energy efficiency improvements in buildings Creating energy communities	Supply security Cost-effective system maintenance Increasing the share of deep energy renovations in buildings Reduction of pollutant emissions Reducing energy costs
	training and awareness-raising	national, local governance academics NGOs	Changing mindsets - behaviour, attitudes Generating strong learning processes	Preserving environmental values

		citizens	Ending energy poverty	Creating a better, more liveable urban environment Mitigating the damage (human, material) caused by climate change
	research and development	University of Miskolc Bay Zoltán Research Institute businesses	Application of basic and experimental research results Introduction of innovative technologies Cooperation between industry and higher education	Preserving environmental values Creating a better, more liveable urban environment Mitigating the damage (human, material) caused by climate change
	funding	European Union Hungarian State Municipality of Miskolc MJV banks, insurance companies private sector	Implementation of infrastructure improvements for decarbonisation	Implementation of interventions to support the green transition Recovering, financially sustainable investments Reducing pollutant emissions
Transport	regulation and policy	Hungarian State Miskolc Transport Company Ltd. Municipality of Miskolc MJV	Shaping the regulatory environment Operation of transport systems	Using a profitable business model Increasing use of public transport by the population
	Infrastructure	Hungarian State MVM ÉMÁSZ Áramhálózati Kft.	National transport infrastructure improvements in the urban area	Cost-effective system maintenance

		Miskolc Transport Company Ltd. Municipality of Miskolc MJV businesses citizens	Improving urban transport infrastructure Expanding and improving community transport services The spread of electromobility devices	Increasing the share of electromobility Increasing service revenues
	training and awareness-raising	national, local governance academics NGOs citizens	Changing mindsets - behaviour, attitudes Generating strong learning processes The spread of micromobility devices	Creating a better, more liveable urban environment Reduction of pollutant emissions
	research and development	University of Miskolc Bay Zoltán Research Institute businesses	Introduction of innovative technologies (electromobility - alternative propulsion - hydrogen)	Preserving environmental values Creating a better, more liveable urban environment Mitigating the damage (human, material) caused by climate change
	funding	European Union Hungarian State Municipality of Miskolc MJV banks, insurance companies private sector	Implementation of infrastructure improvements for decarbonisation	Implementation of interventions to support the green transition Recovering, financially sustainable investments Reducing pollutant emissions

Green and blue infrastructure	regulation and policy	Hungarian State Municipality of Miskolc MJV	Shaping the regulatory environment Protecting urban green and blue infrastructure	Sustainable green space systems
	Infrastructure	Municipality of Miskolc MJV citizens businesses	Preservation and enhancement of urban green spaces	Creating a better, more liveable urban environment Increasing population retention and attraction Increasing the resilience of the city
	training and awareness-raising	NGOs academics citizens businesses	Changing mindsets - behaviour, attitudes Generating strong learning processes	Creating a better, more liveable urban environment Preserving environmental values
	research and development	University of Miskolc	Introducing innovative municipal solutions	Preserving environmental values Creating a better, more liveable urban environment Increasing the resilience of the city
	funding	European Union Hungarian State Municipality of Miskolc MJV	Preservation, maintenance and expansion of green and blue infrastructure	Creating a better, more liveable urban environment Recovering, financially sustainable investments

				Reduction of pollutant emissions
Waste management Circular economy	regulation and policy	Hungarian State	Shaping the regulatory environment Determination of service prices	Using a profitable business model
	Infrastructure	Hungarian State MOL MOHU Waste Management Ltd. MiReHu Ltd. MIVÍZ Ltd.	Operation of waste management systems Designing a circular model	Compliance with legal obligations Increasing service revenues Reducing environmental pressures
	training and awareness-raising	MOL MOHU Waste Management Ltd (MiReHU Kft.) NGOs citizens	Changing mindsets - behaviour, attitudes Generating strong learning processes	Preserving environmental values Waste reduction
	research and development	MOL MOHU Waste Management Ltd. MiReHU Ltd. University of Miskolc businesses	Introduction of innovative technologies The transition to a circular economy model	Preserving environmental values
	funding	Hungarian State MOL MOHU Waste Management Ltd.	Infrastructure development	Recovering, financially sustainable investments

The Transition Team should further explore the role of the population in each emission sector. Detailed target group analysis should be used to identify the different types of citizens (not a homogeneous group) and how to work on changing attitudes in each emission sector depending on the typology of citizens.

3 Part B - Pathways towards Climate Neutrality by 2030

3.1 Module B-1 Climate Neutrality Scenarios and Impact Pathways

Two key strategic priorities that can be highlighted in terms of climate neutrality are the **decarbonisation of the building sector** (through deep renovation and phasing out natural gas) and the **decarbonisation of transport** (mainly through reducing private car use). However, the impact pathways are not only linked to these priorities, but seek to explore the full range of pathways to reach the 80% emission reduction target.

	B-1.1: Impact Pathways (based on an economic model)					
Sector	Subsector	Systemic levers	Early changes (1-2 years)	Late outcomes (3-4 years)	Direct impacts (tCO)2e	Indirect impacts (co-benefits)
Energy systems **Buildings and heating systems**	Building renovation (new energy-efficient buildings)	Technology/ infrastructure	Implementation of a pilot programme in the Győri kapu district (joint pilot with the city of Pécs)	Energy modernisation " Launch of the " Panel Programme Increase in the share of energy-efficient buildings The spread of smart systems	27	Enhanced energy security Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector
		Regulation/ policy	Municipal regulation to help tackle energy poverty Energy modernisation " Development of a " Panel programme			
		Financial financing	Developed business model for decarbonisation of the	The emergence of combined forms of aid		

			buildings sector			
	Decarbonisation of heating	Technology/ infrastructure	Launching a pilot programme	The spread of electric heating solutions - the gradual replacement of natural gas The spread of smart systems Decarbonised district heating - with minimum emissions	87	Enhanced energy security Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector
		Regulation/ policy	State and municipal regulations Miskolc Urban Hydrogen Strategy Miskolc city district heating decarbonisation strategy and business model			
		Social innovation	Energy awareness in society	Increase in the share of renewable energy Phasing out of coal (wood) firing and combustion of pollutants in households		
		Financial financing	Developed business model for decarbonisation of the buildings sector	The emergence of combined forms of aid		
	Efficient lighting and equipment	Technology/ infrastructure	Further roll-out of LED street lighting	Fully modernised street lighting Lighting modernised by the public	23	Enhanced energy security

Energy systems **Electricity**	Decarbonisation of electricity generation	Technology/ infrastructure		Extended electricity network Emergence of energy communities Deployed smart grid and smart metering systems Improving the national energy mix - reducing the emission factor Meeting the electricity needs of the industrial sector with renewable energy sources	106	Enhanced energy security A more liveable urban environment
		Regulation/ policy	Municipal decree to assist energy communities			
		Social innovation	Energy awareness in society	Increasing the share of renewable energy		
		Financial financing	Developed business model for decarbonisation of the electricity sector	The emergence of combined forms of aid		
Mobility and transport	Reduced demand for motorised passenger transport (increased car use)	Technology/ infrastructure	Public transport system	Advanced neighbourhood centres (implementing the 15-minute city concept) Creating a zero emission zone in the city centre The spread of micromobility	32	Improving air quality A healthier society - a less burdened health and social sector
		Regulation/ policy	Review of existing transport and			

			parking strategies Revised SUMP Zero Emission Zone designation in the city centre			
		Participation planning	Citizens' Mobility Centre			
		Financial financing	Operational Programmes			
	Switch to public transport and non-motorised transport	Technology/ infrastructure	Starting the digital switchover in public and road transport	Developing infrastructure to support cycling and walking Full digital switchover in public and road transport	12	Improving air quality A healthier society - a less burdened health and social sector
		Social innovation	Citizens' Mobility Centre			
		Financial financing	Operational Programmes			
	Electrification of cars and engines	Technology/ infrastructure		Expanding electric car fleet	7	Improving air quality A healthier society - a less burdened health and social sector
		Regulation/ policy	Municipal regulations, support - incentive system			
		Financial financing	Central government programmes Individual savings			
	Electrification of buses	Technology/ infrastructure	Building charging capacity for electric buses 20 electric buses to be put into service	Electric charging capacity installed 46% share of electric buses in public transport Pilot - hydrogen-powered bus	9	Improving air quality A healthier society - a less burdened health and social sector
		Regulation/ policy	Revised SUMP Service concept			

		Participation planning	Citizens' Mobility Centre			
		Financial financing	Community transport			
	Optimised logistics	Technology/ infrastructure		Reducing freight traffic in inner city areas	22	Improving air quality A healthier society - a less burdened health and social sector
		Regulation/ policy	Zero Emission Zone designation in the city centre			
	Electrification of trucks	Technology/ infrastructure		Expanding electric truck fleet	8	Improving air quality Reducing noise pollution
		Regulation/ policy	State and municipal regulations			
		Financial financing	Central government programmes			
Waste management - circular economy	Increased waste recycling	Technology/ infrastructure		Improved biogas plant Industrial symbioses Expanding re-use centre	1	A more liveable urban environment Elimination of illegal landfills More conscious food consumption - less waste - smaller carbon footprint
		Regulation/ policy	Introduction of compulsory food waste collection Circular business model			
		Social innovation	Changing public attitudes - " Zero Waste " Waste minimisation campaigns Further development of re-use centres			
Green infrastructure	not relevant	Technology/ infrastructure	Interventions to increase green space	Operation of a complex environmental	Swallowing	A more liveable urban environment

- **nature-based solutions**				information system Increasing inner city absorption capacity Reducing the thermal insulation effect	capaci-tation	Improving air quality A healthier society - a less burdened health and social sector
		Regulation/ policy	Establishing a complex environment al information system			
		Participation planning				
Other (IPPU and AFOLU)	not relevant	Technology/ infrastructure		Part of the energy systems	76[3]	Enhanced energy security A more liveable urban environment
		Regulation/ policy	Adaptive building use strategy	Adaptive reuse of buildings		

[3] Calculated for energy systems in the case of aggregated inventory

Sectors / Subsectors	Note on the impact pathway
Energy systems / heating / households	Based on the phasing out of natural gas in parallel with the strengthening of electrification and the high penetration of renewables. Further expansion of geothermal district heating from 55% to 92%.
Energy systems / heating / non-residential consumers (municipal, industry, services)	Based on the phasing out of natural gas in parallel with the strengthening of electrification and the high penetration of renewables. Further expansion of geothermal district heating from 55% to 92%.
Energy systems / electricity / households	With a minimal increase in electricity demand, a significant improvement in the national energy mix is expected to reduce the emission factor by at least 40% compared to the base year 2021. With the commissioning of Paks Phase II (Paks Nuclear Power Plant expansion) and a further significant increase in the share of renewables, this could even be a more favourable change. Currently the state forecasts 2030/32 for the commissioning of a new unit, if this can be achieved by 2030, an improvement of over 50% in the emission factor can be expected.
Energy systems / electricity / non-residential consumers (municipal, industry, services)	With the development of renewable energy capacity to support industrial processes, we expect a reduction in the emission factor of at least 40% due to a significant improvement in the national energy mix. This, combined with the electrification of industrial processes, could lead to a significant reduction on the emissions side.
Mobility / transport / public transport / local public transport	Replacement of the local public transport fleet of diesel and CNG buses by electric buses, 46% of the bus fleet by 2030 and the entire fleet by 2040.
Mobility / transport / public transport / public transport	State public transport vehicle fleet calculated by replacing diesel buses with electric buses.
Mobility/transportation / private transport / private car	Gradual replacement of passenger car fleet by electric cars (low base value of 0.4%), with a growth potential of at least 10-15 times, with a 40% share by 2040 according to the economic model. Increasing the quality of public transport services, with the aim of shifting from private to public transport. Development of a zero-carbon zone.
Mobility/transportation/individual transport/transport, freight	Gradual replacement of vehicles used for transport (95% diesel) with electric vehicles. Introduction of strong traffic reduction measures.
Waste management / circular economy / municipal solid waste management	Changes in the legislative environment, the extension of selective collection and a change in attitudes have led to at least 50% less municipal solid waste being landfilled.
Waste management / circular economy / waste water treatment	Environmentally sound water management, reduction of water used, with 30% less wastewater generated.
Other (agriculture)	There is no significant agricultural activity within the town. A 40% decrease is expected due to technological changes.
Other (industry)	Within the industrial sector, significant savings of at least 85% are needed in terms of energy emissions from technology and production. As energy demand is more likely to increase, emissions should be reduced. This can be achieved through locally produced renewable energy, energy storage, technology shift.
Balance	At full absorption capacity, the city would be net carbon positive with the planned 80% emission reduction. The significant absorption capacity allows for minimal variation within sectors. The emissions gap can be covered by the absorption capacity.

B-1.2: Description of impact pathways

Basic principles for defining routes: avoidance and change

Avoidance

The widespread dissemination of the concept of "unused energy" among all actors in the city. Avoid unnecessary energy use, whether in energy systems, transport, waste management or industrial activities. A basic urban planning principle and value is to avoid building excess capacity and to integrate environmental considerations into business models.

Change

The resulting energy demand should be associated as far as possible with low emissions. All actors should seek and promote the use of renewable energy sources, the local production and use of green energy, and be open to innovation and technological change.
In addition to building and running the infrastructure, a change in approach is needed, with strong education to manage the processes.

IMPACT PATHWAYS:

ENERGY SYSTEMS - BUILDINGS AND HEATING

Building renovation

In the case of the city of Miskolc, the amount of energy consumed is decreasing, and in addition to energy efficiency investments, renewable energy sources are increasing as a proportion of the energy sources used, which has led to a steady decrease in the associated GHG emissions.
Since 2014, public institutions have achieved significant reductions in CO_2 emissions, mainly through upgrades funded by KEOP and TOP grants. More than 20 institutions have been renovated under the energy efficiency modernisation of municipal buildings tender scheme, and other infrastructure modernisation projects also include energy efficiency measures.
Improving the energy efficiency of homes, the early and widespread use of electric heat pumps and electric cookers, replacing gas boilers with hydrogen boilers and switching to carbon-neutral district heating could be the primary solutions to meet decarbonisation targets.

The private sector would need to achieve an annual renovation rate of between 4% and 5%, for which public programmes are already available and financial institutions are expected to come up with new green loan schemes in the coming years, which will require a much more favourable interest rate environment than 2022/23. For buildings, the installation of efficient lighting and the replacement of large appliances is important and should also be increased to at least 5% per year based on the business model.
For new buildings, the relevant TNM regulation now only allows for the granting of occupancy permits for buildings with near-zero energy demand in Hungary.

Heating decarbonisation

Currently, 55% of district heating used comes from renewable geothermal energy, 3% from biomass and 42% from fossil fuels (the proportion varies minimally from year to year, but geothermal energy is not usually less than 50%).
The energy efficiency improvements made by MIHŐ Miskolc Heating Ltd. so far have all been aimed at reducing emissions. These include the installation of a biogas engine power plant on Futó Street, boiler upgrades, biogas utilisation at the Bogáncs depot, expansion of district heating services, and energy modernisation of the primary district heating system.
The phase-out of fossil fuels in the heating sector will be crucial to achieve the 2030 targets. On the one hand, this can be achieved through public programmes, and the technology is available. On the other hand, further decarbonisation of the district heating sector is also a realistic objective, with ready

plans to geothermalise additional parts of the city and essential building energy renovations to improve the overall geothermal share in the district heating system. The geothermal share could be increased to 92% by 2030.

Geothermal well Kistokaj

Source : miho.hu

In terms of total heat consumed for heating, district heating accounted for 34% of the total heat produced in 2021 (the remaining 66% is fossil), a ratio that can be improved up to 50%.
The share of local heating produced using fossil fuels should be reduced to 60%. To achieve this, the share of local heating produced by electric heat pumps should be increased to at least 40%. Thanks to tendering opportunities and public subsidies, the use of renewable energy sources by households and businesses, which is increasing year on year, is expanding beyond solar systems to include heat pump applications, and this should be exploited to the full over the next 5-6 years. A public education programme and an advisory office will help the process in the city. From 2024, as investment costs become more affordable, heat pumps are expected to become more widespread. Government incentives and subsidies for the installation of heat pumps will also accelerate the switch from natural gas heating of buildings.

There are many other good examples in the city, with sludge digestion biogas production and utilisation at the city's wastewater treatment plant helping to achieve energy self-sufficiency. A solar power plant with a capacity of 1MW is in operation at the landfill site on Bogáncs Street. Heating and cooling technology using heat pumps is already used in several municipal facilities.

ENERGY SYSTEMS - ELECTRICITY

Decarbonising electricity generation

In electricity supply, the transition is most advanced, as the cost of renewable electricity has fallen for solar and wind, but these will never be able to meet the sector's needs due to their dependence on weather (and solar), support for nuclear power varies across Europe, and there are still regulatory barriers (e.g. energy poverty reduction, energy communities). Even so, electrification could be the key to achieving carbon neutrality.

As the demand for electricity is not expected to decrease (mainly due to the expected electrification processes on the heating side), the evolution of the national energy mix and the increase and direct use of locally produced green electricity will be key. Technological innovations are still needed to increase storage capacity, but these are unlikely to be widely deployed in a way that will significantly support solar energy until 2040. According to the Ministry of Energy, the country had 1 megawatt of solar capacity in 2010, and 5,100 megawatts 13 years later. Of this, 3,100 megawatts is industrial and 2,000 megawatts is small-scale domestic. Under the NEKT, this figure will rise to 12,000 megawatts by 2030. The share of electricity generated using fossil fuels could fall below 10%. The grid upgrades are planned to be completed by 2027, largely financed through the Hungarian RRF programme and the operators' own budgets.

According to the revised version of the National Energy and Climate Plan in 2023, Paks II will come on stream in the next decade with two units (with a capacity of 1200 MW per unit), so the six units (if all four units of Paks I are technically suitable for lifetime extension) together would already represent a capacity of 4400 MW and a huge decarbonisation potential for Hungary. In addition, the potential for the installation of small modular reactors (SMRs) is being explored.

(Depending on the evolution of the national energy mix, an improvement of up to 40% can be expected for the associated emission factor.)

MOBILITY AND TRANSPORT

In the transport sector, there will be 3 main segments that will determine the transition.

In the case of private car transport, individuals must be able to finance the purchase of a vehicle, which will require state-subsidised schemes and the introduction of financially tangible benefits during use.

Individual freight transport (mainly in construction and trade) requires the development of controls (e.g. axle-load zones, preference for electric transport, rethinking of transport routes) that contribute to emission reductions.

In public transport, decarbonisation of the fleet must be accompanied by the development of a service package that offers a clear alternative to private transport. This will require more public subsidies than hitherto.

Reduced demand for motorised passenger transport

Develop a 15-minute city concept. Miskolc can be divided into 16 distinct smaller districts. These developments will be squares or strings of squares in some parts of the city, or routes or axes in others. The centres should be able to attract investment and make them attractive to civil and economic operators. The decentralisation of administrative, cultural and recreational functions is equally important.
For each district centre, development directions will be defined according to the functions of the district, with a focus on green infrastructure improvements and the provision of various services.

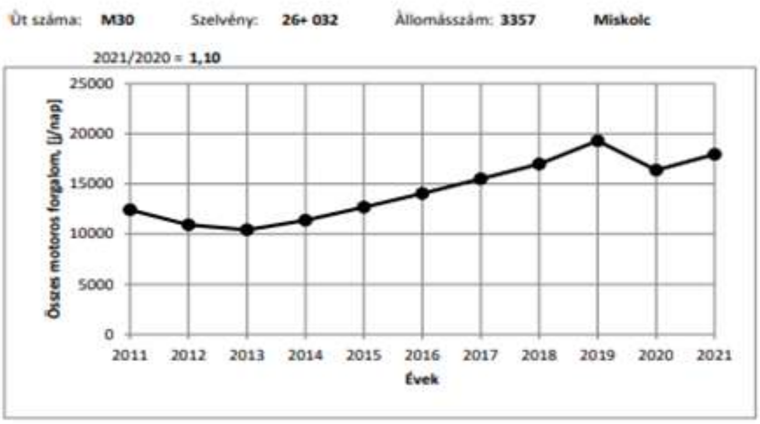
Decentralised access to services is expected to reduce the propensity to travel by car, which will have a significant impact on the achievement of decarbonisation targets.

A further priority development is the development of a comprehensive public transport system in Miskolc, and the promotion of micromobility in the urban area through regulatory instruments and awareness-raising.

Establish a zero emission zone in the city centre.
Switch to public transport and non-motorised transport

Road infrastructure developments in recent decades have sought to reduce urban transit traffic. This arterial road network needs to divert some of the transit traffic away from pendulum traffic as well as local traffic. The biggest problem for road transport is the road congestion in the Sinava Valley and the city centre.

Figure 18: Traffic development on the M30 motorway section 2011-2021



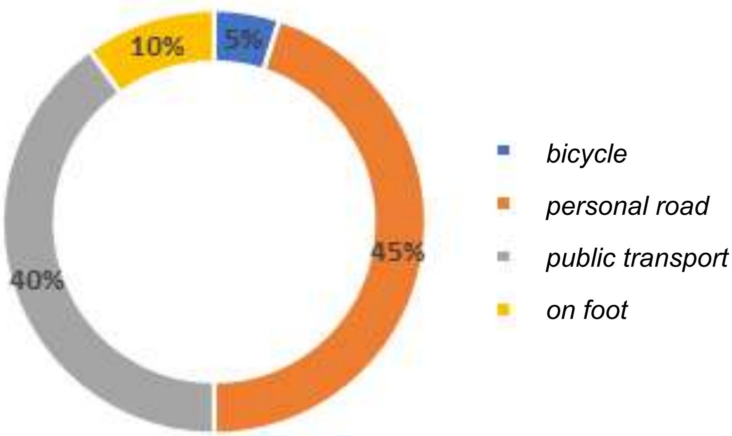
Source: Road Traffic Monitoring 2021, Hungarian Public Roads Nonprofit Ltd.

With a combination of multi-motivated traffic, the access sections of trunk roads are congested, inland areas are under capacity, causing congestion and consequently increasing environmental pressures (mainly air pollution along the trunk road network), and further deterioration is expected in the absence of intervention.

The city's network of cycle paths has been constantly expanding in recent years: in addition to the extensive routes in the city centre, the Bosch - downtown section, the Görmböly cycle path, has also been completed.

The preference for cycling in the city is steadily increasing, currently accounting for 5% of all travel modes. Its further expansion is limited by the fact that infrastructure is incomplete in the main directions and there is no coherent urban cycling network. Combined with pedestrian movements, the share of non-motorised transport is 15%.

Figure 19: Modal split in Miskolc



Source: review of Miskolc's Sustainable Urban Mobility Plan (SUMP)

One of the city's key transport development goals is to improve cycling. The current network of cycle paths in the city is 16.1 km long, of which only about a third are independent cycle paths (34.8%), with the majority being separated footpaths and cycle paths (57.7%) and cycle lanes (7.5%).

The long-term transport development concept planned the city's cycle path backbone network to improve cycling infrastructure, mainly by building new cycle paths.
A structured network of cycle paths is needed, with the levels of each network element defined. New cycle routes are under construction in Miskolc and in the surrounding municipalities, and there are plans to create cycling opportunities along the Szinva Green Corridor.

Electrification of cars and engines

Emissions from private transport have increased significantly, with private transport responsible for more than half of the emissions in this category. In Miskolc, free parking for electric cars supports the uptake of electromobility, but the share of electric cars in the total vehicle fleet is very low (0.4%).

Electrification of buses

Emissions from public transport will also be reduced by the CNG bus fleet and the 10 new electric buses that will join it in 2022. Under the transport company's decarbonisation plans, the bus fleet will be continuously modernised, with nearly 50% of existing buses scheduled for replacement by 2030 and full replacement by 2035.

Optimised logistics

Reducing freight traffic in the inner city areas. Defining load-based zones.
In relevant cases, rail diversion, utilisation of the potential of the ironworks railway in the case of Miskolc's urban districts, on the one hand, the possibility of creating integrated city centres should be created by means of urban planning instruments. In addition, in almost all of the designated locations, it is necessary to take municipal initiatives to develop public spaces and real estate.

Electrification of trucks

Expanding electric truck fleet. A gradual replacement of both the fleet of trucks below 3.5 tonnes (typically petrol) and above 3.5 tonnes with electric vehicles is needed. The business model projects a share of over 50% to be achieved by 2040, with a partial ramp-up to 2030.

WASTE MANAGEMENT - CIRCULAR ECONOMY

Increased waste recycling

The amount of solid waste disposed of in landfills with technical protection has been decreasing in recent years, in line with the increase in selective waste collection, and the resulting emissions have also decreased. The targets set seem realistic, there is no technological barrier in 2030, but resources will need to be mobilised.

Today, bio-waste accounts for 30% of household waste, and its separate collection from 2024 will in itself significantly reduce the amount of municipal waste going to landfill. Green and food waste from kitchens will be recycled in biogas plants, contributing to the circular economy by generating electricity and heat as a renewable energy source. In addition, the residues from the biogas plant, due to their high nutrient content, make excellent compost material for agriculture

In addition to the collection and transport of municipal solid waste, the range of waste management services available in the municipality includes selective waste collection, green waste collection, refuse collection and glass waste collection. There are also three waste yards and a recycling centre. For the main types of waste, the basis for material recovery is available. A part of the sorted waste will be thermally recovered after transfer to the recovery operators, and in the future it would be appropriate to replace this proportion by an increasing share of material recovery in line with the waste management hierarchy.

Table 8: Waste recycling rates (2021 - 2030)

	recycling rate	
	initial state	planned status
Paper recycling	70%	90%
Metal recycling	79%	89%
Plastic recycling	20%	85%
Glass recycling	60%	90%
Organic recycling	20%	70%

There is no local composting facility for green waste, but some households do compost in their gardens, which is helped by the composting frames provided.

Public awareness raising is carried out by NGOs alongside MiReHu Nonprofit Ltd., emphasising the importance of waste prevention and recycling.

Timeline

2023 - 24

- Urban GHG inventory
- CCC Action Plan and Investment Plan
- Creation of a Green Office
- Establishment of the Department of Energy
- Launch of a joint Pilot program with the City of Pécs
- Creation of a municipal decree for the treatment of energy poverty
- Introduction of mandatory food waste collection
- Circular business model

2025 - 26

- Urban hydrogen strategy of Miskolc
- District heating decarbonization strategy and business model of Miskolc
- Developed business model for the decarbonisation of the building sector
- Advanced neighborhood centers (implementation of the 15-minute city concept)
- Complete digital transition in public and road transport
- Expanding Reuse Center
- Operation of a complex environmental information system

2027 - 28

- Spread of electric heating solutions - gradual replacement of natural gas use
- Fully modernized public lighting
- Built-in smart grid and smart metering systems
- Expanded electrical network
- Emergence of energy communities
- Creation of a zero emission zone in the city center
- Construction of infrastructure supporting bicycle and pedestrian traffic
- Industrial symbioses

2029 - 30

- Decarbonized district heating - with minimal emissions
- Improving national energy mix - decreasing emission factor
- Spread of electric heating solutions - gradual replacement of natural gas use
- Increase in the share of energetically modernized buildings
- Block of flats Program
- The proportion of electric buses reaches nearly 50% in public transport
- Expanding ratio of electric cars and trucks

3.2 Module B-2 Climate Neutrality Portfolio Design

B-2.1: Description of action portfolios	
Fields of action Energy systems	Portfolio description
List of actions / *Subsector*	Descriptions
A1. Energy efficiency upgrading of residential, public and business buildings *Building renovations*	The average age of the **urban building stock is** high and as a result, a significant proportion of the building stock does not meet **modern energy standards,** or more problematic, is that these buildings are actually acting as energy sinks. This building stock includes public, corporate and residential buildings. A significant part of the public sector building stock has been renewed thanks to tenders in recent years, but there are still many energy-wasting buildings in the city that could be renovated to achieve significant energy savings. Businesses and residents are gradually renovating their buildings to the extent that they can afford, but it appears that only a negligible proportion of the building stock in these two segments has been renovated in recent times, partly due to lack of capital and partly due to lack of interest or ignorance, and that no significant change in scale is expected in the future in the absence of other motivating factors. For **residential buildings**, the **greatest potential for energy savings** lies in energy renovation and heating modernisation. By upgrading the residential building stock to improve energy efficiency, the NES estimates that up to a quarter of natural gas imports (2 billion m3 of natural gas consumption per year) could be replaced at national level. The ambitious target to reduce the use of natural gas in buildings is based on the fact that **more than two thirds of the current occupied housing stock is in need of energy upgrading** (almost one third is modern or economically unjustified). From 2021 (with a deferred introduction until 2024), the occupancy permit for new buildings will be required to meet the near-zero energy building standard under the Energy Performance of Buildings Directive 2010/31/EU and building renovations will have to be carried out in a compatible way. In line with the National Energy Strategy, Miskolc **plans to achieve a high energy efficiency and decarbonisation of its private housing stock by 2040** at the latest, i.e. to cost-effectively transform existing buildings into near-zero energy buildings. In Miskolc, 58% of the residential buildings are prefabricated, 32% of the total housing stock is between 50-59 m^2 and 20% between 60-79 m2. Currently only 1% of residential properties use heat pumps, but 18% already use air conditioning.

	In Miskolc, many **public buildings** have been **upgraded in terms of energy efficiency over the** years, but there is still a need for complex renovations, especially in the following areas: -social institutions -educational institutions -Health institutions -leisure and cultural facilities **Realisation of complex building energy modernisation of business and industrial buildings in** Miskolc. Under the intervention, an action programme will be launched with businesses in the city, especially local small and medium-sized enterprises, to achieve partial or full substitution of their own energy consumption with locally available renewable energy sources, and to access funds to improve the competitiveness of businesses. Under the project, businesses will receive technical assistance to prepare complex projects to apply for national programmes. Key actors concerned: citizens, businesses, public sector organisations, housing associations
A2. Smart grid and smart metering systems *Building renovations*	**Deployment of customer-centric smart metering** For all systems, the aim is to further develop the existing networks and, as a result of the developments, to organise the missing elements into a management system, a network, and to create integrated management and monitoring systems at city level. By creating a Smart Grid digital monitoring, analysis and planning system, the city will be able to integrate electricity producers and consumers into a single system, thus creating a "closed grid" to achieve full institutional energy independence in Miskolc by 2030. An urban energy management centre will ensure optimal operation of the system. Expansion of **smart metering in** the area of MVM Émász Áramhálózati Kft. The smart metering device, also known as smart metering, provides two-way communication, quarterly consumption and production data, as well as the possibility to control and switch the device. The data is transmitted via a closed system (non-public) telecommunication network to the metering centre of the distribution licensee, which processes, stores and transmits it to the billing system and to the traders and the system operator. The system provides customers with online, Internet access to metering data. The Hungarian RRF programme foresees the installation of more than 40,000 such meters by 2026. The revised NEKT aims to have 1 million smart meters installed in the country by 2030. Key actors involved: MIHŐ Kft., MIVÍZ Kft.

A3. Energy communities (design of PEDs) *Building renovations*	**Energy community - condominium solar distribution system** Many condominiums have significant unused roof space, so it is feasible to develop a system for the production and distribution of solar energy consisting of a roof-mounted solar panel system and a digital control box installed on each level. Within the system, internal information is transmitted to the central server via radio frequency, allowing wireless internet access. The technology distributes the electricity generated by the solar system installed on the building to each floor. The distribution is based on the pre-calculated consumption of the apartments, which means that it is possible to set the system up for increased consumption. The potential energy nodes in the city are unidentified, and this will also need to be addressed in the implementation of the CCC. According to the EU Energy Efficiency Directive, municipalities with a total population of more than 45,000 inhabitants are required to prepare a local heating and cooling plan, and nodes should be identified when preparing this plan. Key actors concerned: citizens, businesses, electricity suppliers
A4. Addressing energy poverty *Building renovations*	In Hungary, a wide section of society is in need of acute social assistance. Reducing social inequalities and helping energy-poor households can only be achieved in a series of interdependent, pre-planned steps. However, top-down measures are not enough, local initiatives play an essential role in tackling energy poverty. Energy poverty is a complex problem, and can be caused by high energy prices (where even a moderate income level puts a disproportionate burden on families to pay for utilities) and poor housing conditions, in addition to low household income. In Miskolc, 16 segregated areas have been identified in 2022, with nearly 10,000 people living in these areas, and addressing energy poverty is a priority for this segment. Local pilot programmes have already been launched (e.g. in the Ironworks area), but further regulation and support (e.g. micro-credit) are needed. Depending on the possibilities, it is also necessary to help people living in energy poverty to be able to apply and implement basic building energy solutions on their own property, even on their own. Key actors involved: the Municipality of Miskolc, NGOs
A5. Addressing energy poverty *Decarbonisation of heating*	Construction of firewood drying and storage facilities in Miskolc. Tackling energy poverty is a complex and long-term process, in which the self-organising communities of

	the neighbourhoods of Lyukó, Bábonyibérc and Tetemvár can be useful partners. Instead of simple firewood distribution, there is a need for district firewood drying and storage facilities and the transfer of firewood should be combined with knowledge transfer on proper heating. As far as possible, people living in energy poverty should also be helped to get access to suitable stoves. Key actors involved: the Municipality of Miskolc
A6. Developing a sustainable urban energy mix *Decarbonisation of heating*	**Connecting new consumers to the geothermal district heating system.** Based on Hungary's National Energy and Climate Plan, we also aim to double the amount of geothermal energy currently used by 2030. MIHŐ Ltd. serves several heat supply areas with independent larger heat production units, which are Avas, Belváros, Diósgyőr, Bulgárföld. The **Diósgyőr** and **Bulgárföld thermal plants** operate in island mode, using 100% fossil fuel (natural gas). The connection point of the two heat circuits is located within 3.5 km from the end point of the downtown district heating system. The interconnection of the systems will ensure their integration into a geothermal, renewable heat supply. The project will allow the replacement of two gas-fired boiler houses, creating a flexible heat generation system and a significant reduction in carbon emissions at city level by replacing the two gas-fired boiler houses and placing them in reserve. **Establishment of a geothermal system in the Miskolc Northern Industrial Area**: a feasibility study was carried out by MIHŐ Kft. to investigate the possibilities of renewable energy supply in the Miskolc Northern Industrial Area. According to MANNVIT Ltd., based on geological data and various previous investigation materials, a water base with a temperature of 50-75 °C and a production parameter of 50-150 l/sec at a depth of 1500-2000 m is predicted, which could result in an energy supply of 4.2-12.6 MW. The investment cost is estimated at HUF 4.5 billion. On the basis of the forecast technical parameters, the payback period of the investment could be 5 years with an annual heat sales of 120 thousand GJ with a 50% non-refundable subsidy. On the basis of the current legal environment and the preliminary results, MIHŐ Ltd. has carried out the delimitation of the area for geothermal exploration at the Regulatory Authority for the Supervision of Regulated Activities (SZTFH). The delimited area is 132.8 km^2 and is located between Sajóbábony-Sajóecseg-Sajópálfala-Felsőzsolca-Miskolc-Sajóbábony.

	Installation of an electric boiler in Diósgyőr: A 1.6 MW electric heater with thermal storage would be installed in the Diósgyőr heating plant by an external contractor. The electric heater would use the electricity generated by the solar parks operated by the contractor during periods when the system operator (MAVÍR) does not receive the electricity generated due to overproduction, and the contractor with the aggregator licence would then use it at an authorised point on the grid system. Since the availability of energy is completely unpredictable, a user is needed who can substitute part of his own consumption with this energy in winter and summer. The amount of electricity produced is planned to be 2150 MWh/year, with a correspondingly very cheap delivery price of 4-5 Ft/kWh. For MIHŐ Ltd., the costs of purchasing quotas for the amount of natural gas used for heat production and the associated CO_2 emissions will be reduced. Low-temperature network reconstruction improvements, decoupling of heat exchanges: the project aims at upgrading the urban district heating provider to reduce heat losses and increase the share of geothermal heat by choosing the right - lower - temperature and heat pipe for both the primary and secondary network. **Solar energy for electrolysis-based hydrogen production** The replacement of the gas-fired natural gas boiler with a new photovoltaic solar power plant with a capacity of 0.5-1 MW, which will provide the electricity for the electrolysis-based production of hydrogen. The water for water treatment can be obtained from dedicated wells in the vicinity of the reclaimed landfill. The hydrogen produced (or biogas produced from it) needs to be stored, mainly for buffering purposes, to meet the changing needs of the day. This requires the construction of a storage facility at the landfill site. The stored gas can be used in two ways: - depending on the amount of gas available and the heat demand, use in a gas engine or boiler in the boiler house in Futó Street, supplemented by natural gas if necessary - to generate electricity using hydrogen in a hydrogen fuel cell system (or other technology) built on-site next to the solar power plant and to balance the production schedule of the 1 MW solar power plant built in Phase 1. Key actors involved: MIHŐ Kft., Miskolc Municipality
A7. Heating decarbonisation (and electrification) programme *Decarbonisation of heating*	A comprehensive energy renovation programme for the urban building stock, including incentives, is needed to ensure a significant reduction in the amount of energy used for heating and cooling buildings, coupled with the use of renewable energy (solar panels, solar collectors, heat pump heating and cooling systems). In addition, the fact that 55% of

	district heating in Miskolc is already geothermal should be exploited, so that priority should be given to connecting buildings that can be profitably connected to the district heating system. The share of geothermal could be increased to 80-90% by the end of the decade. The urban building energy programme should include an energy assessment of the entire urban building stock, both from a technical and an energy consumption point of view, in order to first phase out the buildings that can achieve the greatest specific energy consumption reduction. In terms of share, the reduction in residential final energy consumption will be most significant for natural gas, with the planned measures expected to **reduce residential natural gas consumption by** around 40% between 2023 and 2030, and almost eliminate it by 2040. Thanks to energy efficiency investments, electricity and biomass use will also decrease more significantly, and the amount of electricity used by heat pumps will increase several-fold by 2030. Nationally, residential gas consumption fell to a nine-year low of 3 billion cubic metres in 2022, due to the mild winter and the savings made by households. This represents a 25 percent decrease since 2021. This reduction has been reflected at the city level, so there have been significant positive changes in energy awareness among the population. Key actors concerned: citizens, businesses, electricity suppliers
A8. Use of renewable energy for heating *Decarbonisation of heating*	In Miskolc, further expansion of renewable generation can build on the two locally available renewable energy sources, geothermal and solar, to further integrate them into energy production. In addition to geothermal energy, there are already several small and large solar thermal power plants in the city, as well as one solar power plant that is not a solar thermal power plant. In order to further exploit solar energy and to achieve greater energy independence, it is necessary to install solar systems of HMKE size on as many buildings as possible and to build more solar power plants larger than HMKE. In order to maximise real energy independence, these solar PV systems also need to provide on-site storage of the electricity generated (which obviously increases investment costs, but can provide real energy independence). Significantly lower energy savings and production in terms of volume can be achieved with solar collectors, which assist in the production of domestic hot water. In this case, it is necessary to assess which buildings have a volume of hot water consumption that makes it worth installing solar collectors. The city can be supplied with a large part of its heating energy by 2040 from renewable sources, relying on geothermal and solar energy. This requires the

	preparation of a concept for energy production and supply and a programme for the development of energy communities. Key actors involved: MIHŐ Kft., Miskolc Municipality, residents, electricity suppliers
A9. Network development *Decarbonising electricity generation*	Developing **a flexible and secure electricity network to** serve the electrification process and the transition Target on the high-voltage grid - installation of new trail network due to photovoltaic (PV) integration - Increasing existing grid transmission capacity due to PV integration - interventions needed to increase security of supply as well as power point condensations - medium/low voltage transformer replacement for connection of small household solar power plants (HMKE) to the grid, transformer replacement for transformer extension and replacement to a regulating transformer - interventions needed to increase security of supply For low voltage (LV) network developments, the - line laying, cross-section increase, line replacement and line voltage regulator installation due to small household power plants (SMPP). Key actors concerned: electricity suppliers
A10. Installation of grid energy storage *Decarbonising electricity generation*	Encourage investment in **grid energy storage capacity** potentially available in the balancing energy and balancing capacity market. Aim at integrating weather-dependent renewable energy sources. Key actors concerned: electricity suppliers
A11. Residential, institutional and business LED and equipment replacement programme *Efficient lighting and equipment*	The Municipality will continue the programme, which started in 2022, with six thousand Miskolc residents registered in the first round and nearly two thousand more in 2023. Some seventy-eight thousand LEDs have been distributed to them. The more modern light bulbs distributed as part of the successful replacement programme have resulted in lower consumption and thus lower electricity bills for Miskolc families (savings of 3,000 MWh hours, which represents more than HUF 250 million for households). It is planned to involve the business sector in the programme. Key actors involved: the Municipality of Miskolc
A12. Modernisation of street lighting *Efficient lighting and equipment*	In Miskolc, around 19,000 street lights provide safety lights. Passive and active elements of the street lighting network are in mixed ownership. Of the passive elements, the cables and poles are owned by ÉMÁSZ Nyrt.; the active elements (luminaires) are also mixed ownership. The intervention would mean a **complete urban LED replacement** programme, i.e. all public lighting fixtures that have not been replaced so far. The programme has been continuously implemented since 2015, and the installation of new LED luminaires has already

	improved traffic and public safety conditions in many areas of Miskolc, while at the same time the modernisation will significantly reduce the city's energy consumption for street lighting by about 1,000,000 kW/h per year, equivalent to the annual electricity consumption of nearly 5,600 households. Key actors involved: the Municipality of Miskolc, electricity suppliers
A13. Hydrogen strategy - clean hydrogen and hydrogen technologies for industry *Decarbonisation of industrial processes*	Regional development of the hydrogen economy, which contributes to the decarbonisation of the electricity sector and the greening of transport. Targeted R&D&I activities are needed to support the success of the hydrogen economy in the transition. **High-volume, carbon-free and low-carbon hydrogen production**. Decarbonisation of industrial use - Greening of industrial production processes and product use, initially using mainly low-carbon hydrogen, and in the longer term decarbonising by switching to hydrogen. Two so-called **hydrogen valleys** have been identified in Hungary, one of them is the North-Eastern Hydrogen Valley, characterised by a strong chemical and petrochemical industry (Miskolc-Tiszaújváros-Kazincbarcika axis). Hydrogen will need to be used in industries that are difficult to electrify and typically energy-intensive, in particular in the chemical, steel, cement, glass and ceramics industries. In 2023, the University of Miskolc and FGSZ Natural Gas Transmission Ltd. The Flumen project, which is planned to run for two years, will investigate the transport possibilities of the hydrogen-natural gas mixture throughout the entire Hungarian natural gas system. The aim of the two-phase programme is to build, test and trial system components that will enable the local transport of natural gas with a maximum hydrogen content of ten percent. Hydrogen can be blended with natural gas to provide energy storage and reduce greenhouse gas emissions from natural gas use. *Industrial Technology Exchange Programme* Replacing existing technologies and manufacturing capacity with green, low or zero emission technologies. Key actors involved: the University of Miskolc, businesses

B-2.1: Description of action portfolios - textual or visual	
Fields of action Mobility & transport	Portfolio description
List of actions / *Subsector*	Descriptions
A14. Development of transport infrastructure for sustainable urban mobility - development of fixed rail transport *Switch to public transport and non-motorised transport*	**Development of an interconnected electricity network** North-south rail axis to be implemented with an interconnected design, building on the existing east-west axis. The first stage will be the connection of Búza Square to the existing east-west axis. The second phase is the construction of the entire axis from Búza Square to the northern city limits and from the lighthouse to the Tapolca junction in the southern direction. The north-south axis should be designed to accommodate the tram-train on the Kazincbarcika Miskolc Tiszaújváros line, if it is built later. Both lines will serve a high public transport demand, taking up a significant volume of private transport and bus traffic. Along the axis there are destinations which are the most frequented due to their role as the county seat and are also busy destinations within the city (Northern Industrial Area, County Hospital, Búza Square, downtown, Semmelweis Hospital, Tapolca junction). **Explore the possibility of a tram-train,** with decentres at city gates, so that long-distance traffic is not concentrated in the city centre. Suburban transport development, commuter rail stops at MIDIP and MIP. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors
A15. Development of transport infrastructure for sustainable urban mobility - Cableway to Avas *Switch to public transport and non-motorised transport*	**Construction of the Cableway to Avas** The Avas, the "mountain" of Miskolc, is quite problematic from a transport point of view, the hill being sharply prominent from its surroundings and accessible only via serpentines. In the late 1970s and early 1980s, the largest housing estate in the country was built on this relatively inaccessible site. The Avas is now home to nearly 40,000 people. With the construction of the cable car, an alternative solution has been developed that would provide a new, direct connection between the top of the hill and the city centre. It is planned that the lift would be built between the Town Hall Square and the Avas Roof and would also be connected to the bus terminus at the Avasi Lookout. The 12-seat capsules would also be suitable for transporting bicycles and prams. The cable car would not only play a tourist role, but would also provide public transport as the shortest route between the 40,000 inhabitants and the city centre. The project is expected to be funded by the European Union.

	Key actors concerned: Miskolc MJV, MVK Zrt., public actors
A16. Redesign of the urban parking system *Switch to public transport and non-motorised transport*	**Comprehensive improvement of the parking system** Increase the utilisation of existing **P+R parking spaces** in peri-urban areas, develop missing infrastructure on the east-west and north-south axes. Develop a separate structured P+R system for the city centre. Key actors involved: the Municipality of Miskolc MJV, Miskolc Municipal Landlord Nkft.
A17. Integrated development of urban modal hubs *Switch to public transport and non-motorised transport*	The aim is to **alleviate through traffic** (transfer to an intermodal hub), to build bypasses (relief roads), which will allow the space to be transformed (e.g. green island) or to expand its functions. **Implementation of the Intermodal Modal Connections System (IMCS)** The Intermodal Modal Hub (IMCS) development concept aims to reduce traffic around Búza Square, thereby reducing local air pollution. In the long term, it is envisaged that Búza Square will be transformed into an elevated bus station, serving only as a stop and transfer point for local, intercity and long-distance bus services, and will no longer be used for bus storage. Local, intercity and long-distance bus services and train services will be linked by a system of intermodal hubs, with intermodal services running in parallel. The buses will be stored in the existing premises of Volán and MVK. Following the development, new functions will be added to Búza Square, and green space will be created. The planned investment is also included in the government's development plans. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors
A18. Digital transition in public and road transport *Switch to public transport and non-motorised transport*	**Introduction of an intelligent traffic management system** The main objective of the project is to develop a road measurement and processing system on the Miskolc road backbone network, which will perform continuous and automatic traffic measurement and processing for further objectives. Currently, traffic counts in Miskolc are done manually, and the National Road Data Base (OKA) also contains information on Miskolc. The Magyar Közút Nonprofit Zrt. carries out annual cross-sectional traffic counts and estimates on the national roads, but the OKA data are not sufficient for traffic planning and management purposes, as they are both average daily traffic (ADT) averaged per cross-section in both directions and do not fully cover the city's backbone network (as they only refer to the national roads managed by the Magyar Közút Nonprofit Zrt.).

	The project will implement an intelligent road traffic measurement and processing system, which does not require external human resources and is capable of continuous (real-time) and automatic measurement. The system to be developed is multi-purpose. On the one hand, it will provide a high quality traffic information database and, on the other hand, it will directly contribute to the strategic objectives of the soon-to-be established traffic management centre in Miskolc and the social goals it will help to achieve, in support of the overall Smart City programme. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors
A19. Road and cycle path improvements *Switch to public transport and non-motorised transport*	Miskolc's settlement structure, the location of the city centre and the tourist areas (Miskolc-Tapolca, Diósgyőr) are ideal for sustainable pedestrian and cycling transport, so the development of pedestrian and cycling infrastructure and the renovation of deteriorated sections should be continued. It would be important to develop a properly functioning pedestrian and cycling axis, possibly along the Sinava. The planned network of national and county cycle paths will affect Miskolc, mainly in an east-west direction. There is also a need to build cycle paths and strengthen north-south cycling links. It is also important to implement a complex programme to promote cycling (cycle-friendly workplaces, secure bicycle storage and rental facilities, e-bike system, community scooters). In view of the large number of vehicles and the heavy urban traffic, it is of the utmost importance to improve the city's road network. Further construction of bypasses, upgrading of the capacity of the relief road network, additional high capacity systems (tramways, bus corridors), and the creation of parking areas to alleviate traffic. Primary improvements : - Upgrading and extension of the existing section of the Northern Relief Road (from Autóklub to Búza Square) - Transport solution for the city centre - Diósgyőr (east - west) axis - Implementation of a north-south bus corridor on the Csabai kapu - Kazinczy axis, from the Tapolca junction to Petőfi tér - Eastern extension of the Y-bridge - Four-laning of Futó Street from the Cement Factory junction to the University junction Implementation of new bicycle path network elements (east-west axis on the southern side of the Sinava (Sinava green corridor), Diósgyőr-Lillafüred, Eastern Gate (Felsőzsolca) - Tisza railway station, Búza Square, Martin-Kertváros main axis (Kisfaludy utca or alternative route), Szirma-South Auchan, Tapolca junction - South gate (road 3), Avasi housing estate main spine (Klapka György and Szent György utca)

	Key actors involved: the Municipality of Miskolc, public actors
A20. Enhancing micromobility *Switch to public transport and non-motorised transport*	Construction of a public transport system in Miskolc. Promoting urban micromobility through regulatory instruments and awareness-raising. Key actors involved: the Municipality of Miskolc, NGOs
A21. Developing an electric bus fleet for public transport *Electrification of buses*	Continuation of the Miskolc Green Bus Programme: creation of a dynamic electric bus transport system in the local transport decentres of the city of Miskolc, creation of an electric bus line network on the main urban rail network, creation of a network on the North-South public transport axis of Miskolc. **This will require the replacement of the entire current bus fleet with electric buses in 2 major phases, 46% of the existing fleet by 2030 and 100% by 2035, based on the transport company's current decarbonisation plan for 2022 (based on the economic model, this process needs to be accelerated as much as possible and commitments met by 2030)** Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors
A22. Developing charging infrastructure for public transport *Electrification of buses*	**The electrification of** the transport sector's vehicle fleet can only be achieved if **charging infrastructure capacity is** gradually built up in parallel with the development of the network. Currently, 10 charging heads and satellites have been installed at the transport company's site, but significant network upgrades and green energy expansion will be needed to provide charging capacity for the expanding electric fleet. Based on the operator's practical experience, charging 350 kWh batteries with sufficient range will result in significant energy uptake if all buses are charged simultaneously. Thus, the development of the charging infrastructure does not only involve the installation of charging poles and connection to the electricity grid, but also the capacity to take the energy needed for charging from the distribution network. Carbon neutrality therefore requires that we fill the buses with energy produced without carbon emissions. At MVK Zrt's site, a project to use the entire roof space for green energy production and charging of electric buses is already underway, expected to be completed by 2025, and further projects are being planned to achieve this. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors
A23. Enhancing electromobility in the private sector - individual car traffic *Electrification of cars and engines*	At the national level, more incentive regulations and support schemes are needed to help replace the existing car fleet.According to a 2023 survey, the average age of cars in Hungary is currently 16 years. The majority of individuals cannot afford to buy an electric vehicle for their next car. Miskolc currently has

	0.4% of electric cars in the total number of vehicles on the road. By 2040, at least 40% should be achieved based on the model. Key stakeholders concerned: population
A24. Development of urban charging infrastructure network *Electrification of cars and engines*	There are 28 charging stations in the city and their continuous expansion will also be a key issue in the coming years. To this end, nationally funded programmes will be launched. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors, businesses
A25. Enhancing electromobility in the private sector - freight transport *Electrification of lorries*	In the year 2021, there were 7,337 trucks in circulation in Miskolc, of which only 253 were petrol and 7,084 diesel trucks, typically with a gross vehicle weight of over 3.5 t. The majority of urban truck traffic is related to construction, trade and logistics. For these sectors, EU directives and public incentives, as well as the commitment of companies, will also help the switchover process. The aim is to replace at least 50% of the current fleet with electric vehicles by 2040. Key actors concerned: businesses
A26. Reducing freight traffic in inner city areas *Optimised logistics*	In the case of freight transport, incentive schemes are also needed, as there are other motivations linked to these users (typically construction, trade) and therefore significant results can be achieved by changing the regulatory environment. Load-based zoning, (urban management issue, do not bring in new truck traffic with investments, this is a priority for logistics investments). Where relevant, diversion to rail, exploiting the potential of railway siding. Key actors involved: the Municipality of Miskolc
A27. 15-minute city (parts) concept *Reduced demand for motorised passenger transport and increased car use*	In the case of Miskolc's urban districts, on the one hand, the possibility of creating integrated city centres should be created by means of urban planning instruments. In addition, in almost all of the designated locations, it is necessary to take municipal initiatives to develop public spaces and real estate. In some parts of the city, these developments are squares or chains of squares, in others they are routes or axes. In the centres, there is a need to create opportunities for investment and to make these opportunities attractive to civil and economic operators. For each district centre, development directions will be defined according to the functions of the district, with a focus on green infrastructure improvements and the provision of various services. Concentrated access to services reduces the propensity to travel by car, which has a significant impact on achieving decarbonisation targets. Key actors involved: the Municipality of Miskolc
A28. Traffic damping	Traffic calming in the city centre

Reduced demand for motorised passenger transport and increased car use	Significant traffic calming is needed on the east-west routes in the city centre (Palóczi - Horváth Lajos, Régiposta, Madarász streets). This is particularly justified by the ring road around the city centre, which has already been completed with the Dayka interchange. Traffic calming in residential areas, in some neighbourhoods. Traffic calming in the Lillafüred priority tourist destination area. Key actors involved: the Municipality of Miskolc
A29. Hydrogen strategy - clean hydrogen and hydrogen technologies for transport *Greening public transport*	Regional development of the hydrogen economy, which contributes to greening transport. Targeted R&D&I activities are needed to support the success of the hydrogen economy in the transition. In line with the national strategy, the first industrial pilots producing mainly low-carbon (blue) hydrogen with CCS technology will be operational by 2030. New hydrogen user segments will also emerge: transport and natural gas substitution (or blending). These will typically use green hydrogen. By 2040, there will be a ramp-up in the use of carbon-free hydrogen and transport. **Greening transport** - Accelerate the shift to cleaner modes of transport by phasing out diesel and introducing hydrogen, coupled with fuel cells. In our region, we are piloting the promotion of fuel cell buses and waste collection vehicles in local public transport and municipal waste collection, primarily through the extension of the Green Bus Programme and the launch of local mobility programmes. BOSCH is running a Hungarian representation project in hydrogen production and cell development in cooperation with the University of Miskolc, which is also an important opportunity for Miskolc. In the framework of a local hydrogen production pilot project: 10-20 hydrogen-powered buses free of charge, and a fuel production plant in one of the surrounding municipalities. In another pilot project, HUMDA Hungarian Mobility Development Agency, with the support of the Ministry of Energy, is investigating the possibilities of using hydrogen fuel cell buses in public transport: in addition to the capital's agglomeration, hydrogen fuel cell buses will be put into service in Debrecen, Győr, Kecskemét, Kaposvár, Miskolc and Zalaegerszeg. Volánbusz will test Solaris hydrogen buses on its intercity routes in several cities across the country, including Miskolc, for at least six months from 22 January 2024. Key actors involved: the Municipality of Miskolc, MVK Zrt., public actors

B-2.1: Description of action portfolios - textual or visual	
Fields of action Waste & circular economy	Portfolio description
List of actions / *Subsector*	Descriptions
A30. Development of modern regional waste management *Increased waste recycling*	In order to meet the waste management targets, in addition to reducing the amount of waste generated, a drastic increase in the recovery rate of municipal waste is needed, which requires further developments and investments in the waste management sector. The new separate collection schemes must meet strict requirements for waste streams (textile, bio and hazardous). The implementation of the intervention will be determined by a single waste management concession system that will give the whole sector control. The development of the system, the development of yards, vehicles and equipment will be needed to provide for the compulsory separate collection of textiles (by 2025), the compulsory separate collection of bio-waste and its collection and recovery at source (by the end of 2024) and the separate collection of household hazardous waste (by 2025). The recovery rate of construction and demolition waste should also be increased. Construction of an inert waste processing plant in Miskolc. In the field of selective waste collection, a system of returning plastic and metal bottles will be introduced in a graduated system from January 2024.Free bottles will be introduced for producers and distributors by the end of June 2024, after which a return fee of HUF 50 per bottle will be charged. (In Slovakia, the system has been in place since 1 January 2022, with a 15 cents per bottle redemption fee, with a rate of over 60% in the first year, and a rate of 93% in 2023, with over 1 billion bottles redeemed. In addition to reducing pollution (significantly less landfilled waste), the new system has also saved several 100,000 euros per year in public space cleaning costs). Key actors involved: MOHU MOL Hulladákgazdálkodási Zrt., MiReHu Nkft., population
A31. Expansion of biogas utilisation	The complex development and capacity increase of the wastewater treatment plant and biogas plant could improve the efficiency of the utilisation of the organic matter content of the sewage sludge for energy purposes. This is also necessary for the processing of food waste collection, which will be extended from 2024. The biogas plant is currently only sufficient to cover the energy needs of the wastewater treatment plant. Its expansion will allow the production of part of the surplus biogas, which can be used locally for electricity and associated waste heat. An alternative way of using biogas could be to transfer it to the CHP for the production of thermal energy for buildings, or

	even to the MVK for the alternative fuel supply of LNG buses. The waste heat from the gas engine could be sold as district heating to cover the cooling needs of a cold store through an absorption chiller system. A further step in the recovery process could be the production of pellets from the sewage sludge left over after biogas production, after appropriate drying, and its subsequent energy recovery. The waste heat from the gas engine burning the biogas could be used to dry the sludge. In a complex system, power-to-gas technology can even be used to produce hydrogen to charge hydrogen-powered buses. Key actors concerned: MIVÍZ Kft.
A32. Programme package to support the transition to a circular economy *Increased waste recycling*	The aim is to make the city and the urban area a model of good practice for cities and regions in the circular economy. The intervention will include identifying opportunities for industrial symbiosis and supporting initiatives in this direction, promoting local solutions for the sharing economy, and encouraging the start-up and establishment of businesses that accelerate the circular economy transition. The aim is to minimise waste through the exchange of materials, energy and by-products, and to help businesses operate more economically through exchange, thereby giving them a competitive advantage in the region. In partnership with local small and medium sized enterprises, replace single-use plastic and other products with reusable products. The region also wants to be at the forefront of developing new technologies for the circular economy and producing new products. The city, together with the University of Miskolc, wants to be an active player in the transition to a circular economy. The development of the Reuse Centre in Miskolc will continue in the coming years. The first re-use centre in Eastern Hungary, the Miskolc Re-use Centre, has been operating for four years In the last three years, MiReHu has found new owners for nearly 75,000 pieces of equipment, toys and furniture. This year, almost as many donations were received as in the two years following its opening. In the year 2022, more than 4,500 people have chosen to replace old items with new items and furniture. The reuse centre works on the principle that people donate items that are still in usable condition but are no longer needed to the reuse centre, where others can acquire the items for the same purpose. Key actors involved: the Municipality of Miskolc, the University of Miskolc, public actors, businesses, MiReHu Nkft.

A33. Local economic development programmes	The aim of the intervention is to ensure that the needs of the urban and peri-urban population are increasingly served by businesses in the area, increasing employment and the amount of capital that is circulating locally. An important aspect of development is to encourage the sale of rural raw materials to urban markets and businesses in cities and to encourage the free labour force to locate in cities. Short supply chains ensure higher profits for local assemblers through fewer players, while also reducing negative environmental externalities from transport. In addition to the local markets run by the city, farmers' markets, local produce shops, and community shopping opportunities should be further developed. Key actors involved: the Municipality of Miskolc, BOKIK, producers, NGOs, Miskolc Municipal Land Management Ltd.
A34. Circular food management *Increased waste recycling*	Develop and implement a city-region food strategy. In addition to promoting local products and short supply chains, the focus is on preventing significant food waste and unjustified waste production. Urban food material flows should be assessed, identified and an action plan developed. Pilot areas (Miskolc-Szirma) where separate collection of household food waste and its recovery in a biogas plant have been in place for a year, with separate collection to be ensured throughout the city from 2024. It would also be necessary to fully implement the collection and recovery of food waste from institutions (health, education, social). Key actors involved: MOHU MOL Hulladákgazdálkodási Zrt., MiReHu Nkft., MIVÍZ Kft.
A35. Adaptive re-use of buildings	Adaptation and reuse of existing buildings as an alternative to demolition and new construction has become a key issue in the face of climate change. Looking at the whole life cycle of a building in Hungary, 40% of emissions are generated during its construction, before it is ready for use. This means that it can take up to 30-50 years for a building to "overcome" the emissions generated during its construction. "*If we all start to consider reuse from the very beginning, we open up new territory for creative approaches that we might not otherwise consider.*" (*R. Lang)* One of the biggest advantages of adaptive reuse over historic preservation is the flexibility to use new, effective building materials while paying homage to the building's history. This approach improves building performance while reducing carbon emissions. Development of innovative demolition waste management systems (e.g. demolition monitoring, building materials bank, certification systems)

	Key actors involved: the Municipality of Miskolc, businesses

B-2.1: Description of action portfolios - textual or visual	
Fields of action Green infrastructure & nature-based solutions	Portfolio description
List of actions	**Descriptions**
A36. Integrated development of municipal green and blue infrastructure	Reduction of paving, greening and re-greening of public spaces and publicly used areas owned by the municipality (especially in the case of inner-city areas, to reduce the thermal insulation effect) Rehabilitation of green spaces and green areas, reconstruction of tree-lined areas Developing green spaces for community purposes Improvement of water areas (restoration of the valleys of the Northern valleys (Pece branches) to their natural state, rehabilitation of the watercourses of the Fountain Valley, Bábonyi-bérc, Bedegh Valley, making them suitable for recreational and leisure activities. Implementation of the Szinva green corridor: providing alternative transport options (on foot, by bike, skateboard), serving special needs (dog walking, pushchair transport); creating sub-centres near water (Keleti kapu, Selyemrét, Belváros, Győri kapu, Újgyőr-Vasgyár) Construction of the water and wastewater network in the Avasi basement (Upper, Middle and Lower rows of Nagyavas). Key actors involved: the Municipality of Miskolc MJV, Miskolc Municipal Property Management Ltd., NGOs
A37. Sustainable water management	The drinking water supply of Miskolc is mainly based on the karst waters of the Bükk. The karst water is extracted in gravity waterworks and pumped waterworks. Improvements to the ultrafiltration of the drinking water base should also be implemented at the following karst springs: the Sinva spring (600 m3/hour capacity), the Tavi spring (400 m3/hour capacity), the Ómassa spring (5 m3/hour capacity). In some suburban areas of Miskolc there are no utility networks (e.g. Lyukóvölgy), in residential areas drinking water must be provided and sewage connections must be provided within a 150 m radius. Drinking water network reconstruction - a priority due to high network water losses. The aim is to reduce the demand for water from the population, save water and promote the use of rainwater and greywater. Key actors concerned: MIVÍZ Kft.

B-2.1: Description of action portfolios - textual or visual	
Fields of action Built environment	As part of energy systems, 1 focus area will be highlighted
Portfolio description	
List of actions	Descriptions
A38. Redevelopment of brownfield sites	In and around Miskolc, there are four major brownfield areas that can be distinguished. Three of them (DAM, DIGÉP, Lyukóbánya) are located in the vicinity of each other. The industrial district was originally built on the outskirts of the city, between Diósgyőr and Miskolc, but the municipality has 'built around' it. The metallurgical site, covering almost 200 hectares, and the 45-hectare DIGÉP site are located in the centre of the town. The former ironworks and its successors essentially ceased their activities in the last decades of the last century, which had a significant impact on the life of the town during their period of operation. The change of function of the site is made difficult by the fact that it is densely built-up and much of it is underused. The fourth area is the so-called North-East Industrial Area, covering an area of almost 300 ha. The University of Miskolc is actively investigating the potential for the recultivation of these brownfield sites (mainly DAM). The aim is to develop a long-term zoning plan for the area as a whole, with both functional change and industrial use. As a minimum, the first step of the intervention is the construction of an exploratory road, as defined in the urban development plan, but the road construction is not aimed at urban regeneration, but at the use of the explored areas for economic development. Interventions can be linked to both building renovation/re-use and green space improvements, depending on the mix of functions in each brownfield site. Key stakeholders: the Municipality of Miskolc, the University of Miskolc, businesses

B-2.2: Individual action outlines		
Action outline	Action name	A1. Energy efficiency upgrading of residential, public and business buildings
	Action type	Infrastructure interventions, technology, national and/or EU laws and regulations, business model
	Action description	Continuous deep renovation of the urban building stock for energy efficiency until 2030 and 2040 (In the last 10 years, 30% of the 80,000 or so dwellings have undergone light or partial renovation (3% per year), while the number of medium renovations is much lower, at 1-5%, and the number of deep renovations is negligible.) To make the programme a success, we expect an annual deep renovation rate of 4.5%.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology - Construction Regulation - policy Social innovation Financial financing
	Outcome (according to module B-1.1)	4% building stock renovation per year; Implement pilot projects; Running a green office, building presentation
Implementation	Responsible bodies/person for implementation	Individuals Public sector Businesses
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Electricity suppliers, construction companies, financial financiers (banks, insurance companies)
	Comments on implementation	Based on broad cooperation, change is needed at the level of governance, regulation and individuals.
Impact & cost	Generated renewable energy (if applicable)	Geothermal, solar, heat pump
	Removed/substituted energy, volume, or fuel type	345 000 MWh natural gas, electricity
	GHG emissions reduction estimate (total) per emission source sector	24% 69 700 tCO_{2e}
	Total costs and costs by CO2e unit	384 million EUR approx. EUR 5.500/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A6. Developing a sustainable urban energy mix
	Action type	Infrastructure interventions, technology, national and/or EU laws, municipal regulations, business model
	Action description	The extension of urban geothermal district heating to those parts of the city where it is technically and economically feasible (Bulgaria, Diósgyőr), thus almost fully replacing the

		current fossil (natural gas) based heat generation. Another important element is the further development of the urban biogas plant, the creation of a solar park in the area of the wastewater treatment plant.
Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology - Construction Regulation - policy Social innovation Financial financing
	Outcome (according to module B-1.1)	Smart grid and metering systems; Decarbonised district heating service, further increased share of geothermal in district heating; energy communities; Recovery of sewage sludge; Power-to-gas technology using hydrogen production;
Implementation	Responsible bodies/person for implementation	Miskolc Heating Services Ltd (MIHŐ) Miskolc Waterworks Ltd (MIVÍZ)
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Citizens, institutions, businesses
	Comments on implementation	It requires the involvement and cooperation of local service providers, the city and the government level, based on broad collaboration.
Impact & cost	Generated renewable energy (if applicable)	Geothermal, solar, heat pump
	Removed/substituted energy, volume, or fuel type	204 000 MWh natural gas, electricity
	GHG emissions reduction estimate (total) per emission source sector	14% 41 208 tCO_{2e}
	Total costs and costs by CO2e unit	128 million EUR approx. EUR 3.100/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A7. Heating decarbonisation (and electrification) programme
	Action type	Infrastructural interventions, business model
	Action description	In terms of share, the reduction in final residential emissions will be most significant in the case of the reduction and then phase-out of natural gas, with the planned measures expected to reduce residential natural gas use by around 40% between 2023 and 2030, before it is phased out completely by 2040. With the large uptake of heat pumps to replace fossil-based heating, the amount of electricity consumed will increase several-fold by 2030, so it is important to continue to develop household-scale solar PV systems and to promote the development of local storage capacity, in line with the evolution of the national energy mix.

Reference to impact pathway	Field of action	Energy systems
	Systemic lever	Technology - Construction Regulation - policy Financial financing
	Outcome (according to module B-1.1)	Deployment of highly decarbonised heating systems in the city, which will phase out the use of natural gas.
Implementation	Responsible bodies/person for implementation	Individuals Public sector
	Action scale & entities addressed	Total urban area
	Involved stakeholders	MIHŐ Ltd. Municipality of Miskolc MJV Electricity suppliers, construction companies
	Comments on implementation	Based on broad cooperation, change is needed at the level of governance, regulation and individuals. Strong education and awareness-raising are needed.
Impact & cost	Generated renewable energy (if applicable)	Solar energy, heat pump
	Removed/substituted energy, volume, or fuel type	172 600 MWh natural gas
	GHG emissions reduction estimate (total) per emission source sector	12% 35 000 tCO_{2e}
	Total costs and costs by CO2e unit	128 million EUR approx. EUR 3.650/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A23. Enhancing electromobility in the private sector (private cars and freight)
	Action type	National and/or EU laws, municipal regulations, business model
	Action description	In 2021, the share of pure electric cars in the total urban vehicle fleet was 0.4%. The aim is to achieve at least 10-15 times the national growth projection (8 times growth). Use regulators and incentives to facilitate the transition for both individuals and businesses involved in freight transport.
Reference to impact pathway	Field of action	Mobility and transport
	Systemic lever	Regulation - policy Financial financing
	Outcome (according to module B-1.1)	The share of pure electric vehicles reaches 15%.
Implementation	Responsible bodies/person for implementation	Individuals
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Financial financiers (banks, insurance companies)
	Comments on implementation	Based on broad cooperation, change is needed at the level of governance, regulation and individuals. Banking products, government subsidies need to be introduced.

Impact & cost	Generated renewable energy (if applicable)	-
	Removed/substituted energy, volume, or fuel type	diesel and petrol
	GHG emissions reduction estimate (total) per emission source sector	10% 19 000 tCO_{2e}
	Total costs and costs by CO2e unit	256 million EUR about EUR 13.470/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A14. Development of transport infrastructure for sustainable urban mobility - development of fixed rail transport
	Action type	Infrastructure interventions, technology, national and/or EU laws, municipal regulations, business model
	Action description	The clear objective is to develop rail transport and to create a transport system that integrates traffic management, parking, public safety and defines the role, functions, objectives, medium and long-term development directions of the city in the regional convergence. The operation of the system will reduce unnecessary mileage and unnecessary downtime, thereby significantly reducing the sector's emissions. In addition to the planned infrastructure investments, it is of paramount importance to ensure a high quality of service so that public transport is a real alternative for those who currently use private transport.
Reference to impact pathway	Field of action	Mobility and transport
	Systemic lever	Technology - Construction Regulation - policy Financial financing
	Outcome (according to module B-1.1)	Developed transport infrastructure that prioritises decarbonisation goals.
Implementation	Responsible bodies/person for implementation	Miskolc Municipal Transport Ltd (MVK Zrt.) Municipality of Miskolc MJV Hungarian Public Road Ministry of Construction and Transport Bus MÁV Zrt.
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Transport operators, electricity grid owners, fleet owners, property and land owners, charging infrastructure providers, etc.
	Comments on implementation	A complex, sophisticated planning process involving public stakeholders, public acceptance, strong education and awareness-raising is needed.
Impact & cost	Generated renewable energy (if applicable)	Solar energy

	Removed/substituted energy, volume, or fuel type	diesel, petrol, CNG
	GHG emissions reduction estimate (total) per emission source sector	20% 38 000 tCO_{2e}
	Total costs and costs by CO2e unit	205 million EUR approx. EUR 5.390/CO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A18. Digital transition in public and road transport
	Action type	Infrastructural interventions, technology
	Action description	Intelligent traffic management is essential to compensate for increasing traffic and to ensure the smooth flow of traffic, resulting in significant CO_2 savings in the transport sector. With the right sensors and information and analysis systems, urban road traffic can be managed more efficiently and safely. The digital switchover also includes the introduction of an urban e-ticketing system. With the introduction of the electronic ticketing system, the current sales processes will be transformed, MVK Zrt. will also develop distance sales channels, and public transport will become more attractive for passengers, thanks to more convenient ticket or pass purchase options and the possibility of introducing new, innovative, passenger-friendly fare products. A complete concept for traffic management has already been developed, supported by indicative proposals. The system to be developed is multi-purpose. On the one hand, it will provide a high-quality traffic information database and, on the other hand, it will directly contribute to the strategic objectives of the soon to be established traffic management centre in Miskolc and the social objectives it will contribute to, as a support to the overall Smart City programme.
Reference to impact pathway	Field of action	Mobility and transport
	Systemic lever	Technology - construction and IT sector Financial financing
	Outcome (according to module B-1.1)	Intelligent urban traffic management system Improved e-ticketing system
Implementation	Responsible bodies/person for implementation	Municipality of Miskolc MJV MVK Zrt.
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Hungarian Public Road
	Comments on implementation	Existing technology solutions need to be adapted and deployed, mainly as a funding issue, there are existing collaborations.

Impact & cost	Generated renewable energy (if applicable)	not relevant
	Removed/substituted energy, volume, or fuel type	diesel and petrol
	GHG emissions reduction estimate (total) per emission source sector	10% 19 000 tCO_{2e}
	Total costs and costs by CO2e unit	13 million EUR approx. EUR 684/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A30. Development of modern regional waste management
	Action type	Infrastructure interventions, technology, national and/or EU laws, municipal regulations, business model
	Action description	On the one hand, the recovery rate of municipal waste needs to be drastically increased, which requires further developments and investments in the waste management sector. New separate collection schemes must meet strict requirements for waste streams (textile, bio and hazardous). By improving yards and the fleet of vehicles and equipment, compulsory separate collection of bio-waste should be achieved by 2024, and separate collection of textiles and household hazardous waste by 2025. The recovery rate of construction and demolition waste should also be increased. On the other hand, ongoing awareness-raising programmes should help to minimise waste generation and increase public willingness to cooperate.
Reference to impact pathway	Field of action	Waste and circular economy
	Systemic lever	Technology - Construction Regulation - policy Social innovation
	Outcome (according to module B-1.1)	Separate collection schemes for waste streams (textile, bio and hazardous). Decreasing household waste generation. 50% less municipal solid waste landfilled.
Implementation	Responsible bodies/person for implementation	MOHU MOL Waste Management Ltd.
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Residents, businesses
	Comments on implementation	Continuous education and awareness-raising, and the gradual and prepared introduction of rules and regulations are of paramount importance.
Impact & cost	Generated renewable energy (if applicable)	
	Removed/substituted energy, volume, or fuel type	(municipal solid waste)

	GHG emissions reduction estimate (total) per emission source sector	80% 4000 tCO_{2e}
	Total costs and costs by CO2e unit	25 million EUR approx. EUR 6.250/tCO_{2e}

B-2.2: Individual action outlines		
(Fill out one sheet per intervention/project)		
Action outline	Action name	A32. Programme package to support the transition to a circular economy
	Action type	Infrastructure interventions, technology, national and/or EU laws, municipal regulations, business model
	Action description	The intervention will include identifying opportunities for industrial symbiosis and supporting initiatives in this direction, promoting local solutions for the sharing economy, and encouraging the start-up and establishment of businesses that accelerate the circular economy transition. The region also wants to be at the forefront of developing new technologies for the circular economy and producing new products. The city, together with the University of Miskolc, wants to be an active player in the transition to a circular economy. The Reuse Centre, which has been operating for 4 years, will be further developed and promoted.
Reference to impact pathway	Field of action	Waste and circular economy
	Systemic lever	Technology - Construction Regulation - policy Social innovation
	Outcome (according to module B-1.1)	Industrial symbioses in action. Separate collection schemes for different waste streams. Reduced waste generation from businesses and households.
Implementation	Responsible bodies/person for implementation	MOHU MOL Waste Management Ltd. Municipality of Miskolc MJV
	Action scale & entities addressed	Total urban area
	Involved stakeholders	Businesses, population
	Comments on implementation	Continuous education and awareness-raising, and the gradual and prepared introduction of rules and regulations are of paramount importance.
Impact & cost	Generated renewable energy (if applicable)	
	Removed/substituted energy, volume, or fuel type	(municipal solid waste)
	GHG emissions reduction estimate (total) per emission source sector	10% 500 tCO_{2e}
	Total costs and costs by CO2e unit	7,5 million EUR approx. EUR 15.000/tCO_{2e}

B-2.3: Summary strategy for residual emissions
Miskolc has a very good environmental location. As already described in the GHG inventory, the proximity of the Bükk Mountains provides the city with a significant green space capital, but it cannot replace the role of green spaces within the city. The size of the green area of the municipality is 6.952 ha, the size of the green areas within the administrative territory of Miskolc is 11.228 ha.The municipality has a significant GHG inventory absorption capacity (-197.308 tCO_{2e}), which exceeds 20% of the total annual emissions in 2021. In the future, it will be advisable to specifically target densely populated inner-city and residential areas with a so-called "un. "This strategy should focus on the preservation and expansion of green spaces, with particular emphasis on reducing the thermal insulation effect and improving the quality of life. A comprehensive offsetting strategy has a number of prerequisites, in particular the revision of the 2016 Green Infrastructure Development Maintenance Action Plan, the definition of the value of green assets, the preparation of a tree inventory and green inventory, and the establishment and operation of a comprehensive environmental monitoring system.

3.3 Module B-3 Indicators for Monitoring, Evaluation and Learning

An overview table listing the indicators selected per outcome and impact including targets and evaluation points.

B-3.1: Impact Pathways							
Outcomes/ impacts addressed	Action/ project	**Indicator No.** (unique identified)	Indicator name		Target values		
					2025	2027	2030
(List early changes/ late outcomes and impacts to be evaluated by indicator)	(List action/ pilot project if applicable)	(Indicate unique identifier)	(Insert indicator name)				
Reduction of GHG emission	A1-A38	MI1	Total greenhouse gas emissions per year (tCO_{2e} /year)		309 478	206 319	103 366
Greener buildings and improved energy efficiency in building sector	A1-A8	MI2	GHG emission per year from stationary energy per year (tCO_{2e} /year)		235 856	147 410	52 070
Green transport	A14-A29	MI3	GHG emission from transport per year (tCO_{2e} /year)		91 769	52 439	38 240
Waste recycling	A30-A35	MI4	GHG emission from waste per year (tCO_{2e} /year)		4 946	4 736	4 594
Reduction of carbon emission of industry	A13	MI5	GHG emission from industrial processes and product use per year (tCO_{2e} /year)		57 141	24 489	8 164
Reduction of carbon emission of AFOLU	A36, A37	MI6	GHG emission from agriculture, forestry and land use per year (tCO_{2e} /year)		2 091	1 195	298
Improvement of grid capacity for receiving green electricity and	A9-A12	MI7	GHG emission from grid supplied energy per year (tCO_{2e} /year)		74 620	24 873	18 655

lessen electricity consumption							
Reduction of city energy consumption	A1-A38	MI8	Change in the total energy consumption per year (MWh/year)		-	-	-1 424 230
Decarbonised energy mix	A6, A9, A10	MI9	Change in the energy mix over the lifetime of the project (%)		28,00%	43,00%	55,70
Greener city	A36	MI10	Amount of permanent sequestration of GHG within city boundary (tCO_{2e} /year)		236 768	276 230	300 673
Green transport	A14-A29	MI11	Change of the greenhouse gas emissions in Transport sector during the lifetime of the project (tCO_{2e} /year)		-39 329	-78 659	-92 858
Greener buildings and improved energy efficiency in building sector	A1-A8	MI12	Change of the greenhouse gas emissions in Buildings and heating sector during the lifetime of the project (tCO_{2e} /year)		-33 287	-83 216	-137 038
Improvement of grid capacity for receiving green electricity and lessen electricity consumption	A9-A12	MI13	Change of the greenhouse gas emissions in Electricity sector during the lifetime of the project (tCO_{2e} /year)		-49 747	-99 494	-105 712
Waste recycling	A30-A35	MI14	Change of the greenhouse gas emissions in Waste sector during the lifetime of the project (tCO_{2e} /year)		-316	-526	-668

Reduction of carbon emission of industry and AFOLU	A13	MI15	Change of the greenhouse gas emissions in Other (incl. IPPU and AFOLU) sector during the lifetime of the project (tCO_{2e} /year)		-25 385	-58 933	-76 155
Improved life quality of citizens	A1, A3, A4, A5	MI16	Improved air quality (Highest annual mean of PM2.5 concentration recorded [µg PM2.5 / m^3])		80,8	79,3	73,2
Improved life quality of citizens	A16, A17, A20, A26, A27, A28	MI17	Reduction of noise pollution (% of population exposed to avg. LDEN > 55dB (annual average))		56,8%	50%	39%
Energy efficient buildings	A1, A4	MI18	Building renovation (envelope) (% annual renovation rate)		0,5%	1,5%	5,00%
Energy efficient buildings	A1	MI19	New buildings built to top performing standard (% of buildings built to the top standard)		1%	10%	25%
Reduction of carbon emission of local heating	A1, A2, A3, A5, A7	MI20	Decarbonizing local heating (share of local heating produced using fossil fuels)		99%	85%	60%
Reduction of carbon emission from district heating	A6, A7	MI21	Decarbonizing district heating (share of district heating produced using fossil fuels)		51%	35%	5%
Reduction of carbon emission of electricity	A9-A12	MI22	Decarbonizing electricity (share of non-fossil sources in electricity production)		35%	30%	5,25%

Reduced motorised transport	A14-A20, A27	MI23	Reduced motorised passenger transport needs (% reduction by 2030)		0	15%	39%
Reduced motorised transport	A21, A22	MI24	Electrification of buses (% of fleet electrified)		10%	50%	100%
Reduced motorised transport	A23, A24	MI25	Electrification of cars + motorcycles by 2040 (% of fleet electrified)		5%	20%	40%
Reduced motorised transport	A25	MI26	Electrification of light duty trucks <3.5t by 2040 (% of fleet electrified)		15%	50%	70%
Reduced motorised transport	A25	MI27	Electrification of heavy duty trucks >3.5t by 2040 (% of fleet electrified)		8%	35%	50%
Improved life quality of citizens	A26	MI28	Optimization of trucking logistics - light duty trucks (< 3.5 t) (average utilization of maximum load weight for light duty trucks (< 3.5 t))		15%	35%	45%
Improved life quality of citizens	A26	MI29	Optimization of trucking logistics - heavy duty trucks (> 3.5 t) (average utilization of maximum load weight for heavy duty trucks (< 3.5 t))		20%	45%	60%
Reduced urban waste, improved recycling	A30-A35	MI30	Urban waste reduction; Biowaste recovery (% of recycled domestic waste of the total domestic waste generation)		15%	55%	87%

Sustainable water supply	A37	MI31	Reduction of loss in piped water system (% of loss of total water input)		44%	38%	20%
Sustainable water supply	A37	MI32	Improved water management (Household water consumption [l /capita/day])		81,1	78	73

(*B-3.2: Indicator Metadata sheets are found in Annex 6.*)

4 Part C - Enabling Climate Neutrality by 2030

4.1 Module C-1 Governance Innovation Interventions

C-1.1: Description of the participatory governance model for climate neutrality
The city has already demonstrated a strong commitment to effective citizen and stakeholder involvement, as reflected in its existing participatory governance model. This will be further strengthened by governance innovation measures. **The role of joint planning in climate neutrality** **Participation Programme** Miskolc attaches importance to the development of community work and participatory democracy. In order to recognise and counteract the systemic phenomena of "desertification" or "shrinking civic space" and low democracy, a partnership process called the **Participatory Programme** in Civil and Municipal Cooperation was launched in Miskolc in 2022. The aim of the programme is to strengthen local governance by testing and implementing alternative democratic local government solutions that are committed to open governance based on trust and prioritising public involvement and participation. The programme is based on the implementation of joint plans between local civic and municipal authorities, and is framed by the Participation Concept adopted by Miskolc County Municipality in its Resolution No. 475/2021 (XII.16.), under the name of **Citizen Participation Concept.** The established **Participation Office** will coordinate the Participation Programme. The Bureau is responsible for the high quality implementation of the elements of the Miskolc Participation Programme, which was created with the involvement of NGOs and self-organising communities. The Participation Office is headed by a Chief Participation Officer and supported by a team. The Participation Office will keep stakeholders informed of updates on the participation process. This is done by means of calls for participation events, publication of the results of the participation process, news about community actions in the city or neighbourhood on the municipality's website, the Miskolc Diary and other social media platforms, as well as through advertisements, posters and leaflets. To facilitate the consultation process, the website https://tervezzukmiskolcot.hu has been created as an online space for citizens' initiatives, actions, proposals, ideas and dialogue - and as a tool for shaping climate neutral policies, plans and projects. The office also conducts and processes online questionnaire surveys on demand, several times a year. It also conducts community surveys with local activists on community needs, community concerns, local activities and available community resources. It also has its own stand at city and neighbourhood events, where it informally provides information, collects information and receives feedback. Support for community initiatives is ongoing. In the Community Budget process, once a year, within the legal and financial framework provided by the municipality, the community can directly decide on the use of part of the public funds, thus allowing local initiatives to be implemented. As a result of the Participation Programme, social cohesion and the sense of identity of the people living in Miskolc is continuously strengthened. Functioning communities are being created, responsible citizenship is becoming the norm, and the quality of life of the residents is improving. Miskolc Municipality launched the **participatory budget in** Miskolc in 2022. Initially 15 million HUF, now 40 million HUF can be decided directly by the residents of Miskolc. In the first stage of the participatory budgeting process, residents are invited to come up with ideas that are creative and innovative, and that will benefit as many people as possible in the categories "Greening Miskolc", "Caring Miskolc" or "Our Common Spaces". The ideas will be screened for feasibility by experts from

the Mayor's Office. The prioritisation, i.e. the determination of which 45 ideas from the eligible proposals will be submitted for voting, will be decided by a **Participation Council of** citizens. The winning ideas will ultimately be implemented by the municipality. For the Participatory Budgeting on Greening Miskolc 2023, 31 proposals from citizens were received.

The first **Miskolc Idea Marathon was** organised in 2022 on the initiative of the Dialogue Association, in partnership with the Municipality, where 7 ideas were developed along the dimensions of the Sustainable Urban Development Strategy (Sustainable City, Prospering City, Serving City, Greening City and Digital City).In 2022, the participants could apply with a freely chosen topic, while in 2023 the organisers were looking for community solutions to adapt to climate emergencies.

The **"Adopt a public space" programme** was launched in 2022, under which private individuals, civil and friendly communities, residential communities and institutions can adopt a public space of their choice for one year, where they undertake voluntary work to maintain and keep green areas clean, and to carry out minor repairs to outdoor furniture, with the professional support of the city's chief gardener.

Community planning events for **public spaces and green spaces** involve local stakeholders and communities in the development of a shared vision, community plan or strategy. Stakeholders are involved from the ground zero, i.e. the preparation and planning stage, so that planned developments can be implemented in line with real needs and requirements.
Themes of the Community planning processes so far have been:
- Future development direction of the Görömböly cellar
- Development of the Sinva Green Corridor
- Development of the Park of Honfoglalás
- Renewal of the ornamental square
- Renewal of the square at the intersection of Szinyei-Merse Pál and Munkás streets
- Renewal of the square next to Martinkertváros, Alföldy utca
- Renewal of St. Andrew's Square in the district of Szirma

The **City Evenings Programme** also aims to involve the public in the decision-making process. Each event is preceded by a lengthy preparation process, during which the municipality tries to gather as much useful information as possible on the topic in question, involving a range of experts. Public opinions are collected through a questionnaire survey. The data processed will form the basis for specific discussions.
In 2023, Urban Evenings were organised around 3 themes:
- Possibility of reopening the Diósgyőr beach baths
- Expansion of the Népkert
- Transport

Climate Protection Group

The Climate Protection Unit of the Mayor's Office is the technical unit for the preparation of urban policies and interventions for climate adaptation, in addition to climate neutrality. Its tasks include the further development of Miskolc's environmental and climate policies, in line with the policy objectives (energy, transport, waste and water management) and the Sustainable Urban Development Strategy. Preparing proposals for the development of a climate strategy and for raising awareness of climate change, and developing measures to mitigate the effects of climate change. It provides climate and environmental opinions on the draft urban strategy documents and legislation.

Ecomanager Office

HungAIRy HungAIRy was established as part of the HungAIRy LIFE IP project, which aims to improve air quality in 8 regions of Hungary, in 10 municipalities, including Miskolc. The eight-strong team runs a social media platform and has stands at events in the city.

ZöMi - Green Miskolc

Social media platform for sharing green news in the city.

Building the COOL Miskolc brand

COOL Miskolc is a brand and a way of life. It aims to bring individuals closer to the mitigating aspects of their lifestyle through personal communication. A fundamental change of attitude is needed, and the solution is to identify and strengthen motivations, especially as individuals have to make many trade-offs in order to be climate neutral. There is a need to develop a willingness to give up and build community consensus on urban climate neutrality. The COOL Miskolc brand will make climate-conscious living trendy among city dwellers.

The CoolMiskolc facebook profile was launched in 2023. This is complemented by a sub-page on the website https://tervezzukmiskolcot.hu/cool-miskolc, but there are also plans to launch a separate online platform www.coolmiskolc.hu. The °coolmiskolc initiative aims to help our city meet the challenges of climate change: to be a liveable, sustainable, lovable, healthy, safe, smart, adaptable green city. CoolMiskolc provides information, offers partnerships and encourages action and awareness.

Transition Team

The Climate Neutral Team (Transition Team) has been established under the leadership of Deputy Mayor Andrea Klára Varga and the coordination of the Mayor's Representative for Climate Protection, Ádám Márton. The task of the team is to ensure the professional quality of the climate-neutral transition, to define professional directions, to set up and run working groups. In addition to the relevant municipal actors, the team brings together key stakeholders and external consultants. On the Net Zero Cities side, the team is supported by the designated City Advisor.

There are currently 4 thematic climate neutrality working groups in the city:

- Transport Working Group,
- Blue and Green Infrastructure Task Force,
- Energy Working Group,
- Working Party on Enterprise and the Economy.

All relevant stakeholders have been involved in the joint planning process through thematic working groups, face-to-face meetings and consultations, including the University of Miskolc, all municipal-owned enterprises (organisations operating in the fields of energy, transport, real estate management, water management, waste management, urban green space maintenance), major enterprises operating in the city (both SMEs and large companies), NGOs, thematic experts and representatives of public organisations.

C.1.2: Sample Table: Relations between governance innovations, systems, and impact pathways

Intervention name	Description	Systemic barriers / opportunities addressed	Leadership and stakeholders involved	Enabling impact	Co-benefits
(Indicate name of intervention)	(Describe the substance of the intervention)	(Refer to barriers and opportunities identified in Module A-3)	(List leaders and all stakeholders involved and affected, referring to the stakeholders mapped in Module A3)	(Describe how intervention enables climate neutrality)	(Indicate how intervention helps achieve the impact listed in Module B-1)
Developing an environmental information system	**The aim of** the intervention **is to introduce a state-of-the-art environmental information system in Miskolc** that can effectively support the following objectives: - exploring and monitoring the environmental processes in the city - preparing for climate change mitigation - predicting and preventing environmental incidents and disasters, increasing the safety of assets - laying the foundations for environmentally sound planning and investment - protecting the health of the population - reducing vulnerability to flooding - increasing the security of drinking water supply Content of the intervention:	**Green and blue infrastructure:** Missing inventory of green assets and trees, incomplete inventory of green infrastructure assets Uncoordinated data sharing between data holders with environmental data Missing urban information system and monitoring The karst aquifer is vulnerable to extreme weather events **Waste management, circular economy:** Insufficient data collection Limited	**Municipality of Miskolc MJV (geoinformatics)** MIVIZ NGOs MiReHu Ltd. University of Miskolc	The Environmental Information System enables the measurement and monitoring of processes affecting climate neutrality, the accurate planning of targeted interventions and the back-measurement of results. It helps the tax-based development of urban green and blue infrastructure that acts as a CO_2 sink.	Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector Ending illegal dumping

	- Environmental surveys and databases based on remote sensing and other techniques: - Creating high-resolution topography and surface models based on LIDAR surveys - Create and regularly update detailed orthophoto maps - Create land cover, land use and habitat maps - Creation of a green inventory and related green space databases e.g. tree inventory, playground inventory, park inventory, local protected values, etc. - Surveys on environmental pollution, e.g. asbestos shale roof inventory, illegal landfill inventory, etc. - Environmental resource surveys e.g. wettability, roof areas suitable for solar panels and solar cells, etc. - Digital infrastructure maps, databases and other targeted surveys: e.g. network water loss, heat loss, etc. Installing environmental monitoring systems using advanced sensors and urban IT, telemetry and other infrastructure - Meteorological and Climate Observation Network	community engagement and support.			

	- Air pollution detection network - Upgrading and extension of the Karst Water Detection System (KDWS) - Other hydrological and soil monitoring systems (water yield, groundwater, lakes, etc.) - Surface movement detection system - Vehicle traffic detection system - Establishment and operation of systems for situation analysis, support for settlement management and decision preparation - Flood forecasting system, - Development of a building register, survey and integration of energy system input data into the system.				
Review/development of transport strategies	**Preparing documents for transport improvements** - Review and update of the Cycling Network Plan - Review and update of the Sustainable Mobility Management Plan (SUMP) - Transport strategy review (priority areas: Downtown - Diósgyőr (East - West) axis, Extension of the existing Northern Relief (NRLA) section, Parking strategy, Traffic calming strategy,	**Transport:** Lack of systems thinking and action in the areas of urban planning and development Lack of a cross-cycle transport concept and strategy Lack of systemic integration of different	**Municipality of Miskolc MJV** MVK Zrt. NGOs	New transport strategies and plans can deliver measures that will lead to less fossil fuel use.	Improving air quality Reducing noise pollution A more liveable urban environment A healthier society - a less burdened health and social sector

	Feasibility of the North-South bus corridor) - Cycling and public transport coordination (feasibility and impact assessment of small, medium and large-scale solutions) for current strategies, indicate missing/revisited	transport modes and related facilities			
Service improvement in public transport	The biggest challenge in decarbonising the transport sector is to shift the population away from individual fossil fuel-powered modes of transport towards public transport, micromobility and walking. This will require a complex urban development challenge, alongside continuous awareness raising. Modern public transport must be provided as a good quality alternative, and accessibility of services must be improved, with adequate urban and central budgetary resources. The spatial structure of the city and the development of rail transport can provide a good basis and opportunities for ensuring the right level of service. **The aim is to ensure as much as possible a transfer-free transport in the city, and to introduce combined fare products.**	Public transport infrastructure is inadequate (outdated transport, traffic management systems, information services). In the values of local society, the prestige of private motorised transport is higher than public transport.	**MVK Zrt.**	As public transport becomes more attractive, more people are switching from more polluting private transport.	Improving air quality Reducing noise pollution A more liveable urban environment A healthier society - a less burdened health and social sector

	eTicket further development The server-based implementation of the electronic ticketing system in Miskolc should be based on the systems and services of the central systems, HKIR and NEJP. The sales channels (pre-sales, on-board, telesales, B2B) and the sales endpoints will be developed, connected to the HKIR system and integrated with the central systems of HKIR and using the services provided by NEJP. With the introduction of the electronic ticketing system, it will be possible to adapt the current product and tariff system. The season ticket type products will remain, while the technical solution for tickets will allow the introduction of a transferable product. With the introduction of the electronic ticketing system, the current sales processes will also be transformed, MVK Zrt. will also develop distance sales channels, and public transport will become more attractive for passengers, which can be ensured by				

	more convenient ticket or pass purchase options and the possibility of introducing new, innovative, passenger-friendly fare products.				
Development of strategic planning documents for green and blue infrastructure development	The aim is to develop a green and blue infrastructure that supports mitigation and climate adaptation, provides high quality ecosystem services and is also capable of conserving and enhancing biodiversity. The development of urban green spaces and special green areas will be integrated with blue infrastructure developments. Documents to be prepared: - Review of the Municipal Green Infrastructure Development and Maintenance Action Plan (ZIFFA) - Preparation of an Integrated Municipal Water Management Plan (ITWMP) - Urban Green Book	**Green and blue infrastructure:** Lack of an effective regulatory framework for the protection of green spaces Shortcomings in the conscious management of green spaces Wasteful land use hinders systematic planning of green spaces Lack of inventory of green assets and trees, inventory of green infrastructure values Vertical and roof surfaces unused **Surface and groundwater:** Lack of a complex climate and environmentally sound water management system Outdated approach to water planning/construction	**Municipality of Miskolc MJV** Municipal Landlord Ltd. MIVIZ NGOs	The strategic planning documents will allow for the implementation of green and blue infrastructure projects that will increase the city's carbon absorption capacity.	

		The state of the public utility network does not allow water conservation Karst aquifer vulnerable to extreme weather events			
Municipal regulation to help tackle energy poverty	In any housing environment, financing energy costs that rise during the heating season, let alone financing minimum energy investments, can be a problem. On the regulatory side, help should also be given to those experiencing temporary or permanent energy poverty, through the creation of local ordinance(s).	High incineration of waste for heating in the context of energy poverty	**Municipality of Miskolc MJV** NGOs	For people living in energy poverty, waste incineration and wet firewood burning will be reduced, thus reducing their carbon footprint	Improving air quality Reducing noise pollution A more liveable urban environment A healthier society - a less burdened health and social sector
Developing and operating a climate platform	The aim of the Climate Platform is to support continuous cooperation with stakeholders involved in the climate transition, facilitate mutual information exchange and monitor the implementation of the Action Plan	Lack of climate-neutral business models	**Municipality of Miskolc MJV** Total concerned (see Table A-3.2)	facilitates stakeholder involvement and the implementation of non-municipal interventions	Improved intersectoral cooperation
Strengthening public participation	Strengthening the Participation Programme's climate action, increasing public involvement. Strengthening and promoting the CoolMiskolc brand, development of the CoolMiskolc website.	Gaps in information and public awareness	**Municipality of Miskolc MJV** Participation Office NGOs	helps to involve the public and implement private interventions	Overall increase in public support for environmental issues

Establish and operate a Green Advice Bureau	The Green Advice Bureau is a one-stop shop for the retrofitting of residential buildings with energy efficiency, providing advice and assistance to the public.	Gaps in information and public awareness	**Municipality of Miskolc MJV**	helps to involve the public and to encourage private investment	Overall increase in public support for environmental issues

4.2 Module C-2 Social Innovation Interventions

C.2.1 Sample Table: Relations between social innovations, systems, and impact pathways					
Intervention name	Description	Systemic barriers / opportunities addressed	Leadership and stakeholders involved	Enabling impact	Co-benefits
Capacity building training programmes	Renewing the training of **professionals needed for the green transition** and adapting training skills to technological progress will be a priority for the region to ensure the right quality and quantity of **labour.** To this end, the city will conclude a cooperation agreement with the more than 100 vocational training centres in the region, involving the businesses concerned.	**Information flow and awareness-raising gaps** Low emphasis on training energy professionals, even at the sales level. Lack of basic energy knowledge in education	**Municipality of Miskolc MJV** Miskolc Vocational Training Centre BOKIK	The availability of professionals will speed up the implementation of energy efficiency, decarbonisation and renewable energy investments.	A more liveable urban environment
Strengthening the knowledge hub role and RDI potential of the University of Miskolc	The University of Miskolc has a unique track record and experience in the Hungarian oil and gas industry, which also supports the decarbonisation of the energy sector and the transition to renewable energy sources. The interventions planned by the University of Miskolc cover the following areas: - Digital transformation of education - Operation of the Centre of Competence for Geothermal Energy Sources - Implementation of R&D&I projects (e.g. Complex integrated technology development for the production of aromatic isocyanates feedstock (ARIZO); Development of an ICT platform to support soil information	Lack of information on technological innovation hinders decarbonisation of the energy sector and the transition to renewable energy sources	**University of Miskolc** Municipality of Miskolc MJV	The University Knowledge Centre will successfully capitalise on its capacities to decarbonise the energy sector and to shift to renewable energy sources. The RDI projects implemented will bring market-ready solutions to decarbonisation and the transition to renewable energy sources	Enhanced energy security

	driven agriculture; Innovative diagnostic developments to identify diseases of high public health importance; Station and node methane emission monitoring and operational, technological development)				
Targeted cooperation with the National Renewable Energy Laboratory	The National Energy and Climate Plan and the National Energy Strategy emphasise decarbonisation targets. In order for Hungary to become a winner in the "Green Economy", the knowledge base and competence ensemble that will enable domestic economic actors to compete in the various decarbonisation technologies must be established. To this end, the National Laboratory will build the scientific and technological, legal, economic and industrial property base for low carbon energy technologies, in particular H2 production/transport/storage/use and CO_2 recovery (CCU). In parallel and in support of each other, the two sets of technologies can play an important role in sector integration, in strengthening domestic security of supply and in achieving decarbonisation goals. Main research areas: - Test stations comparing H2 and CCU technologies and their life expectancy - Scaled-up H2 generator and CO_2 converter electrolysers and catalytic technologies - Design of a pilot plant for the production of e-syngas	Information flow and awareness-raising gaps	**University of Miskolc** Municipality of Miskolc MJV	Benefits to be expected from laboratory research: - Outstanding publications - New researchers and new scientific degrees - New R&D&I projects - New international projects - Carbon dioxide technologies - Fuel cells and Li-ion battery components - laying the foundations for industrial development - Renewable energy system - laying the foundations for economic development goals - Applied research in H2 production and storage - Education, training	A more liveable urban environment A healthier society - a less burdened health and social sector

	- Disruptive H2 production/storage and CCU processes - Economic and legal analysis of H2 and CCU and technologies - Supporting enterprise competence building and sector integration and education activities - Electroactive and structural components of fuel cells (TCs) and new generation Li-ion batteries, recycling, electrochemical, electrical engineering and manufacturing aspects The University of Miskolc is an active member of the National Laboratory. The aim of the cooperation with the city is to apply the results locally as soon as possible.				
Targeted cooperation with the Multidisciplinary National Laboratory on Climate Change	The Multidisciplinary National Laboratory on Climate Change conducts research and development in the field of technological, economic and social adaptation, in addition to studying the drivers of climate change and their impact on nature, economic systems and society. Main research areas: - Climate change drivers and their impacts - Climate impacts of soot particles - Planktonic organisms and climate change - Impact of climate change on chemical communication in living waters - Research on biodiversity conservation - Experimental investigation of changes in ecosystems	Information flow and awareness-raising gaps	**University of Miskolc** Municipality of Miskolc MJV	Benefits to be expected from laboratory research: - Identifying hitherto uncontrolled sources of soot particles, quantifying their energetic contribution to climate change, minimising soot emissions from industrial combustion plants - better understanding the impact of climate change on freshwater ecosystems	A more liveable urban environment A healthier society - a less burdened health and social sector

	- Clay sediments and bio-minerals - Bioaccumulators The University of Miskolc is an active member of the National Laboratory. The aim of the cooperation with the city is to apply the results locally as soon as possible.			- monitoring the complex impacts of climate change. - clarifying the role of bio-minerals as climate indicators - the use of bio-electrochemical systems in carbon sequestration - data and systems science analysis, decision support solutions - more efficient water supply problems due to climate change Management	
Targeted cooperation with the National Laboratory for Social Innovation (TINLAB)	The main goal of the National Laboratory for Social Innovation is to implement innovations that improve the well-being of society, enhance the quality of life, and foster new social relationships and cooperation. The initiative will contribute to people-centred development in specific areas, generating rapid progress and results in a relatively short time. The laboratory will develop a series of thematic RDI forums and workshops, which will contribute to the development of innovative solutions to societal problems and technological change needs, and to their testing in real-life settings, in municipalities, regions and institutions. Main research areas:	Information flow and awareness-raising gaps	**Network for Regional Development Foundation** University of Miskolc Municipality of Miskolc MJV	The benefits of laboratory research: - rapid progress in the human-centred development and penetration of new technologies - making good practices available - increasing the active participation of individuals - developing a national support system for social innovation - pilot projects carried out on the subject	A more liveable urban environment A healthier society - a less burdened health and social sector

	- The social impact of digitalisation - Cultural innovation and creative industries - Local development - Environmental social innovations, climate - Social well-being - Human systems (social and educational care, health) - The future of work, the economy of the future - Social innovation management The University of Miskolc is an active member of the National Laboratory. The aim of the cooperation with the city is to apply the results locally as soon as possible.			- Developing a Social Innovation Readiness Level (SIRL) system	
Public awareness programme for net-zero energy use	Given that the ultimate "consumer" is the population, and that every decision and action depends on individuals, it is of paramount importance to raise public awareness in the following areas: - context and opportunities for reducing carbon emissions - energy management, heating and cooling - energy efficient use of buildings - environmentally friendly solid fuel combustion - reducing overconsumption - promoting a mindset for future generations In addition to a wide range of awareness-raising activities, the programme also includes the holding of	**Information flow and awareness-raising gaps** Lack of information on renovation, deep renovation Low energy awareness People are not aware of their options and the limits of energy use Lack of awareness-raising programmes and transition alternatives Lack of user knowledge in the operation of heating systems	**Municipality of Miskolc MJV** Urban NGOs Education and training institutions	Changes in public behaviour patterns will help the implementation of technological interventions and lead to an increase in overall energy awareness.	Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector Reduction in residential energy costs

	community forums for residents and community representatives. Special access for the elderly and for groups with difficult financial circumstances must also be ensured. The programme should also provide information on the financial resources available.				
Public awareness programme for green and blue infrastructure development	Given that the ultimate "consumer" is the population, and that every decision and action depends on individuals, it is of paramount importance to raise public awareness in the following areas: - the role of green and blue infrastructure in combating climate change - treating urban green assets as assets - preventing illegal logging - the importance of soil life - design and maintenance of green spaces in a climate-friendly and ecological way - the importance and potential of rainwater retention and recovery	**Green space systems, natural state** Low proportion of living topsoil in the city Infrastructure improvements are typically at the expense of biologically active surfaces Preference for paved surfaces over paving on private residential property Green spaces are not treated as an asset at the design/construction stage Buffer areas for green and blue infrastructure elements are scarce The management of green spaces is not ecological. Invasive species spread **Surface water and groundwater**	**Municipality of Miskolc MJV** Urban NGOs Education and training institutions	Changes in public behaviour patterns will help the implementation of technological interventions and lead to an increase in overall energy awareness.	Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector

		The retention of stormwater is not typical for the population.			
Public awareness programme for net-zero transport	Given that the ultimate "consumer" is the population, and that every decision and action depends on individuals, it is of paramount importance to raise public awareness in the following areas: - context and opportunities for reducing carbon emissions - carbon neutral urban transport - walking, cycling and public transport - car sharing - 15-minute city concept - P+R solutions in the city - alternative/electric vehicles	**Community transport** The public values the prestige of private motorised transport over public transport. The car is a status symbol, both forced and unjustified. In urban areas, public transport is less popular because of public safety.	Municipality of Miskolc MJV Urban NGOs Education and training institutions	Changes in public behaviour patterns will help the implementation of technological interventions and lead to an increase in overall energy awareness.	Improving air quality A more liveable urban environment A healthier society - a less burdened health and social sector

C-2.2: Description of social innovation interventions

Innovative capacity-building training programmes are needed, led by the Miskolc Vocational Training Centre, to flexibly address the growing shortage of skilled workers in specific technological fields. At the same time, the learning and adaptation of technological innovations needs to be accelerated, which requires strengthening the role of the University of Miskolc as a knowledge hub and its RDI potential. All of these have the potential to mobilise a significant number of present and future professionals in the service of climate neutrality.

Innovative, targeted cooperation with the National Laboratory for Renewable Energies, the Multidisciplinary National Laboratory for Climate Change and the National Laboratory for Social Innovation is needed to focus the scientific community on concrete urban problems and provide adaptable solutions for the city.
Involving marginalised groups could be facilitated by targeted social innovation pilot projects, such as those from national laboratories.

The city will continue the tradition of awareness-raising campaigns, but with a much stronger focus on carbon neutrality, by launching personalised awareness-raising programmes for target groups in three priority areas: energy (building), green and blue infrastructure and transport, where it is clear that there is a lack of general knowledge and commitment to make personal sacrifices.

5 Outlook and next steps

Plans for next CCC and CCC Action Plan iteration

Iteration process and reviews

The town of Miskolc is committed to the net zero emissions target, and this commitment comes with a serious responsibility. The action plan and investment plan submitted to the NetZero consortium represents the current state of a long process, but this **iterative process** will continue with the involvement of key stakeholders in terms of planning, implementation, monitoring and evaluation. Addressing key systemic weaknesses is already underway and will need to be continued in the coming years.

Given the imminent target date of the Action Plan, future iterations should be carried out by the end of every two years, starting at the end of 2025.

Development and expansion of the monitoring and economic model

In order to ensure **measurability, monitoring, evaluation** and **feedback,** it would be useful to link the data needed to produce the urban carbon inventory in a system with the relevant data already collected during the urban development and operation, and those to be measured in the next 5 years as part of the green and digital transition process. Through this integration, the model would also form the basis for an urban monitoring system, a process that is underway and needs to be carried through with resources.
The city intends to use digital models to estimate current and future energy consumption and greenhouse gas emissions. These models will help identify opportunities to improve energy efficiency and reduce emissions in different sectors, including transport, buildings and industry. Digital models also allow the city to explore different climate protection and adaptation scenarios. Spatial information systems are used for spatial planning, allowing the city to analyse land use, spatial planning and infrastructure development in the context of climate resilience and sustainability.
In the city, real-time data is collected from various sensors such as weather stations, air quality monitors and traffic cameras to monitor current conditions and assess the direct impact of climate-related events. Part of the system is already operational. Data from multiple sources need to be integrated into a central system to provide a comprehensive picture of urban conditions and analysed to help identify trends, anomalies and areas for intervention. Data systems provide decision-makers with valuable information to prioritise and plan climate action and monitor the performance of climate initiatives.
Detailed national and regional benchmarks will be identified and incorporated into the model design. The model will also greatly support the biennial review of the action plan and the subsequent monitoring of planned interventions and projects, thus preparing and facilitating appropriate decision-making. It can also be used for the 2024 review of existing transport and urban development strategies.
Reports are required to be sent not only to the city system but also to the Covenant of Mayors.

Inclusion and socialisation

Communication and **socialisation**, **cooperation with** citizens, young people and businesses and **joint actions** will be a priority. The process of engagement will continue. Education activities will be planned from early childhood to old age, with tools adapted to the age groups. Educational institutions, the University of Miskolc and the Chamber of Commerce of Borsod-Abaúj-Zemplén County are also partners in this. The impact of awareness-raising, and thus of environmental and energy awareness, goes far beyond the impact of a single project, and will be key to the success of the scale of the transition.
The **Green Office** and the **Climate Action Group** in the municipality will continue to operate as described in the Action Plan, providing a key forum for stakeholder engagement.

Action plan

The **Action Plan** planning process has identified a large amount of data and interventions. However, further details and assessments are needed in all sectors to achieve the objectives set. For example, attitudes towards motorised passenger transport and the underlying reasons, spatial patterns of passenger and freight transport, the utilisation of vans and trucks providing logistics services, attitudes towards net zero zones within the city. Regarding the building stock, a detailed survey of municipal and state-owned buildings has been carried out in recent years, but a survey of the residential building stock should also be carried out. The technical and technological conditions for the supply of geothermal energy to other parts of the city have been developed, and the timetable for implementation depends on the mobilisation of resources. The increasing electrification process requires continuous coordination between the suppliers and the city. The implementation of coordinated, systemic improvements based on real needs can only be achieved with careful planning and proper communication.
Ongoing collaboration with industry, commercial actors and institutions is necessary to obtain detailed energy consumption and emissions data and to develop a transition plan to meet the targets set by the city.

Further detailed design of the project portfolio and its financing model

Currently, a two-pronged approach has been applied, using an economic modelling tool to identify the investment needs to reach the 80% emission reduction target. In doing so, it has identified key intervention frameworks and is using a bottom-up approach to identify relevant projects that deliver the 'frameworks'. The economic modelling has also identified investment needs and potential savings that will guide further planning. The business models and business plans are designed as initial work for the project, while grant financing monitoring and market investment financing negotiations are initiated. The further development of the project plan is a prerequisite for the implementation of appropriate financing and investment.

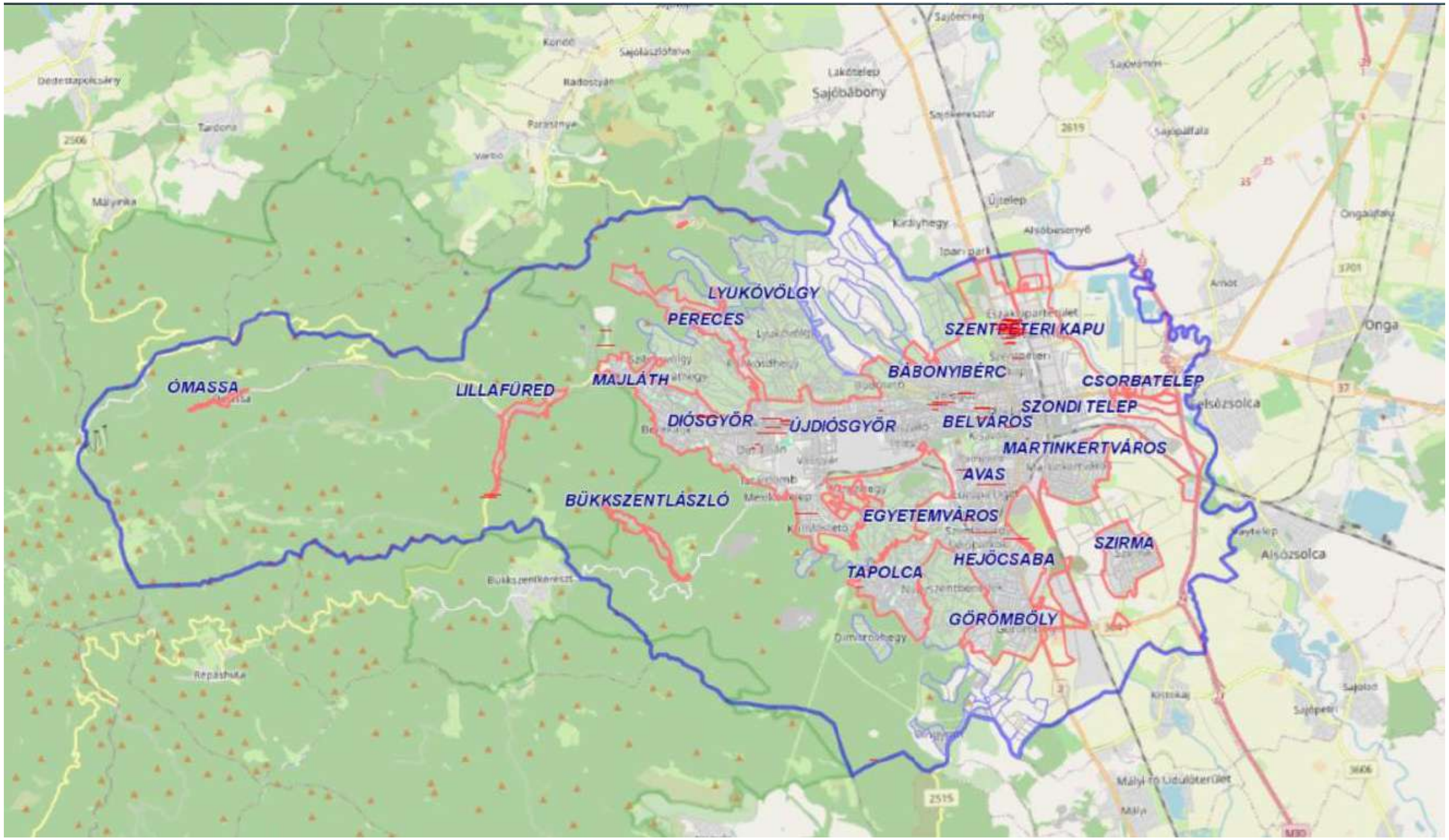
Resource map, funding

Given the limited budgetary possibilities of Hungarian cities, it will be of paramount importance to explore all available and accessible resources. A complex management structure within the urban development department, involving existing internal capacities and external actors, should be set up to prepare grant applications, draw down and use the funds. A dedicated budget should be identified, allowing for the use of appropriate engineering and IT market knowledge. In the year 2024, a dedicated energy team should be established, employing a city thermal energy specialist. The own resources invested in adequate preparation (professional and time) will pay back several times over in terms of both grants and the city's ability to attract capital In addition to the resources of the Operational Programmes, a significant improvement in the use of direct EU funds should be achieved. Preparations should be made now for the 2028-35 planning and budget cycle, preparing Miskolc at city-region level for the timely and efficient use of resources.
One of the keys to the green transition will be the capacity of the real economy, the manufacturing and service sectors, and the emergence of further technological innovations, without which resources will be available but not used.

The urban ambitions can only be achieved through broad cooperation, in which the municipality can play an integrating and coordinating role, in addition to modernising its own infrastructure. However, the ultimate goals can only be achieved through cooperation between local players, citizens, NGOs, businesses, academics and public authorities.

6 Annexes

Miskolc City Map



B-3.2: Indicator indicator metadata sheets

B-3.2: Indicator Metadata	
Indicator Name	Total greenhouse gas emissions per year (MI1)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city, including emissions from all sectors
Calculation	Cumulative value of CO_2 equivalent emissions from all sectors
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Buildings, Transport, IPPU, AFOLU
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1-A38
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MIHŐ, MVM ÉMÁSZ, Hungarian Public Road, Városgazda Nonprofit Kft., KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset on city GHG emission
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emission per year from stationary energy per year (MI2)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from stationary energy
Calculation	Cumulative value of CO_2 equivalent emissions from stationary energy
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Buildings
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1-A8
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	

Expected data source	MIHŐ, MVM ÉMÁSZ, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset on energy consumption of buildings
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emissions from transport per year (MI3)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from transport
Calculation	Cumulative value of CO_2 equivalent emissions from transport
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A14-A29
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	Hungarian Public Road Nonprofit Ltd., Miskolc Municipal Nonprofit Ltd., MVK Zrt., Volán Zrt., MÁV Zrt., KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset on transport
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emissions from waste per year (MI4)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from waste
Calculation	Cumulative value of CO_2 equivalent emissions from waste
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Other
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR

Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A30-A35
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MOHU Zrt, MiReHu Nonprofit Kft., MIVÍZ Kft.
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset on wastewater
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emissions from industrial processes and product use per year (MI5)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from IPPU
Calculation	Cumulative value of CO_2 equivalent emissions from IPPU
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Other
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A13
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MEKH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MEKH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emissions from agriculture, forestry and land use per year (MI6)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from AFOLU
Calculation	Cumulative value of CO_2 equivalent emissions from AFOLU
Indicator Context	

Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Other
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A36, A37
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	GHG emissions from grid supplied energy per year (MI7)
Indicator Unit	t CO_2 equivalents / year
Definition	Annual CO_2 equivalent emissions for the whole city from grid supplied energy
Calculation	Cumulative value of CO_2 equivalent emissions from grid supplied energy
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Electricity
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A9-A12
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MVM ÉMÁSZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MVM ÉMÁSZ
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change in the total energy consumption per year (MI8)

Indicator Unit	MWh/year
Definition	Annual change in the amount of energy used in the city
Calculation	Amount of energy used in the current year minus amount of energy used in the previous year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Electricity, Buildings
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1-A38
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	carbon inventory
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset on energy comsumption
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change in the energy mix over the lifetime of the project (MI9)
Indicator Unit	%
Definition	Share of renewable energy in the urban energy mix
Calculation	Amount of energy used from renewables divided by total energy used
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Electricity
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A6, A9, A10
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MIHŐ, MVM ÉMÁSZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MIHŐ and MVM ÉMÁSZ

Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Amount of permanent sequestration of GHG within city boundary (MI10)
Indicator Unit	t CO_2 equivalents / year
Definition	Amount of GHG sequestered by green spaces within the city boundary
Calculation	The sum of GHG sequestered by different types and sizes of green surfaces
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Other
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A36
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	Monitoring system of Miskolc
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset from the monitoring system of Miskolc
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change of the greenhouse gas emissions in Transport sector during the lifetime of the project (MI11)
Indicator Unit	t CO_2 equivalents / year
Definition	Change in GHG emissions from intra-urban transport
Calculation	Total GHG emissions from different transport modes in the current year minus total GHG emissions from different transport modes in the base year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A14-A29

Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	Hungarian Public Road Nonprofit Ltd., Városgazda Nonprofit Kft., MVK, Volán, MÁV, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset from Magyar Közút, Városgazda NKft., MVK, Volán, MÁV, KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change of the greenhouse gas emissions in Buildings and heating sector during the lifetime of the project (MI12)
Indicator Unit	t CO_2 equivalents / year
Definition	Change in total GHG emissions from the operation of buildings in the city
Calculation	(GHG emissions from local and district heating in the current year + GHG emissions from electricity used by buildings in the current year) minus (GHG emissions from local and district heating in the base year + GHG emissions from electricity used by buildings in the base year)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Buildings
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1-A8
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MIHŐ, MVM ÉMÁSZ, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MIHŐ, MVM ÉMÁSZ, KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change of the greenhouse gas emissions in Electricity sector during the lifetime of the project (MI13)
Indicator Unit	t CO_2 equivalents / year
Definition	Change in GHG emissions from the Electricity sector without the GHG emissions of electricity used in the Buildings sector

Calculation	(Total GHG emissions from Electricity sector in the current year - GHG emissions from Building sector in the current year) minus (Total GHG emissions from Electricity sector in the base year - GHG emissions from Building sector in the base year)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Electricity
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A9-A12
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MVM ÉMÁSZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MVM ÉMÁSZ
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change of the greenhouse gas emissions in Waste sector during the lifetime of the project (MI14)
Indicator Unit	t CO_2 equivalents / year
Definition	Change in total GHG emissions in Waste sector
Calculation	Total GHG emissions in Waste sector in the current year minus total GHG emissions in Waste sector in the base year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Waste
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A30-A35
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MIVIZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	

Deliverables describing the indicator	Dataset downloaded from MIVÍZ
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Change of the greenhouse gas emissions in Other (incl. IPPU and AFOLU) sector during the lifetime of the project (MI15)
Indicator Unit	t CO_2 equivalents / year
Definition	Change in total GHG emissions in Other (incl. IPPU and AFOLU) sector
Calculation	Total GHG emissions in Other sector in the current year minus total GHG emissions in Other sector in the base year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Other
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A13
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	yes
Data requirements	
Expected data source	MEKH, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MEKH and KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Improved air quality (Highest annual mean of PM2.5 concentration recorded) (MI16)
Indicator Unit	µg PM2.5 / m³
Definition	Reduction in the recorded highest annual mean of Pm2.5 concentration in the official air quality monitoring network of the city
Calculation	Recorded data from the air quality monitoring network of Miskolc
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	air quality improvement
Is the indicator useful for monitoring the output/impact of action(s)?	yes

If yes, which action and impact pathway is it relevant for?	A1, A3, A4, A5
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	official air quality monitoring system of Miskolc
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from the official air quality system of Miskolc
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Reduction of noise pollution (% of population exposed to avg. LDEN > 55dB (MI17)
Indicator Unit	annual average
Definition	Reduction in the % of the population exposed to avg. LDEN > 55dB
Calculation	Noise pollution survey in the affected areas of the city in every two year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	reduced noise pollution
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A16, A17, A20, A26, A27, A28
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	survey in every two year
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	every two year
References	
Deliverables describing the indicator	Dataset come from the survey
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Building renovation (envelope) (MI18)
Indicator Unit	% annual renovation rate
Definition	Annual renovated buildings as a percentage of total buildings
Calculation	Number of buildings renovated in the current year / Total number of buildings
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no

If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	reduced heating energy consumption
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1, A4
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	building register of the city
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset from the building register of the city
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	New buildings built to top performing standard (MI19)
Indicator Unit	% of buildings built to the top standard
Definition	New buildings as a percentage of all new buildings that exceed the statutory then zero standard
Calculation	Number of new buildings built to top performing standard / Total number of new buildings
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	reduced heating energy and electricity consumption
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	building register of the city
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset from the building register of the city
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Decarbonising local heating (MI20)
Indicator Unit	share of local heating produced using fossil fuels
Definition	Reduction in the share of fossil-based local heating in total local heating

Calculation	fossil-based local heating emissions in the current year / total local heating emissions in the current year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Buildings
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A1, A2, A3, A5, A7
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	MIHŐ, MVM ÉMÁSZ, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MIHŐ, MVM ÉMÁSZ and KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Decarbonizing district heating (MI21)
Indicator Unit	share of district heating produced using fossil fuels
Definition	Reduction in the share of fossil-based district heating in total district heating
Calculation	fossil-based district heating emissions in the current year / total district heating emissions in the current year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Buildings
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A6, A7
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	WHAT
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MIHŐ

Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Decarbonising electricity (MI22)
Indicator Unit	share of non-fossil sources in electricity produce
Definition	Reduction in the share of fossil-based electricity consumption in total electricity consumption
Calculation	fossil-based electricity consumption in the current year / total electricity consumption in the current year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Electricity
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A9-A12
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	MVM ÉMÁSZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded form MVM ÉMÁSZ
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Reduced motorised passenger transport needs (MI23)
Indicator Unit	% reduction by 2030
Definition	Reduction in the proportion of people travelling in motorised vehicles
Calculation	Motorised passenger transport / Total passenger transport
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	lower GHG emission, less traffic jam, better air quality more secure space for pedestrians and cyclists
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A14-A20, A27
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	

Expected data source	Hungarian Public Roads, Városgazda Nonprofit Kft., MVK
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	every two years
References	
Deliverables describing the indicator	Dataset downloaded from Magyar Közút, Városgazda Nkft. and MVK
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Electrification of buses (MI24)
Indicator Unit	% of fleet electrified
Definition	Increasing the share of electric buses in the urban bus fleet
Calculation	Number of electric buses / Total number of buses
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A21, A22
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	MVK
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MVK
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Electrification of cars + motorcycles by 2040 (MI25)
Indicator Unit	% of fleet electrified
Definition	Increasing the share of electric cars and electric motorcycles in the urban fleet
Calculation	Number of electric cars + electric motorcycles / Total number of cars + motorcycles
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport

Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A23, A24
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	Interior Ministry, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from Interior Ministry and KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Electrification of light duty trucks <3.5t by 2040 (MI26)
Indicator Unit	% of fleet electrified
Definition	Increasing the share of electric light duty trucks (<3.5t) in the urban fleet
Calculation	Number of electric light duty trucks (<3.5t) / Total number of light duty trucks (<3.5t)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A25
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	Interior Ministry, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from Interior Ministry and KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Electrification of heavy duty trucks >3.5t by 2040 (MI27)
Indicator Unit	% of fleet electrified
Definition	Increasing the share of electric heavy duty trucks (>3.5t) in the urban fleet

Calculation	Number of electric heavy duty trucks (>3.5t) / Total number of heavy duty trucks (>3.5t)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Transport
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A25
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	Interior Ministry, KSH
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from Interior Ministry and KSH
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Optimization of trucking logistics - light duty trucks (< 3.5 t) (MI28)
Indicator Unit	average utilization of maximum load weight for light duty trucks (< 3.5t)
Definition	reduce the number and routing of light duty trucks (<3.5t) in the city centre by controlling traffic
Calculation	traffic counting
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	lower GHG emission, less traffic jam, better air quality more secure space for pedestrians and cyclists
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A26
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	traffic counting by the city
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	every two year
References	
Deliverables describing the indicator	Dataset from traffic counting
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Optimization of trucking logistics - heavy duty trucks (> 3.5 t) (MI29)
Indicator Unit	average utilization of maximum load weight for heavy duty trucks (< 3.5t)
Definition	reduce the number and routing of heavy duty trucks (<3.5t) in the city centre by controlling traffic
Calculation	traffic counting
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	lower GHG emission, less traffic jam, better air quality more secure space for pedestrians and cyclists
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A26
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	traffic counting by the city
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset from traffic counting
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Urban waste reduction; Biowaste recovery (MI30)
Indicator Unit	% of recycled domestic waste of the total domestic waste generation
Definition	Increasing recycling of waste collected in the city
Calculation	Recycled waste (t) / Total waste (t)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	yes
If yes, which emission source sectors does it measure?	Waste
Does the indicator measure indirect impacts (i.e., co-benefits)?	no
If yes, which co-benefit does it measure?	NR
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A30-A35
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no

Data requirements	
Expected data source	MOHU MOL Zrt.
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Dataset downloaded from MOHU
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Reduction of loss in piped water system (MI31)
Indicator Unit	% of loss of total water input
Definition	Reduction of loss in piped water system of the city
Calculation	volume of water withdrawn from the water system based on consumption (l)/volume of water injected into the water system (l)
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	freshwater stock protection
Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A37
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	MIVIZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Data downloaded from MIVÍZ
Other indicator systems using this indicator	

B-3.2: Indicator Metadata	
Indicator Name	Improved water management - Household water consumption (MI32)
Indicator Unit	l/capita/day
Definition	Reducing household water consumption
Calculation	Household water consumption (l/capita/day) in the current year
Indicator Context	
Does the indicator measure direct impacts (reduction in greenhouse gas emissions?)	no
If yes, which emission source sectors does it measure?	NR
Does the indicator measure indirect impacts (i.e., co-benefits)?	yes
If yes, which co-benefit does it measure?	freshwater stock protection

Is the indicator useful for monitoring the output/impact of action(s)?	yes
If yes, which action and impact pathway is it relevant for?	A37
Is the indicator captured by the existing CDP/ SCIS/ Covenant of Mayors platforms?	no
Data requirements	
Expected data source	MIVIZ
Is the data source local or regional/national?	local
Expected availability	available
Suggested collection interval	annual
References	
Deliverables describing the indicator	Data downloaded from MIVÍZ
Other indicator systems using this indicator	

NET ZERO CITIES

EU MISSION PLATFORM | CLIMATE NEUTRAL AND SMART CITIES

Climate City Contract

2030 Climate Neutrality Commitments

Climate Neutrality Commitments of the City Miskolc

MISKOLC

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Mayor's welcome

Dear Citizens of Miskolc,

We live in an age of challenges. A pandemic, an energy crisis, record inflation - one threat is not over and the next is already knocking. In recent years, we have experienced the hottest summers, winters, autumns and springs on record. No one is now questioning the reality of climate change, the unforeseeable consequences of which will be felt across the globe. I am not concerned about the planet, which has experienced countless such changes. Human civilisation, and in it our narrow neighbourhood of Miskolc, all the more so.

There are three important things we need to do when it comes to climate change: raise awareness of the risks, prepare for the negative consequences and mitigate the impacts. We have therefore decided to look to the future, despite the difficulties of our daily lives, and embark on a joint path towards climate neutrality.

It is a source of pride for all of us that, among nearly 400 applicants, Miskolc has been selected as one of the 100 climate-neutral and smart cities based on our experience, good practices and commitment. Our mission is to drastically reduce greenhouse gas emissions by acting as centres of experimentation and innovation. But we want to achieve even more! In the meantime, we want Miskolc to become a human-scale, liveable, attractive city - a place that is healthier, greener and friendlier, a place that is provides a sustainable present and future for our children and grandchildren.

Becoming a climate-neutral city is a transformation on a scale that is unparalleled in the life of a municipality, but I believe that it will not paralyse us, the people of Miskolc, but will inspire us to action! There will be many challenges that will hinder us along the way, because as pioneers, as trailblazers, we have no map in front of us. But we have a compass in our hands: the Climate City Contract. Although this document has been prepared at the request of the European Commission, it is primarily the people of Miskolc who are the contracting parties. All Miskolc residents, NGOs, institutions and companies. Change requires everyone: from small lifestyle and consumer decisions to strategic management decisions; from individual residential insulation to city-wide renewable energy systems and communities. It is my sincere hope that this will not just be the mission for the municipality, but a shared mission for the whole city. And building on all of this, if we combine the tremendous knowledge and determination of the people of Miskolc, we will be able to create together the Miskolc that is the most livable Hungarian city.

Deputy Mayor's welcome

A few years ago, thujas were a symbol of suburban life; today, their withered trunks or cold spots warn us. A few years ago, the solar panel, the electric car or the hydrogen bus seemed like science fiction; today they are part of our everyday life. The change is unstoppable, it affects every aspect of our lives, and many of us - not without good reason - are filled with fear. Climate change is no longer an issue to be feared rather than frightened of, but when we walk down the street in winter without a coat, when we install air conditioning in our homes to protect us from the heat, or when we wonder whether we should start planting in spring now, as the first trees and shrubs bloom in February, we are already unconsciously or consciously adapting.

The question rightly arises: what can the individual do? First and foremost, it is to get informed, think and act. To help us do this, we have launched the °CoolMiskolc platform, so that all interested citizens of Miskolc can access authentic and local information. I encourage everyone to choose from a wide range of complex topics the one that addresses their real-life situation and that they feel they can take small steps to change. By driving four days a week instead of seven, by planting and caring for plants instead of mowing your lawn to three centimetres, by collecting rainwater and watering with it, by composting instead of burning or putting garden waste in green bags, you are doing something for your health, the environment, the climate and your wallet. As city leaders, it is our responsibility to make these decisions as easy and self-evident as possible, to shape the way we run, operate and develop the city so that we lead by example in line with these goals.

Many of these practices are already in place. For example, many green sustainable interventions have been and are being implemented through participatory budgeting, the number of communities adopting green spaces to improve the microclimate of their environment is increasing, or the growing number of people choosing active mobility solutions due to the expanding cycling infrastructure. I ask everyone to do what they can to ensure that Miskolc remains liveable for our grandchildren! With a little attention, anyone can buy less, waste less, collect rubbish selectively. And those who can, invest in energy-efficient building renovation, become active, productive citizens of the city and support others in doing the same. After all, the strength of a community is shown by the way it treats those less fortunate than itself. We will work to involve all disadvantaged groups in the development process to ensure that the transition is not only swift, but also fair.

This requires systemic change in approach, operation, funding and governance - we are committed! Are you? Cleaner air, tidier, greener spaces, a sense of community are all hard to put a price on, but they are essential for longer, happier, healthier lives. We would like to thank the people, NGOs and companies in Miskolc who have already joined us in the first steps! Thank you if you will partner with us and join us on the path ahead to realize the 100 climate neutral and smart cities mission!

°coolmiskolc
on a joint path towards climate neutrality

1. Introduction

From Steel City to °coolmiskolc?

The North-Hungary region has a significant industrial heritage, with Miskolc being the centre of the Hungarian iron and steel industry until the 1990s. This region was the biggest loser of the regime change, with heavy industry and agriculture collapsing. The region's GDP used to be above the national average, but is now less than two-thirds of the national average. In Miskolc, the last 10-15 years have seen a clear structural change in the economy; the number of registered business organisations has increased, most of them are individual or micro and small enterprises, and the mechanical engineering sector is now central.

With this industrial and cultural heritage behind it, the city started to catch up in the 2000s. **In 2011,** Miskolc committed to follow the **Green City** principles, to respect the points of the Milan Green Charter, to apply the Green City Accreditation Point System in the launch and implementation of all developments affecting the city and **in 2015, to** join **the** European **Covenant of Mayors**, committing to reduce CO_2 emissions by at least 20% compared to the 2008 base year. **In 2016,** it prepared the **SEAP** (Sustainable Energy Action Plan), **in 2019** the **SECAP** (Sustainable Energy and Climate Action Plan) and **in 2020 the** City **Climate Strategy**, which already sets a target of 43% emission reduction. It is involved in a number of **international cooperation** and initiatives to **support the urban green transition**.

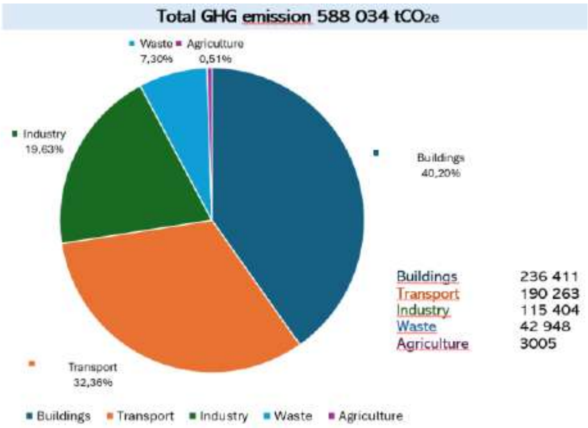
In January 2022, the Municipality of the City of Miskolc with County Rights submitted its application for the European Union's "100 Climate Neutral and Smart Cities Mission" programme, as part of the European Green Deal, to be implemented within the framework of Horizon Europe. The European Commission selected the City of Miskolc with County Rights as one of the nearly 400 cities that applied for the programme. **Under the mission, Miskolc aims to become a net zero carbon** city **by 2030.** To this end, a document providing a strategic framework for the transition, a so-called Climate City Contract (CCC), has been prepared to be submitted to the European Commission. **However, this ambitious goal can only be achieved in a broad partnership involving all stakeholders.** In addition to the Municipality of the City of Miskolc with County Rights, the commitment of the main actors in the city is also needed, as only **a joint effort can achieve a net emissions figure.**

Over the past 15 years, Miskolc has been clearly committed to protecting the urban environment and striving to become as carbon neutral as possible. **Joining the 100 climate neutral cities mission** has given **new impetus and perspective to this process!**

Over the past decade, Miskolc has become one of the most committed municipalities in Hungary to reducing emissions, while continuously improving the quality of life of its residents, and developing activities and infrastructure that impact on quality of life.

It is in the city's vital interest to implement climate neutrality programmes and to promote climate-aware attitudes as widely as possible. Taking demographic trends into account, it is clear that **all planned interventions in Miskolc should contribute directly or indirectly to increasing the city's population retention and attractiveness, in addition to reducing emissions.** The use of **resilience and urban adaptability** as a horizontal aspect in the design was of particular importance.

WHERE ARE WE NOW?

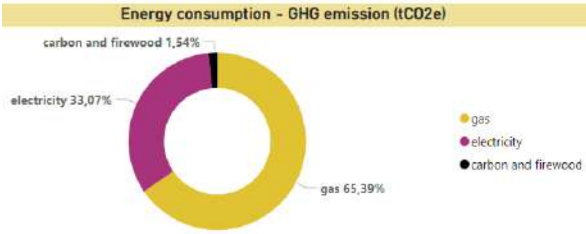


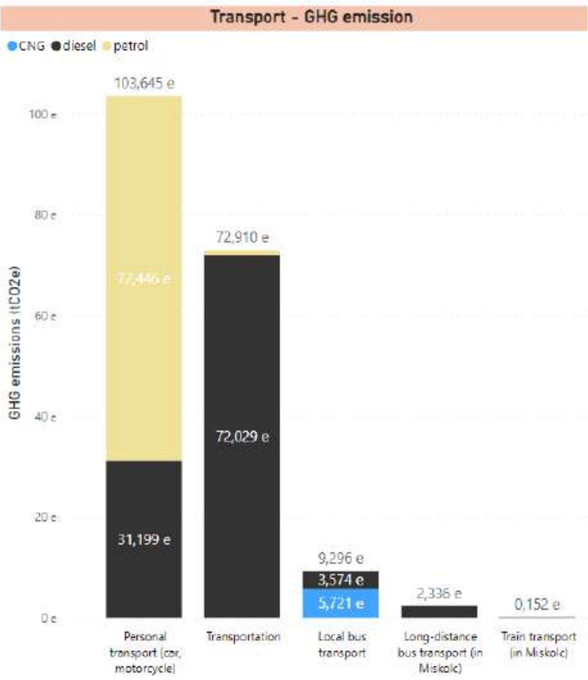
Total urban emissions in the base year 2021 were 588,034 tCO_{2e}, with annual emissions per capita of 3.9 tCO_{2e}.

In the case of the city of Miskolc, the **largest greenhouse gas (GHG) emitting segment is the building sector**, followed by the **transport sector** and then the energy used by industry.

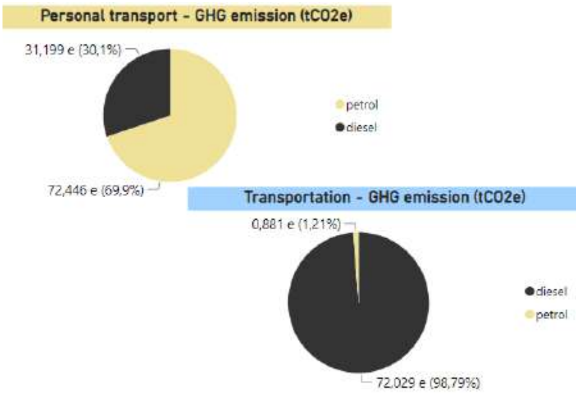
The waste management sector is in line with the national average, while the agricultural sector has much lower emissions than the national average.

For **energy systems**, the aggregate GHG emissions from natural gas use are 231,569 tCO_{2e}, for electricity use 117,130 tCO_{2e}, i.e. **40% of total emissions and 2/3 of sector emissions are attributed to natural gas**. Emissions from residential coal and firewood heating are on a downward trend, but represent a more significant energy security, energy poverty and air quality problem in some parts of the city than calculated.





The total emissions from the **transport sector are** 188,338 tCO2e, which is **32% of total urban emissions**. The most dominant element is private transport, and on a specific basis, trucks running in the city are the largest emitters, as transport and haulage in this segment is almost entirely done by diesel vehicles.



Miskolc is well positioned to build on existing developments and processes to achieve the planned climate-neutral urban operation, i.e. to minimise greenhouse gas emissions while being able to sequester as much carbon dioxide as the urban infrastructure emits.

An outstanding achievement of the last decade is that the **district heating company** now **provides** more than 50% of its primary energy needs from renewable **geothermal energy sources,** a share that is steadily increasing. The city's district heating company has concrete plans and feasibility studies in place to achieve these targets.

Institutional building energy efficiency programmes have been ongoing for more than 10 years, and the residential LED replacement programme will continue in 2024, as in previous years, reaching nearly 8,000 households.

The extension of the electric network for the development of **public transport** has been completed, with 75 CNG buses and 10 electric buses, and from 2024 onwards, on a pilot basis (with the support of the Hungarian Mobility Development Agency HUMDA and the Ministry of Energy), hydrogen-powered buses will also strengthen environmentally friendly urban transport. Miskolc Municipal Transport Ltd. has its own decarbonisation plan, revised every year, with clearly identified goals and tasks.

Through the **University of Miskolc,** there is a **significant R&D&I** capacity available to support the green transition process in several segments (BOSCH, the city's largest company in terms of turnover, is running a Hungarian representation project in **hydrogen production and cell development in** cooperation with the University of Miskolc, which is also an important opportunity for Miskolc.)

The city has a **well-organised waste management** and **selective collection system**, which will be extended to food waste from 2024. Bio-waste currently accounts for 30% of household waste, and its separate collection from 2024 will in itself significantly reduce the amount of municipal waste going to landfill.

Taking into account currently projected social and economic trends, the calculated value of urban greenhouse gas emissions in 2030 would be 516 $ktCO_{2e}$. The 2030 reduction target is 412 $ktCO_{2e}$, i.e. 80% of the emissions value, which is in line with the mission's expectation.

The message of the mission

Cities can initiate and sustain positive processes by transforming and regulating their own infrastructure, but for a complex urban ecosystem, this process can only be advanced at a significant social cost. The emissions from the operation of municipal infrastructure and services are a relatively small part of the total city emissions, so the municipality can only have a direct impact on this segment, but stimulating and influencing other sectors will be an important task for the next decade. In addition to **the need for industry to make the green transition**, **the public** must also play an active role, firstly **by reducing consumption**, and secondly by **improving private property**, modernising energy efficiency and changing existing habits.

Attitude formation and **change in approach** is a priority at both individual and community level and is also a **priority for the city**.

By implementing these processes, it will be possible to create a liveable and environmentally resilient urban environment that will help retain the city's population and attract the young people and working-age population that are attached to the city. Achieving climate-neutral urban operations alongside a prosperous economy that makes the green transition could be a breakout point for the city, differentiating it from other large cities in the region and creating good practice within Europe.

The processes are not complete, and much of the work is still to be done. Results can only be achieved **through continuous** stakeholder **engagement** and **dialogue.** This programme can only be successful if all Miskolc citizens find their place in it. Let this be our common cause! Let us work together for our children, let us work together for our common future.

2. Goal: Climate neutrality by 2030

MISKOLC CITY AIMS TO BECOME CLIMATE NEUTRAL BY 2030

In practice, this means that, based on the city's greenhouse gas inventory for the base year 2021 and taking into account current trends, Miskolc will be able to reduce its carbon emissions by 80% by 2030, with the remaining 20% "neutralised" by its expanding green spaces.

The need for completeness

The city plans to implement its climate neutrality plans within its entire administrative boundary, covering 236.66 km^2. There is no emission source or sector that is not being investigated or for which reductions are not being sought.

Based on the detailed calculations set out in the Action Plan, this would require a reduction of 412 kilotons of carbon dioxide equivalent emissions. This represents a reduction in emissions of three greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). The city will of course seek to measure and reduce emissions of the other greenhouse gases over time.

The scope of emissions assessed and targeted for reduction includes direct GHG emissions within the city boundary (Scope 1), which can be attributed to stationary energy use (buildings/facilities/equipment), but also to transport, waste/waste water disposal and treatment, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU). Added to this are the indirect GHG emissions within the city boundary (Scope 2), which are primarily from electricity consumption supplied from the grid. In addition, GHG emissions outside the city boundary (Scope 3), which result from the disposal and treatment of waste/wastewater generated.

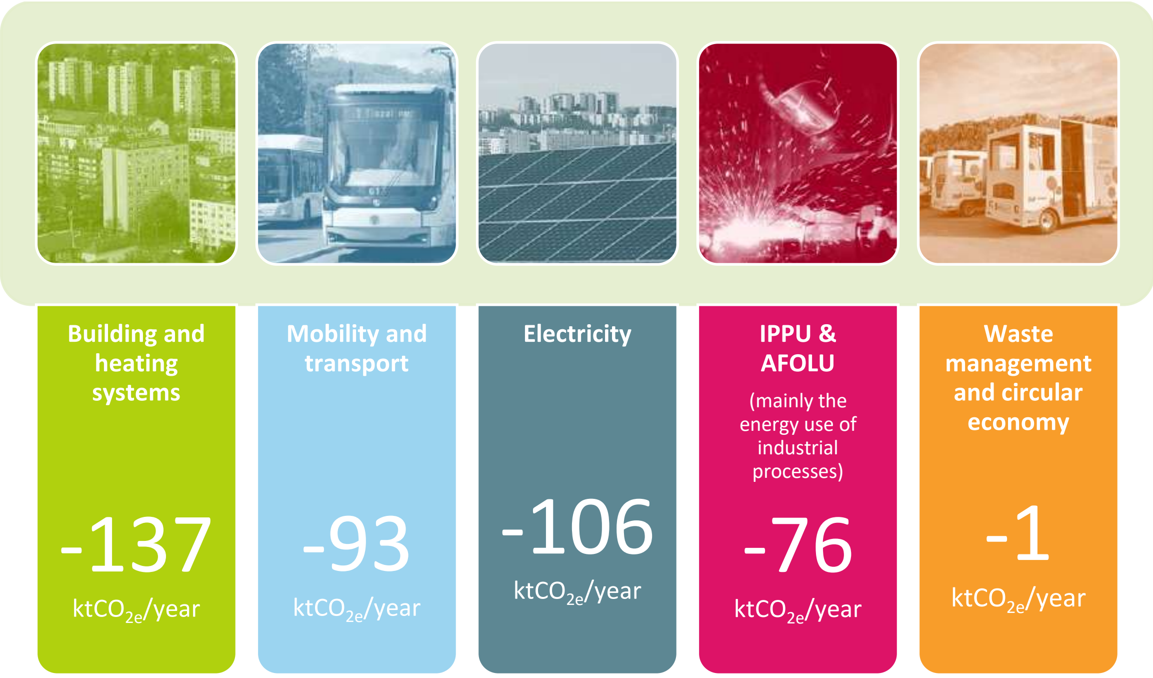
However, we are aware that such a rapid transition requires a number of key success factors to come together. The commitment of the municipality and its own actions are not nearly enough to achieve ambitious goals. We therefore put a strong emphasis on building partnerships within the city, at national level and internationally, and on creating regulation, funding and social support. This requires the active and supportive involvement of governments, professional organisations, institutions, NGOs and citizens.

Quantified targets

To set the emission reduction targets, we used the economic model recommended by NetZeroCities, tested and applied jointly by 100 cities, which fine-tunes the 2030 no-intervention scenario to EU trends and identifies realistically achievable - and financially feasible - emission reduction targets in each sector.

In addition to a specific project portfolio to achieve the emission reduction targets, the Action Plan also identified governance and social innovations that will enable systemic change.

In the key areas and sectors, the city has set the following quantified emission reduction targets for 2030.



For these areas, specific impact pathways have been formulated, taking into account technological/infrastructure, regulatory-policy, social innovation and financial financing impact factors.

Social benefits

Besides reducing emissions, climate neutrality actions have many positive social externalities!

Increased energy security: the implementation of the CCC will increase the energy security of the City, and the export of natural gas will reduce the exposure to natural gas imports. Increasing the share of local energy production will not only make energy supply more carbon neutral, but also more secure.

Reduced energy costs for households: the energy demand of the population is decreasing due to the deep renovation of buildings, and they have access to cheaper green energy instead of increasingly expensive natural gas, thus reducing their related costs.

Improved air quality: air pollution from heating and transport will be drastically reduced, waste incineration will be stopped, and the fresh air from the Bükk Mountains will once again be the air of Miskolc.

Reduced noise pollution: due to modern traffic management, traffic calming, replacement of vehicles and the elimination of private car use, noise pollution in the city will be minimised.

Eliminating illegal landfills: waste is recycled in waste management and does not pollute our environment.

More conscious food consumption - less waste - smaller carbon footprint: We get what we eat from local supply chains (our markets, farmers' shops, community food basket). We don't waste, and what food waste is generated becomes biogas and then green electricity.

A more liveable urban environment: sustainable urban development offers a liveable, attractive urban environment for city dwellers, which is also inviting to businesses and citizens looking to settle.

A healthier society - less strain on health and social sectors: the European Environment Agency estimates that each year one in eight deaths in the European Union is caused by various forms of pollution. In addition to air and water pollution and soil degradation, longer and more frequent droughts, heat waves and other extreme weather events, as well as the spread of climate-related diseases, pose a significant threat to human health.
The implementation of a green transition can be a powerful tool to address threats to human health, reducing the increasing pressure on care systems.

Improved cross-sectoral cooperation: our common cause leads to cross-sectoral collaborations that bring benefits in other areas, increasing business competitiveness and trust capital.

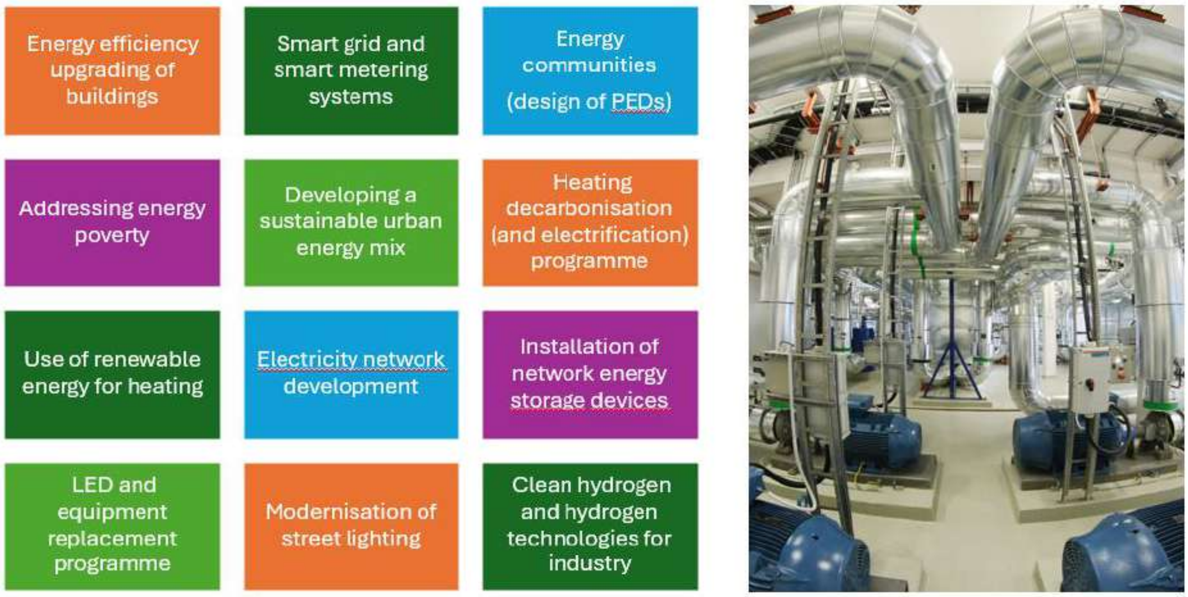
General increase in public support for environmental issues: participation in carbon neutrality measures and extensive public awareness raising will also increase the general environmental sensitivity and awareness of citizens, and will also increase their support for other environmental issues.

3. Strategic priorities

Systemic strategic priorities and interventions have been identified in the field of energy systems, transport, waste management and circular economy, complemented by green infrastructure and nature-based solutions at city level.

ENERGY SYSTEMS

Energy systems - interventions to support the transition



Modernisation of buildings

A strategic priority for climate neutrality is the **decarbonisation of the building sector**, notably through deep renovation and the phasing out of natural gas, and the extension of geothermal energy in district heating to new city districts.

For buildings, the greatest potential for energy savings lies in upgrading energy efficiency and heating modernisation. Miskolc plans to achieve a high energy efficiency and decarbonised building stock of private residential buildings by 2040 at the latest. This will require a significant increase in the rate of deep renovation, with a target of around 4.5% per year by 2030. In terms of share, the largest reduction in residential final energy consumption will be in natural gas consumption, with the planned measures leading to a reduction in residential natural gas consumption of around 40% between 2023 and 2030, and almost complete phase-out by 2040. By 2030, the consumption structure will have been transformed significantly. Due to energy efficiency investments, electricity and biomass use will decrease more significantly, but the amount of electricity used by heat pumps will multiply by 2030.

The entire building stock will be upgraded to include the private sector (residential and business), municipal and state-owned institutions.

Expanding geothermal energy in district heating

Based on Hungary's National Energy and Climate Plan, we also aim to double the amount of geothermal energy currently used by 2030. The **city-owned Miskolc Heat Supply Ltd.** serves several heat supply areas with independent larger heat generating units. Heat plants in the Diósgyőr and Bulgarian parts of the city are operated in isolated mode, using 100% fossil energy carriers (natural gas). The connection point of the two heating districts is located within 3.5 km from the end point of the downtown district heating system. The **interconnection of the systems will ensure their integration into a geothermal, renewable heat supply.** The project will allow the replacement of two natural gas boiler houses, creating a flexible heat generation system and a **significant reduction of carbon emissions at city level by** replacing the two natural gas boiler houses and placing them in reserve. The potential for renewable energy supply in the Miskolc Northern Industrial Area is also being investigated. In addition, the capability that 55% of the district heating service in Miskolc is already geothermal should be exploited, so for buildings that can be profitably connected to district heating, the implementation of the connection to the district heating system should be a priority. The share of geothermal could be increased to 90% by the end of the decade.

Grid development, decarbonisation of electricity generation

In addition to geothermal energy, there are already several small and large solar power plants in the city that are classified as small and medium sized thermal power plants (SMPPs) and one solar power plant that is not a SMPP. In order to further exploit solar energy and to achieve greater energy independence, it is necessary to install solar systems of small household power plants size on as many buildings as possible and to build more solar power plants larger than small household power plants size. In order to achieve real energy independence, these solar systems will also need to provide for on-site storage and/or direct use of the electricity generated. The decentralisation of the hitherto typically centralised energy systems, smart grids, the spread of energy communities and the strengthening of energy citizenship could play a key role in this.

The expected positive change in the national energy mix due to increasing electrification will be decisive for **the timely completion of grid upgrades**.

The development of a flexible and secure electricity network to serve the electrification process and the transition, which is primarily **the responsibility and competence of** the **Ministry of Energy** and the **Hungarian Electricity Company**. Permanent and continuous cooperation with the supplier is required.

It is crucial to transform the energy use of industry (especially mechanical engineering and construction), to replace fossil fuels for production, manufacturing and logistics processes, and to generate and use electricity locally.

However, the impact pathways are not only linked to these priorities, but also seek to fully explore the pathways to reach the 80% emission reduction target.

COMMUNICATION

Transport - interventions to support the switchover

Decarbonising transport is a **strategic priority of** the climate transition, which the city plans to achieve primarily by reducing private car use and promoting public transport, while encouraging the spread of electric vehicles and micro-mobility devices, and increasing the share of active mobility, especially walking. A prerequisite for this is to minimise transport constraints and give systemic priority to active forms of mobility, in line with the principles of the 15-minute and compact city. In addition, the decarbonisation of freight transport and haulage should be remembered: this is a sector that the city can influence, mainly through incentives and regulation.

Extended track-based transport

The **development of the fixed-rail transport system** includes the creation of an **interconnected tram network**, in the first phase by connecting Búza Square to the existing east-west axis, and in the second phase by building the new north-south axis. The second phase involves the construction of the complete axis from Búza Square to the northern city limits and from the "Traffic Light" junction to the Tapolca junction in the southern direction. The north-south axis should be designed to accommodate the tram-train connection on the town of Kazincbarcika-city of Miskolc-town of Tiszaújváros line, if it is later realised. Both lines will serve a high public transport demand, taking over a significant volume of individual and bus transport. Along the axis there are destinations which are the most visited due to their role as county seat and are also busy destinations within the city.

Digital switchover

Intelligent traffic management is essential to offset the increase in traffic and to ensure the smooth flow of traffic, which is why the other key project in the field of decarbonising transport is **the digital switchover in public and road transport.** With the right sensors, information and analysis systems, urban road traffic will be managed more efficiently and safely. An **intelligent road traffic monitoring and processing system** will be implemented, without the need for external human resources, capable of continuous (real-time) and automatic monitoring and even automatic intervention. The system to be developed is multi-purpose. On the one hand, it will provide the basis for a high-quality traffic information database and, on the other hand, as part of the Smart City programme, it will directly contribute to the strategic objectives and social benefits of the soon-to-be established traffic management centre in Miskolc.

Community transport

Public transport accounts for 6-7% of sectoral emissions (around 2% of total urban emissions), so while it is important to **decarbonise the vehicle fleet, it is** even more important to **develop and maintain adequate service levels (frequency, comfort, cost-effectiveness and punctuality)**. As private car use is the largest emitter of all modes of transport, a clear **objective is to shift private users to public transport.** This can only be achieved through **passenger-oriented, full-service, competitive public transport**, for which adequate municipal and central budgetary resources must be allocated.

The biggest challenge in decarbonising the transport sector is to shift the population away from individual fossil fuel-powered modes of transport towards public transport, micromobility and walking. This will require a complex urban development challenge, alongside continuous awareness raising. The valley location and spatial structure of the city severely limit the integration of new areas into transport, and therefore the reallocation of land could be a major loss of value.

15-minute city (parts)

To achieve climate neutrality, it is essential to look at transport habits and constraints, in addition to decarbonising transport modes. The 15-minute city concept puts people-centred urban design at the core, avoiding unnecessary commuting and ensuring that basic services are accessible without the need for a car. Our city has a good basis in this area, as before the current administrative boundaries were established, many of the individual municipalities had their own centres. The **development of the district centres** currently being planned should aim to develop towards a 15-minute city: public spaces and real estate should be developed with a focus on the availability of basic services, prioritising active mobility and increasing green spaces.

Concentrated access to services will reduce the number and length of car journeys, which will have a significant impact on achieving decarbonisation targets.

In the green transport transition process, both the municipal transport organisation and the responsibility of individuals are crucial: the attitude of all Miskolc residents, the dedicated work of civil society and advocacy organisations, and the economic incentives of transport operators. The primary actors in the development of infrastructure and services are the Municipality of the City of Miskolc with County Rights, the Miskolc Municipal Transport Company, the Ministry of Construction and Transport and the public institutions under its control.

WASTE MANAGEMENT AND CIRCULAR ECONOMY

Waste management / circular economy - interventions to support the transition

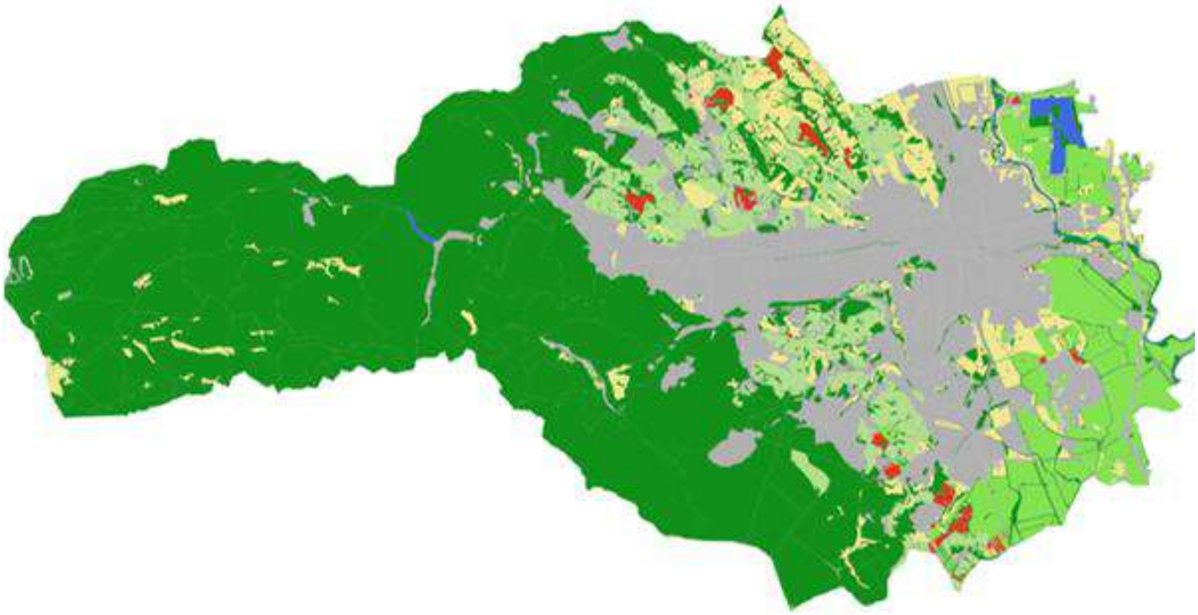
The **strategic priority for** waste management and the circular economy is **to prevent waste generation and increase waste recycling in** Miskolc and the region**.**

The aim is to continuously increase the proportion of waste collected separately and to achieve a high rate of recovery of materials from the municipal solid waste generated. This could mean recycling up to 90% of paper waste, 89% of metal waste, 85% of plastic waste, 90% of glass waste and 90% of organic waste by 2030. **The development of a modern regional waste management system with a focus on recycling will be** mainly managed by MOL MOHU Waste Management Ltd. as the national concessionaire, with the participation of MiReHu Nonprofit Ltd. as the local public service provider. The service of waste yards will be extended, the return system for beverage packaging will be fully developed, and the organised collection of food waste in the city will be implemented. Organic waste will be used to generate green energy in the city through extended biogas recovery and to replenish soil in urban gardens through on-site composting.

The implementation of the **circular economy transition package** will allow the exploitation of industrial synergies identified in the city region, the promotion of local solutions for the sharing economy, the promotion of the start-up and establishment of enterprises that accelerate the circular economy transition, the development of circular economy technologies and the production of products, the expansion of the Miskolc Reuse Centre. The General Assembly of the Municipality of the City of Miskolc with County Rights has committed itself by its Resolution 221/2023 (XII.14.) to the needs of local investments and economic actors, to the understanding of the environmental, social and economic impacts of their activities and to the promotion of sustainable investment, and is preparing a thematic cooperation between companies, the creation of a so-called Climate Platform.

The key players in the implementation of the priorities are MOL MOHU Waste Management Ltd, MiReHu Ltd, MIVÍZ Ltd, Miskolc City Maintenance Non-profit Ltd, large companies operating in the region and their suppliers. The role of the city, the University of Miskolc, the Chamber of Commerce and Industry, entrepreneurs and civil society organisations is mainly to organise the ecosystem and to exploit opportunities for innovation and cooperation.

Green infrastructure and nature-based solutions



Miskolc has a very good environmental location, but is also highly exposed to the challenges of climate change. The proximity of the Bükk Mountains provides the city with significant ecological and green space capital, but cannot replace the role of green spaces within the city.

In the future, it is worth developing an "offsetting strategy" specifically for densely populated inner-city and residential areas, which is primarily about preserving and expanding green spaces, with a focus on reducing the thermal insulation effect and improving the quality of life. Such a comprehensive strategy has a number of prerequisites, in particular the revision of the 2016 Green Infrastructure Development and Maintenance Action Plan, the definition and management of the value of green assets, the establishment of a tree inventory and green inventory, and the development and operation of a comprehensive environmental monitoring system.

As a result of the **integrated development of municipal green and blue infrastructure,** pavement density is reduced, tree-lined streets are reconstructed, the extent and quality of urban green spaces is increased. **Reducing paved surfaces in inner city areas is a strategic priority**: greening of industrial areas, public spaces and private areas can significantly reduce the heat island effect. All this will help to create a liveable urban environment while increasing absorption capacity. **A priority project for** the next 2-3 years will be the implementation of the **Szinva Green Corridor** (the Stream Szinva will run west-east through the entire length of the city), which will not only serve specific needs (dog walking, transport with pushchairs) but also provide alternative transport options for city residents (walking, cycling, scooter and skateboarding) and direct access to the water surface in several neighbourhoods.

Miskolc's drinking water supply is primarily based on the vulnerable karst waters of the Bükk Mountains, therefore the **protection and sustainable use of the urban water base is** a systemic **strategic priority**. In order to ensure **sustainable water management,** drinking water base ultrafiltration technology should be installed at the Tavi and Ómassa spring intakes. **Long-overdue drinking water network reconstruction should be implemented to eliminate high network water losses.** In addition, the aim is to reduce domestic water demand, promote water saving, rainwater and greywater utilization. In the case of stormwater, there is a need to revise the current standards, which clearly support the fastest possible drainage, and to test and promote water conservation and slowing down run-off.

In addition to mitigation and absorption capacity considerations, a systemic rethinking of blue and green infrastructure is also essential from an adaptation perspective. Beyond their direct temperature-reducing effects, they are also important for water conservation, storm damage and landslide prevention, and flood protection. The revitalisation of the areas surrounding the city that were formerly used as gardens will contribute to a healthier lifestyle, food security and biodiversity, as well as improving the urban climate.

The key players in the implementation of the priorities are MIVÍZ Ltd., Miskolc City Maintenance Non-profit Ltd., the city's NGOs and communities active in community planning.

4. Principles and processes

Since our selection for the 100 Cities Mission, the preparation of the Climate City Contract (CCC) has focused on the first three steps of the climate transition process, including building a strong mandate for collective action, understanding the systemic context, and jointly developing a portfolio of interventions, i.e. building an inclusive ecosystem that understands and promotes change. Certainly, the implementation of actions already initiated continued in parallel with the planning process. The preparation of the CCC is seen as an organic learning process, the lessons of which will be incorporated into the implementation of interventions and the revision of the CCC, making it the "new normal" to accelerate the climate transition.

"Map" for the climate transition in the context of Net Zero Cities

Source : https://netzerocities.app/ClimateTransitionMap

A strong mandate for action

Commonly agreed targets, sustained commitments and concerted action by all stakeholders are essential to identify and implement the actions and investments needed to achieve climate neutrality by 2030, so building a strong mandate is not only the first but an ongoing task - a mandate that means not only political support but also a real partnership in action and the necessary empowerment. In line with Miskolc's Participation Concept, we seek to actively involve the whole local ecosystem of stakeholders (citizens, civil society groups and media, as well as the private and public sectors) through the Participation Office. The three key areas of focus in building the mandate are the involvement of the academic community, effective media communication and transparency. In line with this, the University of Miskolc has been our first partner since we were selected for the mission.

In the context of the mandate, we must not forget the national level, as the government, the line ministries and their back offices, the national professional and scientific organisations and the public service companies are indispensable actors in such a transformation process.

Understanding the system

Although Miskolc already had a number of strategic documents and data sources at the time of applying for the mission (SECAP, Climate Strategy, SUMP, Environmental Status Report, studies at the University of Miskolc), these point data records and situation analysis are not integrated into a coherent monitoring, evaluation, learning and feedback system, making data for planning difficult to access and limited comparability. We have therefore invested a great deal of effort to compile our baseline GHG inventory as carefully as possible. A strategic priority is to set up an integrated environmental information and monitoring system to ensure that the right data and information is available

At the same time, to lay the technical and scientific foundations for the mission, we have convened the **Transition Team**, a group of climate change actors to bring together the knowledge, skills and perspectives of different disciplines and sectors to work on a city-wide climate neutrality mission. The Transition Team has involved stakeholders through thematic **climate neutrality working groups** (Energy, Transport, Urban Land Use, Business), with nearly 100 participants representing more than 50 organisations. The task of the working groups was to develop a problem map and identify areas for intervention to better understand Miskolc's environmental and climate system, and we count on the active participation of the working group members in the implementation of the CCC.

Joint design of the intervention portfolio

Isolated solutions and uncoordinated agendas cannot achieve the kind of transformation that the city's climate neutrality objective requires. In jointly creating the portfolio of interventions, the Transition Team and working groups integrated existing policies, actions and programmes with new and accelerated interventions. Only the resulting portfolio, which will be continuously developed, refined and implemented, can bring together the individual efforts planned by the city's departments and all stakeholders. It has been experienced that the process of joint creation of the portfolio clearly helps to overcome obstacles and exploit positive synergies. In developing future scenarios, we have taken into account the drivers for change, identified usable models, capital raising opportunities and financing strategies.

Building an inclusive ecosystem

An effective, rapid and equitable climate transition clearly requires more than what city governments can do alone. It requires the positive commitment, passion, creativity and drive of all local stakeholders. We also count on the diverse experience and expertise, resources and investments of our partners. That is why we want to mobilise the city's ecosystem in all its diversity: knowledge transfer institutions, innovative companies and start-ups, as well as grassroots initiatives and civil innovators. We are working to create the conditions for all actors to become truly empowered in the transition. Within this inclusive ecosystem, the Transition Team facilitates effective collaboration, allowing space for needs and risks to be explored, considered and debated, encouraging change and innovative thinking. This collaboration can provide new opportunities to identify possible solutions and new alternatives, to exploit synergies.

Supportive measures

A number of management and operational innovations are also needed to deliver the project portfolio. It is not sufficient to respond to the challenges of climate change sector by sector, but a systemic approach is needed, coordinating activities that previously operated in isolation. To this end, the position of Commissioner to Mayor Responsible for Climate Affairs has been created and the Transition Team convened. The challenge ahead is to bring the knowledge, information and skills needed for climate-smart municipal management to all levels of the organisation.

Partnerships, governance, regulatory and financing innovations are needed not only locally, but also at national level. This requires effective cooperation between the three Hungarian cities (Budapest, Pécs and Miskolc), the involvement of other national actors and real support from the government.

The *development of the Environmental Information System* will support more effectively the detection and monitoring of the city's environmental processes, the preparation for mitigating the effects of climate change, the prediction and prevention of environmental emergencies and disasters, the improvement of asset security, environmentally aware and data-driven planning and decision making, the protection of the health of the population, the reduction of flood risk and the improvement of the security of drinking water supply.

The *preparation of documents for transport development includes the* revision of the Cycling Network Plan, the Sustainable Mobility Management Plan (SUMP), the Transport Concept; the coordination of cycling and public transport (feasibility and impact assessment of small, medium and large-scale solutions). The aim of the measure *Improvement of public transport services* is to develop modern public transport offering a high quality alternative, improve the accessibility of services, introduce combined tariff products and further develop the eTicket. The *Green and Blue Infrastructure Development Strategy planning documents* will include the revision of the Municipal Green Infrastructure Development and Maintenance Action Plan (ZIFFA), the Integrated Municipal Water Management Plan (ITWMP) and the Municipal Green Book. Regulatory assistance should also be provided for people experiencing temporary or permanent energy poverty or for energy communities, and the Local Building Code and the above documents should be harmonised.

An urban planning principle and basic value is the abandonment of the expansion of unnecessary capacities, the emphasis on the inclusion of environmental aspects in business models.

In addition to redefining governance, social innovation is needed. A green transition requires renewed training of professionals *through capacity building training programmes*. *Strengthening the role of the University of Miskolc as a knowledge hub and its RDI potential* will also help decarbonise the energy sector and support the transition to renewable energy sources. With a focus on climate neutrality, the municipality *plans targeted cooperation with the National Laboratory for Renewable Energies, the Multidisciplinary National Laboratory for Climate Change and the National Laboratory for Social Innovation. Public awareness programmes* are needed to promote net-zero energy use, green and blue infrastructure development, and climate-friendly transport modes. Continuous experimentation is needed to ensure active involvement of the public, civil society and business organisations.

We help the public by providing information and awareness-raising actions!

The future **Climate Platform** will aim to support ongoing cooperation with organisations and businesses involved in the climate transition, facilitate mutual exchange of information and monitor the implementation of the Action Plan. The successful **Participatory Programme** and **Participatory Office** will further strengthen public participation in the climate transition. The establishment and operation of the planned **Green Advice Bureau** will further strengthen climate-smart cooperation and equitable transition with citizens in the city.

A basic principle is the widespread dissemination of the concept of "unused material and energy" among all actors in the city!

What can I do?

Monitoring and review of the CCC

In order to ensure accurate measurement, monitoring, evaluation and feedback, the city intends to integrate the current urban development and operational data available for the urban carbon inventory and the data that will be generated in the coming years as a result of the green and digital transition into a single system. This model will form the basis for a comprehensive urban monitoring system. The planned digital models will help identify opportunities to improve energy efficiency and reduce emissions in different sectors, including transport, buildings and industry. Detailed national and regional benchmarks will be defined and incorporated into the model design, which will also greatly support the annual review of the Action Plan and the subsequent monitoring of planned interventions and projects, thus preparing and supporting appropriate decision-making. It can also be used for the 2024 review of existing transport and urban development strategies. The current carbon inventory will also be sent to the Covenant of Mayors. The CCC will be reviewed by the municipality every two years from 2025 until the end of the two-year review cycle.

Key actions for the next 2 years

- Continuous refinement of the interventions and quantified target values of the Action Plan through an iteration process.
- Development and expansion of monitoring system and economic model.
- Continuation of stakeholder engagement and socialization, implementation of awareness-raising programs.
- Detailed planning of project portfolio and financing model, acquisition of necessary permits.
- Resource mapping, continuous search for financial resources.
- Launching and implementing developments with a resource framework.

YES! From Steel City to **°coolmiskolc!**

The above will require the partnership and active participation of the people of Miskolc. Therefore, it is essential that the processes are transparent and that climate-neutral attitudes and climate-smart lifestyles become trendy for the citizens of the city through positive communication. This is the only way to motivate them to understand and do what is necessary to achieve urban climate targets.

°coolmiskolc on a joint path to climate neutrality!

°coolmiskolc
on a joint path towards climate neutrality

https://tervezzukmiskolcot.hu/cool-miskolc

Miskolc, 14 March, 2024

Miskolc Megyei Jogú Város Polgármestere

Pál Veres

Mayor

5. Signatories

The table lists the signatories who have already committed to the Climate City Contract in the pre-submission period and are helping the city to achieve climate neutrality by 2030. The number of committed organisations and individuals continues to grow, and the joint commitment of the municipality and the signatory organisations was confirmed by the Parties in a ceremony on 12 March 2024.

Name of the signatory (organisation)	Sector / Domain / Level of operation	Legal form	Name of the responsible person	Position of the responsible person
University of Miskolc	Education, higher education / national	Budgetary authority	Prof. Dr. Horváth Zita	Rector
MIHŐ Miskolc Heating Ltd.	District heating provider / local	Ltd	András Korózs	Managing director
Miskolc Municipal Transport Ltd.	Local public transport / local	Private limited company	Péter Demeter	Managing director
Miskolc City Maintenance NKft.	Maintenance of public space / local	Non- profit ltd	Zoltán Osváth	Managing director
Miskolc Regional Waste Management Nkft. (MiReHu Nkft.)	Waste management / regional	Non – profit ltd	Roland Ladányi	Managing director
Miskolc Municipal Law Enforcement Body	Municipal law enforcement / local	Law enforcement body	Ferenc Szabó	Director
National Association of Entrepreneurs and Employers	Advocacy / national	Asso	Ádám Imre	President

Bükk National Park Directorate	National Park, nature conservation / regional	Central budgetary authority of a public institution	Kálmánné Rónai	Director
Miskolc Unified Social, Health and Child Welfare Institution	Social sector, healthcare, child protection / local	Budgetary authority	Péter Attila Gúr	Director
Centre for Sustainable Communities	Regional development, consulting / national	Ltd	Dr Lilla Judit Bartuszek	Project Manager
Starters E-Components Generators Automotive Hungary Kft.	Automotive company / international	Ltd	Dr Péter Dobos	Factory manager
MIDMAR Ltd.	Tourism and marketing / local	Ltd	Krisztina Tóth- Bodnár	Managing director
M-Plus Central Europe Kft.	Machine parts production / international	Ltd	Csaba Filip	Managing director
Miskolci Autóház Kft.	Automotive company / national	Ltd	Gábor Brózsely	Managing director
Eastjob Bt.	Labor recruitment and employment services/ regional	Company	Krisztina Kiss	Owner/General manager
Íz- Kalauz Ltd.	Restaurant, catering/ regional	Ltd	Henriett Vargáné Bodnár	Managing director
Miskolc Cultural Centre NKft.	Local event organization, cultural broadcasting / local	Non- profit ltd	Tünde Majorné Bencze	Managing director
Miskolc Institute for Health Promotion	Health service / local	Budgetary authority	Ildikó Balog	Director

Ferenc Rákóczi II Library	County library and cultural activity / regional	Budgetary authority	Gábor Varga	Director
Jakab Education Ltd.	Adult training, education / regional	Ltd	Éva Supák	Managing director
Miprodukt Kft.	Printing and sewing industry / local	Ltd	Lívia Lukács	Managing director
EX-ACT Project Consulting Ltd.	Professional, scientific, technical activity / regional	Ltd	Attila Pásztor	Managing director
Hotel Palota Lillafüred Kft.	Hotel, catering/ national	Ltd	Krisztina Borda	Managing director
Borsod- Abaúj- Zemplén County Chamber of Commerce and Industry	Chamber of commerce and industry / regional	Association	Tamás Bihall	President
Kilián North Community Association	Local NGO / local	Association	Zsolt Jakab	President
Holocene Nature Conservation Association	Local NGO, nature conservation / local	Association	József Kiss	President
Miskolczi Cellars Table Society	Local NGO / local	Association	Dr Pál Tibor Jancsó	President
Miskolc and its Region Tourist Association	Local NGO, tourism / local	Association	Szendrei Mihály	President
Like a Company	Local NGO, cultural acitvity / local	Association	Aida Sándor- Lenkei	President
MiskolcÉrt Community Foundation	Local NGO / local	Foundation	Mató Edina	President

Association of Hungarian Nature Conservationists	NGO, nature conservation / national	Association	Éger Ákos	President
Bükk Circle for Miskolc and Bükk Tourism	Local NGO, tourism / local	Association	Angyal Enikő	President
Miskolc Women Have a Chance Foundation	Local NGO, equal opportunity / local	Foundation	Dr Marianna Matiscsákné Lizák	President
Next Generation Foundation	NGO / national	Foundation	Ágnes Durda	President
Borsod- Abaúj- Zemplén County Heritage Association	Local NGO, national knowledge / regional	Association	Titkos Sándorné	President
Compass for Sustainability Foundation	NGO, sustainability / national	Foundation	Péter Lenkey	President
Ányos Jedlik Scientific Dissemination Society	NGO, scientific dissemination / local	Association	Tamás Szamosfalvy	President
Martin-Suburban Pensioners Club	Local NGO, Pensioners' Club / local	Association	Zoltánné Greutter	President
Miskolc-Diósgyőri Reformed Primary School and Kindergarten	Primary school and kindergarten / local	Church-run educational institution	Attila Nagy	Director
Miskolc City Student Council	Local student government / local	Association	János Bálega	President
Miskolc Open Door Baptist Primary School and Kindergarten	Primary school and kindergarten /local	Church-run educational institution	Ildikó Molnárné Kertész	Director

GHG Inventory of Miskolc City

2021

Content

1 Introduction

In January 2022, the Municipality of Miskolc MJV submitted its application for the European Union's "100 Climate Neutral Cities Mission" programme, part of the European Green Deal, to be implemented within the framework of Horizon Europe. The European Commission has selected Miskolc County Municipality as one of 99 other cities to participate in the programme. In addition to 100 cities from EU Member States, 12 non-EU cities from other European countries are also part of the mission. As part of the mission, Miskolc has set itself the goal of becoming net zero carbon by 2030. To achieve this, a City Climate Contract will be signed with the European Commission. However, this goal can only be achieved through a broad partnership and stakeholder involvement. In addition to the Municipality of Miskolc MJV, the commitment of the main urban emitters is also needed, as only a joint effort can achieve the net emission value.

To sign the Climate Agreement, the city have to prepare a Climate Neutral Action Plan 2030 and an Investment Plan showing how the activities set out in the plan will be financed.

In the last decade, Miskolc MJV has been one of the most committed cities in Hungary to continuously improve the quality of life of its residents, to develop activities and infrastructure that have an impact on the quality of life, and to reduce emissions. The development of a climate strategy and the implementation of a climate-aware approach on as wide a scale as possible is in the city's fundamental interest. In line with EU directives, local authorities must also contribute to reducing greenhouse gas emissions and to climate protection efforts.

- ✓ In September 2011, the Municipality of Miskolc MJV signed a cooperation agreement with the Nonprofit Ltd. for Greener Cities. In the cooperation agreement, the city undertook to follow the principles of Green City, to respect the points of the Green Charter of Milan, to apply the Green City Accreditation Point System in the initiation and implementation of development in the city.
- ✓ In 2013, Miskolc MJV, within the framework of the ATTAC project, prepared the Sustainable Urban Transport Plan (SUMP) of the city, led by Miskolc Holding Zrt. and MVK Zrt., of which two positive examples have been implemented, without claiming completeness: the extension of the tram network for the development of public transport has been completed, and 75 CNG buses strengthen the environmentally friendly urban transport.
- ✓ In 2013, the city also prepared a Sustainable Development Strategy (2013), which aims to "offer the city's population the opportunity to choose sustainability, to offer the development of a sense of identity in Miskolc based on the values of sustainability."
- ✓ In 2015, it joined the European Covenant of Mayors, committing to reduce its CO_2 emissions by at least 20% (compared to the base year of 2008).
- ✓ In 2016, it prepared the SEAP, in 2019 the SECAP and in 2020 the Urban Climate Strategy, which already set a target of 43% emission reduction.
- ✓ It is involved in a number of international collaborations and initiatives to support the urban green transition.

In 2022, Miskolc prepared its Sustainable Urban Development Strategy (SUDS) for the 2021-2027 programming period. **The Sustainable Urban Development Strategy** of Miskolc City with County Rights has been prepared with **full planning**, ensuring consistency with the Commission's Sustainable Urban Development Strategies Manual.

In planning the strategy, the city **has redefined its vision, objectives and action plan based on changing challenges and needs, and the** SUDS will also provide the basis for future strategic documents for the city. The **SUDS is a constantly evolving strategic document** and it is important that it is regularly reviewed and updated in the light of the challenges and needs facing the city.

The strategy for the SUDS was developed along the **5 planning dimensions** (Prosperous City, Sustainable City, Serving City, Digital Transition, Green Transition). In the detailed elaboration of the planning dimensions, the application of **resilience** and **urban adaptability** as a horizontal aspect was of particular importance.

The SUDS Executive Summary states:

"*The continuously and rapidly changing economic environment, the pandemic that reached the whole world in just a few months and changed our habits, the Russian-Ukrainian war that started in February 2022 and has been ongoing since then, and the accelerated climate change have caused significant problems in economic and social processes, but together they pose completely new challenges to all actors in a community, including urban management and urban development.*

Although cities cover only a few percent of a country's surface area, they consume 60-80% of all energy produced and are responsible for 75% of total carbon emissions, making cities the most important arena of our daily lives, and achieving meaningful results can only be achieved with the involvement of cities.

Hungarian municipalities, including the city of Miskolc, are not only having to respond to the challenges of climate change, the rapid technological advances offered by digitalisation, and unexpected external situations, but - unlike the vast majority of cities in the world - are not facing the increasing use of infrastructure caused by overpopulation, but the fact that their population is drastically decreasing. Despite (or even in spite of) the problems present in the municipality, Miskolc has a number of assets and strengths that give it the potential to stop this negative trend and start to move in a positive direction. In the short term, it is possible to address some of the problems (for example, reducing car use and reducing emissions by improving public transport), but to make Miskolc a sustainable city and a liveable home for its residents, fundamental changes are needed.

Based on the demographic trends, it was a clear objective in the current planning period that all interventions assigned to the dimensions should also contribute directly or indirectly to increasing the population retention capacity of the city.

Miskolc is in a good position to build on the developments and processes already underway to achieve the planned climate-neutral urban operation, i.e. to minimize the emission of greenhouse gases and to capture almost as much carbon dioxide as the city infrastructure will emit. An outstanding achievement over the last decade is that the district heating company has been able to provide more than 50% of its primary energy needs from renewable geothermal energy sources. In 2021, the renewable share in the Avas urban area was already 68.28% and in the city centre it was 60.31%, which is also outstanding at European level.

In Miskolc, the urban environment will become sustainable by minimising environmental impact, reducing air, carbon and water pollution, eliminating water losses from the network, while minimising energy use by relying mainly on renewable energy sources, and reducing the urban heat island effect in densely populated inner city areas, thereby improving the quality of life for city dwellers. Efforts should be made to reduce waste production and increase waste recycling, and to strengthen the circular economy. In addition to energy, it is also important to help improve the city's self-sustainability in the food supply sector, by empowering local (urban and county) economic operators, strengthening short supply chains and playing a greater integrating and supporting role.

These can help to create a liveable and environmentally resilient urban environment that helps to keep the current population and also attracts young people of working age who are attached to the city. In addition to ensuring economic prosperity, achieving climate-neutral urban functioning could be a breaking point for the city that could differentiate it from other large cities in the region and create good practice within Europe."[1]

The green transition, and the possibility and pace of the transition, will of course be strongly influenced by both national and international developments. The experience of the past shows that it will take decades before there is a significant positive change in energy use and energy mix. It is also worth bearing in mind that the emergence of new technologies and the increasing use of renewable energy sources have not, on the whole, led to a reduction in the use of fossil fuels (and not at all to their replacement), but rather to the servicing of growing energy demand.

From this brief introduction, it is clear that Miskolc has a long-standing commitment to protecting the city's environment and strives to create as carbon-neutral urban operations as possible. This process has been given new impetus and perspective by the city's accession to the 100 Climate Neutral Cities Mission.

By transforming their own infrastructure and regulating their operations, cities can initiate and carry out favorable processes, but in the case of a complicated urban ecosystem, progress in this process can only be made at the cost of significant social costs. Emissions from the operation of municipal infrastructure and services are only a relatively small part of the emissions generated in the entire city, and the municipality has a direct impact only on this segment, however, stimulating and influencing other areas will be an important task in the coming decades.

This can be based on the urban **GHG inventory** prepared on the basis of data from the year **2021**. During the selection of the base year, the 2020 total shutdown due to COVID and the 2022 energy crisis due to the Russian-Ukrainian war were taken into account. Both years would have given a distorted picture of consumption, so the intermediate year 2021 was chosen.

[1] Miskolc Sustainable Urban Development Strategy 2021-2027

2 History

Miskolc MJV Sustainable Energy and Climate Action Plan (SECAP) 2019
Miskolc MJV Climate Strategy 2020

The background has been explored and the city's SECAP and Climate Strategy have been examined in detail separately.

Based on the achievements of the City of Miskolc and the development plans set out in its strategic documents, the City of Miskolc has set out its international commitments and the necessary measures in 2019 in the SECAP to increase energy efficiency and protect the environment and climate. In this way, the Municipality of Miskolc MJV, in line with its membership of the Covenant of Mayors, wished to join the European municipalities that are preparing **their Sustainable Energy and Climate Action Plans and are monitoring closely the implementation of their commitments, including the municipal programme for the reduction of CO_2 emissions by 40% by 2030, set by the European Union. The** Covenant of Mayors has nearly 10,000 signatory municipalities/municipalities as members, representing more than 260 million European citizens.

The Municipality of Miskolc MJV, by joining the Covenant of Mayors in 2015, undertook to prepare its SEAP within one year, which was submitted in 2016. In the document, it outlined how it intends to achieve the 2020 target. It has chosen 2008 as the base year and 2014 as the intermediate year for data analysis. SECAP intends to achieve the target of a minimum of 40% by 2030 compared to the 2008 base year emissions, along the lines previously set out and complementing them. The document also addresses measures to reduce the impact of climate change and to adapt to it.

The SECAP includes data for 2017 and these values are also included in the 2020 Climate Strategy, as this is the date for which the data needed to define the indicators was available.

The SECAP may include not only the energy use of the population and the municipality, but also the emissions of businesses (services, industry) and measures to reduce them, but the data available for the municipality (except for transport) **are mostly limited to the population and the municipality in terms of baseline emissions, but mainly in terms of measures and emission target.** Dialogue with businesses, encouraging them to use energy efficiency, renewables and clean technologies in general, and involving them in voluntary agreements are important tasks for the municipality, but the regulatory instruments of the state, both normative and economic, are more likely to influence the business sector's activities in this direction. Thus, within the scope of the SECAP, there remain those issues over which the municipality can have greater influence.

In the Climate Strategy 2020 prepared by the city, the SECAP GHG inventory was partly refined using the methodology published by the Covenant of Mayors (COM), but even this document was developed based mostly on the data series published by the CSO, without separate detailed data collection and analysis.

2.1 Main historical data

Before presenting a detailed inventory, it is important to record the key demographic, social and economic trends that have taken place in the city over the past 5-10 years.

2.1.1 Demography

Table 1: Population by main age groups

(thousand persons)								
	2011				2022			
	0-14 years	15-64 years old	65 years and over	total	0-14 years	15-64 years old	65 years and over	total
Miskolc City with County Rights	23	115	30	168	19	92	34	144
other cities	37	162	39	239	34	135	45	215
municipalities	52	185	43	280	50	166	44	260
Total Borsod-Abaúj-Zemplén County	112	462	113	686	103	393	123	619

Source: HCSO - preliminary census data 2022.02.

Between 2011 and 2022, the city's population will decrease by 14.29% (-9.8% at county level), with domestic and international migration -5.4% and natural increase and decrease - 4.4%. Over the last 30 years, the population of Miskolc has decreased by almost 50,000, or almost a quarter. Further modelling the trends of the last 20 years suggests that by 2035 there will be as many people of working age in the city as inactive and the population will not be much more than 130,000. This poses huge challenges for the organisation and maintenance of public services. This negative demographic trend has not yet been reflected in consumption and energy use data, which shows both the emergence of energy-intensive sectors in the city and the significant overconsumption of gas by households, which is also observed here, as is the case almost everywhere in Europe (2022 has already brought a change in this respect, with a sharp drop in residential gas consumption due to significantly higher overheads above average consumption).

2.1.2 Housing stock

Table 2: Change in the number of dwellings

	2011 (thousands)	**2022 (thousands of units)**	**Housing stock in 2022 as a percentage of 2011**
Miskolc City with County Rights	77	78	101,4
other cities	95	98	102,8
municipalities	112	110	97,7
Borsod-Abaúj-Zemplén County	284	285	100,4

Source: HCSO - preliminary census data 02.02.2022.

Nearly 1,000 new dwellings have been built in 10 years, an increase of 1.4%, with negative demographic trends already having an impact on the supply side.

There has been minimal change in the number of households in recent years. Data for 2021 was used in the carbon inventory.

Table 3: Total number of dwellings in Miskolc

Period	Total number of dwellings at the beginning of the year (units)
Year 2017	76.772
Year 2018	76.807
Year 2019	77.114
Year 2020	77.251
Year 2021	77.352
Year 2022	77.541

Source: KSH - Annual statistics on settlements

Demographic and housing data for the 2022 Census are presented in the table below. The table includes 2011 data (where available) and is supplemented with a projected 2030 dataset based on trends over the past 10 years.

Table 4: Comparison of census data

Census data	2011	2022	2030
Population number (persons)	167 754	145 735	131 162
Number of dwellings	76 539	79 051	81 423
Occupied dwelling	69 381	66 548	63 886
Unoccupied dwelling	7 158	12 503	17 536
Number of households with wood heating (number)	9 767	8 258	7 019
Number of households heating with coal, lignite (number)	2 282	564	141
Number of dwellings with district heating (units)	31 669	33 216	
Heating one or more dwellings with central heating, boiler or other means (units)		25 960	18 172
Mains (piped) gas heating (pcs)	38 459	39 608	31 686
LPG (cylinder, tank) gas fired (pcs)	211	130	0
Number of dwellings with electric heating (units)	609	4 501	31 507
Number of households with solar panels (number)		2 106	10 530

Number of households with heat pump heating (pcs)		960	4 800
Number of households with solar collectors (number)		570	2 850
Number of households with air conditioning (number)		14 291	21 437

Source:KSH - 2022 Municipal census data series

The data series have also been used in the determination of consumption trends and associated emission values, with the difference that the population decline has been calculated at a lower rate than would be expected from the trend in previous decades.

2.1.3 Economy

In the last 10-15 years, Miskolc has clearly started to **change its economic structure**; the number of registered business organisations has increased, most of them being individual, micro and small enterprises. The distribution of local enterprises by economic sector shows that the weight of construction and retail trade has decreased in recent years. Of the top 10 enterprises with the highest turnover in the city, the top 5 are 4 mechanical engineering enterprises (Robert Bosch Energy and Body Systems and Robert Bosch Power Tool Kft., Joyson Safety System Hungaria Kft. and Starters Automotive Hungary Kft.) and one utility (MVM ÉMÁSZ Hálózati Kft.).

Looking at the structure of the exporting sectors, it is also clear that the machinery industry plays a central role, and the concentration of Miskolc's economy is clearly visible, as the machinery industry accounts for 83% of export turnover in the county seat of Borsod, and the city's concentrated industrial structure has made it highly vulnerable to crises, especially when the most important sector is directly linked to vehicle production.

Through the **University of Miskolc, the** city is a **significant R&D&I centre in the region**, cluster cooperation related to the key sectors (chemicals, automotive, mechanical engineering, IT) helps economic growth, and it is important to further strengthen dual training. The further strengthening of the **IT sector** in the municipality **could be a starting point for the creation of high added value jobs**.

2.1.4 Transport

Miskolc is an important logistical hub on the Via Carpatia road and rail transport corridor linking Europe's northern and southern borders. The city is located at the intersection of the main transport corridors of Central Europe and thus plays an **important role in the region's transport**.

The city's road network, formed by a hierarchical structure of primary and secondary arterial roads, collector roads and secondary roads, is essentially an offset cross-shape, with a few circular elements in a ring structure.

The length of the road network of the Miskolc City with County Rights is 527 km. The total length of state roads in the administrative area is 42 km, which is maintained by the Hungarian Public Road Nonprofit Zrt.

Road infrastructure developments in recent decades have sought to reduce urban transit traffic. This arterial road network should carry some of the transit traffic, pendulum traffic as well as local traffic. Road congestion in the city centre is one of the biggest problems in road transport.

With a combination of multi-motivated traffic, the access sections of trunk roads are congested, inland areas are under capacity, causing congestion and consequently increasing environmental pressures (mainly air pollution along the trunk road network), and further deterioration is expected in the absence of intervention.

The public transport network of the city of Miskolc adapts to the structure of the city, so more than half of the passengers travel along the two axes (North-South and East-West). The shopping centres are located along the east-west axis (at the eastern end of the city); slightly south of this is the city's main passenger railway station, the Tisza station.

The public transport network, based on the socialist metropolitan system, needs a major overhaul. There is a need to improve the tramway network on the north-south axis, and to connect Búza Square and possibly Gömöri station to the network. The bus network should be adapted to the tram lines. At the Tapolca junction, interconnecting bus lines should be linked to the E to D tram line.

It is important to create competitive public transport corridors that are independent of other motor traffic.

2.1.5 Public utilities

A particular problem in the town is the **deteriorated technical condition of the** existing **basic utility networks and in two parts of the town (Martinkertváros, Miskolc-Szirma) the drainage of rainwater is not solved**. Currently, the length of the public drinking water network is 685.44 km, and due to its age and technical condition, it is in need of continuous renewal. The volume of drinking water used (billed) by the city in 2020 was 7 131 000 m^3 /year, of which 5 035 000 m^3 /year was supplied to households. **Despite the improvements, the system has been subject to a significant annual loss of water from the network, which in 2021 was 44-45%, with the amount of water injected into the system now almost double the amount used.**

The heat production and heat supply activities of MIHŐ Miskolci Hőszolgáltató Kft. cover the administrative territory of Miskolc, providing district heating and hot water services to 32 thousand residential and nearly a thousand other public users. The proportion of residential properties connected to the district heating system is 42%. The **age of the equipment owned by the heating company is very high, averaging over 30 years, while the average age of the network is unfortunately even higher, over 40 years.**

2.1.6 Green area - green space

Existing **green spaces within the** municipality (public parks, public gardens; green spaces in residential areas; green strips, tree-lined areas; green spaces in institutions, institutions with significant green spaces; private gardens; inland forests) are to be fully preserved. The inner area of Miskolc is well provided with **green space elements**, but the distribution of green spaces is uneven and urban green spaces are not integrated into a real network system. The use of green spaces is significant, their condition is in many cases degraded, and the quantity of green strips and tree-lined areas is insufficient. Systematically increasing the extent of green spaces could offset the natural cooling of the city and the warming caused by climate change. The heat island effect could also be mitigated through the thoughtful development of green spaces. **It is important to develop a modern Environmental Information System**, which should include an up-to-date green space inventory to help monitor green networks and inform the necessary measures.

3 GHG inventory

According to the National Clean Development Strategy, about 72% of Hungary's current total GHG emissions are mainly generated by the use of fossil fuels. In recent years, these emissions have increased in the residential and transport sectors. The majority of GHG emissions are therefore linked to energy production and use (burning fossil fuels). This includes electricity generation, heating and cooling, and transport fuel use.

In Hungary, the transport sector is responsible for 20% of total GHG emissions, with road transport accounting for 98%, agriculture for 11% and the waste sector for 5.7% of total emissions.

Emissions per capita were around 6.6 tCO_{2e} in 2017, below the EU average. Hungary's per capita emissions of around 6 tonnes are lower than the European average of over 8 tonnes per capita, largely due to low per capita energy consumption and the dominance of nuclear power and relatively low specific emissions of natural gas in energy production.
The situation is less positive for GHG emissions as a share of GDP: Hungary is a larger emitter than the EU average (as are other Eastern European countries), while the Scandinavian countries or France are much further ahead.

Basis for the greenhouse gas inventory

The greenhouse gas inventory, like the carbon footprint, expresses in tonnes of carbon dioxide equivalent how much greenhouse gas the city has directly and indirectly emitted into the air for a given inventory year. According to the calculation model, the emissions were examined for three greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). According to the Intergovernmental Panel on Climate Change (IPCC), the emission factors defined in terms of impact are:

- the value of carbon dioxide is taken as a base unit (1),
- the greenhouse gas factor of methane is twenty-one times that of carbon dioxide (21),
- nitrous oxide has a greenhouse gas factor of three hundred and ten times that of carbon dioxide (310),

That is, while one methane (CH_4) molecule is equivalent to 21, one nitrous oxide (N_2O) molecule is equivalent to 310 carbon dioxide (CO_2) molecules. Hence, in quantifying GHG emissions, the emissions of all three substances have been calculated in tonnes of carbon dioxide equivalent (t CO_{2e}), which are summed to give total GHG emissions.

The conversion indicators used in the inventory are summarised in the table below.

Table 5: Conversion indicators used in the inventory

		GJ	kWh	therm	toe	kcal
Energy	Gigajoule, GJ		277,78	9,47817	0,02388	238 903
	Kilowatt-hour, kWh	0,0036		0,03412	0,00009	860,05
	Therm	0,10551	29,307		0,00252	25 206
	Tonne oil equivalent, toe	41,868	11 630	396,83		10 002 389
	Kilocalorie, kcal	0,00000418	0,0011627	0,00003967	0,00000010	

Source: Ember Climete - ghg conversion factors - 2022

The emission factors used in the inventory are described in detail in the excel help and presented for each sector.

Data retrieval

At some territorial levels, and for the emitting sectors studied, we worked with published data, but it was also necessary to obtain data that are not publicly available. In preparing the Action Plan, data published by the Central Statistical Office (KSH) were requested, and KSH was also contacted to obtain other unpublished data and to discuss methodological issues. In addition, the GHG inventory also required data obtained through direct contacts with the industrial companies, public service providers and member companies of Miskolc Holding Zrt. The Hungarian Energy and Public Utilities Regulatory Office was contacted separately in order to map detailed (sectoral) consumption data.
The aggregation of the data received also clarified the discrepancies between the data published by the HCSO and the detailed data requested by the target, so that there are sectors (e.g. energy management - electricity consumption data supplied to the city) where the data provided by the specialised institution/service provider responsible for the area were used instead of the data published by the HCSO. These are shown separately in the analysis.

Sectors assessed in terms of consumption and emissions

In Miskolc, as in the country as a whole, five sectors are responsible for greenhouse gas emissions: energy production and management (including buildings), industrial production, transport, waste management and agriculture. The natural carbon sink capacity (a collective term for land use, land use change and forestry) to offset emissions was also examined.

1. Energy management, energy consumption
    a. electricity
    b. natural gas
    c. district heating
    d. domestic firewood

2. Large industrial consumers

3. Transport
    a. Local urban public transport (MVK Zrt.)
    b. Local urban long-distance transport (bus)
    c. Local urban rail passenger transport (MÁV)
    d. Private car traffic on individual municipal roads
    e. HGV traffic on individual municipal roads
    f. Individual public roads affected by car traffic
    g. Individual public roads affected by lorry traffic

4. Waste management, waste water treatment

5. Agriculture

6. Urban absorption capacity

The methodology for the GHG inventory was partly based on the guidelines and calculation model available on the website of the Association of Climate Friendly Municipalities, which was made available to the cities in cooperation with the Association of Climate Friendly Municipalities, the Hungarian Geological and Geophysical Institute and the Climate Policy Ltd. In order to make the methodology more complete, the guidelines issued in the CCC guidelines were used and the final GHG inventory was also developed according to both methodologies. The calculation used by both approaches was also used as a control throughout the process. Where we deviated from the calculation methodology published by COM due to more detailed data collection, this is indicated in the study.

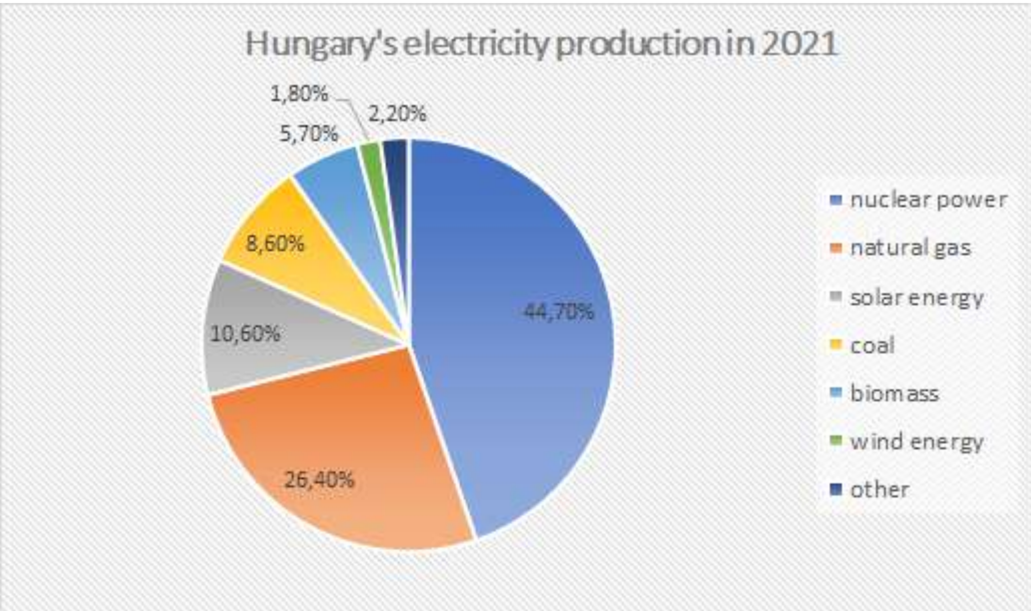
3.1 Energy consumption

3.1.1 Electricity

Based on the data of MEKH for the year 2021, it can be concluded that nuclear energy continues to be the most important energy source with 44.7%. There is no significant change here, the figure is almost identical to the previous years, but the share of increasing production has fallen slightly. Five years ago, it was true that Paks provided about half of our production, but over the years this share has gradually decreased.

Natural gas also maintained its second place, with a share of 26.4%. This means that, despite rising purchase prices, gas-fired power generation increased by almost 4% compared to 2020. This may explain why specific carbon dioxide emissions from electricity in 2021 were slightly negative compared to 2020, with a significant downward trend over the last 10 years. Almost all the SECAPs and Climate Strategies written between 2017 and 2020 (including the Miskolc documents) have used the specific value of 362 (360) g $CO_{2\,eq}$ published for 2008, although this value is constantly changing for electricity due to the changing energy mix.
Solar energy has taken third place in the national mix. Solar energy grew by 54% in one year and reached a share of 10.6%, with small household-scale power plants (CSHP) growing by 61% thanks to state subsidies.
Coal accounted for 8.6% of total production, with biomass in fifth place with 5.7% and wind energy in sixth place with 1.8%.

Figure 1: Hungary's energy mix



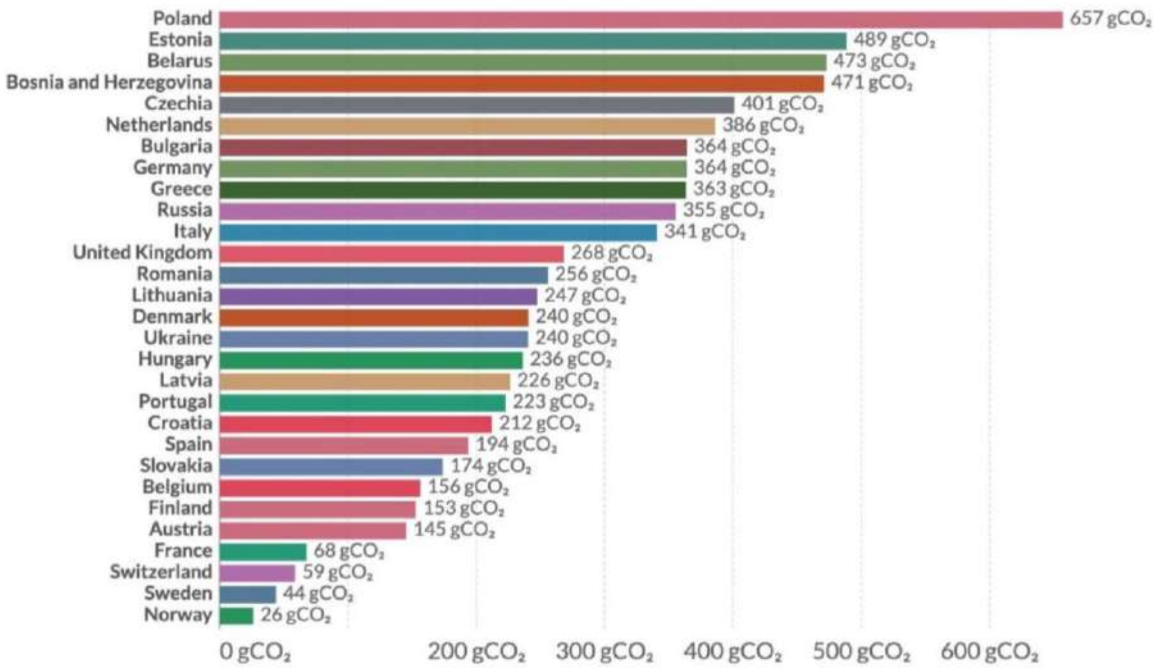
Source: MEKH

Looking at the main categories, this is how the energy mix has evolved:

- nuclear energy: 44.7%
- fossil energy: 35,1 %
- renewable energy: 19.2%

Looking specifically at 2021, the specific carbon emissions from electricity generation in each country are as follows:

Figure 2: Electricity carbon intensity in 2021 in European countries



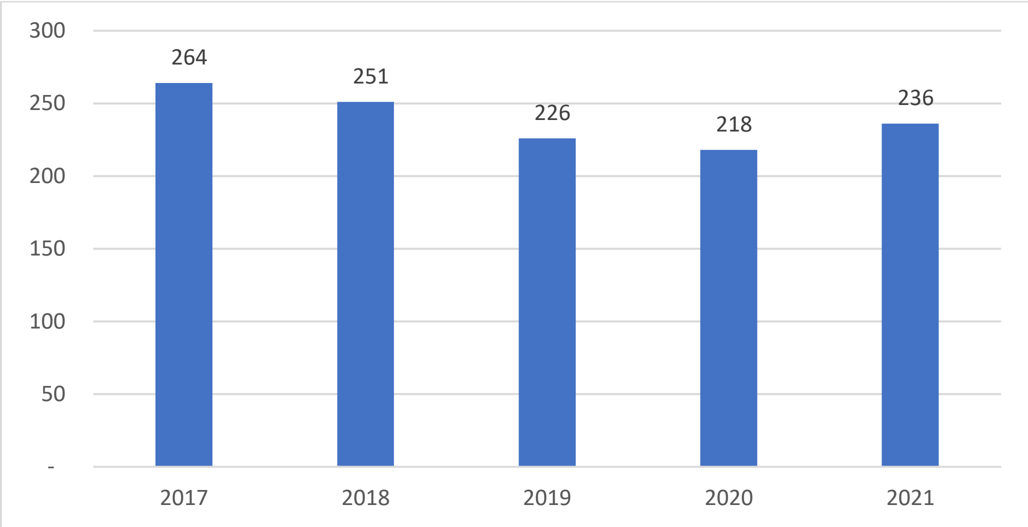
Source: Ember Climate (from various sources including the European Environment Agency and EIA)

The carbon dioxide emissions from producing one kWh of electricity vary by up to ten times between countries in Europe.

- In general, **the greenest countries (11 of them) in the** category below 150 g/kWh rely **on nuclear and/or hydropower for their electricity generation**. Four out of the top five countries (Switzerland, Sweden, France, Finland) rely heavily on the climate policy benefits of nuclear energy. Norway, the silver medallist after Switzerland, relies almost exclusively on hydropower.
- **The second most favourable band, 151-300 g/kWh, includes, for example, Belgium, alongside Hungary, which is relying heavily on nuclear power**. In addition to the important role of nuclear power, the use of hydropower also contributes to the favourable specific emissions figures for Romania and Slovenia. Spain and the UK are ideally located for wind power, but have not given up the security of supply and other benefits of nuclear power. Croatia is also relying heavily on hydropower, along with Portugal, which is in a practically optimal position for weather-dependent renewables.
- Almost all countries in the third category, between 301 and 450 g/kWh, have a significant share of coal in their electricity mix. This may be partly compensated by nuclear energy (e.g. Bulgaria and the Czech Republic), or by renewables (e.g. Ireland, which is also in a favourable geographical position for wind energy), or a combination of the two, as in the case of Germany.
- Almost all countries in the last two most polluting emission categories (between 451-600 g/kWh and above 600 g/kWh) rely heavily on coal and hydrocarbons for electricity generation, with nuclear and hydroelectric power playing a minor or absent role in their electricity mix.

The specific CO_2 emissions from electricity generation in Hungary between 2017 and 2021 varied as follows.

Figure 3: CO_2 intensity of electricity generation (gCO_{2e} /kWh)

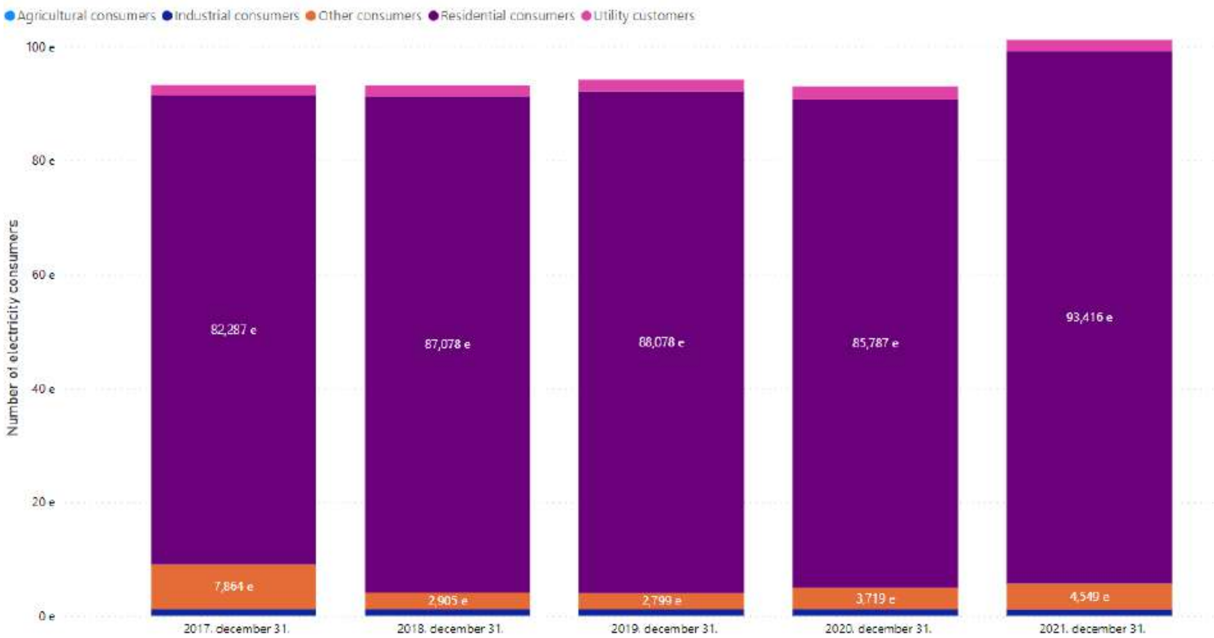


Source: Ember Climate (Dataset European Power Sector)

For the GHG inventory of the Municipality of Miskolc City with County Rights, the emission factor of 236 gCO /kWh$_{2eq}$ for the year 2021 was used for the conversions.

There has been no significant change in the number of consumers in the last period, with household consumers representing the largest share in terms of number of units.

Figure 4: Change in the number of electricity consumers in Miskolc (2017-2021)



Source:KSH: Electricity supply - Electricity consumption and network data

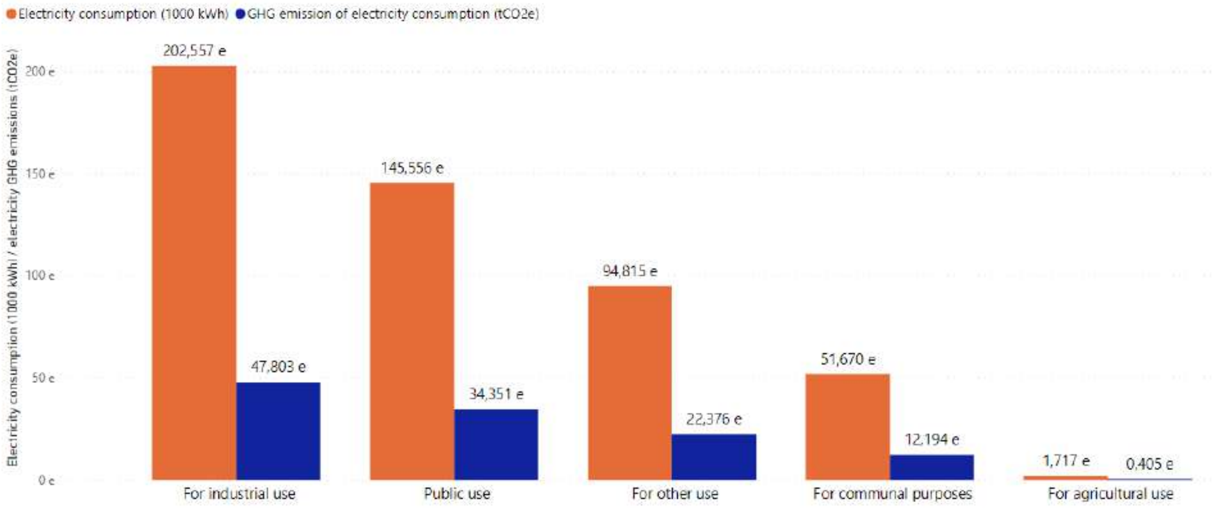
The classification of consumers is based on the methodology of the HCSO as follows:

Table 6: KSH consumer categories Concept explanation

KSH category	Explanation of terms
For the general public	Residential (household) electricity consumer**:** a property (residential building, apartment, holiday home, weekend house, garage used for residential purposes) which is supplied with electricity and whose consumption is billed separately by the supplier on a household tariff basis. A household customer may have more than one meter at the same point of use, but in this case it is counted as only one household customer. However, different properties owned by the same individual are counted as separate household customers (and places of use).
Municipal use	TEÁOR 84-91; institutions in the fields of public administration, defence, education, human health and social work activities and certain arts and entertainment activities
For street lighting	Included in the category Municipal use, based on municipal data
Industrial use	TEÁOR 05-43 (divisions B, C, D E); mining, manufacturing, construction, manufacturing, utilities (water, sewerage, waste, electricity, gas, electricity generation, supply)
For agricultural purposes	TEÁOR 01-03 Agriculture, forestry and fishing
Other purposes	TEÁOR between 44 and 84 (Retail trade, Wholesale trade, Repair of motor vehicles and motorcycles, Transport and storage, Service activities (office, administrative, Sport and leisure, Accommodation and food service activities)

Statement of electricity consumption (broken down by HCSO categories, based on MEKH data.)

Figure 5: Electricity consumption and associated CO_{2e} emissions in Miskolc - 2021



Source: data provided by KSH and MEKH

In terms of the electricity consumed by each sector and the associated CO_2 emission value, the use of electricity for industrial purposes is the most significant in the city.

Electricity supplied for industrial purposes is 202 560 MWh, with emissions of 47.8 thousand tonnes of CO_{2e} , total urban electricity consumption in 2021 is 497 151 MWh, with emissions of 117 324 tCO_{2e} .

Based on the value of electricity supplied to households, the per capita electricity consumption is 998 KWh/capita, compared to 804 KWh/capita in 2017 in the previous SECAP (the population forecast for 2017 at the time of data collection was used, which was probably already lower, so the per capita consumption may have been higher in 2017)
If we look at households only from the consumption side, there has been a steady increase since 2017, but from this perspective, especially 2020 (and partly 2021) should be treated with caution due to COVID.

Table 7: Electricity supplied to households

	2017	2018	2019	2020	2021
Electricity supplied to households (1000 kWh)	128 891	131 631	131 150	140 496	145 557

Source:KSH: Electricity supply - Electricity consumption and network data

During the preparation of the Climate Change Agreement and its working documents, the Municipality of Miskolc Municipality requested aggregated, anonymised consumption data according to TEÁOR codes from the Hungarian Energy and Utility Regulatory Office. After the data had been provided, it was found that there is a significant discrepancy between the electricity consumption data for the town of Miskolc published by the KSH and those provided by the MEKH.
During the discussions it was clarified that the annual data in the data series "Electricity supply - Electricity consumption and network data" published by the Hungarian Central Statistical Office (KSH) for the city of Miskolc, and within that the annual data in the column "Electricity supplied for other purposes (1000 kWh)" do not match the data published by the MEKH, which is the reason for the discrepancy. The figure published by the HCSO for this category is 457 947 MWh, while the figure provided by MEKH is 94 815 MWh. A comparison of the total consumption and the consumption data for this category with the consumption data of other similar cities based on the KSH data also confirms that the data provided by MEKH shows the true picture for Miskolc.

Table 8: Electricity consumption in 2021 - municipal comparison

	Indicators	
Municipality	**Total electricity supplied (1000 kWh)**	**Electricity supplied for other purposes (1000 kWh)**
Miskolc	860 140	457 947
Pécs	399 649	128 744
Nyíregyháza	487 856	99 936
Szeged	536 005	142 148
Debrecen	773 461	161 023

Source:KSH - Electricity supply - Electricity consumption and network data

Table 9: Electricity consumption in Miskolc - KSH statement

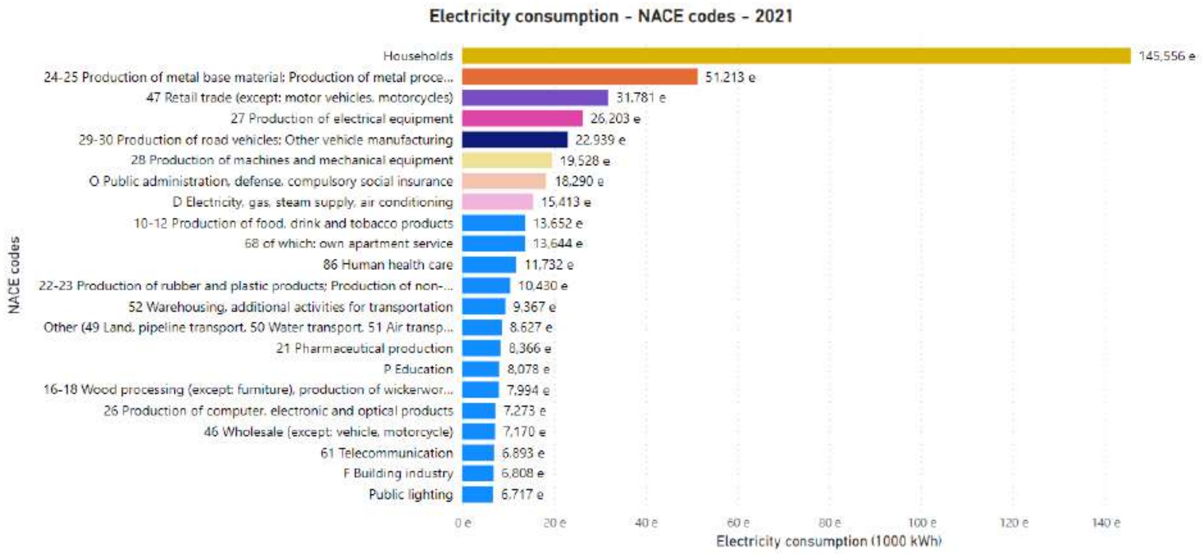
Period	Total electricity supplied (1000 kWh)	Electricity supplied for other purposes (1000 kWh)
Year 2017	900 983	523 668
Year 2018	927 367	543 491
Year 2019	914 939	535 639
Year 2020	931 415	544 895
Year 2021	860 140	457 947

Source:KSH - Electricity supply - Electricity consumption and network data

Based on the above data series, it can be concluded that there is a significant discrepancy in the *Electricity supplied for other purposes (1000 kWh*) data series, which distorts *the Total electricity supplied (1000 kWh)* data series. The 2019 SECAP and the 2020 Climate Strategy used the 2017 CSO data to calculate the CO_2 emissions generated by the electricity sector.

For the rest of the analysis, we use detailed data from MEKH for electricity consumption data.

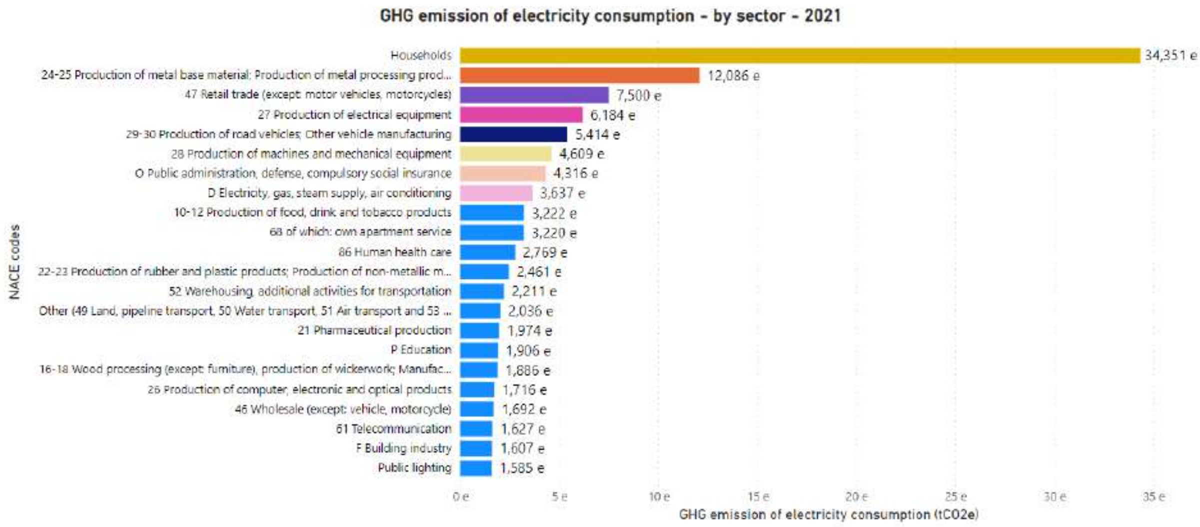
Figure 6: Electricity consumption by sector in Miskolc - 2021



Source: data provided by MEKH

Households are the largest consumers in terms of volume (145 557 MWh), but overall industrial consumers (mainly mechanical engineering sectors) consumed a larger amount (202 557 MWh) on an annual basis. The total consumption of other consumers (service sector) is 94 815 MWh, and the electricity consumed by municipal consumers (44 952 MWh) is about one third of the household consumption.

Figure 7: CO_{2e} emissions from electricity by sector in Miskolc - 2021



Source: data provided by MEKH

The CO_{2e} emissions of one sector can be measured according to consumption, the potential for savings is mainly in the replacement of industrial and household consumption with green electricity, and it is unrealistic to expect a decrease in consumption due to electrification processes.

3.1.2 Natural gas

An analysis of gas capture data over the last 5 years shows that the distribution between sectors is rather uneven. The annual gas consumption for residential buildings has varied between 32-38% over the last 5 years, while the annual gas consumption of the electricity, gas and steam supply sector (which includes gas supplied to district heating) has varied between 20-28%.

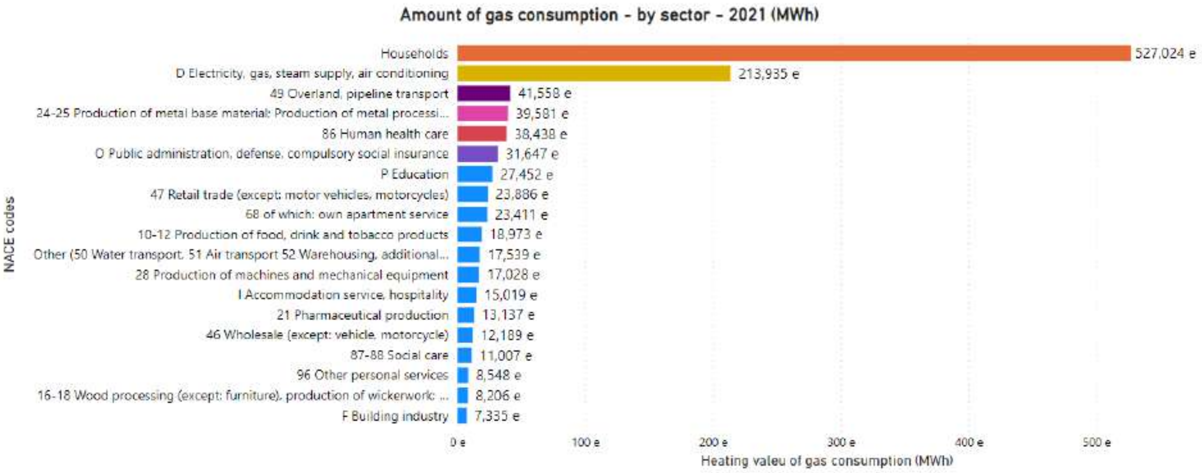
Figure 8: Annual consumption of natural gas by HCSO category - 2021

Source: KSH - Gas supply to settlements

The gas consumption of the electricity, gas and steam supply sector also needs to be examined separately. Based on the relevant data provided by the MHŐ, in 2021, 770,174 GJ of the total thermal energy produced was fossil-based (including own boilers and fossil-based produced purchased from MVM MIFÜ and MVM Balance), which is equivalent to 22,480.000 m^3 of gas consumption (calculated at an energy content of 34.26 MJ/m^3). On this basis, the remaining amount was used by MVM MIFÜ Ltd. and MVM Balance Zrt. for electricity generation (this amount is no longer included in the current inventory due to ETS).

For the year 2021, a detailed set of data on gas consumption has also been requested from MEKH and is presented below. For this sector, there is a minimal deviation within the margin of error with the 2021 data provided by the HCSO. The data for electricity, gas, steam and air conditioning D has been corrected for the amount of gas used for electricity generation by MVM MIFÜ Kft. and MVM Balance Zrt.

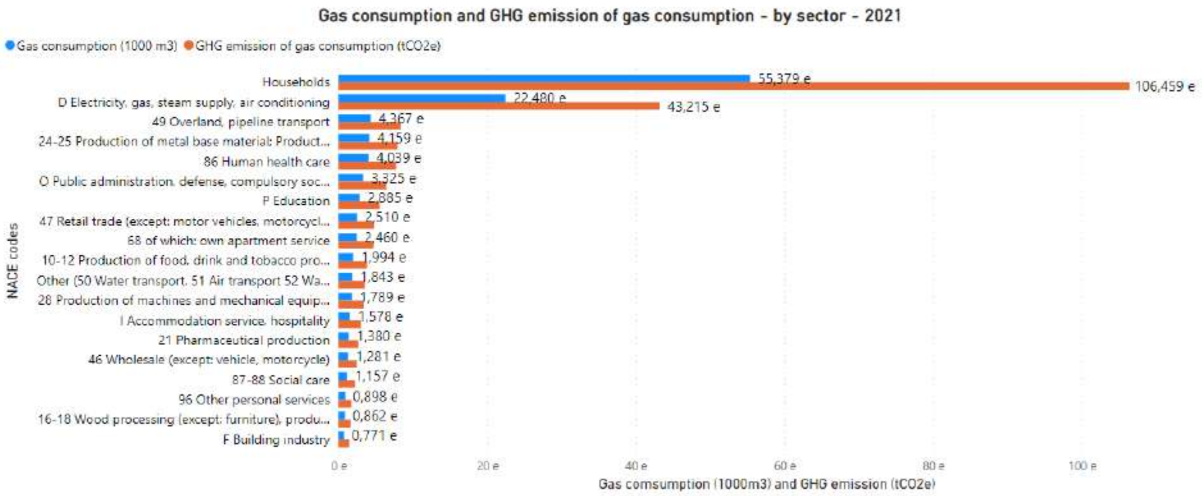
Figure 9: Energy content of natural gas consumed, broken down by NACE - 2021



Source: data provided by MEKH

As the residential sector, i.e. total household consumption (527 024 MWh) is almost equal to the annual gas consumption of all other sectors (619 360 MWh), no significant savings in gas consumption can be achieved without upgrading the residential building stock. In contrast to electricity consumption, the consumption of natural gas by the industrial sector as a whole is much lower than the consumption for residential purposes, at around 24% overall.

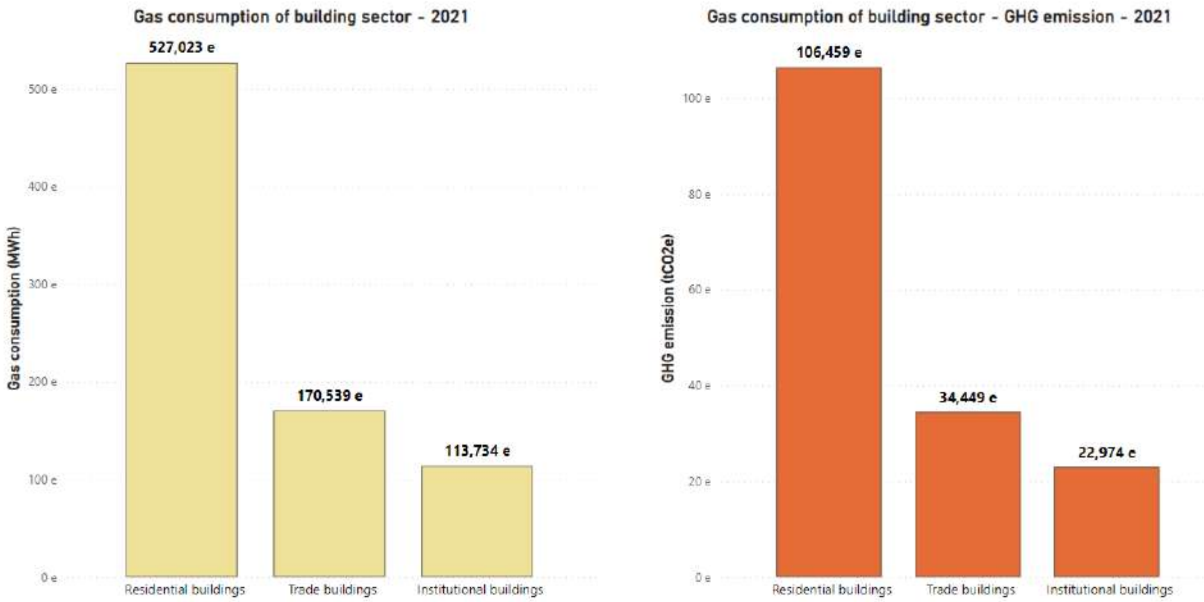
Figure 10: Annual natural gas consumption and emissions by TEÁOR - 2021



Source: data provided by MEKH

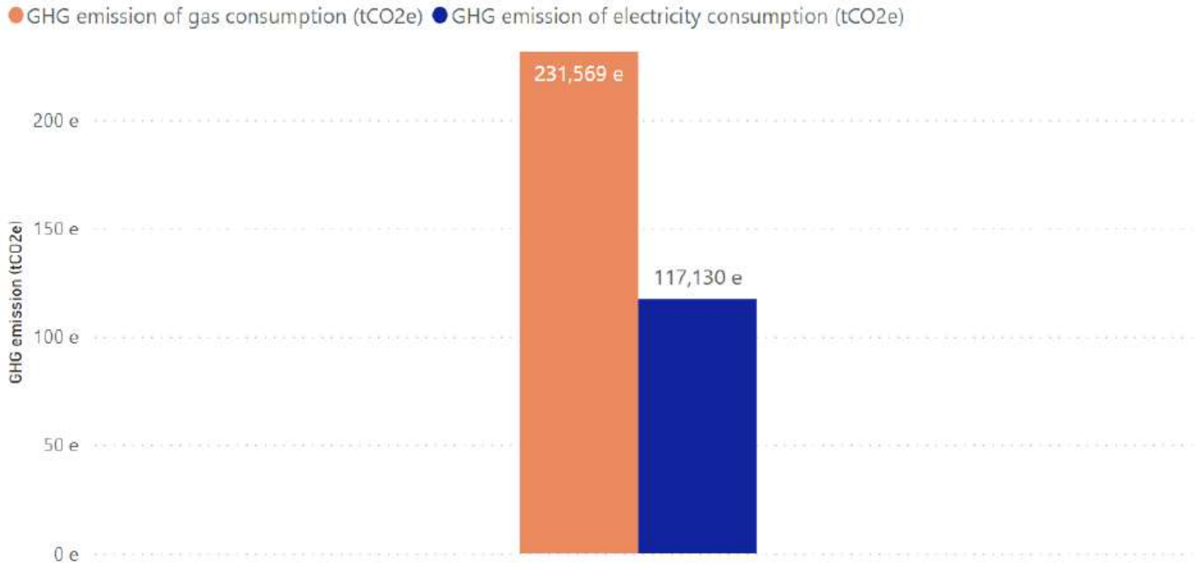
GHG emissions from residential buildings for gas use are 106,459 tCO_{2e}, emissions from the total building sector are 163,881 tCO_{2e}, with residential buildings accounting for 65%. The most significant savings potential lies in a large reduction in household natural gas use.

Figure 11: Building sector gas consumption and emissions - 2021



Based on aggregated data, the emissions from gas use are 231,569 tCO_{2e}, and from electricity use 117,130 tCO_{2e}.

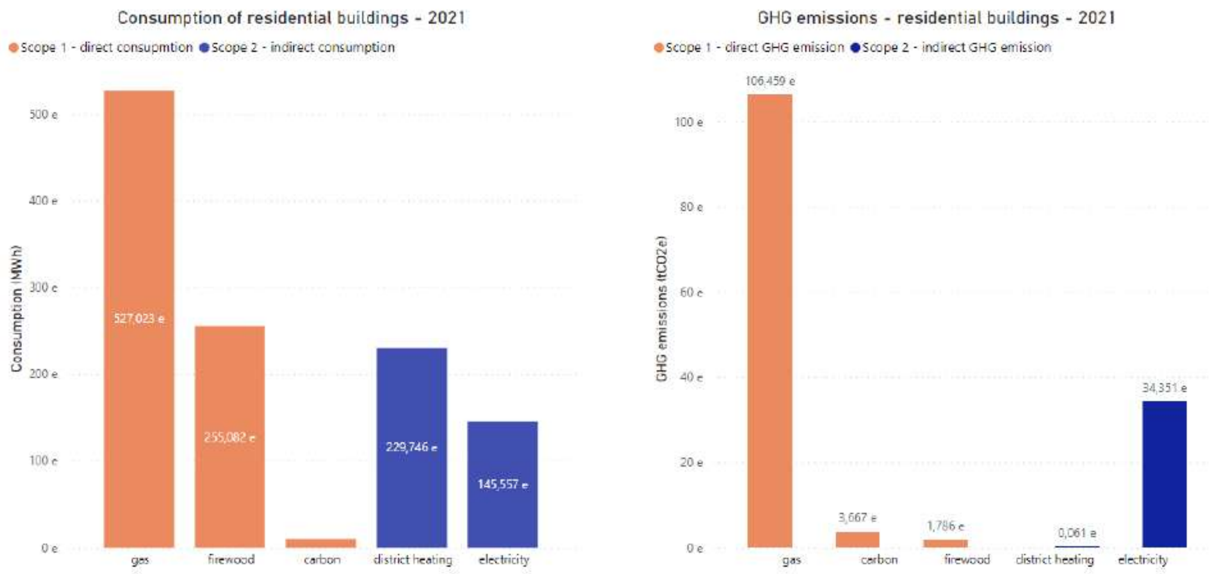
Figure 12: Aggregated statement of CO_{2e} emissions from electricity and gas consumed at city level - 2021



Source: data provided by MEKH

The largest emission segment is the use of natural gas in cities, with a value of gas consumed per tCO_{2e} of 2 times the emissions from electricity consumption.

Figure 13: Residential buildings consumption and emissions - 2021



Residential buildings are the largest consumers of energy, with emissions from natural gas consumption in households almost 3 times higher than electricity, accounting for 25% of total emissions.

3.1.3 District Heating

MIHŐ Kft. is a key member of the Miskolc Holding Zrt. group of companies, providing customer-oriented district heating services based on renewable energy production in Miskolc.

Geothermal

While in 2010 all heat demand was generated 100% on the basis of pure fossil energy carriers (natural gas), today in Miskolc, district heating is supplied to consumers in 10 independent heat districts based on three different types of primary energy carriers.

Miskolc makes use of the

- geothermal energy extracted from a depth of 2300 metres,
- energy from wood chip biomass,
- energy from natural gas cogeneration and boilers.

MIHŐ Miskolci Hőszolgáltató Kft., owned by the municipality, and PannErgy Nyrt. founded the Miskolc Geothermal Energy Ltd. project company in August 2009 with the aim of supplying a very significant part of one of Hungary's largest cities with heat energy from renewable sources. This will further reduce the use of natural gas and emissions from Miskolc's heating plant, resulting in a cleaner and more liveable city.

Since May 2013, as a result of the Miskolc Geothermal Project, a significant part of the district heating and hot water supply of the Miskolc-Avas district has been provided from geothermal sources, with a thermal capacity of 5-8 MWth in summer and 30-35 MWth in winter.From 2014, the heating and hot water demand in the Miskolc city centre and the University of Miskolc will also be partially supplied with geothermal energy. This will make the 780,000 GJ of annual primary heat output originally planned available.

Smart solutions

The heat extracted from the well is piped to the district heating consumers through heat exchangers and the cooled liquid is then returned to the heat exchanger. A key requirement was the ability to control the system via a central remote monitoring system.

Biomass

In Miskolc, MIHŐ Kft. and WIS Investment and Trading Ltd. founded the Bioenergy-Miskolc Kft. project company on 7 December 2009 in order to supply the Kilián district and the Dorottya Street heat circuits with renewable energy. The project company has built a biomass heating plant in Muhi Street, directly adjacent to the premises of the heating company, with a 3 MW biomass boiler, replacing the gas boilers in Gagarin and Dorottya Streets. The thermal energy produced by the boiler house is supplied by MIHŐ Kft. Kenderföld and Dorottya Street heat centres of the company.

The biomass boiler house is only in operation during the heating season. It is characterised by automatic power and fuel control. The type of fuel used is forest fuel.

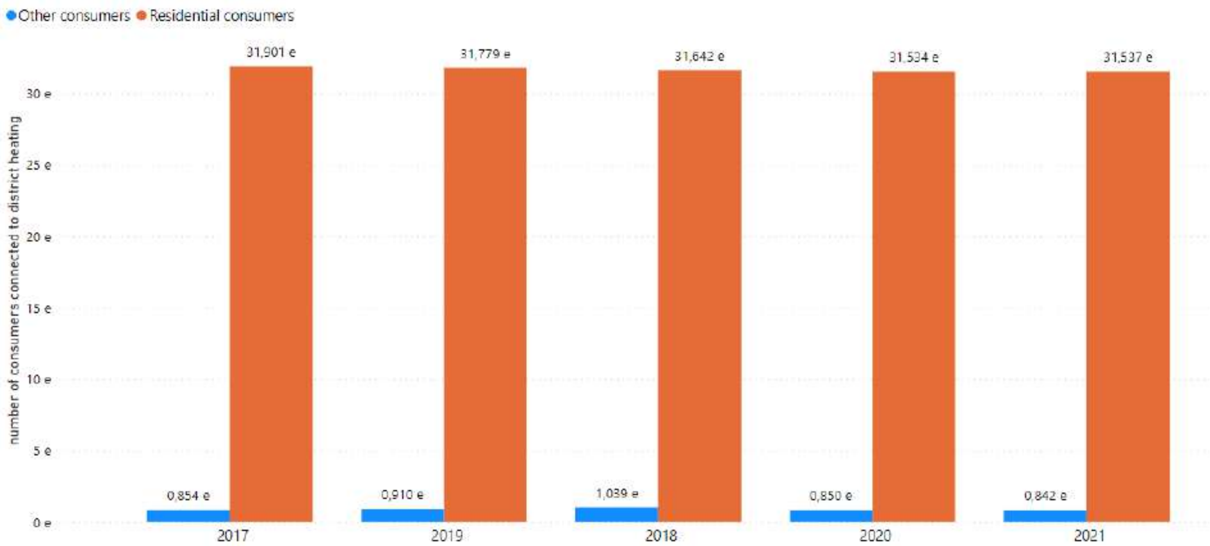
As a result of the investment, the city's dependence on natural gas has been further reduced, and in the event of a temporary shortage of natural gas, the basic district heating service can be provided in the area served even in the coldest weather.
As of 6 March 2017, the project company Bioenergy-Miskolc Kft. became 100% owned by Mihő Kft.

Results of biomass utilisation:

- 1,355,800 m^3/year of natural gas substitution using an annual average of about 4,500 t/year of wood chips,
- more bases for heat production, less vulnerability,
- increasing renewable primary energy use by ~35,000 GJ/year,
- contribute to the reduction of GHG emissions.

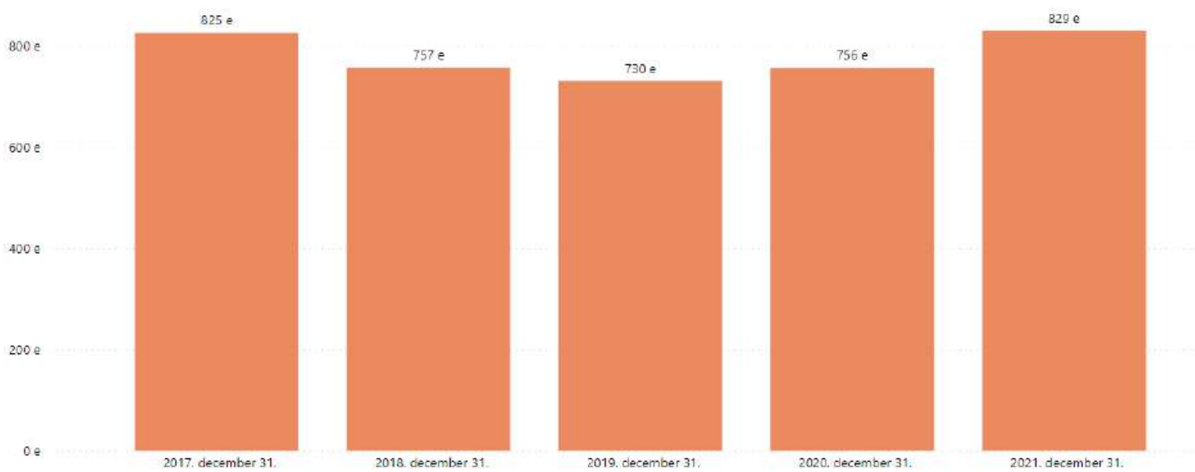
District heating service data 2017-2021

Figure 14: Number of consumers connected to district heating (2017-2021)



Source: KSH

Figure 15: Heat supplied by district heating - GJ (2017-2021)



Source: KSH

Based on the methodology used, the emissions value of the district heating sector alone is negligible, however, as indicated in the natural gas consumption data, based on the relevant data provided by the MHŐ, 770,174 GJ of the total thermal energy produced in 2021 was fossil-based (including own boilers and fossil-based purchased from MVM MIFÜ and MVM Balance), which translates into an order of magnitude of 22,480,000 m^3 of gas consumption. Replacing this with further expansion of geothermal energy, by including urban areas, would lead to significant emission reductions at city level.

3.1.4 Coal and firewood

In the case of coal and firewood consumption, no data for 2021 are available, as only census data can be used, so consumption and emissions were calculated from the 2022 Hungarian census data published in advance by the Hungarian Census Office.

Methodology shows that in Hungary today, 1 household uses on average 5.5 tonnes of firewood per heating season, and 3.2 tonnes of coal on average. As the energy content per tonne of wood does not include a correction factor for possible moisture content, an energy content of 5.5 MWh/t was calculated in the inventory. This may be much lower in reality (given the heating habits), so the 8,258 households that have specified wood as a heating fuel in Miskolc probably use on average more than 5.5 tonnes of firewood.

Emissions from residential firewood are 1,786 tCO_2

Residential carbon emissions amounted to 3,667 tCO_2

3.2 Transport

For most travellers today, travelling by private car by road seems to be the most fluid and seamless way of getting around - even for short distances. However, the increasing demand for transport and the growing number of cars in Miskolc, in line with economic development, are also causing serious environmental and sustainability problems, posing a major challenge to urban planners and operators. Therefore, one of the strategic challenges for cities in the near future, recognised both at EU level and in Hungary, is to influence (ultimately, reduce if possible) transport demand from a sustainable development perspective, and to shift transport to public transport, alternative modes of transport and/or environmentally friendly vehicles.

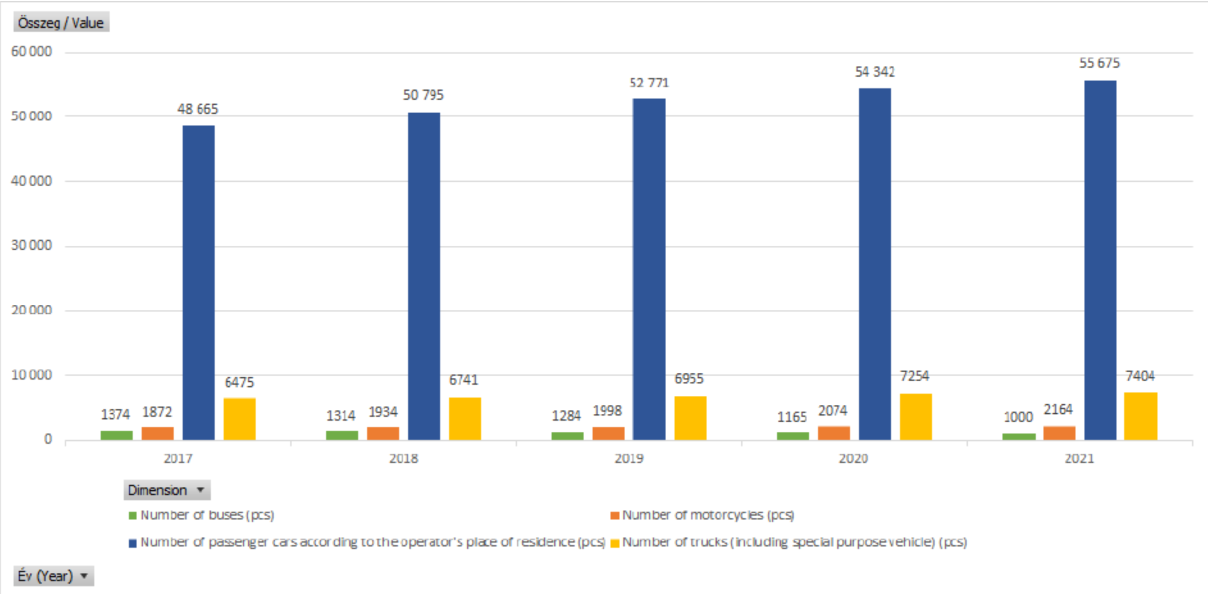
When examining GHG emissions from the transport sector, several segments were examined.

1. Individual car and lorry traffic on 527 km of municipal roads. The emissions data are calculated from the number of vehicles registered, mileage and the amount of fuel sold.
2. Individual car traffic and lorry traffic on 42 km of state-maintained roads (of which 37 km are inland roads). Emission data for this segment were derived from traffic counts on the given traffic segments of the Hungarian Roads.
3. Local public transport. Based on data and decarbonisation plans of MVK Zrt.
4. Long-distance public transport. Based on data provided by Volánbusz Zrt., using only the mileage within the administrative territory of the city.
5. MÁV passenger transport. Based on the data provided by MÁV Zrt., using only the mileage within the administrative territory of the city.
6. Commuter vehicle traffic emissions data derived from KSH data.

3.2.1 Individual car and lorry traffic on local authority-maintained roads

In Miskolc, the number of cars has been growing steadily despite the negative demographic trends of the last 10 years. Based on 2017 data from SECAP and the current base year 2021, 7,000 new vehicles were registered, an increase of 14.4% over 5 years.

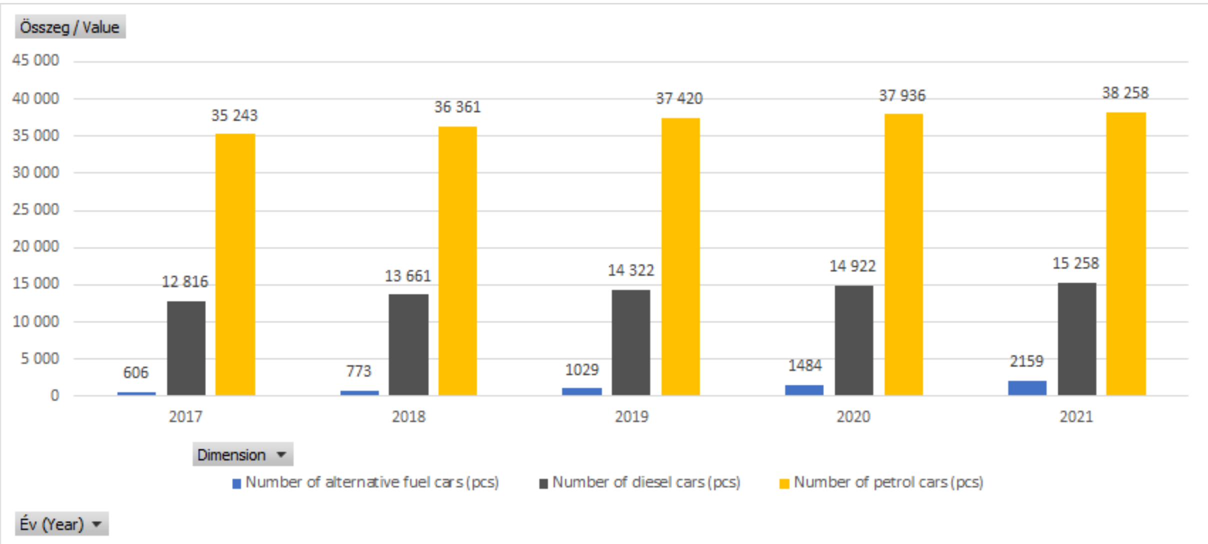
16Figure 1: Number of vehicles registered in Miskolc (2017-2021)



Source: BM/KSH - vehicle registration data

In 2021, 55,675 cars and 7,404 trucks were registered in the city. 68% of the passenger cars were petrol-powered, representing 38,258 cars, and a further 15,258 diesel-powered vehicles were registered, with no change in the proportions over the last 5 years. In 2021, 223 pure electric cars and 25 pure electric trucks were on the road, up from 19 and 3 registered in 2017, with a significant increase in electric cars, but still below 0.5%.

17Figure 1: Stock of passenger cars in Miskolc (20217-2021)



Source:BM/ KSH - motor vehicle traffic data

The individual passenger car traffic and lorry traffic on the segment of municipal roads has been calculated from the number of registered vehicles registered by the Ministry of Interior and the Central Statistical Office, taking into account the following factors:

- annual mileage/intra-city mileage
- average travel time by car to work within the municipality of residence in one direction (based on individual KSH data request)

- petrol or diesel vehicles
- fuel blending ratios
- average consumption per 100 km of mileage

All these data have been compared with the data series issued by the NAV on the amount of fuel sold in the city.

Calculated GHG emissions from private car transport on municipal roads 79,054 tCO_{2e}

Calculated GHG emissions from single-occupancy vehicle transport on municipal roads 59,243 tCO_{2e}

3.2.2 Individual car and lorry traffic on state-maintained roads

The individual passenger car and lorry traffic on the state-maintained roads was calculated from the traffic census data provided by Magyar Közút (recorded on the specific sections of the road segments), taking into account the following factors:

- traffic counts were carried out on roads 3, 26 and 306 for 19 km
- proportion of petrol or diesel vehicles in the county
- fuel blending ratios

Calculated GHG emissions from private car transport on public roads 24,243 tCO_{2e}

Calculated GHG emissions from single-occupancy vehicle transport on public roads are 13,666 tCO_{2e}

3.2.3 Local public transport

The City of Miskolc has successfully applied for the "Green Investments" support programme (ÚSZT-ZBR-CNG-2014), as a result of which the City of Miskolc has replaced the outdated diesel buses of Miskolc Municipal Transport Ltd. with new, environmentally friendly gas-powered buses, by providing the necessary own funds.

With the introduction of CNG, or compressed natural gas, buses in Miskolc are now mostly low-floor, comfortable, air-conditioned buses. MVK Zrt. has purchased 75 CNG buses, 40 solo and 35 articulated buses. The gas-powered CNG buses from Miskolc easily meet the most stringent Euro 6 environmental standards, with local emissions close to zero.

The emissions of gas and diesel power plants in Hungary were measured for the first time in real conditions in Miskolc at the end of March 2016. The test involved comparative measurements on Neoplan (diesel, Euro IV engine) and the new MAN (compressed natural gas, Euro VI engine) buses on three lines in Miskolc with a 90-passenger workload, and showed that the gas-powered buses emit 98-98.5% less nitrogen oxides (NO2) than the diesel version. The new bus fleet will reduce NO2 emissions into Miskolc's air by 30 tonnes per year. Noise pollution has also been significantly reduced thanks to the new buses, as CNG engines are much quieter than diesel engines and generate less vibration. Positive feedback from the citizens of the city confirms that the investment has been a success.

Diesel and CNG engines emit a significant amount of carbon dioxide when burning the fuels they use: burning 1 litre of diesel produces 2 490 grams of carbon dioxide and burning 1 kg of CNG produces 2 666 grams of carbon dioxide. On average, diesel buses providing urban public transport services emit 3 833 tonnes of carbon dioxide per year, while CNG buses emit 7 333 tonnes (11 167 tonnes in total). However, this is only the so-called tank-to-wheel emissions, which cannot be considered as the total emissions generated by urban public transport buses, but is methodologically calculated using this factor for other transport modes, including local public transport.

Table 10: Miskolc local public transport CO2 emissions in 2021

Engine	Solo/Sliding vehicle	Number of vehicles in use (units)	Average annual mileage per vehicle (km)	Annual mileage (km)	Fuel consumption (diesel: litres/100km, CNG: kg/100km)	Consumption (diesel: litres, CNG: kg)	TTW emission factor (Tank-to-Wheel) (g CO2/litre, g CO2/kg)	TTW CO2 emissions total (tonnes CO2)
EURO 3	Speaker	4	101 015,500	404 062	34,88	140 936,83	2670	376,30
	Hinge	10	66 040,500	660 405	58,94	389 242,71	2670	1 039,28
EURO 4	Speaker							-
	Hinge	19	73 698,526	1 400 272	57,74	808 517,05	2670	2 158,74
Total diesel		***33***		***2 464 739***		-		***3 574***
CNG	Speaker	38	63 824,895	2 425 346	48,00	1 164 166,08	2666	3 103,67
	Hinge	33	48 775,788	1 609 601	61,00	981 856,61	2666	2 617,63
Total CNG		***71***		***4 034 947***		-		***5 721***
TOTAL BUSES	**SUMMARY**			**6 499 686,00**				**9 295,62**

Source: Decarbonisation plan and data provided by MVK Zrt.

The energy demand for the operation of electric transport in 2021 was 4,785 MWh, but the consumption and emissions value for electric transport is also within the energy consumption sector and is therefore only calculated once for the inventory.

The public transport of the future will bring major changes to urban mobility in a relatively short time - 5-10 to 3-5 years.

As a first step, Miskolc's public transport service provider, Miskolc Városi Közlekedési Zrt. put 10 double-axle, pure electric buses into service in 2022, but this is not yet included in the GHG inventory for the base year 2021.

Simultaneously with the purchase of the buses, a 10-piece electric vehicle charging unit was built at the MVK Zrt. site, which ensures simultaneous charging of the buses by incorporating optional slow and fast charging functions. While CNG has significant carbon dioxide emissions, electrically powered buses can operate with effectively zero emissions when charged with green electricity.

The calculated GHG emissions from local public transport are 9.295 tCO_{2e}

3.2.4 Long-distance public transport (Volánbus and MÁV passenger transport)

In the case of public transport operated by Volánbus, the average number of Volánbus buses operating in the administrative area of Miskolc on working days and on days off and public holidays (1290 buses/day, 790 buses/day) was examined. The actual emissions were determined on the basis of the mileage measured in the administrative area of the city, calculating the mileage of buses arriving in Miskolc, departing from Miskolc and passing through Miskolc, and the average consumption of the buses.

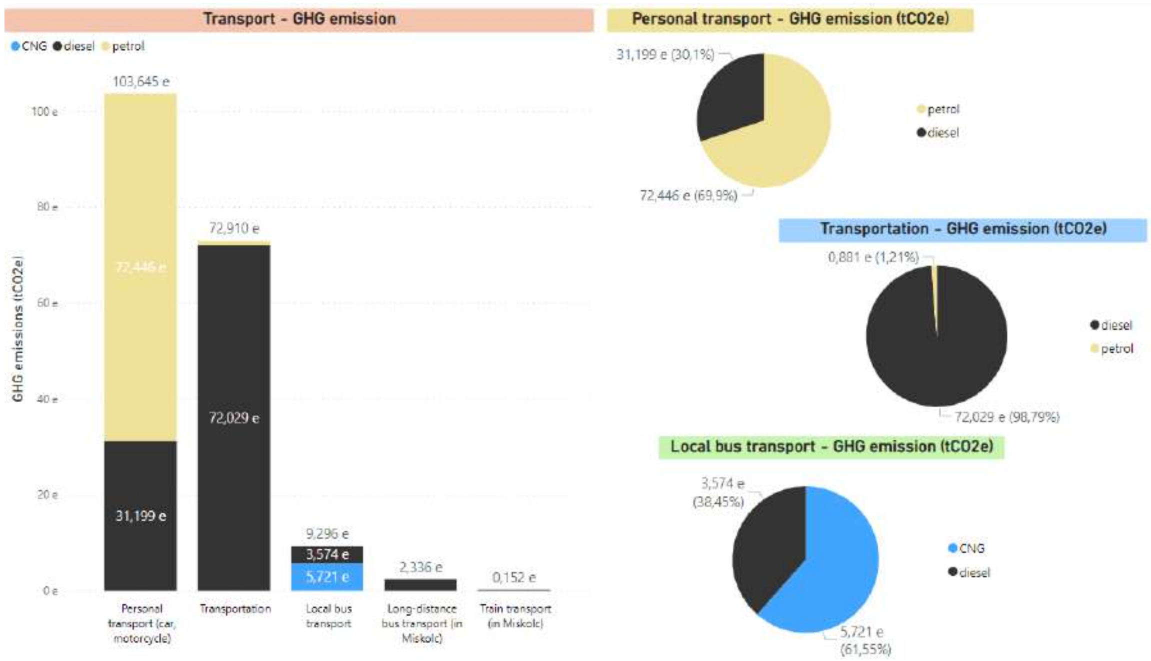
The calculated GHG emissions from long-distance bus transport are 2.335 tCO_{2e}

For passenger transport operated by MÁV Zrt., only the mileage within the administrative area was also taken into account. The annual mileage of vehicles running on gas oil fuel in 2021 in the administrative territory of Miskolc is 103 023 km. The annual mileage of vehicles using electricity for the year 2021 in the municipality of Miskolc is 395 093 km. Again, the calculation is based on the average consumption given by MÁV Zrt.
The calculated GHG emissions from passenger transport of MÁV are 947 tCO_{2e} , however, in the GHG inventory transport sector this has been disaggregated because 795 tCO_{2e} of this is the emission value of locomotives running on electricity, which is also included in the emission value of electricity supplied in the city (under 49 TEÁOR codes) for the purpose of the aggregated inventory.
Urban emissions of diesel locomotives.152 tCO_{2e} .

3.2.5 Shuttle

Calculated on the basis of 4,183 commuter journeys based on individual data provided by KSH, the value (348 $tCO_{2e)}$) is included in the individual transport category.

Figure 18: Total GHG emissions from the transport sector in 2021



Total emissions from the transport sector amount to 188,338 tCO_{2e} , which is 32% of total urban emissions.The most significant element is private transport, and the largest emissions are from lorries running in the city. Transport and haulage in this segment is almost entirely carried out by diesel vehicles, while electrification of other modes of transport (private, public) is underway, but still lags far behind.

3.3 Waste management, waste water treatment

The management of solid and liquid waste from households accounts for 6.60% of total emissions.

Unfortunately, solid waste landfilling still dominates municipal solid waste management. The amount of solid waste disposed of in technically protected landfills in 2021 was 32 172.90 tonnes. The CoM methodology calculates the methane emissions of this as GHG emissions, i.e. 33 781,55 t CO2e load.

It should be noted that a further 9 415.80 tonnes was the amount of waste recovered by incineration with energy recovery, i.e. incineration. No data is available on the material composition of this waste, but it can be assumed that the majority of it is biomass, so the associated greenhouse effect can be considered relatively small. Precise data can only be obtained after methodological development.

Emissions from waste transport are integrated in the transport sector, while emissions from waste treatment facilities are included in emissions from commercial buildings. As only the methane load from landfilling of the WWTP has been included here, the above waste management loads are not duplicated in the inventory.

The volumes of wastewater and non-publicly collected domestic wastewater entering the treatment plant are shown in the table below.

Table 11: Wastewater treatment plant inputs (2018-2021)

Wastewater received at the treatment plant quantity	Year 2018	Year 2019	Year 2020	Year 2021
Public channel [m]^3	12 821 398	12 290 563	12 902 698	13 272 727
On the sea (TFH+leachate) [m] ^{3}	21 705,3	25 705,3	29 922,3	40 161,24

Source: MIVÍZ data

The majority of the wastewater arriving at the treatment plant comes from the town of Miskolc.In 2021, the treatment plant received 13 272 727 m^3 of wastewater from the public sewer and 40 161.24 m^3 of wastewater from the town of Miskolc on the axis. The latter included 20 554 m3 of municipal liquid waste and 19 607.24 m^3 of process wastewater (leachate). The amount of leachate from the landfill is therefore significant.

The CoM methodology uses the population covered by wastewater treatment as the basis for the wastewater treatment discharge. For the population, we can assume 150 695 persons in 2021 as calculated by the CSO. For the national emissions, only the 2014 National Greenhouse Gas Inventory provides a reference, which is 376 437.78 t CO /year$_{2e}$ methane load and 224 388.62 tCO_{2e} /year nitrous oxide load per inhabitant. The emissions of the municipality are thus characterised by a methane load of 5743.37 tCO_{2e} /year and a nitrous oxide load of 3423.53 tCO /year.$_{2e}$

Although the above calculation does not take into account the sewage sludge treated by MIVÍZ through biogas production and recovery, which would reduce the actual emissions from wastewater treatment. There are currently methodological obstacles in detecting this reduction, so it has been omitted from the inventory.

The Biogas Plant - Power Plant not only processes the sludge produced in Miskolc, but also receives waste from distillation, waste cooking oil and grease, biodegradable waste and animal by-products from four suppliers.

Table 12: Quantity of waste accepted (2018-2021)

Waste identification code	Title	Year 2018 (kg)	Year 2019 (kg)	Year 2020 (kg)	Year 2021 (kg)
02 02 04	sludge from the treatment of liquid waste at source	-	27 280	-	-
02 03 04	material unfit for consumption or processing	316 980	360 200	276 050	249 040
02 03 05	sludge from the treatment of liquid waste at source	-		22 680	-
02 05 01	material unfit for consumption or processing	-		-	150 140
02 05 02	sludge from the treatment of liquid waste at source	-	1 189 510	982 150	365 260
02 07 02	distillation waste	-	201 580	-	-
02 07 04	material unfit for consumption or processing	556 650	769 140	396 230	135 300
19 08 05	sludge from urban waste water treatment	374 890 150	302 089 910	317 459 600	406 951 430
19 08 12	sludges from biological treatment of industrial waste water other than those mentioned in 19 08 11	274 920	-	-	-
20 01 25	cooking oil and fat	273 190	266 500	117 990	283 740
20 02 01	biodegradable waste	232 400	140 660	163 430	171 180

Table 13: Quantity of Category III animal by-products received (2018-2021)

Source from	Year 2018 (kg)	Year 2019 (kg)	Year 2020 (kg)	Year 2021 (kg)
Jásztej Kft.	3 119 370	3 146 980	3 968 260	3 674 470
Abaújtej Ltd.	12 770	1 775 540	580 190	-
Kőröstej Kft.	-	-	23 960	-
Eb-Mex Ltd.	-	-	-	4 890

3.4 Agriculture

In Miskolc, agriculture is not a dominant sector, accounting for only 0.39% of the city's total GHG emissions.

Based on the available 2020 data, KSH counted only 154 cattle and 695 sheep, which are responsible for 444.10 t CO2e of methane emissions per ruminant.

In addition to the above, the 85 pigs and 1263 poultry kept are also the cause of slurry formation. The methane load from slurry formation is 79.71 t CO2e and the nitrous oxide load is 43.00 t CO2e, i.e. a total of 122.71 t CO2e, which could be reduced by using the slurry as biogas feedstock.

The 1 478.03 t CO2e of manure and organic fertiliser use and the 465.35 t CO2e of fertiliser application were calculated by multiplying the county data (available in 2015). Taking into account that the total arable area of the municipality is 4.73 thousand ha, the total fertiliser applied could be 5918 tonnes, which represents 1 943.38 t CO2e emissions.

3.5 Urban carbon dioxide absorption capacity

The location of the town of Miskolc has very good environmental conditions *(see map annex 1*). The proximity of the Bükk Mountains provides the town with a significant green space capital, but it cannot replace the role of green spaces within the town.

Miskolc's green spaces are adequate, but their condition needs constant improvement due to the high use. The Green Infrastructure Development and Maintenance Action Plan of the city has mapped the green space provision in the different parts of the city.
For forests, green spaces, tree-lined areas, green strips, green lanes, institutions with large green areas, the green coverage is 740.31 m^2 /person. The addition of water management areas increases the figure to 1166.07 m /person. [2]
The value for public parks and gardens is 10.38 m^2 /person. This figure is corrected for the large garden zones, where each inhabitant has his own garden but very few public parks.
There is no precise data on the extent of biologically active surfaces. The proportion of biologically inactive surfaces is 8-16% of the municipality's area, reaching 30-40% in the interior. This is a very high value in itself, which is realistic at 50% when corrected for the area. Accordingly, the proportion of biologically active surfaces may be around 50%.
Green areas are the biologically active surfaces of the municipality permanently or temporarily covered by vegetation. Parks and streets covered with vegetation contribute to the character and appearance of the settlement, participate in the structural organisation of the settlement and cover up and conceal the undesirable parts. Green spaces link and organise the different areas of the settlement with each other and with the outside world. Vegetation is an important component of the urban environment as it is closely linked to the visual appearance.

Municipal green area: 6.952 ha.

Brief analysis of green areas and green spaces

1. Public parks and gardens

There is no accurate data on the condition, quality and size of current public parks, as the city does not have a green space inventory. The city's maintenance data does not match the data shown in the regulatory plans, because the maintained areas include residential green spaces, which are classified as residential zones in the regulations.

Miskolc's park system is rather fragmented due to the typical built-up area, consisting mainly of small parks of high utility value, with the only parks in the city centre being the Népkert and Avas, which are 5-6 ha in size, and the 6 ha Tapolca park system in the Miskolctapolca district, which provide a significant amount of green space for the residents.

Several public park developments are planned for the near future, including in the areas between Martinkertváros and Szirma, around Lake Csorba, in the Pece Valley, along sections of the Lyukó stream and in Hejő-liget.

2. Green spaces in residential areas

Green spaces in housing estates play an important role in the life of the city, as they are densely built-up and populated, and therefore subject to high levels of demand. This type is most widespread in the Avasi housing estate, extending towards Újdiósgyőr, and also in the Szentpéteri kapu district, Komlóstető and Hejőcsaba. There are also significant well-established green areas in the neighbourhoods of the Selyemrét, Kilián (north-south) and Bulgárland residential areas.

The main problem of green spaces in residential areas is the loss of canopy cover and lack of proper maintenance, which leads to degradation. Poor species composition and the continuing loss/decay of shrub cover, as well as vandalism, are also problems to be addressed in these areas.

In addition, in the case of green spaces in residential areas, the public often raise the issue of overgrown vegetation - such as overgrown trees near buildings, overgrown hedges.

3. Green lanes, alleys

Although tree-lined streets and green strips are of particular importance for the urban landscape and conditioning, they are the most deficient, despite the fact that the conditions for tree planting are present in the most deprived streets. They are also poorly recorded (ITS) and future plans are not available.

The Vár Street (a locally protected chestnut tree line), the Szentpéter Gate, the Győri Gate - Andrássy Avenue, the Görgey Street - Csabai Gate and the Soltész Nagy Kálmán Street are characterised by significant tree-lined areas.

Roadside green strips and tree-lined areas are mostly not segregated, but belong to a traffic zone, and the larger green strips are classified as public parks, so we do not have precise data on their size and quantity. There are a number of streets where there is potential for the installation of multi-level green strips, but there is only one grass strip, and their development and renewal should be the main objective. At the same time, there are several streets, mainly in the area of detached houses, where 'quasi' tree-lined areas have been created, but these often do not form a coherent whole because of their diversity in species and age. However, they have a good conditioning and aesthetic effect.

The most commonly used tree species are the rattlesnake (Koelreuteria paniculata), various maple species (Acer platanoides, A. pseudo-platanus, A. saccharinum, A. campestre), lime trees (Tilia argentea, T. cordata, T. platyphyllos), chestnut (Aesculus hippocastanum), Japanese chestnut (Sophora japonica). In the family house zone, fruit trees such as cherry and walnut are planted. Unfortunately, there is also a proliferation of the tuja-grass type of garden with poor vegetation.

4. Institutions of a green space nature

These institutions have extensive green spaces. These include cemeteries, beaches, sports grounds, campsites, and zoos and botanical gardens.

Cemeteries: have a significant plant population. They currently cover about 72 ha in the city. The old cemeteries - the Heroes' Cemetery, the Evangelical Cemetery and the Avasi Cemetery - have a very varied vegetation, with shrubs and herbaceous plants playing an important role alongside the old trees, many of which are very valuable and need to be protected. These are very valuable green spaces in the city that need to be protected and preserved. However, care must be taken to ensure that they are properly maintained, as the Mindszent cemetery, which was also once known as a beautiful wooded cemetery, has lost its beauty due to the death of the old chestnut trees, and the vegetation in the newer cemeteries is not even comparable to that of the old cemeteries.

Beaches: They cover a total area of about 15-20 ha, with a minimum green cover of 65%. The transformation of Tapolca beach has resulted in the retention of mature trees, while the reforestation of the beach at Selyemrét is a positive change. This shows that these are very important and valued green spaces for the town.

Sports areas: these represent about 1% of the inner area, the largest of which is the Diósgyőr Sports Park (16 ha). The minimum green area to be provided is 75%, but due to their use, the canopy cover is very low.

Campsites: located in green areas of landscape value in residential and recreational areas of high tourist interest. They have a minimum green area of 75% and are well vegetated and tidy. Their active green cover should be maintained.

Zoological and botanical gardens: they play an important educational, recreational, fitness and cultural role in the life of the municipality. The Municipal Wildlife Park is located on the outskirts of Miskolc, where the protection of natural vegetation is of primary importance, as it is located in the immediate vicinity of the Bükk National Park. The Avasi arboretum and the a-garden are located in the inner area and are protected. They cover a total area of 6,5 ha.

5. Institutions with significant green space

The category covers institutions with a mainly regional role in health, education and culture. Their active green cover and tree canopy cover should be maintained.

The hospital gardens cover an area of around 50 hectares. Many of these are old gardens, over 100 years old, with valuable and rare species, which need to be protected with special attention during maintenance and renewal.

The gardens of educational institutions (with a special focus on the University of Miskolc), with their varied size, quality and condition, are also important for the development of both students and residents, as they play an important role in the city's green spaces, due to their concentrated, dense green areas.

6. Private gardens

The city has extensive green spaces within private areas, which are not negligible elements of the Miskolc green space system. The green areas of the city are increased by agricultural areas, enclosed gardens, small gardens and orchards. These can be the future green poles and green corridors of the city.

The green area between Görömböly and Miskolc-Tapolca, which is mainly home to small gardens, small vineyards, orchards and semi-natural meadows, justifies the connection of the two nearby areas with green corridors.

Forest areas

Size of the fortified areas in the administrative territory of Miskolc: 11.228 ha

Miskolc has a negligible amount of inland forest compared to the size of the forest outside. The current ratio is about 3% (inland forest/land area), which is to be increased to about 7% in the current regulation plan, partly by including existing forests in the areas to be included in the inland area (e.g. Hejőcsaba), partly by providing for significant afforestation (Hejőcsaba, Görömböly), and partly by increasing the forest area in the current inland area (Diósgyőr, Sajó mente).

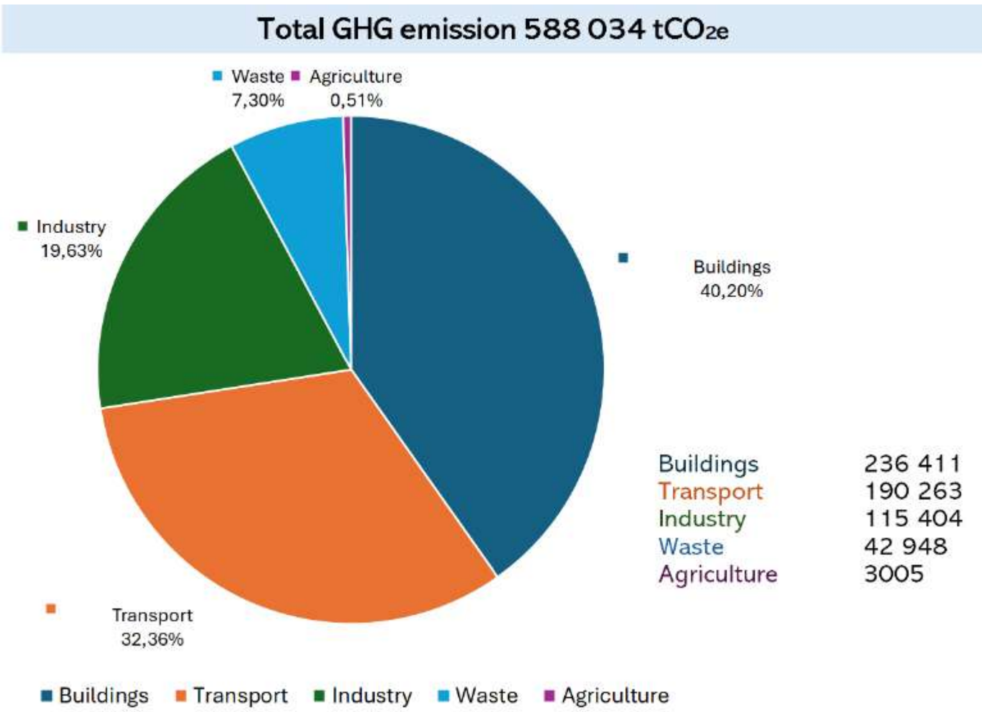
For extensive green areas, a value of -9 tCO_2 /year/ha was calculated based on the Climate Resilience Guidelines 2021-2027 published by the Prime Minister's Office.

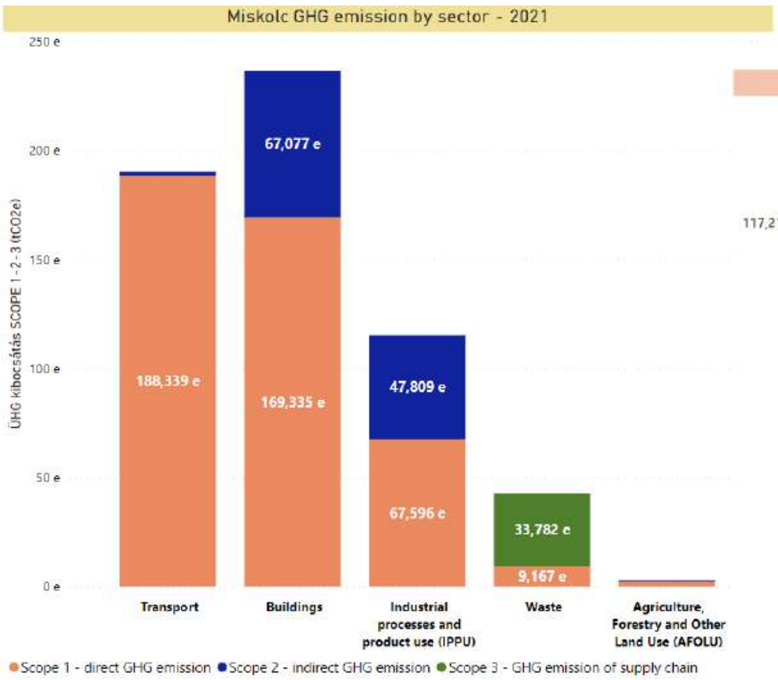
For forested areas, the value of -12 tCO_2 /year/ha given by the Ministry of Finance in the Sustainable Urban Development Strategy 2021-2027 methodological manual was used.

3.6 City of Miskolc aggregated GHG inventory

In the case of the city of Miskolc, the largest emission segment is the building sector, followed by the transport sector and then industrial processes. Waste management is in line with the national average, while the agricultural sector has much lower emissions than the national average. Total urban emissions are 588,034 tCO_2, with an annual per capita emission of 3.9 tCO_2.

Figure 19: Total GHG emissions by sector in Miskolc in 2021





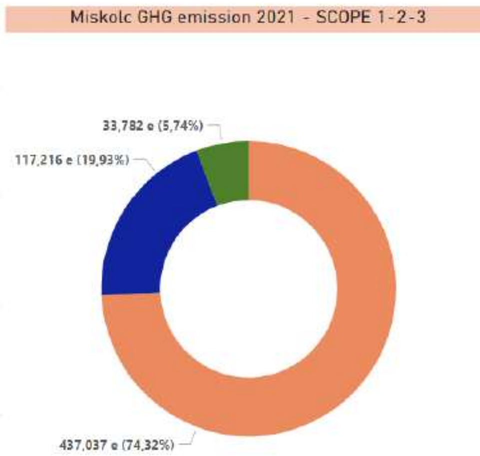
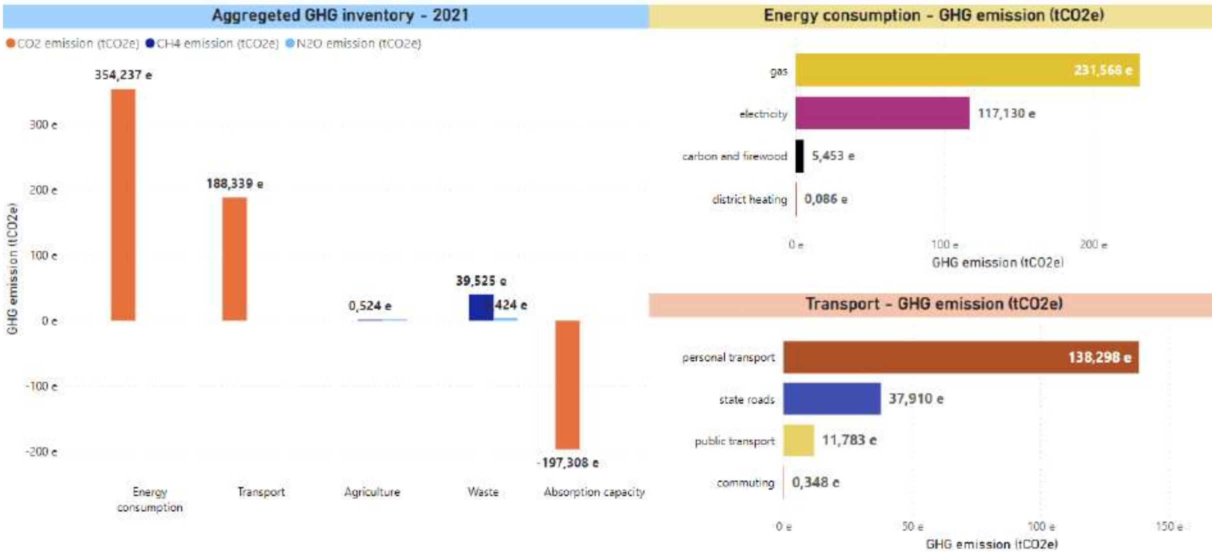


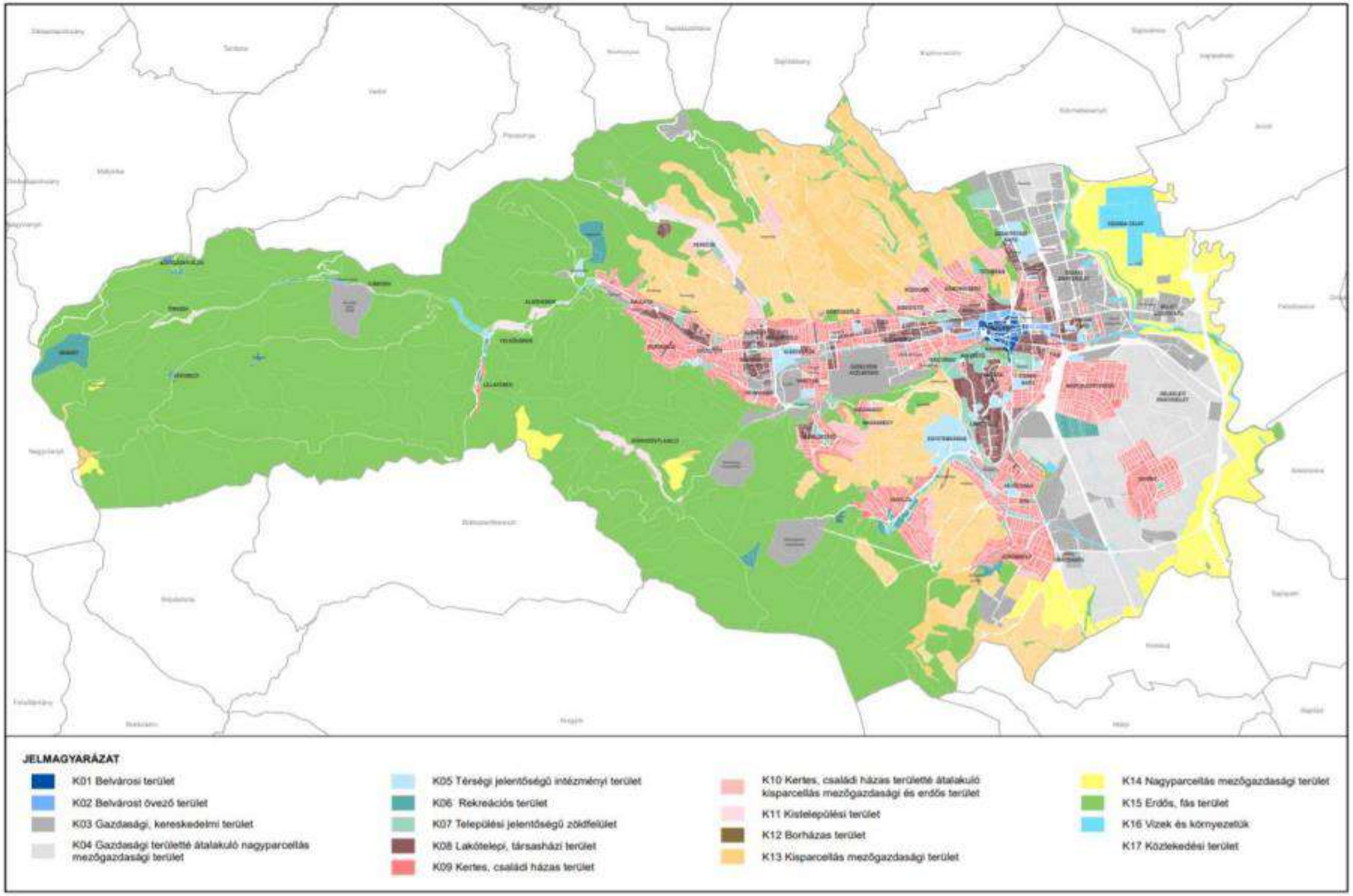
Illustration of aggregated emissions data for Miskolc based on the previous SECAP methodology

Figure 20: Miskolc 2021 aggregated GHG inventory



Annexes

1. map: map of Miskolc



Source: the Town of Miskolc's Town and Country Planning Manual, 2017

Table 14: Final energy consumption by source sector in 2021

A-1.1: Final energy consumption by source sector				
Base year	2021			
Unit of quantity	MWh/year			
	Scope 1	Scope 2	Scope 3	Total
Buildings	**1 076 105,96**	**584 810,56**	**-**	**1 660 916,53**
Residential buildings	*791 833,61*	*375 303,00*	*-*	*1 167 136,61*
electricity		145 557		145 557,00
Gas	527 023			527 023,48
district heating		229 746		229 746,00
firewood	255 082,49			255 082,49
Carbon	9 727,65			9 727,65
Commercial buildings	*170 538,67*	*132 681,56*	*-*	*303 220,23*
electricity		86 657		86 657,26
Gas	170 539			170 538,67
district heating		46 024		46 024,30
Institutional buildings	*113 733,68*	*76 826,00*	*-*	*190 559,68*
electricity		51 669		51 669,00
Gas	113 734			113 733,68
district heating		25 157		25 157,00
Transport	**731 964,61**	**8 157,74**	**-**	**740 122,35**
Local bus transport	*41 748,93*	*-*	*-*	*41 748,93*
diesel	13 399			13 399,01
CNG	28 350			28 349,92
Local tram transport	*-*	*4 785,50*	*-*	*4 785,50*
electricity		4 785,50		4 785,50
Long-distance bus transport (within the administrative area of Miskolc)	*8 756,18*	*-*	*-*	*8 756,18*
diesel	8 756			8 756,18
Train transport (within the administrative area of Miskolc)	*569,76*	*3 372,24*	*-*	*3 942,00*
diesel	569,76			569,76
electricity		3 372,24		3 372,24
Private transport (car, motorcycle)	*407 345,14*	*-*	*-*	*407 345,14*
diesel	116 956			116 955,89
petrol	290 389			290 389,25
Shipping	*273 544,59*	*-*	*-*	*273 544,59*
diesel	270 013			270 012,78
petrol	3 532			3 531,81
Waste	**-**	**-**	**-**	**-**
No data on energy use in waste management				-
Industrial Processes and Product Use (IPPU)	**334 634,55**	**222 281,70**	**-**	**556 916,25**
electricity		202 557,00		202 557,00
Gas	120 699,88			120 699,88
district heating		19 724,70		19 724,70
Enterprises supplying district heating	213 934,67			213 934,67
Agriculture, forestry and other land use (AFOLU)	**447,28**	**1 716,00**	**-**	**2 163,28**
electricity		1 716,00		1 716,00
Gas	447,28			447,28
district heating				-
IN TOTAL:	**2 143 152,41**	**816 966,00**	**-**	**2 960 118,41**

Table 15: GHG emissions by source sector in 2021

A-1.4: GHG emissions by source sector				
Base year	2021			
Unit of measurement	tonnes CO2 equivalent per year			
	direct emissions Scope 1	indirect emissions Scope 2	supply chain emissions Scope 3	Total
Buildings	**169 334,66**	**67 076,88**	**-**	**236 411,54**
Residential buildings	*111 911,64*	*34 412,86*	-	*146 324,50*
electricity		34 351,45		34 351,45
Gas	106 458,74			106 458,74
district heating		61,40		61,40
firewood	1 785,58			1 785,58
Carbon	3 667,32			3 667,32
Commercial buildings	*34 448,81*	*20 463,41*	-	*54 912,23*
electricity		20 451,11		20 451,11
Gas	34 448,81			34 448,81
district heating		12,30		12,30
Institutional buildings	*22 974,20*	*12 200,61*	-	*35 174,81*
electricity		12 193,88		12 193,88
Gas	22 974,20			22 974,20
district heating		6,72		6,72
Transport	**188 338,59**	**1 925,23**	**-**	**190 263,82**
Local bus transport	*9 295,62*	-	-	*9 295,62*
diesel (TTW)	3 574,32			3 574,32
CNG (TTW)	5 721,30			5 721,30
Local tram transport	-	*1 129,38*	-	*1 129,38*
electricity		1 129,38		1 129,38
Long-distance bus transport (to Miskolc)	*2 335,80*	-	-	*2 335,80*
diesel (TTW)	2 335,80			2 335,80
Train transport (to Miskolc)	*151,99*	*795,85*	-	*947,84*
diesel (TTW)	151,99			151,99
electricity		795,85		795,85
Private transport (car, motorcycle)	*103 645,46*	-	-	*103 645,46*
diesel	31 199,15			31 199,15
petrol	72 446,31			72 446,31
Transportation	*72 909,73*	-	-	*72 909,73*
diesel	72 028,61			72 028,61
petrol	881,12			881,12
Waste	**9 166,91**	**-**	**33 781,55**	**42 948,45**
Solid waste management	-	-	*33 781,55*	*33 781,55*
Solid waste landfilling (solid waste disposed of by landfilling methane emissions)			33 781,55	33 781,55
Waste incineration (energy recovery combustion with CO2 capture)				-
Waste water treatment	*9 166,91*	-	-	*9 166,91*
Waste water treatment Methane emissions	5 743,37			5 743,37
CO2 emissions from waste water treatment (as a result of biogas production and recovery)				-
Waste water treatment Nitrous oxide emissions	3 423,53			3 423,53
Industrial Processes and Product Use (IPPU)	**67 596,18**	**47 808,72**	**-**	**115 404,90**
electricity		47 803,45		47 803,45
Gas	24 381,38			24 381,38
district heating		5,27		5,27
Enterprises supplying district heating	43 214,80			43 214,80
No data on direct industrial gas emissions				-
Agriculture, forestry and other land use (AFOLU)	**2 600,55**	**404,98**	**-**	**3 005,53**
Energy needs of agriculture, forestry and fisheries	*90,35*	*404,98*	-	*495,33*
electricity		404,98		404,98
Gas	90,35			90,35
district heating		-		-
Issuance of ruminants	*444,10*	-	-	*444,10*
dairy cow	257,64			257,64
beef cow	69,70			69,70
sheep	116,76			116,76
Slurry emissions	*122,71*			122,71
Use of farmyard manure or organic manure	*1 478,03*			*1 478,03*
Fertiliser application	*465,35*			*465,35*
Deforestation, if detectable				
IN TOTAL:	**437 036,89**	**117 215,80**	**33 781,55**	**588 034,24**

Table 16: Aggregated GHG inventory by sector in 2021

	Scope 1	Scope 2	Scope 3	Total
electricity (buildings+industry+agriculture)		117 130,10		117 130,10
gas	231 568,29			231 568,29
district heating		85,70		85,70
coal and firewood	5 452,90			5 452,90
transport	188 338,59			188 338,59
solid waste			33 781,55	33 781,55
waste water	9 166,91			9 166,91
animal husbandry, ruminants	444,10			444,10
slurry emissions	122,71			122,71
organic and synthetic fertilisers	1 943,38			1 943,38
GROSS GHG INVENTORY	437 036,89	117 215,80	33 781,55	**588 034,24**
forest areas of the municipality				- 134 736,00
municipal green spaces				- 62 571,61
SINKS				- 197 307,61
NET GHG INVENTORY				**390 726,62**

Table 17: Aggregated GHG inventory for the city of Miskolc - 2021

Miskolc GREENHOUSE GAS INVENTORY - 2021		CARBON DIOXIDE CO_2	METAN CH_4	NITROUS OXIDE N_2O	TOTAL
		t_{CO2} equivalent			
RELEASE	**1. ENERGY CONSUMPTION**	354 236,99	0,00	0,00	354 236,99
	1.1. Electricity	117 130,10			117 130,10
	1.2. Natural gas	231 568,29			231 568,29
	1.3. District heating	85,70			85,70
	1.4. Coal and firewood	5 452,90			5 452,90
	2. LARGE INDUSTRIAL EMISSIONS	0,00	0,00	0,00	0,00
	2.1 Other industrial energy consumption	0,00	0,00	0,00	0,00
	2.2. Industrial processes	0,00	0,00	0,00	0,00
	3. TRANSPORT	188 338,59	0,00	0,00	188 338,59
	3.1. Public transport	11 783,40			11 783,40
	3.2. Individual transport	138 297,53			138 297,53
	3.3. Shuttling	348,11			348,11
	3.4. State roads	37 909,55			37 909,55
	4. AGRICULTURE	0,00	523,81	1 986,39	2 510,20
	4.1. Livestock		444,10		444,10
	4.2. Slurry		79,71	43,00	122,71
	4.3. Organic and synthetic fertilisers			1 943,38	1 943,38
	5. WASTES	0,00	39 524,92	3 423,53	42 948,45
	5.1. Solid waste management		33 781,55		33 781,55
	5.2. Waste water treatment		5 743,37	3 423,53	9 166,91
	TOTAL EMISSIONS	**542 575,59**	**40 048,73**	**5 409,92**	**588 034,24**
	WITHOUT LARGE INDUSTRY	**542 575,59**	**40 048,73**	**5 409,92**	**588 034,24**
Absorption	**6. SINKS**	**-197 307,61**			**-197 307,61**
	FINAL EMISSIONS	**345 267,98**	**40 048,73**	**5 409,92**	**390 726,63**
	WITHOUT LARGE INDUSTRY	**345 267,98**	**40 048,73**	**5 409,92**	**390 726,63**

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EX-ACT PROJECT
TANÁCSADÓ IRODA

Sustainable spatial and urban development, circular economic development, social innovation, international cooperation

EX-ACT Project Consultancy is committed to climate-neutral, green and sustainable development and improvements. In the process of strategy development, our staff focuses on extending sustainability considerations to all areas of a municipality's operations, thus helping to achieve a green transition.