THE DEVELOPMENT POSSIBILITIES OF ENVIRONMENTALLY CONSCIOUS OPERATION THROUGH THE EXAMPLE OF THE CITY OF DEBRECEN

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Abstract: *In this research material, I review the energy policy of the municipality of Debrecen today and its impact on the future. Compliance with the Environmental Protection Programs is important for the municipality of Debrecen, in which a new environmental protection policy was developed for the city in addition to the existing ones. At the end of 2023, the city of Debrecen established the Green Working Group, the task of which is to operate an environment-conscious, climate-friendly and family-friendly environment in addition to the structure and operation of companies settling in Debrecen. Recently, the Green Code was created in the city of Debrecen, which envisages a livable environment for the residents so that economic development goals can also be achieved. In my research, I cover the Civaqua program, green urban mobility, the topic of carbon neutrality, and the development of a green approach in Debrecen city management. Since several well-known foreign companies have settled in Debrecen in the past short period (battery factory and its subcontractor groups, automotive factories, etc.), I think it is appropriate to examine the role of the Debrecen Municipality in remedying the situation. The topics mentioned in my presentation regarding Debrecen are the following: waste collection, water use, climate, industrial water supply, air cleanliness, and the examination of the concentration of carbon monoxide in the air.*

Keywords: energy policy, energy management, Green Code, environmentally conscious
JEL Classification: F64, K32

1. Introduction

Debrecen, as one of Hungary's most important county seats, created a collection of objectives called the Debrecen Green Code in 2023, which refers to the regulation of the environmental policy of the city of Debrecen (Press Center – KSzD (2024); Profitline, 2024). The basis of the environmental protection program contained in the code was adopted by the government on the meeting of 12.07.2022, and it is also due to this that companies came to Debrecen last year and in 2024, for which it is important to observe/enforce the highest level of environmental protection, and ensuring an environmentally conscious lifestyle in the case of companies. The municipal government of the city of Debrecen was able to implement its current environmental protection measures from its own resources, from funds provided by the European Union and the government.

Since the idea of an environmentally conscious and sustainable city has become stronger by 2024, in this research I would like to review in detail the topic of green energy in the city of Debrecen in the light of climate change and economic development. In order to present the topic in as much detail as possible, I will touch on the Civaqua program, the Debrecen Green Code, the needs and expectations of the companies setting up for environmental protection and environmental awareness.

2. Beginnings

The basis of the environmental protection code of the city of Debrecen was the Green Working Group, which began its operation in 2019 (their first public appearance was in 2020) (EDC, 2024). Even then, the goal of the professionals and researchers participating in the

Working Group was to ensure that the city of Debrecen achieves the application of the green vision as much as possible, and that a safe and healthy environment for the residents of Debrecen is given as much priority as possible. The Green Working Group was also the initiator of the "Future of Debrecen" movement (Dehir, 2021), who undertook to coordinate the environmental protection issues of the city of Debrecen and to organize programs for the people living in Debrecen and its surroundings, with which they can better convey environmental awareness. The Working Group devoted a lot of attention to reaching all age groups of Debrecen residents in some form through events (Nature of Debrecen, etc.) and being able to inform them about current developments. In my opinion, this was an appropriate procedure for the residents to feel the care of the city administration. The municipality also received great recognition during the Civaqua program's idea competition (Debrecen, 2021), as the public's opinion was sought on the developments related to the topic. More than 270 people from Debrecen took part in this idea competition.
Debrecen's accession to the LIFE IP HungAIRy program, which aimed to improve environmental protection and air quality in the region, showed great progress. As part of this series of programs, the "COMPOSTold" campaign (where the residents of Debrecen were drawn to the correct composting options), the distribution of compost bins (where the municipality distributed 7,000 compost bins in 2019) and the "car-free" day (where they asked residents to change cars to public transport, bicycles or walking) (Ökomenedzser, 2022).

3. An overview of greening projects

In the following, I summarize the most significant projects related to greening:
1. ”10,000 trees to Debrecen!" In the case of the program called "Future of Debrecen", the municipality announces community tree plantings with the participation of the population of Debrecen, where anyone can go and plant a tree as a result of joint work (Future of Debrecen, 2023). The locations of tree planting are around public areas, residential areas, and institutions in Debrecen. The goal of tree planting is to create a greener Debrecen, and to bind pollution, reduce temperature, optimize humidity, improve air cleanliness, and provide a habitat for birds and insects in terms of shading. So, in my opinion, the goal is to ensure a healthier environment alongside the large companies that settle here. "10,000 trees to Debrecen!" after the project, there are additional goals for tree planting, as the fruit tree planting program also has a beneficial effect on air quality.
2. In the case of the "Community protective afforestation" project, afforestation processes are and have been carried out near the Vértessy manor (Debrecen 2022).
3. The "Civaqua program" was established with great success in the western part of Debrecen, since water is invaluable and indispensable for everyone, and therefore every Debrecen resident considered the realization of this objective a matter of heart (Civaqua Debrecen, 2022). Within the framework of this program, the distribution of residential rainwater collection barrels distributed during the "water is our common treasure" rainwater collection campaign was realized (Dehir, 2023). Within the framework of the program, an inland water reservoir with a water surface of 1.5 hectares was also created in Debrecen.
4. The program is of nature conservation significance, as the water of the Tisza has been successfully diverted to the Tócó River, with which Debrecen's water management can be improved, and Debrecen can make better use of the potential inherent in natural waters.
5. The second phase of the Civaqua program will be the "Water Forest" program, which will greatly contribute to the maintenance of the deployed defense forces (Civishir, 2024). With the continuous water replenishment of the Great Forest, the aim is to restore the original natural flora and fauna, and to increase the groundwater level.
6. "DO NOT mess with the people of Debrecen!" by announcing community garbage collection with the slogan, you eradicated illegal waste disposal sites with the help of community cooperation (Szűcs – Hameczm, 2024).

7. Residents of Újkert, Vénkert and Tócoskert enjoyed the creation of "Community gardens". These gardens give the local residents the opportunity to grow plots of vegetables, fruits and herbs and spices (Debrecen, 2023).
8. In 2023, the LED exchange program was considered an important movement throughout Hungary, which also arrived in Debrecen in the spring of 2023 (Piros, 2023). Within the framework of the program, the population of the city of Debrecen was able to get the required amount of LED lamps for their apartment/house free of charge, which can be used to save energy. In addition to energy savings, the fact that costs can be reduced in households where these LED burners are used cannot be neglected. In the LED replacement program, which will be successfully completed in the spring of 2023, 76,000 LED light bulbs were allocated based on the municipality's database, which will help the energy management of approximately 6,000 households in the future.
9. By using ZÖLD Mozi, they want to achieve the widest possible awareness among the residents of Debrecen by watching movies free of charge. The main focus of each screening is environmental protection, efficient energy management, and the prevention of air pollution (Dehir, 2024).
10. The "Green City Program" has been operating in the city for almost 5 years, where the parks of the housing estates are renovated, the major parks are reconstructed, new public spaces are created, and grassy areas of the housing estates are given new functions for use (Future of Debrecen, 2024). Based on the news reports, 290,000 square meters of green space were renovated, 900 trees were planted as parks, 7 new playgrounds were created in addition to the renovation of the 27 previous playgrounds, and street furniture was installed or renovated where necessary.

4. The importance of the Environmental Control System in the city of Debrecen

To solve the problems, an Environmental Control System (ECS) was created, in which the University of Debrecen helps the city to develop an appropriate environmental policy and draws attention to the preservation of natural values among residents (d2023.hu, 2023). The system examines 4 main environmental factors individually or together. These factors are air, water, soil and biodiversity. The system has 16 measuring stations, which continuously provide data for the system. As can be read in the Urban Environmental Protection Program 2023-2026 of the City of Debrecen County, the monitoring system was established with a center in Debrecen and examines the environmental effects at a regional level, especially in the areas of air quality, water quality, soil, farmland and biodiversity (Szűcs – Hamecz, 2024). One of its key points is maintaining and improving air quality. Since the city of Debrecen is constantly improving road traffic, developing various investments, and changes in the energy structure, the city of Debrecen must constantly pay attention to changes in the structure of air pollution sources.
The KER's objectives include outlining and measuring the factors that play a role in improving the quality of life. The main goal is to exclude negative effects and strengthen positive effects (unideb.hu, 2023).

5. Elements of the implementation of a livable environment

JövőMűhely podium discussions were started by the Future of Debrecen, where a presenter always discusses the environmental protection and technology topics with experts relevant to the given topic. This was aimed at informing the residents and passing on information (haon.hu, 2024). In addition to the University of Debrecen, the Hajdú-Bihar County Chamber of Commerce and Industry and the Hajdú-Bihar County Chapter of VOSZ also participate in the podium discussions and help entrepreneurs and residents understand the topic.
In the area of environmental awareness, the city has introduced a lot of innovations in the past period, with which they intend to reduce the environmental burden. The most important of these are the following (Debrecen2023, 2024):

- introduction of electrical devices into the operation of the settlement: An environmentally conscious approach is also important when carrying out works in public spaces. The city is constantly using newer and newer electronic devices for the maintenance of public green areas. The tools that are still in operation in the settlement operation are, for example, litter collection, grass cutting, park care and park maintenance work, etc. The amount of harmful emissions, air pollution and noise pollution can also be reduced by using these devices.
- installation of waste containers with sensors: The garbage collection process can be optimized with this waste collection. By installing the sensors, the waste handlers can monitor the saturation of the bins, and if necessary, the amount of emptying of the bins can be changed. With the help of the sensors, the frequency of emptying can be optimized, and the transport routes can also be redesigned (this can also reduce air load and energy consumption).
- paperless administration in the case of park maintenance and public cleaning works: The e-Papír application was introduced to manage general matters, where customers can manage their affairs online with the relevant bodies. During the internal case management of the office, the biggest task is the documentation and administration of the cases. Electronic processing takes place automatically in the electronic case initiation system. Of course, based on the law on electronic administration, customers must also be given the option of paper-based administration if required (EDC, 2023). As a result, full electronic case management is not possible in the offices (it is only possible to introduce partial case management)
- creating a green cadastre: The establishment of the green cadastre helps the administration of the life course of trees and their care. The future goal with the cadastre is to create a geospatial register of the city's green space.
- urban afforestation and protective afforestation: Based on the planning plan, the afforestation of areas belonging to the protection zone or the supply of trees to public parks is currently being implemented. With this urban tree planting, they were able to create "green corridors". With the establishment of protective afforestation, approximately 4,000 horticultural trees and 50,000 shrubs were planted in the north-western and southern parts of Debrecen in 2023 and in the first half of 2024, with the possibility of sequestering 76 tons of carbon dioxide and approximately 356 tons of dust based on calculations. (Szűcs – Hamecz, 2024). Of course, with the planting of trees, based on calculations, it is also possible to produce an additional 51 tons of oxygen.
- In order to create a livable environment, the "10,000 trees to Debrecen" program was also established in 2019, where 10,000 trees will be planted in different parts of Debrecen over 5 years with the involvement of the population.
- continuous replacement of the local bus fleet: In 2009, the entire bus fleet will be replaced with more modern (EURO 5) buses. 10% of the replaced buses were already converted to electric buses, while the remaining 90% remained in diesel operation. As a result of the development, in 2022 buses with an environmental protection classification of EURO6 were purchased. In 2022, 40 low-floor buses were put into service, and in 2023, 39, with this development the entire solo bus fleet was renewed (dkv.hu, 2024).. According to plans, another 40 full-floor articulated buses will be replaced in 2024. The innovations reduced fuel consumption by almost a quarter (900,000 liters of fuel were saved in 2023), which reduced carbon dioxide emissions by 2,500 tons, according to calculations. This value can be considered good, since 230,000 tons of carbon dioxide emissions come from Debrecen's traffic, which must be continuously reduced not only by Hungary, but by the entire European Union member states. Based on European Union regulations, the goal is to phase out traditional cars/buses/vehicles with internal combustion engines and replace them with more environmentally friendly solutions, naturally at an affordable price. These efforts are also supported by the fact that one of the parts manufacturing groups of BMW has settled in the city of Debrecen, which will produce batteries, electric cars, and the parts necessary for cars (sensors, electrical housings, battery parts, automotive parts, etc.) in the future. The greater

penetration of electric cars in transport would also be more important, as electric cars play a relevant role in reducing greenhouse gas emissions (Europar, 2019).
- development of residential communities with the help of panel programs: Since there are continuous regulations regarding the use of gas boilers in the European Union, continuous development is also necessary in the case of panel houses. According to EU regulations, gas boilers can no longer be installed in 2030, while all gas boilers will be taken out of operation by 2040.
- The replacement of windows and the thermal insulation of the facade and slab can also help optimize the energy management of panel buildings and save energy (based on calculations, the energy savings of panel buildings can be reduced by 18-20%).
- improving the energy efficiency of public lighting: Based on data from the Debrecen Municipality, approximately 25,000 lamps provide public lighting, with an energy consumption of around 8.4 million kW (Table 1).

Table 1: Electricity consumers in Debrecen in 2022

Designation	The year is 2023
All lamps (pcs)	25 113
Annual burning time (hours/year)	3 990
Built-in power (kW)	1 612
Street lighting energy demand (kWh/year)	6 432 846

Source: Own editing based on data from the Debrecen municipality

Since an environmentally friendly solution is also necessary in this area, it is also necessary to modernize the entire street lighting. Within the framework of the LED replacement program, it is expected that 6,000 lamps will be replaced with LED designs, which will achieve a reduction of 700 tons of carbon dioxide emissions per year (material savings can be HUF 800 million, which can be considered good in the case of the current HUF 2.43 billion expenditure). In the summer of 2023, nearly 3,000 LEDs were already replaced, which has already reduced the amount of maintenance costs.
- LED replacement program for the public: The organization of energy management is also important for Debrecen households, in which the city can and was able to help by participating and participating in the Residential LED replacement program after 2023 and in 2024 (Debrecen, 2024). Within the framework of the program, in order to improve the energy efficiency of households, traditional light bulbs can be replaced with LED light sources, which can lead to significant energy savings (thereby also reducing the amount of the residential electricity bill).
The plan to minimize the emission of harmful substances in traffic can also be considered a major milestone, where the environment is improved by the introduction of green transport. The goal with the introduction of green city mobility is to reduce the emissions of transport pollutants throughout the entire life cycle of transport elements. The goal in the future is to involve as many residents as possible in public transport in their daily lives. In order to achieve this goal, the city continuously expands the length of bicycle paths and improves their quality. The smart creation and operation of city bicycle storage facilities facilitates the storage of bicycles.
In the case of businesses settling in Debrecen, it is also expected that they burden their environment as little as possible. The BMW factory, which is currently still in the installation phase, is paying attention to meeting international and, of course, Debrecen expectations, as it plans to operate in a carbon-neutral manner. The factory plans to operate with the introduction of fully renewable energy sources into energy management, for which purpose the construction of a solar park is underway in the factory area. As a future goal, the factory also plans to use geothermal energy, but research is only now being conducted in this regard.

It is important for both Hungary and Debrecen that energy dependence on external energy players is minimal. The aim should be to rely on the potential of renewable energy sources in the case of energy sources necessary for maintenance. A shift towards local energy sources can lead to a reduction in the amount of dependence. The city of Debrecen also sees the possibilities of solar energy, and to this end, it has created a 24 megawatt solar park next to the Debrecen airport (on 52 hectares). This amount can cover the annual electricity needs of approximately 15,000 households, which can reduce carbon dioxide emissions by 33,000 tons annually in the future.
By studying current electricity consumers, it can be seen that in 2022 residential consumers accounted for nearly 90% of the amount of electricity, while industry accounted for 2% (Table 2).

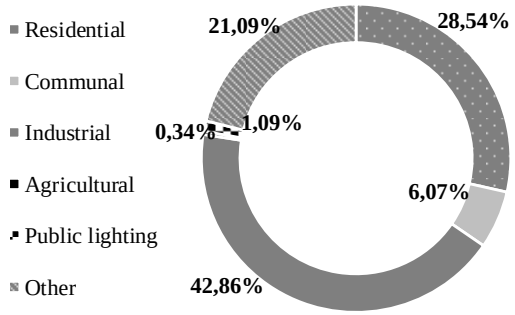
Table 2: Electricity consumers in Debrecen in 2022

Type of consumers	Quantity (pieces)	Share (%)
Residential	116 931	92,25%
Communal	862	0,68%
Industrial	2 527	1,99%
Agricultural	177	0,14%
Other	6 251	4,93%
Altogether	**126 748**	**100,00%**

Source: My own editing based on the KSH – OSAP 1058 report

Table 3: Electricity consumers in Debrecen in 2022

Type of consumers	Electricity provided (1000 kWh)
Residential	216 012
Communal	45 938
Industrial	324 480
Agricultural	2 589
Public lighting	8 282
Other	159 683
Altogether	**756 984**



Source: My own editing based on the KSH – OSAP 1058 report

In Table 3, I collected the quantities supplied from electricity according to the types of consumers.
These rates remained the same for 2023, with the difference that industrial electricity consumption increased from 2% to nearly 3.5%. According to forecasts, by 2024 this value may rise to 5% thanks to the large companies that are moving in.
It can be seen that, in the case of examining the quantities, we get different ratios compared to Table 2 as a result. Industry accounted for 43%, while the population accounted for nearly 30% of the amount of electricity supplied in 2022.

6. Future actions

In the next phase of the Civaqua program, the applicants want to implement a solar park and the associated operation management system.
In order to improve water management, the management also targeted the replenishment of water in the Mézeshegy lake system and Lake Vekeri, as this would enable safer operation. With this effort, it will be possible to create a sustainable situation even in extreme weather situations.
Future plans also include the creation of another green corridor, which would play a major role in the water ring surrounding the city.

One of the key elements of creating a green Debrecen is the development of bicycle paths, and the partial or complete transfer of car traffic to bicycle (or other alternative) options. In order to achieve this goal, the city aimed to create "Green Váltók", which means that a parking space will be created for cars, where it would be possible to reach the destination in several ways: transfer to public transport, bicycle rental, electric car charging points provision for an additional cost, placement of parcel pick-up points, and other services.
In order to identify sources of air pollution and to reduce the level of air pollution, the city intends to establish an air quality measurement network in the near future. The reason for this is that there are continuous investments in the city (which create a cloud of dust during construction), road transport and industrial investments, which increase the concentration of dust in the air. Residential burning, traffic and agricultural work also play a significant role in the emission of air pollutants. The release of air pollutants from traffic into the air can be reduced by traffic organization measures and the introduction of changes to the traffic order, which can be considered continuous in the city (reduction of traffic through the city by creating a ring road, modernization of public transport, efficient development of sustainable public transport, expansion of cycle paths, etc.). Of course, air cleanliness is also helped by the previously mentioned urban afforestation and protective afforestation
In order to improve air quality, the Sustainable City Mobility Plan 2.0 was created in Debrecen in 2023, which was named SUMP. In the framework of this program, the sustainable development of the transport system of the city and surrounding settlements was targeted. The aim of this program is to create a more efficient transport organization while taking into account the needs of companies settling in Debrecen. The SUMP program is a great help in reducing noise pollution and air pollution, reducing traffic jams, and improving the quality of urban traffic.
In order to improve air quality, the city of Debrecen is also working on setting up the complex system "LevegŐr", which helps the Environmental Control System by making the composition and source of air pollutants identifiable. This system aims to measure air quality as the main point, with which they want to help improve the quality of life of the population and organize the maintenance of a more livable environment.
Transformations involving the introduction of renewable energy sources in energy production and residential heating can also result in significant changes. By establishing an air quality measurement network, it is possible to control the increase in the amount of pollutants entering the air.
By providing free bicycle racks, the city is waiting for the arrival of the cycling enthusiast. However, it is important to take into account that car transport can only be persuaded to achieve a greener workplace if
- while charging the electric car, you can reach your workplace with a bicycle or some other means of public transport (so while the car is being charged, you can reach your destination by bicycle or public transport),
- near the parking space, it is possible to use public transport at a discounted rate,
- the parking lot is controlled and safe,
- etc.

Future improvements can also be expected in public transport, as the replacement of the bus fleet has been ongoing in recent years, and the goal for the introduction of new buses is to have a more favorable environmental classification. It must be taken into account that public transport can only improve by increasing the proportion of vehicles with alternative drives. Their operation takes place from the energy produced by the recently established solar parks for the electric buses.
The fact that they want to establish a solar park in two places in the western part of Debrecen with the support of the government can also be considered an additional development project. In order to partially cover the energy needs of the South Industrial Park, a solar park with a capacity of 10.85 MW and 19.18 MW is planned. Part of the energy produced is also intended to cover the charging of electric buses and trolleybuses. Of course, the amount of

energy produced will be stored in batteries. These solar parks will have an environmentally friendly design, which will fit into the urban environment, and since it will be realized by increasing green space, the air quality will also improve.

7. In conclusion

It can also be seen in this summary study that the main goal of the Debrecen city government is to maintain the existing green areas in Debrecen, to create new green areas, and by organizing various programs (events), they want to help the residents of Debrecen to think about efficient energy and environmental management. All of the greening programs aimed to preserve the environment of the city of Debrecen and further green it. As a result of greening, the green landscaped area at the Bear statue in downtown Debrecen was born in 2023 after the construction of an underground parking lot. The greening has been greatly advanced to 2023-2024. annual community tree plantings, in which 10,000 trees are/were planted in Debrecen with community cooperation.

By processing environmental protection problems and raising environmental awareness, the municipality aims to create a community in Debrecen that has sufficient knowledge and infrastructure to solve Debrecen's problems.

The city of Debrecen also played an important role in environmental education by creating environmentally friendly infrastructure, bicycle paths, nature trails, and recreation parks.

The material also summarizes the programs that can help create a healthy environment in the city of Debrecen. In order to achieve this goal, continuous recreational and infrastructural development of public areas, housing estates and busy roads is needed in Debrecen, which the current Debrecen administration is trying to solve as efficiently as possible. All of the currently ongoing programs aim to create a more environmentally conscious, climate-friendly environment and a higher quality of life. All of the businesses that settle in the city of Debrecen support the economic development goals defined/formulated by the municipality and the Future of Debrecen.

By implementing future plans, it will be possible to create a higher quality of life and a healthy environment.

Based on the information described in the research material, it can be concluded that the Sustainable Urban Mobility Plan (SUMP) of the County City of Debrecen is leading Debrecen on the right path towards development. The material of this plan is the first in Hungary to contain a series of measures that comply with European Union directives and best reflect the implementation of the transport strategy.

It is also clear from the measures taken by the city of Debrecen that the city is developing in accordance with the environmental protection program in Hungary. With the thinking and actions represented by the city of Debrecen, the city contributes to the reduction of air pollution, the optimal use of fuel in public transport, and the achievement of climate, energy and environmental goals.

We can also see the application of an improvement strategy in the energy management of the city of Debrecen, as the city of Debrecen, in cooperation with the MVM, developed a solar power park on the outskirts of Debrecen last year. With the built-up solar park, the carbon dioxide emissions of Hungary and Debrecen can be reduced, environmental benefits can be created and thus we contribute to the continuation of the green approach, and the energy dependence of the city of Debrecen is also reduced.

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