

THE SMART CITY STRATEGY OF DEBRECEN



Debrecen
SMART CITY



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1 INTRODUCTION

The aim of preparing the Debrecen Smart City Strategy is to support the improvement of urban prosperity and quality of life with the help of the Smart City concept. In Hungarian comparison, among so-called cities of county authority, Debrecen has been at the forefront in terms of solutions introduced in the field of Smart City; however, a systemic level switch requires more than successful projects introduced in various areas: it takes a higher degree of integration with a shared aim.

In many of the directly funded programmes in the 2021-2027 programming period (Horizon Europe, LIFE programme, etc.), it will be almost like a prerequisite for at least the medium-term Smart City strategy approved by the municipal council and drawn up in agreement with the important stakeholders of all key areas. The most important task of the strategy is the identification of the areas that are indispensable for the economic development of the city, the assessment of their current situation, the presentation of the Smart City solutions already introduced, the definition of the objectives, and the discussion of the possible projects supporting the achievement of the objectives.

Since Smart City is a relatively new area, and in many cases, it relies on innovative, previously unused solutions, and even the scope of tools accessible in the medium range is difficult to determine. Therefore, it is not the task of the strategy to collect all possible solution, prioritise

them, determine their financial needs, and to map the sources necessary for their implementation and the risks involved with their introduction. In terms of its content, the document is linked to the Debrecen 2030 programme, and therefore, its time frame is also the period until 2030. The objectives of the Smart City programme are related to the objectives of the European Union in the next programming period¹ as well:

- **a smarter Europe**, through innovation, digitisation, economic transformation and support to small and medium-sized businesses;
- **a greener, carbon-free Europe**, implementing the Paris Agreement and investing in energy transition, renewables and the fight against climate change;
- **a more connected Europe**, with strategic transport and digital networks;
- **a more social Europe**, delivering on the European Pillar of Social Rights and supporting quality employment, education, skills, social inclusion and equal access to healthcare;
- **a Europe closer to citizens**, by supporting locally led development strategies and sustainable urban development across the EU.

The Debrecen Smart City strategy was drawn up on the initiative of EDC Debrecen, based on consultations with key urban actors (both municipally and privately owned), with the possibility of feedback provided for companies, civil society associations, organisations and the general public.

¹ New cohesion policy, European Commission, 05.08.2019, https://ec.europa.eu/regional_policy/hu/2021_2027/



2 WHAT IS THE SMART CITY?

Smart City is an urban development concept that appeared with the spread of **information and communication technologies** (ICT) in the first half of the decade, and it envisions an **intelligent and innovative, liveable and efficient, smart and sustainable, moral and just, healthy and wealthy city**. There are numerous definitions of what constitutes a smart city; in Hungary, on the basis of Government Decree 314/2018 (XI. 8.)², it is defined as a settlement that draws up and executes its integrated settlement development strategy on the basis of a smart city methodology. The smart city methodology is defined as a methodology for a settlement or group of settlements, aimed at the development its natural and built environment, digital infrastructure, and the quality and economic efficiency of services available within its area, by using sophisticated and innovative information technologies in a sustainable way, with the increased involvement of the local population.

The **aim** of the Debrecen Smart City strategy is to improve urban prosperity and quality of life. It does so by:

- being a part of our everyday life,
- expanding the infrastructure,
- renewing services operating in the city (public utilities, mobility, waste management, public sanitation, healthcare, education, etc.),
- developing urban management,
- stimulating the local economy,
- encouraging and improving education, research, creativity, enterprises, civil and social relationships,
- creating a sustainable, green approach, and contributing to the application of innovative technologies.

² net.jogtar.hu, 05.08.2019, <https://net.jogtar.hu/jogszabaly?docid=a1200314.kor>



The aim of the present document is to summarize the experiences of the Debrecen Smart City programme, presenting its main directions, and delimiting its future development areas. In the course of drawing up the Smart City strategy, we took the Digital National Development Programme, the Digital Prosperity Programme, the Modern Cities Programme, as well as the developments realised and planned in the framework of the New Phoenix Plan and the documents in the various specialized fields (ITS³, SUMP⁴, SECAP⁵) into account. The document is aligned with the joint D2030 development programme of the Municipality of Debrecen and the University of Debrecen.

The strategy looks ahead until 2030, using the results and objectives of the present and the medium-term plans.

³ Integrated Urban Development Strategy

⁴ Sustainable Urban Mobility Plan

⁵ Sustainable Energy and Climate Action Plan

3 THE PRESENTATION OF THE CITY OF DEBRECEN

With its population of **208 thousand**, **Debrecen** is the **second largest city** of Hungary⁶. After the capital city, Debrecen is the Hungarian settlement with the biggest force of territorial integration, and at the same time also the centre of the North Great Plains region and of Hajdú-Bihar County, located at a distance of 220 km east from Budapest and 35 km west from the Romanian border. The city plays an important role in international trade, thanks to its proximity, in addition to Romania, also to the Slovak and the Ukrainian borders, which can be reached in less than 2 hours.



It is one of the country's most developed cities, the cultural and knowledge centre of the region. Education, and specifically within that, higher education, which has a history of almost 500 years, has always played an important role in the city, thanks to which the **University of Debrecen**

has grown into the institute of higher education offering the widest range of academic programmes, as well as the largest university of Hungary, with nearly 30 thousand students. As a result of the development of programmes in foreign languages, the number of international students has increased to over 6 thousand.

Also part of the city's good infrastructure is that, following Liszt Ferenc Airport in Budapest, Debrecen has the second most significant **international airport** in Hungary, which has also experienced immense development in recent years. While the volume of passenger traffic was still **below 20 thousand in 2011**, only six years later, in 2017, it was already close to 320 thousand⁷, **exceeded 380 thousand in 2018**⁸, and is expected to reach 650 thousand in 2019. A significant contribution to this growth was made by WizzAir, which started its scheduled flights from Debrecen in 2012, and after further developments, since the end of 2018 has had two aircraft based in the city. With the flights of WizzAir serving 13 destinations and Lufthansa flying to Munich, a total of 14 destinations can be reached directly from the airport by scheduled flights since the spring of 2019. According to the long-term vision of Debrecen International

⁶ KSH Micro Census 2016, 05.08.2019, http://www.ksh.hu/mikrocenzus2016/docs/tablak/02/02_09_hajdu_bihar_3_1.xls

⁷ The volume of passenger traffic at airports (2004-2017) KSH. 05.08.2019

⁸ Soma Somorjai, The passenger traffic of the airport of Debrecen has exceeded expectations, 05.08.2019, <https://www.dehir.hu/debrecen/a-varakozasokat-is-tulszarnyalta-a-debreceni-repuloter-utasforgalma/2019/01/04/>

Airport, as many as **2-3 million passengers** may be using the services of the airport by **2030**.



Overall it can be concluded that Debrecen is a major city in Hungary that has the biggest force of regional integration after the capital. In terms of its capabilities, it is well-suited to become the **economic, transport, educational, cultural and healthcare centre** of a larger region consisting of eastern Hungary, as well as Eastern Slovakia, Western Ukraine and Western Romania.

Through the implementation of the **New Phoenix Plan**, which built on the Modern Cities Program, the Territorial and Settlement Development Operational Programme, and other EU and domestic sources, establishing the outstanding role of the city in the region in the 2014-2020 period, and **Debrecen 2030**, a new, complex development program created as the continuation of the New Phoenix Plan, Debrecen can become the capital of the north-eastern part of the Carpathian basin.

For this, however, it is indispensable to increase the size of the city's population, as well as to create a closer integration with the agglomeration, including the linking of the surrounding cities to the economic, transport,

educational and cultural opportunities offered by Debrecen, the proper development of these areas, as well as the joint development of the region's settlements in close cooperation.

It is a guiding principle that in case the city is able to offer competitive employment opportunities, affordable housing, and outstanding quality of life, then Debrecen becomes the primary target of settling in the region. In the interest of the above due emphasis has been given to investment promotion, in both the manufacturing and the service providing sector, thanks to which a total of **500 billion HUF of working capital** was invested in the city **between 2015 and 2018**, creating **6 thousand new jobs**.

The investors arriving in the early 2000s, such as National Instruments, British Telecom, and IT Services Hungary, were followed in the period between 2015-2018 by international corporations each needing hundreds of employees, such as **Thyssenkrupp, Diehl Aviation, Krones, Continental** or the **BMW Group**, the investment of which is of outstanding importance even on a national scale.

The purposefulness is well characterised by the continual development of the existing and newly designed industrial parks, of which a total of 7 can now be found in the city, as well as the development of office space, such as the category "A" Forest Offices, opened in the last quarter of 2018, which will be an important business centre of the region with its Leed Gold qualification, technical content and modern appearance. These strategic efforts and their proactive implementation has resulted in international recognition on several occasions,

such as the title of “Emerging City of 2017” in the CEE Shared Services and Outsourcing Awards, or the “Best FDI Strategy Award” given in 2018 by fDi Intelligence, the unit of Financial Times dealing with international capital flows and investments, in the category of small and medium-sized cities, as a result of which Debrecen can use the title of European City of Future in 2018-2019. Thanks to the model established so far, it is a realistic **objective** to create a total of **20 thousand new jobs** in Debrecen **between 2015 and 2025**.



The city of Debrecen intends to be at the cutting edge in introducing 21st-century solutions, in order to create as attractive an environment for its population and the local companies as possible. In its conscious infrastructural development, Debrecen wishes to devote an important role to **smart mobility development**, whereby it will become the unavoidable transport centre of the region. This necessitates, however, transport developments also beyond the New Phoenix Plan, in order to serve the mobility-related needs

accompanying the population growth and the increasingly mobile workforce.

In order to achieve its long-term objectives, Debrecen has started a future-oriented, strategic urban development programme, even the first steps of which were defined in such a way that, after ensuring the initial conditions on the given area of intervention, they should facilitate the implementation of the further steps of the programme as a self-sustaining tool.



4 THE PRESENTATION OF DEBRECEN SMART CITY, FOCUS AREAS

Conscious Smart City thinking in Debrecen can be traced back to 2015, the year when the municipal leadership established the organisational background within the city's urban and economic development centre, EDC Debrecen Nonprofit Kft. The first Smart City projects across the city can also be traced back to this year.

The most important task of this initial period was the determination of the focus areas of Smart City, jointly with the municipal leadership and the population. It was necessary to understand which were the areas that are important to the city, where a proper effect or improvement in the services can be achieved with smart solutions. The following areas and their objectives have been defined:

• Digital literacy

Every resident of the city should have a fundamental right to acquire digital literacy.

• Urban services

The services of the city should operate comfortably, efficiently, and accessibly to all.

• Energy

Debrecen reduces the utility bill of the city with smart solutions.

The citizens of Debrecen should behave consciously in the area of water use, should plan and optimise their energy consumption.

• Public safety

Smart solutions and processes should perceivably improve public safety and the residence sense of security.

• Mobility

The throughput of the main roads in the city should improve perceivably.

Urban development plans support the organisation of traffic with smart devices.

• Sports

More physical exercise for a healthier population. Smart solutions for more enjoyable competitive sports and a wider range of the population involved in mass sport activities.

• Healthcare services

The work of healthcare service providers should be well coordinated, and the flow of information between them made more efficient.



On the basis of the experience gained in the first few months, a weighing of the seven focus areas has become increasingly necessary. With attention to, as well as aligned with the priorities of economic development, the following 3 focus areas have been finally delimited:

- **Smart Mobility**

the most important area, which affects everyone who lives in or comes to the city, regardless of which mode of transport they choose.

- **Sustainable Energy**

beyond the reduction of energy consumption, this also means taking sustainability and the involvement of renewable energy sources into consideration.

- **Digital Debrecen**

digital literacy in the broad sense, not only for the residents, but also for businesses and providers of public services.



5 SMART CITY SITUATION ASSESSMENT

The joint Smart City survey prepared, on commission by **European Investment Bank (EIB)**, by the advisory department of **JASPERS** (Joint Assistance to Support Projects in European RegionS) and **PricewaterhouseCoopers (PwC)**, which focused on the **Visegrád countries**, was of particular significance for us.

This external, objective, all-encompassing Smart City survey and the direct comparison with other regions and cities was extremely useful in several ways. On the one hand, it helps us place Debrecen on the map of development in the region; and on the other hand, it validates the importance of the focus areas, and may shed light on the development opportunities inherent in less emphasised areas. The survey was unavoidable for the EIB, since in order to finance the implementation of the proper projects, it is necessary to get to know the individual Smart City areas and developments, as well as to survey the possibilities of regionally combining some potential projects.

Part of the complex survey prepared on **8 selected cities and regions of 4 countries** (Debrecen and Kaposvár in Hungary, Nitra and Prešov in Slovakia, Plzeň and the South Moravian Region in the Czechia, as well as the Bydgoszcz and Kujawsko-Pomorskie regions in Poland) consisted of reviewing the available strategic documents, conducting personal interviews with key players, as well as holding workshops⁹. Debrecen used this opportunity, as a result of which an international, unbiased,

comprehensive survey was prepared, in which **7 key areas** have been defined and examined, which are as follows:

- Integrated governance and design
- Information and communications technology (ICT)
- Mobility
- Energy and the environment
- Water and waste management
- Social infrastructure
- Integrated financing and implementation models

The maturity of each area was determined on a 4-level scale (basic, integrated, developing, advanced).



⁹ PwC Smart Cities Individual Report Debrecen, October 2018

Mobility has been identified as the **most developed** area. In this area, which is on the level of integrated operation, several projects have been realised that are outstanding also in international comparison, such as the **e-ticket**, first introduced in Hungarian public transportation in Debrecen, or joining the **data exchange** of the Connected Citizens Program of the navigation application **Waze**, as well as **smart pedestrian crossings**, which were also first used in Debrecen.

In terms of their developments, the **two other outstanding areas** are **integrated governance and planning**, and **the use of information and communication technologies**.

The creation of a dedicated unit to serve as the organisational background, **EDC Debrecen Smart City**, was also **highly appreciated**, and was unique among the cities participating in the survey. The specified focus areas are quite relevant, since each of them is necessary for the promotion of foreign investments, for keeping graduates and young workers in the city, and for economic development, and thereby for increasing municipal revenues, and they also respond to relevant challenges (increasing number of motor vehicles on the roads, CO₂ emissions and need for labour force).

An indispensable precondition for the spreading of Smart City solutions and the development of businesses is reliance on **modern ICT solutions**, for which the infrastructure in Debrecen provides a good foundation. The length of the **optical network** in 2018 exceeded 65km, **WiFi** coverage

in the city is considered good, and we have already established an open data portal called **Open Data Debrecen** (available at opendata.debrecen.hu), which may serve as the basis of strategically treated data management in the future.

There are also initiatives worth mentioning in the other areas examined, and as an aggregate result of the above, Debrecen was ranked among the best of the 8 cities covered in the survey of the European Investment Bank and PwC.

The vast majority of the possible developments proposed are well aligned with the plans of the city itself. According to the survey, the first step should be the creation of an approved **Smart City strategy**, which is the condition that the present document aims to satisfy. Much emphasis should be given to the **collection of data** and to strategic **planning based on that data**. A good foundation for this and also for future projects may be the creation of the proposed municipal control centre, and this is also the reason why data-driven decision making, as a horizontal element connecting all focus areas, also appears in the following chapters. There is significant potential inherent in **cross-border cooperation**, and the strengthening of international relations is deemed to be important also from the point of view of the diversification of financial resources. The fourth key proposal is the **ranking of projects on the basis of the financial return on investment** (projects that are revenue-generating or entail savings), which can provide further resources for projects that have a social return on investment.



6 THE OBJECTIVE TREE OF DEBRECEN SMART CITY

The focus areas of Debrecen are smart mobility, sustainable energy and digital Debrecen. As a horizontal element, bringing society on board concerning these areas, data-drive decision

making, and the establishment of international relations and cooperation opportunities appear. The objectives of the individual areas are presented on the objective tree below (Figure 1).

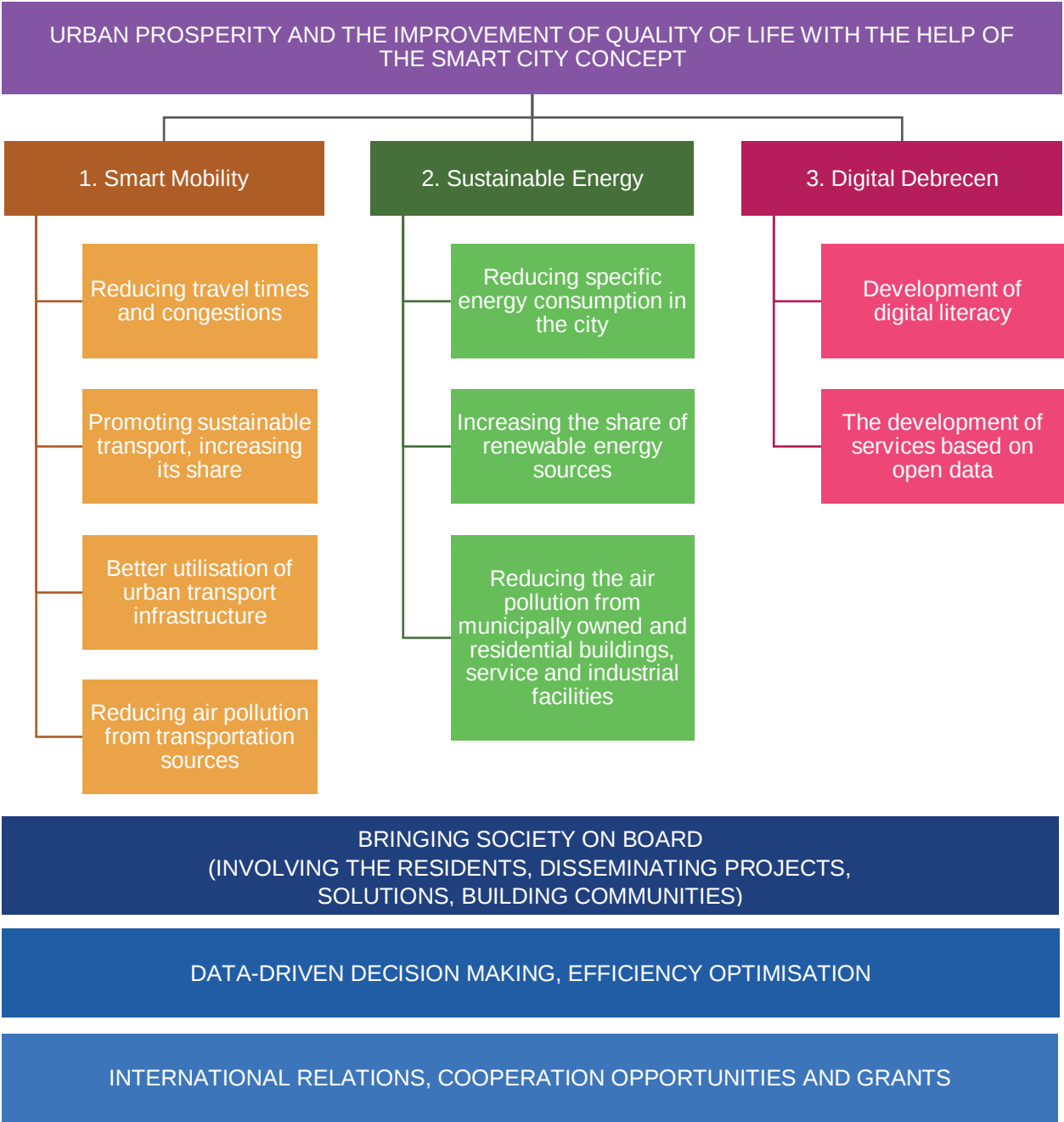


Figure 1: The hierarchy of the objectives of Debrecen Smart City

7 SMART MOBILITY

Smart mobility is the most important of the three focus areas, which stands out as a flagship. Many cities with a similar size to Debrecen struggle with traffic as their most acute problem. On the one hand, this is because all residents are affected by it, regardless of the means of transport they choose: public transport, some form of non-motorized transport or individual transport. On the other hand, the development of motorisation was unbroken over the past decades and will also continue to increase in the future. Some examples from abroad are quite dreadful: British motorists spend an average of 5.9 minutes searching for somewhere to park after each journey, adding up to almost four days per year. In bigger cities, the average length of time before one finds a parking space after each journey is even longer: it is nearly 8 minutes in London¹⁰, and may be as long as half an hour in Paris¹¹. The economic costs of the above is estimated to be tens of billions of euros.

In Debrecen, the road tax was paid after 55 thousand vehicles in 1999, while in 2018 that number increased to 97 thousand, which means a nearly 80% increase in the number of motor vehicles on the roads¹². Furthermore, this number does not even include commuter traffic from nearby communities as well as the transit traffic crossing the city; the weight of these is illustrated well by another indicator, which is the

daily number of vehicles passing through a certain section or road. One of the most important of these is the junction of Kossuth and Burgundia Streets with over 55 thousand motor vehicles crossing every day, but Figure 2 also clearly indicates that many other junctions also have to handle over 30 thousand motor vehicles per day.

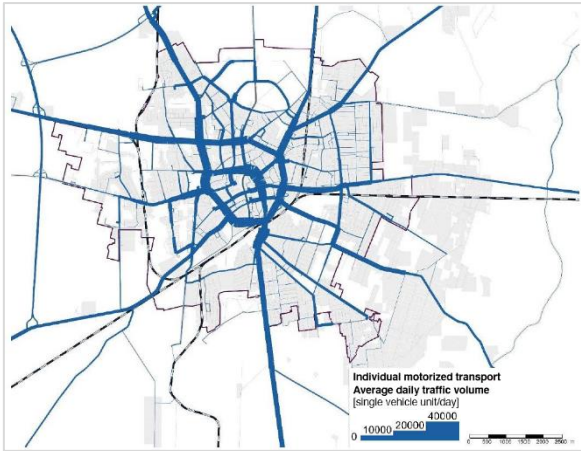


Figure 2: The average volumes of traffic on the public road network of the city
Source: The sustainable urban mobility plan (SUMP) of Debrecen

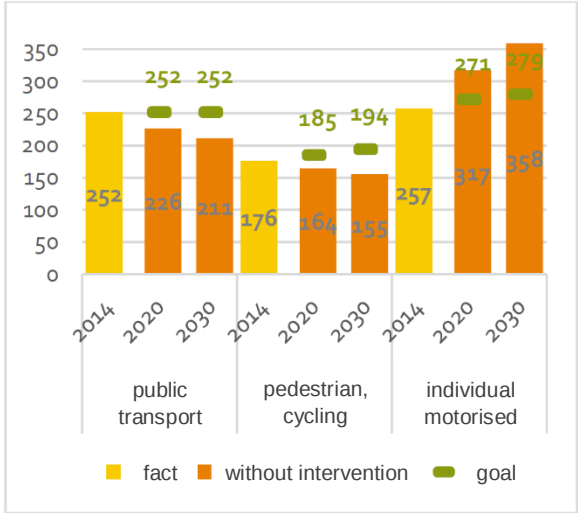
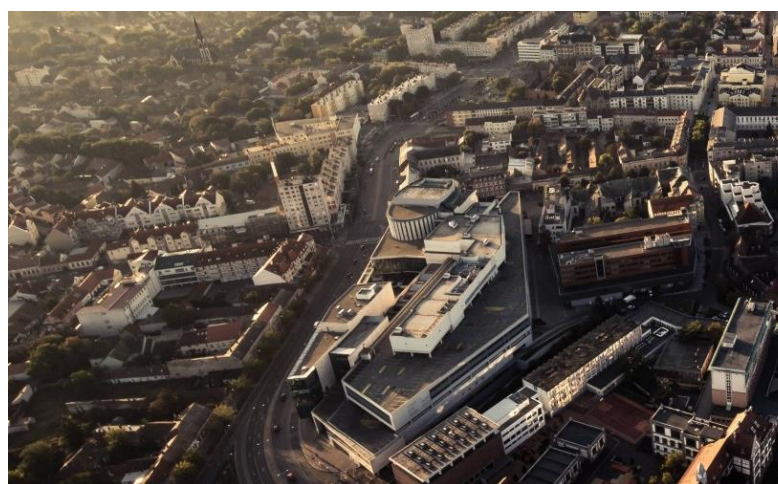


Figure 3: The evolution of the transport structure and the objectives (daily number of trips, in thousands)
Source: The sustainable urban mobility plan (SUMP) of Debrecen

¹⁰ Patrick Sawyer, Motorists spend four days a year looking for a parking space, 05.08.2019, <https://www.telegraph.co.uk/news/2017/02/01/motorists-spend-four-days-year-looking-parking-space/>
¹¹ Skema Ventures, Switch: Revolutionizing vehicle-parking in Paris, 05.08.2019, <https://skema.ventures/must-read/switch-revolutionizing-vehicle-parking-in-paris/>
¹² We are together, Debrecen. Presentation by László Papp, mayor, 05.08.2019, <http://www.dehir.hu/debrecen/papp-laszlo-debrecen-ujra-fellepett-a-tortenelem-foutcajara/2019/02/13/>

To support its mobility development efforts, Debrecen was among the first cities in Hungary to draw up its Sustainable Urban Mobility Plan (SUMP), from which we highlight some important data and findings:

- Debrecen is a regional centre with an extensive “catchment area”. The total population of the area within a radius of 40 km, from where the city can be reached with public transportation within an hour is 661 thousand.
- The number of daily commuters to Debrecen is 42 thousand, 84% of which (i.e. 35 thousand people) come from this area within 40 km.
- The majority of the commuters use public transportation, but nearly 10 thousand people also arrive by car.
- In Debrecen, the average number of cars per one thousand residents is 310, which is the third highest value in the country. In case of those who have a motor vehicle, this is the chosen means of transport by far in the highest proportion.
- The competitiveness of both local and regional public transport is weakening, the number of passengers is continually decreasing (in local public transport there were 125 million passengers in 2003, and only 100 million in 2010, while in regional bus transport in the 3 counties of north-eastern Hungary there were 79 million passengers in 2015 and 74 million in 2017¹³), and since the mileage numbers are unchanged, the specific cost of the service is becoming higher.
- The daily number of trips is approximately 685 thousand, which is expected to further increase in the future, and may reach 725 thousand in a little over ten years. Much more harmful than the absolute growth, however, is the shift in the modes of transport at the expense of sustainable modes, with a decrease in the share of public transport, as well as pedestrians and cyclists is expected (*Figure 3*). There are also economic processes behind this: on the one hand, higher-added-value jobs can provide better levels of income, resulting in more families being able to afford their own motor vehicles; on the other hand, the industrial parks and multinational companies, just as units of commercial chains attract the population from an increasing distance, all of which are factors reinforcing the role of individual motorized transport. Furthermore, the changes can also be traced to demographic processes: strong processes of suburbanization are at play, city-dwellers are becoming increasingly mobile and travel to larger distances, with suburban areas becoming higher appreciated.



¹³ Presentation by Bertalan Fukker ÉMKK and Attila Nagy DKV at the 11th Conference of the Hungarian Scientific Association for Transport (KTE), Debrecen, 26-28.04.2016, Presentation by Tibor Kocsis ÉMKK at the 13th Conference of the Hungarian Scientific Association for Transport (KTE), Debrecen, 30-31.05.2018

Motorisation and the strengthening individual transport poses an ever bigger challenge to the city, and in order to counterbalance these effects, Debrecen has already carried out a lot of developments. In the framework of the **New Phoenix Plan**, implemented between 2014 and 2020, the city will spend 15.7 billion HUF on mobility-related developments, not counting the national investments that are also realised in Debrecen. 2017 saw the start of the conversion of more than 50 traffic junctions in the city (the main components of the programme include converting some of the major streets in the city centre into one-way streets, the construction of roundabouts and new roads), as a result of which several longer “green waves” were programmed into the traffic lights, **increasing their throughput capacity of intersections by an average of 50%**, thereby accelerating traffic, shortening waiting times and resulting in more

transparent and safer urban traffic. Half of the planned conversions have been completed by the end of 2018 in accordance with the time schedule. The **sustainable urban mobility plan (SUMP)** of Debrecen contains more than 100 additional mobility development projects.

Thanks to the efforts in the field of economic development, the newly arrived companies and the increase of the city’s attractiveness, the population of the city may reach 250 thousands in the next few decades. This jump of scale will pose a set of new challenges for Debrecen, and it is therefore necessary to proactively focus on this area from which some, even internationally recognized and successful project have been removed, such as **e-tickets** introduced in public transportation, or the community-based traffic navigation application **Waze**, with which the city concluded a strategic partnership.



The aim of Debrecen is not only to satisfy the demands created by increasing motorisation, but to further improve the current quality and the travel experience. In order to achieve this, it is extremely important to address the introduction of **innovative and effective Smart City solutions**. In themselves, they are not a substitute for all mobility development interventions, but they are supplementing them, they can improve their efficiency immensely. For the measuring of the individual areas, the introduction of a new, hitherto unused monitoring system and performance indicators may be necessary – e.g. in case of installing a smart pedestrian crossing, the number of fatal accidents should not necessarily be the only indicator, but the difference in drivers' willingness to stop in case of pedestrian crossings equipped and not equipped with this system may be another one, for example. Generally speaking, in case of developments aligned with the objectives of the focus areas, it is necessary to examine, and as far as possible use, Smart City solutions as part of the optimisation. In the interest of effectiveness, the indicators should be defined in advance, and their impact tracked afterwards. Measuring and data-drive decision-making will appear in all areas in the future, and their earliest integration into the processes may be a competitive advantage.

In the area of smart mobility, **we defined 4 objectives**. The first and most important one is to **reduce travel times and congestion**, which is now a problem not only in big cities. One possible way of measuring this is by comparing travel times in peak hours to travel times without traffic,

with the former being an average of twice as long as the time normally necessary.

The second objective is that, due to the expected increase in traffic, it is very important to promote **sustainable mobility and increasing the share of sustainable means of transport**. Thanks to their capacity, vehicles used in public transportation are much more efficient than individual motor vehicles, and they pose less burdens on the environment and the infrastructure. In addition to their zero environmental loads and minimal infrastructural needs, active modes of mobility also have beneficial health effects. Due to the above, in order to maintain liveability in the city, increasing the share of sustainable modes of mobility is indispensable. The prognosis of Sustainable Urban Mobility Plan warns about the necessity of the interventions – Figure 3 shows that the number of trips using sustainable means of transport may otherwise decrease by 13-18% by the end of the next decade, while the total number of passengers increasing, resulting in a further opening of the gap in terms of the proportions.

The third objective is **the better and more efficient utilisation of the existing urban mobility infrastructure**, since the extensions of the systems often have physical, resource and liveability-related limitations, and may not be expedient as long as optimisation can help avoid the need for such extensions.

The fourth objective is **the improvement of air quality**, as a factor strongly affecting liveability, since nearly one-third of all CO₂ emissions come from transport.



7① REDUCING TRAVEL TIMES AND CONGESTIONS

The first and most important objective is to **reducing travel times and congestions**, which cause a lot of damage. The time spent with unnecessary waiting on the road has a negative impact on the economy, on air pollution, and quality of life. This harmful effect may further intensify if the number of cars continues to increase. All small and medium-sized European cities struggle with the challenges posed by the development of motorisation: on the basis of the congestion index of TomTom navigation, for example, during the afternoon rush hours, **travel times increase by 30-50%** in many cities of similar size (32%-34% in Gent, 41-41% in Brno, 44%-45% in Graz¹⁴) **in comparison with travel times outside of the rush hours**. In Hungary, this figure is only available for Budapest (41-46%), but on the basis of the vision for the future drawn up in the previous chapter, it can be rightfully assumed that a similar problem will arise also in Debrecen, since the duration of the congestions continues to increase and affects an ever bigger large area. Therefore, the aim is to maintain and to improve the current level, the assessment of which is necessary.

I. THE CURRENT SITUATION

Motorisation and the ever intensifying individual transport makes the city more and more congested. In Debrecen, **the average number of cars per one thousand residents is 310**, which is the third highest value in the country, but in the suburban areas, this value is even higher than

550¹⁵. On weekdays, the duration and the territorial distribution of peak-time congestions is increasing, and it may reach half an hour in the morning (06:45 to 8:15) and also in the afternoon (3:30 to 5:00) rush hours. In comparison with other major Hungarian cities, such as Szeged, Pécs or Miskolc, the roles of passenger cars is more marked in Debrecen. It is particularly high among the active adult segment of the population: **41% of those in the age group between 26 and 65 travel by car¹⁶**. Similarly to other cities of similar size, parking in the city centre causes increasing problems, which also disturbs, in addition to those using individual transportation, also the pedestrians and the residents and increases air pollution. Surface parking spaces and parking garages alike are overcrowded during the day, with free spaces mostly available outside working hours and on weekends. Parking zones and the average revenues from a single parking space are shown in Figure 4.

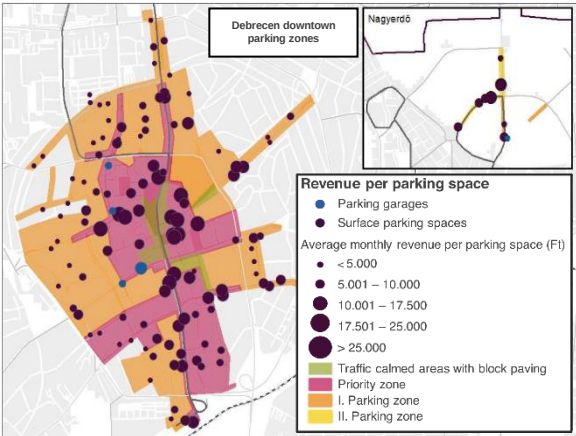


Figure 4: Territorial differences in the revenues from a single parking space
Source: The sustainable urban mobility plan (SUMP) of Debrecen

¹⁴ TomTom Traffic Index, 05.08.2019, https://www.tomtom.com/en_gb/trafficindex/

¹⁵⁻¹⁶ The current transport situation of Debrecen and its catchment area, Sustainable Urban Mobility Plan (SUMP)

Further gaining of ground by motorisation and those **choosing to drive** can be expected; according to the forecasts, the number of trips **may increase by 40%, from 257 thousand to 358 thousand** by the end of the next decade (*Figure 3*). Therefore, the planned interventions may only mitigate this effect and slow the pace of growth, which is catalysed by economic development and the growth of the city. This is a huge challenge for cities of similar size, including Debrecen, as developments need to be carried out in the field of individual transport and people must be motivated towards other means of transport.

The smart solutions introduced between 2015 and 2018

Thanks to joining **Connected Citizens**, the 2-way, free data exchange programme of **Waze**, the world's largest, community-based navigation application, **real-time traffic data** are available for every day from the summer of 2017 for the entire area of Debrecen. The other direction of the data flows, i.e. **the introduction to the map of Waze of proposed changes affecting traffic** (restrictions due to events, changes in traffic order, etc.) has also started, in order to ensure that users can navigate with the help of a map on which everything is up to date, and is fully in line with the current traffic order. The consistent promotion and spreading of information on the application itself can **contribute to the spreading out of heavy traffic, thereby reducing congestion** and travel times. After the cooperation was started, the city has invested heavily into spreading information about the application, and in 2018, the city of Debrecen has

received a City Marketing Diamond Prize for the education campaign of Waze.



Traffic lights operate in the most important junctions in Debrecen, at nearly 120 locations, about half of which are operated by the municipality, and other half, specifically those along the main roads with 1 or 2 digits in their numbers that go through the city by the Hungarian Traffic Authority (Magyar Közút). The IT background of the two systems are different, and as a result, their aligned operation is not currently solved. All traffic lights run with several, typically 3 different fixed programmes, which change depending the time of the day. These provide proper throughput in the main directions, but they hold back the traffic coming from the secondary streets for a long time. Public transport is accelerated by way of the method of giving buses a priority, with supplementary green lights, in case of junctions with traffic lights and bus lanes. The technical conditions necessary for giving further priority to vehicles of public transportation vehicles are given on the part of the buses, but with the exception of two junctions

and a part of tram line no. 2, the traffic light systems are not able to handle this as yet. Overall, there is still room for development in the system, primarily by way of adjusting the programmes and period times to the current, real-time traffic in a dynamic way.

The junctions maintained by the municipal government and those by the Hungarian Traffic Authority include some in which various **sensors** have been installed, e.g. inductive loop detectors or radars, but the throughput of these junctions is not traffic-dependent even in the places where it would be justified. A characteristic feature in Debrecen is the use of supplementary **countdown indicators** installed next to the traffic lights, which help drivers prepare for changes in the cycle, so that they can start earlier, thereby increasing the throughput of the junctions.

II. OBJECTIVE

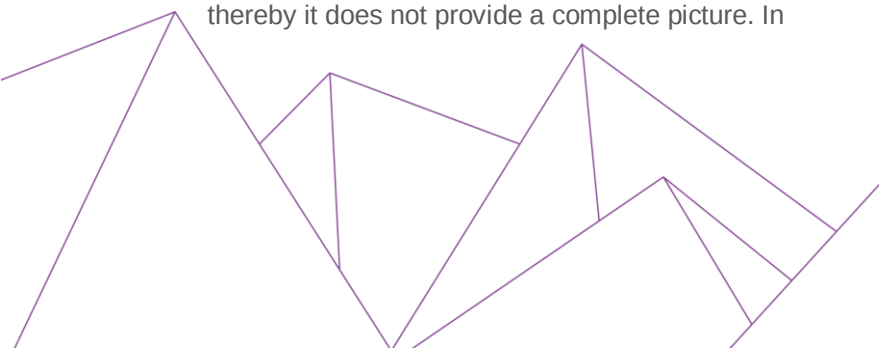
In its sustainable urban mobility plan, Debrecen projects a smaller, **8% increase in individual motorised traffic, from 257 thousand to 279 thousand daily trips** (as opposed to the prognosis of 358 thousand without the intervention, *Figure 3*).

The decreasing of the use of the motor vehicles definitely has a favourable effect on reducing congestions, and thereby also travel times. The planning of the directed traffic takes place with the help of a computer simulation, and the most accepted method of measuring its efficiency is by way of the capacity and throughput of the junctions. Such measuring, however, is quite cumbersome, requires considerable human resources, and is done only occasionally, and thereby it does not provide a complete picture. In

case of many congested sections it is still difficult to calculate from these the travel times, since the throughput has a maximum level, and in the course of the measurements it does not transpire how long an individual vehicle was waiting. Therefore, it is necessary to collect the data from as wide a basis as possible, as well as to establish an urban and traffic control centre, until which time some guidance may be provided by the database generated from Waze data.

III. PROGRAMMES TO BE REALISED

This sub-chapter will introduce, without claiming to be complete, some possible programmes that may have an outstanding effect on achieving the objectives. At the same time, it is necessary to mention that, especially in the area of Smart City and ICT tools, the direction and extent of development is difficult to forecast, and solutions not yet known today may emerge in the medium term.



The development of traffic control

Part of the proposed **Urban Control System** would be a **smart traffic control system**, for the exploitation of the full potential of which it is necessary to **collect traffic data** from as wide a range of sources as possible, as well as to provide for the **possibility of intervening**. One pillar of the database of traffic data could be the real-time Waze data stream (as well as data from other mobile applications and navigation software) in which there is already great potential at present.

- From the data of Waze, the congestions may be analysed, and the direct effects of interventions at an individual junction can be evaluated. Waze collects and publishes the best implementations by partners who have joined the Connected Citizens Programme, and on the basis of these as well as relying on the data, various solutions may be tested. There are also good examples from Hungary, for example, the expressway to Liszt Ferenc International Airport in Budapest, where the data of Waze show that with the reduction of the speed limit the actual travelling speed did not decrease, but the number of accidents reported did drop by more than a third¹⁷.
- In other words, in addition to congestions, the sites of accidents can also be tracked, and if necessary, traffic flows can be improved by increasing or decreasing the speed limits. Accident reports submitted via Waze now serve as the primary source of information for dispatchers in several states of the USA, ahead of calls to emergency services, which arrive, in

the majority of cases, only several minutes later and often with inaccurate locations provided by callers.

- The reports also reveal where potholes disturbing the majority of drivers are located, as a result, road repair works can be optimised, and the examination of the effect of the work performs also becomes simpler.

The larger number of users also has a beneficial effect on the urban database, as a result of which better established and more detailed mobility development proposals, based on actual data, can be drawn up, and therefore, popularising campaigns, like the one in 2017, would be expedient also in the future. In addition, there are several solutions providing simple modes of support, such as adding a main message or logo to mobility-related articles and reports on events appearing in the communication channels of the city.

Another important source of the data is the gradually increasing **network of smart cameras**, the first of which are being installed during 2019. The current sources are sufficient for approximately 20% of the sites in the camera concept drawn up in 2016, and therefore, it is definitely necessary to identify additional possibilities for extending the system. In addition to **spatial surveillance** functions (facial identification, detection of aggression, crowd, intrusion, etc.), the smart camera network can also be prepared for **traffic monitoring** (license plate recognition, determination of vehicle type, checking the validity of the roadworthiness test, payment of road tax, etc.). With these data, as

¹⁷ Waze Hungary Group, Accidents on the expressway, 05.08.2019, <https://www.waze.hu/2017/balesetek-gyorsforgalmi/>

well with data from other devices (sensors, as well as devices measuring other modes of transport, e.g. bicycle counters), the expected volume of traffic can be determined. For **dynamic traffic light programmes** adjusted to the rhythm of the traffic, it is necessary to ensure that all junctions equipped with traffic lights can be **reached from the distance** and **programmed** in the system (solar-powered smart traffic lights), and in the interest of flexibility, and that the duration of the green light at junctions can be extended or shortened within the period, as a function of the current traffic in the different branches.

In the area of **traffic organisation**, it is of key importance that the various modes of transportation should not compete with each other and run parallel, each at a lower level of utilisation, but that **in accordance with the real traffic situations based on measured data, the most effective solutions, with the best utilisation and the highest cost-efficiency**, should be brought to the foreground. After the availability of an ever increasing dataset and with the development of motorisation and the increasing regional role of Debrecen, the significance of joint traffic organisation will increase, the organisational background and the resources for which need to be provided.

With “decentres” to be established on the edge of the city for local and regional public transport, bus traffic in the city can be significantly reduced, since the inner parts of the city could only be reached by way of local lines of public transport. With the establishment of P+R parking lots in the vicinity of the decentres, individual motorised traffic in the city can be further reduced. The

unification of the local and the regional public transportation tariff systems is indispensable in order to allow for transfers at the decentres.

Debrecen has been traditionally strong in the area of electromobility in public transport, and as a system whose energy consumption is linked to a schedule, the regulating algorithm requires important real-time data for **operating the electric network in a Smart Grid**, which can also be provided by the **intelligent traffic control system**.

One broader aspect that is necessary to mention is that with solutions of **urbanistics, city planning and urban organisation**, the conscious planning and creation of urban sub-centres (services and retail outlets), as well as with the development of various urban services (e.g. e-administration), the **lengths of the trips could be shortened**, which would have an impact on the mobility needs, and the individual and pedestrian modes of traffic would come more to the foreground. The emergence of congestion could be prevented if the employers in industrial parks would schedule shift changes not at the same time, if schools would start teaching at a later hour, if more employers allowed working from home, and if it was not necessary to personally appear for the use of various services, which can also be carried out electronically, from a distance. The assessment of the options, the creation of the strategy, the drawing up of the action plan, and the monitoring of the impacts are all indispensable.



The development of pedestrian traffic

Thanks to IoT devices and smart phones, a solution has now been found to the **monitoring of pedestrian traffic** as well. By way of observing various routes, customs and the counting of pedestrian traffic, sufficient data and information may be available on the basis of which **the traffic order can be further optimised**, and priority may be given to passengers at crossings with large traffic. Active means of mobility should be supported not only because own energy is used, but also because, as the examples from many cities show, giving them priority reduces congestion; in other words, with pedestrian- and bicycle-friendly measures, public transport and the general traffic of motor vehicles can also become faster. The FLOW project, financed by the Horizon 2020 programme, was established for the purpose of researching, quantifying, proving and transposing into practice these findings, the aim of which is to contribute to a change of perceptions, thanks to which walking and bicycling can be put on the same level with motorised means of transport, in order to reduce urban congestions¹⁸. The counting of pedestrians can be used not only for controlling traffic, but it also **becomes possible to quantify the expected turnover** of municipally owned stores, and as a result their renting out or the determination of rent becomes simpler. In a given case, the devices can also be combined, e.g. when smart pedestrian crossings are installed, **pedestrian counting and air quality monitoring** can also be implemented.



The development of cyclist traffic

It is expedient to install further bicycle counters along busier bicycle roads, with the **data recorded** and also **available from a distance** by way of a data link. Supplementing the above, if there are possibilities in the future for other smart solutions, e.g. **telephone-based applications** with which an image may be obtained by way of sampling for the whole of Debrecen, these data could be connected and also **made publicly available**. By way of sharing data, new services can be created, or in possession of the information, grocery stores, shops, municipal government offices, buildings with public services, schools, doctor's offices could decide on the installation of bicycle storage facilities, if it can be clearly seen that they are located along a road with busy bicycle traffic. The same applies to infrastructure elements already realised with which the community or the market can develop routing and other practical applications (maps for bicycle storage facilities, pumps, service stations, stores selling accessories, etc.) or integrate such

¹⁸ Furthering Less Congestion by Creating Opportunities for More Walking and Cycling (FLOW), 05.08.2019, <http://h2020-flow.eu>

information into existing maps (e.g. Google Maps).

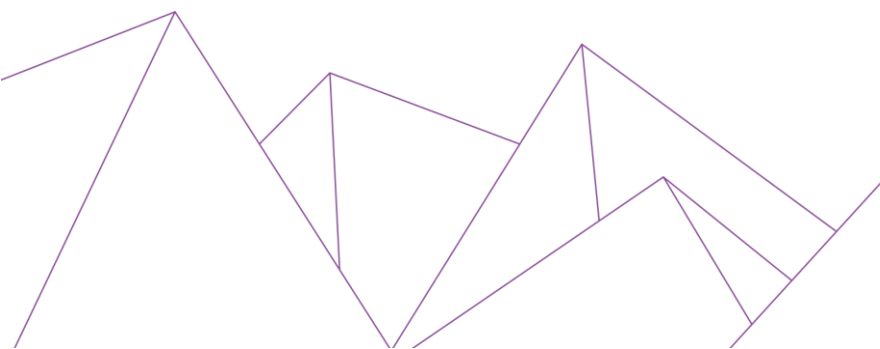
Awareness-raising

Part of the programmes to be implemented is the **awareness-raising activity**, which can be linked to all areas. Of course, a significant impact on congestions is the number of people in traffic at the same time, and therefore, it is quite important – and not only from a sustainability point of view – **what mode of traffic people choose**. This is illustrated most authentically perhaps by the photograph below, which shows the demand of 60 persons for urban space if they use a bus, bicycles or cars (each of them using a separate vehicle).



Source: Human Transit, 05.08.2019,
<https://humantransit.org/2012/09/the-photo-that-explains-almost-everything.html>

On the individual level, city-dwellers can do the most against congestion if they do not generate it. Raising everyone’s awareness concerning this issue is definitely necessary: any alternative mode of transport they use for their travel – even only partly or wholly – instead of cars, is a huge step in the direction of eliminating congestions. Naturally, for the above it is indispensable to develop other modes of transport, as well as giving them advantages and making them more attractive infrastructurally and in traffic organisation as well.



⑦② PROMOTING SUSTAINABLE MOBILITY AND INCREASING THE SHARE OF SUSTAINABLE MODES OF TRANSPORT

Promoting sustainable mobility and increasing the share of sustainable modes of transport is also an objective of key importance. This objective focuses on the infrastructural developments of public transport and non-motorised transport (pedestrians and bicycles), as well as awareness-raising. The advent of sustainable modes has a beneficial effect on the city's liveability, air quality, the better utilisation of its infrastructure, the health of its citizens, and therefore, it is definitely worth supporting these.

PUBLIC TRANSPORT

I. THE CURRENT SITUATION

In terms of trips within the city, public transport has a 35% share, making it the most popular mode of transport. For the purposes of local transport, buses of EURO-5 classification, put to use in 2009 are currently used. While in the regional traffic only a quarter of the vehicles are of favourable emission classification, in national comparison, the public transport fleet of Debrecen can be considered quite modern. The running of the local public service operated by DKV Zrt. costs approximately 8-9 billion HUF per year, only a part of which is covered by the fares paid by the passengers. The annual number of passengers decreased from over 150 million to 100 million, i.e. by more than a third, between 2003 and 2010¹⁹, after which it stabilised from

2010, and it actually increased slightly in 2018 to 101 million, but it is an unfavourable tendency that the number of people regularly travelling and purchasing a pass nevertheless decreased, owing to several factors, by 7.5% between 2010 and 2016²⁰. Stopping the decreasing of passenger numbers is of key importance in terms of both sustainability and operational efficiency; therefore, the local transport company uses several smart solutions to make the service more attractive, in line with the expectations of the 21st century, and accessible for more people.

The smart solutions introduced between 2015 and 2018

Such smart solutions include, for example, the 10 **ticket-issuing machines** put into service in 2015 along the line tram line no. 2, which can be used in 8 languages, and which allow payment, in addition to cash, also with bank cards, including contactless payment (PayPass). This is a good example for the effort to extend the scope of customers, since these vending machines operating in multiple languages are very popular among foreign students and tourists. From the spring of 2017, free **WiFi service** was started on all trams and on 2 trolley buses. A **real-time passenger information system** was also realised on the whole length of both tram lines.

¹⁹ The role of DKV Zrt. in transport in the city of Debrecen, 11th Conference of the Hungarian Scientific Association for Transport (KTE): The current questions of regional transport

²⁰ DKV Zrt.



Along tram line no. 2, as well as in the stops close to the junctions in dedicated bus lanes in the city centre, **vehicles of public transport are able to check in**, and thus receive a green light at the traffic lights, so that they can run on schedule more accurately. On the most popular online

map, in the route planning application **Google Maps**, public transport is available as an option from the second half of 2017, relying on static timetable information, which is great help to both frequent and occasional passengers. In October 2017, **electronic tickets and passes** can be purchased and linked to the new types of national identity cards and student IDs. These tickets and passes can also be **purchased online**, with a bank card, from December 2017, on the website of DKV.

II. OBJECTIVE

With developments and Smart City programmes, **the objective** is the achievement again and the maintenance of the level of 2014, as also formulated in the Sustainable Urban Mobility Plan, i.e. **252 thousand trips per day**.

The number of trips by public transport within Debrecen and crossing the boundaries of the city was 252 thousand in 2014; however, by 2020, this number is expected to decrease by 10% to 226 thousand, and then by 2030 further down to 210 thousand²¹. With the increase in the number of motor vehicles, without active interventions, this decrease cannot be stopped, and in addition to the effects on traffic, the trend will also continue to increase the specific operating costs.

III. PROGRAMMES TO BE REALISED

Already in 2010, the New Széchenyi Plan set as an objective the introduction of interoperable electronic identification, the scope of which would have been extended beyond local transport to regional bus and train tickets as well. If interoperability and the settlement of accounts

²¹ Promoting public transport, increasing its overall share, Sustainable Urban Mobility Plan (SUMP)

between local and regional transportation companies is solved, their vehicles could be used within the city by those having passes for either of them, routes could be optimised, superfluous kilometres and costs could be eliminated, and overall higher quality services would be provided for the passengers. This is a key question from the point of view of the operation of the public transportation, since data on the levels of authorisation of users, the products purchased by them, as well as the length of their trips also becomes available. For the completion of the infrastructure necessary for controlling the electronic tickets and passes introduced in Debrecen, as well as in the interest of obtaining accurate travel information, it is **indispensable to install validators (electronic ticket inspection devices) in every vehicle**. Currently, in local transport, it is only possible to purchase electronic passes for a whole day or longer, while **single-trip tickets are still paper-based, but their replacement would be necessary**, a precondition of which is also the existence of the validators. With a decrease in the number of paper-based tickets purchased from the driver, the length of time buses spend in the stops will also become shorter, and therefore, it will be easier to adhere to the timetable. The official mobile phone **application** of DKV can be currently used for route planning, but this is a platform that could be extended with a **ticket purchasing option** as well. Even though the travelling public is price sensitive, but they expect the convenience experienced in other areas of life, and it is important that the service can be purchased anytime and anywhere, which would

have a favourable impact on the number of passengers.

In the short term, **real-time timetable information should be made available for online platforms** that are the most frequent services used by foreign visitors and tourists for route planning. On the basis of foreign good practices, it would be useful to **provide open access to real-time data** on timetable-related information, **on the basis of which further services and applications can then be developed**. Digitalisation determines the everyday life of an increasingly large part of the travelling public, and they expect 21st-century services; however, we should not forget about those who do not use smart phones either, and therefore it is necessary to **install dynamic digital passenger information displays at stops of larger volumes of traffic** (especially where different modes of transport are interconnected).

When **traffic light systems** in junctions are modernised, the principle of giving **priority to public transport** should be kept in mind, which can significantly reduce travel times and thereby make public transport more attractive.

At busy transfer locations (e.g. terminals, sports hall, industrial parks), it is expedient to install **smart stops** which, in addition to providing information, also improve the passengers' sense of comfort; in addition, the construction of **P+R** (park and ride, i.e. parking lots for passenger cars) and **B+R** (bike and ride, i.e. high-capacity bicycle storage facilities) **parking lots should also be built**, thus helping to improve the



accessibility of public transport and promote its use.

PEDESTRIAN TRAFFIC

I. THE CURRENT SITUATION

The network of pedestrian pavements is well developed in the incorporated area of Debrecen, and the city centre has an extensive pedestrianised zone. This is where the demand for services for pedestrians is also the most concentrated, as the local, business and tourism-related traffic are all high. In the previous decades, motor vehicular traffic enjoyed a priority, and the level of transit traffic is high to this day. A frequent source of irritation is the fixed-time traffic lights, changing during the day, where the length of green light for pedestrians needs to be reviewed. Apart from the city centre, busy areas also include the transit points of public transportation, as well as the areas of the University of Debrecen and the University Clinics. Further away from the city centre, mainly in housing estates, areas with traffic calming measures have also been designated (residential-resting zone, limited speed zone, Figure 5).

Thanks to the fact that walking is beneficial for one’s health and also a cost-effective way of transport, ever larger areas of space are returned to passenger traffic in cities around the world. Twenty minutes of walking every day may extent life by up to 7 years, reduce the risk of cardiovascular diseases, strokes by 35%, the risk of Type 2 diabetes by 50%, the emergence of certain types of cancer by 20-50%, the onset of

Alzheimer’s disease by 45%. In addition to mental welfare, it also has a beneficial effect on the environment²². Accordingly, using EU funding, the Municipality of Debrecen continues to extend the pedestrianised zones. The encouragement of walking helps improve the share of sustainable modes of transport, and also has a beneficial effect on air quality.

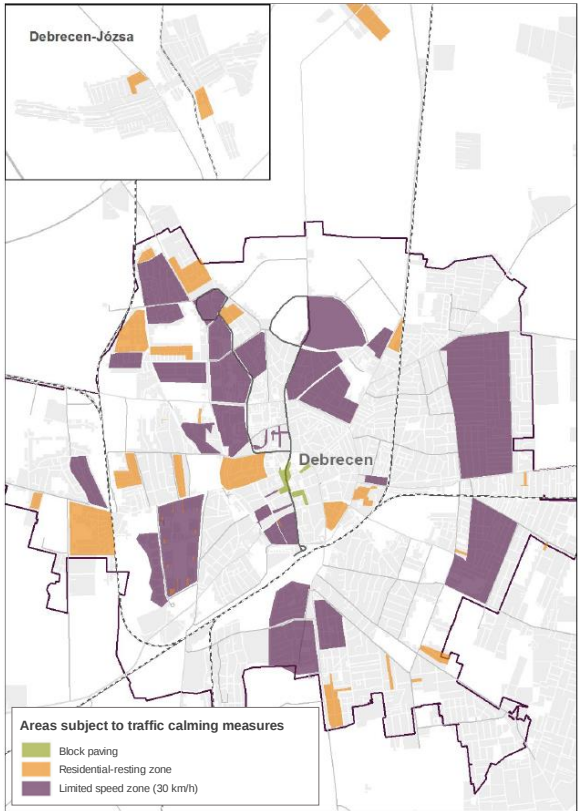


Figure 5: Areas subject to traffic calming measures in Debrecen
Source: The sustainable urban mobility plan (SUMP) of Debrecen

The smart solutions introduced between 2015 and 2018

In October 2016, Debrecen was the first settlement in Hungary which in introduced a smart solution in order to ensure the safety of pedestrians, the so-called **smart pedestrian**

²² Supporting and Encouraging Walking in SUMP. Presentation by Bronwen Thornton, 6th European Conference on SUMPs, 17.06.2019

crossing. After the very positive reception of this **active safety technology solution** and its appearance in the national and international media, it was installed in several other locations as well.



II. OBJECTIVE

Similarly to public transport, the share of non-motorised (pedestrian and bicycle) traffic within all trips completed has been continuously decreasing due to the increase of the number of motor vehicles in the city. Based on international trends, however, reversing this trend and achieving a 10% increase, from 176 thousand to 194 thousand daily thousand trips from 2014 to 2030, would be a realistic objective.

III. PROGRAMMES TO BE REALISED

In order to increase the share of pedestrian traffic the development of three areas would be necessary. First, **the infrastructural conditions need to be provided, a pedestrian-friendly environment created by way of pedestrianized zones and landscaping.** In case of all developments, **accessibility** (e.g. dropped kerbs

at crossings to facilitate bicycle traffic, as well as other, alternative means of transport, such as scooters, rollerblades, etc.) **and security** must be ensured, and the improvement of public safety is also a fundamental expectation. For the purposes of **awareness raising**, it is important to emphasise the advantages of physical exercise and active lifestyle, including its role in preventive health, and walking can also be made more attractive by way of smart solutions, e.g. pedestrian streets where the public can encounter **smart solutions**, such as smart benches, smart mobile phone charging stations, etc. There may be solutions with an impact on several areas at the same time, such as the smart pedestrian crossings, which is a smart solution enhancing safety and raising awareness at the same time. For this latter potential development, there are approximately 250 pedestrian crossings in the city without traffic lights, where the installation of additional smart pedestrian crossings is recommended. Due to the infrastructural needs of smart pedestrian crossings, their installation may also be combined with other developments, such as the installation of measuring devices (traffic, noise, air quality, etc.).

BICYCLE TRAFFIC

I. THE CURRENT SITUATION

An important element of urban traffic bicycle traffic. Generally speaking we can say that the gross time needed for making a trip of less than 5 km is shorter if using a bicycle than in case of driving. From the point of view of the utilisation of the infrastructure, it is also important that, in an average urban environment, where 2 thousand

cars per hour can pass through the cross-section of a road, the equivalent number of bicycles is 14 thousand. The local conditions are fundamentally favourable for bicycle-based mobility; in fact, Debrecen is among the best situated in this respect among larger cities: there are no significant elevation differences (like in Pécs), no river that divides the city into two parts (like in Szeged), the city is symmetrical in its structure, there are no protrusions in opposite directions (like in Miskolc), as a result of which the city centre can be reached by bicycle from most parts of the city within 15-20 minutes. The bicycle infrastructure of the city has evolved much in the past few years: the total, interconnected length of designated bicycle roads and lanes is **over 80 km**, and further developments are also planned: as a result of the **New Phoenix Plan**, the total length of the network will exceed 100 km (Figure 6).

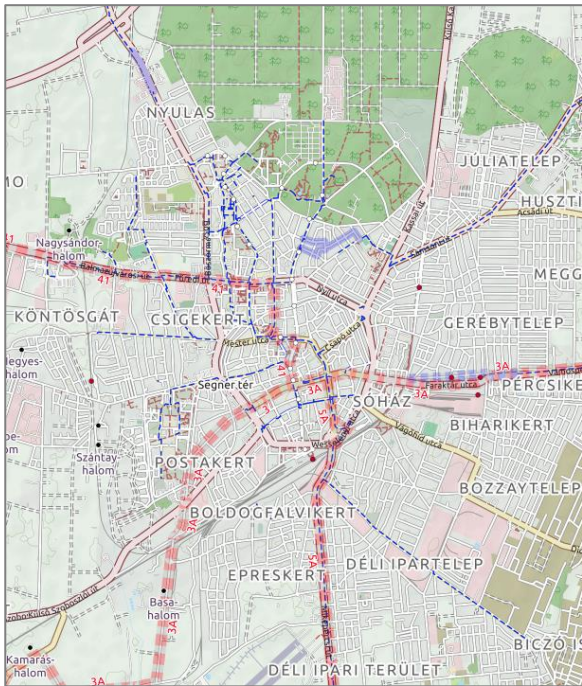


Figure 6: Bicycle roads in Debrecen (marked in blue)
Source: openstreetmap.org, 05.08.2019

The number of bicycle storage facilities is also gradually increasing: modern, U-shaped or P-shaped racks allowing the securing of the frames of bicycles are increasingly widespread, and today there are more than **2 thousand bicycle** storage places in **240 locations** across the city, although most of them still without a roof. In addition to the further extension of the network, it is also important to create links with the neighbouring settlements, which are still missing, and which may be in higher demand in the future with the spread of electric bikes and scooters. Problems posed are the often physically unseparated pedestrian and bicycle lanes, which account for more than half of the entire length, and this is also the main source of conflicts. Further, in many cases, this sustainable mode of mobility is subordinated to other means of transport (e.g. in terms of the programming of the traffic lights, prohibition by the Highway Code for cyclists to enter one-way streets from both ends, joint bus-bicycle lanes due to lack of space, etc.), or the needs of cyclists are not handled in any way (e.g. the first two sections of the western inner ring road), which are also obstacles of the further spread of bicycle traffic. It is a welcome development, however, that some big companies now separately promote commuting to work by bicycle, and in the spirit of **awareness-raising**, Debrecen has been participating in the **European Mobility Week** and in the **Car Free Day** events since 2011. In the light of the above we can conclude that many developments have occurred in the past several years, but there is still much room for development in Debrecen.

The smart solutions introduced between 2015 and 2018

In 2016, the **UniBike bicycle sharing service** was launched at four campuses of the University of Debrecen, with a fleet of 90 bicycles and as many as 7 stations across the city, which may be used by citizens of the university only. At the same time, in the majority of bicycle-friendly cities in Europe, bicycle sharing services accessible to the public have been introduced, which are important not only because of the increasing number of tourists, but are also indispensable as an urban marketing and awareness-raising tool, and is therefore important for Debrecen as well.

This is because, without **awareness-raising**, it is much more difficult to increase the share of bicycle transport, and also conversely, when supplementing with “soft” elements, the efficiency of the infrastructural developments increases manifold. It is partly this purpose that the **bicycle counter** installed in front of the Truncated Church in the summer of 2018 also serves, the significance of which is also higher because of the **data** gathered.

II. OBJECTIVE

On the basis of the census figures from 2011, as well as the survey of households in Debrecen, **the share of bicycle traffic** in Debrecen is around **7-8%**. Even though this proportion is over 10% in certain parts of the city, especially in the suburbs and on the outskirts, but it is still behind the comparable figures of Miskolc or Szeged (15-16%), despite the fact that the geographical conditions are much better in Debrecen, and the

city centre is rarely more than 5 km away from the outskirts. In September 2018, the Hungarian Bicycle Club conducted a representative survey, with the support of the Ministry of Innovation and Technology which found that the proportion of people using bicycles as their primary means of transport was 30%; therefore, **reaching 20-25% in Debrecen** by the end of the next decade is a realistic objective.

III. PROGRAMMES TO BE REALISED

The **further development of the infrastructure is necessary**, in particular the connections through junctions, as well as the creation of the **trunk network** of bicycle traffic in areas not yet connected to the rest of the bicycle roads. According to the survey of the ECF (European Cyclists’ Federation), weather and terrain are only the tenth reason why people do not choose to ride their bicycles; the most important reasons include the traffic culture, the sense of risk, the design and condition of the roads, for which a proper infrastructure would provide a solution²³.

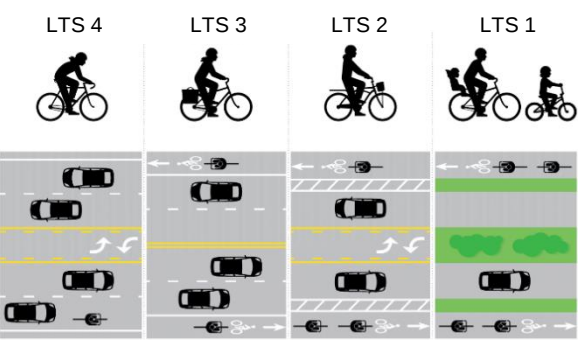


Figure 7: Level of Traffic Stress, 05.08.2019, <https://blog.altaplanning.com/level-of-traffic-stress-what-it-means-for-building-better-bike-networks-c4af9800b4ee>

The Mineta Transportation Institute established 4 levels of stress bicyclists are exposed to (Level of

²³ Practitioner briefing: Cycling. Presentation by Fabian Küster, 6th European Conference on SUMPs, 18.06.2019

Traffic Stress, LTS²⁴), where level 1 means the most comfortable and safest mode, which can also be used by children (an example being a physically separated bicycle road), while level 4 means sharing the same traffic lane that motor vehicles use (Figure 7). The survey conducted by the city of Portland, which is also supported by the findings of research conducted in several other cities, 60% of all citizens would be interested in using a bicycle for mobility and would consider this option if the proper infrastructure was available (Figure 8).

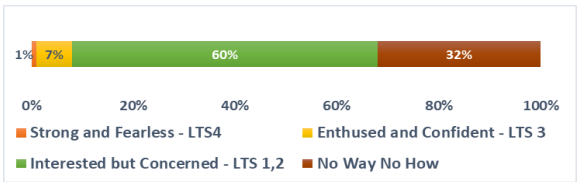


Figure 8: Portland (Oregon, USA) Survey about willingness to cycle: 60% interested in case of suitable conditions, 05.08.2019, <https://www.portlandoregon.gov/transportation/article/158497>

According to the ECF, this would mean roads of LTS 1 or LTS 2, where the bicycle road is either separated from motor vehicle traffic physically, or at least with road signs and a proper distance. Solutions with LTS 3 level – unprotected bicycle lanes – are alternatives for enthusiastic and self-confident cyclists, who only account for 7%, while LTS 4, which means sharing the same lane with motor vehicles, would only suit the needs of 1%. Infrastructure also includes **bicycle storage facilities** (primarily at the railway station and the bus terminal, which could also be suitable for long-term storage or supplemented with smart bicycle storage units, which simplify and accelerate the locking and the issuance of bicycle, also at busy areas in the city centre, at

large institutions and along public roads). Their importance is also shown in the ECF survey, which mentions these as the 5th most important reason, right behind reasons related to the road network. These storage facilities could be racks, covered bicycle storage stations, lockable enclosures, or even guarded parking areas. The current infrastructure has a radial structure starting from the city centre, and it covers mainly the north-western part of the city, but coverage in the other parts of the city, as well as the interconnecting roads is deficient. With the installation of additional **bicycle counters**, primarily on sections arriving to the city centre, as well as along roads coming to the city and in neighbourhoods of importance for tourism, the real-time collection and analysis of data may be started. Solutions similar to smart pedestrian crossings – warning lights at dangerous crossings, the installation of active, solar-powered prisms on road sections with low visibility – all contribute to the enhancing of security and increase commitment toward cycling, and therefore, it is worth using such measures even in the form of pilot projects.

It is increasingly necessary to create Debrecen Bike, or **DeBi**, by way of extending UniBike, the existing **bicycle sharing service** by way of adding more docking stations across the city.

Awareness-raising elements are also indispensable, since using bicycles facilities, in addition to health preservation and improving the liveability of the city, serve all three major objectives: it increases the share of sustainable mobility, it generates no noise or air-pollution, and

²⁴ Low-Stress Bicycling and Network Connectivity, Mineta Transportation Institute, 05.08.2019, <http://transweb.sjsu.edu/sites/default/files/1005-low-stress-bicycling-network-connectivity.pdf>

due to its limited demand for space, it also reduces congestion. These may include “bicycle days”, media appearances and various campaigns. It is worth aligning these efforts with education (in kindergartens and schools), so that children can learn the basic rules of bicycle use and make them instinctive. In the absence of a dedicated organisation, market players may also be involved in the form of corporate social responsibility programmes and brand building. It is important to create an environment including the renting of bicycles, supplying parts, repair services and **information** to the target audience, by way of modern and good-quality **maps, route planning** possibilities (the sharing of the bicycle infrastructure on online surfaces, e.g. the navigation service of Google Maps), in print and especially in digital form.

All developments supporting bicycling, including applications, awareness-raising campaigns, even combined with various promotions or with **gamification** would contribute to building the bicycling community and popularise this form of mobility. The annual “Ride Your Bike to Work” (“Bringázz a munkába”, or BAM) has a positive effect not only on the above, but through the recording of the routes via the application, we can obtain information on the busiest commuting sections, and therefore, the infrastructural deficiencies can be easily identified. The community building may also take place with the support of civil initiatives.

In terms of **traffic organisation**, the **re-tuning of traffic lights** along the busiest bicycle traffic routes should also be considered, since it currently gives a priority to higher-speed modes of transport, and breaks the rhythm of both public transport and bicycle traffic. The city of Grenoble is an interesting example where from 1 January 2016 the maximum speed for 80% of the roads was set at 30 km/h instead of 50 km/h, as a result of which the safety risks resulting from the larger speed difference between motorised vehicles and bicycles could be significantly reduced²⁵. With similar solutions, it could be achieved that the share of those using individual motorised mobility was reduced from 70% to 32%, to the benefit of public transport and bicycle traffic, with the latter's share now exceeding 20%. The improvement of safety does not only affect cyclists, as this measure also reduced the likelihood of fatal accidents involving pedestrians to one-ninth, and reduced environmental loads in terms of noise and emissions as well. The Hungarian Bicycle Club concluded that there were also positive experiences with two-way access in one-way streets in Budapest and Szeged, and therefore they support the use of this measure also in Debrecen²⁶.



²⁵ Joel Kermabon: Circulation in Grenoble: 50 km/h the exception, 30 km/h the rule, 05.08.2019, <https://www.placegrenet.fr/2016/02/04/circulation-in-grenoble-50-kmh-the-exception-30-kmh-the-rule/75090>

²⁶ Dehir.hu, Two-wheeled dilemma: Can you drive into a one-way street in Debrecen? Or not? 05.08.2019, <http://www.dehir.hu/debrecen/ketkerekes-dilemma-debrecenben-be-lehet-hajtani-az-egyiranyu-utcaba-vagy-nem/2014/03/20/>

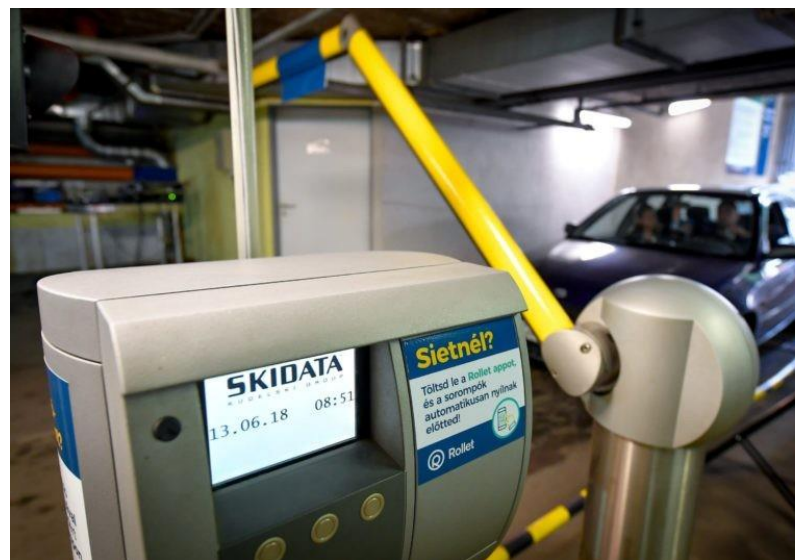
⑦③ BETTER UTILISATION OF URBAN MOBILITY INFRASTRUCTURE

Due to the limitations of expansion and to facilitate liveability, **the better utilisation of urban mobility infrastructure** is an important objective. A significant part of public spaces is currently occupied by parking lots, with the better utilisation of which not only can traffic be accelerated, but in a given case some of the parking spaces can be given back to pedestrians or for infrastructure of other self-propelled traffic, or converted into green spaces, thereby improving the urban environment.

I. THE CURRENT SITUATION

The continuously increasing number of motor vehicles poses an ever bigger challenge to urban infrastructure, and therefore, efforts must be made in all areas to **improve efficiency and make a better use of the existing infrastructure**. The level of acceptance of underground parking garages is continuously increasing, partly due to the lower rates in comparison with parking spaces on the surface level, and the building of more such facilities is likely to be needed after the developments in the city centre (completion of the western inner ring road, appearance of office buildings). On the basis of international examples, it is expedient to design these in such a way that later, with the appearance of self-driving cars and a transformation of habits in transport, they can be reused. As regards further developments, out of the 160 parking machines installed on the surface, all of those in the busiest locations, a total of 27 at the beginning of 2019, were capable

of accepting bank card using the Paypass service.



The smart solutions introduced between 2015 and 2018

Waze is not the only **smart phone application** making the life of drivers easier in Debrecen. In the summer of 2018, the **Rollet** parking fee payment application was introduced in two locations in Debrecen, which **completely eliminates the need to purchase parking tickets**. All it requires is an initial registration; after leaving the parking garage, the system automatically settles the parking fee from the bank card assigned to the user's account. This solution proved to be extremely popular right after it was introduced, since mobile payment was often problematic in underground garages due to the weak signal, and therefore, the city leadership decided on extending the system to all locations, which has already taken place, meaning a total of 9 locations including the airport.

Similarly to Waze, this application also serves purposes beyond the convenience of its users: thanks to the IT background, it also **collects data** to be used as the basis for further developments. It becomes possible to monitor the lengths of parking, habits, rates of utilisation in real time, and the system also provides the conditions for introducing **dynamic pricing** varying depending on the current rate of utilisation. The determination of the price as a factor of free capacities, i.e. supply, has an effect on demand, and as a result, traffic loads and congestions can be reduced.

II. OBJECTIVE

Various studies estimate that the number of kilometres driven in the centres in big cities looking for a place to park the car is as high as 30%. This creates unnecessary congestion, increases travel times and air pollution, while reducing economic performance and liveability. With information on the exact occupancy of parking spaces, applications – which also help in navigation – can **significantly improve this without compromises**, and therefore, it would be necessary to realise these solutions for all parking spaces.

III. PROGRAMMES TO BE REALISED

The development of motorised individual transport

Underground parking garages and “city centre” parking lots account for only 20% of municipally owned parking spaces; in addition, we can also

find over 5,300 pay parking spots on the surface, in addition to the **parking garages in downtown shopping centres** offering 1,680 more spaces. As regards the purchasing of parking tickets for the latter, their connection to the existing municipal system, as well as the installation of additional devices for the real-time monitoring of **surface parking** would be needed. Depending on the characteristics of the given location, these could be IoT devices, various **sensors or cameras**, which could, in addition to monitoring **occupancy**, also be suitable for **spatial surveillance**. If occupancy information is available, the payment of the parking fee can be later automated with applications. It is also **expedient to share the occupancy information**, which can be used in the future by various applications, such as Waze, thereby optimising navigation to free parking spots.

Another type of approach would be **car sharing services**, not yet available in Debrecen, with the use of which the number of cars simultaneously present on the roads can be reduced, as a result of which congestion and the occupancy rates of parking spaces can also be decreased. According to a study focusing on Vienna, every shared car removes 5 cars from the roads²⁷, while another study on Munich found that 3 parking spots can be freed across the city by one shared car (in terms of net balance, this means 2 spots, since one is occupied by the shared car)²⁸. If car sharing is introduced as a new service, it is advisable to use a fleet of electric cars, also with an aim to improving air quality. Possibly helping

²⁷ Herry Consult GmbH – Carsharing Wien, Evaluierung, 05.08.2019, <https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008470.pdf>

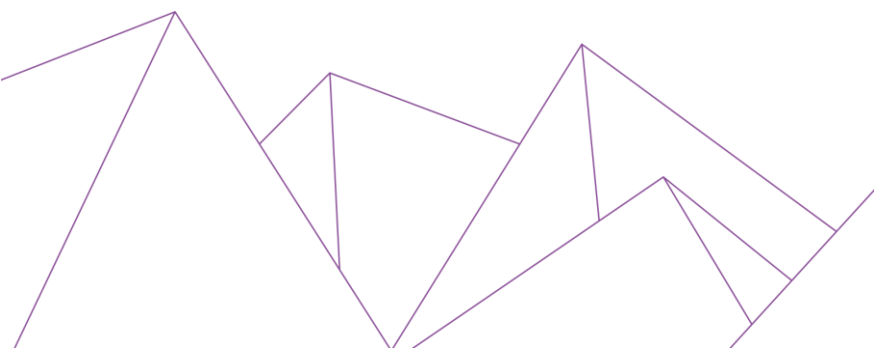
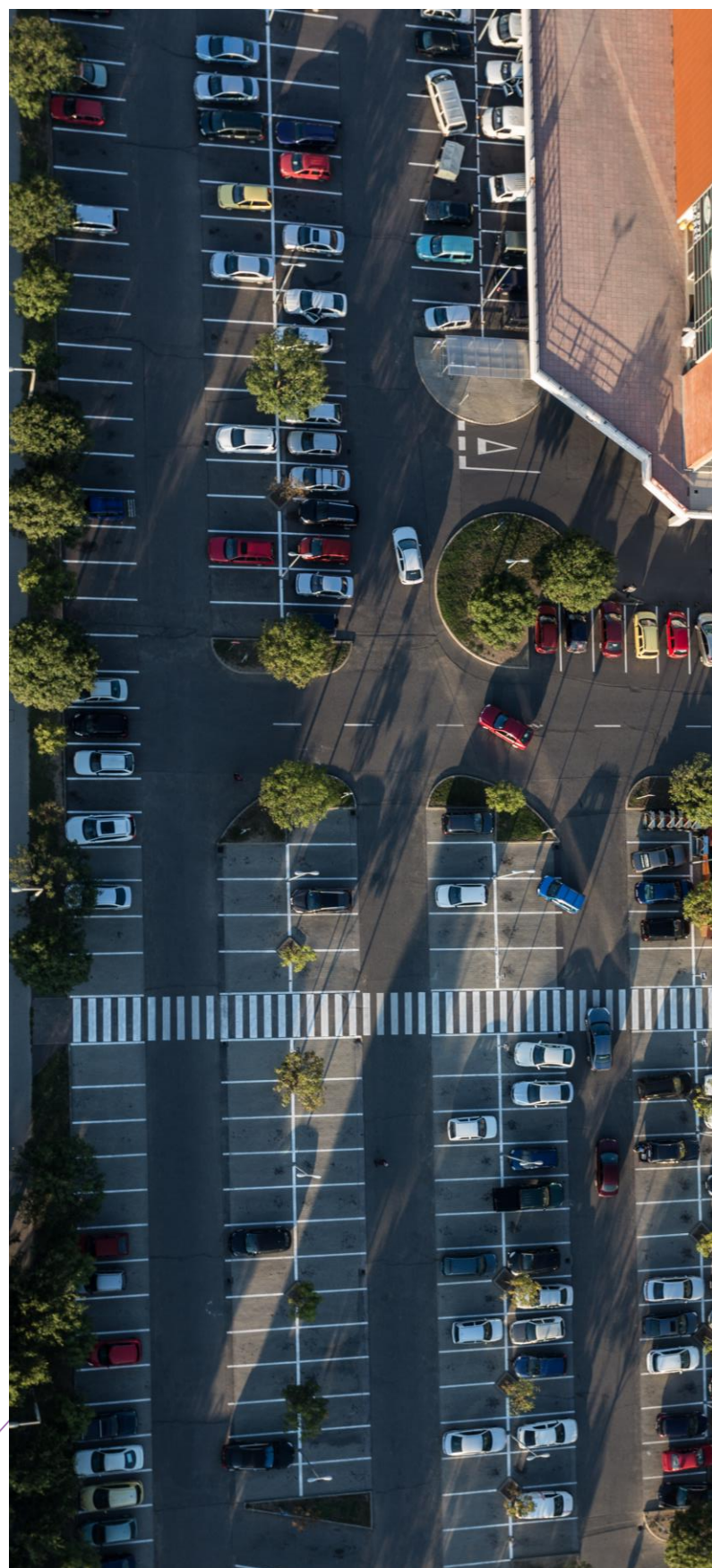
²⁸ Team Red, Final Report, Evaluation Car-Sharing, City of Munich, 05.08.2019, https://civitas.eu/sites/default/files/report_eva-cs_munich_short_version_eng_v2.pdf

in the introduction of the service would be the **BMW Group's Center of Competence Urban Mobility**. In cooperation with municipal governments, the Center is looking for innovative solutions (e.g. demand-driven mobility programme, the spreading of electromobility) to answer challenges in the field of mobility, such as air pollution, congestions or parking. Thanks to the new plant of the BMW Group to be built in Debrecen, an exceptional relationship and cooperation may be forged between this global company and the city; it would be expedient to use the opportunities inherent in this as far as possible.

The development of public transport

Approximately 2/3 of the 125 city buses operated by the Cívibusz Consortium formed by DKV Debreceni Közlekedési Zrt. and InterTan-ker Zrt. are solo buses, with the remaining 1/3 being articulated buses. The further development of the electronic ticket and pass system would not only serve the convenience of the passengers and enhance the quality of the service, but after the installation of the **validators**, if used on a larger scale, the data generated from the controlling of the tickets and passes, it would also provide a more accurate picture of travel habits and the number of passengers. The efficiency of such a solution could be further improved if supplemented with dedicated passenger counting systems. Thanks to the data, the fleet could be operated more efficiently, routes could be optimised, and the decisions on solo versus articulated buses could be made more reliably.

In addition to the above, in the interest of the exploitation of the full potential inherent in the municipal infrastructure, regular dialogue between key players in traffic organisation, experts, representatives of associations is also indispensable.



⑦④ REDUCING AIR POLLUTION FROM TRAFFIC, THE IMPROVEMENT OF AIR QUALITY

Because of the ever increasing number of motor vehicles in the city, an increasingly important objective is the **reduction of traffic-generated air pollution, as well as the improvement of air quality**. Apart from the dedicated projects of the latter objective, efforts toward the first two objectives also have an effect of improving air quality, and it can be concluded on all transport development projects that they have a positive effect on liveability, environmental loads, i.e. on noise and air pollution, as well as on economic efficiency.

I. THE CURRENT SITUATION

In November 2017, the city council of Debrecen accepted the city's Sustainable Energy and Climate Action Plan (SECAP). The starting point of the action plan is a base year, after the selection of which, the city's annual energy consumption, as well as the annual, estimated CO₂ emission are determined. Taking the year 2013 as the basis, approximately 1/3 of the resulting 595 thousand tonnes of CO₂, i.e. **180 thousand tonnes can be attributed to mobility**, most of which is from private-purpose trips and commercial deliveries. For the year 2015, the municipal CO₂ emission arising from transport increased by over 8% in comparison with the base year (mainly due to the increase of nearly 5 thousand cars in the city, as well as the 1-year increase in the average age of the motor vehicles), to 195 thousand tonnes per year. The electric proportion of the power output of local public transport currently exceeds 20%.

II. OBJECTIVE

The objective of Debrecen is to achieve the **24% decrease** undertaken in the Sustainable Energy and Climate Action Plan by 2030, which would mean a decrease of the city's transport-related CO₂-emissions to **133 thousand tonnes**.

III. PROGRAMMES TO BE REALISED

Public Transport

In the spirit of sustainability, **the replacement of the entire fleet of buses will be necessary** in public transport by the end of the next decade, with modern, state-of-the-art vehicles of the latest, EURO-6.2 or then current environmental classification, possibly with electric vehicles, which would – in addition to improving the quality of the service – also have a favourable effect on the air quality of the city. The replacement of the entire fleet with electric vehicles would reduce CO₂-emissions from public transport by 90%. Nearly one-third of the fleet, 40 solo buses, for electric vehicles are planned to be replaced much earlier, by 2021.

The development of motorised individual transport

The availability of the necessary infrastructure is indispensable for increasing the share of electric cars in individual motorised transport. Thanks to the "Jedlik Ányos" Plan, at the end of 2018, **9 new electric charging stations** were added to the infrastructure operated by the municipality, thus



bringing their total number to ten²⁹. With the spread of electric and plug-in hybrid vehicles, this coverage by charging stations is expected to increase further. This gaining of ground by cars of electric drive trains is also supported by the local government, for example, by providing free parking for them. In addition, it is expedient to examine other incentives and regulations, such as support for the installation of chargers at home, prescribing in the building permits of parking garages or office buildings a minimal number of charging stations to be built, etc. In February 2019, a total of 12 electric charging stations were added to Malompark Shopping Centre³⁰, which proves that market players can also contribute significantly to the spreading of electromobility. According to the survey by e-Mobi, thanks to their gradual gaining of ground, the share of electric vehicles will increase on a national level from 0.09% to 11.6% between 2017 and 2030. These half a million vehicles may also be important from an energy management point of view, as households will also appear on the market as potential energy storage locations. The increasing of the number of electric cars in Debrecen from below 100 in 2018 to 2,000 would result in eliminating approximately **9 thousand tonnes of CO₂**. Even though it is not significant in terms of scale, in terms of setting an example and contributing to awareness-raising, the replacement of the fleet of vehicles owned by the municipality with electric ones would also be worth considering.

The development of bicycle transport

One of the most efficient ways of reducing air pollution is the promotion of alternative means of transport (bicycles, scooters, roller blades, skateboards and longboards, walking, etc.). For this it is not sufficient to develop a bicycle-friendly transport network, but it is also necessary to create an attractive environment for cyclists, to launch awareness-raising and popularising campaigns, engage in educational activities to improve traffic safety, to establish partnerships and cooperation with professional associations and NGOs, in order to ensure that road development investments are realised in a cyclist-friendly way. According to the available data, a **bicycle road** built parallel with a busy road reduces **CO₂** emissions by **21.1 tonnes per kilometre**. Beyond the reduction of CO₂-emissions, facilities for bicycling also have a demonstrably favourable effect on local air quality, as well as the health and welfare of people. Electric scooters of small power, which are spreading at a fast rate, are considered as moped, which means that they can use the infrastructure for bicycles. Thanks to technological development, a distance of 30-40 km can be now easily covered with a single charge, which is sufficient for travelling within the city, or even for daily commuting, which means that these vehicles constitute a real alternative to those currently using cars.

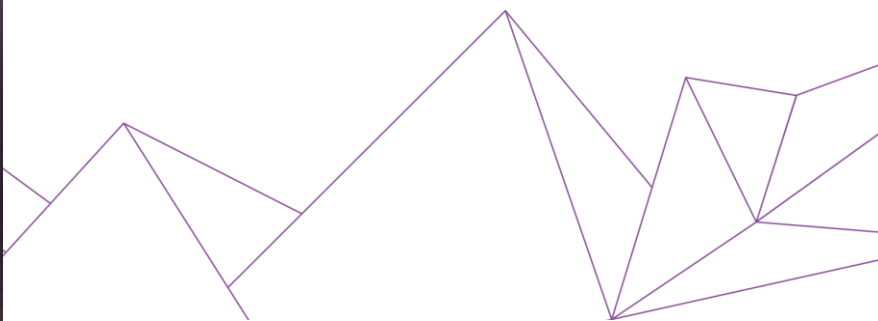
²⁹ Dehir.hu, New electric vehicle charging stations to be opened in Debrecen, 05.08.2019, <https://www.dehir.hu/debrecen/uj-elektromos-toltoallomasokat-nyitnak-debrecenben/2018/08/09/>

³⁰ Dehir.hu, New electric vehicle charging stations were added to Malompark Shopping Centre, 05.08.2019, <https://www.dehir.hu/gazdasag/uj-elektromosauto-tolto-allomasokat-telepitettek-a-malomparkban/2019/02/11/>

In several European cities, services for sharing electric scooters and bicycles have already appeared, which also further help spread the news of the existence of this option.

Traffic control

At this point it is worth mentioning that the **intelligent traffic control system** that can constitute a part of the urban control centre also has a beneficial effect on harmful traffic-related emissions. The increasing of the capacity and the rate of utilisation of the existing transport system and infrastructure with the tools of electronics, IT and logistics (solar-powered smart traffic light system, passenger and traffic information system, database and databased management system, including coordination with an application such as Waze) is expected to decrease **CO₂** emissions by **18 thousand tonnes**, which is more than the emissions from public transport. Several innovative sub-programmes of this complex implementation are conceivable, in which **international cooperation** is of special importance, as it is not only best practices that can be taken over, but new solutions can also be jointly introduced with partnerships, also with **EU grants** and sources.



8 SUSTAINABLE ENERGY

Non-renewable resources and the issue of a constantly growing population make **sustainability** an increasingly important area for both developed and developing cities today.

Communities, cities, potential investors and businesses share the need for **conscious economic management** and a gradual increase of the share of **renewable sources of energy**.

For future generations, conscious economic management means more than rational consumption and paying closer attention to resources; it involves protecting the environment as well. Despite the fact that the sharing economy started in the 2000s and therefore it is relatively new, its popularity is growing. The main concept is that the population or consumers are able to access services when they actually need them without having to own the tools for them³¹. The rising number of mobile applications also helps to spread the sharing economy; the most widely known services are Airbnb in the area of accommodations, or ride-sharing applications Uber and Oszkár. Services that combine car sharing with energy consumption coming from renewable sources have also emerged in Hungary such as GreenGo and MOL Limo with only or mainly electric cars in their fleets. From 2019, sharing services for electric scooters and bicycles have also become available, as a result of which a further gaining of ground by electromobility is expected.

On some levels, cities can be considered competitors, since liveability as a factor and common approaches weigh in more and more on the decision of choosing a place to live. Another important target group, aside from the population, are potential investors, which place a stronger emphasis on improving sustainability indicators; in many cases striving for sustainability is part of the brand and the company's image. For their future establishments and factories these investors are going to choose a city that they can identify with the approaches and the intentions of.

On the basis of the above, **three main goals** can be defined in the field of sustainable energy for Debrecen. The most important of these goals is to **decrease specific energy consumption**, which leads to cost savings and indirectly affects air quality as well. The second goal is to **increase the share of renewable energy sources**, which fundamentally determines sustainability. Finally, the third goal is to **reduce air pollution caused by municipal and residential buildings, service provider buildings, facilities and industrial activities**, and thereby to improve air quality. In medium-sized cities the main causes of air pollution are the heating of buildings and transportation described in the previous chapter.

³¹ Ildikó Molnár, Network knowledge, 05.08.2019, <http://konyvtartudomany.elte.hu/KONYVTAR/dolgozatok/2015a2/sharingeconomy.html>

8① REDUCING SPECIFIC ENERGY CONSUMPTION IN THE CITY

The first and most important objective is **the reduction of specific energy consumption in the city**. Thanks to the economic development and the growth of the city, the absolute value of consumption is expected to increase, which trend is also supported by historical data; therefore it is crucial to improve the efficiency of existing consumers in order to ensure sustainability.

I. THE CURRENT SITUATION

In **2013** the annual energy use of Debrecen was **2 million MWh³²**, **2/3** of which is added up by the energy consumption of **buildings**, equipment/facilities, municipal public lighting and industrial activities; among the above, residential buildings are the largest consumers of energy. The remaining **1/3** of the energy consumption is attributed to **transport**, most of which is private-purpose trips and commercial deliveries. The industry of the city is developing, motorisation is increasing and the growth of the population is expected in the forthcoming decades as well, which is why it is not surprising that energy consumption **increased by nearly 5%, i.e. 100 thousand MWh**, each year between **2013** and **2015**.

The smart solutions introduced between 2015 and 2018

Thanks to the Territorial and Settlement Development Operational Program, the modernisation of nearly 50 buildings (15 kindergartens, 4-5 schools and nurseries, 14

doctor's and dentist's offices, residence halls, libraries) in terms of energy use is in progress. During the renovations, insulation, doors and windows will be replaced, the heating system will be modernised, modern adjustable lighting, solar systems and solar collectors will be installed. In addition, within the Environment and Energy Operational Program several investments related to renewable energy have been realised (8 kindergartens, 5 elementary schools, 2 secondary schools, a library, and a swimming pool); district heating has been modernised and the installation of energy efficient public lighting has been started.

The monthly consumption figures of all consumers (institutes, fountains, parking lots, etc.) maintained by the municipal government based on the invoices are registered by the Institution Operating Centre of Debrecen per PODs (points of delivery, i.e. metering point identifications; in case of several electricity, water, gas and district heating meters) in a shared database, in which the performance of home solar power plants is also recorded.

II. OBJECTIVE

The first step of reducing specific energy consumption in the city was the creation of the **annual municipal energy consumption inventory** drawn up as part of the Sustainable Energy and Climate Action Plan (SECAP), approved in November 2017. Without metering,

³² Sustainable Energy and Climate Action Plan (SECAP)

improvement cannot be achieved; therefore, it is necessary to strive for data collection that is from as wide of a basis and as detailed as possible. **The SECAP should be reviewed every 2 years** to have an overview of the evolution of the energy consumption of the city.

The Municipality of Debrecen has a direct effect on its maintained buildings; therefore the establishment of **real-time metering and monitoring of the consumption of all institutes** is necessary.

In addition, based on the historical consumption data and a forecast of consumption based on it, **centralised energy procurement** can be realised. Thanks to this modern solution, **commitment consumption can be estimated more accurately**, the flexibility of certain institutions is greater, which overall can lead to more **cost savings and consumption reduction**; managing daily changes becomes easier without having to compromise, without the comfort level of the users of the facilities deteriorating.

Beyond the modernisation of the metering system, if grant resources are available, **for the purposes of awareness-raising and demonstration it is worth modernising on a deeper level, constructing low/zero emission buildings or smart buildings** (shading, cooling, heating, ventilation, automated operation of weak current systems, recording consumption data and the optimisation of consumption), which can have an effect on the operation of other large-scale consumers.

III. PROGRAMMES TO BE REALISED

In the short term, **it is necessary to establish an energy management registration system, which would be used as a basis by the energy management centre of the proposed urban control centre.** The shared database created by the operating centre, in which electricity, water, gas and district heating consumption of all municipally owned institutions or parts of institutions are being registered on a monthly basis could serve as a basis for that. This helps to eliminate anomalies, opens up possibilities to analyse trends, and as a result it can highlight areas where actions need to be taken or it can support the planning process of modernisations and savings. The energy-conscious use of the buildings in itself can lead to significant (occasionally up to 10-20%) savings.

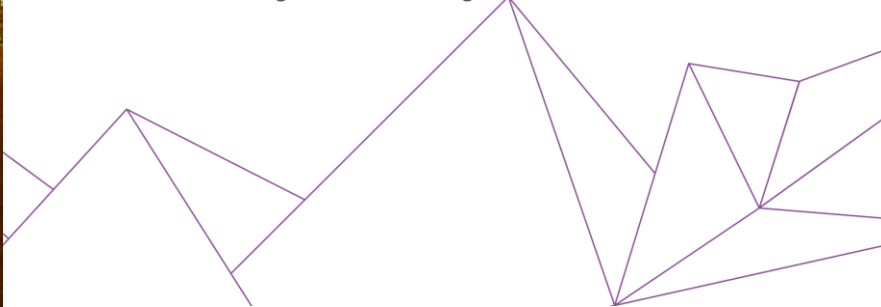


The long-term objective is to **install a smart metering system of electricity, water, gas, district heating in all municipally owned buildings** (in the order of the extent of consumption and the return on the investments) with a remote intervention option, therefore it is key to establish and prepare a proper infrastructure for the installation of the metering devices during the **modernisation of the buildings** (which is necessary to **continue**). Accomplishing the above is supported if **a decree regulates** that it is necessary to install smart metering devices during the energy-conscious modernisation or the replacement of meters in all public buildings. During the modernisation process it is worth examining if occurring waste heat can be used and whether the use of it would bring returns (e.g. the ventilation or air handling of swimming pools and similar buildings requiring extensive air exchange). A possible form of realising energy-related refurbishment projects are ESCO (Energy Service Company) or third-party-financed projects, in the case of which as ESCO provides energy supply and/or energy efficiency services for the facilities of the user, by assuming a part of its economic risks. In these projects, the consideration for the service is covered by the energy efficiency intervention, on the basis of a set of criteria set down in an Energy Performance Contract (EPC).

There are two options to establish the proposed energy management system for the long term. One of them is the **Internet Based Smart Facility Operating System**, which:

- allows the analysis of the energy consumption of the institution based on the daily consumption curve;
- allows the preparation of quarterly reports, which help to make institution's expenditures predictable;
- contributes to the making of informed decisions about investment in energy on the basis of systematically assembled and constantly available data;
- helps the preparation for energy efficiency tenders using energy consumption data;
- allows the monitoring of the effectiveness of the energy efficiency investments by checking the expected savings against the actual, metered data;
- contributes to the optimisation of consumer habits by sending notifications (e-mail, text message) of detected unusual activities using automated intervention (turning energy consuming devices on/off), if needed;
- on the basis of the above, the energy costs can be reduced.

Another option is the introduction of an international standard, the **ISO 50001** energy management systems standard, which aligns with the operation of the regulated energy management system. On the basis of continuous metering, observation and analysis, a constantly improving energy management can be achieved after the introduction. Instead of ad hoc arrangements it provides energy management based on long-term metering, delivers more



secure and more predictable energy supply, and as a result, also helps the institution to meet the requirements of environmental legislation, strengthens the commitment of the employees, improves innovation and enhances the prestige of the institution³³. However, to implement the city is in the use of such a system, a dedicated staff is necessary for efficient, market-based operations.

The installation of the Smart Grid system, which aligns with smart metering, is also recommended. The Smart Grid system is a modularly structured energy network that is capable of the smart integration of the behaviours and operation of the actors – manufacturers, consumers, and those who fit in both categories – related to the system, in order to create an efficient, sustainable and economical network system that delivers a secure supply. If the buildings are connected to a network, their consumption can be optimised; if a smart grid is created, the volatility of the network can be reduced. Even in simple households there are consumers (e.g. water heaters), which do not necessarily need to operate at a certain fixed time; therefore the users are not forced to compromise if these consumers are turned off at certain times.

It is worth separately mentioning the upgrading of **public lighting**, in which there is also potential for savings thanks to the more than 20,000 units, by way of installing more energy efficient lighting fixtures and their controlling. There are several

possibilities for financing, such as the ELENA programme of the European Union, the whole preparatory phase of which can be supported by way of non-repayable grants. Smart lighting poles can simultaneously also function as the key infrastructural elements for the data sources of the city in the future, since they can be supplemented with various sensors, cameras, microphones or chargers.

A review and necessary adjustments of the Sustainable Energy and Climate Action Plan (SECAP) every 2 years are indispensable in the interest of monitoring the evolution of energy consumption of the city, measuring the success of the programmes and checking reached milestones.

Raising awareness is crucial, since facilities, buildings have people at their core. There is no better way to save energy than not using any at all; therefore, bringing attention to the importance of savings and wasteful behaviours could be more effective than a costly modernisation process. It is necessary to place a strong emphasis on education, whether it is about kindergarteners turning the tap off while brushing their teeth, students turning off lights that were left on unnecessarily, or households slightly turning the heating down during wintertime and wearing more layers of clothing instead, to mention only a few examples. In case of residential buildings, the reviewing of the regulatory environment against the objectives is also necessary from time to time.

³³ Energy management system, the Sustainable Energy and Climate Action Plan (SECAP) of Debrecen



8② INCREASING THE SHARE OF RENEWABLE ENERGY SOURCES

The second objective is **increasing the share of renewable energy sources** for both for producing thermal energy and for generating electricity. In the region of eastern Hungary, the significance of wind energy in energy production is low; the potential for Debrecen – with the involvement of the district heating system – is primarily in biomass, biogas, as well as geothermal energy (average water temperature of 55°C at points of exit), solar energy (1,250 kWh/m²) and heat pumps.

I. THE CURRENT SITUATION

In the interest of the implementation of the Europe 2020 programme, the EU has committed to establish the Energy 2020 strategy supporting the “20-20-20” initiative. In this strategy, commitments have been made to reduce greenhouse-gas emissions by 20% compared to the level in 1990 by 2020, to increase the share of renewable energy sources to 20% within the final energy consumption and to improve energy

efficiency by 20%. After that the National Renewable Energy Utilisation Action Plan 2010-2020 (2012) became one of the most important documents of the national energy policy, which aims for a 14.65% share of renewable energy within the final energy consumption by 2020. Partially based on this document and on the 20-20-20 programme, in 2012, the Ministry of National Development published the document titled “National Energy Strategy 2030”, which aims to provide guidance for the implementation of an economically and environmentally sustainable energy strategy until 2030.

While exact figures are not available about the share of **renewable** energy sources specifically in Debrecen, on the basis of the data of Eurostat, the share of renewables in the gross final energy consumption nationally was 13.3% in 2017³⁴. One of the basic conditions of the gaining of ground by smart solutions is the modernisation of the outdated infrastructure, which allows

³⁴ Share of renewable energy in gross final energy consumption, EUROSTAT, 05.08.2019, https://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=t2020_31&language=en

significant improvements. In the past few years, thanks to the operational programmes, several municipal institutions, such as kindergartens and doctor's offices were renovated. Since buildings account for the majority of energy consumption, the goal is the modernisation of more buildings. During the renovations, the increase of the share of renewable energy sources (**solar energy from solar power plants and solar collectors, biomass**) can be achieved as well. In addition, the extension of district heating (which serves nearly half of the population) and the gradual conversion of its heat production, turning to the use of renewable energy are also important, which allow the reduction of air pollution related to heating and the share of the renewable energy sources to be increased to the largest extent. It is a great advantage to have an infrastructure with a 90 km long district heating pipeline network across the city, which could receive renewable, "clean" energy or the usable waste heat arising at industrial facilities (depending on the technology) that can be entered in a decentralised way and controlled by a smart system.

The smart solutions introduced between 2015 and 2018

A second **landfill gas power plant** was dedicated in Debrecen in August 2017, and was installed next to a small power plant that was put into operation on the waste treatment site in 2006. Landfill gas power plants generate heat and electricity with high efficiency, collecting and burning gases released at landfill sites, especially methane, which enhances the greenhouse effect. The new 499 kW power plant reduces greenhouse gas emissions by an equivalent

amount of 15 thousand tonnes of CO₂ per year by converting it into valuable electricity.

II. OBJECTIVE

The objectives of Debrecen are aligned with those of the Hungarian national economic policy, while guaranteeing a higher degree of energy independence, as well as clean, sustainable, smart and affordable energy.

III. PROGRAMMES TO BE REALISED

In order to increase the share of renewable energy sources, it is expedient to install additional solar panels and solar power plants, which can be connected to the Smart Grid system. The Sustainable Energy and Climate Action Plan proposes the creation of a **central solar power plant of 4 MWp nominal power as the central element of the Smart Grid** system to be established by 2030, supplemented by several other **smaller solar power plants of 1 MWp capacity in total, to be installed in public institutions**. Parallel with the arrival of the new industrial players, it would be worth examining the possibility of creating an even larger **solar park on 50-100 hectares, having a power capacity of 25-50 MWp**.

Currently, there are a total of 14 **thermal water wells** in Debrecen, where the temperature of the water extracted is between 49-69°C, which also offers a potential for utilisation, primarily for generating heat energy. The significant agricultural production in the area also provides the necessary basis for the establishment of biomass, **biogas power plants**, which can further increase the share of renewable energy sources.



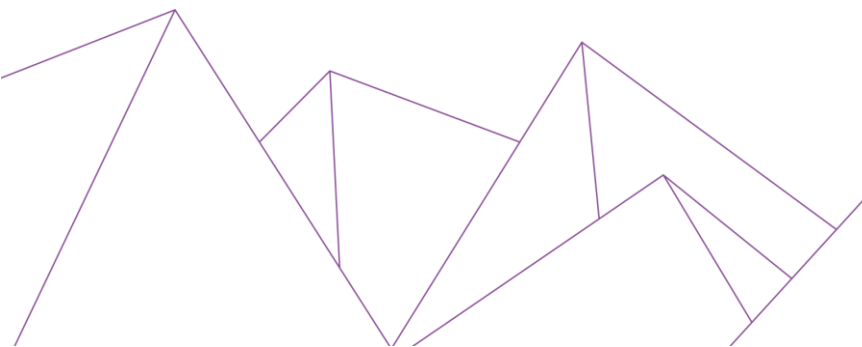
The production of heat and electric energy with the use of **secondary raw materials** is also possible, for example:

- Planting energy plants (e.g. oilseed rape)
- Sewage gas from sewage sludge
- Biogas from agricultural waste
- Gas from waste dumps
- Other possibilities from waste recovery operations.

Today there are already modern solutions and procedures (proper temperature, flow conditions, holding time, large volume of air, knowledge of the exact physical and chemical and physical properties of the secondary raw materials, etc.) with which the disadvantages of the energy generation process can be minimised, and the environmental load may be reduced to a large extent.

For the optimum operation of these, however, it is indispensable to establish the urban control centre, which could also serve as the **energy management centre**.

Also playing an important role in increasing the share of renewable energy sources are **awareness-raising**, calling attention to the protection of the environment, as well as the **education** of all age groups, since the commitment of the population in this respect is of vital importance.



⑧③ REDUCING THE AIR POLLUTION FROM MUNICIPALLY OWNED AND RESIDENTIAL BUILDINGS, SERVICE AND INDUSTRIAL FACILITIES

The third objective is to improve air quality, in the present case as the counterpart of the objective formulated in connection with smart mobility, by way of **reducing the damage caused to air quality by buildings, facilities and industry.**

I. THE CURRENT SITUATION

Upon joining the Covenant of Mayors³⁵ in early 2018, the city formulated specific objectives in connection with the drawing up of the **Sustainable Energy and Climate Action Plan (SECAP)**. In the action plan prepared on the basis of broad professional cooperation, the objective was to achieve a **43% lower CO₂ emission** in Debrecen by 2030, in comparison with the 2013 data. The 43% savings in emission would be the equivalent of **257 thousands of tonnes of CO₂**, from which the biggest potential for savings is inherent in connection with buildings, facilities, industry, locally produced electricity, local district heating, power co-generation, and sustainable mobility development.

On the basis of the data for the base year, **buildings, machines, facilities and industry are responsible for the emission of 415 thousand tonnes of CO₂**, which is more than 2/3 of the total emission of **595 thousands of tonnes**

of CO₂, and is therefore an area of outstanding importance.

The smart solutions introduced between 2015 and 2018

For an understanding of the current situation, it was essential to prepare an assessment of the annual energy consumption of the city, which is the point of departure for the preparation of the Sustainable Energy and Climate Action Plan (SECAP). A Sustainable Energy Action Plan (SEAP) including the 2020 targets, which does not address the topic of climate, was prepared by nearly 6 thousand European settlements by the end of 2018; however, **fewer than 200 European settlements prepared a SECAP (in Hungary, only Debrecen and the 18th District of Budapest)**, and therefore, this is definitely a forward-looking step. The SECAP does not only contain an assessment of the situation and objectives, but also an action plan, in which the programme is segmented into specific interventions. The purposes and advantages of SECAP, in addition to increasing **energy efficiency, reinforcing consciousness, and reducing harmful emissions, is facilitating access to grant sources** (it can serve as the basis for the use of financing from ELENA³⁶ and

³⁵ The Covenant of Mayors is a European co-operation movement involving local and regional authorities, created by the European Commission, with an aim to increasing energy efficiency and the use of renewable energy sources.

³⁶ European Local Energy Assistance

JESSICA³⁷, but is also already a precondition of H2020 Smart City grants), as well as achieving a cleaner, liveable settlement, and establishing the foundation for subsequent developments (e.g. energy-conscious Smart City development programmes, such as Smart grid, Smart metering).

II. OBJECTIVE

The aim is, as formulated in the **Sustainable Energy and Climate Action Plan (SECAP)**, the **planned 52% reduction**, relative to the base year of emissions from buildings, facilities and industry by 2030, which corresponds to **214 thousand tonnes of CO₂**.

III. PROGRAMMES TO BE REALISED

Upgrading projects in the field of energy and the use of renewable energy sources are beneficial for the efforts aimed at the reduction of harmful emissions, which is of fundamental importance from the point of view of liveability and quality of life. Real-time data for measuring the **quality of air** are currently provided by **3 measuring stations**. Thanks to the availability of IoT devices, it is now possible to obtain data not only from fixed stations, since several cities (e.g. Malaga³⁸) started to experiment with **mobile sensors** installed on buses from the early 2010s, suitable for the measuring of CO, NO_x, SO₂ and ozone values. As a result of the **open data sharing** of such measurement results (Open Data Debrecen), the population can have access to the relevant information, and different **applications** can also

be developed, which can, on the one hand, help people with a higher level of exposure (those suffering from asthma, parents wishing to choose which playground to take their children depending on the level of ozone concentration, etc.), and on the other hand, they can also be useful in **awareness-raising** and educating the public (e.g. placing certain values, in an easily interpretable form, on digital information signs along major roads).



Once accurate data are available, the problematic points can be identified across the city, and the areas to be developed can be prioritized. For these, it is expedient to apply for **direct European grants**, since these projects do not only have a beneficial effect on air quality but, thanks to the savings they make possible, they also provide a return on the investment.

³⁷ Joint European Support for Sustainable Investment in City Areas

³⁸ CIVITAS, Dynamic Air Quality Management Through Mobile Sensors Installed On Public Transport Buses 05.08.2019, <http://civitas.eu/measure/dynamic-air-quality-management-through-mobile-sensors-installed-public-transport-buses>



While the **extension of green areas** does not reduce the extent of emissions, it significantly helps in reducing CO₂ levels. This can be done by the replacement of paved areas with lawns, the installation of green roofs, the planting of trees, building of parks, etc. On top of reducing the level of air pollution, they are also favourable from an aesthetic point of view, and thereby also significantly improve the liveability of the city.

In the winter and in colder periods with no wind, an important factor in the air pollution of certain parts of the city is the quality of the fuel used for heating. To counterbalance this effect, in addition to **regulations and benefits provided**, an important role can also be played by **awareness-raising** and calling attention to the damage caused.



9 DIGITAL DEBRECEN

In addition to smart mobility and sustainable energy, economic development also relies on Digital Debrecen as a focus area. Looking back on the past few decades we can easily see that the scale of development that happened in digitalisation is much higher than experienced in the fields of mobility and energy.

Digitalisation determines the directions of the city's economic development, the population's labour market opportunities and quality of life, as well as the operation of the city and of public services. With the fast-paced development of information and communication technologies (ICT), there is an increasingly wide range of areas where digital and online services and solutions become a part of our everyday lives. In the interest of the highest possible utilisation of the

demand created by this development, as well as the inherent opportunities, it is necessary to devote special attention to digital literacy, and in the wider sense to **Digital Debrecen**. It is the firm objective of Debrecen to have a competitive advantage in this area, and to prepare its population for the challenges of the 21st century, to strengthen the online presence of SMEs, and to improve the digitalisation of their internal processes.

For the implementation of the above, two main objectives are defined within the focus area of Digital Debrecen: the **development of the digital literacy** of the population, businesses and public services, as well as the **development of** open data sharing and **services based on Open Data**.



9① DEVELOPMENT OF DIGITAL LITERACY

The first objective, the **development of digital literacy**, is important with respect to the population, businesses and public services as well.

I. THE CURRENT SITUATION

In order to be able to utilise the development potential, it is indispensable for the population of the city to understand, know and use the solutions and results of digitalisation. Although the digital literacy of the **population** is a diverse area, the **familiarity with smart solutions** (applications, software, e-banking, etc.) and the **tools** necessary for these (tablets, smart phones, computers, etc.) are of outstanding importance in particular. **Communication** with friends and family members on **online** platforms is increasingly a part of everyday life. From a **labour market** point of view, in time, a continuously decreasing proportion of the potential investors and large corporations will work in positions that do not require at least a fundamental level of digital literacy, whether in the form of using e-mail, intranet or software related to the company's operations. It is a further advantage for employees if they are familiar with channels of e-learning and are able to develop themselves. In addition, it is also indispensable for the users to be aware of the potential dangers and to be able to make online purchases **safely**, and use all necessary devices in a safe manner.

Companies must also develop to achieve the level of digitalisation experienced by the population in different fields if they wish to maintain their competitiveness. With the increase

of the younger population and of international students, as well as the growth in the number of foreign tourists thanks to the many new flight destinations, the digitalisation of small or medium-sized enterprises, as well as their **presence on digital and online platforms** is becoming indispensable. Services, whether restaurants, hair salons, shops, etc. that are not present on **Google Maps**, on **social media** platforms, or do not have their own, up-to-date, **responsive** (optimised for devices of various sizes) **website** also in English will ultimately lose business.

The **public services** of a liveable city will also have to keep up with this development. From the point of view of economic development, **reducing the administrative burdens of enterprises**, spreading **electronic administration and payments** in a wider area are all important aims. **Digitalization, artificial intelligence, augmented reality, and knowledge utilisation based on databases** all have huge development potential **in municipal operations**.

The smart solutions introduced between 2015 and 2018

In the first 2-3 years, the **Smart City projects of Debrecen** also strongly relied on ICT tools and used digital solutions, and this expected to continue also in the future. The strategic agreement concluded with **Waze**, a navigation application aimed at those using individual means of transport, the **Rollet** application facilitating payment for parking services, as well as **e-tickets** in public transport are all solutions that would not

have been possible to implement before, but can make urban services much more efficient. It is necessary to continue and extend these steps. At the same time, it is not enough to create the solutions; it is also important for the population to be able to use the possibilities offered by **e-(local) government**, and therefore, in addition to promotion, it is also necessary to educate the public.

With the participation of 7 sectors (the companies operating in the region, the university, institutes of public education, cultural institutions, non-profit organisations, governmental, sectoral experts, local government) and a consultancy firm, Debrecen prepared **the city's development strategy aimed at digital literacy**, in the course of which the following important challenges have been identified:

- The digital maturity of Debrecen should be a distinctive competitive advantage in terms of economic development, investment promotion, job creation and quality of life in the region.
- The digital competences and proficiency of the city's population should be advanced to a level to enable people to meet the digital challenges they face.
- Instead of isolated, infrastructure-driven and unsustainable developments, a programme of synergic and relevant interventions should be drawn up.

II. OBJECTIVE

Following the challenges, the main objectives were defined divided into 3 main areas:

The competitiveness of the population:

- the development of the digital skills of teachers, educators;
- the development of young people's digital competences on all levels of education;
- the development of the digital competences of people with disabilities;
- the development of the digital competencies of people outside the school system;
- the education of the population (and especially the target groups at high risk) concerning safe internet use, increasing the population's trust in internet use;
- the availability of IT retraining programmes (in accordance with labour market needs) in the city;
- training content as part of vocational and higher education programmes preparing for the IT requirements of various vocations/professions.

The competitiveness of companies:

- increasing the number of IT professionals;
- strengthening the culture of e-commerce among SMEs.

The competitiveness of public services:

- the electronic use of municipal data and databases;
- the development of the digital competences of people working in the public sector;
- the development of urban-level communication and information flows;
- increasing the level of digitalisation at the local government;
- the development and promotion of e-administration.



The **tools** related to digital development can be placed into 5 groups in terms of their types:

- Providing information and shaping attitudes
Possible forms: delivering information via digital channels, “evangelisation” using various methods, the promotion of digital literacy
- Motivation
Possible forms: tax benefits for companies, generating cooperation (between educational institutions and companies), benefits for the population (e-tickets, card programme)
- Coordination and cooperation
Possible forms: the joint platform of stakeholders (developers) (“digital round table”)
- Infrastructure development
Possible forms: the development of the capacities of the municipality, the development of tools
- Training
Possible forms: formal (in educational institutions) and non-formal (other organised training) programmes; types: individual, community-based, collaborative.

III. PROGRAMMES TO BE IMPLEMENTED

In the course of the digital literacy development strategy, the first step was the definition of the challenges. This was followed by the identification of the target groups of the various challenges. As the first step, the appropriate tools to be used for the development of the given challenges of the target groups were identified. The result was the following action plan, consisting of 14 points, divided into 3 main areas, which include the interventions that develop the competitiveness of the population, of public

services, and of the population and the companies in a mixed way:

The development of digital education

- Teachers in schools providing formal education programmes should be enabled to develop and subsequently teach digital competences and skills;
- The School District and the Vocational Training Centre should prepare a digital competence development programme, using the “leeway” available in the local curriculum;
- There should be local-level trainings in the interest of the development of the digital competences of people with disabilities;
- For programmes providing vocational qualifications, there should be preparatory programmes building on the IT requirements of the given vocations;
- IT education should be reviewed and updated on municipal level, aligned with the curricular, exit requirements (up to the age of 18).

The development of municipal and local governmental digitalisation, IT

- The municipal data and databases should be available electronically;
- In the public sector, there should be digital competence development programmes building on the competence needs of the public sector;
- A municipal-level, digital communications strategy should be drawn up;
- Establishing digital administration processes by way of the digitalisation of the local government.



The implementation of activities supporting digitalisation



- Establishing a series of social programmes aimed at the realisation of campaigns related to digital competence development, the aim of which is the shaping of the population's attitudes toward digital competence development;



- Operating a coordination forum in Debrecen and its region for the alignment of the industry's needs and demands, as well as the supply side provided by education;



- Establishing an information forum for micro, small and medium-sized enterprises (MSMEs) in the interest of sharing the advantages and best practices of digitalisation;



- Operating a digital service providing centre for the MSMEs of Debrecen;



- The implementation of municipal-level infrastructural developments necessary for the development of digital competences and the everyday use of digital skills.

The main milestones of the implementation of the actions

- The designation of the party coordinating the implementation of the strategy;
- The alignment of actions with the available grants and other financing opportunities, the breaking down of the planning into smaller units (assigning responsible parties – channelling into grant applications);
- The establishment of measurements (generating indicators, conducting additional research, collecting data, establishing target values);
- The communication of the strategy (on municipal, local economic, local professional and national professional levels);
- Operating a round table the aim of which is monitoring implementation, and keep the momentum of the implementation of the strategy going.



THE COMPETITIVENESS OF THE POPULATION



THE COMPETITIVENESS OF PUBLIC SERVICES AND COMMON QUALITY OF LIFE

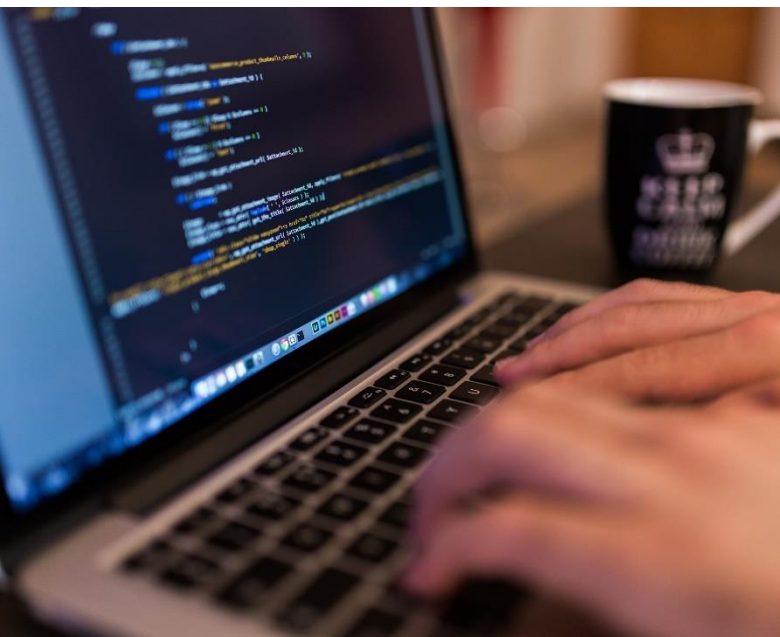


THE COMPETITIVENESS OF COMPANIES



9② THE DEVELOPMENT OF SERVICES BASED ON OPEN DATA

The second objective within Digital Debrecen is **the development of services based on Open Data**. Countless examples from abroad show that, thanks to IT professionals and start-up companies, there is huge potential in open data sharing. In London and Sydney, thousands of smart phone applications have been created based only on traffic data and having 4-star evaluations on a scale of 1 to 5, which shows the real need for such applications. This quantity sheds light on the nodes of development, either as deficiencies or opportunities, thanks to which the quality of the service providing the data may improve. Some of these can be transparent, which the service providers are also aware of, but have not yet been addressed due to other priorities, or the scarceness of human or financial resources, but the need for developments may also transpire that could not be seen before the data were shared.



The policies of the European Commission are also focused on creating value for the economy and society by way of the reuse of information from the public sector, i.e. government data (generated collected or paid for by state organs). Open data policy is linked to the policy of open research data, but further commercial and other purposes may also be defined by way of the reuse of data from the public sector:

- the encouragement of economic growth and innovation: public data have a significant potential for the re-use of new products and services;
- innovative solutions, e.g. the handling of social challenges in the areas of healthcare services and mobility;
- increasing evidence-based decision-making and the efficiency of public administration;
- they should become critical tools from the point of view of new technologies, e.g. the development of artificial intelligence (AI), which require the processing of a large quantity of high-quality data;
- the promotion of the participation of citizens in political and social life, increasing the transparency of governance.

Open Data Directive (EU) 2019/1024 on open data and the re-use of public sector information entered into force in July 2019, which the Member States must transpose into their national laws by 17 July 2021. Its significance is well shown by the fact that the provision of law before the above directive, the PSI (Public Sector Information)



Directive no. 2003/98/EC, which focused on the economic aspects of the reuse of information, already existed in 2003, and also by the fact that the direct economic value of public sector information in the EU is expected to increase from 52 billion EUR to 194 billion EUR in the period between 2018 and 2030³⁹.

I. THE CURRENT SITUATION

Thanks to technological development, a large amount of data is generated these days, and therefore, in order to create high added value, it is indispensable that such data can also be retrieved and used easily. The things necessary for this include the creation of a central, structured, exportable database, with the widest possible data sets (e.g. GIS – Land Registry records, traffic data, air quality and other liveability data), the installation of indispensable data collection tools, as well as awareness-raising and community building (innovative companies, university, start-up companies, general public). Apart from stimulating the economy, the presence of a strong start-up community and innovative enterprises also creates an attractive environment for highly-trained workforce. With open data sharing, such solutions improving liveability and the available services could be realised for which the necessary resources would not otherwise be available.

The smart solutions introduced between 2015 and 2018

The Debrecen Open Data portal (<http://opendata.debrecen.hu/>), started in 2016, is the official depository of open data related to

the city. It was launched with the publication of four main data sets: high-resolution digital photographs of Debrecen, HR, education, tourism and business data.

Thanks to technology, there are also examples for bottom-up initiatives, and these are not necessarily based on data from state or municipal sources only. An example is the special, thematic information map created in 2017, the main purpose of which is to help freshers and other new members of the university community get their bearings (<https://geosmart.unideb.hu/magyar.html>), developed by students at the Faculty of Science and Technology at the University of Debrecen. The “smart map” provides answers in more than 25 topics (e.g. where can you find bicycle racks, photocopiers, ATMs, hospitals, etc.).

II. OBJECTIVE

The issues of **data management** need to be addressed in a strategic manner. The data may be stored in multiple locations, but they must be **published through a single location** in order to facilitate their better accessibility. A good foundation for the above may be the already created Open Data Debrecen portal (opendata.debrecen.hu); however, this is still a platform in a rather rudimentary form with limited data sets available and therefore IT specialists and start-up companies cannot yet take advantage of the potential inherent in the sharing of open data. The **further expansion of the data sets** would be necessary, and these could be useful only if the data are made available in a

³⁹ Andrus Ansip, Digital Single Market, 05.08.2019, https://europa.eu/rapid/press-release_IP-19-525_en.htm

systematised way, and they can be easily **exported and edited**.

The scope of the data sources will continuously expand in the future. Following international good practices, an effort should be made in case of all municipal data for **open data sharing**. It may happen in several cases that the usefulness of the data, or the solution or service relying on it cannot yet be clearly seen at the time when the measurements are taken and the data are collected, and therefore, also in case of state-related data it is expedient to publish them in an open, machine-readable form.

III. PROGRAMMES TO BE IMPLEMENTED

It is necessary to establish a **central, structured, exportable database**, in which as wide and organised **data sets** should be added as possible, and in certain given situations it is indispensable to also **install data collection devices** serving as the sources of the data.

The most important parameters of the data are the following:

- **Availability and accessibility:** the data should be accessible in their entirety, for a cost not higher than their real reproduction costs, and if possible, published in downloadable form. Further, the data should be available in a convenient and editable form.
- **Suitability for re-use and redistribution:** the data should be available with such terms of use that allows re-use and redistribution, also including the merging with other data sets.
- **Universal participation:** the data should be usable, re-usable and redistributable by anyone, without discriminating any area of use, person or group. Provisions such as “not for

commercial use”, which would prohibit the use of for any profit-making activity, or only allows use for a given purpose (e.g. education) should be omitted.

At the same time, it is necessary also to define what data are available free of charge and what for a fee only, and which cannot be made part of the Open Data.



In addition to the above, it is of key importance to create a **community** whose members help each other in creating great things by using the data, and who can also make recommendations concerning what other types of data they would have a need for. One possible tool of such community-building is, for example, **creating dedicated groups in social media**, for which there was also an earlier initiative in Debrecen: (facebook.com/groups/opendatadebrecen).

Another efficient tool is the organisation of developers' competitions, “**hackathons**”, **get-togethers**, **workshops**, **conferences**, **meet-ups**.

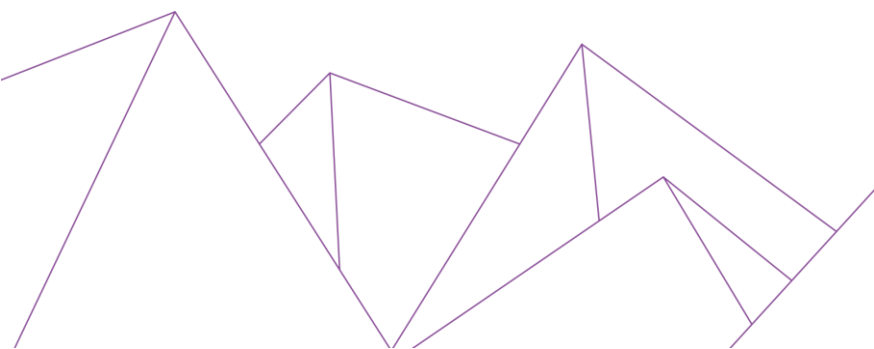
HORIZONTAL ELEMENTS

Horizontal elements appear in the focus areas of smart mobility, sustainable energy and digital Debrecen as well.

The first step is **bringing society on board**: on the one hand, as an awareness-raising and community-building element, and on the other hand, in the interest of involving the population, spreading information on the solutions introduced, popularising and promoting them.

The second horizontal element is the collection of the data in the widest possible scope, **in the interest of data-driven decision-making, the aim of which is the increasing and optimisation of efficiency.**

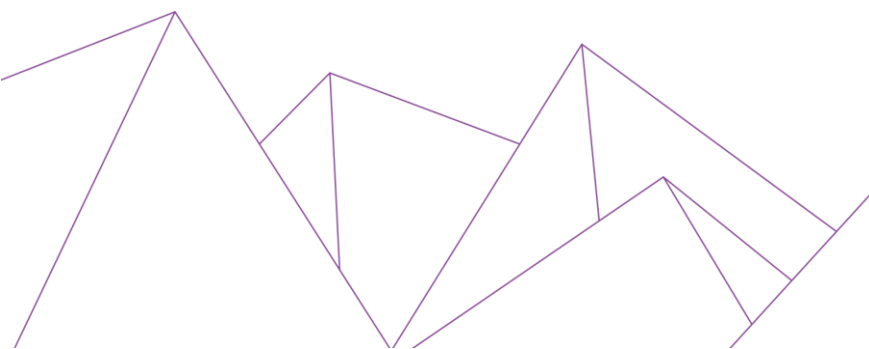
Thirdly, **international relations, cooperation opportunities and grants** are also of key importance: since this is an area featuring innovative solutions, it is indispensable to get to know best practices and tested solutions also in a cross-border way, with the possibility of also importing the successful ones to our own country.



10 BRINGING SOCIETY ON BOARD

Even though bringing society on board is an independent focus area in Debrecen Smart City, but unlike smart mobility, sustainable energy and digital Debrecen, it is a horizontal area which bridges all focus areas and is equally linked to each. Since Smart City is an innovative area and it often contains new, previously less-known solutions, bringing society on board and communication are of special importance in every project. In many cases, even a solution that has been tested and works well somewhere else needs to be customised and adjusted to the specificities of the given city.

We can fundamentally formulate 3 objectives. Especially in case of pilot projects, experimental solutions (e.g. smart pedestrian crossings), which are in most cases limited in terms of area or functionality, it is important to **involve the population**, in the interest of collecting and providing feedback and assessing the expected effects. This way, the level of acceptability by the local population increases (the earlier stage they receive information, the more), and they can also make suggestions. To stay with the previous example, they can suggest locations where new smart pedestrian crossings could be installed. Fundamentally, the urban population can react to a solution that they have already seen and experienced solution then at the time when the assessment and definition of the needs takes place.



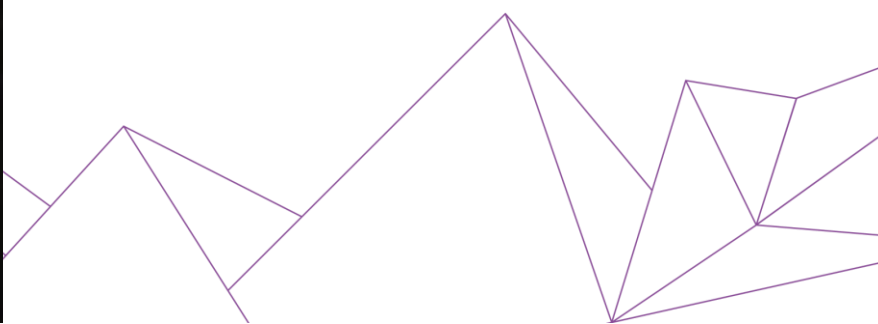
The second objective is the **spreading of the projects and solutions** as quickly as possible. The introduction of e-tickets, the Waze partnership of the Rollet application are not for their own sake; they only serve the purpose of improving liveability and can become useful if the solution is known among the population, and people start to use it, a precondition of which is the widest possible reach.



The third objective is **community-building**, since in case of a larger, living Smart City community, economic players can find each other and cooperation is forged with the university community more easily, start-ups can develop and Smart City solutions can spread faster.

The smart solutions introduced between 2015 and 2018

Bringing society on board has been part of **Debrecen Smart City** since the very beginning. The **conscious building of the Smart City community** is of outstanding importance, in the interest of which an own, dedicated **website**, also available in English, was created in 2016, which received, still in that same year, the Website of the Year certificate from the Hungarian Marketing Association in the Local councils and settlements category. In addition, social media provides an opportunity for two-way communication, whereby the **Facebook page of Debrecen Smart City** with 2,500 followers is the largest Smart City page in Hungary. The Smart City Meetup series is of outstanding importance, in that it departs from the online interface and provides an opportunity for personal interaction, networking and the sharing of opportunities between the local population, market players, university instructors and members of the Debrecen Smart City team. The first event of this now internationally recognized programme series was held in 2015, and there have been more than 22 occasions by the end of 2018, occasionally with as many as 100 attendees.



11 DATA-DRIVEN DECISION MAKING, EFFICIENCY OPTIMISATION

The most frequently recurring element of the previous chapters is data. **The future belongs to data**: what we have no processed information available on is much more difficult to operate efficiently.

In case of the projects of all focus areas the importance of data emerges: in case of mobility, without the claim for exhaustiveness, these include traffic data from Waze, parking data from Rollet, the number of users of public transport and the travelling habits as measured by the validators (electronic ticket control) and derived from the number of those connecting to the WiFi network, the pedestrian and cyclist counters, as well as the smart camera system overarching all modes.

In the field of sustainable energy, the use of smart meters for the real-time measuring of energy consumption, the energy management centre for managing the same, air quality sensors, etc.

Within Digital Debrecen, a specific objectives is the development of services based on Open Data, the most fundamental element of which is data and its public sharing. Thanks to 21st-century technology, **measurements** can be taken and **data** are generated in many more areas, relying on which the projects can be **better designed**, **measuring indicators** can be defined with the help of which their **efficiency** and the expected **implementation** can be controlled.



12 INTERNATIONAL RELATIONS, COOPERATION OPPORTUNITIES, TENDERS

In addition to bringing society on board and data-drive decision-making, the third important horizontal element in all focus areas is the **forging of international relations** and searching for **cooperation opportunities**.

First off, due to the innovative nature of Smart City, solutions often never tested in Hungary are being considered, for which purpose it is indispensable to get to know **good practices** from abroad, along with the difficulties inherent with their implementation, so that Debrecen can choose from the widest possible range of possibilities and learn from any mistakes.

Secondly, in many cases, the Hungarian or Debrecen market may be too small for the introduction of a given solution, in which case a **regional cooperation, together with other cities in the Visegrád region** can be of a sufficient scale.

Thirdly, after the 2014-2020 programming period, the system of financing from various European Union funds is expected to change, and therefore, it is necessary to get to know the grant opportunities still available, as well as to **establish partnerships for the joint, cross-border grant applications**.

A few examples for such European programmes:

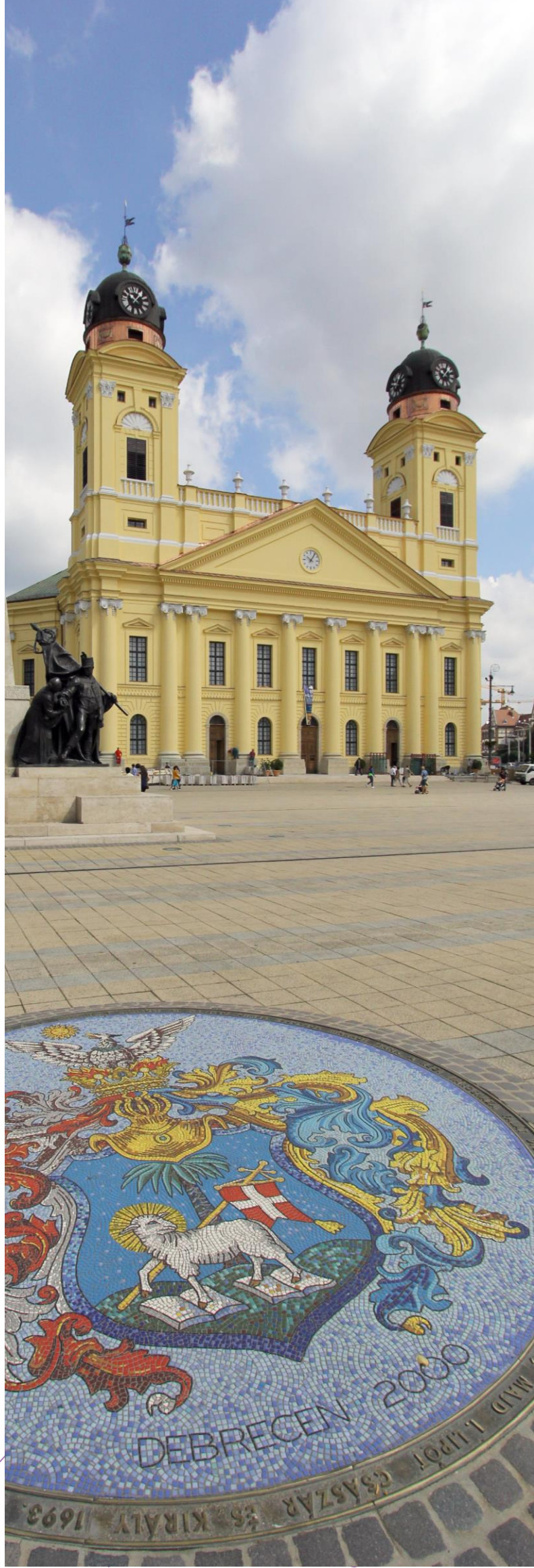
- LIFE (Environment and Climate programme)
- CLLD (Community-led Local Development)
- URBACT III
(Sustainable Integrated Urban Development)
- CIVITAS (Sustainable Urban Mobility)
- Regional Cooperations
(Cross-border cooperation, Transnational cooperation, Interregional programmes, Interreg Europe, Urbact III)



Beyond the abovementioned programmes of the European Union, significant assistance may also be provided by the various project development tools, e.g.

- ELENA
European Local Energy Assistance
- JESSICA
Joint European Support for Sustainable Investment in City Areas
- JASPERS
Joint Assistance to Support Projects in European Regions
- EEF-F
European Energy Efficiency Fund
- HORIZON 2020
(The programme determining the research, development and innovation policy of the European Union between 2014 and 2020)

In addition to the above, alternative financing methods and third-party financing (e.g. ESCO) and the Norwegian Financial Mechanism should also be examined as possible sources.



Thank you all for your contributions:



A Debreceni Vagyonkezelő tagvállalata



Debrecen
SMART CITY

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