SMART PRAGUE INDEX

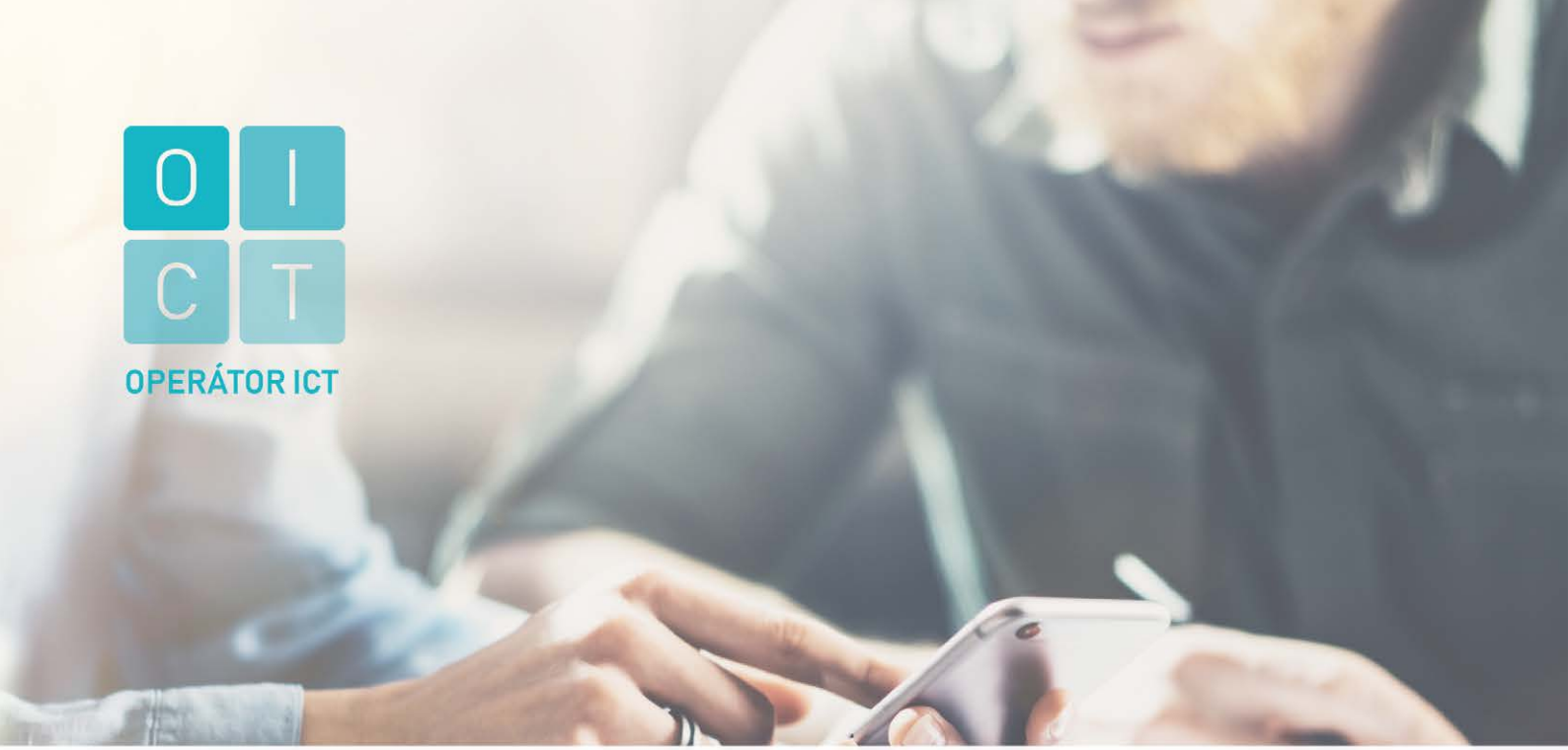
YEARBOOK 2020

OPERÁTOR ICT

SMART PRAGUE

PRAHA PRAGUE PRAGA PRAG

OPERÁTOR ICT

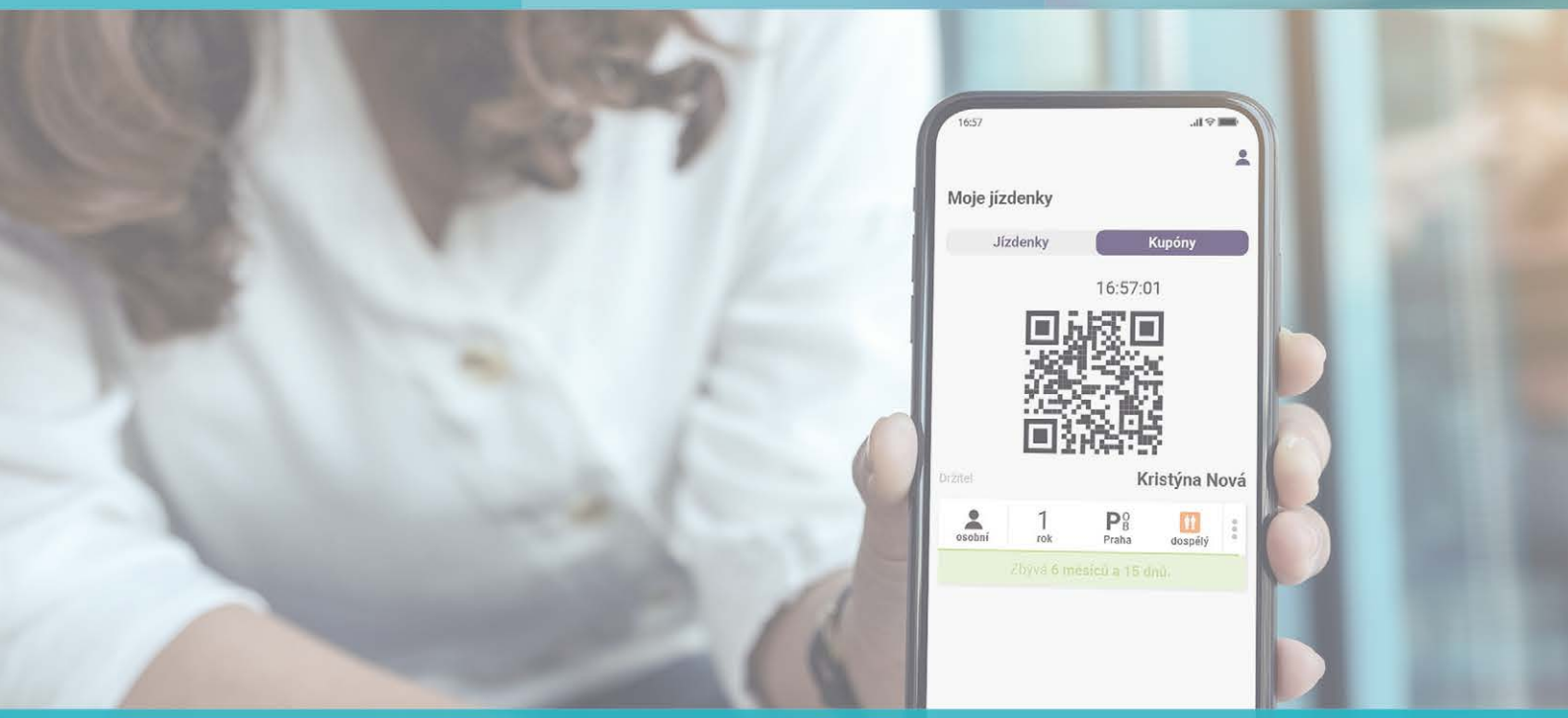


We create a technological future for a better life in Prague

Smart Prague and innovations

IT services

Mobility as a Service



SMART PRAGUE · moje Praha · změňte.to · PRAGUE VISITOR PASS · GOLEMIO PRAGUE CITY DATA · PORTÁL PRAŽANA · PID Lítačka

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OPERÁTOR ICT

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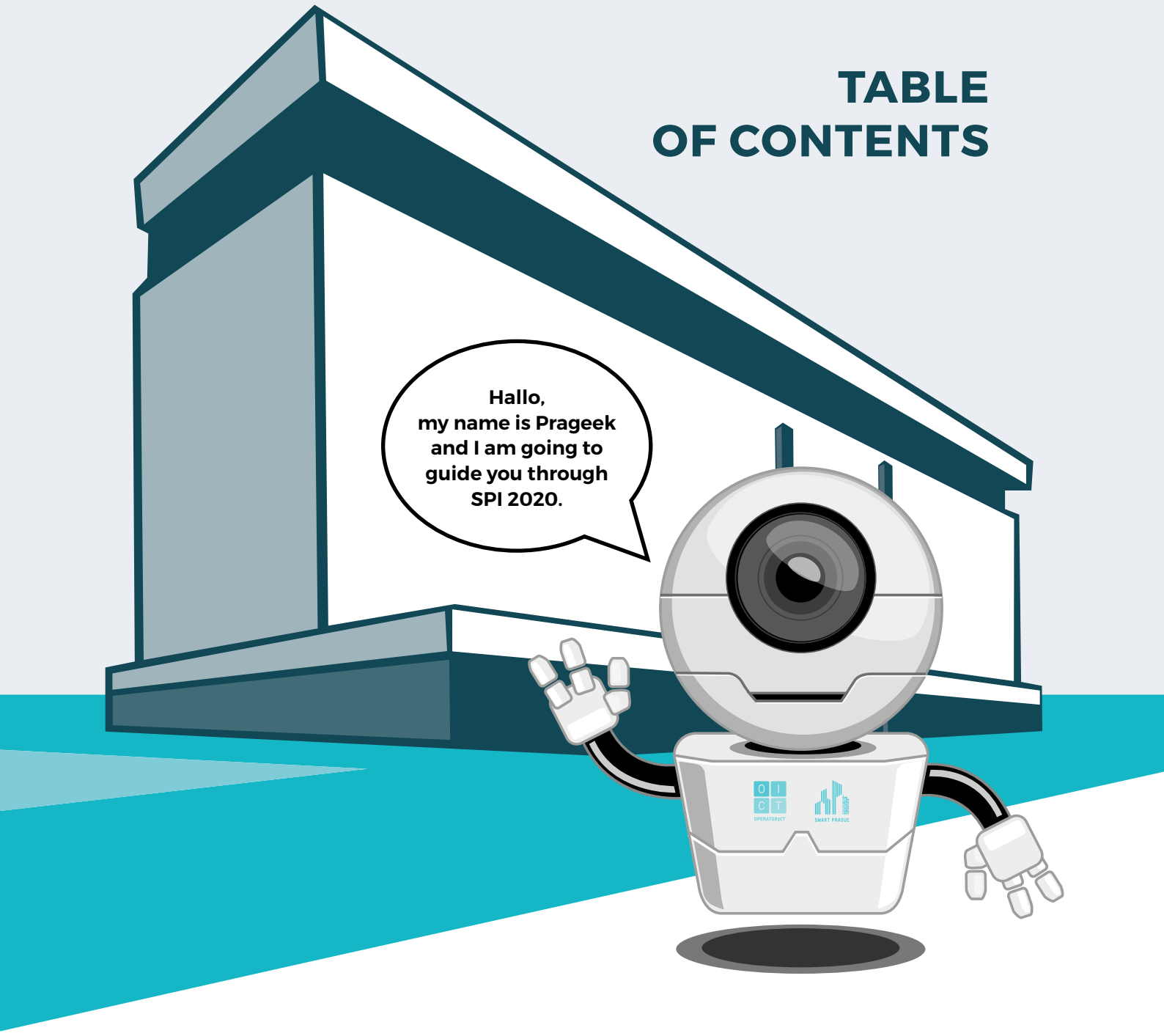


1.

MUDr. Zdeněk Hřib
Mayor of Prague Capital City

INTRODUCTION BY THE **MAYOR OF THE CAPITAL CITY OF PRAGUE**

Dear readers,

I am very pleased that you have again received the new edition of the Smart Prague Index, this time for the year 2020. This is the fourth edition of this unique analytical document, which is prepared by a team of experts of the city company ICT Operátor and aims to map in detail the fulfilment of the set goals of the Smart Prague 2030, strategy, using a precise methodology our "Smart Prague".

It will certainly not come as a surprise to you that, like all aspects of our lives, the projects of Smart Prague have been significantly affected by the coronavirus epidemic over the past year. It is this experience that has further assured us that a city can be resilient only if it can properly process and subsequently use the data at its disposal. For example, in the area of public transport, we obtained very valuable data during the pandemic, thanks to which we were able to react operatively to the use of public transport by the citizens of Prague during the individual waves of the epidemic.

The daily use of "hard" city data and the methodology tailored to Prague are unique tools available to Prague, and our experience with data is of interest not only to cities in Europe, but also around the world.

In this year's Smart Prague Index, you will also learn about the development of projects in the six priority areas, which are targeted by the Smart Prague 2030 concept. These are the Mobility of the Future, Waste-free City, Smart Buildings and Energy, Attractive Tourism, People and the Urban Environment and the Data Area. For example, the data from 2020 show that the number of charging stations in the streets of Prague has grown by almost 20 % in comparison to 2020, in order to comply with the high demand of the citizens of Prague. The number of registered electric vehicles in Prague in 2020 rose to 7,938 which represents an increase of more than three times of the interannual amount.

All of the data prove that the citizens of Prague are very interested in individual electromobility.

I wish you a nice and inspiring read and you can already look forward to the next yearbook of our Smart Prague Index, our colleagues from OICT are already working on it very intensively.

2.

Michal Fišer, MBA

Chairman of the Board
of Directors and CEO
of Operátor ICT, a. s. (Plc.)

INTRODUCTION BY THE **CHAIRMAN OF THE BOARD OF DIRECTORS OF OPERÁTOR ICT, A. S.**

Dear readers,

the COVID-19 pandemic brought with it a number of limitations in the work and personal lives of each of us. However, for OICT, this time also meant confirming the path we have been following since its inception – whether it is finding and publishing accurate information in the form of data that helped the city management respond quickly to pandemic developments, operationally provide quality IT service and support, which enabled our and municipal employees to work from home, but also to launch a project that will simplify communication between citizens and the authorities.

At the end of September 2020, the Portal Pražana was launched, which at the end of 2020 competed among 27 public administration electronification projects and won the **Egovernment the Best 2020 competition in the Urban Projects category**. And we are still at the beginning, other functionalities will be added during 2021!

In 2020, several long-term OICT projects were awarded in prestigious competitions. Two projects succeeded in the final of the **17th year of the IT project of the year 2019, a competition organized by the Czech Association of Information Technology Managers (CACIO)**. Representatives of the **Smart Waste Collection and Data Platform of Prague Capital City – Golemio projects received the award at the Liechtenstein Palace**. The second one of these projects won **the 22nd year of the Golden Coat of Arms competition in The Best Electronic Service and Smart City Projects category**.

Another award was awarded to OICT for the project System for automated entry and exit of vehicles from the city car park, which the company OICT launched in 2019 in Letňany, Prague. **The project placed third in the Parking of the Year competition in the Innovation category**. The competition is organized by the Czech Parking Association.

A simple list of these awards would certainly be enough to mark the past year as successful from the OICT's point of view. But we do not rest on our laurels. As the situation slowly returns to normal, we want to be more and more active and further develop not only existing successful projects, but to prepare new ones that will help us fulfil our credo in 2021 "We are creating a technological future for a better life in Prague".

3.

SMART CITY CONCEPT

3.1 SMART CITY COMPETITIONS AND RANKINGS

The promotion of the Smart City concept and smart solutions helps to increase general awareness of the benefits of smart cities and to bring this concept closer to the public. With the development of the Smart City concept, there is also a growing need to compare individual cities or sub-projects and to share the applied solutions - Smart City competitions and rankings evaluating the smartness of cities enable mutual comparison of the cities. Nowadays, there are many events and contests that award the most interesting and innovative ideas and projects that the cities implemented in the past within the Smart City area. Also, the purpose of these competitions is to find out what the practice is in implementing smart solutions, as well as to provide lessons and inspiration for the management of other cities. Some competitions in the Czech Republic make smart solutions accessible to citizens and enable the assessment of sub-projects directly to the residents of a specific city. Most competitions are focused on methodological support and sharing of good practice, such as smart cities. We also present the placing of Prague in the evaluation of the IMD Smart City Index, which is based on the evaluation of cities by its residents.

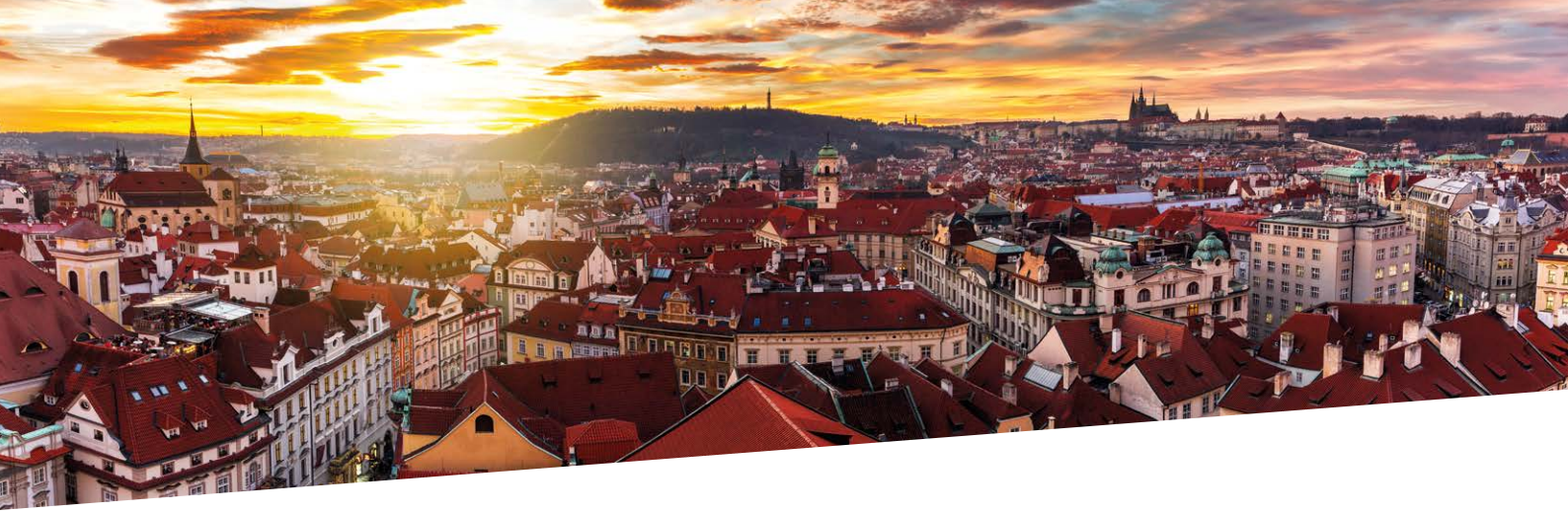
The Place to Live 2020[1/]
The best place to live in the Czech Republic is Prague, winning the poll of the same name for the fourth time. The Hradec Králové region came in second and the South Bohemian region came in third. The biggest positives of Prague include, for example, healthcare and social services, the highest number of doctors and the ratio of capacities in hospitals to the number of residents. Prague is number one in longevity in the Czech Republic and has the lowest morbidity. Other positives include cultural activities, labour market opportunities and wages. On the contrary, the negatives include bad environment and a lower level of safety, to give a few examples.

Quality of Life Index 2020
The Quality of Life Index compares 206 municipalities with extended powers, including Prague, on the basis of publicly available data. It includes a total of 29 indicators, which express, among other things, the level of health, environment and availability of health care, optimal material conditions, sufficiency of services, but also relationships between people. In the Quality of Life Index, Prague has repeatedly ranked 2nd, following the town of Říčany.[2/]

Smart Cities 2020
The competition is organised by the Smart City Innovations Institute in cooperation with the Ministry of Regional Development, the Union of Towns and Municipalities of the Czech Republic and the Association of Regions of the Czech Republic. The main purpose of the competition is to promote specific projects and long-term strategies of nationwide Smart City models. Within the fourth year of the national competition Smart Cities, Prague got into the final duel with its project PID LÍTAČKA Prague entered by the Central Bohemia region in the category of Project for cities over 200,000 residents.[3/]

We are Opening 2020 Data Together
The OSF Foundation, which was originally part of the transnational Open Society Foundations network, announced the 8th year of the competition of the same name for the best applications based on open data. There was a total of five categories in the competition. The winner in the special category COVID-19, which was intended to support digital "emergency" projects helping to solve the coronavirus crisis, and again point out the importance of working with data, was the Overview of COVID-19 sampling points in Prague and the Central Bohemian region by the ICT Operátor. The key task was to increase public awareness in the crisis situation of the rapid onset of the second wave of COVID-19, when state structures did not offer an easy-to-use way of orientation at sampling points.[4/]

SOURCE: **1/** ČTK, "The best place to live in the Czech Republic is Prague, the Ústí nad Labem Region took the last place", Aktuálně.cz, 3 September 2020, available at https://zpravy.aktualne.cz/domaci/nejlepsi-mistem-pro-zivot-je-praha-nejhur-je-na-tom-ustecky/r~fb110df6eddd11eaa7deac1f6b220ee8/, check on 6 May, 2021. | **2/** Pavla Adamcová and Jan Kačer, "The influx of young people and the fight against unemployment. The ranking of cities rreveals how people live in the Czech Republic ", Aktuálně.cz, 10/2020, available at https://zpravy.aktualne.cz/ekonomika/index-kvality-zivota-2020-kde-se-v-cesku-nejlepe-zije/r~82cfd188144811eb8972ac1f6b220ee8/, check 2 May, 2021. **3/** Protext, "Czech smart cities came up with new revolutionary projects and solutions", České noviny, 12/2020, available from https://www.ceskenoviny.cz/zpravy/ceska-chytra-mesta-prisla-s-novymi-prevratnymi- projects-and-resenimi / 1970959. check on 2 May, 2021.



IT Project of 2019

In 2019, the 17th year of the IT Project of the Year competition took place, which is announced by the Czech Association of Information Technology Managers. Due to the measures against the spread of the COVID-19 virus, the ceremonial announcement of the results of the competition took place on September 15th, 2020.[5/]

The following placed among the best projects in the finals – the "Smart waste collection" from the Office of the City of Prague / ICT Operátor, a. s. (Plc.), and the project "Data Platform of Prague Capital City – Golemio" for the Office of the City of Prague, city districts, state-funded institutions and established organizations of the Office of the City of Prague and the city districts, OpenData for the general public, by the Office of the City of Prague / ICT Operátor, a. s. (Plc.)

Zlatý erb (Golden Crest) 2020

The 22nd year of the Golden Crest competition for the best websites of cities and municipalities and electronic services and Smart City took place under the official auspices of the Ministry of the Interior, the Union of Towns and Municipalities, the Association of Local Authorities CZ and the Association of Secretaries of Municipalities CZ. The main partner of the competition was the company Gordic.

In the Electronic Services and Smart City category, Prague was awarded the 1st place: Open-source Data Platform of Prague Capital City – Golemio. In the category named Websites of towns and municipalities, the 1st place was held by Prague 12.[6/]

Carpark of the Year Competition

In 2020, the Czech Parking Association, z. s. p. o. awarded several projects related to parking. Voting took place in 3 categories and each category was awarded on the basis of the opinions of the expert jury as well as the public. The pilot project of the System for automated entry and exit of vehicles from the city carpark won the 3rd place in the Innovation category.

The pilot project of the System for automated entry and exit of vehicles from the city carpark, specifically P+R in Letňany, was completed in 2020, including a study and analysis of the Smart Prague OICT project office that focused on payment terminals in paid parking zones. As part of the testing of automated entry and exit from P+R Letňany, not only was the economic advantage of this solution proven, but also the benefit of using mobile applications as universal payment channels for the implementation of non-cash payments proved convenient. The mobile application of the Lítačka card offers navigation to the carpark or display of the online status about the number of vacancies to its users. Thanks to this pilot project, automated entrances and exits can be implemented in another approximately 20 P+R carparks in the city, which will provide citizens with better user comfort when using them.[7/ 8/]

IMD Smart City Index 2020

The IMD Smart City Index is a newly created index that evaluates a city's performance compared to others based on its perception by residents, with 120 residents of each city being addressed. Based on the HDI value, individual cities were included in one of four groups. Within each HDI group, cities are assigned a "rating scale" (AAA to D) according to the perception score of that city compared to the scores of all other cities within the same group. Two pillars were assessed: "Structural", related to existing urban infrastructure, and "Technological", describing technological measures and available services. For each pillar, five key areas were defined: health and safety, mobility, activities, opportunities and governance.[9/] The resulting city profiles contain ratings for each pillar and an overall ranking within the 109 cities. Prague took the 44th place – ahead of Paris or Milan.[10/] In comparison, Stockholm took the 16th place, Berlin the 38th, Budapest 77th and Bratislava 76th place.[11/]

SOURCE: **4/** OSF Foundation, "Together We Open Data 2020", OSF Foundation, accessed 2 May 2021. available at https://osf.cz/programy/ziva-demokracie/nas-stat-nase-data/soutez-spolecne-otevirame-data-2020/, check on 2 May, 2021. | **5/** Cacio, "Cacio in the Veils 2020", Czech Association of Information Technology Managers, undated, available at https://www.cacio.cz/akce/2020/cacio-v-rouskach-2020, check on 2 May, 2021. **6/** Prokop Kanopa, "Results of the National Round 2020", Golden Coat of Arms, 25 November 2020, https://www.zlatyerb.cz/vysledky-celostatniho-kola-2020/d-1598/p1=1755, check on 6 May, 2021. | **7/** OICT, "The year 2020 was smart also from the point of view of OICT", Smartprague.Eu, 1/2021. available at https://smartprague.eu/aktuality/i-covidovy-rok-2020-byl-z-pohledu-oict-smart, check 2 5. 2021. | **8/** OICT, "The OICT project, which enables 'smart parking', succeeded in the Parking of the Year competition", Operatorict.cz, 6 august 2020, available at https://operatorict.cz/projekt-oict-ktery-umoznuje-chytre-parkovani-uspel-v-soutezi-parkoviste-roku/, check on 2 May, 2021. | **9/** On the methodology itself, comp. IMD et al., Smart City Index 2020, 2020, p. 13. available at https://www.imd.org/globalassets/wcc/docs/smart_city/smartcityindex_2020.pdf, check on 6 May, 2021. **10/** IMD et al., Smart City Index 2020, s. 92. | **11/** IMD et al., Smart City Index 2020, s. 108, 25, 35 a 31.

3.2 SMART CITIES DEVELOPMENT

prof. Dr. Ing. Miroslav Svítek, dr. h. c.

When we start dealing with the area of smart cities, in the first approach we come across the collection and processing of a large amount of data. Unfortunately, the data itself won't tell us that much if we can't create information from it that already give us answers to questions like: How much? How often? How far? The information is relevant, but it is still not enough to run the city. Based on the available information it is necessary to extract the required knowledge in the form of answers to the questions: Why? Due to what reason? In order to answer these questions, we need to create a model of the system at a certain distinguishing level, which we can then use for better governance and management of the city.

From the technical point of view, the area of smart cities resembles a building set made of smart elements. The basis is smart homes with their control systems (temperature, comfort, etc.). At the next level, we can talk about smart buildings (residential buildings, theatres, schools, railway stations, etc.). From buildings and smart city infrastructure, you can create a smart street, a park, a neighbourhood, and finally the whole city. Although each household, building and infrastructure is managed differently, SMART solutions can seek coordination between them to minimize energy consumption, environmental impact, maximize the use of urban infrastructure, increase the attractiveness of the area or ensure better sustainability and resilience of territorial units.

Sustainability is a term that is often used in the context of smart cities, especially in the field of environment. Despite the considerable importance of the environment, I dare to say that the other two components are equally important for the development of the city. Economic sustainability guarantees the attractivity of the city for qualified companies, experts in various fields, educational institutions etc. It is necessary to realize that each city is in a certain competitive, but also cooperative relationship with other cities. Although the city may have excellent environmental parameters, if there are no interesting job opportunities, it will be difficult for young people to want to live there and the city will suffer in the long run. The same can be said for social sustainability. If there was unrest or disorder in a given city and great social differences were be visible at first glance, if people did not feel comfortable in the city, the city would not develop either.

In view of the COVID-19 pandemic, current urban development places much greater emphasis on strengthening resilience to global climate change, natural disasters, social unrest, terrorist attacks, as well as cyber-attacks and power outages. We should learn from the COVID-19 pandemic and realize what has strengthened us and increased our resilience. It was pleasant to see that people were able to take care of themselves and also provide help within their community and surroundings. In the framework of solidarity, they have created a tremendous amount of innovation and contributed creatively to solving acute problems.

On the other hand, we should also talk about weaknesses that have damaged as well as weakened us, or actually proved useless. It will certainly be necessary to think about strengthening the self-sufficiency of partial territorial units, creating reasonable stocks, preparing more detailed crisis scenarios, but also more effective use of smart applications to deal with similar situations.

The area of smart cities is already a major topic not only for technical fields, but also for experts in the humanities, for example sociology, psychology, etc., who definitely have much to say on the topic. I believe that the fields of science, research, innovation and education are key activities of all future "smart" solutions. Smartness, among other things, means that we all realize that together we can achieve more.

A great example is the National Centre for Cybernetics and Artificial Intelligence (NCK TAČR), where an interdisciplinary team was created, consisting of experts in indi-

vidual fields, namely transport systems, energy networks, spatial planning, smart buildings and environmental modelling. During the discussions, the idea arose of the so-called "Smart European", i.e. Prague's "digital polygon", which would begin with a roundabout in Dejvice ("Kulaťák") and end at Václav Havel Airport. The polygon conceived in this way includes practically all modes of transport - air transport thanks to the airport, railway transport thanks to the Prague - Veleslavín railway station, public transport with tram and bus lines, but also important metro stations Dejvická, Bořislavka and Veleslavín. I am very glad that both the ICT Operátor and other city organizations have joined this plan.

Thanks to the polygon, it will be possible to test synergies between different smart solutions in one place and evaluate their impact on the sustainability and resilience of territorial units. The discussed live laboratory will be an integral part of teaching in the new study "double-degree" program "Smart Cities", which has been taught since 2020 at the Faculty of Transportation CTU (www.fd.cvut.cz) in cooperation with the University of Texas at El Paso (www.utep.edu) listed in category R1 of research universities in the USA. Graduates of the new study program will receive both a Czech and an American master's degree, which will open up opportunities for a wide international application in this field.

At the same time, in 2020, the doctoral program "Smart Cities" was successfully accredited, in which the Faculty of Architecture of the Czech Technical University (www.fa.cvut.cz) also participates. The dissertations of the doctoral students will naturally deal with smart solutions for Prague Capital City, which opens up further possibilities for mutual cooperation between the city and academic institutions.

In conclusion, the area of smart cities is becoming an integral part of the ongoing fourth industrial revolution. Indeed, it is a revolution, and not just evolution, because the impact of interconnected systems on the Internet of Things, services and people will affect all known socio-economic processes. In this context, we are talking about Company 4.0 or also Thinking 4.0. Let us be glad that we can live and work in such an inspiring turning point and jointly develop specific projects within the Smart Prague program.

3.3 A SMART AND RESILIENT CITY

The concept of smart and resilient cities seeks to make an appropriate use of modern technologies to create synergies between different sectors (transport, energy, logistics, security, environment, building management, etc.) based on reliable data, information and knowledge, with regard to the resilience and sustainable development of urban units and the quality of life (QoL) of their citizens.

Smart city applications can be divided into target and species. Target applications seek to optimize energy consumption, improve air quality, reduce noise, regulate traffic, etc. Species applications, on the other hand, support the identity of a given place, i.e., its own historical, cultural, ecological or aesthetic essence.

As urban units are characterized not only by their high population density, but also by interacting and physically overlapping infrastructural elements with different functions, the role of urban resilience cannot be studied separately. The solution must include all the links and synergies between the sectors concerned, including a significant decentralization of the necessary resources. This is a very important area that cannot be covered by one expert or any large company. To successfully manage this problem, cooperation between individual professions is necessary, which requires mutual understanding of different perspectives on the particular problem.

Smart solutions offer not only better prevention based on a better understanding of sub-processes, but also better optimization of interventions in the event of emergencies. In crisis situations, it is necessary to guarantee the functionality of the selected critical infrastructure, to ensure its constant monitoring and management of its traffic. This enables the deployment of modern technologies for simulations of various scenarios, together with the recommendation of the best possible responses to the situation.

Reactions to various hazards, e.g. global climate change, natural disasters, social unrest, terrorist attacks, cyber-attacks or power outages are part of urban resilience, which is defined as the measurable ability of urban units together with their residents to maintain the operation of these units despite the threat of diverse emergencies and at the same time positively adapt and transform these units towards sustainable development.

The area of smart and resilient cities is an integral part of the ongoing fourth industrial revolution. It is really a revolution, and not just evolution, because the impact of interconnected systems on the Internet of Things, services and people will affect all known socio-economic processes. Therefore, we talk about the Society 4.0 or the Thinking 4.0. It is the challenge that we all should use in order to transform to a smarter and more resilient society that we were before the start of the COVID-19 pandemic.

3.4 CITY MANAGEMENT

Smart City management uses a number of sensors starting with physical detectors to processing cosmic views (weather forecast, thermal city maps, or emission maps). It should be noted that within this concept even your own vehicle or mobile phone becomes an intelligent sensor providing important data. With the help of public light-

ing infrastructure, it is possible e.g. to implement a sensor network and at the same time ensure the availability of telecommunications services throughout the city.

From a technical point of view, the Internet of Things (IoT), the Internet of People (IoP), the Internet of Energy (IoE) or the Internet of Services (IoS) infrastructure will be increasingly used. From a theoretical point of view, a copybook example of a cyber-physical-system (CPS) or better said in the case of a smart city of a social-cyber-physical-system (S-CPS) is created.

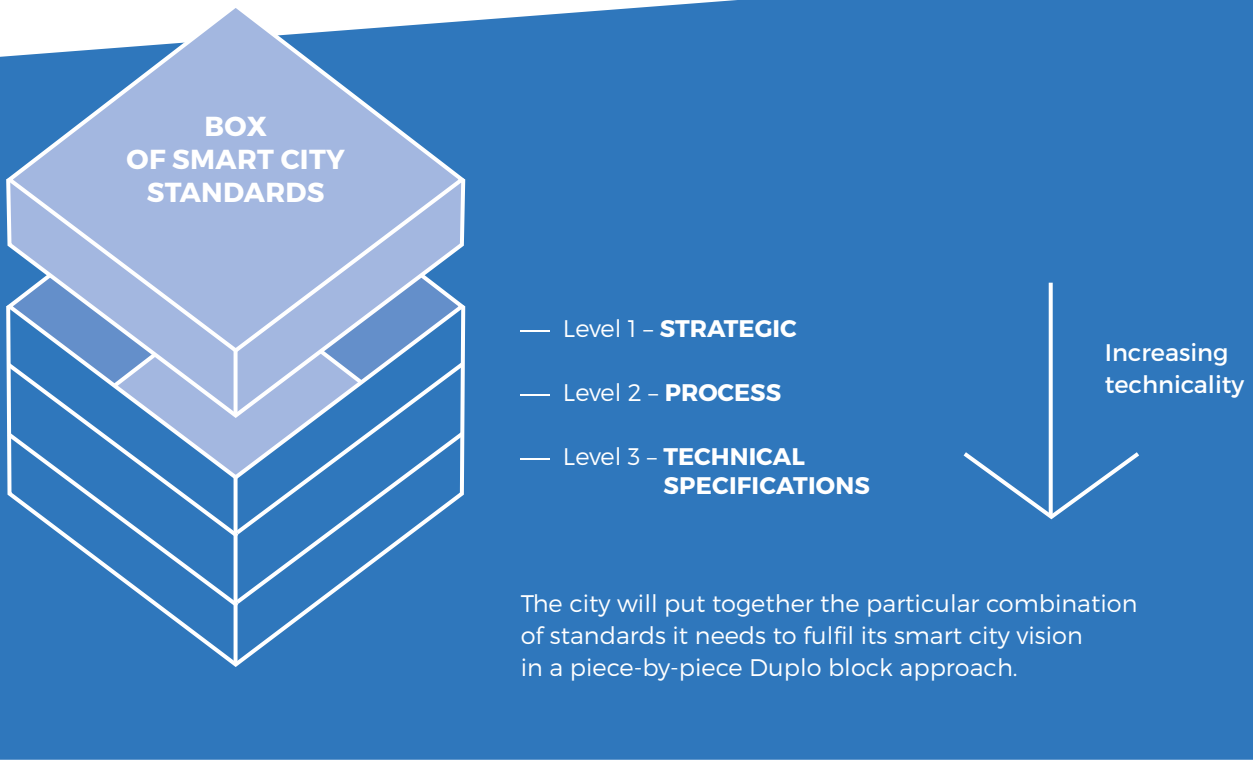
Supercomputers, including cloud computing services, are increasingly being used to process large amounts of acquired data (Big data). Thanks to current data, city management is shifting from the original predefined dynamic plans to adaptive control algorithms that ensure the coordination of entire territorial units. Various simulation tools are successfully used to verify individual strategies. In virtual space, it is much easier to model responses to different types of emergencies. Proven strategies can then be translated into real city management through action members, which can be both physical infrastructure facilities and navigation or assistance services, up to the prospective operation of autonomous systems such as unmanned vehicles.

3.5 SMART CITY STANDARDS

Smart City standards are not the work of a single standardization organization, but there are several major players in the field. Standards play a key role in the introduction of new technologies and are important for the global growth of smart cities. Below are selected standards that form the basis of the Smart City concept. Their list is far from final, a more comprehensive list of standards can be found in The British Standards Institution's (BSI) documentation in the English original Mapping Smart City Standards.[12/] This framework is used to classify standards and categorize them into three levels, as indicated in the figures below [Figure 3.5.1, Figure 3.5.2].

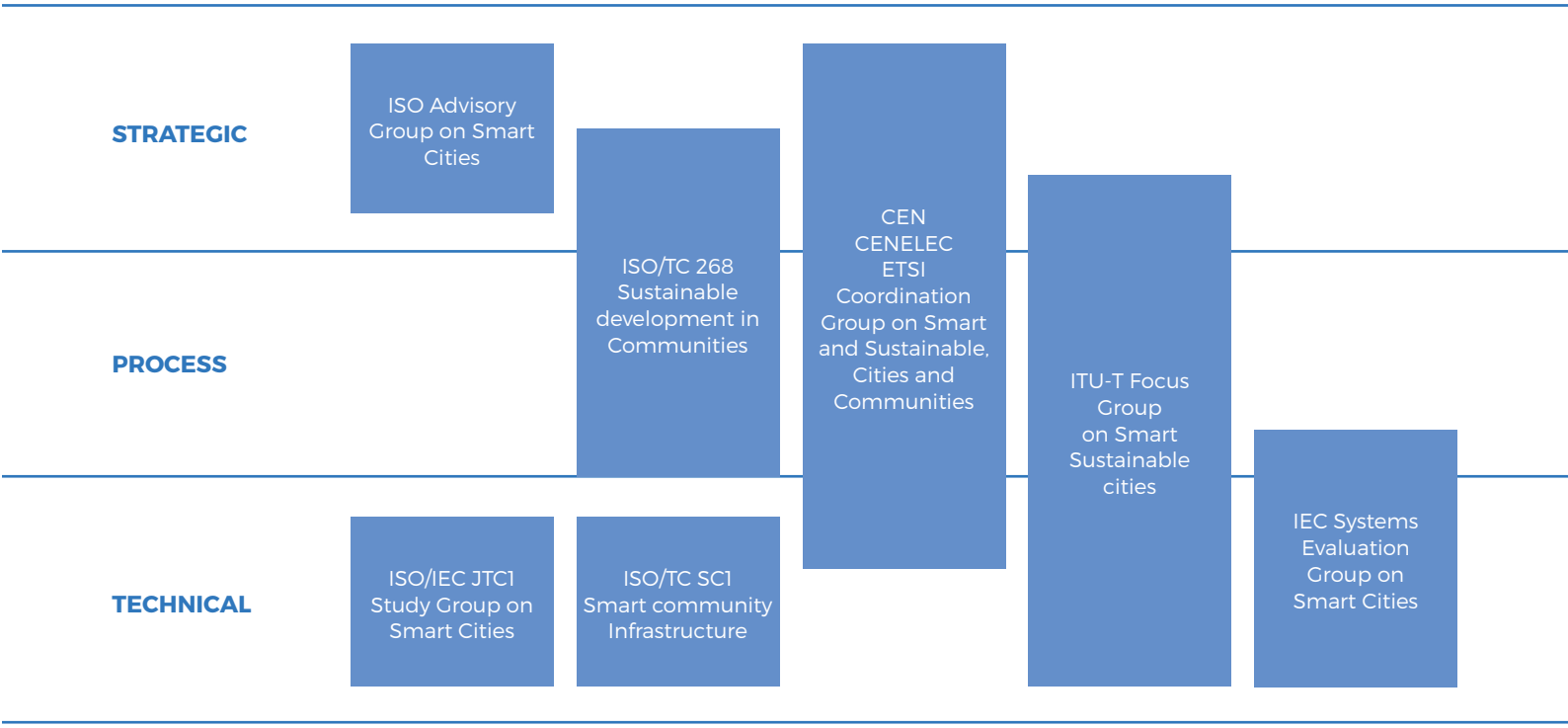
It can be said that the implementation of standards for Smart City is a very complex task, as it seeks to bring order to a very wide range of activities – from water pipes to the residents themselves. SMART solutions do not mean various sub-solutions without links and contexts, but rather solutions that include more interrelated areas also because it is a relatively new phenomenon and most standardization organizations are in a phase where they are just trying to find their place and way, how to best contribute to the topic.

FIGURE 3.5.1 – SMART CITY STANDARDS[13/]



SOURCE: **12/** Koen Van Dam, Mapping Smart City Standards (London: bsi, nd), available at https://www.bsigroup.com/LocalFiles/en-GB/smart-cities/resources/BSI-smart-cities-report-Mapping- Smart-City-Standards-UK-EN.pdf, check on 22 April, 2021.
13/ Available from http://urbanopus.net/wp-content/uploads/2016/06/Screen-Shot-2016-06-18-at-3.27.17-PM.png, check on 22 April, 2021.

FIGURE 3.5.2 – SMART CITY STANDARDS, DETAIL[14/]



LEVEL 1: STRATEGIC

This category of standards focuses on the process of developing a smart city strategy, trying to provide city leaders with guidance on development and a solid basis for establishing a clear and effective smart city strategy. It contains instructions for setting priorities, developing an implementation plan and effectively monitoring and evaluating progress.

- ISO 37120: Sustainable cities and communities - Indicators for city services and quality of life / Sustainable cities and municipalities – Indicators of urban services and quality of life
- ISO 37101: Sustainable development & resilience of communities – Management System / Sustainable development & resilience of communities – Management system
- ISO 37102: Sustainable development & resilience of communities – Vocabulary / Sustainable development and resilience of municipalities – Vocabulary
- BS 8904: Guidance for community sustainable development

LEVEL 2: PROCESS

The standards in this category address the assigning and management of smart cities projects. They provide guidance and best available practices for managing Smart City projects.

- PAS 181: Smart Cities Framework
- PAS 182: Smart Cities Data Concept Model

LEVEL 3: TECHNICAL

The last group of standards is focused on the implementation of Smart City projects. It covers a large number of technical specifications that are necessary for implementation of smart city tools and services in order to achieve the goals of Smart City.

- ISO/EIC AWI 30145: Information technology
- ISO/EIC AWI 30146: Information technology – Smart city ICT indicators
- IEEE P2413: Approved Draft Standard for an Architectural Framework for the Internet of Things (IoT)

SOURCE: **14/** Available from http://urbanopus.net/wp-content/uploads/2016/06/Screen-Shot-2016-06-18-at-4.00.41-PM.png, check on 22 April, 2021.

As an example of the standard used in the Smart Cities community, we can mention "ISO 37120 – Indicators for city services and quality of life", which comprehensively defines 100 indicators (46 basic, 54 supporting) divided into 17 categories, e.g. economy, education, energy, environment, healthcare, security, housing, telecommunications, water and waste management.[15/]

WCCD (World Council on City Data)[16/] awards certificates to cities based on this standard. For example, a bronze certificate involves publicly publishing all 46 basic and 0 to 13 supporting indicators. A silver certificate means publishing 14 to 29 supporting indicators. In order to obtain a gold certificate, in addition to the 46 basic indicators mentioned, it is necessary to publish 30 to 44 supporting indicators. The publication of more than 45 supporting indicators leads to the acquisition of a platinum certificate. This example demonstrates how an international standard can be used to encourage public publication of data while guaranteeing the same informational content of these communications.

3.6 SMART CITY MEASUREMENT

Evaluating Smart City is a very difficult matter, because, as with attempts to create a uniform definition, there is a number of obstacles in trying to establish a comprehensive system of measurement and standards. Each city has its specific interests, problems and needs, which the city officials must take into account when implementing the concept. The benefit of Smart City is to increase the efficiency of the city and increase the satisfaction and quality of life of its citizens, so it is necessary that these specific needs also appear in the measurement system in the form of suitable criteria tailored to the city.

The creation of a uniform measurement system is therefore to some extent almost impossible between cities, as some criteria of the index may change as the borders of a country or region cross, so the proposed solution will never be fully transferable. To ensure relevant comparison, these indices are applied to cities that have somewhat similar characteristics (geographical location, size, population, etc.) and are often very general.

SOURCE: **15/** ISO 37120: Sustainable community development - indicators for urban services and quality of life Mosaic of methodologies and indicators of sustainable development (mozaika-ur.cz). | **16/** The World City Council, established in 2014 as a consultative body for the implementation and compliance with ISO standards, see https://www.dataforcities.org/about-wccd, check on 22 April, 2021.

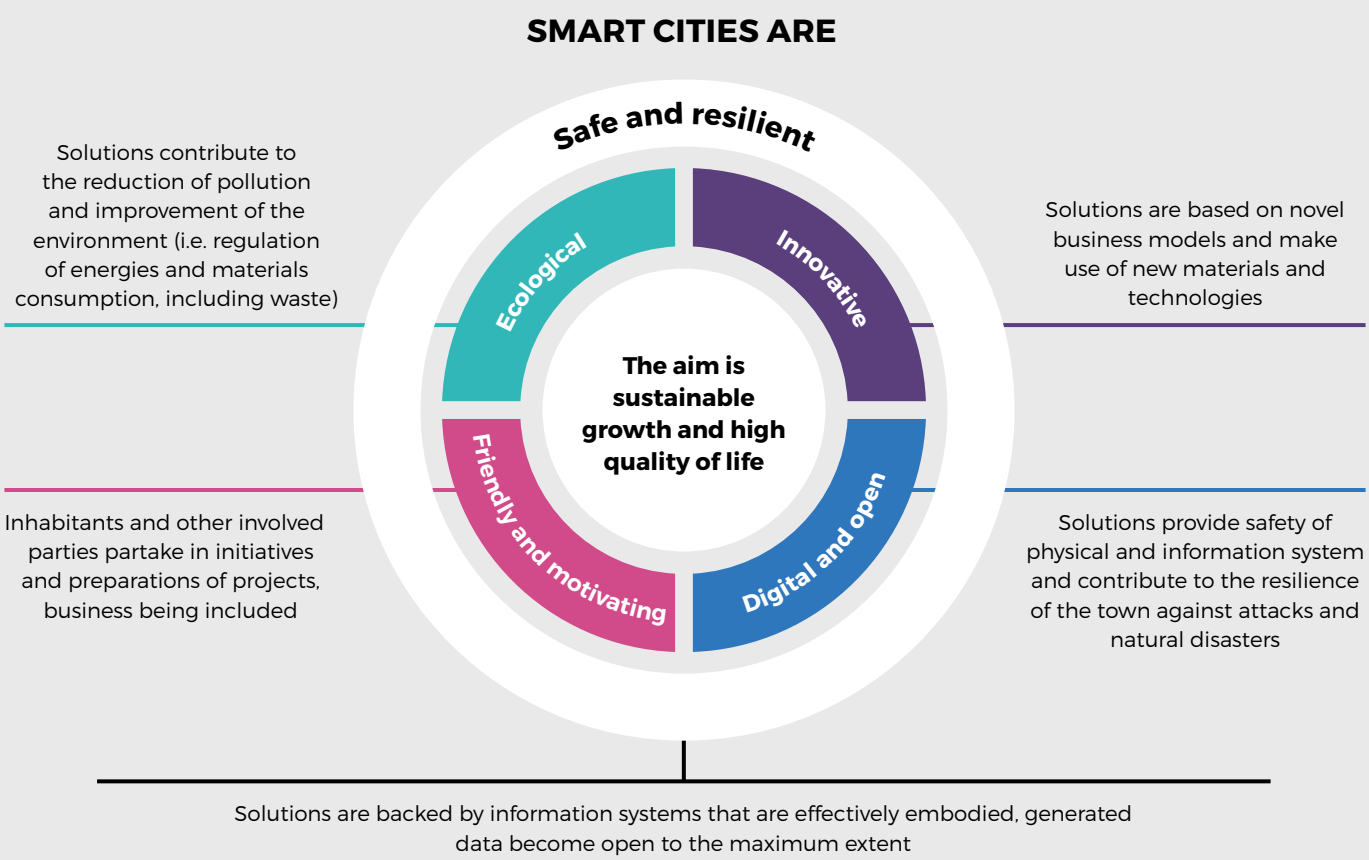
Many methodologies are currently used to evaluate the smartness of cities - the Smart City Index. It is an evaluation of the digitization of various processes of the city, the evaluation of partial functional areas such as mobility, energetics, and security or the assessment of information links between smart service operators and their users. Based on various methodologies, an annual evaluation of the best smart cities in the world takes place at a global level.

Regular monitoring of indicators, used to measure the smartification of the city, expands the base of easily available data that are used for planning the development of the city and its sustainability. It can also identify weaknesses and evaluate new approaches to problem solving.

There are two main reasons for measuring smartness. Firstly, it is an attempt to measure the change that has occurred after the implementation of smart solutions. The second reason is the creation of a system of comparison of individual cities, where their representatives and residents can watch how their position in the overall ranking develops.

In general, all smart city solutions should be based on five basic principles, namely that the city is: Ecological, Innovative, Friendly and Motivating, Digitized and Secure. Taking into account the specific needs of the measured areas and the diverse possibilities of the evaluated cities, it is always necessary to adapt the whole instrument.

FIGURE 3.6.1 – SMART CITIES[17/]



SOURCE: **17/** EY, "Smart Prague - Methodology for Evaluating Project Success" (Smart Prague, 2017), available at https://smartprague.eu/files/EY_171117_REP_SmartPrague_FINAL_v13.pdf, check on 26 June, 2021.

Overview of indexes sorted by their publisher:

INDEX	INDEX PUBLISHER	PUBLISHER TYPE
IESE Cities in Motion Index	The IESE Business School	Academic institution
Smart City Index (EY)	Ernst & Young	Private company
UK Smart Cities Index	Huawei	Private company
Smart City Index (EasyPark Group)	EasyPark	Private company
The Green City Index	The Economist Intelligence Unit	Private company
Innovation CitiesTM Index	2thinknow	Agency
Europen Digital City Index	European Commission	Public institution
Sustainable Cities Mobility Index	Arcadis	Private company
CITYkeys indicators for Smart City Projects and Smart Cities	European Commission	Public institution

The Ministry for Regional Development (MRD) is responsible for the application of the Smart Cities concept in the Czech Republic and is involved in publishing methodologies related to the Smart Cities concept. In 2016, the Government Council for Sustainable Development approved a Working Group for Smart City, the purpose of which is to supplement the methodology, organize professional seminars and promote the implementation of the SC concept and create materials for strategic documents. The national concept of SMART Czechia – Sustainable Czech Republic was also created, in which in 2019 the Association of Towns and Municipalities in the Smart City Area continued with the elaboration of the "Strategic Framework of the Union of Towns and Municipalities in the Smart City Area" defining the targeted areas within the concept and issuing documents related to the issue of Smart City.

In 2020, the SMART Cities Concept – resilience through SMART solutions for municipalities, cities and regions was prepared at the Ministry of Regional Development. The concept fulfils the Innovation Strategy of the Czech Republic 2030 from the point of view of municipalities, cities and regions, brings proposals for areas for new solutions to ensure a quality life for people and for us to be an attractive country for others, a good partner for others in the European and global context. At the same time, the concept responds to the situation associated with the COVID-19 pandemic and its effects on the whole of the Czech Republic. The emphasis is mainly on resilience in four basic dimensions: social and economic, geopolitical, green and digital. The structure of the concept is based on the pillars of sustainable development, those are: People and communities, Local economy, Environment for life. The aim of the concept is to strengthen resilience and to ensure good living conditions in cities and towns.

3.7 CREATION OF THE SMART PRAGUE CONCEPT

Since 2014, the newly established Commission of Prague City Council for the development of the Smart Cities concept in Prague Capital City (hereinafter referred to as the "Commission") has been working on the implementation of the Smart City concept in Prague Capital City and the Institute of Planning and Development of Prague Capital City (IPD), which in cooperation with the Fraunhofer Institute created the Morgenstadt City Lab study (2015–2016).[18/] The main goal of the study was, among other things, to create a profile of the capital city and, together with this, to define the strengths and weaknesses, potential and current obstacles that stand in the way of the transformation of Prague into a smart city. With the help of this analysis, an individual plan for sustainable development was created, which takes into account the specific conditions of the city.

In 2016, a series of conferences dedicated to the development of Smart City in the capital took place, and in this context the discussions about a concept of Smart Prague (SP) began. In the same year, the Commission started approving the first project plans entrusted to the ICT Operátor, a. s. (Plc.), for implementation, on the basis of the so-called Order Agreement on the provision and ensuring of services within the implementation of the Smart Cities concept.

SOURCE: **18/** Fraunhofer-Institute for Industrial Engineering IAO in Stuttgart, Morgenstadt: City Insights City Lab Report Prague (Stuttgart, 2015), available at https://www.iprpraha.cz/uploads/assets/dokumenty/ssp/SMART%20Cities/Full_Morgenstadt_CityReport_Prague_EN.pdf, check on 22 April, 2021.

In 2017, a concept of Smart Prague until 2030 was created and approved by the City Council of Prague, the concept was created in connection with the existing priorities of the city given by the Strategic Plan of Prague Capital City and sector concepts, which were then examined in relation to the possibilities of applying technological trends. The concept defines six areas: Mobility of the future, Smart buildings and energy, Waste-free city, Attractive tourism, People and urban environment, Data area. Each of these key areas is further developed into visions for 2030 with regard to best available practice and subsequently into thematic areas for each key area. These are not isolated solutions for individual key areas, but a system linked to the city-wide Golemio data platform, which enables data to be evaluated and interpreted by citizens and companies alike. The data platform manages and evaluates city data as a whole, thus providing city officials with a structured overview of its operation.

Within the Smart Prague concept, the ICT Operátor, a. s. (Plc.), plays the role of a project manager, using innovative technologies in solving the Prague challenges and proceeding to the maximum possible extent while respecting competence neutrality in the context of other development projects associated with the digitization of the office. Smart Prague projects are managed by the ICT Operátor, a. s. (Plc.), through the globally recognized method of project management PRINCE2, which in practice means that the implementation carrier and the recipient of the output are determined. ICT Operátor, a. s. (Plc.), after the end of the pilot phase, forwards the projects to the operational phase of the relevant subject of Prague Capital City.

From the organizational point of view, the implementation of projects is ensured by five levels of concept management. The highest level is represented by the Prague City Council and its former Smart Cities Agenda Committee, now the IT and Smart City Committee. The governing committee of the concept, which sets the direction, is the Prague City Council and its respective Commission of the Prague City Council for the development of the Smart Cities concept. Advisory body to the ICT Operátor, a. s. (Plc.), remains the Smart Prague Council, which consists of representatives of the ICT Operatár, a. s. (Plc.), representatives of the Czech Technical University in Prague, Charles University and representatives of public institutions (representatives of the Prague City Hall, Ministry of Regional Development, Ministry of Industry and Trade, Ministry of the Interior, Ministry of the Environment, University Centre for Energy Efficient Buildings CTU, Technological agencies of the Czech Republic, the Union of Towns and Municipalities of the Czech Republic, the National Centre for Energy Savings and the Czech Smart City Cluster), which deal with projects in the smart cities field. The goal of the Smart Prague Council is to obtain feedback on the development of the Smart Prague concept from key partners, increase the transparency of the concept processes and, last but not least, serve as an advisory board for further strategic direction of the concept and thematic units. Another supporting body is the Smart Prague Working Group, which consists of representatives of municipal organizations – e.g. Technical Administration of Roads (TSK), Transport Company of the Capital City of Prague (DPP), Prague Services (Pražské služby), components of the Integrated Rescue System of the Capital City of Prague, ROPID, Prague Technologies (THMP), Prague City Tourism, the newly established Prague Innovation Institute and others. This less formal platform serves mainly for comprehensive information, mutual knowledge of projects, sharing ideas, but also specific steps of cooperation on the concept.

At the end of 2019, it was decided that for mutual information on projects, it is desirable to supplement the working group with subgroups divided according to individual areas of Smart Prague. The reason for this decision was the start of work on the preparation of the Smart Prague Action Plan. The Smart Prague 2030 Action Plan document was created at the beginning of 2020 for the needs of Prague Capital City, in order to clarify the planned projects in the Smart City area across municipal organizations and the City of Prague. The Smart Prague Action Plan follows the Smart Prague 2030 concept given in June 2017 and generally deals with the SWOT analysis of the Smart Prague 2030 concept and its consequences, the definition of the action plan, the definition of Smart Prague projects, their evaluation, organizational structure and other areas. The main part of the action plan deals with individual project intentions and ideas in the field of Smart Prague, which can be implemented until 2030, and at the same time sets the rules for determining the success of their implementation. The action plan thus allows projects and ideas to be aggregated into one document for all municipal organizations that participated in its creation. Thanks to this, it is possible to have a general overview of individual Smart Prague projects that the City of Prague and individual city organizations plan or are considering implementing. In addition to the fact that the Smart Prague 2030 Action Plan contains a list of individual projects and ideas, it also contains selected measurable indicators for determining whether the implementation of the Smart Prague concept is being implemented successfully or not. These measurable indicators are set for those areas where there is currently sufficient information to enable these measurable indicators to be set. The Smart Prague Action Plan – version 1 was approved by the City Council at the end of 2020 and will be updated annually. A web version was created for better clarity in project plans and topics (available here: https://akcniplansmartprague.eu/).

3.8 SMART PRAGUE INDEX

For effective management and fulfilment of the long-term vision of Smart Prague until 2030, which sets the basic requirements for implemented projects, a detailed mapping of the city's development and continuous evaluation of steps is necessary. To this end, the Smart Prague Index (SPI) was developed in 2017 together with Ernst & Young (EY). The tool thus provides the Capital City of Prague the possibility of mapping the initial state, monitoring changes over time and monitoring the impact and evaluating the success of implemented projects in terms of the principles of the Smart City concept.

The whole SPI concept was based on the Cities in Motion Index ("CIMI") developed by the aforementioned private company EY. CIMI evaluates cities on the basis of mutual comparison in 471 indicators and subsequently aggregated within each thematic area. To ensure consistency and at the same time simplicity, the use of key indicators of the annually published CIMI index was proposed for SPI. The shift in the ranking of cities in selected CIMI areas also indirectly expresses the shift in the relevant SPI areas, as there is a correlation between the CIMI and SPI indicators in these areas.

The starting point in creating the methodology for the Smart Prague Index (SPI) was 5 + 1 strategic areas of the Smart Prague concept, the appropriate development of which is described through specific, qualitatively set strategic goals. These goals are interpreted as general manifestations of smartness, which reflect the development trends of smart cities in the area. Each of the defined strategic objectives is described within the SPI through specific quantifiable indicators and grouped into thematic areas.

MOBILITY OF THE FUTURE	Development of electromobility and infrastructure Shared electromobility Ecological buses Intelligent transport Self-driving vehicles Mobility as a service
WASTE-FREE CITY	Sorting and use of municipal waste Material utilization of waste Intelligent waste collection and storage system Use of Wastewater and Rainwater for Energy and Raw Material Purposes
SMART BUILDINGS AND ENERGY	Prague Clean Energy Fund Smart Lighting Smart local area networks
ATTRACTIVE TOURISM	Big Data in Tourism Mobile-based tourism Advanced Technologies for Tourism
PEOPLE AND THE URBAN ENVIRONMENT	Urban Environment in Mobile Phones A Safe City for People Healthy Lifestyle City Technology for Municipal Greenery Innovative Gadgets and Sensors Digitization and Participation in Public Administration
DATA AREA	Golemio data platform Virtualization of Prague Project

Indicators of strategic goals and quality of life in the city are further supplemented by indicators of sustainability and indicators of financial goals in connection with the requirements of the Smart Prague concept. Indicators from the (sixth) data area also extend to all five functional areas. Overall, the proposed indicators can be divided into four basic categories:

- Indicators evaluating a specific strategic area
- Indicators assessing the impact on the environment and quality of life
- Data area related indicators
- Indicators related to sustainable financing

Through quantified, tailor-made almost 130 indicators, the Smart Prague Index provides information on the degree of implementation of innovative projects that contribute to the smartification of Prague Capital City. Dozens of partners from the public and private sectors participate in the compilation of the Index, providing the necessary data.

3.9 EVALUATION OF SMART PRAGUE PROJECTS

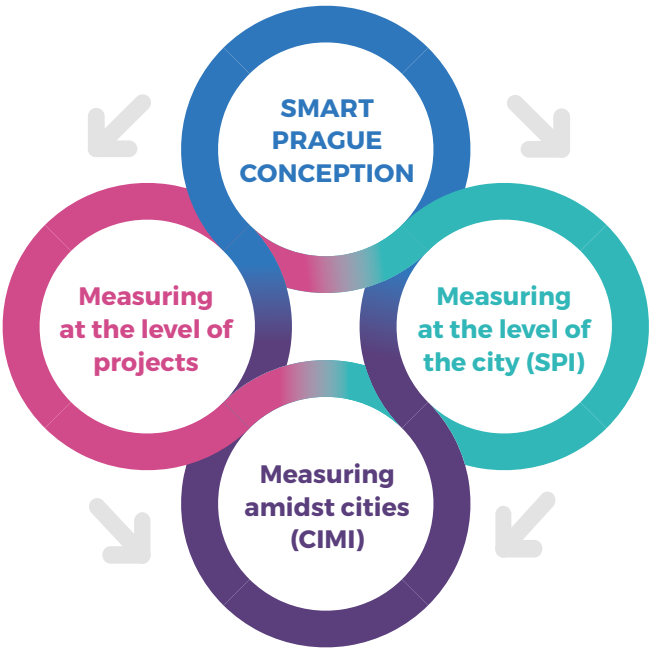
The SPI is followed by the methodology of evaluation of individual projects. The rating is set for pre-and the post-implementation phase. The evaluation parameters reflect the type of project (pilot vs. standard), at the same time weights are assigned to the parameters according to their strategic importance. Qualified indicators of the city's smartness are also connected with the evaluation, which means that the more the project can influence the indicators, the higher the point evaluation will be. This approach allows a relative comparison of different projects, both with regard to their potential and its subsequent confirmation. Identification of project weaknesses is facilitated. The higher the evaluation of the project, the higher the positive impact can be expected within the evaluation of the city through SPI, and thus in the implementation of the Smart PRAGUE concept.

For each area, the SP concept also describes the main challenges and examples of best available practice and proposes briefly defined visions. For the identification and selection of suitable projects, the principles are defined, which aim to ensure the success of the Smart Prague concept:

- it must have a demonstrable impact on improving the quality of life of Prague residents or on the sustainability of the city,
- be primarily in pilot mode and on a small scale to test new technologies, verify their potential and prepare for their later dissemination, or to test tried and tested technologies and to verify their rapid deployment,
- the purchase and operation of city-owned technologies should be kept to a minimum; the goal of the public sector is to eliminate the possibility of market failure and invest in strategic infrastructure.

FIGURE 3.9.1 – COHERENCE OF THE CONCEPT AND PROJECTS OF SMART PRAGUE, SPI AND CIMI.

Interconnection of indicators:



SOURCE: Operátor ICT, a. s. based on[19/]

The output of the SPI is the measurement of the success of the SP concept and at the same time the evaluation of the success and monitoring of the impact of individual implemented projects falling under the SP concept. The proposed indicators will make it possible to map the initial state, monitor changes over time and perceive the connections between projects from different thematic areas. At the same time, the indicators for project evaluation will be set so that it is possible to determine at the beginning with an acceptable degree of certainty that the evaluated project will have a demonstrable and fundamental precondition for increasing the quality of life of Prague residents or the sustainability of the city.

Smart Prague Index provides:

- independent, comprehensive and clear measurement of the success of fulfilling the Smart Prague concept,
- a tool for monitoring the success of the implementation of Smart Prague projects,
- a source of information for planning (direction) of suitable future projects for fulfilling the strategic goals of the Smart Prague concept,
- a comparison of how successful Prague is in dealing with the challenges in comparison with other world cities,
- a possibility to monitor developments on a long-term and ongoing basis, including the impact of emergencies.

SOURCE: **19/** EY, "Smart Prague - Methodology for Evaluating Project Success" (Smart Prague, 2017), available at https://smartprague.eu/files/EY_171117_REP_SmartPrague_FINAL_v13.pdf, check 26. 6. 2021.

3.10 SMART CITY PROJECTS OF THE ICT OPERÁTOR, A. S.

JUDr. Matej Šandor, Ph.D.

Deputy Chairman of the Board of Directors, ICT Operator, a. s. (Plc.)

The year 2020 brought new challenges and many changes that needed to be adapted. But looking back, I must say that, despite the circumstances, it was a successful one for our project office Smart Prague Operátor ICT, a. s. (Plc) It was in the spirit of efficient use of urban data and energy, simplification and innovation. We have implemented or participated in about 30 projects, which is a respectable number.

We have started the preparation of **five new projects**. We started testing innovative technologies for traffic sign management and preparing a study for the implementation of the Autonomous Mobility pilot project. We also worked on the preparation of the Green City, Intelligent Traffic Analysis projects and also the Maas iD project, which aims to make it easier for citizens to use various transport mobility services.

The **Smart Traffic Signs** pilot project will provide the city with information on the GPS position of the signs and also on the change in their position compared to the initial state. It mainly concerns mobile traffic signs, which draw attention to the ban on stopping during the block cleaning period. At present, the city has to regularly (every day, seven days before the start of the cleaning) check that the mobile signs are in the right place and it is clearly visible so that Prague residents find out about the planned cleaning in time. The vehicles that perform these inspections travel tens of thousands of kilometres a year. Thanks to this project, it will be possible to perform the inspection only at traffic signs, where the sensor sends information about the change of condition – for example, when turning, deviating due to wind or vandalism. The number of inspections could thus be reduced by 70 percent, which would also lead to significant financial savings. We also plan to test smart tags with a variable display with the possibility of remote setting.

In addition to the already running project, where we measure the **intensity of bicycle traffic**, we also monitored the **intensity of pedestrian traffic** in selected public spaces and parks, and we tested the technologies that are most suitable for recording pedestrian traffic.

In 2020 we also successfully completed five pilot projects, namely Smart Waste Collection, Virtualization of Prague, the System for Automated Entry and Exit of Vehicles from the City Carpark, Digital Energy Measurement and eHealth – the Metropolitan Emergency and Health Care System.

The eHealth project responded to the need to provide a higher standard of care services for the elderly and people with disabilities. In practice, the way this service worked was that the client, on the recommendation of a doctor, received a loan of an electronic bracelet. With the help of this bracelet he or she could call for help by simply pressing the SOS button when his or her health deteriorated. The bracelet was also able to detect a person's fall and trigger an alarm automatically. Thanks to this pilot project, it was possible to obtain very detailed feedback from the users themselves, which shows how much emergency care is needed and that its importance will continue to grow in the future. I am glad that the information that was obtained thanks to the project can also be used not only in Prague, but also in national strategic documents or in other regions.

As part of the Smart Waste Collection pilot project, we installed 460 sensors in sorted waste containers that indicate which container needs to be exported. We primarily installed underground containers, but the sensors can also be placed in above-ground containers. In the My Prague application, Prague residents can also monitor the current occupancy of containers in their area. In the autumn, we were also approached by a manufacturer of technology for measuring the level of filling in waste containers, so we decided to test a new type of sensors that use laser beams. The new devices communicate via Narrowband IoT (NB-IoT) technology, so it is possible to measure occupancy even in places where existing networks did not offer sufficient coverage. Following the successful results of this project, we are preparing to expand it to another approximately 6 locations throughout Prague.

Last year, we also paid significant attention to the topic of electromobility, we prepared the General Development of the Charging Infrastructure in Prague, which contains the outlook for the development of the charging infrastructure in Prague for electric vehicles until 2030. Project office of the Smart Prague ICT Operátor, a. s. (Plc.), also cooperated with TS on the project of securing the supply of the first 14 electric vehicles out of a total of 27 for Prague contributory organizations. The development of electromobility in the metropolis is also related to the project of electrification of the bus line in the form of four-pole charging, which also started in 2020. Bus line 134. which regularly transports passengers between Podolská vodárna and Dvorce, will thus become the first line on which the city will put the so-called four-pole charging into operation. We also started working on a study to prepare a pilot project for autonomous mobility. I believe that the gradual deployment of self-driving cars for individual and public transport in Prague traffic will lead to a better use of the existing capacity of transport routes.

Despite the COVID-19 pandemic, we developed international cooperation, participated in the MUNI Expo 2020 in Tel Aviv, established cooperation with the British agency FutureGov and published the Smart Prague Index in English for the first time. I am also very happy that we were able to support talents in several hackathons, including the #NakopniPrahu event, the second year of which we are organizing for Prague.

In 2020, we also continued energy saving projects. At the beginning of the year, we prepared a public analysis of energy consumption in buildings owned by Prague. The obtained data make it possible to identify uneconomical use of energy and to design an effective energy management system, which could then be used for all city buildings.

Given that this is the fourth edition of the Smart Prague Index, looking back, we can take a closer look at the developments and trends of recent years and see our work in a broader context, making it easier to choose which projects will bring the most benefits to Prague residents. However, innovations without a vision do not make sense, so I am very pleased that last year, thanks to the all-Prague cooperation**, we completed the Smart Prague Action Plan to 2030. There are approximately 150 project plans and ideas for possible implementation, so Prague's outlook for the future in the Smart City area suddenly has clearer outlines.**

So, what will 2021 be like? There is often talk of a return to normal, we wish the situation returned to normal as soon as possible. But it is already clear that some things will be different than we are used to, and returning to normal life will be a complex process, both socially and economically. We see this as a motivation to do our job even better. Opportunities can also be seen in the acceleration of the digitization process, which will, among other things, speed up the implementation of Smart Prague projects in practice.

Maintaining the current pace will not be easy in the current circumstances, but I am optimistic about the determination of my colleagues, without whom none of the above would be possible. I would like to thank our excellent project team and all the OICT employees for their work. I would also like to thank the representatives of Prague Capital City, municipal organizations, the academic sector, city districts and all other collaborators. I know that together we will do everything in our power, and not only through innovation, but also thanks to the human approach, Prague will be a pleasant place to live, a modern and smart city of the 21st century.

Details about all Smart Prague projects implemented by OICT can be found on the website www.smartprague.eu.

4.

SPECIFIC INDICATORS

4.1 MOBILITY OF THE FUTURE

The vision of Mobility of the Future responds to the identified challenges of the Capital City of Prague. One of the leading identified challenges is the growth of the population of Prague and its surroundings. Precisely due to population growth and especially population growth in the surroundings of Prague, the demands on transport performance are increasing, commuting time is increasing (e.g. commuting to work or school, for services, to the doctor, etc.) and traffic congestion arises. With the growing demand for mobility, the transport performance, freight transport, but also the rate of motorization are increasing, thus intensifying the pressure to ensure sustainable measures, both quantitative (e.g. ensuring a sufficient number of intercepting carparks or higher use of public transport, etc.) as well as qualitative (increasing the efficiency and comfort of public transport, electronic automation of transport and digitization of transport handling services). These measures can contribute to changes in the modal split, which are supported by changes in society (growth of economic strength of the population, pressure for a healthy lifestyle and technological development). At the same time, they will help solve the unsatisfactory condition of the transport infrastructure.

The above-mentioned situation also raises environmental challenges, which relate mainly to traffic congestion, air pollution from internal combustion engine emissions, high noise levels, traffic accidents and the degradation of public spaces in the city with low priority for pedestrians and cyclists. These factors have a negative impact on clean air and at the same time have a direct impact on the life and health of residents and visitors of the Capital City of Prague. It is road transport that produces more than 70 % of emissions of solid pollutants and total emissions of nitrogen oxides. In addition, carbon monoxide and hydrocarbons are released into the environment. All of the above pollutants have a negative impact on human health and vegetation and have a major impact on the quality of life in the capital.

The key grasp of transport issues and a comprehensive list of necessary measures in the field of transport is represented by SUMP - Sustainable Mobility Plan for Prague and its Surroundings,[20/] which was approved in 2017 by the Prague City Council. SUMP defines the direction of mobility in the territory of the capital and the Prague agglomeration until 2030. Its strategic goals include, among others, reducing the space requirements of transport, reducing the carbon footprint, increasing performance and reliability, increasing safety and more. The priority axes of the Plan include, among others, reducing air pollution, noise pollution and carbon footprint, as well as reduction of space requirements of transport and reduction of traffic accidents.

Following the projects summarized in the Sustainable Mobility Plan, the Smart Prague concept brings a vision of Prague mobility that is modern, technologically advanced,

SOURCE: **20/** SUMP, see "Sustainable Mobility Plan | The future of Prague transport ", Polad' Prahu, available at https://poladprahu.cz/, check 17 June, 2021.

cleaner, safer and more efficient. This vision of transport is based on several pillars, the main one of which is the motivation to make more intensive use of the public transport (VHD) network. It is VHD that presents public transport that represents environmentally friendly means of transport, such as the metro, tram, electric bus or train. With the help of state-of-the-art technologies, the comfort of passengers is increased and the passengers are being better informed thanks to improved technologies, which leads to an increase in the motivation of citizens to use public transport. The Smart Prague concept includes a system of modern multi-channel public transport handling services, which provides passengers with a number of services, such as extension of payment channels for fare purchase in the PID Lítačka mobile application, search for connections, including their delays, and much more. Within the mobile application PID Lítačka or the application MojeP-raha and others, it is possible to pay for parking in selected P+R carparks and paid parking zones (ZPS). As part of the Smart Prague concept, it is planned to expand the city's PID Lítačka application with a portfolio of mobility services (MaaS) in the future, which will ensure search, handling and payment for all modes of passenger transport, including alternative methods such as carsharing or bike sharing.

Another pillar of the Smart Prague concept is the support of shared mobility and electromobility, which is supported within the Smart Prague concept by the conceptual construction of a network of charging stations. Prague also plans to make more use of real-time traffic data for adaptive control of traffic lights at intersections, which will enable better use of road capacity and active management of traffic flows. This will reduce the occurrence of traffic congestion, reduce waiting times in convoys, especially for public transport, and thus reduce the production and release of pollutants into the air. Decision-making and management processes in transport will work with continuously analysed data, on the basis of which relevant information will be obtained, which will be further provided to users through mobile applications and a web interface. The concept of the data platform of the Capital City of Prague Golemio. The next pillar of the Smart Prague concept is support for the development of autonomous mobility, especially on the side of transport infrastructure, but also on the side of means of transport.

Thematic areas include:

- Development of electromobility and infrastructure
- Shared electromobility
- Ecological buses
- Intelligent transport
- Self-driving vehicles
- Mobility as a service

4.1.1 Development of Electromobility and Infrastructure

Throughout 2020, the topic of not only personal but also public electromobility resonated deeply. A total of 1.42 million battery electric vehicles (BEVs) and plug-in hybrids (PHEVs) were sold in Europe in 2020, therefore collectively electrified vehicles (EVs). Between 2019 and 2020, there was an increase in EV sales of 147 %. In the Czech Republic, 5 243 EVs were sold in 2020, which is approximately 2.58 % of all newly sold cars. However, if we compare the situation with 2019, when only 1,979 EVs were sold in the Czech Republic, this is a significant increase in sales. In 2020, a total of 202,972 of all passenger cars were added to the Central Vehicle Register, which is 19 % less than in 2019. This is therefore a positive development in favour of electromobility.

It should be emphasized that the EV group includes all vehicles that meet the conditions of § 7b par. 6 of the Act no. 56/2001 Coll., On the conditions of operation of vehicles on roads, i.e., even hybrid vehicles if their CO_2 emissions are less than 50 g/km.

At the turn of 2019 and 2020, the Prague City Council commissioned OICT to prepare a General for the development of charging infrastructure in the capital city and to coordinate the construction of charging stations. The document was approved by the city at the beginning of 2021 and after completing a comparison of the two best-rated variants, the City of Prague will deal with the decision on the approval of the implementation project. It is assumed that the capital city could support the construction of public charging infrastructure as early as 2022.

The aim of supporting the development of public charging is to ensure the operation of 750 parking charging stations in Prague in the first phase by the year 2025. Until 2030, the number of public stations could be increased up to 4,500 stations. Depending on the actual growth in the number of electric cars, the Capital City of Prague would provide charging capacity in this way for up to 200 battery electric cars and plug-in hybrid cars (PHEV). This would represent 30 % of all passenger cars and small vans in Prague when operating approximately the same number of cars as today.

When proposing support for the construction of charging stations, it is important to take into account the possibilities of the electricity distribution network in Prague and its capacity for connection and operation of charging points. Within this issue, four types of connection of parking charging stations to the electrical distribution network were processed. Based on the overall benefits, it was recommended to use synergies with the renewal of the electricity distribution network and the electricity public lighting network to ensure the future connection of charging stations on public lighting lamps. This way of connecting parking chargers, together with the standard connection of stations directly to the low-voltage electricity distribution network, should ensure the best ratio of the necessary investments to the resulting number of public charging points. At the same time, it is only possible to ensure the necessary capacity of stations for even coverage of the city by public charging points by combining

both of these connection methods. It is calculated that in 2022 up to 300 so-called EV-ready lamps owned by the Capital City of Prague could be ready to be equipped with charging stations. By 2026 the joint project of the Capital City of Prague with PREdi anticipates the establishment of up to 3,000 EV-ready lamps in Prague.

In 2020, Prague also started the preference for electric cars for its state-funded institutions and started the initial delivery of 27 electric cars, which also contributes to the 5,591 new registrations of electric cars in 2020. The overall view of the development of electromobility and its infrastructure is then described in detail by the following indicators.

Number of EVs Per Capita

The indicator captures the number of electric cars registered in the Capital City of Prague per 1,000 residents. Electric cars registered outside the territory of Prague, but permanently operated in the capital city, are not included in the calculation. Therefore, the indicator does not express the absolute rate of penetration of the vehicle fleet in the capital by electric vehicles, but above all in the long term will show the trend of electric vehicles in the capital city and capture the impact of policy decisions to promote individual electromobility (e.g. construction of a network of fast charging stations, advantage of parking in paid parking zones, etc.). All these measures can only be implemented until the number of EVs reaches a certain penetration value. Favouring electric cars should therefore take place in line with efforts to curb individual car traffic.

In the period 2017–2019, there was a gradual increase in the number of registered electric cars. The largest year-on-year increase occurred between 2019 and 2020, when there were 5,591 more registrations than in the previous year. This represents more than threefold growth. While in 2019, there were on average 2 electric cars per 1,000 inhabitants, in the last monitored year there were 6 electric cars and it can be assumed that this number will continue to grow. The number of electric cars is growing among corporate and private users.

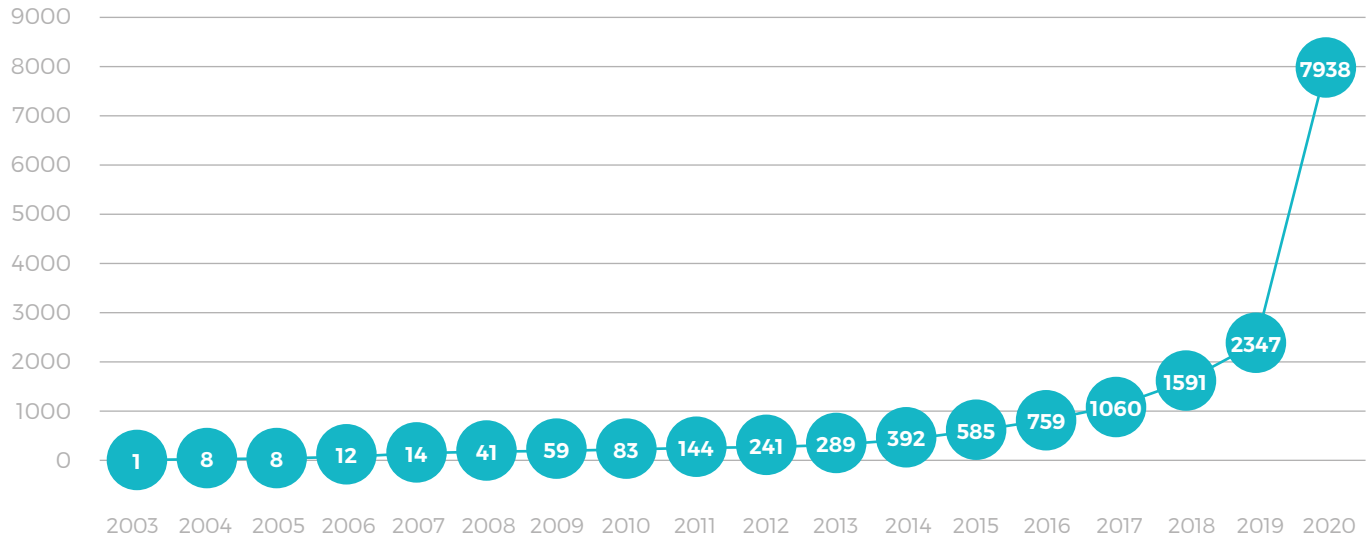
In the future, it is assumed that the number of EVs can be verified by another methodological procedure, which will, depending on the available monitoring technology, for example by using current camera systems on backbone roads, capture the number of EVs operated in the city.

Number of EVs per capita

	2017	2018	2019	2020
Resulting indicator value	**1,221**	**823**	**564**	**168**
Calculation	Population / Number of registered EVs			
Number of registered electric cars	1,060	1,591	2,347	7,938
Population of Prague *	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Internal communication with the Department of Transport and Administrative Activities of the Capital City of Prague. | * CSO[21/]

The development of the number of registered EVs is shown in the following graph:



SOURCE: **21/** "Population - Region | CZSO in Prague Capital City", available at https://www.czso.cz/csu/xa/obyvatelstvo-xa, check on 17 June, 2021.

Number of Parking Permits for EV

Based on the Resolution of the Prague City Council No. 1,709 from July 18th, 2017 was, according to the "Price list of parking permits and cards in paid parking zones for areas in the Capital City of Prague delimited by the territory of the entire city district" allowed electric cars to use all paid parking zones only for a handling fee paid during the registry of the electric car. In the course of 2018, hybrid vehicles were also included in this group of vehicles excluded from the parking fee. Resolution of the Prague City Council No. 803 to the intention of favouring the parking of vehicles with hybrid propulsion in paid parking zones in the territory of the Capital City of Prague from April 17th, 2018 defines the requirements for these hybrid vehicles, which can take advantage of the same benefits as EVs if the conditions are met. Due to the growing number of hybrid vehicles, the registration was modified under the original conditions. Since April 2019, owners of electric cars, hydrogen vehicles and selected hybrid vehicles (PHEV) have been able to apply for vehicle registration plates beginning with the "EL" mark. In order to reduce bureaucracy and support the owners of more environmentally friendly vehicles, the city management has decided that cars marked in this way can park in Prague's paid parking zones without registering with a parking permit. All these decisions have a significant positive impact on the motivation to use electric vehicles and hybrid vehicles in the Capital City of Prague.

Number of parking permits for EV

	2017	2018	2019	2020
Resulting indicator value	**742**	**1,311**	**1,282**	**5,950**
Calculation	Number of issued parking permits for EV and vehicles that have EL in SS			

SOURCE: Internal communication with ODO MHMP.

The value of the indicator for 2020 consists of the number of parking permits for EV (476) and vehicles that have "EL" (5,474) included in the licence plate, and are therefore not obliged to register further, the monitoring system evaluates their parking as authorized automatically. Compared to 2019, the total number of issued permits has quadrupled. This growth not only copies the overall growth of electromobility, but due to the decrease in the share of cars with a license without a "green" licence plate, it is evident that when purchasing EV, users count on the benefits that are offered for EV in the city.

Legislation regarding EV parking permits will change in the future. At present, vehicles whose owner does not have a permanent residence, registered office or establishment in Prague can also obtain authorization. The explanatory power of the indicator will probably need to be reconsidered, as the number of EVs using parking spaces in the territory of Prague will eventually be significantly higher than the number of issued parking permits.

Penetration of Public Charging Infrastructure

The Smart Prague 2030 concept defines the support of electromobility as a key activity. The development of city-wide electromobility is fundamentally influenced by the availability of the necessary charging infrastructure. The key document of the Capital City of Prague in this area is the General Development of the Charging Infrastructure in the Capital City of Prague until 2030, which sets out another direction for the development of electromobility. Charging stations are generally divided into fast and slow:

- **Fast charging stations** – These stations are usually for direct current (DC) and energy goes directly to the battery. They have an installed power of more than 50 kW, which in a conventional electric car represents recharging for another 200 km range in about 40 minutes (depending on the battery capacity, charging management and consumption of a particular EV).
- **Slow charging stations** – operate on alternating current (AC) directly from the mains, which is converted into direct current (DC) in the car's on-board charger. Power consumption during charging, usually from 3.7 kW to 22 kW, is limited by the vehicle's equipment and charging the electric car battery thus takes several hours compared to fast charging ones, where it can be assumed to charge the electric car battery in tens of minutes.

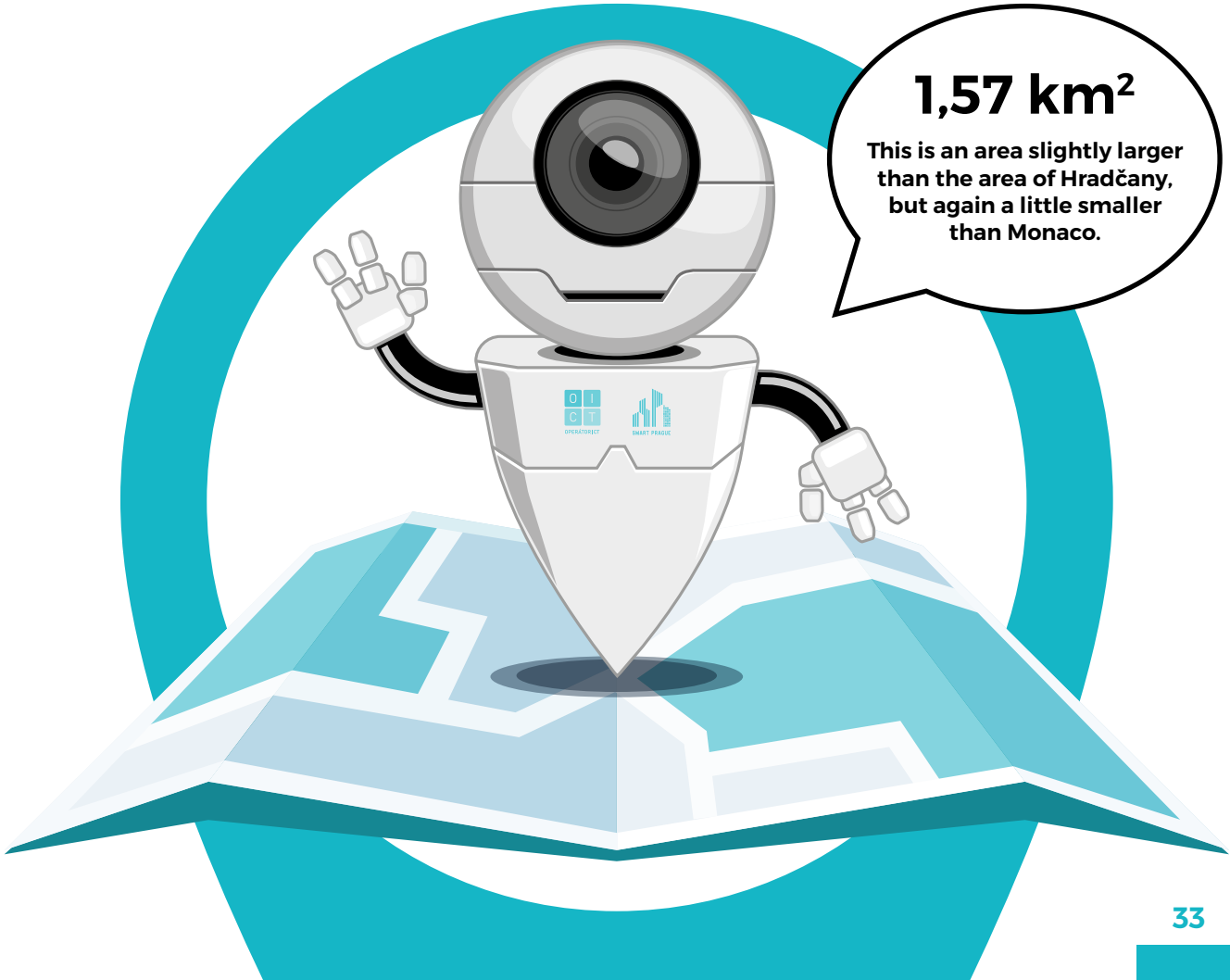
There are already several hundred charging stations of both types in the Capital City of Prague and they have an output of up to 150 kW. In the future, a further increase in the number of stations with higher performance, which are already located in several places in the Czech Republic, can be expected. The stations use various types of charging EU standardized connectors according to the Regulation IEC 62196: for AC, the so-called Type 2 Mennekes connector is used very often and for DC charging it is the so-called CCS (Combined Charging System) connector. So far, some carmakers commonly use the Japanese CHAdeMO standard, so current public DC charging stations in the EU usually have a connection to both standards. In addition to the availability of the capacity of the electrical connection in the given locality, the assumed parking regime is also very important for the planning of a suitable type of charging station for a specific location. In places with expected short-term standing, it is necessary to install higher power and vice versa.

The indicator monitors the effective coverage of the entire city by charging stations.

Penetration of public charging infrastructure

	2017	2018	2019	2020
Resulting indicator value	**8,55 km²**	**2,74 km²**	**1,89 km²**	**1,57 km²**
Calculation	City area / Number of charging stations			
Number of charging stations	58	181	263	315
CCP area	496 km²			

SOURCE: Internal communication with PRE, ČEZ, innogy, Pražská plynárenská.



For the purposes of this indicator, a charging station means a geographical point on the map. Although one station usually has more charging points, the spatial accessibility of stations in the city is crucial for this indicator. The above table shows that in 2018 there was an increase in the number of charging points by 123 compared to 2017. In 2019, another 82 charging stations were added, so that there is one charging point in less than 2 km². The number of charging stations continued to grow in 2020.

According to the data provided, another 52 charging stations were added during 2020. From the point of view of the monitored indicator, it is desirable that its value be low in order to ensure geographically available service. The value of the indicator thus represents the average area on which the user will find the charging station. In 2020, the availability of charging stations was 1.57 km².

Widespread Use of Fast Public Charging Infrastructure

The indicator shows the ratio of the number of fast-charging stations to the total number of charging stations. This is the readiness of the public charging infrastructure for high turnover of electric vehicles (e.g. taxi vehicles, shared vehicles, delivery of goods, etc.). Charging stations are also expanding in shopping centres, where customers are motivated to purchase EVs, which they can recharge when shopping or visiting a cinema. It is the availability of places that allow charging EV within 30 minutes to at least 80 % of the battery capacity is a key parameter for the development of electromobility as a whole.

	2017	2018	2019	2020
Resulting indicator value	**28 %**	**19 %**	**35 %**	**38 %**
Calculation	Number of DC charging stations / Total number of charging stations [%]			
Number of DC charging stations	16	35	92	121
Number of AC charging stations	42	146	171	194
Total number of charging stations	58	181	263	315

SOURCE: Internal communication with PRE, ČEZ, innogy, Pražská plynárenská.

For the development of the Mobility of the Future area of the Smart Prague 2030 concept, urban support for the expansion of fast charging stations is an essential and key component. Most charging stations in the Capital City of Prague are operated by PRE, a. s. (Plc.), (Pražská energetika), other operators are ČEZ, a. s. (Plc.), innogy, a. s. (Plc.), and PP, a. s. (Plc.), Pražská plynárenská.

Availability of Charging Infrastructure According to the Development of the Number of EVs

The indicator shows the ratio of charging stations and the number of registered EVs. It is important to take into account the Penetration of Public Charging Infrastructure indicator when interpreting this indicator.

	2017	2018	2019	2020
Resulting indicator value	**18.28**	**8.79**	**8.92**	**25.20**
Calculation	Number of registered EVs / Number of charging stations			
Number of charging stations	58	181	263	315
Number of registered EVs	1,060	1,591	2,347	7,938

SOURCE: Internal communication with ODO MHMP, PRE, ČEZ, innogy, Pražská plynárenská.

The recommended target value for the availability of the charging infrastructure is set at 10 EV per charging station. During the years 2018–2019 this indicator value ranged to the level of 10 EV per charging station. However, 2020 shows a trend where the number of EVs has outpaced the development of charging infrastructure. The number of EVs has increased disproportionately to the current state compared to the charging infrastructure.

For the development of electromobility, it is important that the charging infrastructure motivates more mass use of EV, and therefore the density of the area coverage of the Capital City of Prague by charging stations is also an important part.

Use of Charging Infrastructure (number of charges)

The indicator shows the rate of use of the charging infrastructure to the number of registered EVs.

	2017		2018		2019		2020	
Type of station	Fast rechargeable	Slow rechargeable	Fast rechargeable	Slow rechargeable	Fast rechargeable	Slow rechargeable	Fast rechargeable	Slow rechargeable
The resulting value of the indicator	16.7	12.0	16.9	6.9	31.0	11.7	9.1	3.6
Calculation	Number of conquests / Number of registered EVs							
Number of recharges	17,650	12,723	26,946	10,942	72,787	27,548	72,019	28,276
Number of registered EVs	1,060		1,591		2,347		7,938	

SOURCE: Internal communication with PRE, ČEZ, innogy, Pražská plynárenská.

The values of the indicator show its year-on-year decrease compared to 2019, despite almost the same frequency of recharges. This anomaly can be explained by the fact that despite a significant increase in the number of registered EVs, there was a decrease in the expected charging. This sudden drop in demand thus reflects the overall decline in the use of individual car transport during the COVID-19 pandemic.

Use of Charging Infrastructure (amount of energy taken)

This indicator indicates the load on the charging infrastructure in terms of energy consumed.

	2017	2018	2019	2020
Fast charging station (DC)	224,509 kWh	324,116 kWh	818,133 kWh	1,857,053 kWh
Normal charging station (AC)	141,174 kWh	121,281 kWh	268,615 kWh	970,489 kWh

SOURCE: Internal communication with PRE, ČEZ, innogy, Pražská plynárenská.

The values of the indicator show a significant jump in the energy consumed, which corresponds to an increase in the number of recharges. The increase in value with almost the same number of recharges is probably due to the recharging of cars with larger battery capacities as supply is renewed and new generations of electric cars are supplied to the market. Since 2017, the volume of energy from public infrastructure has almost doubled to 2.9 GWh in 2020.

4.1.2 Shared Electromobility

The COVID-19 pandemic, which lasted for most of 2020 tested the viability of Czech carsharing, and it can be stated that carsharing has performed well in the individual mobility market in Prague, where carsharing is most concentrated in the Czech Republic. Although the use of mobility in the form of carsharing decreased sharply right in the first two weeks of "hard lockdowns", because government measures aimed at restricting the mobility of the population. However, for most carsharing services, the demand for carsharing services has revived and increased well above expectations. The total number of cars in carsharing reached 1,516 cars in Prague. Out of this number, 242 were purely electric cars and 278 were hybrid cars. This confirms the interest in alternative drives for hybrid and purely electric cars. Unfortunately, there was no increase in the number of electric cars in 2020 because most carsharing companies still did not find

a favourable economic model for operating these cars. Originally, some hope was focused on the ŠKODA CITIGO iV, which ceased production without compensation. Initial initiatives to introduce electric cars in carsharing fleets and plans for faster gradual replacement of internal combustion engines are now slowed down mainly by the fact that the largest domestic car manufacturer does not yet produce more affordable electric car models that would be economically viable for carsharing and the arrival of cheaper competitive alternatives (e.g. Dacia) was only recently announced. The economic factors associated with the TCO of an electric car will be the primary factor for the inclusion of these cars in carsharing fleets in the years to come. Although the development of charging infrastructure is a necessary precondition, it is a secondary factor for the further development of shared electromobility.

The increase in the total number of all cars in the carsharing offer has also contributed to the development of this service in the past two years. This happened not only by increasing the number of cars at existing providers, but also thanks to the entry of other companies into the market. The current offer of cars, especially in Prague, already has a sufficiently wide coverage and is varied in models; from the latest models of cars meeting the Euro 6 standard through modern hybrid cars to purely electric cars. And the fact that carsharing had a significant number of regular customers before the start of the COVID-19 pandemic also played a positive role during the pandemic, when, thanks to various events, it was possible to acquire new customers and motivate existing ones. However, this support for the use of carsharing has reduced profitability for operators who are still coping financially with the start-up costs of these relatively young mobility services. Then there were also some new customers, who considered this type of mobility to be a safer alternative to public transport with regard to the pandemic.

Another positive factor is the fact that carsharing has not been used by tourists yet, and is not so dependent on tourism. The expansion of carsharing is thus associated primarily with changes in the lifestyle of the young generation, preferences and perceptions of the real mobility needs of individuals and families, young and middle-aged people and, last but not least, trends in a positive approach to the environment.

Number of Shared EVs

Thanks to increasing popularity and based on data from the previous period, further growth in carsharing services can be expected. In order for carsharing to be beneficial for users, it is necessary to maintain and develop the parameters required by the Prague City Council, which are listed below.

Carsharing is dealt with in the publicly available Resolution of the Prague City Council no. 1,548 for the implementation of carsharing in paid parking zones in the territory of the Capital City of Prague on June 21st, 2016. The most essential requirements for city-supported carsharing include, for example: 24/7 service operation, short-term rental – even less than 1 hour, vehicles must be equipped with self-service pick-up and return facilities and carshare service providers are obliged to deploy vehicles in geographically different areas in the Capital City of Prague, it also requires uniform marking of the service on vehicles and the average age of the vehicle fleet is less than 4 years. Vehicles with internal combustion engines must meet at least the Euro 5 emission standard.

According to the user evaluation, the quality of services provided in Prague is currently at a high level thanks to a positive evaluation of the cleanliness of rented cars. Among the afflictions of services, users mention e.g. lengthy record of damages.

Number of shared EVs

	2017	2018	2019	2020
Resulting indicator value	**29.2 km²**	**8.1 km²**	**7.2 km²**	**2.1 km²**
Calculation	City Area / Number of shared EVs			
Number of shared EVs	17	61	69	242
CCP area	496 km²			

SOURCE: Internal communication with ODO MHMP.

The value of the indicator is determined as the ratio of the area of the capital and the number of EVs. It expresses the average area on which 1 shared EV is available. In 2020, one shared electric car is approximated to around 2.1 km².

Number of Shared EVs Per Capita

The indicator follows the previous indicator concerning the number of shared electric cars, with the difference that it is tied to the sample of the population, not the area of the capital city.

	2017	2018	2019	2020
Resulting indicator value	**76,148**	**21,453**	**19,192**	**5,517**
Calculation	Population / Number of shared EVs			
Number of shared EVs	17	61	69	242
Population of Prague *	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Internal communication with ODO MHMP. | * CSO[22/]

The increase in the number of shared EVs in 2020 was significant compared to the previous two years, as a result of the expansion of GreenGo's vehicle fleet, even though the number of electric cars at other providers is declining. In general, with the growing number of inhabitants of Prague, the number of shared EVs is also increasing. In 2017 there was one shared EV for more than 76 inhabitants of the City of Prague, in 2018 it was already for about 21.5 thousand inhabitants, and in 2019 there was one shared EV for approximately 19.2 thousand inhabitants of the capital. In 2020 thanks to a several-fold increase in shared EVs, one shared EV per 5 517 inhabitants of the capital is calculated.

The nature of the fleet sharing system

The indicator is related to the above indicator, but expresses the proportion of cars with alternative drives in the fleet of shared vehicles.

	2017	2018	2019	2020
The resulting value of the indicator	**6 %**	**9 %**	**18 %**	**36 %**
Calculation	Number of shared EVs and hybrid cars / Number of shared cars [%]			
Number of shared EVs	17	61	69	242
Number of shared hybrid cars	0	0	100	278
Number of cars shared	265	650	919	1,466

SOURCE: Internal communication with ODO MHMP and freely available information.

SOURCE: **22/** "Population - Region | CZSO in Prague Capital City", available at https://www.czso.cz/csu/xa/obyvatelstvo-xa, check on 17 June, 2021.

The indicator is sensitive to the representation of EVs and hybrid cars in the fleet, which means that even while maintaining the total number of shared vehicles, the change of the fleet from conventional to alternative is recorded. Given that in the course of 2018 the critical penetration value of shared vehicles in the territory of Prague (set by EY at 479) was significantly exceeded, it was appropriate to expect an increase in the value of this indicator. In 2020, the number of shared EVs increased 3.1 times compared to the previous year, and the total number of shared cars increased 1.5 times. The trend of alternative drives among shared cars is still upward and is higher than the expansion of the number of cars of these services.

However, according to representatives of carsharing services, the offer of suitable and available cars on the market and the building of a wider network of charging stations is very important to support the increase of EV's share in the entire fleet of shared vehicles. The increase in the number of shared hybrid vehicles is related to the introduction of new mobility providers in the capital city, whose fleets have exclusively hybrid vehicles.

E-carsharing in passenger transport

	2017	2018	2019	2020
Resulting indicator value	**2.01 ‰**	**6.91 ‰**	**7.56 ‰**	**26.14 ‰**
Calculation	Number of shared EVs / Number of registered vehicles of category M1 [‰]			
Number of shared EVs	17	61	69	242
Number of registered M1 vehicles	844,613	882,717	911,844	925,716

SOURCE: Internal communications with the provider of e-carsharing, Central Register of Vehicles of the Ministry of Transport. In 2017, the value of the number of shared EVs from the EY study (36) was replaced by data from the Department of Transportation. The data on the number of registered M1 category vehicles for 2018 were specified.

The indicator expresses the ratio of the number of shared EVs to the total number of registered M1 vehicles in the Capital City of Prague. The number of shared EVs in 2017 included vehicles from one provider, which ceased its activity on November 3rd, 2017. In 2018, more providers were added and the absolute number of shared EVs increased 3.5 times. Thanks to the overall growth in the number of EVs in shared services, this indicator increased threefold in 2020. It can be assumed that with the gradual development of electromobility, especially if the support of EV by the city and the state is expanded, their number in carsharing services will continue to grow.

Accessibility of Shared EVs

The indicator evaluates the quality of coverage of the entire territory of the Capital City of Prague by the system of shared EVs.

	2017	2018	2019	2020
Resulting indicator value	**3.55 %**	**12.73 %**	**14.41 %**	**50.5 %**
Calculation	Number of shared EVs / Critical penetration value [%]			
Number of shared EVs	17	61	69	242
Critical penetration value of shared cars in the Capital City of Prague	479			

SOURCE: Data coming from the above-mentioned EY study and the values provided by ODO PCH.

According to a study prepared by EY, which deals with the issue of shared cars, the critical penetration value of the number of shared cars in the Capital City of Prague corresponds to 479. This value expresses the minimum necessary number of shared cars in the Capital City of Prague in order for the service to become available in space. When the critical penetration value is reached, the availability of 1 shared car on an average area of 1.03 km² will be ensured. Given that it was already significantly exceeded for the entire fleet of shared vehicles, including EVs, in 2018, a further increase in this indicator can be expected in the future in connection with the change of the fleet of shared vehicles in favour of EVs. If only EVs are taken into account, the current value of the availability of shared EVs in 2020 corresponds to an area of 2 km². The value of the indicator thus shows that only the number of shared EVs in 2020 reaches approximately 50,5 % of the critical penetration value of the share of shared cars. In terms of absolute numbers, there was the largest year-on-year increase in the number of shared EVs (+ 173). This is also related to the increase in the value of the indicator by 36.09 %.

Other Indicators in the Topic of E-carsharing

Under this topic, it would be desirable to monitor other indicators, however, data on the arrival of vehicles or the time of their use are not publicly available, as it is a trade secret of the service operators. Indicators that cannot currently be quantified include:

1/ **Use of e-carsharing**
- Calculation: Performance or time for shared EVs / Number of shared EVs

2/ **The popularity of e-carsharing in car sharing systems**
- Calculation: Performance or time for shared EVs / Performance or time for shared cars

3/ **Popularity of car sharing systems in passenger transport**
- Calculation: Average performance per person for shared cars / Average performance per person for own cars

4/ **Maturity of carsharing systems**
- The indicator assesses technological readiness for the integration of single registration, payments, reservations, sales services, shared customer service, shared loyalty and benefit programs.
- One point is added for each defined category that meets the technological readiness requirements for integration into the single service. Resulting indicator value is determined as the sum of these points.

4.1.3 Ecological Buses

Public transport is another source of urban air pollution. The current trend is the transition of public transport vehicles to alternative propulsion, which is environmentally friendly. This sub-area of Mobility of the Future is therefore dedicated to the gradual modernization of the vehicle fleet through the deployment of electric buses, which partially replace diesel vehicles.

Buses Powered by an Electric Motor

The Smart Prague 2030 concept provides support for the electrification of buses as a form of transition to the so-called clean fleet. This indicator provides an idea of the number of electric buses operated in Prague's integrated transport.

	2017	2018	2019	2020
Resulting indicator value	**1,052**	**1,092**	**1,247**	**536**
Calculation	Total number of buses in the fleet / Number of electric buses			
Number of electric buses	2 *	2	2	5
Total number of buses in the DPP fleet	1,170	1,162	1,144	1,166
Total number of buses of other PID carriers	934	1,022	1,350	1,516

SOURCE: Internal communication with Arriva, DPP, ROPID. | * Includes 1 battery trolleybus.

The most significant part of the transport performance of buses on the territory of the Capital City of Prague is provided by Dopravní podnik hl. m. Prahy. Other carriers within the framework of Prague Integrated Transport (PID) perform transport services mainly on the 3xx and 4xx series lines. The 3xx series lines are suburban buses, which means that in most cases these vehicles do not drive deep into the city, but transport passengers to the outskirts of the city – especially to metro stations. The 4xx series lines are run within the PID tariff zones, but do not pass through the territory of the Capital City of Prague. The year-on-year increase in the number of buses outside the DPP is due to the congestion of lines within the PID, and thus the purchase of additional vehicles for their operation and at the same time the expansion of Prague's integrated transport deeper into the Central Bohemian Region.

Electric buses are in the fleet of Dopravní podnik hl. m. Prahy (DPP) represented by one SOR NS 12 electric bus and one SOR TNB 12 battery trolleybus. Under current legislation, a trolleybus is not a road vehicle, but a rail vehicle.

In the capital, 2 more electric buses from Arriva are regularly operated. These electric buses are outside the PID system, because they are a contracted transport for BBC Brumlovka in Prague 4, which connects the business centre with the Budějovická location. One of these electric buses will run in normal operation on a single charge and with passengers in a speed of 130 to 150 km. The capacity of the bus is 73 passengers and, in both vehicles, passengers can also use Wi-Fi connection.

The values of the indicator did not differ much in the monitored period, however, in the next few years, a significant increase in the number of electric buses operated in the Capital City of Prague can be expected with regard to the renewal of the DPP fleet and new PID quality standards. The values of these indicators will be increased mainly due to the fact that DPP is active in the field of pilot testing of electric buses. At the end of 2021, one electric bus will be delivered to Škoda Electric, which won the public contract announced by DPP. The delivery of another 13 electric buses of the same manufacturer can be expected next year. The plan is to deploy these electric buses on lines no. 154 and 213.

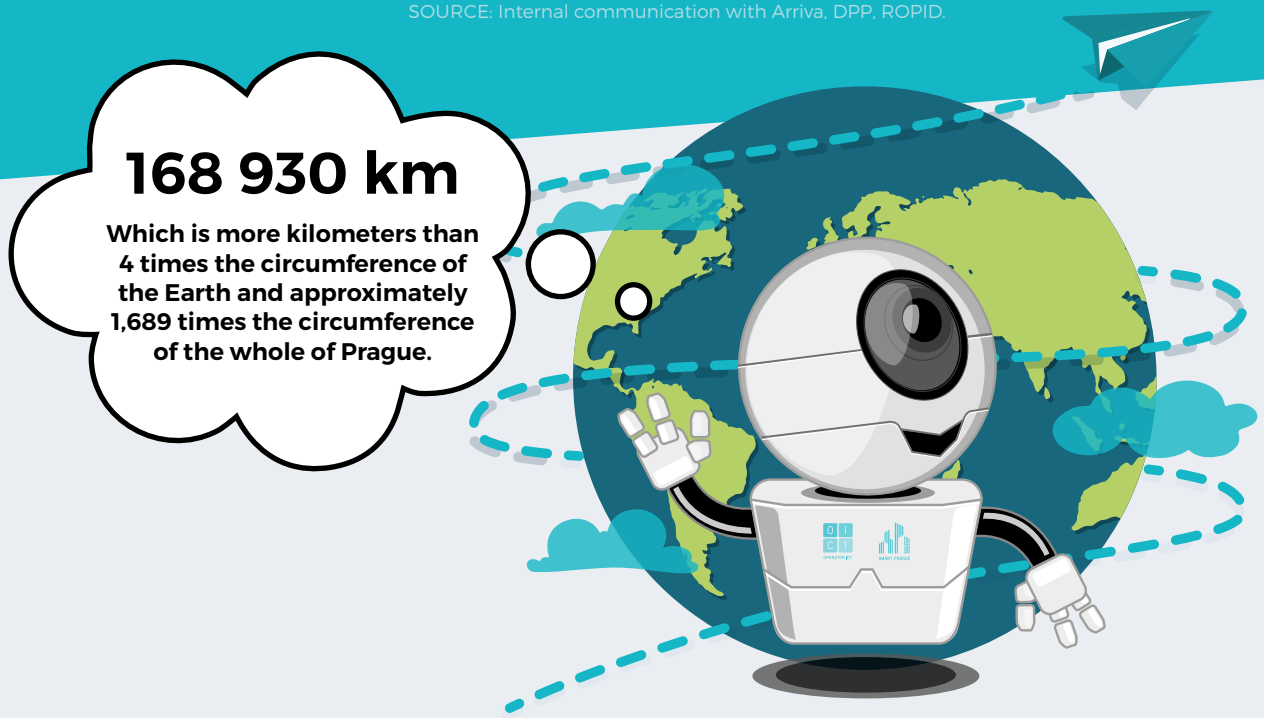
Another activity that may contribute to the increase in the number of electric buses in the coming years is pre-project preparation, which focuses on the suitability of the technology of four-pole charging of electric buses in the conditions of line 134 (Podolská vodárna – Dvorce). OICT is cooperating with DPP on this project and the prerequisite is the full replacement of 12 buses with electric buses.

E-bus Distance Travelled

The indicator complements the previous indicator Buses powered by an electric motor with information containing the actual deployment in the ratio of transport power.

	2017	2018	2019	2020
Resulting indicator value	**1,192**	**1,646**	**648**	**416**
Calculation	Total number of bus kilometres / Number of km driven by e-buses			
Number of km driven by e-bus	60,755	45,940	116,660	168,930
Total bus kilometres travelled	**72,450,000**	**75,632,100**	**75,577,309**	**70,349,690**
Number of vehicle kilometres of DPP buses in the Capital City of Prague	64,683,000	67,900,000	67,540,000	61,100,000
Vehicle kilometres of city buses outside the DPP in the Capital City of Prague	7,767,000	7,732,100	8,037,309	9,249,690

SOURCE: Internal communication with Arriva, DPP, ROPID.



The continuing trend of increasing the number of vehicle kilometres driven by electric buses is due to the inclusion of the approach of 5 cars that are in test operation. In the coming years, a further increase in the number of vehicle kilometres driven by electric buses is expected based on an increase in the number of electric buses within the DPP fleet.

The total number of vehicle kilometres of buses is calculated as the sum of transport performance of DPP and other PID carriers in the City of Prague. Within the mileage of vehicle kilometres in the City of Prague, a significant year-on-year decrease of 7% can be identified, and overall, the number of vehicle kilometres was the lowest since 2017. The decline is attributed to the COVID-19 pandemic, which had an impact on traffic restrictions.

The increase in the number of vehicle-kilometres of city buses outside the DPP in the territory of the Capital City of Prague is caused by the congestion of lines of private carriers in the PID system.

4.1.4 Intelligent Transport

An integral part of intelligent transport are modern information and communication systems enriched with transport engineering, collectively referred to as intelligent transport systems (ITS). These systems provide alternative approaches to reducing congestion, reducing journey times, increasing transport safety and reliability, reducing environmental impact and increasing the efficiency of transport and transportation. All this taking into account, the fact that endless expansion of the physical transport infrastructure is not possible.

One of the main indicators of the level of intelligent traffic in the city is the dynamic control of traffic lights at intersections. Dynamic control adjusts the parameters of the signal plan depending on the current traffic situation. In-

formation about the current traffic situation is obtained from traffic detectors (such as inductive or virtual loops), which provide enough data on the traffic flow. Typically, the parameters to be modified are, for example, the length of the cycle or the time of the green signalling in a certain direction, for example in order to prefer public transport vehicles. Decisions on these parameters can take place at the local, regional or municipal level. In addition to managing traffic hubs and monitoring the current situation, information and navigation systems are also among the key areas of smart transport. Also, parking or transport in peace is an important part of the transport system. It also includes sensors that monitor the current occupancy of individual parking lots (e.g. P+R) and this information is provided to drivers together with routing by means of variable traffic signs. The future development of intelligent parking may also aim at parking space reservations. In the street network of cities, modern technologies are used mainly as options for paying parking fees (cashless payment by credit card, payment via mobile application, text message, etc.). Payment for a parking ticket can be made, for example, via the city mobile applications Moje-Praha or PID Lítačka.

An integral part of intelligent transport is also the development of systems for informing other transport participants, public transport passengers and further streamlining the flow of traffic.

Number of Smart Parking Spaces

So-called smart parking spaces are individual parking spaces that are equipped with sensors for individual or collective occupancy measurement. Individual measurements are performed, for example, the so-called a puck located in the road surface of each individual parking space. For mass measurement, for example, a camera system is used to record several parking spaces at once or a system of counters in the carriage barriers. If the car park is equipped with smart parking spaces, the driver can be guided directly to a specific free parking space. Guiding the driver to a specific location saves time and reduces emissions produced when looking for a free parking space.

	2017	2018	2019	2020
Resulting indicator value	**0 %**	**7 %**	**6 %**	**7 %**
Calculation	Number of functional P+R parking spaces equipped with intelligent sensors / Total capacity of P+R car parks in the Capital City of Prague			
Number of functional P+R parking spaces equipped with intelligent sensors	0	260	260	260
The total capacity of P+R car parks in the Capital City of Prague	3,709	3,966	4,010	3,710

SOURCE: Internal communication with TSK.

In 2018, the P+R car park (Park & Ride) was put into operation in the Prague Congress Centre with a capacity of 260 parking spaces, which are equipped with a camera system. It is this camera system that is used to monitor the occupancy of individual parking spaces. Other Prague P+R car parks are equipped with an entrance / exit gate (entrance system with a barrier), which counts the current number of vehicles in the car park. For this reason, Prague's P+R car parks do not need sensors of individual parking spaces. Recording the entry / exit of vehicles is a significantly less costly option and at the same time provides enough data for the purpose of monitoring current occupancy. Therefore, a significant change in the value of the indicator cannot be expected in the future.

At the beginning of 2019 the Švehlov car park was closed and from the end of the same year, another P+R car park was put into operation. Specifically, these are the new unattended P+R Braník and the reopened P+R Opatov. P+R Braník works in the mode without an entrance gate and it is an unguarded car park. In contrast, P+R Opatov is a guarded parking lot with an entrance gate.

An innovation in P+R car parks is the entrance camera system for reading the vehicle's registration plate. This system enables faster check-in when leaving the car park and at the same time allows users to pay the parking fee using the mobile application PID Lítačka and Moje Praha. In these applications and on the TSK website, a. s., it is also possible to monitor the current occupancy of individual P+R car parks.

The decrease in the total capacity of P+R car parks is due to the closure of P+R Černý Most 1 in June 2020 due to the planned reconstruction, which will increase the capacity to 880 parking spaces.

Intelligent Light Signalling Devices

Intersections equipped with light signalling devices (SSZ) communicate with the controller. It operates with traffic engineering parameters such as cycle length, phase length including their transitions and free time. These parameters thus form a signal plan, according to which the signals at individual traffic lights of the intersection are changed. In this way, the driver is signalled a given driving instruction.

Light-controlled intersections work independently of others, because they are connected to the control panel (in Prague it is the Main Traffic Control Centre – HDŘÚ). It is a higher organizational unit, which ensures the flow of traffic in the city. Light-controlled intersections are designed to ensure fluidity at predetermined traffic junctions. SSZ is standardly divided into dynamic and static. For dynamic SSZs, the parameters of the signal plan change according to data from local detectors or from a higher organizational unit. The aim is to meet current requirements to ensure the flow of traffic.

	2017	2018	2019	2020
Resulting indicator value	**71 %**	**72 %**	**73 %**	**75 %**
Calculation	Number of SSZ connected to HDŘÚ / Total number of SSZ in the territory of the City of Prague			
Number of SSZ connected to HDŘÚ	466	478	484	503
Total number of SSZ	660	665	667	668

SOURCE: Internal communication with TSK.

The indicator shows the degree of integration of land traffic management in the Capital City of Prague. The basic unit for traffic control is the number of intersections that are equipped with SSZ controlled by an intersection controller. These junction controllers are integrated into automated Regional Traffic Control Centres (ODŘÚ). These are then integrated into the highest level of HDŘÚ, which fulfils the function of a dispatching station. It ensures central supervision of the traffic situation and coordinated traffic management in the Capital City of Prague. Data for creating traffic incidents at HDŘÚ are obtained from various sources: traffic detectors, road meteorological system, high-speed scales, surveillance camera system, SSZ, tunnel control systems, data from floating vehicles (FCD), national traffic information centre, control centre Rudná and other systems.

SSZs connected to the HDŘÚ can currently be managed by the decision of dispatchers according to the current traffic situation in order to ensure safe and smooth operation. Further development of systems for decision support of dispatchers or automation of the system further depends on the availability of technologies. In particular, it is artificial intelligence (AI) for a given area or centralization of information from other sources. These sources can be online navigation sensor systems for cars, autonomous vehicles, etc.

In terms of the development trend of the number of SSZs connected to the HDŘÚ, there was a year-on-year increase of 19 SSZs in 2020, which corresponds to almost 4 %. The trend of the resulting indicator for the last 4 years is therefore still rising.

Preference Rate for Public Transport at Intersections

This indicator shows the degree of integration of the public transport preference system at light-controlled intersections. Public transport preferences at traffic lights shorten the waiting time of a public transport vehicle and thus increase the smoothness of these vehicles. The indicator is divided into the preference of tram vehicles and buses.

	2017	2018	2019	2020
Resulting indicator value	**79 %; 35 %**	**83 %; 36 %**	**85 %; 37 %**	**89 %; 38 %**
Calculation	Number of SSZs with preference on the tram network / Total number of SSZs on the tram network; Number of SSZ with preference on the bus network / Total number of SSZ			
Number of SSZ with preference on the tram network	197	206	211	219
Total number of SSZ on tram network	248	248	248	247
Number of SSZ with preference on the bus network	232	238	245	251
Total number of SSZ	660	665	667	668

SOURCE: Internal communication with TSK.

Two types of preferences are used on the tram network – absolute and conditional. Absolute preference allows the tram to pass through a light-controlled intersection without the need to stop (with the exception of the arrival of several tram cars in a row). Conditional preference is achieved by reducing the delay of trams at light-controlled intersections compared to the situation without public transport preference. During 2020, there was an increase in the final value of the indicator, as was the case in previous years. The long-term trend is therefore growing.

The area of public transport bus also uses two types of preferences. Namely, it is an active and passive preference. Active preference is a system where the car logs in and logs out radio signals at specified points to the traffic light controller. Infrared beacons or positioning using satellite navigation systems (GNSS) are used to locate buses. Passive detection means that the bus's right to priority is identified by conventional vehicle detectors on the basis of passing through an induction loop built into the body of the road or by means of a so-called virtual loop in case of video detection. This solution is mainly used in dedicated lanes. During 2020 the resulting indicator of public transport bus preference also increased. This has been the case in previous years.

It is important to mention that the total number of traffic lights on the bus network is not monitored. The reason is the flexibility of bus connections and lines, which can be changed relatively easily. It may depend, for example, on road reconstruction. For this reason, the total number of all traffic lights in the territory of the Capital City of Prague is used to calculate the indicator.

Smart Elements of Transport Infrastructure

This indicator is determined by the number of RSU (Roadsite Unit) units on roads in Capital City of Prague. The RSU is an infrastructure element that serves for two-way communication between the vehicle and the infrastructure (V2I - Vehicle-to-Infrastructure). These infrastructure elements allow the exchange of information such as vehicle speed and direction, weather conditions (temperature, visibility, etc.), traffic information, etc. and can also be connected, for example, to an intersection controller, which transmits information about the time of the next green in a given direction. RSU units belong to the cooperative intelligent transport systems (so-called C-ITS).

	2017	2018	2019	2020
Resulting indicator value	**21**	**21**	**23**	**23**
Calculation	Number of transport infrastructure elements capable of V2I communication			
Number of RSUs	21	21	23	23

SOURCE: Internal communication with TSK.

V2I communication is a platform enabling the exchange of information between the infrastructure object and the vehicle. This platform is also used for V2V (Vehicle-to-Vehicle) communication, i.e. it ensures the redistribution of information between vehicles. The vehicles themselves must also be equipped for this type of communication and the OBU (On-Board Unit) is used for this.

RSUs communicate with in-vehicle OBUs in the 5.9 GHz frequency band, which is reserved worldwide for this type of communication. The relevant standard is referred to in European countries as ITS-G5 and is based on the IEEE 802.11p standard. The communication protocol is DATEX II, which was developed for these purposes.

Traffic Flow

The indicator is focused on the evaluation of traffic flow on major roads. The purpose is long-term monitoring of the success of the implementation of city strategies in ensuring the flow of traffic. This applies in particular to the deployment of traffic telematics measures.

	2017	2018	2019	2020
Rush hour speed (km/h)	**33.8**	**35.4**	**35.4**	**41.8**
Velocity outside of traffic hour (km/h)	43.5	43.5	41.8	54.7
Free traffic speed (km/h)	51.5	51.5	51.5	N/A

SOURCE: INRIX, "Scorecard", Inrix, available from www.inrix.com/scorecard.

The indicator is not systematically monitored on the Prague-wide level. These data come from available studies conducted by INRIX, which evaluate congestion in more than 975 cities on 7 continents. During 2020, there was a significant increase in speed within and outside rush hour. One of the reasons is the decrease in traffic intensities as a result of government measures to combat the COVID-19 pandemic, in particular the reduction in population mobility. According to the TSK, the traffic intensity on the monitored Capital City of Prague network decreased year-on-year by approximately 8 %, which results in a higher increase in the speed of movement than the medium-term average.

Smooth Bus Ride

The indicator of the smooth running of buses represents the average speeds of bus vehicles of the Prague Transport Company (DPP) in the territory of the Capital City of Prague. In the long term, it also monitors the effectiveness of public transport vehicle preferences at traffic lights.

	2017	2018	2019	2020
Resulting indicator value	**25.16 / 16.70**	**25.01 / 16.80**	**24.98 / 16.90**	**24.94 / 16.80**
Calculation	Average cruising speed [km/h] / Average running speed [km/h]			

SOURCE: Internal communication with DPP.

The values express the average speeds of DPP line buses, which include 1xx, 2xx and 3xx series lines.

Cruising speed expresses the share of distance travelled and driving time of public transport bus vehicles. This means that for each line, the cruising speed depends mainly on the length of the line, the number of stops, driving time and the like, but the driver's break at the end stations is not taken into account. The average cruising speed expresses the average cruising speeds of all vehicles on routes in the City of Prague.

The orbital speed is determined by the ratio of the distance travelled and the orbital time of one circuit of a given line. This means that the direct dependence consists of the cruising speed and the indirect dependence the standing time at the final stops – i.e. the driver's break. Orbital speed is an important operating characteristic on which the number of vehicles on the line depend.

Data for 2020 show a slight decrease in both values compared to the previous year.

4.1.5 Self-driving Vehicles

This subcategory of Mobility of the Future is focused on the strategy of transition to autonomous management of individual types of means of transport (e.g. trams, cars, subway, etc.). Through studies, pilot projects and data collection, the Capital City of Prague supports the introduction of autonomous means of transport in its territory.

The experience gained and data from pilot projects serve as a basis for the proposal of legislative and technical measures. The legislative framework and technical readiness of the infrastructure are crucial for the widespread introduction of autonomous means of transport in the Czech Republic. The Ministry of Transport has created an ethics commission for the development of autonomous mobility, which assesses issues related to the operation of automated and autonomous vehicles in the Czech Republic. In the case of autonomous vehicles, the aim is for these vehicles to be able to operate in the existing environment and at the same time road modifications to be minimal. Not only for this, but also for safety and other reasons, the complexity of autonomous vehicles is very high. The difference in complexity can be figuratively compared, for example, in the number of lines of code, which is estimated at around 300 million for a fully autonomous vehicle, which is an order of magnitude difference compared to the 6.5 million Boeing 787 Dreamliner.

The Czech Republic is involved in a European project for testing cooperative intelligent transport systems called C-ROADs.[23/] The aim of this project is to test vehicle-to-vehicle communication (V2V) and vehicles with units installed on transport infrastructure (V2I – vehicle-to-infrastructure communication). Communication between vehicles is used, for example, to coordinate driving characteristics so that unnecessary congestion does not occur. The communication of the vehicle with the infrastructure helps to disseminate various information about a specific place and situation in a targeted and timely manner (e.g., road condition, weather, and visibility). By providing up-to-date information to drivers directly in the vehicle, the project represents the first steps towards intelligent mobility.

Rail transport is an easier solution to the deployment of autonomous means of transport. The movement of rolling stock is limited and in the case of underground transport the environment is almost unchanged and the risk of obstacles on the line is very low. One of the conditions for fully autonomous metro trains are completely physically separated track and platform areas. The trainset must stop so that the doors are always in the same places where passengers would be allowed to pass if the set arrives. On the territory of the Capital City of Prague, it is planned to deploy a fully autonomous train set on the planned metro line D.

Representation of Autonomous Road Vehicles

In the future, this indicator will be used to monitor the representation of autonomous vehicles in Prague transport. In general, it will be calculated as the share of autonomous road vehicles from level 3 (see table below) and above in the total number of registered M1 vehicles.

Currently, this indicator represents the defined degrees of autonomous vehicles using the table below. It therefore serves to inform citizens.

Defined levels of autonomous vehicles

Level 0: No automation	the vehicle is controlled exclusively by the driver, the vehicle systems do not interfere with the steering
Level 1: Driver support	vehicle systems facilitate driving but are not interconnected (e.g. ABS or ASR)
Level 2: Partial automation	vehicle systems are combined and cooperate. The driver must be able to take control at any time and have his hands on the steering wheel most of the time (e.g. adaptive cruise control)
Level 3: Conditional automation	the driver must be able to take control, but may no longer have his hands on the steering wheel
Level 4: High automation	the driver will only take over in rare situations
Level 5: Full automation	completely autonomous driving (the car can already be without a steering wheel)

SOURCE: **23/** For more see "C-Roads | C-Roads Czech Republic ", available at https://c-roads.cz/cs/, check on 18 June, 2021.

Readiness of Roads for the Use of Autonomous Vehicles

The indicator shows information on the number of kilometres of roads eligible for autonomous driving. For the purposes of this indicator, capability means in particular the equipment of the infrastructure with communication units and other technologies enabling completely autonomous driving of vehicles. It is based on the framework given by the Smart Prague 2030, concept, which sets the goal of developing the potential of autonomous management. The indicator is based on the need to have a range of test polygons and roads to attract partners from the automotive industry. The prerequisite is to ensure communication between individual vehicles and infrastructure with vehicles, or also with pedestrians, e.g. via Smart Phone.

	2017	2018	2019	2020
Resulting indicator value	**0**	**0**	**0**	**0**
Calculation	Number of kilometres of roads enabling autonomous driving / Total number of kilometres of roads on the territory of the Capital City of Prague managed by TSK			
Number of kilometres of roads allowing autonomous driving	0	0	0	0
The total number of km of roads on the territory of the Capital City of Prague managed by TSK	2 327	2 365	2 327	2 327

SOURCE: Internal communication with TSK.

The value of the indicator shows the relative share of roads technologically equipped for the operation of autonomous vehicles. Autonomous road vehicles are designed so that they can be put into operation on the existing infrastructure without the necessary construction modifications. The only limiting element for their deployment was the technical equipment. The aim is to adapt selected roads for test scenarios for the deployment of autonomous vehicles by representatives of the automotive industry, who will sign a memorandum with the Capital City of Prague. Currently, only the total number of kilometres of roads in the Capital City of Prague managed by the TSK within the communication network can be observed.

Testing of Autonomous Vehicles

Autonomous vehicle testing is an indicator that indicates the number of scenarios for testing autonomous traffic on eligible roads. At the same time, it builds on the previous indicator.

	2017-2020
Number of autonomous mobility test scenarios	**0**
Calculation	Number of test scenarios valid in a given year

SOURCE: OICT internal resources.

The test scenario describes the operational situation on a selected section of the road in a special mode of operation, namely in the mode of operation of autonomous vehicles. The test scenario describes a scheme for testing the selected situation and the expected behaviour of the autonomous vehicle. Thus, there are several scenarios for several situations, an example of such a situation could be the passage of a vehicle with the right of priority driving (IRS vehicles) through a traffic light or a public transport stop and the exit of passengers to the road.

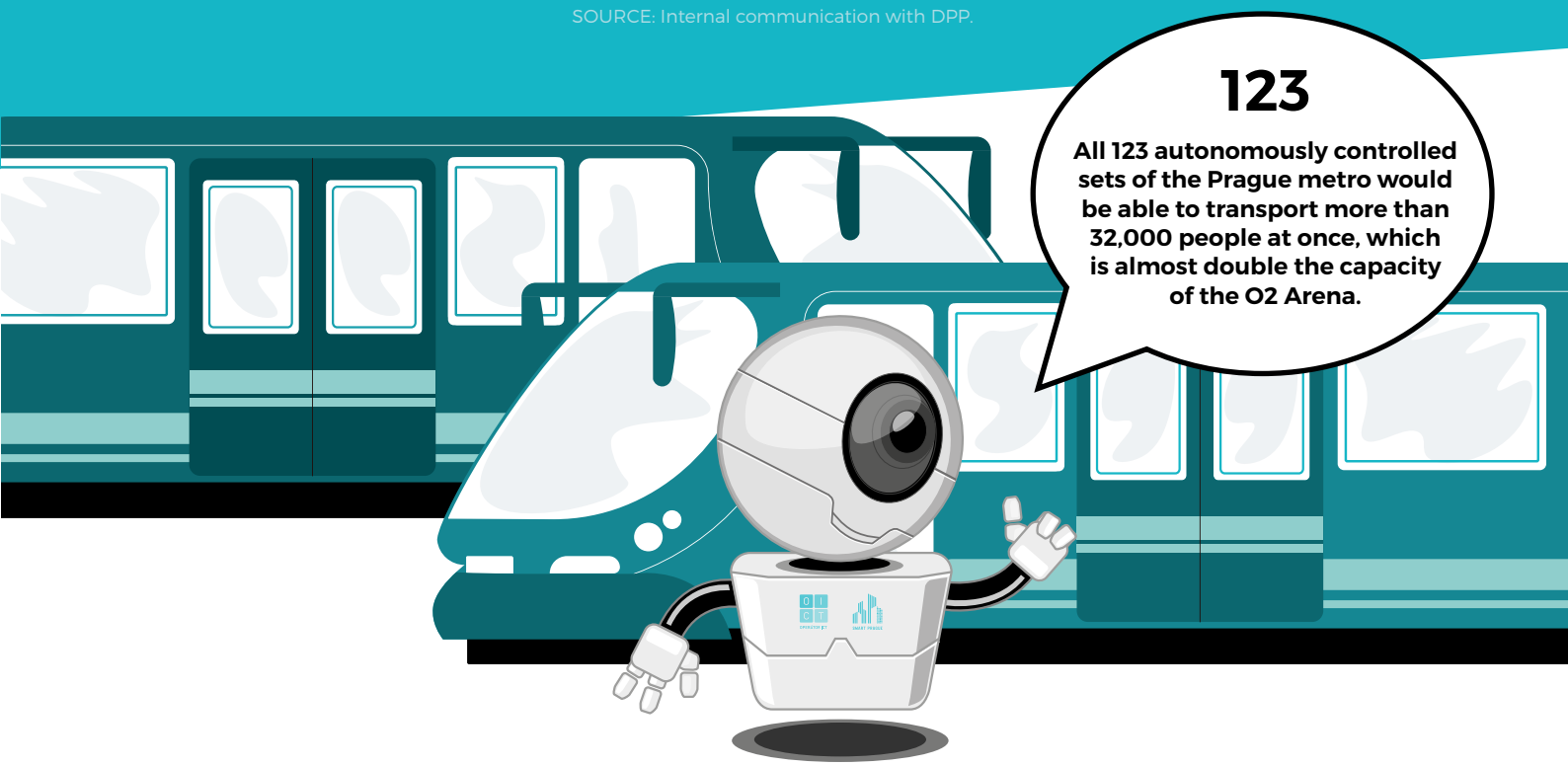
In the future, an expert group of the Capital City of Prague will be established, which will perform the function of an executive body in permitting testing of autonomous driving.

Use of Autonomous Control in the Subway

Autonomous vehicles do not have to be only on roads, where their implementation is very complicated, but they can also be used on railways. The currently closed special tracks of rail vehicles (for example the metro) are among the relatively simplest implementations of autonomous control.

	2017	2018	2019	2020
Resulting indicator value	**64 %**	**71 %**	**77 %**	**84 %**
Calculation	Number of autonomously controlled metro sets / Total number of metro sets			
Number of autonomously controlled metro sets according to automation levels no. 2	94	103	113	123
The total number of subway trains	146	146	146	146

SOURCE: Internal communication with DPP.



The value of the indicator is calculated from the degree of automation no. 2 in the sense of IEC 62267.

Automation level 1	automatic train protection in operation with the driver
Automation level 2	automatic train control in operation with the driver
Automation level 3	automatic train control in operation without drivers but with the presence of a train guide
Automation level 4	automatic operation completely without train staff

Automation level 2 was chosen for the indicator, because it is already implemented in the Prague metro, specifically on the green line A and the red line C. On line A, all 41 sets are equipped with this technology and on the line C all 53 sets. A total of 52 trains run on the yellow line B, of which 29 are equipped with a mobile part of the LZA train protection system.

In particular, operation automation brings savings in the energy required for operation thanks to the optimization of consumption during starting and stopping. In the future, the introduction of automation of stage no. 4 for metro line D.

Use of Autonomous Management in Public Transport

This indicator shows the degree of autonomous control of the Prague metro sets in terms of mileage.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**20 %**	**23 %**	**28 %**
Calculation	Number of vehicle kilometres driven by public transport in autonomous mode / Total number of vehicle kilometres driven by public transport vehicles			
Number of vehicle kilometres travelled by public transport in autonomous mode *	N/A	35,902,645	42,384,313	47,594,400
Total number of vehicle kilometres driven by public transport / DPP vehicles – metro	58,128,000	59,244,000	60,894,000	56,660,000
Total number of vehicle kilometres driven by all public transport / DPP vehicles – trams, buses, cable cars	119,776,000	120,748,000	121,278,000	111,372,000
Total number of vehicle kilometres driven by all public transport / DPP vehicles	177,904,000	179,992,000	182,172,000	168,032,000

SOURCE: Internal communication with DPP. | * the semi – autonomous mode is also included – automation of stage no. 2.

The value of vehicle kilometres is calculated for each individual carriage of the train set. The value of train-kilometres can be calculated for the whole set.

The increase in the number of vehicle kilometres in the autonomous mode is due to the gradual automation of line B of the Prague metro. The decrease in the total number of vehicle kilometres is generally due to a lower range of services in connection with the COVID-19 pandemic.

4.1.6 Mobility as a Service

MaaS (Mobility as a Service) is, in a sense, a user-centrist concept that deals with the integration of all possible modes of transport (e.g. car, parking, taxi, bike / car sharing, public transport and cycling and walking) into one platform (e.g. mobile app). It aims to make this information clearer to users, make it available in one place or platform, create documents for intermodal route planning in Prague and enable payment for all modes of transport in one place. Intermodal route planning means the use of several modes of transport, i.e. their combination on the selected route in order to e.g. speed up and reduce the cost of transport. MaaS represents an innovative solution to the problem of transportation services based on Big Data operations. This platform allows passengers to share information, so they can be informed in time about the delay and the location of selected connections. In addition, an automatic census of passengers in the vehicle would make it possible to increase the overview of the current occupancy of individual cars and to take this information into account when planning. Modern systems then provide the possibility of more efficient route planning, transfers at individual nodes, thus saving passengers time spent commuting.

Access to Traffic Information

This indicator evaluates the possibilities of obtaining information about the current traffic situation.

	2017	2018	2019	2020
Resulting indicator value	**3**	**3**	**3**	**3**
RDS – TMC (Radio Data System – Traffic Message Channel)	working	working	working	working
Active devices for operational information (ZPI)	71 pieces	71 pieces	71 pieces	72 pieces
Open traffic data updated in real time	dic.tsk-praha.cz	dic.tsk-praha.cz, www.dopravapraha.cz	dic.tsk-praha.cz, www.dopravapraha.cz	dic.tsk-praha.cz, www.dopravapraha.cz

SOURCE: Internal communication with TSK

Resulting indicator value reaches values from 1 to 3 (the more identified layers, the higher the value of the indicator). Just one point is deducted for each unfilled layer. In the table above we can see that Prague fills all identified layers.

1/ **RDS – TMC (Radio Data System – Traffic Message Channel)**
2/ **Digital panels on main roads (high-traffic roads)**
3/ **Open traffic data updated in real time**

RDS–TMC stands for Radio System to provide traffic information about the current traffic situation. This system provides data transmitted by radio waves for vehicle navigation infotainment. Traffic Information Devices (ZPI) are vertical information panels along main roads on which drivers are provided with traffic information. In 2020, one new facility was added in the Strahov tunnel.

Selected open data related to traffic in the city are available in the Prague data platform Golemio. These are, for example, data in the field of parking (e.g. occupancy of car parks P+R). In Prague and in all PID bands, the PID Lítačka application is available and is used to search for public transport connections, pay for a transport time coupon (ticket) and more. In the future, this application will be expanded to include other urban mobility services.

The Maturity of Public Transport Payment Systems

The indicator monitors the maturity of public transport payment systems in connection with the digitization of passenger check-in or handling system.

In 2018, a new transport clearance system for Prague and the Central Bohemian Region was put into operation as part of the Prague Integrated Transport (PID). Since then, there has been further development and addition of functionalities of this check-in system. The main priority is the massive advent of new payment technologies and the societal interest in using the mobile phone as a payment, identification and navigation tool. A significant part of the development is therefore fixed in this direction – towards the PID Lítačka mobile platform. In 2019, the mobile application was enriched with information about the passenger's time coupons, as well as the possibility to provide one's ID to the time coupon, i.e. to use the mobile application as one of the other identifiers. This completely eliminated the need to use a plastic card or transferring the complete functionality of the web e-shop to the mobile application. In 2020, the search option in the application expanded to include live data on public transport car delays:

	2017	2018	2019	2020
Resulting indicator value	**4**	**5**	**5**	**5**
Number of paper tickets sold	39,477,388	36,897,108	29,880,022	10,750,379
Number of users Lítačka / Opencard	602,000 / 249,000	757,270 / 133,433	904,719 / 157,496	972,910
Number of text message tickets sold	18,969,763	18,956,145	17,689,319	10,455,118
Number of tickets purchased with a contactless payment card in cars / using new ticket machines for contactless cards	57,912 / 5,087,423	66,244 / 7,025,294	1,956,019 / 12,426,991	1,857,730 / 8,015,042
Implemented MOS	Implementation in preparation	Full operation	Full operation	Full operation
Number of registered bank cards in the PID Lítačka system / with a coupon	N/A	26,234/11,708	71,395/28,208	75,813 / 35,716
Number of registered ČD In Cards in the PID Lítačka / coupon system	N/A	5,816 / 3,743	12,046 / 7,681	14,980 / 9,772
Number of registered PID Lítačka users (created accounts in the e-shop)	N/A	204,955	524,356	753,456
Number of shared / associated accounts	N/A	321 / 16,592	1,487 / 15,602	2,779 / 42,335
Share of accesses to web desktop / mobile devices / tablets	N/A	57.5 % / 39 % / 3.5 %	51.66 % / 46.75 % / 1.59 %	50,22 % / 48.34 % / 1.44 %

SOURCE: Internal communication with DPP, ROPID, OICT.

The value of the indicator is calculated on a scale of 1–5 (each degree of maturity represents one point) and includes the following parameters and functionalities within the multi-channel check-in system:

1/ **paper ticket**
2/ **electronic time ticket**
3/ **text message ticket**
4/ **contactless payment terminals in cars**
5/ **Apple Pay / Google Pay**

The above table also shows a significant increase in the number of registered bank cards and ČD In Cards and active transport coupons on them. The number of registered PID Lítačka users also increased. The share of access to the web application via mobile phones also increased.

The Maturity of Public Transport Check-in and Handeling Systems

The value of the indicator is quantified according to the possible methods of passenger check-in within the multi-channel handling system. Each degree of maturity represents one point.

	2017	2018	2019	2020
Resulting indicator value	**2**	**3**	**4**	**4**
Handling using paper tickets and coupons	Yes	Yes	Yes	Yes
Handling using electronic tickets and coupons on a specific carrier	Yes	Yes	Yes	Yes
Handling using electronic tickets and coupons on the identifier (does not have to be a carrier)	No	Yes	Yes	Yes
Handling using virtual tickets and coupons (in the mobile application)	No	No	Yes	Yes

SOURCE: OICT internal resources.

Since 2019, the MHS system (multichannel check-in and handling system), publicly known as PID Lítačka, has been operating in routine operation. This system is further developed and responds dynamically not only to the requirements of the organizers of the Prague Integrated Transport (PID), but also to suggestions from end users, i.e. passengers. The popularity of supported alternative fare carriers, such as bank cards, the ČD In Card or the PID Lítačka mobile application, continues to grow among passengers. The use of the Lítačka mobile application as a fare carrier made it possible to eliminate the need to own a plastic card and to travel within the PID only using the mobile application. The application is used for both long-term and short-term fares. The trend of increasing popularity of the PID Lítačka mobile application can also be monitored in the table below, which shows the number of unique users of individual platforms. During 2020, the PID Lítačka application was supplemented with live data from public transport vehicles, i.e. the display of their delay. ICT operator, a. s. (Plc.), continues to support this development, which will further increase not only the popularity of the PID Lítačka mobile application, but also other sales channels of the MOS system, thus contributing to the simplification of travel by Prague Integrated Transport.

The strategic development and business team is dedicated to the development of the project. The intention of OICT is to offer the newly set standard of transport handling to the widest possible public throughout the Czech Republic. The OICT project team is ready to modify this transport-handling system for the needs of other regions. An example is the cooperation with the Liberec Region, where a new application called Idolka is being prepared based on the PID Lítačka application. The Idolka application in the Liberec Region is also expected to be developed within the concept of MaaS (Mobility as a Service). At the same time, OICT offers cooperation in the implementation of innovations, the provision of development capacities, for example, for the implementation of mobile applications related to transport or city administration.

Utilization of the City App for Transport around the City

The indicator shows the actual use of the city mobile application PID Lítačka. This application is focused on the transport of passengers around the city in public transport vehicles.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**66.34**	**74.88**	**57.25**
Calculation	Number of connection search requests and ticket purchases / Number of unique application downloads			
Number of connection search requests	N/A	13,968,000	19,854,728	21,552,308
Number of ticket purchases	N/A	227,800	1,932,038	2,284,578
Number of unique application downloads: Android / iOS	50,613 / 7,814	186,000 / 28,000	242,456 / 48,512	264,518 / 151,833

SOURCE: For 2017 it provided ROPID data and they are valid for the mobile application "PID info", since 2018, it is OICT data for the mobile application PID Lítačka.

The value of the indicator illustrates the development of the use of the PID Lítačka application. Due to a change in the methodology for calculating the number of unique users on iOS devices, the table shows a significant increase in these users. It was this increase (number of users of iOS devices) that caused a decrease in the total value of the indicator compared to 2020, although all data continue to grow. From the table, and thus from the data themselves, the growth of values for all monitored items is evident. The popularity of the urban application is growing, which can be seen in the increasing number of unique users. It is remarkable that despite significant restrictions on mobility in the Capital City of Prague in connection with the COVID-19 pandemic, the number of searches and ticket purchases is growing.

Since the end of 2019 the PID Lítačka application has also served as a travel document identifier. Extension of the application functionalities (and subsequent specification of this indicator) is expected within the further development of the Lítačka project in the coming years.

Information Panels at Stops

The indicator shows the degree of digitization of the stop markers. These markers are the key carriers of information on public transport operations directly in public spaces. The value of the indicator shows the relative level of coverage by online information panels to provide up-to-date information to passengers. The lower the value of the indicator, the higher the digitization rate, because there were 16 stops per a smart tag in 2020.

	2017	2018	2019	2020
Resulting indicator value	**27**	**18**	**17**	**16**
Calculation	Total number of stops within the PID on the territory of the Capital City of Prague / Number of stop markers providing information in real time			
Number of stop signs providing real-time information, including information panels providing departure information outside the signs	125	189	203	205
The total number of stops within the PID on the territory of the Capital City of Prague	3,331	3,401	3,354 *	3 ,62

SOURCE: Internal communication with ROPID and DPP and data are valid as of January 31st of the respective year.
* data valid as of December 18th, 2019.

The total number of PID stops includes stops in the PID bands only in the territory of the capital city, and each stop usually has more than one marker. The number of stops in Prague remains very similar and differs mainly according to the ongoing exclusions. Information panels outside the stop signs provide information, among other things on departure times, for example in the lobbies of metro stations (connection to the tram and bus network). Of the total number, 122 markers are located on metro platforms, 14 at the level of the check-in line in the metro lobbies and another installation of 1 stop marker and 1 information panel took place this year at the Palackého square tram stop.

The total number of stops within the PID in the territory of the Capital City of Prague includes stop columns incl. metro and cable car platforms, train stations and ferry berths. In the case of the metro, each platform is counted separately, i.e. as 2 stops.

4.1.7 Other Relevant Information

This sub-area uses indirect indicators to supplement information on the impact of transport on the environment. Other relevant indicators are mainly related to the areas of quality of life and air pollution, in which transport plays a significant role.

Premature Deaths Due to Air Pollution

The indicator shows the number of premature deaths due to air pollution. Based on the implementation of the Smart Prague 2030 concept, the support of electromobility should gradually improve the air condition in Prague conditions. Air quality is also significantly affected by intelligent traffic management, which reduces the impact of traffic by optimizing traffic flows.

	2016	2017	2018	2019
Resulting indicator value	**518**	**693**	**807**	**582**
Calculation	Estimated number of deaths as a result of air pollution / Number of inhabitants of the Czech Republic * Number of inhabitants of Prague			
Estimated number of deaths due to air pollution - national average	4,300	5,700	6,600	4,700
Population of Prague	1,294,513	1,308,632	1,324,277	1,324,277
Number of inhabitants of CZ	10,578,820	10,610,055	10,649,800	10,693,939

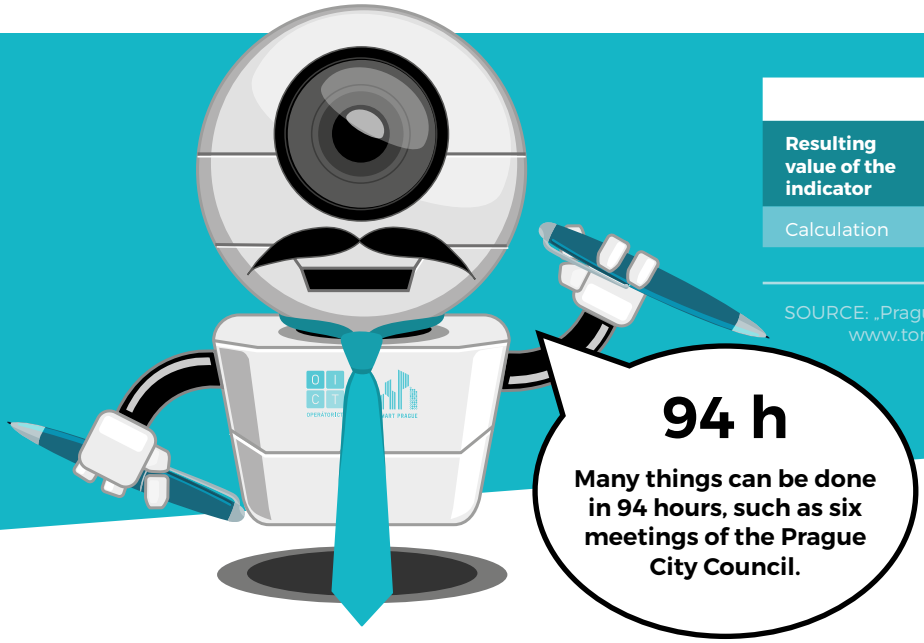
SOURCE: Population data come from official CZSO statistics and always refer to the last day of the year, see "Population – Region | CZSO in the Capital City of Prague "; available reports on the state of the environment 2016, 2017, 2018 and 2019 of the Ministry of the Environment and CZSO.

The air we breathe in the outside environment is polluted by harmful substances from a wide range of sources. The most significant sources of air pollution in the urban environment include combustion processes – industry, energy production (including domestic heating) and transport. It has been shown that air pollution can have significant health effects, such as premature death or worsening of the symptoms of various diseases and health problems associated in particular with the cardiovascular and respiratory systems. The increased risk of cancer is also not negligible. In the conditions of the Czech Republic, Prague is facing the highest traffic intensity. This value of the indicator, which is based on the national average, at least indicatively represents the number of deaths due to air pollution. Based on the established formula, the indicative value of the indicator corresponds to a total of 582 deaths in Prague. Given that it is based on the average value for the Czech Republic, it can be assumed that the value for Prague will be even higher, due to the higher concentration of the population and the corresponding transport infrastructure.

However, in 2019, the national average decreased mortality by 1.9 thousand persons, which can be explained by the year-on-year decrease in PM10. concentrations, this was also reflected during measurements at Prague stations (see the values of the indicator Pollution - dust particles).

Time Spent inTtraffic Congestion

This indicator represents the number of hours that the inhabitants of Prague (including the visitor) spend in traffic due to traffic congestion. It thus reflects the unflattering situation in terms of traffic in the Capital City of Prague. A number of strategic documents respond to this situation. In the case of the Smart Prague 2030 concept, this is a strategic area of Mobility of the Future. The desirable state is to reduce the value of the indicator, because the indicator expresses the degree of potential of the population in hours for the year that is wasted.



	2017	2018	2019	2020
Resulting value of the indicator	**119**	**119**	**128**	**94**
Calculation	Number of hours spent in traffic congestion			

SOURCE: „Prague Traffic Report | TomTom Traffic Index", available at www.tomtom.com/en_gb/traffic-index/prague-traffic.

The value of the indicator captures the difference between the time needed to pass the route in the time without being affected by traffic congestion and the real traffic time, both values are measured at peak times and weekdays. In the period 2017–2019 there was a gradual increase in the number of hours spent in traffic congestion. The value of the indicator in 2020 is fundamentally influenced by the society-wide situation related to the COVID-19 pandemic. In general, in addition to the capacity limits of the unfinished infrastructure, the reconstruction of the backbone roads in the Capital City of Prague also works against the reduction of this value. In the future, it would be appropriate to monitor the extent of ongoing reconstructions, e.g. the total length of traffic restrictions in order to clear this indicator of their impact.

The values given in the indicator are based on newly available data from the TomTom Index, which covers the topic of traffic congestion worldwide (416 cities from 57 countries).

According to the TomTom Index, in 2020, Prague ranked 137th worldwide out of 416 cities with 23 % level of traffic congestion. In terms of ranking, Prague holds a similar position (in 2019 it ranked 136th however, the level of traffic congestion was reduced by 6 percentage points (from the original 29 % to the mentioned value of 23 %).

The time lost in congestion in 2020 corresponds to 94 hours (3 days, 22 hours), which is 1 day and 10 hours less than in 2019. This is a major decline, which can be explained by the limited mobility of the population caused by measures related to the COVID-19 pandemic.

Age of Registered Vehicles

The values given here indirectly show the level of air pollution from traffic due to the technical condition of vehicles, which is usually worse for older vehicles than for new ones.

The table below works with selected categories of motor vehicles that are relevant in the conditions of the Capital City of Prague:

- **M1** – a vehicle with a maximum of eight places of carriage (excluding drivers) and multi-purpose vehicles with a maximum permissible weight not exceeding 3.5 tonnes
- **M2** – vehicles having more than eight places of carriage (excluding the driver's seat) and whose maximum permissible mass does not exceed 5 tonnes
- **M3** – vehicles with more than eight places of carriage (excluding the driver's seat) and with a maximum permissible weight exceeding 5 tonnes
- **N1** – a truck with a maximum permissible weight not exceeding 3.5 tonnes

	2017	2018	2019	2020
Resulting value of the indicator (in years)	**12,6 – 18,9 – 13,5 – 12,5**	**11,6 – 17,3 – 12,6 – 11,8**	**10,6 – 17,3 – 11,4 – 11,1**	**10,8 – 18,3 – 11,5 – 11,5**
Calculation	Average age of vehicles registered in the City of Prague in categories M1 – M2 – M3 – N1			
Category M1	12.6 years	11.6 years	10.6 years	10.8 years
Category M2	18.9 years	17.3 years	17.3 years	18.3 years
Category M3	13.5 years	12.6 years	11.4 years	11.5 years
Category N1	12.5 years	11.8 years	11.1 years	11.5 years

SOURCE: Internal communication with the Department of Transport and Administrative Activities of the Capital City of Prague.

These categories were chosen because they affect the environment and the air in the city the most. Vehicles of category M1 are usually passenger cars and vehicles of category N1 are multi-purpose passenger vehicles (usually vans up to 3.5 t). Vehicles of categories M2 and M3 are buses. Large trucks usually operate outside the city in transit traffic. The same can be said about buses, which very often serve for intra-city transport (DPP) or regularly visit the core city – tourist transport. Motorcycles were not considered because they do not constitute dominant transport performance.

The year-on-year comparison for 2019 and 2020 does not show an improving situation (i.e. rejuvenation of vehicle ages), which is again indirectly attributable to the societal situation and the effects of related measures in the new car market. However, a comparison of the ages of the vehicles over a longer time horizon shows that there is a gradual rejuvenation of the vehicle fleet.

Surveys also show that the problem is not old cars, but cars in poor condition. For example, poorly maintained engines without a particulate filter increase emissions by hundreds of percent. One tenth of cars produce about two-thirds of the most harmful emissions from transport, i.e., very small dust particles and nitrogen oxides.

Pollution – Dust Particles

The indicator shows the degree of load on the city by airborne dust. Thanks to the implementation of measures in the strategic area of Mobility of the Future, a reduction in the above values can be expected in the long term. Compared to previous indicators, this and subsequent indicators work with available data with a delay of more than a year.

Air pollution limits are based on Act No. 201/2012 Coll., On air protection, as amended, and Decree no. 330/2012 Coll., On the method of assessment and evaluation of the level of pollution, the scope of informing the public about the level of pollution and in smog situations.

- Lower assessment threshold (LAT): 20 $\mu g.m^{-3}$
- Upper rating threshold (UAT): 28 $\mu g.m^{-3}$
- Limit value for LV 40 $\mu g.m^{-3}$. Exceeding this value means more demanding measurement requirements.

The calculation of the number of days when the daily LV averages were exceeded is based on the value 50 [$\mu g.m^{-3}$] daily averaging. At the site, this value can be exceeded a maximum of 35 times

	2018			2019		
Location	**Median PM 10 [$\mu g.m^{-3}$]**	**PM 10 average [$\mu g.m^{-3}$]**	**Number of days with exceeded daily average LV – 50 [$\mu g.m^{-3}$]**	**Median PM 10 [$\mu g.m^{-3}$]**	**PM 10 average [$\mu g.^{m-3}$]**	**Number of days with exceeded daily average LV – 50 [$\mu g.m^{-3}$]**
Prague 1 Republic Square	26.9	30,087	38	22.2	24.9	19
Prague 2 Legerova	28.3	30,127	40	21.8	25.5	25
Prague 2 Riegrovy sady	23.45	26	22	16.6	20.0	9
Prague 4 – Braník	N/A	N/A	N/A	N/A	N/A	N/A
Prague 11 – Chodov, managed as Prague 4 – Chodov	19.25	21.58	12	14.0	16.5	6
Prague 12 – Libuš, managed as Prague 4 – Libuš	20,05	22.53	16	14.0	17.0	6
Prague 5 – Smíchov	30.7	32.58	38	23.2	28.1	13
Prague 13 – Řeporyje, managed as Prague 5 – Řeporyje	27.4	30,29	31	19.3	23.5	21
Prague 13 – Stodůlky	21.4	23.68	17	15.0	17.5	9
Prague 6 – Břevnov	21.75	23.98	16	15.1	17.6	10
Prague 6 – Suchdol	21.1	23.88	22	15.9	18.7	10
Prague 8 – Karlín	30,9	32.204	46	23.0	25.7	17
Prague 8 – Kobylisy	21.3	24.337	19	16.5	19.6	10
Prague 9 – Vysočany	26.2	28.803	28	19.7	23.2	16
Prague 15 Průmyslová, managed as Prague 10	26.35	29.79	33	20.1	23.2	17
Prague 10 Šrobárova	19.85	19.84	2	14.1	16.8	5
Prague 10 – Vršovice	29.5	33.75	53	20.6	25.4	28
Prague 6 – Prague Airport	31.75	35.018	49	21.9	24.2	14

SOURCE: Data come from the Czech Hydrometeorological Institute and are valid for the years 2018 and 2019.
Note: At the station Prague 5 – Smíchov, the measurement was interrupted for technical reasons on April 11th, 2019.

As in previous years, the limit value of LV was not exceeded in 2019

In 2018, the value of UAT (28 μg.m^{-3}) was exceeded at 9 stations – Prague 1. Republic Square; Prague 2. Legerova; Prague 5 – Smíchov, Prague 13 – Řeporyje; Prague 8 – Karlín; Prague 9 – Vysočany; Prague 15. Průmyslová; Prague 10 – Vršovice; Prague 6 – Prague Airport. The year 2019 brought an improvement and the UAT value was exceeded only at the station Prague 5 – Smíchov, however, the relevance of the measurement is disturbed, because for technical reasons the measurement at this station was interrupted in April 2019.

In 2018, the LAT lower threshold value (20 μg.m^{-3}) was exceeded at 15 stations out of 16. i.e. at all except the Šrobárova station, where data are only available for the last 4 months of 2018. The situation in 2019 improved in selected localities and the lower LAT threshold was exceeded at 10 stations compared to 15 in the previous year.

An important source of dust particles are older cars with diesel engines, which do not yet have a particulate filter and their exhaust gases contain a number of small dust particles caused by imperfect combustion of diesel.

Pollution – Benzo(a)pyrene

The following indicator follows indirect indicators showing the degree of air pollution, in the Prague agglomeration mainly from internal combustion engines.

- Lower assessment threshold (LAT): 0.0004 μg.m^{-3}
- Upper rating threshold (UAT): 0.0006 μg.m^{-3}
- LV limit value 0.001 μg.m^{-3}

	2016	2017	2018	2019
Location	**Average annual concentration [μg.m^{-3}]**	**Average annual concentration [μg.m^{-3}]**	**Average annual concentration [μg.m^{-3}]**	**Average annual concentration [μg.m^{-3}]**
Prague 2 Riegrovy sady	0.0007	0.0009	0.000725	0.00062
Prague 12 – Libuš	0.0008	N/A	0.000741	0.00068
Prague 13 – Řeporyje	0.0029	N/A	0.002325	0.00151
Prague 10	0.0008	0.0009	0.000708	0.00073

SOURCE: Data come from the Czech Hydrometeorological Institute and are valid for the years 2016–2019.

Benzo(a)pyrene is one of the most toxicologically serious pollutants. Benzo(a)pyrene is also found in coal tar, in automotive exhaust gases (especially from diesel engines), in every smoke generated by the combustion of organic materials.

The value of the air pollution limit for a calendar year is 0.001 μg.m^{-3}. This value was exceeded in 2019 only at the station Prague 13 – Řeporyje. The lower assessment limit (LAT) and the upper assessment limit (UAT) were exceeded in 2019 at all stations. [24/]

SOURCE: **24/** The data come from the Czech Hydrometeorological Institute.

NO_2 Pollution

This indicator follows on from indirect indicators showing the degree of air pollution, in the Prague agglomeration mainly from internal combustion engines. It can be assumed that due to the successful implementation of the measures listed in the strategic area of Mobility of the Future in the Smart Prague 2030 concept, these values will decrease in the long run. This substance irritates the respiratory tract and significantly worsens the symptoms of asthma.

Air pollution limits are based on Act No. 201/2012 Coll., on air protection, as amended, and Decree no. 330/2012 Coll., on the method of assessment and evaluation of the level of pollution, the scope of informing the public about the level of pollution and in smog situations.

Limit value for the annual average concentration of NO_2 in relation to the protection of ecosystems and vegetation:

- Lower assessment threshold (LAT): 26 $\mu g.m^{-3}$
- Upper rating threshold (UAT): 32 $\mu g.m^{-3}$
- Limit value for LV 40 $\mu g.m^{-3}$. Exceeding this value means more demanding measurement requirements.

	2018			2019		
Location	**Median NO_2 [$\mu g.m^{-3}$]**	**Average NO_2 [$\mu g.m^{-3}$]**	**Number of days with exceeded daily average LV – 40 [$\mu g.m^{-3}$]**	**Median NO_2 [$\mu g.m^{-3}$]**	**Average NO_2 [$\mu g.m^{-3}$]**	**Number of days with exceeded daily average LV – 40 [$\mu g.m^{-3}$]**
Prague 1 Republic Square	31.8	33.03	77	26.9	28.7	34
Prague 2 Legerova	53.5	54.38	290	47.4	48.0	238
Prague 2 Riegrovy sady	22.5	24.17	28	21.5	23.5	19
Prague 4 – Braník	N/A	N/A	N/A	N/A	N/A	N/A
Prague 11 – Chodov, managed as Prague 4 – Chodov	16.7	18.16	6	15.0	16.3	4
Prague 12 – Libuš, managed as Prague 4 – Libuš	16.8	18.57	10	14.3	16.2	8
Prague 5 – Smíchov	39	40.16	174	35.0	35.0	35
Prague 13 – Řeporyje, managed as Prague 5 – Řeporyje	22.2	22.46	3	18.4	19.5	8
Prague 6 – Břevnov	22.4	23.76	29	21.0	23.1	20
Prague 8 – Karlín	28.7	30.4	71	28.6	29.2	44
Prague 8 – Kobylisy	18.9	20.75	20	18.1	20.3	15
Prague 9 – Vysočany	33.9	35.02	113	32.6	33.0	83
Prague 15 Průmyslová, managed as Prague 10	29.3	30.34	79	30.1	31.1	88
Prague 10 Šrobárova	24.25	25.53	9	19.1	21.3	22
Prague 6 – Prague Airport	21.7	23.24	23	17.1	19.1	11

SOURCE: Data come from the Czech Hydrometeorological Institute and are valid for the years 2018 and 2019.
Note: At the station Prague 5 – Smíchov, the measurement was interrupted for technical reasons on April 11th, 2019.

In 2019, according to the above table, the annual limit value for NO_2 (40 $\mu g.m^{-3}$) in the territory of the Capital City of Prague was exceeded only at the station Prague 2 – Legerova, which has long been one of the most problematic localities. The average value was at the level of 48 $\mu g.m^{-3}$. In previous years, the limit value was also exceeded at the station Prague 5 – Smíchov. However, this station could not be taken into account in 2019 as the measurement was interrupted in April 2019 for technical reasons. However, it is left in the list of stations.

Upper threshold value of UAT (32 $\mu g.m^{-3}$) in the year 2019 was exceeded at 4 stations: Prague 2 Legerova; Prague 5 – Smíchov; Prague 9 – Vysočany. Lower threshold value of LAT (26 $\mu g.m^{-3}$) in 2019 was exceeded at 6 stations – Prague 1 Republic Square; Prague 2 Legerova; Prague 5 – Smíchov; Prague 8 – Karlín; Prague 9 – Vysočany; Prague 15 Průmyslová.

NO Pollution

This indicator follows on from indirect indicators showing the degree of air pollution, in the Prague agglomeration mainly from internal combustion engines. It can be assumed that due to the successful implementation of the measures listed in the strategic area of Mobility of the Future in the Smart Prague 2030 concept, these values will decrease in the long run. This substance irritates the respiratory tract and significantly worsens the symptoms of asthma. NO pollution also has a very negative effect on the state of vegetation and natural ecosystems.

Air pollution limits are based on Act No. 201/2012 Coll., on air protection, as amended, and decrees no. 330/2012 Coll., on the method of assessment and evaluation of the level of pollution, the scope of informing the public about the level of pollution and in smog situations.

Limit value for the annual average concentration of NO in relation to the protection of ecosystems and vegetation:

- Lower assessment threshold (LAT): 19,5 $\mu g.m^{-3}$
- Upper rating threshold (UAT): 24 $\mu g.m^{-3}$
- Limit value for LV 30 $\mu g.m^{-3}$. Exceeding this value means more demanding measurement requirements.

	2018			2019		
Location	**Median NO [µg.m^{-3}]**	**Average NO [µg.m^{-3}]**	**Number of days with exceeded daily average LV – 30 [µg.m^{-3}]**	**Median NO [µg.m^{-3}]**	**Average NO [µg.m^{-3}]**	**Number of days with exceeded daily average LV – 30 [µg.m^{-3}]**
Prague 1 Republic Square	10	14.9	38	10.7	16.2	45
Prague 2 Legerova	36.1	44.33	159	31.3	40.2	187
Prague 2 Riegrovy sady	42.3	6.5	11	2.1	5.6	12
Prague 4 – Braník	2.75	10.1	16	N/A	N/A	N/A
Prague 11 – Chodov, managed as Prague 4 – Chodov	6	4.3	2	1.5	3.8	5
Prague 12 – Libuš, managed as Prague 4 – Libuš	2.4	4.4	7	1.7	3.9	5
Prague 5 – Smíchov	24	31.78	106	18.9	26.8	35
Prague 13 – Řeporyje, registered as Prague 5 – Řeporyje	N/A	N/A	N/A	N/A	N/A	N/A
Prague 6 – Břevnov	33.8	6.9	9	2.6	6.4	14
Prague 8 – Karlín	3.5	13.4	39	8.6	13.6	33
Prague 8 – Kobylisy	8.2	6.6	9	2.6	5.9	10
Prague 9 – Vysočany	13.1	20,36	44	13.5	21.5	71
Prague 15 Průmyslová, managed as Prague 10	16.2	21.76	52	19.4	24.0	98
Prague 10 Šrobárova	N/A	N/A	N/A	2.2	7.3	17
Prague 6 – Prague Airport	N/A	N/A	N/A	3.1	5.5	7

SOURCE: Data come from the Czech Hydrometeorological Institute and are valid for the years 2018 and 2019.
Note: At the station Prague 5 – Smíchov, the measurement was interrupted for technical reasons on April 11th, 2019.

In previous years, the LV limit value was often exceeded during the year, especially at two locations – Prague 2 Legerova and Prague 5 – Smíchov. In 2019, the value was exceeded only at the station Prague 2 Legerova, which is again due to disregard for the station Prague 5 – Smíchov for technical reasons.

In 2018, the upper threshold value of UAT (24 µg.µg.m^{-3}) was exceeded at the stations in Prague 2 Legerova; Prague 5 – Smíchov. In 2019, Prague 15 Průmyslová, hereinafter Prague 10 joined these stations. The lower threshold value of LAT was exceeded in 2019 similarly to the previous year, at 4 stations – Prague 2 Legerova; Prague 5 – Smíchov; Prague 9 – Vysočany; Prague 15 Průmyslová.

CO Pollution

Data are available only from two stations – Prague 2 Legerova and Prague 4 – Libuš. Only daily averages are available, while air pollution limits are calculated for the CO pollutant to an eight-hour daily moving average. In the following years, the evaluation methodology will be consolidated.

Exceeding Air Pollution Limits

The value of the indicator reflects the relative value of exceedances of air pollution standards in relation to the number of days when the value measurement is performed.

	2016	2017	2018	2019
Resulting indicator value	**14.23 %**	**14.37 %**	**12.42 %**	**9.62 %**
Calculation	Absolute number of days with exceeded air pollution values LV / Number of measured days [%]			
The total sum of the number of days with exceeded air pollution values	3,904	4,030	3,682	1,402
Total sum of days measured at weather stations	27,428	28 ,036	29,650	14,568
Total number of days with exceeded limit values of PM10. NO_2 and NO	1,952	2,015	1,841	1,402
Total number of measured days PM10. NO_2 and NO at weather stations	13,714	14,018	14,825	14,568
Number of days with exceeded PM10 limit values	213	464	482	235
Number of measured days PM10 at weather stations	5,337	5,374	5,657	6,002
Number of days with exceeded NO_2 limit values	943	857	932	629
Number of measured NO_2 days at weather stations	4,310	4,322	4,584	4,294
Number of days with exceeded NO_2 limit values	796	694	427	538
Number of measured NO_2 days at weather stations	4,067	4,322	4,584	4,272

SOURCE: Data come from the Czech Hydrometeorological Institute and are valid for the years 2016–2019.
Note: At the station Prague 5 – Smíchov, the measurement was interrupted for technical reasons on April 11th, 2019.

Resulting indicator value shows the ratio of the total number of days with exceeded air pollution values to the total number of measured days at weather stations. In 2019, it thus appears that the permitted air pollution value of the pollutant in the air was exceeded by almost 10 %. This value means an improvement compared to 2016, 2017 and 2018 when Resulting indicator value ranged between approximately 12–14 %.

Due to the fact that not every day the pollutant concentration is measured at all stations, for example due to technical reasons of failure, etc., the value of the number of measured days is determined for all stations. The calculation based only on the value of the number of days when the concentration was exceeded would otherwise not be consistent for comparison in subsequent years.

4.2 WASTE-FREE CITY

The year 2020 was very specific, the COVID-19 pandemic affected also the waste management, especially the production of municipal waste increased, for several reasons. One of them is the jump in online shopping during the pandemic, which was immediately reflected in the growth of the volume of waste dumped from the city streets. The share of packaging stored in containers for sorted waste increased in particular. In some places in Prague, there are overcrowded containers and waste deposited in the vicinity of sorting centres. Another factor contributing to the increase in mixed waste was related to the protection of employees of collection companies during a pandemic. The Ministry of Health has issued a recommendation that households with quarantined persons should not sort waste, but rather throw it into a mixed container with proper protection against the potential spread of the disease. The increase in the volume of mixed municipal and sorted waste has also been reflected in expenditures for their management, and municipalities have to cope with rising costs in the field of waste management.

Despite the difficult period, several innovations have been introduced in the waste sector. A key helper in waste management is the circular economy, i.e. the use of waste as a source of raw materials, in the long run leads to a reduction in the consumption of primary resources. That is why in March 2020 the European Union approved a New Action Plan for the Circular Economy – A Cleaner and More Competitive Europe, which corresponded in many key respects to the forthcoming amendment to the Waste Act, scheduled for 2021.

4.2.1 Economics of Waste Management of the Capital City of Prague

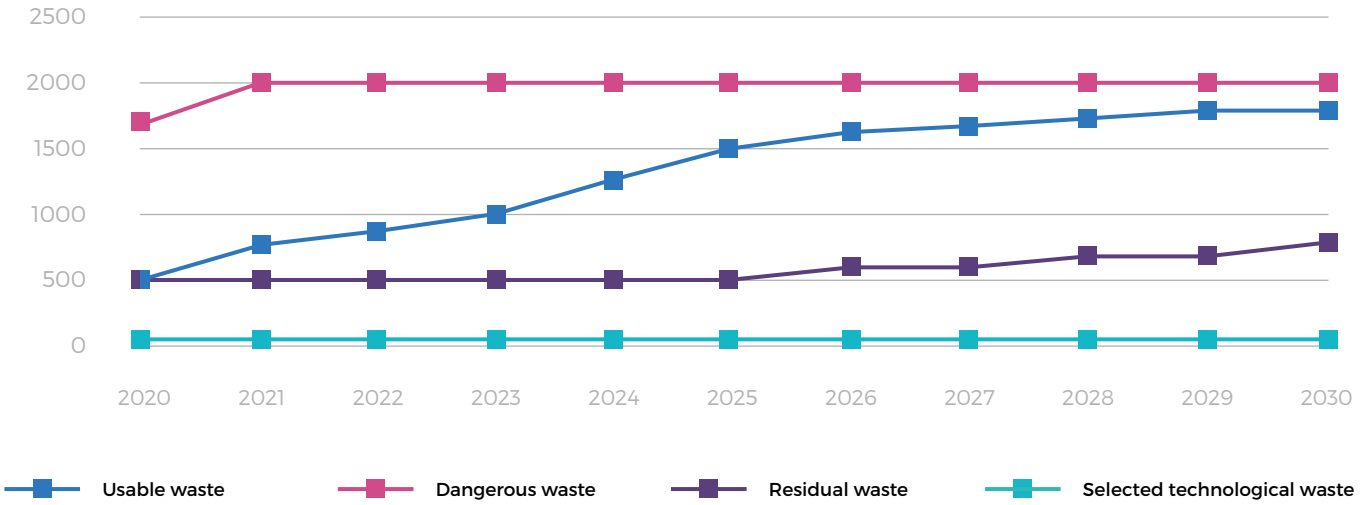
Starting on the January 1st, 2020 the fee for the collection of municipal waste was increased by about 30 % and a new fee for the collection of biological waste was also introduced in the conditions of Prague after 15 years. The new generally binding decree no. 15/2019 Coll., (respectively Decree no. 2/2005 Coll.) of the City of Prague, which determines the amount of the fee for municipal waste collection, came into effect. The reason for the increase is the effort to reduce the amount that the city has to pay annually for the collection of municipal waste. So far, the collected fees and taxes were decreased by about 250 mil. CZK and the city had to cover this difference from its own budget.

The total costs of the waste management system in Prague in 2020 amounted to approximately CZK 1.71 billion, compared to the previous year 2019 which is a stable increase of CZK 0.1 billion. The largest share consists of costs for mixed waste, sorted waste and collection yards. A more significant increase can be observed in the costs of biowaste, which in 2020 began to be systematically collected. Although the fee for municipal waste collection has increased, the total income still cannot fully cover the costs of waste management in Prague and the city has to subsidize the difference from its own budget. However, this difference, which the city itself has to pay, is decreasing every year. Total revenues in 2020 amounted to approximately CZK 1.125 billion and covered 66 % of costs compared to 2019 when revenues were sufficient for less than 60 % of costs. In addition to the above-mentioned increase in the fee, the increase in income was also due to a higher fee from EKO-KOM and a fee for the collection of edible oils (for details, see the table below).

	2016	2017	2018	2019
Resulting indicator value	**58 %**	**58 %**	**56 %**	**66 %**
Calculation	Total costs / Total incomes [%]			
Total costs for OH (mil. CZK)	1,487.18	1,530.02	1,600.53	1,717.58
Total revenues including contribution from EKO-KOM (mil. CZK)	862.02	883.79	899.38	1,125.3
Costs converted to 1 inhabitant (CZK)	1,148.83	1,169.16	1,208.6	1,286.5
Income converted to 1 inhabitant (CZK)	650.45	658.72	679.15	842.9

SOURCE: Evaluation of the waste management system of the Capital City of Prague in 1998–2020.

EXPECTED DEVELOPMENT OF THE FEE FOR LANDFILLING OF USABLE WASTE (in CZK per tonne)



SOURCE: Internal communication with the Ministry of the Environment, Waste Management Plan of the Czech Republic.

The fee from the originator, i.e. municipalities and companies, the landfill operator collects when depositing waste in the landfill (currently this amount is CZK 500). An increase in landfill fees has been recommended by the European Commission in the Czech Republic for a long time. In many Member States of the European Union, landfill fees are already tens of percent higher than in our country.

Communication Campaign

Motivation and enlightenment of citizens are considered to be the first step to success, as people's behaviour significantly affects the production of individual components of municipal waste and its cleanliness. This was particularly evident during the COVID-19 pandemic, when people worked more from home and produced more household waste than in the workplace, and there was also an overall increase in mixed municipal waste at the expense of sorted waste. For this reason, great emphasis needs to be placed on motivation and awareness that support people in proper waste management. Communication should start already in the implementation phase of the project to obtain feedback and also to maintain public interest. Social media is an effective way to show the range through an attractive and thematically focused display.

Thematic Areas Include:

- Material utilization of waste
- Intelligent waste collection and storage system
- Use of Wastewater and Rainwater for Energy and Raw Material Purposes

4.2.2 Sorting and Use of Municipal Waste

In the Prague metropolis, pick-ups are carried out on the basis of a fixed schedule, which is continuously updated depending on the requirements of the city and city districts. Requests to change the collection frequency are submitted by the city districts to the Waste Department of the City of Prague, which then assesses the application and, if necessary, processes it, as funds for waste collection are allocated in the budget chapter of the City of Prague Waste Department. The total annual costs for the collection of usable components in 2020 were approximately 516.1 mil. CZK.[25/] It is therefore important to coordinate all activities in a common strategy of responsible waste management, which will efficiently collect the produced waste and use it materially and energetically.

Waste collection using modern technologies can ensure more efficient waste management not only from a technical point of view, but also from an economic point of view. In addition to the field of OH, these technologies can also help in other areas, such as use of wastewater or rainwater.

The capital city, together with the municipal company Pražské služby, plans to purchase a new plastic waste sorting line in 2021 This line will be able to separate several types of plastic waste, including PET bottles. The Pražské služby still lack a plastics sorting machine, which complicates the sale and processing of waste. The new equipment, which will be able to sort plastic, for example by colour, should enable the sale of waste to specialized companies.

Next year, Prague will also complete the modernization of the Malešice incinerator, where it will replace the last of the four boilers. New data have shown that modernization has also significantly reduced emissions, and the incinerator now emits only a minimum of steam and pollutants.

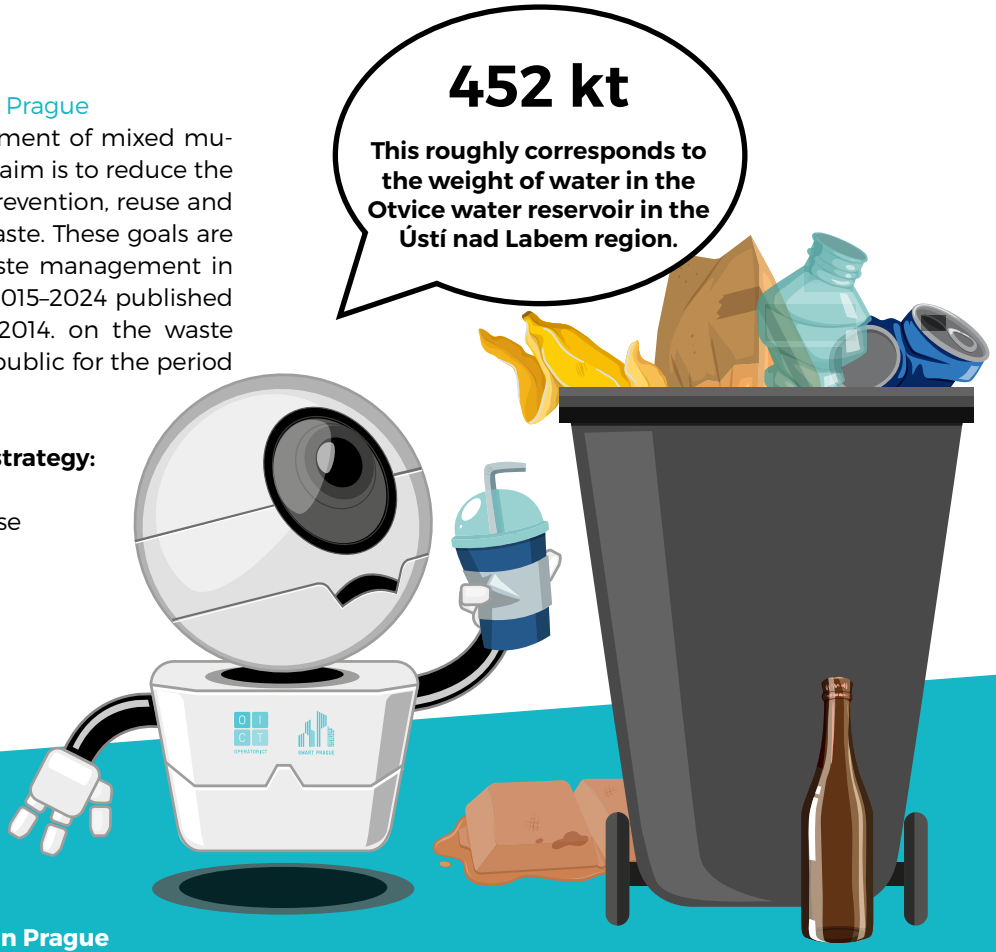
SOURCE: **25/** Evaluation of the waste management system of the Capital City of Prague in 1998–2020.

Total Municipal Waste Production in Prague

The indicator monitors the development of mixed municipal waste production (SKO). The aim is to reduce the value thanks to the rules of waste prevention, reuse and recycling, i.e. material recovery of waste. These goals are based on the strategic goals of waste management in the Czech Republic for the period 2015–2024 published in the Collection of Laws no. 352/2014. on the waste management plan of the Czech Republic for the period 2015–2024.

These principles are based on this strategy:

1/ Waste prevention
2/ Preparation of waste for reuse
3/ Recycling
4/ Energy recovery
5/ Safe disposal (landfill)



Total municipal waste production in Prague

	2017	2018	2019	2020
Resulting indicator value	**58.15 %**	**58.64 %**	**57.95 %**	**57.06 %**
Total amount of municipal waste (kt)	430.3	432.8	440.9	451.8
Mixed municipal waste	250.2	253.8	255.5	257.8

SOURCE: Evaluation of the waste management system of the Capital City of Prague in years 1998–2020.

The value Mixed municipal waste shows the amount of waste produced by the inhabitants of the Capital City of Prague and stored in household or street waste containers. The aim is to further reduce this amount, which has been steadily increasing since 2015. The year 2020 recorded a large increase in the total amount of municipal waste (451.8 kt), by almost 12 kt compared to 2019. However, the increase in mixed municipal waste was not so significant (257.8 kt) and its share in the total amount of municipal waste, on the other hand, decreased by almost one percent (57.06 %) compared to the previous year.

The ongoing COVID-19 pandemic and its impact not only on waste management can be considered as one of the causes of the increase in the total amount of municipal waste. In several municipalities in the Czech Republic, it was observed that the increase occurred mainly in the spring months, when the Czech Republic was most affected by measures and people worked mainly from home. These were mainly sorted waste and also a larger amount of bulky waste. Also, for security reasons, quarantined households were not allowed to sort waste and should have stored everything safely in black bins for mixed waste. Due to the growth of this indicator, it is highly desirable to know detailed data and analyse their causes of growth and propose appropriate countermeasures.

The annual production of waste in Prague is related to the scope of construction activity, as construction waste accounts for almost 80 % of the total waste production.

Not all waste generated in Prague is treated within the city itself. It is estimated that only about 30 % of the total waste produced is treated in the area delimited by the city limits, the remaining approximately 70 % is treated outside the city limits (source: Circular Scan Prague 2019).

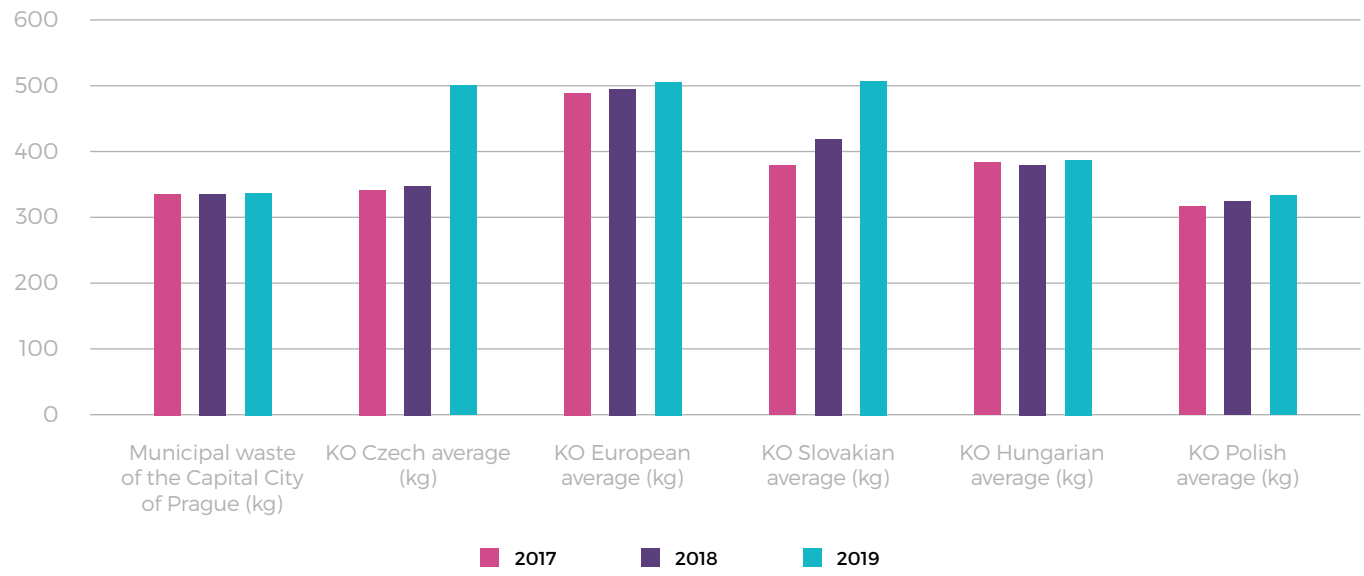
KO Production Per Capita Per Year

Prague households produce a relatively small amount of waste per capita per year compared to the Czech or European average. In 2020, Prague residents slightly increased the average waste production from 332.94 kg to 338.51 kg.

	2017	2018	2019	2020
Municipal waste of the City of Prague (kg)	332.40	330.73	332.94	338.41
KO Czech average (kg)	344	351	500	N/A
KO European average (kg)	490	492	502	N/A
KO Slovak average (kg)	378	414	504	N/A
KO Hungarian average (kg)	385	381	387	N/A
KO Polish average (kg)	315	329	336	N/A

SOURCE: CZSO, "Production, utilization and disposal of waste – 2019", available at https://www.czso.cz/csu/czso/produkce-vyuziti-a-odstraneni-odpadu-2019. Data for 2020 will be available after finalization of this publication.

AVERAGE WASTE PRODUCTION PER CAPITA



In 2020, each inhabitant of the City of Prague sorted a total of 44.6 kg of paper, glass, plastics and beverage cartons together. Household waste is collected in various ways. Of the total amount of 451,800 tonnes of waste generated in Prague households, a category of mixed waste is still the most represented, which accounts for approximately 57 % of the communal waste in general and its share has been declining since 2017. The remaining approximately 43 % is collected separately. The collection of municipal waste through the collection of mixed waste contaminates the quality of residual streams and reduces the potential value that can be recovered from the stream, and therefore an effort is made to reduce this amount. Most household waste is incinerated to obtain energy. Approximately 251,300 tonnes of household waste is processed in the form of energy recovery, which in the case of municipal solid waste (approximately 55.6 %) is the most common waste management activity. Nevertheless, the percentage of waste that has been used as material is also growing. Its amount in 2020 increased by 6 kt from 119.6 to 125.5 kt. In Prague, the main facility for energy utilization of waste is ZEVO Malešice, which annually processes over 200,000 tonnes of waste.[26/]

SOURCE: **26/** Evaluation of the waste management system of the Capital City of Prague in 1998–2020.

Energy Utilization of SKO

The indicator monitors the percentage of SKO energy use in the City of Prague. During the SKO burning process, the released energy is converted in the cogeneration unit into heat and electricity.

	2017	2018	2019	2020
Resulting indicator value	**92.17 %**	**93.08 %**	**94.08 %**	**92.89 %**
Energy recovery of SKO	92.17 %	93.08 %	94.08 %	92.89 %
SKO landfilling	7.83 %	6.92 %	5.92 %	7.11 %
Amount of iron scrap captured at ZEVO Malešice	4 293.58 t	4 162.20 t	4 881.23 t	5442.62 t

SOURCE: Internal communication with OCP MHMP and Pražské služby, a. s. (Plc.)

The maximum effort of the Capital City of Prague is to reduce landfilling as much as possible. The fluctuating value of SKO energy utilization is given by a combination of causes that cannot be specified in more detail. The Capital City of Prague set the maximum share of landfills for energy use of SKO at 10 %. This share has been met. The residual slag can be used as a building material and its further use in this area is planned in the future. At the same time, iron scrap is separated from the residues, the amount of which captured from the slag after energy recovery of waste is also shown in the table. The amount of scrap collected depends on the composition of the incoming mixed waste, it cannot be influenced in ZEVO processes. However, its reduction may indicate positive trends in the sorting of waste during its collection.

Trends in classification in the City of Prague

At present, the following components of municipal waste are sorted on the territory of Prague Capital City:

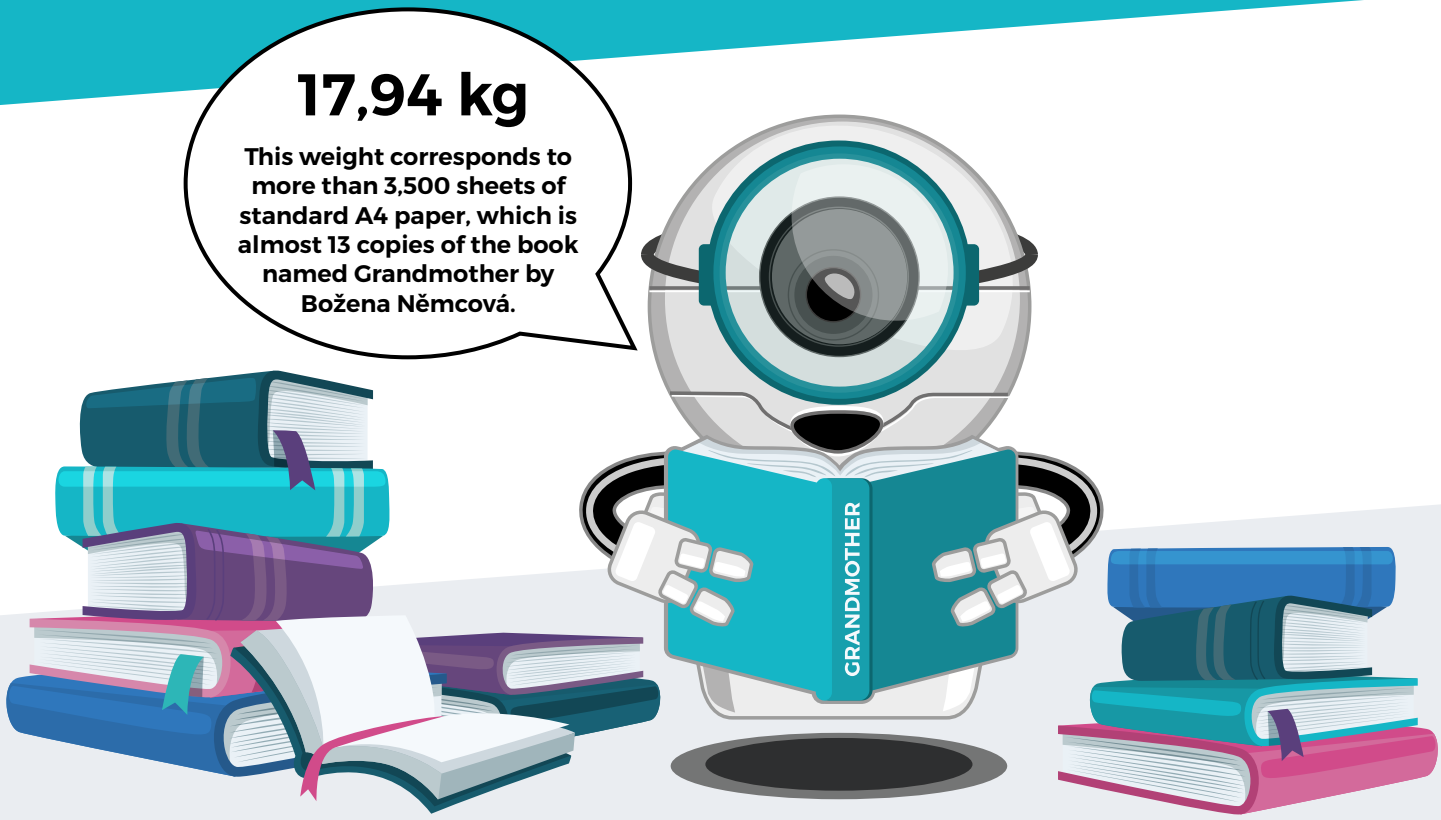
- paper
- mixed glass
- mixed plastics
- bulky waste
- mixed waste
- hazardous waste
- ferrous and non-ferrous metals; from August 1st, 2016 takes place in the form of attached containers for approx. 1 sorted waste collection sites so-called metal packaging
- building rubble
- take-back products
- wood waste
- tires
- biodegradable waste
- gastro waste
- beverage cartons; the containers are already delivered at about 2 sites
- clear glass; equipped with about 1,776 sites
- worn textiles, clothing and footwear
- used edible oil and fat

Amount of Separate Collection Per Capita

This indicator is a very important parameter, which can be used to compare the performance of separate collection, the so-called yield, which indicates the amount (in kg) of sorted waste per inhabitant per calendar year.

	2017	2018	2019	2020
paper (kg)	17.37	18.04	18.65	17.94
glass (kg)	12.84	13.29	13.92	13.81
plastic (kg)	10.74	11.22	11.84	11.58
beverage carton (kg)	0.76	0.76	0.82	0.84
metals (kg)	0.11	0.20	0.32	0.47
population of Prague *	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Evaluation of the waste management system of the Capital City of Prague in years 1998–2020.
* CZSO – data on the number of inhabitants always available as of December 31st of the respective year – population – region CZSO in the Capital City of Prague (czso.cz)



In 2020, Prague residents sorted a total of 23 tons of paper, which corresponds to approximately 947 kg per capita, 17.94 tons of glass, which is less than 18 kg per capita, and 437 tons of plastic packaging, which is less than 13.81 kg per capita. The people of Prague separated a total of 1 tons of beverage cartons and metal packaging. The collection of edible oils was also added to the separate collection, which citizens could hand over free of charge in closed PET bottles either to collection yards or to containers designed for that purpose. The total amount of sorted waste is slightly lower than in the previous year 2019 (2019: 60,312 tonnes, 2020: 59,597 tonnes).

Paper and plastic decreased slightly, but the amount of sorted beverage cartons and metals increased significantly. At the end of 2020, a total of 5,651 separate waste disposal sites were established in the city, including the so-called "house" habitats located in apartment buildings mainly on the territory of the Prague Monument Reserve. The distance of households from these habitats plays a key role in waste sorting and directly affects the sorting rate of citizens. The aim is to optimize the number of collection points and to adapt their number and frequency of collection to the number of inhabitants and the type of development in the given locality.

Waste Sorting Efficiency

The indicator follows up on the topic of meeting the binding EU targets in the area of circular economy and fulfilling the Regional Waste Management Plan of the Capital City of Prague 2016–2025.

	2017	2018	2019	2020
Sorting efficiency (material use only)	27.10 %	26.90 %	27.10 %	27.80 %
Proportion of waste used (material and energy recovery)	83 %	84 %	84 %	83 %

SOURCE: Internal communication with OCP MHMP.

Method of Waste Management (percentage share in the total production of KO)

The table shows how waste is managed in Prague. It does not include waste that is collected as part of waste prevention.

	2017	2018	2019	2020
Material used	27 %	28 %	27.1 %	27.8 %
Biologically used	2.17 %	2.05 %	2.4 %	3.29 %
Burned (energy used)	56 %	57 %	56.5 %	55.6 %
Landfilled	13 %	14 %	14.5 %	14.2 %

SOURCE: Evaluation of the waste management system of the Capital City of Prague in the years 1998–2020.

From a long-term perspective, landfilling shows a declining trend in Prague. Compared to 2013 when the share of landfilled waste reached almost 20 % of the total waste production, this method decreased by more than 5 % (to 14.5 %). A large proportion of waste is still incinerated (55.6 % in ZEVO Malešice. Bio-waste will certainly show an increasing trend from 2020 thanks to its separate collection, in which more and more city districts of the Capital City of Prague are involved.

Construction and Demolition Waste

Construction and demolition waste represents everything that remains after the reconstruction or demolition of a building, including, for example, distribution and piping. According to the analysis of the waste management plan, it accounts for approximately 46 % of waste production, and thus makes up almost half of the total waste production in the Czech Republic. The biggest complication is the possibility of using recycled material, down recycling is largely used, which means reuse and reducing the volume of waste.

This indicator represents a year-on-year comparison in the production of construction and demolition waste in the Capital City of Prague. According to the latest data, there has been no large fluctuation in the amount of waste with this indicator.

	2017	2018	2019	2020
Construction and demolition wastes	11,547.5	11,016.3	11,124	11,743.5

SOURCE: Internal communication with Pražské služby, a. s. (Plc.)

Biodegradable waste

Biowaste or waste subject to anaerobic or aerobic biodegradation becomes a source of hazardous methane during landfilling. Therefore, it shouldn't end up in landfills. On the contrary, it is a raw material very rich in a number of nutrients and organic matter, which can be obtained by composting, and the resulting product – compost – can be applied back to the soil and thus return the nutrients back to nature.

Bio-waste can also be managed in the context of waste prevention, when it is processed in the form of domestic composting, and the production of mixed municipal waste would be significantly reduced. In addition to home composting, there is also the possibility of community composting, which is intended for a larger group of people. Such a composter is suitable for community gardens or courtyards, where it provides people from residential areas with the possibility of composting. Recently became rather popular the so-called vermicomposting, i.e. decomposition of plant residues into quality organic fertilizer using earthworms. The ever-expanding network of community composting has given rise to the map application "Mapko", which collects information about existing community gardens and composters. People here have an overview of their surroundings and can decide what to get involved in. This is a community project and community gardens can add their own profiles here, so the data may not always be completely relevant.

Bio-waste that cannot be managed as part of waste prevention can be collected separately and valuable material can be recovered. The interest in sorting biowaste is growing in the capital city, which confirms the growing interest in the collection of biowaste of plant origin at Pražské služby a.s., which began offering this service at the end of 2019 and since then the number of brown containers in Prague's streets has grown. The collected biowaste is then taken to composting plants in Prague and the Central Bohemian Region for the production of quality compost. At the same time, Prague has launched a campaign to support the collection of plant biowaste – Give BIO waste a second chance! The main goal of the launching campaign is to motivate the citizens of the Capital City of Prague to collect plant biowaste in brown containers provided by the city.[27/]

In addition to composting plants, there is another way to dispose of biowaste. The biogas plant can help to process and use biodegradable waste not only of plant origin from residents and tradesmen, but also from industry. The final product of the biogas plant is BioCNG biofuel suitable for trucks in urban traffic (public transport trucks, pick-up trucks, city and MHMP service cars) or biogas for the municipal network. Municipal biogas station, which has already received support from the City Council of the Capital City of Prague, could be completed by 2028. It will probably be in Malešice, according to a recently completed study. At the same time, the city appeals to the importance of waste prevention, because the best waste is the one that will not be generated.[28/] That's why it's important to learn to shop with caution and not waste food. From this initiative, Prague supports the Save Food project (www.zachranjidlo.cz), which consists mainly of information campaigns and happenings educating the audience in order to reduce food waste. They also collect so-called crooked vegetables – "picking" – which would remain in the field after harvest, often for aesthetic reasons, and donate it e.g. to the food bank. The Community Fridge project in Prague is also intended to reduce food waste and help people in need. There are now a total of 4 refrigerators in Prague, into which anyone can bring food in good condition and also take what they need from the refrigerator. An innovative solution in waste prevention is for example in the UK, namely the Olio project - a mobile application where people can offer their food surpluses, which they no longer want but are still in good quality, to others in the neighbourhood to prevent waste of food.[29/] Biowaste collection is optional for property owners and the fee for biowaste collection is set in a similar regime as the fee for mixed municipal waste, i.e. the payer of the fee is the owner of the property.

Fee for biowaste collection per month in CZK

frequency / week	1× in 2 weeks	1× per week	2× per week
120 litres	56	112	224

SOURCE: For more information see the "Environmental Portal of the Capital City of Prague".
Note: Year-round collection takes place from January 1st until December 31st, there is a seasonal pic-up from the April 1st until November 30th.

The facts described above are captured by the indicators below, which deal with the overall production and use of biowaste.

SOURCE: **27/** Environmental portal of the City of Prague, "Give BIOwaste a second chance! (Environmental Portal of the Capital City of Prague) ", available at http://portalzp.praha.eu/jnp/cz/odpady/pro_obcany/novinky_a_pilotni_projekty/dejte_bioodpadu_druhou_sanci.html, check on 26 June, 2021. | **28/** The City of Prague, "The biogas plant project is supported by the City Council (Portal of Prague)", available at https://www.praha.eu/jnp/cz/o_meste/zivot_v_praze/zivotni_prostredi/projekt_bioplynove_stanice_ma_od_mestske.html, check on 26 June, 2021. | **29/** Jiří Hošek, "20000 Londoners are already using a mobile application that allows them to donate food. Will he go to the Czech Republic as well?", Radiožurnál, 31 January 2016. available at https://radiozurnal.rozhlas.cz/mobilni-aplikaci-ktera-umoznuje-darovat-jidlo-uz-pouziva-20-tisic-londynanu-6224690, check on 26 June, 2021.

Total Biowaste Production

	2017	2018	2019	2020
Resulting indicator value	**1 %**	**5 %**	**6 %**	**5 %**
Calculation	Composted / Total production [%]			
Total BIO production (t)	9,368	8,855	10 600	14,847
Our of that already composted (t) *	140	411	631	699
BIO production per capita (kg)	7.24	6.77	8.00	11

SOURCE: Evaluation of the waste management system of the Capital City of Prague in years 1998–2020.
* This is the amount of waste transported to the Slivenec composting plant.

Raw Material Utilization of Biowaste

	2017	2018	2019	2020
Resulting indicator value	**97,369 t**	**86,453 t**	**96,057 t**	**100,515 t**
Biowaste received at the city's collection yards (t)	6,976	6,477	7,466	6,729
Biowaste accepted by mobile collection yards (t)	35	43	42	56
Biowaste – bulk containers in the streets (t)	1,202	1,058	1,280	1,268
Composting plant of Prague Capital City in Slivenec (t)	140	411	631	699
Stable biowaste collection point in Prague 10 – Malešice (t)	1,016	866	1,181	1,063
Hygiene dewatered sewage sludge (t)	88,000	77,598	85,457	90,800

SOURCE: Evaluation of the waste management system of the Capital City of Prague in years 1998–2020.

Energy Use of Biowaste

The indicator monitors the city's capacity and the rate of use of bio-waste in the processing into usable energy in the form of biogas.

According to Decree no. 341/2008 Coll., as amended, means biodegradable waste. In the case of the Prague Water Supply and Sewerage (PVK) operations, these are mainly liquid wastes received and processed by wastewater treatment plants in the Capital City of Prague. Heat and electricity are produced from waste in cogeneration units. Residual stabilized sludges are modified by technological measures for reuse in agriculture. The production of usable biogas takes place only in the Central Wastewater Treatment Plant.

	2017	2018	2019	2020
Resulting indicator value	**10,094.43 t**	**2,532.57 t**	**14,766.68 t**	**13,568.48 t**
Liquid waste received and processed by the WWTP in the City of Prague	10,094.43 t	2,532.57 t	14,766.68 t	13,568.48 t
Biogas production at the Central Wastewater Treatment Plant *	14,810,698 Nm^3	16,285,510 Nm^3	17,358,766 Nm^3	15,063,150 Nm^3

SOURCE: Internal communication with PVK. Nm^3 = normative cubic meter

The years 2017 and 2018 had a lower state of waste intake and biogas production due to accidents. Now, the reduced biogas production corresponds to the lower production of sludge in the WWTP due to the lower amount of imported waste entering the digestion tanks due to the COVID-19 pandemic.

Edible oils and fats

Starting on the January 1st, 2020 the municipalities provided places for separate concentration of edible oils and fats. Prague was preparing for this duty in advance. Residents of the capital could hand over used edible fats and oils at all collection yards in the Capital City of Prague or as part of a mobile waste collection and, since 2020, also in special containers located in the streets. Their distribution and collection are at the discretion of each separate district. Separate collection of edible fats is particularly important in terms of protecting the sewer network, which could be clogged and thus reduce its flow in the presence of large amounts of fat in the sewer.

Bulk waste

Large quantities of waste can be transported by citizens to collection yards or to large-volume containers (VOK). With the increasing number of collection yards, the Capital City of Prague decreases the number VOK. In 2020, a total of 5,166 containers were added. Other options for the collection of bulky waste are collection yards and mobile collection yards.

	2017	2018	2019	2020
Total amount (t)	30,846	34,205	37,585	40,627
Amount per capita (kg)	23.83	26.14	28.4	30.43

SOURCE: Evaluation of the waste management system of the Capital City of Prague in years 1998–2020.

4.2.3 Material Utilization of Waste

Material recovery of waste is in the third place in the hierarchy of waste management after waste prevention and reuse. Waste material is returned to circulation as a secondary raw material, which often does not differ in quality from primary raw materials. This sub-area is based mainly on modern large-capacity automated technology for sorting one stream of mixed municipal waste and sorted waste (e.g. with the help of sensors, mechanical and physical way), which will be able to separate e.g. organic matter, metals, paper, plastics, glass and residual waste. In the future, the implementation of other innovative approaches to support the material recovery of waste can be expected. This is closely related to citizens whose activity directly affects the rate of municipal waste sorting and subsequent recycling. Therefore, emphasis is also placed on education and motivation of citizens to sort waste directly in the household.

Take-back Points

The indicator shows the degree of permeation of the Capital City of Prague's areas of take-back of electrical equipment for their further material use. It thus shows the degree of availability of collection points for electrical equipment. Discarded electrical equipment is a valuable source of raw materials, especially precious metals, which would otherwise be disposed of in an inefficient manner.

	2017	2018	2019	2020
Number of km² per ZO place	**1.69**	**1.68**	**1.66**	**1.69**
Number of inhabitants using one place of ZO	**4,418**	**4,421**	**4,429**	**4,557**
Number of collection points for electrical equipment – red containers *	293	296	299	293
CCP area	496 km²			
Prague population **	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Population – Region CZSO in Prague Capital City (czso.cz).
* Internal communication with OCP MHMP. | ** CZSO – always as of December 31st of the given year.

The number of take-back points has changed only due to a temporary withdrawal due to the modification of a public space or the reconstruction of streets. Otherwise, their number shows a year-on-year growth trend and is expected to increase to 300 containers in the streets of Prague. Permanent collection yards, in the total of 19 places, and three collection yards operated by city districts are also used for the take-back of electrical waste (see the map of collection yards on the Capital City of Prague's environmental portal).

The product take-back system significantly increases the amount of electronic waste that is recovered from consumers for further material recovery. However, it is probable that there is still potential to increase this amount, because according to physical analyses of the composition of mixed municipal waste, a certain part of Czech households still disposes of small electronic appliances into containers for mixed municipal waste.

Utilization of Take-back Points

The practical impact of the use of collection points for electrical equipment from the previous indicator is quantified in the following table:

	2017	2018	2019	2020
Quantity of collected electrical equipment according to categories (t):				
TVs and monitors	819.60	805.7	970.4	899.2
Other ASEKOL equipment	415.64	377.1	365.5	392.2
Lamps:	22.80	20.7	19.7	17.9
Cooling group	882.41	880.8	916.9	905.7
Large and small appliances ELEKTROWIN	1 228.39	1 296.6	1 527.6	1 791
Batteries	272	287	276	314
Stationary red containers:				
Batteries	30.85	37.23	32.26	28.76
Small electrical equipment	224.90	330.03	306.1	432.5

SOURCE: Internal communication with OCP MHMP and ECOBAT, s. r. o. (Ltd.)

In 2020, take-back increased only for some commodities. More and more, batteries have been removed, while the number of TVs and monitors and cooling groups is lower. Products that have reached the end of their useful life can be further recycled, which is especially important in the case of batteries and small electrical equipment, the presence of which in landfills is harmful to the environment.

Electrical waste has been a problematic topic so far. It is represented by tons of electrical equipment discarded in a still functional state and ending in electrical waste collection points. The main reasons for this increase are the increased demand for new electronic devices and their declining lifespan. Citizens are constantly exposed to advertisements and presentations of new, more powerful products, which encourage consumers to buy a new electrical appliance without damaging existing

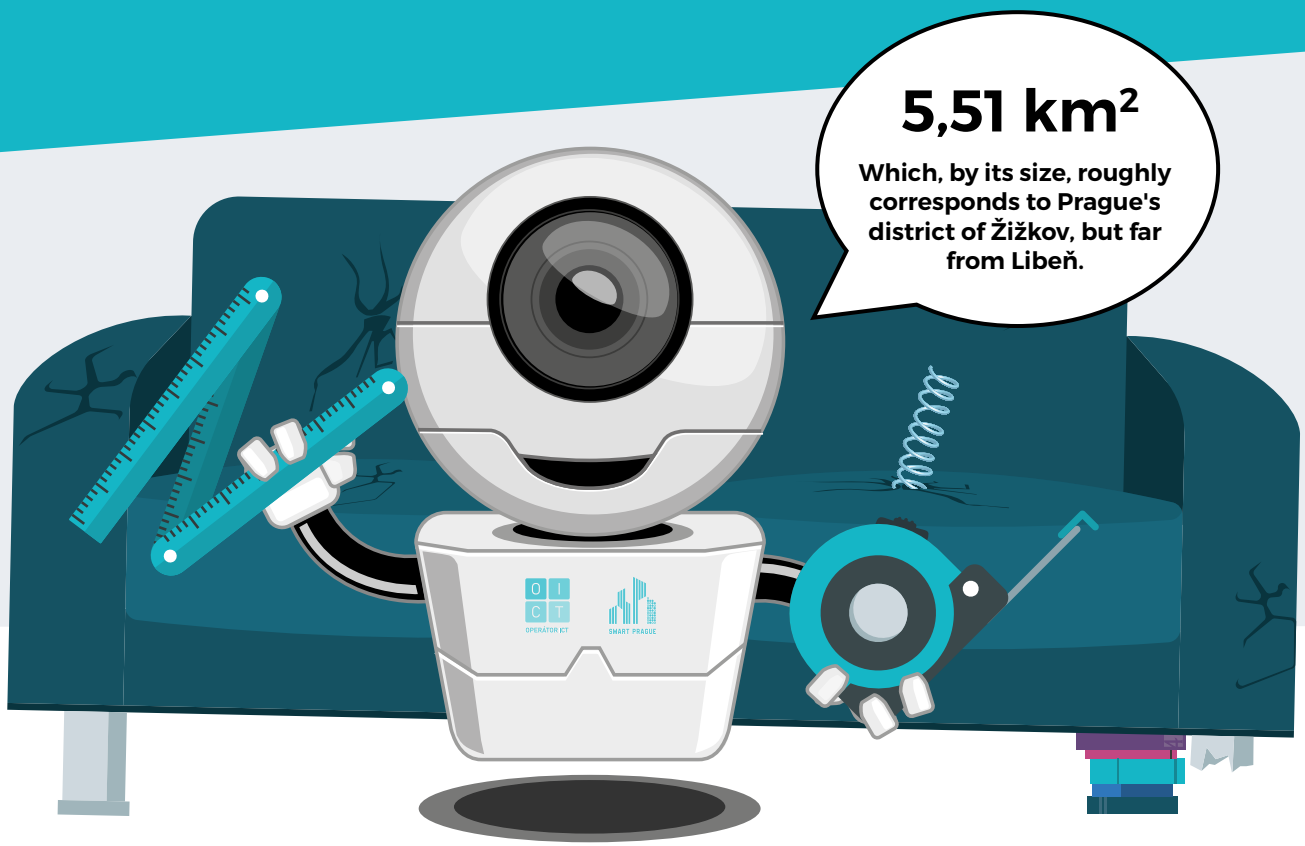
equipment. At the same time, consumers may be discouraged by high repair prices, outdated functionality and appearance. Just to give you an idea, precious metals worth more than one billion crowns are built into mobile phones alone. If an old phone is dumped, this potential is lost forever. On average, electrical waste is about 95 % usable for other, especially material uses. Another example is that 1 kg of copper recovered from electrical waste eliminates the need to extract 142 kg of ore and saves 80 % of the energy needed to produce the raw metal. In order to implement the concept of a waste-free city, it is necessary to maintain the availability of take-back points and not waste material potential hidden in electrical waste. However, it should be noted that decreasing or increasing the values of this indicator cannot be unambiguously (i.e., without a detailed analysis of the context, e.g. with the trend of buying new appliances) as a positive or negative phenomenon.

Collection Yards

Like the Take-back Point indicator, this indicator also measures the availability of collection yards in the Capital City of Prague. People should dispose of bulky waste (furniture, etc.), rubble from home improvement, wood waste, biowaste, metal waste, paper, plastics, beverage cartons, hazardous components of municipal waste, tires, discarded electrical equipment, worn textiles and used food oil and fats.

	2017	2018	2019	2020
Number of km² per SD	**5.57**	**6.05**	**4.91**	**5.51**
Number of inhabitants using one SD	**14,545**	**15,959**	**13,111**	**14,834**
Number of collection yards	89	82	101	90
City Hall area (km²)	496 km²			
Number of Prague inhabitants	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Internal communication with OCP MHMP, CZSO – always as of December 31st of the given year.
Population – Region CZSO in the Capital City of Prague (czso.cz)



The indicator shows the density of coverage of the Capital City of Prague with collection yards. The value of the number of collection yards includes 19 permanent collection yards of the Capital City of Prague, 3 collection yards of city districts and the implementation of mobile collection yards in the relevant year. On the portal of the Capital City of Prague (Praha.eu), there is a map of collection yards and other selected facilities for waste management in Prague.

Compared to 2019, the number of collection yards did not change, there were 19 collection yards in operation. In 2020, 7,844 kg of used batteries were sorted into containers at these collection yards. If the batteries ended up in a regular trash can, they would travel to a landfill or incinerator.[30/] In both cases, they would release harmful substances, including heavy metals. These would then pollute the air, soil, groundwater and surface water. On the other hand, thanks to the recycling of secondary raw materials, we save mineral resources and do not have to burden the environment with further mining. It makes a lot of sense. After all, through recycling, we are able to obtain 100 kilograms of metal-bearing raw materials from 65 kilograms of batteries, which are again used by people for their benefit.

The construction of new collection yards is hindered in some parts of the city mainly by historic buildings and layout options. In these areas, a possible alternative could represent the so-called "Mobile collection yards" - i.e., several large-volume containers with professional waste sorting will be added. In 2020, a total of 71 mobile collection yards were implemented (source: Evaluation of the Waste Management System of the Capital City of Prague in 1998–2020).

Second-hand Collection Yards (re-use centres)

Re-use or "use it once more" centres around the world have been set up for this purpose. The goal of re-use is not to throw away when it can be fixed or can serve others. According to the waste management hierarchy, this is the second strategic goal immediately after waste prevention. Reusing things is more crucial to reducing waste than reducing or recycling it. The year 2020 was very significant in terms of re-use for the Capital City of Prague, as in October, a pilot project of re-use points was launched in two collection yards. Prague is now appealing to its residents to consider whether, for example, furniture, books or sports equipment could be re-used for the needy residents of Prague. Thanks to a new project of the Capital City of Prague, people can now simply take them to a collection yard with a re-use point. Here, employees of Pražské služby will find a new job for them through an electronic application. There are two collection yards in the pilot project: in Zakrytá Street, Prague 4 – Spořilov, and Pod Šancemi 444/1. Prague 9 – Vysočany. They are equipped with a special closed large storage container for storing bulky items (such as furniture, sports equipment, strollers, medical devices, etc.) and a building cell for storing small items (dishes, books, toys, etc.).

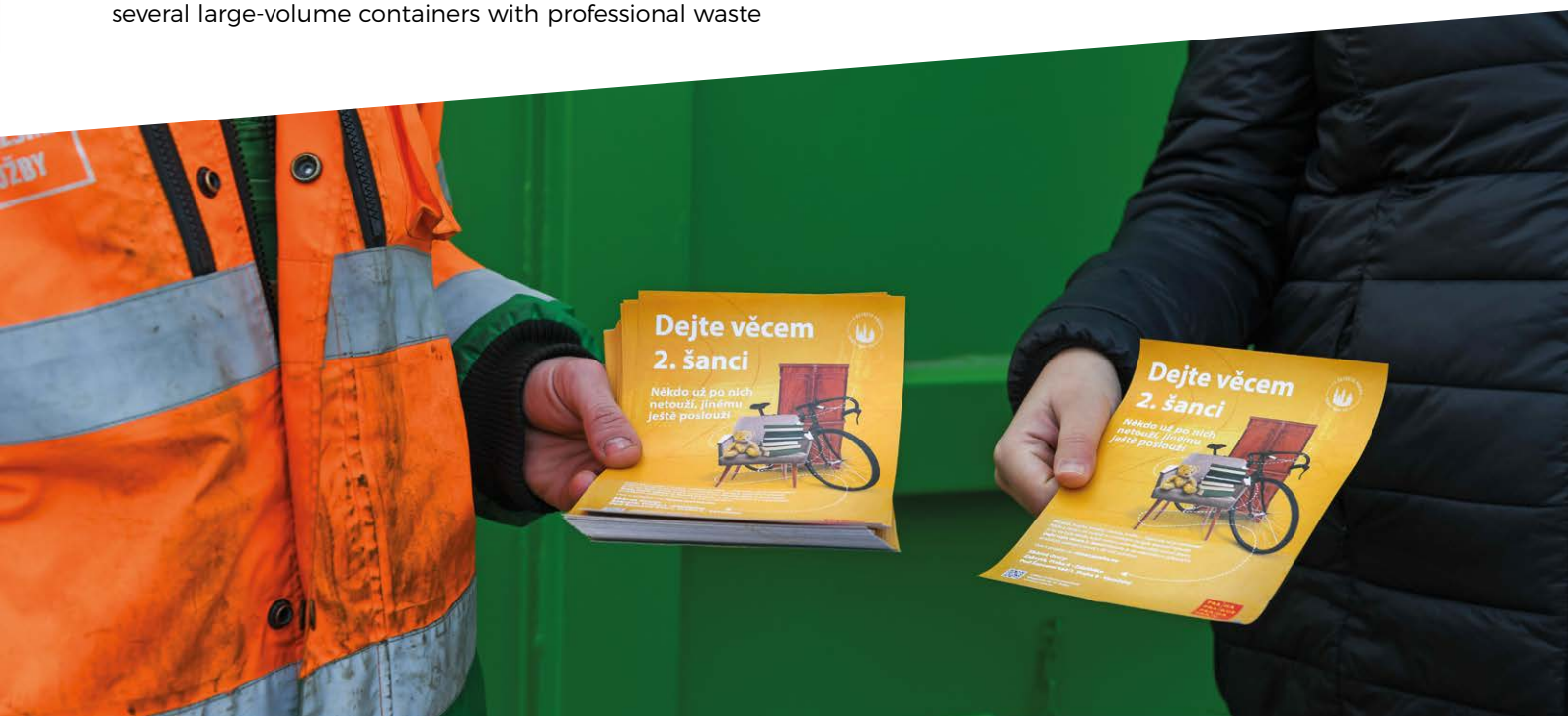


PHOTO: Project Campaign Give things a second chance in Prague.[32/]

SOURCE: **30/** Environmental portal of the City of Prague, "Prague residents handed over 7844 kg of batteries to collection containers (Environmental Portal of the Capital City of Prague)", available at https://portalzp.praha.eu/jnp/cz/odpady/pro_obcany/prazane_v_roce_2020_odevzdali_do.html, check on 26 June, 2021. | **31/** Don't throw it away | Prague", available at https://praho.nevyhazujto.cz/, check on 26 June, 2021. | **32/** Environmental portal of the City of Prague, "Prague gives used things a second chance. (Environmental Portal of the Capital City of Prague)", available at, http://portalzp.praha.eu/jnp/cz/odpady/predchazeni_vzniku_odpadu/praha_dava_pouzitym_vecem_druhou_sanci.html, check on 26 June, 2021.

PHOTO: Collection yard with re-use point, Pod Šancemi Prague 9.[33/]

The indicator thus shows the level of utilization of the submitted material. At the same time, after the launch of the second-hand re-use centres, the composition of the material will also be monitored.

Second-hand collection yards (re-use centres)

	2017–2019	2020
Resulting indicator value	**0**	**83.5 %**
Calculation	IIssued (sold) material / Obtained material	
Number of pieces of issued (sold) material	0	264
Number of pieces of material obtained	0	316
The total number on the territory of the Capital City of Prague	0	3

SOURCE: Internal communication with OCP MHMP; Statistics – Re-use points Pod Šancemi, Zakrytá, Počernice. Evaluation of the waste management system of the Capital City of Prague in the years 1998–2020.

In October 2020, two pilot projects were launched at re-use centres in Prague and immediately received positive feedback from citizens. "It's a very good idea. A renovated old chair is better than new one.", "This should have been possible a long time ago..." – people say in connection with the report on the novinky.cz website. In November 2020, another centre under the administration of the Prague Horní Počernice district was opened, from where data will also be collected and used to evaluate the use of re-use centres by citizens and to plan their opening in other districts. Despite the the re-use point in Horní Počernice being opened as the last one from all of the three centres, the most amount of items were handed in and the most kg of waste was saved at the Horní Počernice re-use point. In the future, the city plans to involve more non-profit organizations to increase the interest and awareness of citizens. So far, the social departments of the city districts of Prague have been primarily involved.

4.2.4 Intelligent Waste Collection and Storage System

In 2020, Prague Capital City has started the routine operation of the innovative Smart Waste Collection project, which consists in the installation of 424 sensors for measuring the level of fullness of waste containers for sorted waste with a bottom dump. The sensors, together with a specially developed software tool, will enable city employees to monitor the utilization of containers and more efficiently plan the waste collection schedule. Modern and innovative tools can purposefully reduce the environmental burden, effectively use the capacity of currently available waste containers, and thus respond operationally to

SOURCE: **33/** Environmental portal of the City of Prague, "Prague gives used things a second chance. (Environmental Portal of the Capital City of Prague)", available at http://portalzp.praha.eu/jnp/cz/odpady/predchazeni_vzniku_odpadu/praha_dava_pouzitym_vecem_druhou_sanci.html, check on 26 June, 2021.

changes. This is very desirable, especially at a time when the COVID-19 pandemic is significantly changing waste patterns. The city can react flexibly to these changes by adjusting the collection frequency for individual containers and thus more efficiently direct expenditures in waste management. For this reason, expanding the sensors to other vessels in the coming years has been planned.

The indicators listed in this area are influenced by a number of different factors that need to be considered when evaluating them. For example, mileage is affected by traffic closures, newly established or relocated sites, the expansion of collection with a new commodity or service. The economic situation in society, the behaviour of users (natural and legal persons, districts, the City Hall), the introduction of new technologies, etc. also have a fundamental impact. Therefore, it is possible to evaluate the informative ability of these indicators over a longer period of time.

Trips of Collection Companies

The indicator is used for long-term evaluation of the number of shifts (trips) of collection cars for SKO for a given calendar year.

	2017	2018	2019	2020
Resulting indicator value	**40 %**	**37 %**	**45 %**	**41 %**
Calculation	Separations for separated waste / Total number of departures [%]			
Number of trips (shifts) of collection vehicles for SKO and trade waste	**32,184**	**33,338**	**35,374**	**32,541**
Number of trips (shifts) of the collection vehicles for separated waste	21,082	19,973	28,469	22,387

SOURCE: Internal communication with the companies Pražské služby, a. s. (Plc.), AVE, a. s. (Plc), Komwag, a. s. (Plc.), and Ipodec, a. s. (Plc.)

In 2020, there was a change in the collection routes. More congested routes were divided into multiple routes or redistributed with others.

In the coming years, it will be possible to determine the success of meeting the set strategic goals of waste management in the Czech Republic, which define the strategy of waste management, which are mainly waste prevention, reuse and recycling (material separation) of waste due to decrease or increase in the number of shifts (trips) of the collection cars.

It will be possible to monitor the development of this value by comparing it with the indicator Trips of collection companies for recycled waste and comparing these two groups of waste. In comparison with the total volume of SKO and the volume of sorted waste, not only the efficiency of waste collection will be evaluated in the future, but especially the practical impact of the implemented elements of the circular economy.

Trips by Collection Companies

The indicator provides additional information on the number of shifts of collection cars (Trips of collection companies for SKO).

	2017	2018	2019	2020
Resulting indicator value	**35 %**	**42 %**	**42 %**	**45 %**
Calculation	Raids for separated waste / Total raid [%]			
Number of vehicle kilometres driven by vehicles of collection companies for SKO and trade waste	3,296,077 km	3,014,255 km	3,262,574 km	2,781,229 km
Number of vehicle kilometres travelled by vehicles of collection companies for separated waste	1,789,940 km	2,175,285 km	2,381,559 km	2,256,562 km

SOURCE: Internal communication with Pražské služby, a. s. (Plc.), Ave, a. s. (Plc), Komwag and Ipodec, a. s. (Plc.) For 2017 no value was available for Komwag, a. s. (Plc.), which within the Prague Waste Consortium 2016-2025 carries out the collection of SKO in the territory of Prague 2.

Compared to previous years, the number of vehicles has decreased slightly, which meets the long-term goal of reducing the number of kilometres of collection vehicles. This can basically be achieved in two ways – by optimizing vehicle departures and lower waste production. However, it is necessary to realize that e.g. excessive efforts to optimize exits, especially for sorted waste, without intelligent monitoring of the filling of waste containers can lead to overfilled containers for sorted waste, pollution of public space by dumping waste outside containers and demotivation of citizens for waste sorting.

Dynamically Adjusted Collection Routes for SKO

It is currently not possible to determine the indicator, the values are not available. The indicator will focus on long-term monitoring of the application of advanced concepts for the implementation of waste collection depending on the operation of the process of optimization of collection routes, which are adjusted according to the current filling of waste containers thanks to built-in sensors.

The potential for the introduction of sensor-controlled optimization is especially for separated waste, specifically glass. This is due to its ability to evenly fill the waste container, gradual compaction of glass shards and long export intervals. Currently, the collection of separated waste is taking place on the basis of a fixed schedule according to the contract between the Capital City of Prague and the consortium "Prague Waste 2016–2025". It is not possible to directly introduce a dynamic collection, but it is possible to adjust the frequency of collection according to the yield of individual containers.

Smart Waste Bins

At the end of June 2020, the City Council approved the final report of the Smart Prague pilot project entitled Smart Waste Collection. Thanks to this project, more than 420 sensors were installed in the Czech capital city, which were placed in containers for sorted waste. Current data with information on the actual occupancy of individual containers are available to the city districts involved in the project, as well as to all Prague citizens via the My Prague application. An intelligent system built into waste bins will enable online monitoring of the filling status of bins for the collection of certain waste and, based on the collected data, optimize waste collection in the capital city. The data can be used for long-term monitoring of usage and fullness of individual containers, setting the optimal frequency of dumps, monitoring the amount of waste produced and refining decisions on the direction of investment in collection frequency and thus optimizing waste collection in the capital city. At the same time, through the mobile application, citizens are able to search for containers for sorted waste in their vicinity, where they can find out the level of waste and the time of the last measurement. In the autumn, the project team immediately started cooperating on testing a new type of sensors using a laser beam. Following the results of this project, its expansion to another approximately 7,000 places in Prague will be prepared.

The number of waste containers equipped with sensors indicates the capacity of cities to use modern sensor technologies for more efficient waste collection and processing.

	2017	2018	2019	2020
Resulting indicator value	**0 %**	**3 %**	**3 %**	**2 %**
Calculation	Number of smart bins / Total number of bins [%]			
Number of smart waste bins	**69**	**529**	**509**	**510**
Number of smart waste containers operated within OICT projects	30	454	424	424
Number of smart waste bins – TD *	39	39	49	50
Number of smart waste bins – Zoological Garden of Prague Capital City	0	36	36	36
Total number of waste bins	**16,254**	**16,593**	**18,355**	**21,600**
Waste bins of the city districts **	7,697	7,711	9,171	12,494
Waste bins of Dopravní podnik a. s. (Plc.)	715	768	1,079	1,003
Waste bins of the Pražské služby, a. s. (Plc.)	5,972	6,244	6,230	6,222
Waste bins Department of Environmental Protection of the City of Prague	1,050	1,050	1,050	1,065
Waste bins operated by JCDecaux	820	820	825	816

SOURCE: 2017 – Passportization of waste containers of the company OICT, a. s. (Plc.) Other years – Internal communication with individual districts, OCP MHMP, DPP, Pražské služby, a. s. (Plc.), and JCDecaux.
* Out of the total number of 57 districts, 50 provided the data in 2017: 41; 2018: 41; 2019: 44; 2020: 44
** Out of the total number of 57 districts the data were provided in 2017: 39; 2018: 39; 2019: 42; 2020: 42

A smart waste bin is a bin that is equipped with a sensor that monitors status and operating information, such as the filling of a container. Smart baskets located in city districts and in the Prague Zoo are from the company Verb Group, s. r. o. (Ltd.) These are BigBelly solar compression bins.

The total value of smart waste containers did not change much as just 1 new piece was added year-on-year in 2020. Some districts do not plan for this technology in the future, mainly due to its high acquisition costs and characteristics, which are more suitable for a centre with tourism than for a green urban area with less building density. However, other districts (Prague 6 and 7 districts) use smart technology in the form of sensors installed on underground containers for sorted waste, which share real-time data on the actual fullness of a given container.

The total number of waste bins has been growing steadily in recent years, with their increase in the last year jump-

ing very significantly, from 18,355 pieces in 2019 to 21,600 pieces in 2020. Above all, the street waste bins of the district for mixed waste and dog excrement were added. The main reason for the constant growth in the number of new waste bins is the growing number of buildings and the constant development of the city. The city's effort is always to add new waste bins to newly built or revitalized localities. However, this trend is not recorded in all districts, some of them are trying to maintain or reduce the number of waste bins. On the other hand, a slight decrease is recorded for other waste bins, e.g. number of waste bins of Dopravní podnik hl. m. Prahy, a. s. (Plc.), was reduced by 76 pieces to 1,003 pieces, and the same applied to waste bins owned by Pražské služby. Other waste bins operated by JCDecaux decreased slightly due to closure work on some sections or dismantling of part of the shelters.

Digitization of Waste Collection and Processing

At present it is not possible to determine the value of the indicator; the values are not available. The indicator will capture the potential for full digitization of waste collection, including dynamic optimization of collection routes. There is currently no dynamically modified pick-up route for SKO. All collection companies participating in the Prague Waste Consortium 2016–2025 are equipped with collection vehicles, cleaning vehicles and service vehicles, including reference vehicles, with GPS units.

The indicator relates to new forms of waste collection and recycling, where waste is collected in a mixed way and is recycled in sorting plants as part of the use of sophisticated sorting technologies.

Using the Door-to-door System

The indicator relates to new forms of waste collection and recycling, where waste is collected in a mixed way and is recycled in sorting plants as part of the use of sophisticated sorting technologies.

	2017	2018	2019	2020
Resulting indicator value	**29 %**	**31 %**	**35 %**	**40 %**
Calculation	Number of collection points connected to a door-to-door system or other alternative system / Total number of separation points [%]			
Number of collection points connected to the system door-to-door or other alternative system	**1,362**	**1,511**	**1,890**	**3,182**
Total number of separation points	**4,732**	**4,907**	**5,324**	**7,877**
Number of outdoor separation points	3,370	3,396	3,434	4,695
Number of separation points in the interior of the house	1,362	1,511	1,890	3,182
Number of places where the delivery is carried out	10,587	10,351	8,970	12,454

SOURCE: Data on the number of separation points for the entire territory of the Capital City of Prague were provided on the basis of internal communication by the company Pražské služby, a. s. (Plc.) Number of places with realised delivery provided based on internal communication of the company Pražské služby a. s. (Plc.), Komwag, a. s. (Plc.), AVE, a. s. (Plc.), and Ipodec. a. s. (Plc).

The indicator captures the rate of use of alternative separate waste collection systems. These include, for example, the door-to-door system, where citizens put sorted waste in bags in front of their house, or the pay-as-you-throw system, where citizens pay only for the waste they produce. The number of places with realized delivery includes the total number of delivery places, only a fraction of the stated value is formed by delivery places within the sorted waste, it is mostly mixed waste.

The potential for the door-to-door system can be captured by recording the number of points where the so-called door-to-door service is operated. This is a service where the collection company offers the option of removing waste containers from the interior of the house. Today we can identify a trend whereby large outdoor separation points are being removed and waste containers are being placed more frequently in the interiors of buildings. Large outdoor separation points are often associated with a mess in public spaces.

In 2020, we saw greater interest of citizens in the door-to-door system, especially thanks to the promotion of urban areas. The example here highlights the importance of motivation and promotion among citizens and how it can have a positive effect on waste management (comment from the City Hall).

The number of registered door-to-door places increased to 12,454 year-on-year. This service is also supported by the City Hall and work is underway to expand this service, which has been slowed down by the pandemic.

Ecological Collection Vehicles

The indicator expresses the number of eco-friendly collection vehicles in the collection fleet (includes, for example, CNG).

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**N/A**	**17,31 %**	**16,08 %**
Calculation	Number of collection vehicles using alternative fuel propulsion / Number of collection vehicles [%]			
Number of collection vehicles	**N/A**	**N/A**	**283**	**342**
Pražské služby, a.s. (Plc.)	44	37	45	51
Komwag, a. s. (Plc.)	2	1	0	0
Ipodec, a. s. (Plc.)	2	2	3	3
AVE, a. s. (Plc.)	1	1	1	1

SOURCE: Internal communication with Pražské služby, a. s. (Plc.), Komwag, a. s. (Plc.), Ipodec, a. s. (Plc.), and AVE, a. s. (Plc.)

During 2020, Pražské služby, a.s. (Plc.) acquired another 6 vehicles for alternative fuels. The use of such environmentally friendly vehicles has also increased. The number of vehicle kilometres travelled increased by approx. 100,000 km year-on-year (see the following indicator). Resulting indicator value – the share of alternative fuel vehicles in the total number of collection vehicles – is still lower than in the previous year. This is mainly because the number of conventional collection vehicles has also been increased. Pražské služby, a.s. (Plc.), are also striving for the modernization of the vehicle fleet, which aims to streamline the trips of collection vehicles (commentary taken from the Pražské služby).

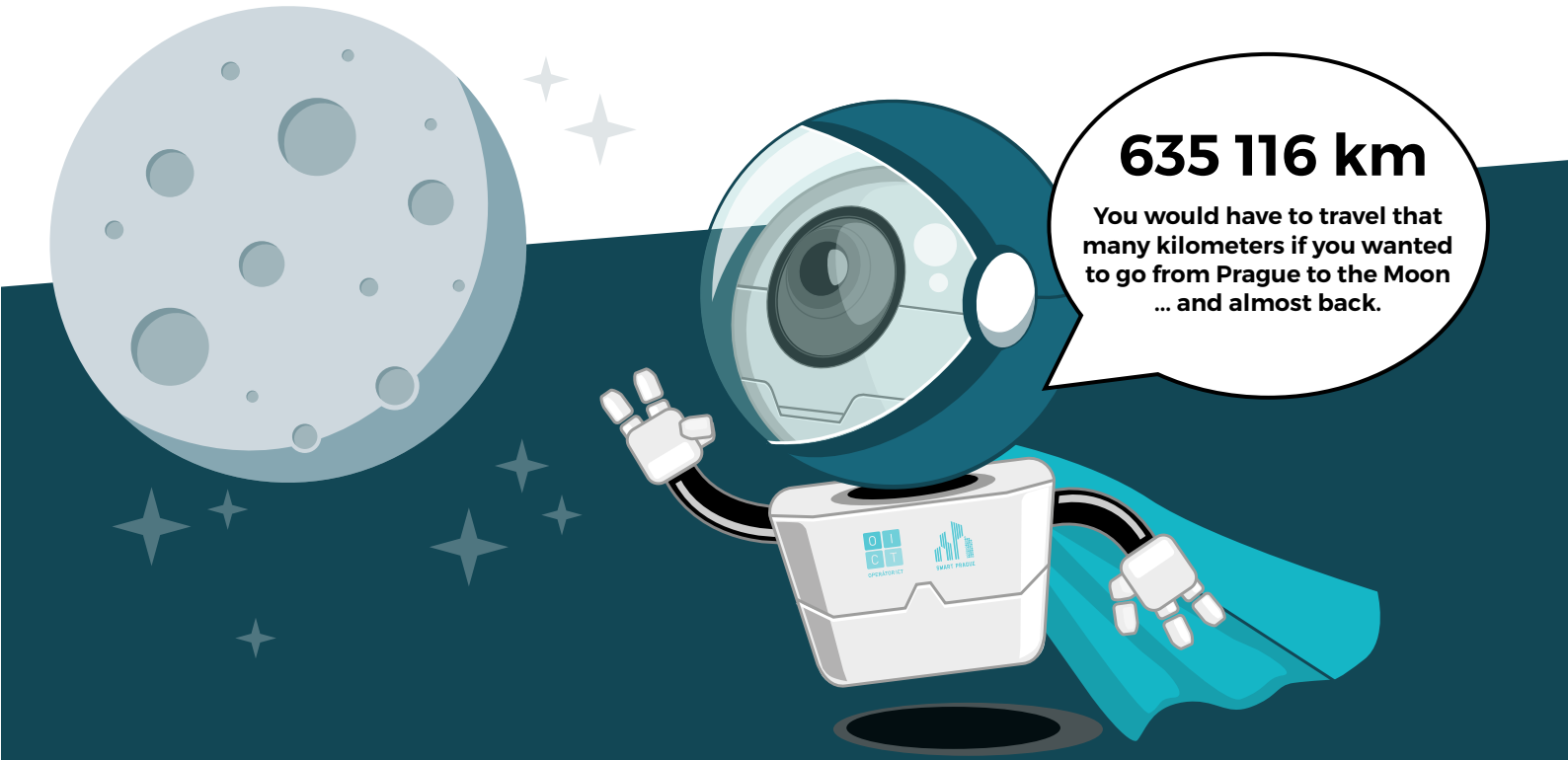
The number of collection technology for alternative (ecological) propulsion is constantly changing in relation to the purchase and disposal of obsolete equipment. For a correct interpretation of this indicator, monitoring over a longer period of time will be appropriate.

Utilization of CollectionVvehicles for Alternative Fuels

The indicator monitors the active use of environmentally friendly vehicles for waste collection in the context of the overall drive of collection vehicles.

	2017	2018	2019	2020
Resulting indicator value	**11 %**	**12 %**	**10 %**	**13 %**
Calculation	Number of vehicle-kilometres driven by alternative fuel vehicles / Number of vehicle-kilometres driven by all collection vehicles			
Number of vehicle kilometres driven by alternative fuel vehicles	558,317	601,550	551,615	635,116
AVE, a. s. (Plc.)	18,000	10,500	15,000	14,200
Ipodec, a. s. (Plc.)	43,708	45,779	43,270	63,567
Pražské služby, a.s. s. (Plc.)	496,609	503,646	493,345	557,349
Komwag, a. s. (Plc.)	N/A	41,625	0	0
Number of vehicle kilometres driven by all collection vehicles	5,086,017	5,189,540	5,644,133	5,037,791
Vehicle kilometres for separated waste	1,789,940	2,175,285	2,381,559	2,256,562
Vehicle kilometres for SKO together with trade waste	3,296,077	3,014,255	3,262,574	2,781,229

SOURCE: Internal communication with Pražské služby, a. s. (Plc.), Komwag, a. s. (Plc.), AVE, a. s. (Plc.), and Ipodec, a. s.(Plc.)



The indicator shows the practical use of alternative fuel vehicles in waste collection. In contrast to the absolute number of alternative fuel vehicles, this indicator focuses on the real use of alternative fuel collection vehicles. The aim is to increase the value of the indicator, which implies a reduction in the use of vehicles on conventional fuels, which burden the environment in the city. Both this indicator and the indicator of the number of environmentally friendly collection vehicles show that waste management companies are trying to use more collection vehicles for alternative fuels, although their number and mileage are increasing gradually. Vehicle-kilometres for separated waste have decreased slightly in the last year, but this is mainly due to a more accurate calculation methodology, while waste separation is still increasing. In the last year, there has been a decrease in trade customers, which led to a decrease in vehicle-kilometres with trade waste (Source: comment from Pražské služby and AVE CZ).

4.2.5 Use of Wastewater and Rainwater for Energy and Raw Material Purposes

The general trend is long-term support for maximizing the use of wastewater as a raw material source (e.g. biopolymers, phosphates, nitrogen, ammonia, synthesis gas, carbon dioxide, sulphur and cellulose), energy sources (e.g. sewage sludge and heat in sewers) and sources of treated water for further use (e.g. watering, rinsing, return of water to the landscape). Follow-up activities will also be support for retention and further use of rainwater in the city.

The Czech Republic has been struggling with drought for a long time, which is also reflected in the MoE's support in the fight against drought, which is intended for both municipalities and individuals. In addition to the Dešťovka subsidy, which is intended for owners or builders of flats and houses for the use of rainwater and wastewater in the home and in the garden, the Velká dešťovka subsidy intended for helping municipalities in combating drought also returned in 2020. The Ministry of the Environment has released one billion crowns from the Operational Program Environment for measures that will make the infiltration of rainwater in urbanized parts of towns and municipalities more efficient and support their capture for further use. For example, municipalities will be able to capture rainwater in underground reservoirs and use it to irrigate municipal greenery, to cool streets during the summer heat, or to flush out schools, offices and other public buildings. Instead of draining all rainwater into the sewer, it will also be more efficient for the municipality to let it soak into the soil freely and thus subsidize the groundwater supply. [34/]

Use of Rain Gauges

Number of rain gauges providing real-time data and their coverage of the entire territory of Prague.

	2017	2018	2019	2020
Resulting value of the indicator (rain gauges)	**9.92**	**9.54**	**9.54**	**9.19**
Calculation	City area / Number of rain gauges			
CCP area	496 km²			
Rain gauges operated by PVK	23	23	23	23
Rain gauges operated by CHMI *	27	29	29	31
Resulting value of the indicator (meteorological sensors)	**16.53**	**23.62**	**22.55**	**23.62**
Calculation	1	1	1	1
Meteorometers on TSK roads	30	21	22	21

SOURCE: Internal communication with PVK and TSK.
* Data on CHMI rain gauges see "CHMI HPPS – Current information of hydrological forecasting service", available from https://hydro.chmi.cz/hpps/hpps_act_rain.php, control June 26th, 2021.

The indicator of city coverage by rain gauges expresses the degree of penetration of the physical measuring infrastructure for finding information on precipitation, especially for hydrological purposes. Information from rain gauges provides a database for engineering operations in the field of drainage. Rain gauges also provide essential input data for the hydrology of urban river basins. This information will also be used in activities aimed at increasing the use of rainfall. They form a significant source of water generated in the capital city. Sensors with real-time measurement are included. Real-time data on the amount of precipitation can also be obtained from other sources, e.g. from meteoradar data. So far, experimentally, these data are also obtained from measurements of attenuation of microwave links in the telecommunications network.

TSK meteorometers provide basic real-time information on the meteorological situation and its impact on traffic. Not only the air temperature but also the road temperature is measured. In 2020, the Opatov meteorometer was dismantled.

SOURCE: **34/** "Deštovka subsidy", available from https://www.dotacedestovka.cz/, check on 26 June, 2021. Ministry of the Environment of the Czech Republic, "The Big Rainwater Program: The Ministry of the Environment releases another billion to combat drought in cities and municipalities", 4 February 2020, available at https://www.mzp.cz/cz/news_20200204-Startuje-Velka-Destovka, check on 26 June, 2021.

Permeable Surfaces

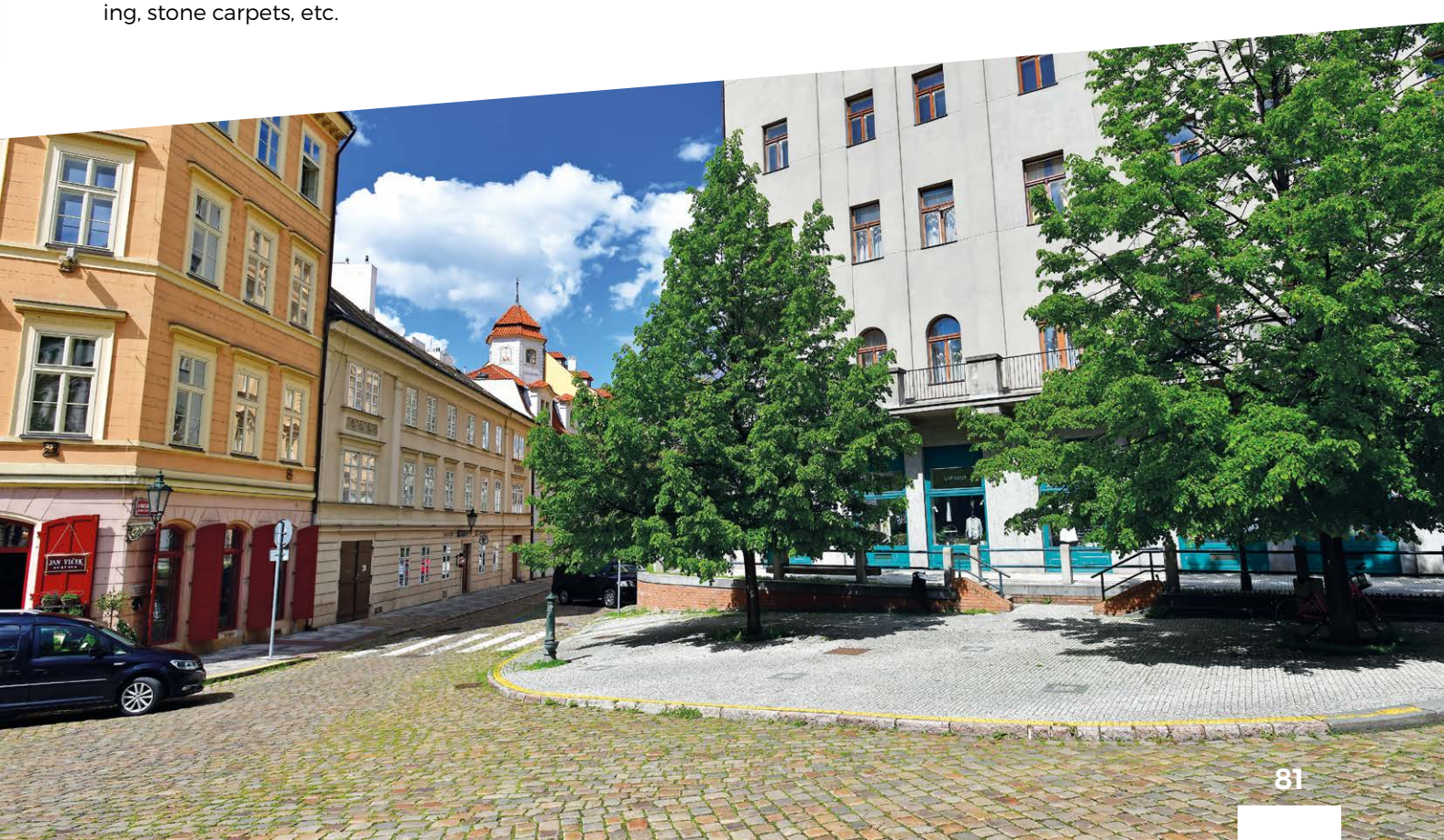
The indicator of the area of permeable areas in terms of the total area of Prague shows the share of areas with a significant potential to retain rainwater in the Capital City of Prague.

	2017		2018		2019		2020	
Resulting indicator value	**27,831 ha**	**56.17 %**	**27,771 ha**	**55,88 %**	**27 724 ha**	**55,80 %**	**27 657 ha**	**52,99 %**
Growing landscape	2,605 ha	5.25 %	2,689 ha	5.41 %	2,672 ha	5.38 %	2,656 ha	5.34 %
Forest landscape	5,504 ha	11.09 %	5,498 ha	11.06 %	5,496 ha	11.06 %	5,493 ha	11.05 %
Non-forested landscape	3,928 ha	7.92 %	3,993 ha	8.03 %	3,983 ha	8.02 %	3,975 ha	5.34 %
Natural recreation	3,003 ha	6.05 %	3,067 ha	6.17 %	3,074 ha	6.19 %	3,093 ha	6.22 %
Active recreation	1,004 ha	2.10 %	1,151 ha	2.32 %	1,149 ha	2.31 %	1,166 ha	2.35 %
Waste and resources	147 ha	0,30 %	148 ha	0.30 %	148 ha	0,30 %	148 ha	0.30 %
Agricultural landscape	11,640 ha	23.46 %	11,225 ha	22.59 %	11,202 ha	22.54 %	11,126 ha	22.39 %

SOURCE: The data are based on territorial analytical data prepared by the Institute of Planning and Development of Prague.

The above indicators are based on the basic structure of land use. The percentage expression of the area is calculated from the base area of the Capital City of Prague, which is 49,616 ha. The choice of these basic land use structures was based on the context of rainwater management. These areas form the retention potential of the area until the moment the profile is saturated with water. However, the total area of these areas decreases slightly (52.99 %) and, conversely, the area increases (47.01 %), which is not very effective in rainwater infiltration. To increase water retention in the Capital City of Prague, there is a replacement of concreted or asphalt surfaces with surfaces with higher permeability, e.g. paving, stone carpets, etc.

Unfortunately, even in 2020, the gradual decline of the agricultural landscape did not stop, which remained at 22.39 %. Another significant change can be observed in the non-forest landscape, which decreased by almost 3 % compared to 2019. On the contrary, a lasting increase can be seen in natural recreation, whose area increased by 0.17 % compared to 2017.

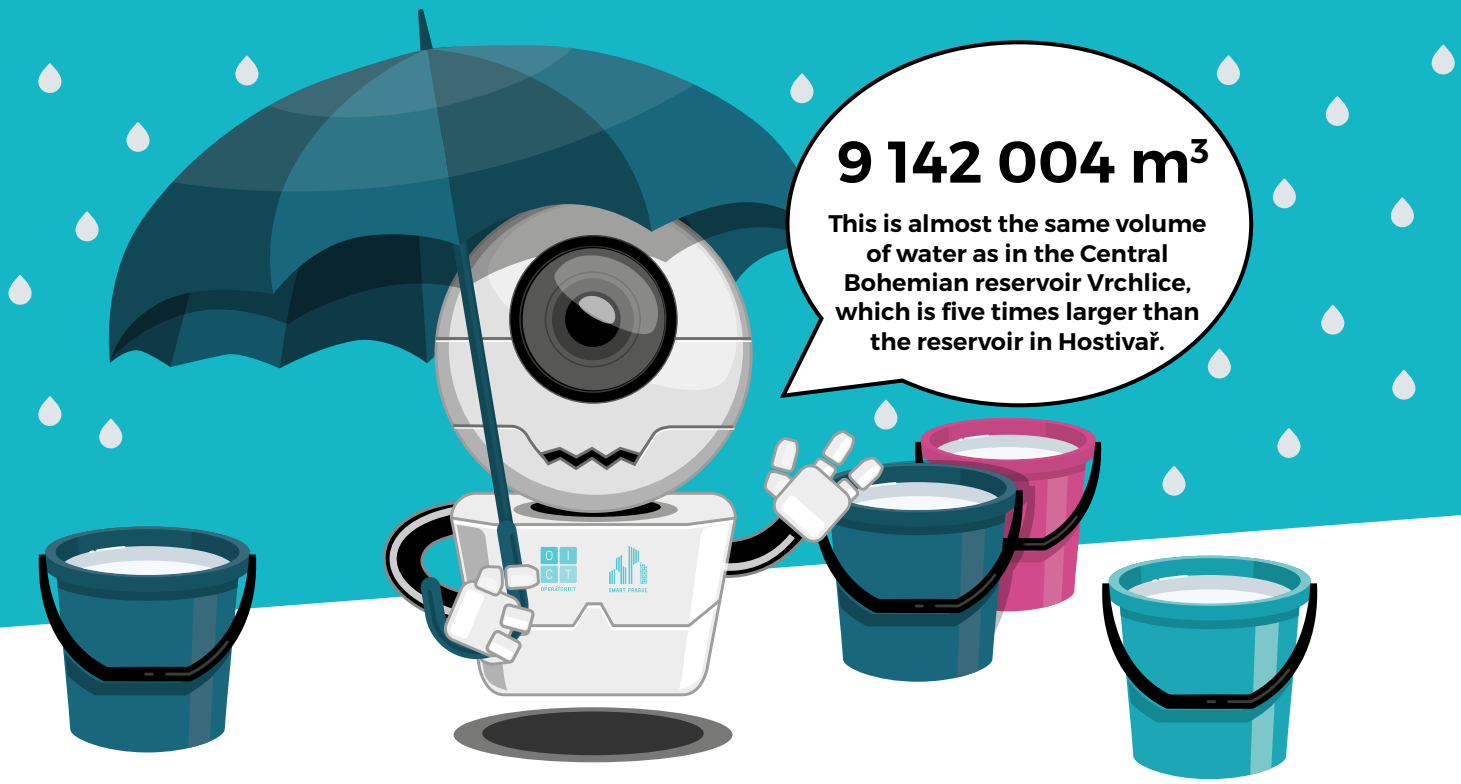


Rainwater Tanks

The indicator expresses the city's capacity to capture rainwater for further use or processing.

Category	2019			2020		
	Amount of elements	Level area (m²)	Ponding Volume (m³)	Amount of elements	Level area (m²)	Ponding Volume (m³)
Resulting value of the indicator – sum	**165**	**2,949,483.0**	**7,191,984.0**	**171**	**3,281,127**	**9,142,004**
Ponds	81	971,139.0	2,148,296.0	83	1,176,965	2,540,215
Retention tanks	36	760,242.0	1,430,724.0	39	859,160	2,864,075
Rainwater settling tanks (DUN) *	39	N/A	N/A	39	N/A	N/A
Dry polders	5	385,842.0	873,639.0	5	385,842	873,639
Waterworks	4	24	2,739,325.0	5	859,160	2,864,075

SOURCE: The data come from the records of the Forests of the Capital City of Prague.
* DUN values are not available at the time of publication finalization.



Ponds are water reservoirs used mainly for fish farming and recreation. They also have a landscape-creating and ecological function and can also cool the microclimate on a local scale. In 2020, new ponds were added in Prague, which significantly increased the total area of ponds in the capital, the difference compared to 2019 rose to 205,000 m² and even greater is the difference in volume, which increased by almost 400,000 m³. The completion of the new documentation of the existing ponds also contributed to the increase in the area, as the data were significantly refined (Source: MHMP).

In the same way, retention tanks were added in Prague, by 100,000 m² compared to 2019 and the volume increased to 2,540,215 m³. The retention tank is used to contain torrential rainfall. The rainwater is then discharged into the sewer in a controlled manner so that the flow rate does not burden the sewer capacity and does not disturb the sewer body. Without retention tanks, the sewer profile could be filled and the free surface flow could become a pressure flow, which could cause damage to the sewer network, or water could start gushing out in the lower places on the network and flood the lower places. Therefore, unlike ponds, retention tanks are never filled to their maximum values during normal operation.

Rainwater sedimentation tanks (RST) are designed to capture the major proportion of rainwater pollution com-

ing from the ground into the rainwater drainage system in order to reduce water pollution in watercourses. These were mainly built in the 1980's and are very important for ensuring the cleanliness of the water in streams and fish ponds. The tanks are regularly inspected and cleaned to keep them working as well as possible. Some RSTs underwent complete reconstruction in 2018 including repairs to concrete structures and the replacement of equipment.

The number of tanks remained unchanged year-on-year. In 2019, the Centre for Watercourses, the Water Management Department prepared 11 new handling regulations and, based on these data, was able to specify the coverage of flooded areas and the volumes of reservoirs. However, these data are still not available, so the total area and volume of the settling tanks remain unknown.

A dry polder is a place where an increased water level on a watercourse, i.e., in the event of a flood, will result in a harmless overflow of water into a designated area. Dry polders are empty in the absence of a flood situation.

A water body in this context means a dam. There are four of these in the Capital City of Prague – Džbán, Hostivařská přehrada, Jiviny and N4.

The Division of Prague reservoirs according to Decree no. 471/2001 Coll., on technical and safety supervision of waterworks:

- Category II waterworks – Hostivařská nádrž
- Category III waterworks – Jiviny, N4, Džbán
- Category IV waterworks – all Prague ponds and retention reservoirs

Relief Chambers

The number of relief chambers equipped with sensors for monitoring the state of flow and fullness compared to the total number of relief chambers.

	2017	2018	2019	2020
Resulting indicator value	**4,83 %**	**4,83 %**	**4,79 %**	**N/A**
Calculation	Number of relief chambers equipped with sensors / Total number of relief chambers in the capital [%]			
Number of relief chambers equipped with sensors	7	7	7	7
The total number of relief chambers in the capital	145	145	146	N/A *

SOURCE: Internal communication with PVK, MZE. | * The information will be available after the finalization of this publication.

A relief chamber is a technical device in the sewer network which, in the event of torrential rain, uses an overflow to drain some wastewater diluted with rainwater into a recipient (river, stream). This solution reduces the flow into the rest of the sewer network in the event of torrential rain and thus protects it from damage or failure due to overloading. It also avoids the need for disproportionately large oversize sewers to carry out large volumes of rainwater during torrential rain. The solution is based on the idea that the overflow from the sewer occurs when the wastewater is significantly diluted and so the concentration of pollutants is minimal. The question is the extent to which the water is safe due to its pollution by run-off from paved surfaces. During intense precipitation, water in the relief chamber is discharged into a water recipient in the appropriate dilution ratio (most often in the ratio wastewater: stormwater 1:4–1:6).

Ideally, as little rainwater as possible should be drained to the common sewer and mixed with wastewater.

In 2020, the amendment to Act on waters, No. 544/2020 Coll., which brings a big change concerning relief chambers. Until now, wastewater treatment plants were obliged to have a valid wastewater treatment permit and to pay for the discharge of pollution, because the inlet into the integrated sewerage system, the rainwater becomes wastewater. The current amendment to the Water Act proposes a change so that no relief chambers will need a permit for the discharge of wastewater.

The indicator expresses the share of the number of relief chambers equipped with sensory measurement (so-called emergency monitoring) of the level of dilute wastewater falling into the recipient to the total number of relief chambers.

Sensory monitoring of relief chambers provides information on the volume of wastewater discharged without treatment.

Use of Recycled Water – Public Sector

This monitors the consumption of recycled water in public buildings. Gray water is sewage from households and other non-industrial buildings that does not contain toilet waste. Gray water is therefore created primarily through the use of bathrooms, washbasins and washing machines.

Utilization of recycled water in buildings owned by the City of Prague

	2017	2018	2019	2020
Resulting indicator value	**0 %**	**0 %**	**0,3 %**	**0,9 %**
Calculation	Recycled water consumption / Total water consumption in public sector buildings [%]			
Recycled water consumption	0	0	3 529 m^3	10 334 m^3
Total water consumption in public sector buildings (domestic hot water and cold water)	1,506,823,820 m^3	1,187,699,670 m^3	1,385,154,701 m^3	1,141,642.5 m^3

SOURCE: The data relate to the number of 1 registered building in theCapital City of Prague information system that are owned by the Capital City of Prague.

The value of the total water consumption in public sector buildings is calculated from the amount of water abstraction carried out at abstraction points registered in the Energy Broker system, which as of December 31st, 2020 registered 1,047 abstraction points.

As part of the EPC project, an innovative technology was implemented in the Šutka aqua centre, which will clean up the part of the pool water that would normally be discharged into the sewer and return the water to the pool.

Decrease in water consumption by approximately 243,000 m^3 between 2019 and 2020 is undoubtedly caused by the first wave of the COVID-19 pandemic, which caused closing schools, swimming pools, theatres, libraries and limited the functioning of offices. Water consumption has thus shifted to households. A further reduction in consumption is due to the replacement of older equipment using drinking water with more economical equipment. Manufacturers of taps already supply drain fittings, including energy-saving aerators.

In the field of wastewater management, the information provided by PVK is known. The table shows the amount of reused water in the above operations.

Wastewater management

	2017	2018	2019	2020
Central wastewater treatment plant	873,051 m^3	869,566 m^3	658,611 m^3	602,556 m^3
Subsidiary wastewater treatment plants (20 plants)	20,058 m^3	20,391 m^3	21,036 m^3	21,687 m^3

SOURCE: Internal communication with PVK.

Between 2018 and 2019, the decrease in the technological need for service water was mainly associated with the launch of a new water treatment plant during the year and, as a result, the inflow of wastewater to the existing water line was reduced by up to 52 %. In 2020, the amount of reused water did not change much.

Use of Recycled Water – Private Sector

It is currently not possible to determine the value of the indicator, the values are not available. The indicator monitors the involvement of the private sector in the use of recycled water. The number of companies using recycled water is currently unknown.

Utilization of Sewage Sludge

The indicator captures the amount and proportions of the processed mass of stabilized sanitized sewage sludge.

	2017	2018	2019	2020
Hygienic dewatered sludge from wastewater treatment	88,000 t	77,598 t	85,457 t	90,800 t
Storage on agricultural land	89 %	94 %	89 %	89 %
Composting	7 %	3 %	11 %	11 %
Energy recovery	4 %	3 %	0 %	0 %

SOURCE: Internal communication with PVK.

Stabilized sludge is considered to be one that does not cause any damage to the environment and does not cause difficulties (e.g, unpleasant odour) when working with it. Sanitized sludge is generally considered to be sludge in which the indicators of pathological organisms have been reduced to the required values.

The result of wastewater treatment is the separation of pollution from water. It is then returned as clean water back to the recipient – a river or a stream. During the stabilization process, biogas is captured from the sewage sludge, which is used in cogeneration units installed at the WWTP. These units produce electricity and heat from biogas. In heat production, the WWTP is fully self-sufficient and in electricity production the self-sufficiency rate reaches 56 %.

The residual stabilized and sanitized sludge is then used in the ways described by the indicator above. Energy use means burning sludge in an incinerator.

Only sanitized sludge can be reused. Untreated sludge must first undergo a sanitation process in order to significantly reduce the content of pathogenic organisms in the sludge and thus the health risk associated with its application by verifying the effectiveness of sludge treatment technology in accordance with the requirements set out in the implementing legislation.

The Municipal Water Management Company of Prague (PVS) prepared a concept for the management of sludge generated during wastewater treatment and submitted it to the capital for approval. So far, sludge is used as a fertilizer in agriculture, but this will probably not be possible in the future due to stricter rules. This concept describes two options for the disposal of sludge, if the legislation on the use of sludge for agricultural purposes is further tightened, most likely incineration.

In 2020, the amount of sanitized dewatered sludge increased again. This trend has been going on for the third year in a row. The share of sludge deposited on agricultural land did not change significantly and amounted to 89 % in 2020. The application of sewage sludge on agricultural land is governed by Act No. 185/2001 Coll., On waste and further by Decree no. 437/2016 Coll., On the conditions for the use of treated sludge on agricultural land. The application of sludge is one of the alternative ways to supply a certain amount of organic matter and nutrients to the soil and thus provide protection against erosion and water retention by the soil. The share of sludge for composting remained at the same level as in 2020 and the energy sludge used for energy remained at 0.

Thermal and Electrical Energy from WWTP

The indicator describes the heat-energy balance at the Central Wastewater Treatment Plant.

	2017	2018	2019	2020
Percentage of thermal self-sufficiency of the WWTP	100 %	100 %	100 %	100 %
Percentage of self-sufficiency in electricity consumption at the WWTP	56 %	56 %	87 %	82 %

SOURCE: Internal communication with PVK.

In terms of electricity consumption, the WWTP is a highly self-sufficient operation. It still sticks to a high percentage of electricity, which is covered by its own production. This increase occurred with the commissioning of a new water line. 93.1 % of all wastewater in the Capital City of Prague is treated at the WWTP.

4.2.6 Other Relevant Information

These indicators illustrate the overall situation in the Capital City of Prague in terms of the strategic area Waste-free City.

Wastewater Raw Materials and Wastewater Energy

The indicators monitor both the raw materials that are obtained from wastewater outside the sewage sludge, as well as the ability of wastewater treatment plants to use wastewater for energy production.

	2017	2018	2019	2020
Biogas volume	14,810,698 Nm³	16,285,510 Nm³	17,357,124 Nm³	15,063,150 Nm³
Amount of produced electrical and thermal energy within the WWTP	57,165 MWh	68,094 MWh	66,387 MWh	61,195 MWh

SOURCE: Internal communication with PVK.

During the wastewater treatment process, biogas is obtained at the Central Wastewater Treatment Plant (WWTP). No other materials such as phosphates, polymers, ammonia, nitrogen, CO_2, sulphur or cellulose are recovered from the wastewater.

Thermal and electrical energy in wastewater treatment plants is produced in cogeneration units using energy gas from sewage sludge. Cogeneration units produce electricity and produce heat energy from waste heat.

The reduced biogas production corresponds to a lower production of sludge at the WWTP and a lower amount of imported waste entering the digestion tanks due to the COVID-19 pandemic. Therefore, less electrical and thermal energy was produced.

Maintaining Purified Water in the Landscape

It is currently not possible to determine the final value of the indicator, the values are not available. Water from the wastewater treatment process is not retained in the landscape, it is returned to the recipient, in this case to the Vltava River.

4.3 SMART BUILDINGS AND ENERGY

Energy, as one of the key areas of Smart Prague, is on the threshold of change. The entire energy sector is moving in a direction that is to ensure a safe and reliable supply of energy obtained in an ecological way so that the Capital City of Prague meets its obligations and reduces its carbon footprint according to the approved Climate Commitment.[35/]

The year 2020 was affected in all directions by the ongoing COVID-19 pandemic, including energy. In 2020, electricity consumption in the Czech Republic reached a five-year low of 71.4 TWh.[36/] Electricity consumption decreased mainly in the corporate sector, while electricity consumption increased in households. For the time being, electricity is mainly produced from fossil fuels,[37/] which is why the consumption of this kind of energy leaves the most significant carbon footprint. For this reason, it is necessary to constantly monitor and evaluate electricity consumption. In the future, growth in electricity consumption is expected in Prague, which will be caused by the expansion and population of the capital city and the associated construction, development of telecommunications and data services and growth in electromobility. The Smart Prague concept until 2030 responds appropriately to these challenges, in the form of energy-efficient and sustainable energy in healthy and intelligent public buildings.

Modern energy-saving and highly efficient technologies are already part of the construction and energy industries today, but they are also becoming more and more widespread in the field of public lighting. In the construction industry, objects are currently designed and built, which are assessed in terms of environmental friendliness and future sustainability and based on the analysis of a number of criteria, are subsequently evaluated and certified. In the Czech Republic, several methodologies are used to certify buildings, which are specified in more detail later in this chapter. The field of construction, energy in combination with the use of modern energy-saving technologies is not only the domain of newly built buildings but it is also becoming a common part in the reconstruction of existing buildings. An intelligent approach to the energy management of public buildings must be ensured not only by efficient and therefore lower energy consumption, but also by the ability to produce its own energy from renewable sources and to consume or store it efficiently. Renewable energy sources will also play an important role in the overall energy mix in the Capital City of Prague.

Public lighting is also an integral part of energy consumption in the city. At present, Prague, like other Czech cities, is still struggling with uneconomical public lighting. The average age of public lighting is more than 30 years, so Prague is gradually implementing the renewal of this lighting. In Prague, there are about 135,000 lamps powered by electricity and over 400 posts for gas lamps to preserve the cultural character of old Prague..

Energy in Prague must be economical in the future – lower and efficient energy consumption, sustainable – own production, storage and management of energy consumption from renewable sources. Public buildings in Prague will be transformed into intelligent and healthy – public buildings will automatically provide a healthy environment.

Thematic areas include:

- Prague Clean Energy Fund
- Smart Lighting
- Smart local area networks

SOURCE: **35/** Resolution of the Prague City Council no. 8/42 of 20 June, 2019 to announce the Climate Commitment of the Capital City.
36/ https://www.eru.cz/-/vyroba-elektriny-byla-loni-nejnizsi-za-18-let-spotreba-klesla-na-petilete-minimum.
37/ https://www.ote-cr.cz/cs/statistika/narodni-energeticky-mix.

4.3.1 Prague Clean Energy Fund

In 2020, the Capital City of Prague was preparing several strategic documents that respond to the impending change in the energy sector. One of these documents is the Climate Plan. The Capital City of Prague aims to support the use of clean and sustainable energy sources and achieve a 45 % reduction in its carbon footprint compared to 2010. Massive use of various financial instruments can be expected. Financial support will thus be able to receive promising projects aimed at sustainability, independence and reduction of harmful effects on the use of energy resources.

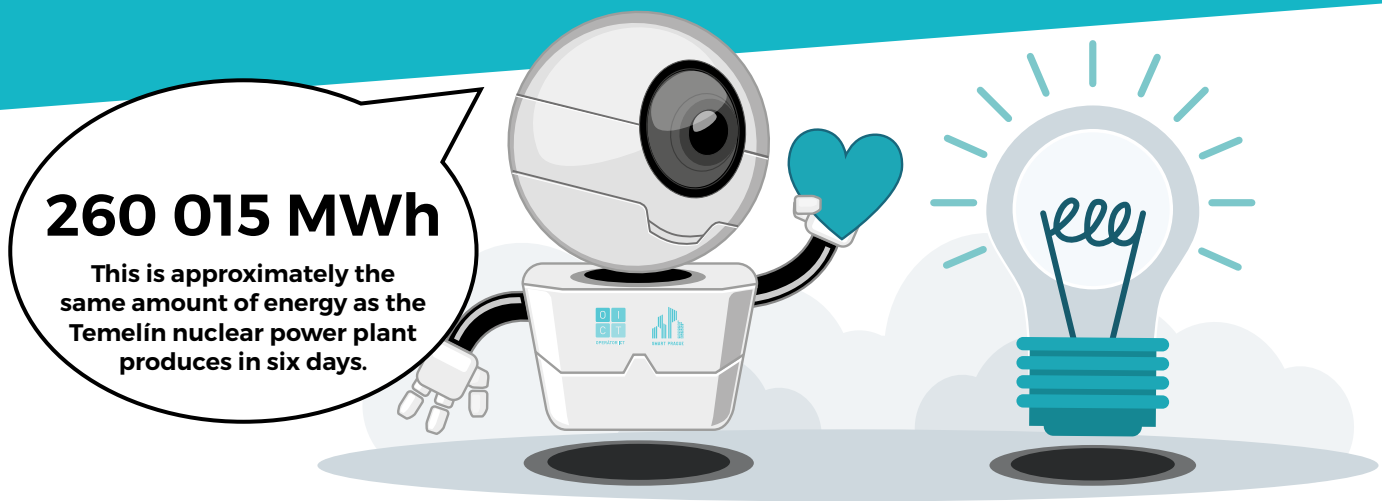
An important milestone was set for the Capital City of Prague in 2020 in the form of the establishment of the energy manager's department.[38/] More and more cities in the Czech Republic are using the position of energy manager to meet climate goals in conjunction with energy and water savings in urban buildings. The Department of Energy Manager, in cooperation with municipal companies, faces a major challenge in the form of the introduction of functional energy management of municipal buildings. Massive use of sensors in public buildings is expected in order to monitor the course of energy and water consumption, but also to monitor the condition of buildings in terms of the quality of the indoor and outdoor environment (i.e. air in schools and kindergartens, room temperature, etc.). Increasingly, advanced technologies in heating, ventilation and lighting are used in public buildings. Heat pumps are installed in the buildings to ensure a more economical form of heating, and a more massive expansion of cogeneration units, which are able to produce electricity and heat at the same time, is also being considered. Energy-saving LED panels are also installed in public buildings, which in some cases qualitatively simulate daylight, which helps increasing the productivity and concentration of people who move in such an environment. In particular, recuperation units are installed in educational buildings, which ensure the quality of the indoor environment. We assume that this trend will increase with the gradual sharing of positive experiences with such installations, which will ultimately help improve the comfort and increase the productivity of people in the buildings, but also more economical operation of the buildings

Energy Consumption in Public Buildings (Energy Performance)

It monitors the energy intensity of public buildings in terms of energy consumption. The indicator now relates to buildings and consumption points registered in the energy management system of the the Capital City of Prague.

	2017	2018	2019	2020
Resulting indicator value	**292 410,4**	**328 800,1**	**340 937,9**	**317 812,1**
Calculation	Recalculated energy consumption according to daily degrees [MWh]			
Annual energy consumption [MWh] in public buildings owned by the Capital City of Prague	265,509.8	272,051.5	280,451.5	260,014.7
Number of day degrees	2,939.3	2,678.4	2,662.8	2,648.4
Long-term average number of day degrees	3,237.1			
Public buildings owned by the Capital City of Prague registered in the information system – number of buildings	1,289	1,243	1,279	1,245
m² of energy reference area	N/A	N/A	N/A	N/A

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.



SOURCE: **38/** MHMP, "Prague establishes the function of energy manager", Praha.eu, 16 June 2020, https://www.praha.eu/jnp/cz/o_meste/zivot_v_praze/zivotni_prostredi/praha_zrizuje_funkci_energetickeho.html, check on 5 June, 2021.

The number of m² of energy reference area is stated in the Building Energy Performance Certificate (BEPC). This information was not available in the information system because the building was not listed in the category with an obligation to prepare a BEPC (building envelope over 250 m²) or it was not entered into the system by the building manager. The energy reference area is currently determined by an energy specialist based on the BEPC calculation or an energy audit or assessment. These data are not machine-readable and so they are gradually being collected. However, also for 2020, the figure is available for a small number of buildings and therefore would not be sufficiently representative, so it is not reported here.

The number of public buildings (addresses) owned by the Capital City of Prague registered in the information system at the end of 2020 is 1,245.[39/] The information system provides an overview of the annual energy consumption [MWh] of all 1,245 buildings. It is the consumption of electricity, gas and heat. Compared to 2019, the number of buildings in the system decreased by 34.[40/]

The average number of day-degrees in the long run is 3,237. This average is considered for the station Prague – Karlov for the period 1961–1990.[41/] The basis of the day-degree method is the knowledge of the course of outdoor temperatures from meteorological data. The calculation of day degrees is used to determine the characteristics of the heating period – the number of day-degrees and the number of heating days. It is one of the procedures used for the design, evaluation and comparison of heat sources and appliances. The calculation is performed over a database of daily average outdoor air temperatures.[42/]

The total energy consumption in the monitored buildings owned by the Capital City of Prague is relatively stable and shows slight fluctuations caused mainly by the influence of heat consumption for heating. Compared to 2019, energy consumption decreased by 7 % in 2020, despite a comparable number of daily degrees. A lower number of monitored buildings may also have an impact (by 34).[43/]

Energy consumption data is available based on meter readings. This information is most often stated on invoices for energy consumed. This data is listed in the database for all public buildings registered.

In the case of the energy reference surface, the situation is more complicated. This data is available for a small sample of buildings that have processed PENB (Energy Performance Certificate), energy audit, etc. For this reason, the information will not be included in the indicator. However, this data will be further monitored and evaluated so that it can be included again in the calculation of the indicator in the future.

SOURCE: **39/** Information system PCC. | **40/** Information system PCC. | **41/** Ladislav Tintěra, "Day-grades – theory for computer aid", TZB-info, available at https://vytapeni.tzb-info.cz/teorie-a-schemata/2592-denostupne-teorie-k-vypocetni-pomucce, check on 17 June, 2021.
42/ For more information, see Ladislav Tintěra, "Day-grades – Theory of Computational Aid", TZB-info, 11 7. 2005. available from https://vytapeni.tzb-info.cz/teorie-a-schemata/2592-denostupne-teorie-k-vypocetni-pomucce, check on 5 June, 2021. | **43/** Information system PCC.

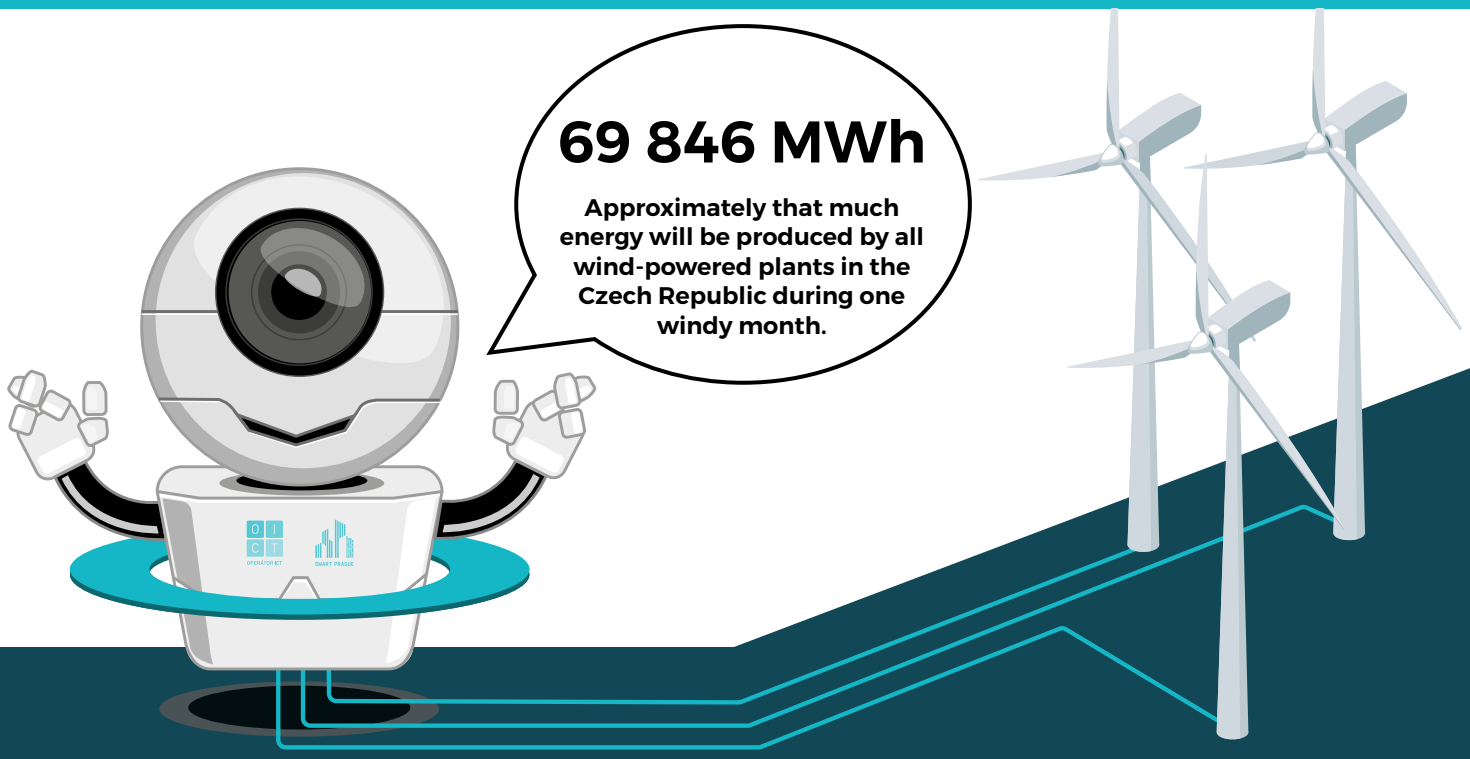
Consumption of Non-renewable Primary Energy in Public Buildings

In September 2020, a new decree no. 264/2020 Coll., on the energy performance of buildings. One of the significant changes is the adjustment of primary energy factors from non-renewable energy sources compared to the original Decree 78/2013 Coll. the factors of primary energy from non-renewable energy sources have been adjusted for most energy carriers. The most significant decrease occurred mainly in the field of electricity, when the factor decreased from 3.0 to 2.6. This decrease is due to a higher share of the use of renewable sources for the production of electricity (PV, biogas, etc.) and an increase in the efficiency of electricity production. The consumption of non-renewable primary energy is thus determined according to the currently valid factors of primary energy from non-renewable energy sources.

Non-renewable primary energy consumption in public buildings 1

		2017	2018	2019	2020
Resulting indicator value		**473,168.5**	**513,016.2**	**545,884.7**	**443,904.7**
Calculation		Total annual consumption of non-renewable primary energy [MWh] in public buildings after recalculation according to daily degrees			
Number of buildings owned by the City Hall		1,289	1,243	1,279	1,245
Electricity	Annual energy consumption in public buildings	76,620	70,274.6	79,029.5	69,846.4
	Annual consumption of non-renewable primary energy [MWh] in public buildings	229,861.1	210,823.9	237,088.6	181,600.5
Gas	Annual energy consumption [MWh] in public buildings	108,883.8	118,725.1	105,276.9	104,240.4
	Annual consumption of non-renewable primary energy [MWh] in public buildings	119,772.2	130,597.7	115,804.59	104,240.4
Heat	Annual energy consumption [MWh] in public buildings	80,005.6	83,051.7	96,145.0	85,927.98
	Annual consumption of non-renewable primary energy [MWh] in public buildings	80,005.6	83,051.7	96,145.0	77,335.2
Total consumption	Annual energy consumption [MWh] in public buildings	429,638.9	424,473.3	449,038.3	363,176.1
	Total annual consumption of non-renewable primary energy [MWh] in public buildings after recalculation according to daily degrees	473,168.5	513,016.2	545,884.7	443,904.7
Number of day degrees		2,939.3	2,678.4	2,662.8	2,648.4
Long-term average number of day degrees		3,237.1			

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.



The consumption of non-renewable primary energy is based on energy consumption. We will achieve it on the basis of knowledge of energy consumption of individual energy carriers and subsequent recalculation using primary energy factors. Previously, these values were based on Decree 78/2013 Coll., on the energy performance of buildings; since 2020, they are based on Decree no. 264/2020 Coll., on the energy performance of buildings. The differences in values are evident from the table below.

Non-renewable primary energy consumption in public buildings 2

FUEL / ENERGY	F [kWh / kWh] 2019	F [kWh / kWh] 2020
Natural gas, black coal, brown coal	1.1	1
Propane-butane, LPG, fuel oil	1.2	1.2
Electricity	3.0	2.6
Wooden pellets	0.2	0.2
Wood pieces, wood chips	0.1	0.1
Environmental energy (electricity, heat)	0.0	0
Electricity – supply outside the building	–3.0	–2.6
Heat – delivery outside the building	–1.0	–1.3
Thermal energy supply system with a share of RES > 80 %	0.1	–
Thermal energy supply system with a share of RES between 50 % and 80 %	0.3	–
Thermal energy supply system with a share of RES < 50 %	1.0	–
An efficient heat supply system with a share of more than 80 % of renewable sources	–	0.2
An efficient heat supply system with a share of more than 80 % of renewable sources	–	0.9
Other heat supply systems	–	1.3
Other unlisted energy carriers	1.2	1.2

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.

The data relate to consumption points registered in the information system of the Capital City of Prague.

Looking at energy consumption in a little more detail, there is a significant decrease of 12 % in electricity consumption compared to 2019. Reducing the consumption of buildings with regard to anti-coronavirus measures probably had an effect on reducing electricity consumption. Compared to 2019, natural gas consumption shows only a slight decrease of 1 %. Consumption of thermal energy from DH shows a decrease of 11 % compared to 2019. This is mainly a reduction in energy consumption for heating buildings. This may also be due to restrictions on the operation of facilities with regard to anti-coronavirus measures.[44/]

Due to the reduced energy consumption and the reduction of primary non-renewable energy factors, the consumption of primary non-renewable energy shows a significant decrease compared to 2019 for all forms of energy. Consumption of non-renewable primary electricity shows a decrease of 24 % compared to 2019. The conversion factor decreased from F = 3.0 to F = 2.6. Consumption of non-renewable primary energy from natural gas shows a decrease of 10 % due to a change in the conversion factor from F = 1.1 to F = 1.0. A conversion factor F = 0.9 was used to recalculate non-renewable primary energy from DH. Compared to previous years, the total consumption of non-renewable energy decreased by 20 %, which was also influenced by the change in the conversion factor.

The total value of the indicator decreased by 2019 compared to 20% due to reduced energy consumption, but also by adjusting the factors of primary non-renewable energy.

SOURCE: **44/** Information system PCC.

Carbon Footprint of Public Buildings

The indicator monitors the carbon footprint of public buildings according to their energy consumption.

	2017	2018	2019	2020
Resulting indicator value	**131,117.69 t**	**115,213.36 t**	**124,610.91 t**	**112,599.33 t**
Resulting indicator value recalculated according to the degree days	**144,402.095 t**	**139,246.257 t**	**151,486.399 t**	**137,628.487 t**
Calculation	CO_2 emissions in public buildings related to energy consumption			
Number of buildings owned by the Capital City of Prague for which statistics are calculated	1,289	1,243	1,279	1,245
Number of day degrees	2,939.3	2,678.4	2,662.8	2,648.4
Long-term average number of day degrees	3,237.100			
CO_2 emissions in public buildings related to energy consumption – energy carrier electricity	89,645.792 t	71,089.826 t	79,946.296 t	70,656.567 t
CO_2 emissions in public buildings related to energy consumption – energy carrier gas	21,776.782 t	23,678.549 t	20,996.425 t	20,789.697 t
CO_2 emissions in public buildings related to energy consumption – energy carrier thermal energy	19,695.117 t	20,444.988 t	23,668.191 t	21,153.063 t

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.

The data relate to consumption points registered in the information system of the Capital City of Prague. The carbon footprint is based on energy consumption. It is reached on the basis of knowledge of energy consumption of individual energy carriers and subsequent recalculation according to the following table based on Decree no. 309/2016 Coll., on energy audit and energy assessment.

Carbon footprint of public buildings

FUEL OR ENERGY		F [kg/GJ]
Solid fuels	black coal, sorted	92.4
	brown coal, sorted	99.1
	other solid fuel	94.1
	coke	107.0
	High-ash low quality black coal	94.1
Liquid fuels	heavy fuel oil (up to 1 % sulphur content) – low sulphur	77.4
	other liquid fuels	76.6
	TOEL	73.3
	Petrol (benznine)	69.2
	gas oil (up to 0.1 % sulphur content)	73.3
Gas fuels	natural gas	55.4
	coke oven gas	44.4
	Propane-butane	65.9
	blast furnace gas	240.6
	other gaseous fuel	54.7
Electricity	electricity	281
Biomass		0

SOURCE: Regulation 309/2016 Coll., available at https://www.psp.cz/sqw/sbirka.sqw?cz=309&r=2016.

The basis of the day-degree method is the knowledge of outdoor temperature profiles from meteorological data. The calculation of day-degrees is used to determine the characteristics of the heating period – the number of day-degrees and the number of heating days. The calculation is performed over a database of daily average outdoor air temperatures.

Long-term normal is considered for the station Prague – Karlov and the period 1961–1990.

Resulting indicator value decreased CO_2 emissions by about 12,000 tons due to reduced consumption, especially of electricity and heat, which was mainly affected by measures and restrictions caused by anti-coronavirus regulations.

Energy and Water Costs

The indicator monitors regular energy and water costs in public buildings registered in the Capital City of Prague information system.

	2017	2018	2019	2020
Resulting indicator value	**385,593.8**	**412,028.9**	**432,876.7**	**401,283.3**
Calculation	Total costs / Number of buildings			
Energy costs *	CZK 453,072,677	CZK 512,151,965	CZK 553,649,412	CZK 497,190,024
Water and sewage costs	N/A	N/A	CZK 124,712,449	CZK 116,702,872
Deduction costs	N/A	N/A	CZK 14,561,578	CZK 25,853,320
Number of buildings to which the data refers – from the Capital City of Prague information system	1,175	1,243	1,279	1,271

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP and VEZ. Cost forecasting is used for some buildings, as billing information is not yet available. This is usually due to a different billing period and will not be available until the finalisation of this publication.

Energy costs are based on the billing of energy consumption of public buildings. They therefore correspond to energy consumption according to the Energy Consumption in Public Buildings indicator (stated in MWh).

Compared to 2019, there was a decrease in total energy costs, which is due to lower energy consumption, especially electricity and heat. Overall, the availability of data needed to compile this indicator has improved.

Energy Performance Class of Public Buildings

This indicator can be determined on processed PENBs (Energy Performance Certificates) for buildings owned by the Capital City of Prague. These can be processed on the obligation under Act no. 406/2000 Coll., on energy management, to obtain a certificate for a building used by a public authority with an energy reference area:

- **greater than 500 m² (since July 1st 2013)**
- **greater than 250 m² (since July 1st 2015)**
- **or when constructing new buildings or performing-major alterations to completed buildings**

	2017	2018	2019	2020
Resulting indicator value	**5.32**	**5.32**	**4.26**	**4.26**
Calculation	Weighted average of energy performance classes of public buildings owned by the City of Prague			
The total number of public buildings owned by the City of Prague with the developed PENB (Energy Performance Certificate)	492	492	510	510

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.

The energy performance class is indicated A to G, where the designation A is given to extremely economical buildings and the designation G is given to extremely uneconomical buildings. To quantify the indicator, each energy class was assigned a numerical value, see the table below.

Energy performance class of public buildings 2

CLASSIFICATION CLASS	VERBAL EXPRESSION OF THE CLASSIFICATION CLASS	ASSIGNED NUMERIC VALUE	NUMBER OF BUILDINGS
A	Extremely economical	1	2
B	Very economical	2	24
C	Economical	3	117
D	Less economical	4	166
E	Uneconomical	5	127
F	Very uneconomical	6	45
G	Extremely uneconomical	7	29

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP. [45/]

Resulting indicator value 4.26 indicates an energy-obsolete building fund owned by the Capital City of Prague. For buildings owned by the Capital City of Prague, energy sources are gradually being replaced, the building envelope has been reconstructed and the PENB (Energy Performance Certificate) has been updated. For this reason, the indicator has and will have an improving trend.

Public Buildings with almost Zero Consumption

The indicator monitors the city's success in promoting the concept of energy-sustainable buildings.

	2017–2020
Resulting indicator value	**0**
Calculation	Total number of public buildings with almost zero consumption / Total number of public buildings
The total number of public buildings with almost zero consumption	0
The total number of public buildings owned by the Capital City of Prague	7,819

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.

A building with almost zero energy consumption is simply a building that has qualitatively stricter requirements for the building envelope. It has well-adjustable heating, ventilation and lighting. Its technical systems cover energy consumption with high efficiency and the building will be supplied partly from renewable energy sources, or it produces energy (electricity, heat).

This requirement applies to the construction of new buildings and is based on Directive 2010/31/EU of the European Parliament and of the Council on the energy performance of buildings. At the national level of the Czech Republic, the transposition of certain requirements of the European directive concerning the control and assessment of energy performance of buildings was carried out through legislation. This was an amendment to Act

SOURCE: **45/** „ČSN 73 0540-2 (730540) - Preview Standards", available at https://nahledy.normy.biz/n.php?i=89012, check on 17 June, 2021.

no. 406/2000 Coll., on energy management, as amended. Technically, these requirements are specified in the implementing decree 264/2020 Coll., which took effect in September 2020 and replaced the hitherto valid decree no. 78/2013 Coll.

The value of the indicator is also evaluated for existing buildings that would meet the requirements for new buildings, i.e., buildings with almost zero energy consumption. All buildings for which processed BEPC (Energy Performance Certificate) was available were evaluated.

Compliance with the energy performance requirements of a nearly zero energy building owned and used by a public authority is required for new buildings with a total energy reference area of:

- **greater than 1 500 m² since January 1st 2016**
- **greater than 350 m² since January 1st 2017**
- **less than 350 m² since January 1st 2018**

In 2020, the reconstruction of the Českobrodská Secondary School was started, which will significantly exceed the requirements for a building with almost zero consumption. The building will be energy active, producing more energy than it consumes. The reconstruction should be completed in 2021.

Public Buildings with a Green Building Certificate

Certification systems are used to assess and evaluate buildings in terms of sustainable construction. Many of these tools have already been developed in various countries around the world. Their importance is constantly increasing from an ecological and marketing point of view, as well as that of operating costs and life cycle costs in general. Certification creates a comprehensive assessment of the construction, which provides potential investors or tenants with an idea of possible operational savings and marketing benefits and thereby serving as a motivating factor. Certification is also a suitable tool for the public sector, which enables the fulfilment of efficiency requirements, not only for newly built buildings, but also for the existing ones.

In the Czech Republic, there are currently two certification systems that are the most widespread. One of them is the **LEED** (Leadership in Energy and Environmental Design) certification system, whose country of origin is the USA. In 2020, five buildings were assessed in Prague by this certification system.[46/] Another very popular certification method is **BREEAM** (British Research Establishment) originating from the Great Britain. In 2020, 28 buildings in Prague were evaluated using this method.[47/] It should be noted that these certification systems are used mainly by foreign investors building administrative buildings in Prague.[48/]

The Czech certification tool for expressing the level of quality of buildings is **SBToolCZ** (Sustainable Building Tool), in accordance with the principles of sustainable construction, i.e., considering a set of environmental, social and economic criteria. The certification system was created within the CIDEAS research centre. The SBToolCZ methodology is based on a multicriteria concept, where a set of different criteria is entered into the evaluation, which take into account the principles of sustainable construction. The range of criteria that enter into the evaluation process varies according to the type of building (residential buildings, office buildings, schools, etc.) and according to the life cycle phase that is assessed (building design quality evaluation phase, building quality evaluation phase). In 2020, no SBToolCZ certificate was issued.[49/]

Energy Monitoring

IThis monitors the level of supervision over the energy consumption of public buildings.

	2017	2018	2019	2020
The total number of public buildings with energy monitoring and intelligent control at a high level of automation	6	22	29	56
Total number of energy-active public buildings	N/A	N/A	0	0

SOURCE: OICT internal resources.

At present, there is no unified central register of buildings owned by the Capital City of Prague with operational energy monitoring. In the future, this information will be provided thanks to energy-focused pilot projects of the company Operátor ICT, a. s. (Plc.), especially the Comprehensive Energy Management project.

SOURCE: **46/** "Projects | US Green Building Council", available at https://www.usgbc.org/projects, check on 17 June, 2021.
47/ "GreenBook Live: Certified BREEAM Assessments', available at https://www.greenbooklive.com/search/scheme.jsp?id=202, check 17 6. 2021.
48/ "GreenBook Live: Certified BREEAM Assessments".
49/ Ing. Jiří Tencar, Ph.D., communication within the training of authorized persons, undated.

The basic prerequisite for the successful energy management implementation is the measurement of consumption and monitoring of key parameters. The goal of consumption measurement is to provide a comprehensive set of correct and objective data in the required level of detail. The measurement of key variables provides the necessary information for the subsequent implementation of energy management activities.

Categories:

0/ Manual meter readings

Energy management is not performed, readings are managed manually at predetermined intervals (e.g. day, month, year) and the data are not centrally available.

1/ Remote meter readings

Meter readings are performed automatically at predetermined intervals (e.g. 15 mins); the data are stored centrally, so can be evaluated. Secondary measurement is installed depending on the operation of the building. The return on energy-saving measures can be determined based on actual consumption. It is possible to detect the fault very quickly and thus prevent the occurrence of damage.

2/ Remote meter readings with energy consumption control

Remote readings are continuously evaluated and energy consumption is regulated. Control of the building operation is possible via the central control room. Advanced regulation means that operating costs are reduced.

3/ Smart building

Smart buildings are buildings with integrated management, i.e. with unified management systems (environmental technology, communication and energy technology), security (access control, fire protection and security system) and building management (planning, rental, leasing and inventory). Optimizing these components and the interrelationships between them creates a productive and cost-effective environment. A smart building helps the owner, manager and user achieve their own goals in terms of cost, environmental comfort, safety, long-term flexibility and saleability.

There have been 27 buildings with implemented energy monitoring systems added compared to 2019.[50/] We can, therefore, assume that the way energies are used in these buildings is now monitored and that appropriate measures resulting in savings will be taken.

No energy-active building with intelligent control at a high level of automation has been registered yet, however, in 2020, the reconstruction of the Českobrodská Secondary School was started. This building should reach the parameters of an energetically active building.

The Degree of Digitization of the Electrical Distribution System

This indicator is focused on monitoring the degree of readiness of the Prague electricity distribution network (PREdi) for the use of services related to the smart grids possibilities.

	2017	2018	2019	2020
Resulting indicator value	**< 0.01**	**< 0.01**	**< 0.02**	**< 0.02**
Calculation	Number of smart meters / Total number of all meters within the PREdi distribution network			
Number of smart meters	< 1 %	< 1 %	< 2 %	< 2 %
The total number of all meters within the PREdi distribution network	791,000	791,000	810,000	817,000

SOURCE: Internal communication with PREdi.

The total number of meters on the distribution network means the number of consumption points. A smart meter is one that has at least a remote reading function.

The indicator monitors the degree of basic assumption for the function of services related to the possibilities of smart grids.

In general, energy distribution companies are spending more and more on the installation of smart meters, which has already been reflected in the increased value of this indicator.

SOURCE: **50/** Implemented Smart Prague projects, see Matěj Nejedlý, "Smart Prague", ICT Operator, available at https://operatorict.cz/smart-prague/, check on 17 June, 2021.

Digitization Rate of Distribution Systems

This indicator expands the previous category to capture the degree of digitization of all distribution networks in Prague.

	2017	2018	2019	2020
Resulting indicator value	**1.1 %**	**1.2 %**	**1.6 %**	**1.8 %**
Calculation	% of smart meters within the distribution network PREdi, Prague Gas Distribution, PVK			
Number of smart meters	**14,621**	**15,853**	**21,215**	**24,668**
Number of smart meters, PREdistribuce a. s.*	7,000	7,000	10,000	11,000
Number of smart meters Pražská plynárenská, a. s. (Ltd.)	2,120	2,150	2,971	3,290
Number of smart PVK meters, a. s. (Ltd.)	5,501	6,703	8,244	10,378
Total number of meters	**1,327,958**	**1,326,935**	**1,345,221**	**1,352,453**
Total number of distribution meters, PREdistribuce a. s. (Ltd.) *	791,000	791,000	810,000	817,000
Total number of meters Pražská plynárenská, a. s. (Ltd.)	424,742	423,215	421,373	421,086
Total number of PVK meters, a. s. (Ltd.)	112,216	112,720	113,848	114,367

SOURCE: Internal communication with PREdi, a. s.(Ltd.), Pražská plynárenská, a. s.(Ltd.), and PVK, a. s.(Ltd.) | * Approximate values.

In 2020, the number of smart meters at Pražská plynárenská, a. s. (Plc.), recorded an increase, which concerns the category Medium consumption, but especially the category Small consumption, where several projects were implemented.

The total number of meters at Pražská plynárenská, a. s. (Plc.), recorded a decrease, which mainly concerns customers in the Household category, most often customers who disposed of their gas stoves and do not have another gas appliance at home.

The share of water-meters with remote reading of the counter status is increasing every year. In 2020, the total number of water meters with remote reading was 10,378 pieces of water-meters, which is by 20.6% more than in the previous year.

The total number of meters in the distribution network means the number of consumption points. A smart-meter is one that has at least a remote reading function.

This indicator monitors the level of the basic assumption for the function of services related to the smart grid possibilities, this indicator recorded an increase due to the increase in the total number of smart-meters in all of the distribution companies. In the future, the installation of smart meters cannot be expected for all customer categories, so we do not expect the indicator to reach 100 %.

Water Consumption

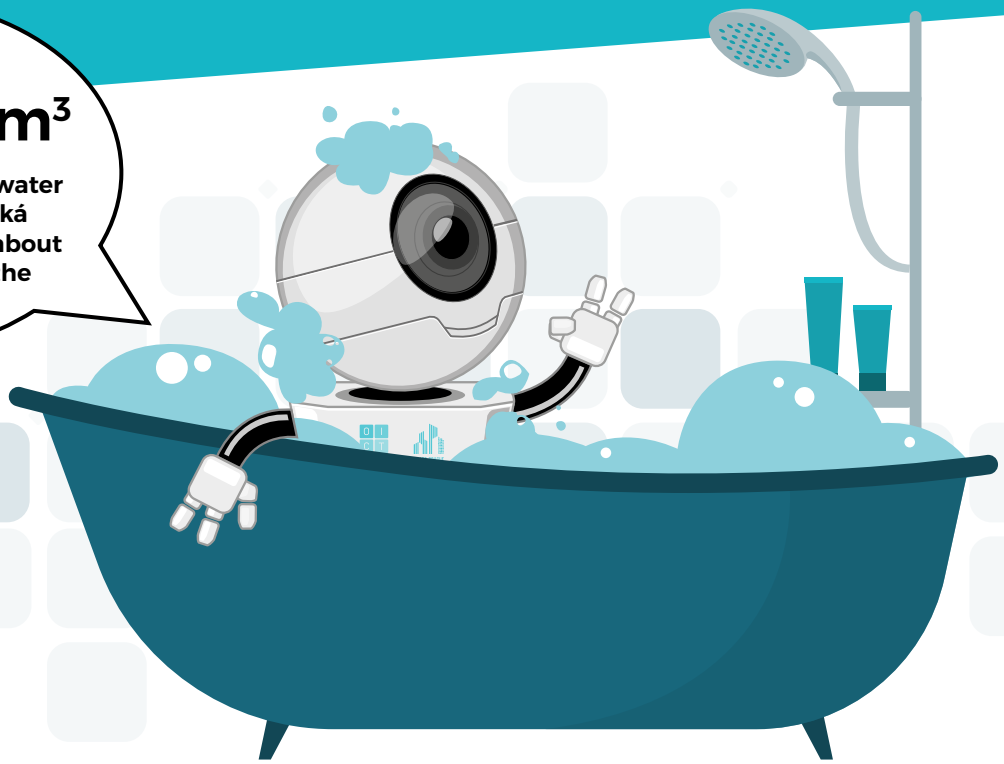
This indicator monitors the average water consumption per inhabitant of Prague per year. This is the total quantity of water supplied to the water mains network. It is consumed not only trough domestic water mains, but also for technological activities within the city administration – road cleaning, irrigation, etc. The indicator forms the basis for evaluating the impact of measures to reduce drinking water consumption (recycling, use of rainwater).

	2017	2018	2019	2020
Resulting indicator value	**75,8 m³**	**74,7 m³**	**73,4 m³**	**68,3 m³**
Calculation	Quantity of water supplied to the mains in the territory of the Capital City of Prague / Number of inhabitants of the Capital City of Prague			
Quantity of water supplied to the mains in the territory of the Capital City of Prague	98,097,594 m³	97,746,193 m³	97,190,076 m³	91,238,775 m³
Population of Prague *	1,294,513	1,308,632	1,324,277	1,335,084

SOURCE: Internal communication with PVK, a. s. (Ltd.) | * CZSO, data always as of December 31st of the given year.

91 238 775 m³

This is a larger volume of water than in the Novomlýnská water reservoir, which is about fifty times larger than the Hostivař reservoir.



The quantity of water supplied to the mains in the Capital City of Prague includes drinking water and industrial water. The data shows the total quantity of water supplied to the mains together with technical losses – failures, leaks, etc.

In 2020, PVK supplied the water supply network by 91,239,000 m3 of water, which is by 6.1 % less than in the previous year. The reduction in drinking water consumption affected the cessation of tourism, the closure of hotels, restaurants, shops and service establishments.

A large part of the employees of closed companies used the home office or took care of children and thus reduced commuting to work in Prague. All types of schools, museums, exhibitions, accommodation facilities, university dormitories and more were closed.

4.3.2 Smart Lighting

The modernization of Prague lighting into smart lighting, which, for example, can adjust its intensity according to the movement of people, allows remote maintenance, will be at least partially powered by its own energy source and will use sensory measurements (air pollution, parking spaces, people and transport flow) remains a major task of the Capital City of Prague and one on which it is intensively working.

Smart Lighting

This indicator is focused on capturing the degree of modernization of public lighting..

	2017	2018	2019	2020
Resulting indicator value	**44,666**	**1,318**	**1,012**	**250**
Calculation	(Total number of all street lamps – Number of smart lamps) / Number of smart lamps			
Total number of smart lamps	3	103	134	549
Number of OICT smart lamps	0	92	92	0
Number of PRE smart lamps	3	11	11	12
Number of THMP smart lamps	0	0	31	537
Total number of all street lighting lamps	134,000 *	135,868	135,690	138005

SOURCE: Data provided on the number of smart public lighting lamps and the number of public lighting lamps in the territory of the Capital City of Prague based on internal communication with THMP. | * approximate values.

Following the OICT pilot project (installation of smart lighting in Karlín), the renewal of the public lighting infrastructure (specifically public lighting poles, power cables and switching points) was also implemented and completed in 2020 through THMP. This is the part that starts in the area of Karlínské náměstí, extends to Sokolovská and Křižíkova Streets and from the square to the Křižíkova metro station where smart lighting with remote control technologies were pilot-tested in 2018–2019. The lamps were installed on 92 existing public lighting poles. The aim of the project was to test a network of smart lamps that will enable automatic regulation of lighting intensity and thus reduce electricity consumption. After the completion of the pilot project, the lighting was taken over by the THMP at the beginning of 2020.

THMP thus continues the trend of restoring the original public lighting columns and is implementing several pilot projects. Dynamically controlled public lighting is being tested in a number of Prague parks. The original existing sodium lighting is being replaced by more economical LED luminaires with a communication interface and control. This technology will make it possible to test the night dimming of public lighting. Some pilot projects also include fully dynamic lighting, which in its intensity responds, for example, to the movement in the park. Specific localities, in which these technologies are tested are the Ladronka, Fidlovačka, Jezerka, Riegrovy sady, Bezručovy sady and Chotkovy sady parks.

Smart lighting from PRE uses two types of lights – SMIGHT Base Station and SMIGHT Base Slim. The lamps are equipped with LED lighting, have a Wi-Fi hotspot, SOS communicator connected to an integrated rescue system, noise, temperature, dust and humidity sensors and an information display. The charging station for electric cars is built into 7 of the total number of 11 smart lamps.

4.3.3 Smart Independent Local Networks

Ensuring partial or full independence of Prague's critical infrastructure (e.g., hospitals, water treatment, public lighting), using smart grids, which have their own intelligent production, storage and management of electricity consumption, are among the strategic security issues facing the Capital City of Prague.

Microgrids

The indicator monitors the rate of expansion of energy microgrids in the Capital City of Prague.

	2017–2020
Resulting indicator value	**0**
Calculation	Number of energy-microgrids in the Capital City of Prague

SOURCE: OICT internal resources.

Microgrids are versions of a centralized electrical system that locally generate, distribute and regulate the flow of electricity to consumers. They are an ideal way to integrate renewable energy sources.

This indicator monitors the expansion of energy microgrids in the Capital City of Prague. In 2020, the City District of Prague 3 prepared project documentation for a project aimed at creating a Smart Grid in the Pražačka Sports and Recreation Complex.

In addition to the implementation of projects in the field of Smart Independent Local Networks, a complete reconstruction of the distribution network under the management of PREdistribuce, a. s. (Ltd.) PREdistribuce, a. s. (Ltd.), in 2020, it successfully put into operation already 100th so called smart station. Smart stations are taking a step further increasing the reliability and quality of electricity supply in the Capital City of Prague. Use of renewable resources and other technologies also play an important role in the development of electromobility.

Decentralized Solar Electricity Generation

This monitors the installed capacity in the Capital City of Prague in terms of the supply of renewable solar electricity.

	2017	2018		2019		2020	
Resulting indicator value	**22,927 MW**	**22,823 MW**		**22,388 MW**		**23,39 MW**	
Calculation	Installed solar power plant capacity in the Capital City of Prague [MW]						
Number of electricity sources installed in the Capital City of Prague	1,223	1,242		1,481		1,724	
Average installed solar power	0.019 MW	0.018 MW		0.015 MW		0.014 MW	
Total power and number of other electricity micro-sources	N/A	23.040 MW	32 sources	23.129 MW	12 sources	23.129 MW	12 sources
Landfill Gas	N/A	5.552 MW	7 sources	5.650 MW	2 sources	5.650 MW	2 sources
Sludge gas	N/A	5.402 MW	5 sources	5.402 MW	1 source	5.402 MW	1 source
Hydropower	N/A	12.084 MW	19 sources	12.075 MW	8 sources	12.075 MW	8 sources
Wind energy	N/A	0.002 MW	1 source	0.002 MW	1 source	0.002 MW	1 source

SOURCE: Internal communication with the Energy Regulatory Office and PREdi, a. s. (Ltd.).

Only licenses where electricity production takes place directly in the Capital City of Prague were considered.

An average value of 0.014 MW of installed capacity per license granted indicates significant decentralization. Due to the nature of the matter, there are a large number of private solar cells on the roofs of houses.

In 2020, a number of subsidy titles were prepared, which aim to support the development of renewable energy sources in the Czech Republic. It can be assumed that a significant number of projects that will be implemented in the future in the Capital City of Prague will also be registered for these subsidy titles.

4.3.4 Other Relevant Information

Unplanned Outages

Reliability of water supply expressed by the number of water outages in terms of the length of the water supply network.

	2017	2018	2019	2020
Resulting indicator value	**1.4012**	**1.4716**	**1.4186**	**1.2319**
Calculation	Number of faults on the water mains network / Length of water mains network [km]			
Length of water mains network [km]	3,539	3,539	3,545	3,549
Number of faults on the water supply network	4,959	5,208	5,029	4,372

SOURCE: Internal communication with PVK, a. s.(Ltd.).

The indicator expresses the reliability of water supply – per one kilometre of the water supply network, there is an average of 1.2319 faults in 2020. The most common cause of faults was corrosion of the material, namely in 73.8 % of cases, and 20.1 % fell on the movement of soil, e.g. due to frost. These two reasons were the cause in more than 94 % of cases. The cause of the remaining less than 6 % of f was outer faults, material defects and more.

Heat Consumption from DH

DH is an abbreviation for heat supply system, sometimes also referred to as district heating or district heating network.

	2017	2018	2019	2020
Resulting indicator value	**80,005.61**	**83,051.74**	**96,145.05**	**85,927.98**
Number of objects connected to DH	196	163	195	200
Calculation	Heat consumption from DH in public buildings [GWh / year]			

SOURCE: Internal communication with the Department of Sustainable Energy of the OCP MHMP.

DH is an opportunity to efficiently supply heat to large agglomerations. This method of heating is often used not only in the Czech Republic, but it is also largely widespread in developed western countries that have comparable climatic conditions, whether it is neighbouring Austria, Germany, Denmark or Finland. DH reduces energy consumption and its price, it is more environmentally friendly and improves living conditions in cities. By being a large central source, it is possible to use cogeneration, i.e. the production of electricity and heat, and thus significantly increase the efficiency of these sources. These central sources can burn not only natural gas and coal but also waste, and thus contribute to reducing the environmental burden of landfilling, which will no longer be possible from 2024.

It is appropriate to monitor the consumption of heat from DH not only in the total sum, but according to individual sources / heating plants, so that it is possible to determine the emissions of pollutants. Based on this, it is possible to assess the environmental benefit in the case of cost-saving measures on buildings owned by the Capital City of Prague or possible disconnection from DH and replacement of the source. Each heating plant uses a different energy carrier or energy carrier ratio.

The advantages of DH can be considered high efficiency, the absence of local emissions of pollutants and maintenance-free operation.

The main disadvantages are the high cost of heat and the need to periodically shutdown the heat supply.

In 2020, there was a decrease in the consumption of thermal energy supplied by the thermal energy supply system in public buildings. This decrease was probably caused by the reduction of traffic, e.g., schools, etc. with regard to anti-coronavirus measures.

Use of Grey Water for Energy Needs – Public Sector

Gray water is wastewater that does not contain faeces and urine. It is water mainly from showers, bathtubs and washbasins. Exceptionally, it is water from the kitchen, laundry or technological processes, the use of which is conditional.

Gray water can be used in several ways. The basic one is the use of grey water after cleaning and reuse, for example, for flushing toilets. Another way of using grey water is to use the energy of the draining grey water to preheat the water entering the heat management system.

The table below shows how much water was preheated by the energy taken from the grey water. These systems are in their infancy in public buildings and over time these implementations will expand. In 2020, the reconstruction of the Českobrodská Secondary School was started. Among other energy-saving solutions, the use of grey water is also planned in this building.

Use of Grey Water for Energy Needs – Public Sector

	2017	2018	2019	2020
Resulting indicator value	**0**	**0**	**0**	**0.8 %**
Calculation	Amount of water preheated by grey water energy / Total water consumption in public sector buildings			
Amount of water preheated by energy from grey water	N/A	N/A	N/A	8,712
Total water consumption in public sector buildings (domestic hot water and cold water)	1,506,823.820 m³	1,187,699.670 m³	1,385,154.701 m³	1,141,642.5 m³

SOURCE: Capital City of Prague Information System.

DETAILED INFORMATION ON THE ENERGY PERFORMANCE OF BUILDINGS, THEIR CONSUMPTION AND THE FULFILMENT OF THE CLIMATE OBLIGATION CAN BE FOUND HERE:

4.4 ATTRACTIVE TOURISM

Prague is an important tourist destination and the number of tourists has increased year-on-year in recent years.[51/] Prague has become one of the most visited cities in the world. In recent years, a higher number of tourists have come to Prague than, for example, to Venice, and the relative total number of foreign visitors a year corresponds to about five times the population of the capital. Compared to previous years, the year 2020 was specific to major changes in the field of tourism. Many foreign visitors stayed in their countries of origin due to travel restrictions due to COVID-19. Significant restrictions were thus reflected in the number of arriving tourists. In the prestigious comparative rating of Travellers' Choice by the travel server TripAdvisor. In the year 2020, Prague was still ranked amontg the 14th of the most popular destinations in Europe.[52/]

Due to the restrictions associated with the COVID-19 pandemic, Prague welcomed only 2.2 million tourists in 2020 and its attendance fell by 73 % compared to 2019 when it welcomed almost 8 million tourists. Guests overnight stays counted upto 4.9 million. In 2020, a total of 1,446,945 foreign guests came to Prague, i.e., by 78.6 % less than in 2019. Approximately 731,300 domestic visitors came, i.e., by 41 % less than in the previous year. In total, guests overnight stays reached upto about 4.9 million in Prague, i.e., by 73. 5% less than in 2019. The average overnight stay remains approximately the same in the long run – around 2.2 nights. However, only the number of guests staying in an accommodation facility providing more than 5 rooms or 10 beds is included in the official statistics. It follows from the very definition of collective accommodation establishments that the statistics do not include guests staying in other types of official and unofficial accommodation. This applies, for example, to various individual accommodation facilities, Airbnb and, of course, accommodation in free accommodation (such as staying with friends and relatives). According to qualified estimates, the number of tourists in Prague could be twice as high).[53/]

Despite the unfavourable situation in 2020 it is expected that tourism will return to normal in the future, and therefore it needs to be further developed in a coordinated manner using innovative technologies and based on the reliable data on the movement and preferences of visitors to Prague. The load of the main tourist sites must also be sensitively regulated so that the number of visitors is tolerable not only from the point of view of the protection of monuments and local inhabitants, but also from the point of view of the visitors themselves. Guiding visitors to equally attractive but lesser-known parts of the wider centre of Prague can be one way to lighten the most visited locations, such as the Prague Castle, Charles Bridge or the Old Town Square. To support this activity, in 2017 a Prague mobile tourist application called the Prague Visitor Guide was created. The application, which almost four-year operation was terminated in November 2020, will be replaced by the Prague Visitor Pass product in accordance with long-term plans (the so-called tourist card) in parallel with the return of the usual tourist intensity in 2021. One of the main medium-term goals is the pilot operation of this new attractive tourist card, which will, among other things, be connected to the mobile application and linked to other city services, including public transport. Geographic data, data from social networks (Twitter, Facebook, etc.), statistical information from the use of credit cards or advanced video analysis systems have a huge but not yet widely used potential in the development of tourism and urban tourism. All this information, after their correct evaluation, can theoretically be used for more active management of tourism and ensuring greater comfort for residents and visitors. Currently, Prague does not make greater use of the possibilities of modern technologies in the automated collection

SOURCE: **51/** Tourism – Region CZSO in Prague Capital City (czso.cz), check on 26 June 2021.
52/ https://www.tripadvisor.cz/TravelersChoice-Destinations-cPopular-g4 | **53/** Pavel Vašek, "The Airbnb Phenomenon and Its Economic and Social Impacts" (Diploma Thesis, 2020), https://insis.vse.cz/zp/72814, check on 3 June, 2020.

of aggregated data and to enrich the tourist experience. Augmented reality during sightseeing tours or the involvement of robots equipped with artificial intelligence should become a natural part of controlled, friendly, safe and fun tourism in Prague in the foreseeable future.

Another initiative for the development of tourism in the capital city is the preparation of the Inbound Tourism Concept, which was created in cooperation with Prague City Tourism and the Institute of Planning and Development of the Capital City if Prague and the city management. The concept deals with the plan of how to cultivate tourism and reflect the needs of the city and its inhabitants. The concept responds to the long-term congestion of the centre and its focus mainly on tourists. The main task is to create an environment for the development of tourism within the sustainable development of the city.

The concept was approved by Prague representatives in October 2020. This will be implemented through an action plan prepared annually by the marketing agency Prague City Tourism. Currently, these are activities associated with the development of new tourist routes that lead outside the city centre, and are preparing tools called smart tourism, i.e., an application that will bring data on tourist preferences, thanks to which it will be possible to set other related services. Related to this is the challenge for the metropolis to become a barrier-free city. Prague City Tourism is also working on a sign of sustainable tourism or greening the city's supply.

Thematic areas include:

- Big data in Tourism
- Mobile-based Tourism
- Advanced Technologies for Tourism

4.4.1 Big Data in Tourism

The aim of the Smart Prague 2030 concept is to ensure the automatic collection of aggregated data that will serve to evaluate the activities, preferences and experiences of visitors to Prague. It will also help to identify less visited places and their subsequent promotion so that tourists have the opportunity to discover all the interesting and accessible places. In addition, this will create space for the decentralization of tourists and their movement outside the main monuments in the centre of Prague.

The Usage of Big Data in Tourism

This indicator expresses the level of collection and analysis of available data for the controlled development of tourism in Prague. Mobile network administrators and operators have information on the approximate location, quantity and country of origin of SIM cards in switched-on mobile devices at a given time. This information exists due to the standard communication of the mobile phone with the BTS base stations and the location is derived on the basis of the signal delay in its path between the mobile phone and the base station and / or by means of triangulation.[54/] In combination with other Big data sources, such as GPS data, payment card usage data, accommodation statistics, etc., is a valuable basis for obtaining an overview of the concentration and other socio-economic characteristics of residents or visitors in specific locations. They can be successfully used in the planning and management of tourism-related activities in bulk. In connection with related information such as the results of analysis of the sentiment of users of social networks, it is possible to evaluate the satisfaction of visitors with the services in a given place and possibly their preferences.[55/] In this way, it is possible to target the promotion of the Capital City of Prague according to specific groups of visitors, plan the development of tourism, including related infrastructure and improve the quality of tourist services.

	2017	2018	2019	2020
Resulting indicator value	**1**	**1**	**1**	**2**
Calculation	Number of actively used types of data sources for controlled development of tourism			
Social networks and the web (e.g. Google Analytics)	Yes	Yes	Yes	Yes
Geographic data (e.g. mobile network)	No	No	No	No
Sentiment from social networks	No	No	No	No
Data from payment cards	No	No	No	Yes

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), Operátor OICT.

At present, the Capital City of Prague uses Google Analytics when monitoring data in the field of tourism on the official website for tourists (especially https://www.prague.eu/en). With social networks, it actively communicates with tourists through an employee in charge. Among other things, Prague City Tourism is testing new work with statistical data from payment card providers as part of pilot projects.

SOURCE: **54/** Method of determining the position by a combination of coordinates and distances.
55/ Natural language processing at the level of subjective expressions, which are usually unstructured. The basis is automated analysis based on machine learning.

Occupancy of Tourist Sites

This indicator is based on the Smart Prague 2030, concept, which sets the goal of evenly spreading tourism throughout Prague, relieving extremely exposed localities and raising awareness of tourist attractions outside the narrowest centre of Prague. This indicator is not currently quantified as a relevant database on the number of visitors to an area is not yet available. In the future, the use of Big Data analyses, tourist cards and tourist apps are anticipated.

Fulfilment of the indicator is also anticipated in connection with the launch of the Prague Visitor Pass tourist card, which will undergo its pilot operation with the return of tourists to the capital. After the transition to full operation, it will allow entry to about 80 tourist-important localities (assuming that the number of sites will further increase). For lesser-known and lesser-visited sites, it will be desirable in this respect to increase traffic by appropriate measures, especially marketing measures.

	2017–2020
Resulting indicator value	**N/A**
Calculation	Number of visitors to lesser-known areas / Number of visitors to all monitored tourist destinations

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT.

Tourist Heatmapping

This indicator captures the number of created tourist-oriented heatmaps. Heatmap is a graphical representation of a variable in the form of a range of colours, geographically linked to a specific point. The purpose of these maps in tourism is to obtain clear and easy-to-read information about which localities are of the greatest interest or, conversely, which places are less visited.

	2017–2020
Resulting indicator value	**0**
Calculation	Number of created tourist-focused heatmaps

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT. This indicator will be used in connection with the launch of the Prague Visitor Pass tourist card, which is currently being postponed due to the current situation associated with the COVID-19 pandemic.

Tourist Feedback

This indicator focuses on the number of interactions with visitors to Prague through individual communication channels and monitors the quantity of directly received and indirectly identified feedbacks. Feedback from visitors to the city provides information on the strengths and weaknesses of the organization of tourism in the capital and also provides incentives for further development of the services offered.

	2017	2018	2019	2020
Calculation	Number of interactions by a given information channel			
Number of interactions in information centres	**1,233,364**	**1,633,623**	**2,043,093**	**438,117**
Facebook	**600**	**750**	**850**	**430**
E-mail	**511**	**1,975**	**1,860**	**853**

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.).

The data provided show that Prague City Tourism, a. s. (Plc.), monitors feedback from visitors to Prague and records interactions at Prague information centres, from records on social networks and from e-mail communication. As regards social media, it may be indicating greater interest in visiting the city, but the growing interest in social media as such also needs to be taken into account.

In the future, it will be possible to monitor interactions also through the tourist app. This should be an evaluation of tourist sites integrated into the app within the development of the Prague Visitor Pass tourist card.

4.4.2 Mobile-based Tourism

In recent years, the Prague Visitor Guide app has been available for tourists for better orientation in Prague, which will be replaced by the Prague Visitor Pass app, a multi-purpose tourist card under which the capital intends to provide comprehensive tourist services in Prague. The tourist card will have a physical and electronic form and a mobile app will be connected to it. All this while covering a large number of services, including public transport. It will be available in several categories (children, students, and adults) and several time zones (two, three or five days).

The card underwent a test run in 2020 and its launch was planned for the turn of the year 2020/2021. Due to the current situation, the start of the pilot operation was postponed.

In accordance with the Smart Prague 2030 concept, a tourist mobile app in several language versions is gradually being developed within this thematic area. The basic functions facilitate the visitor's orientation around the city, including the display of interesting places and recommendations for activities in the city according to the preferences of the mobile app.

Geolocation Games

The aim of the development of this area is to make the tour of Prague's monuments more attractive to visitors in an entertaining way and also to draw attention to interesting Prague locations outside the main tourist routes. Geolocation games are based on popular geocaching, a game on the border between sport and tourism, in which tourists search for hidden boxes or collect points using geographical coordinates. In combination with a smartphone, mobile data connection and location data, this can also be used for comfortable, interesting and fun way to plan tourist tours and trips around Prague and its surroundings. The routes are usually chosen so that the visitor is guided through attractive but less well-known to tourists.

	2017	2018	2019	2020
Resulting indicator value	**2**	**41**	**10**	**47**
Calculation	Number of available geolocation games			

SOURCE: OICT internal resources.

The GeoFun geolocation game with 20 routes, the Hidden Stories game with 26 routes and the game called With Technicians Round and Round with a route focused on interesting places in Prague 6 are currently available in Prague. Companies also offer private or corporate games with individual settings. The principle of the game is not only to find a place, but also to perform the tasks that players are waiting for after reaching the place.

4.4.3 Advanced Technologies for Tourism

The goal of the Smart Prague 2030 concept is to incorporate 3D virtual or augmented reality. Tourists will be able to experience Prague's sights in a completely new way. New technologies could increase the interest of tourists and at the same time revive less visited sites. An integral part should be the involvement of artificial intelligence, e.g., through guide robots to tourism as a fun interactive form of city tours.

Augmented Reality

Augmented reality, unlike virtual reality, combines images and possibly sounds from the real world with virtual data or objects. Hence the name. The user moves in a real environment and can see objects around him, supplemented by specific added visual information that relates to them.

Virtual and augmented reality technologies are gradually shifting from the areas of military and industrial use to everyday life. Nevertheless, their mass mobile use can be expected only with the impending development of 5G networks and the improvement and price reduction of wearable HW (such as glasses for virtual and augmented reality). Subsequently, it will be possible to expect a more significant increase in the number of their tourism-related apps.

	2017	2018	2019	2020
Resulting indicator value	**0**	**1**	**0**	**0**
Calculation	Number of tourist sites using augmented reality			

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT.

Artificial Intelligence

Artificial intelligence and machine learning technologies using big data will allow us to understand the patterns and trends that have so far eluded us in the field of tourism in Prague. Another area of application of these tools is communication via chatbots. They learn from previous conversations and can either effectively answer the most common questions from tourists or redirect them to the human operator.

	2017–2020
Resulting indicator value	**0**
Calculation	Number of tourist sites using elements of artificial intelligence

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT.

The provided data and market research indicate that no artificial intelligence elements are being used for tourism in Prague.

Ideas for tourism apps using artificial intelligence are slowly emerging. With the help of a certain level of ambient or artificial intelligence, it would theoretically be possible to guide the visitor through the monument zone and monuments themselves with the commentary system adapting to the behaviour of its user. For example, if a visitor stops at a monument for a longer time, the application could offer him even more information about the monument or the locality. Furthermore, it would theoretically be possible to distinguish, for example, a school child from an adult, or even an expert in the field, and thus adapt the commentary accordingly.

Guide – Robot

Generally speaking, a robot is a machine with a degree of independence that performs specified tasks. The degree of independence is given by the implemented level of artificial intelligence and the range of data obtained from the sensors with which the robot is equipped. In general, robots should primarily replace constant, repetitive and tedious human activities. When using robots as guides, in addition to providing routine interpretation and interactive provision of basic information, the functions such as collecting data from sensors, providing online environmental and safety information, and automatically calling for human assistance or help are added. The fun factor and general interest in modern technology can also play important roles in the case of tourism.

	2017	2018	2019	2020
Resulting indicator value	**0**	**2**	**2**	**2**
Calculation	Number of active guide robots			

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT.

The Audioguide (voice robot-guide) was launched in the Prague Visitor Guide app in the second half of 2018. This was an audio guide on the historic line of tram number 23 in both directions.

Prague City Tourism also works with the Smart Guide app, which already offers private audio guides with the potential for machine learning and customization. The content of routes outside the centre is supplied to this app by PCT.

Innovative Tourist Locations

This indicator is not quantified. Based on the findings so far, the indicator will need to be adjusted in the future in connection with activities and implementation of projects focused on innovation in tourism. It is not realistic to obtain the number of all tourist sites and what they offer if they are operated privately.

Sensor Counting of Visits

Sensor counters can automatically detect the presence of a person using a variety of technologies. We can use these systems to add and subtract arrivals and departures to determine the number of people in an area.

	2017–2019	2020
Resulting indicator value	**0**	**5**
Calculation	Number of locations using sensors to count visitors	

SOURCE: Internal communication with Prague City Tourism, a. s. (Plc.), OICT.

With regard to the occupancy of specific monuments or objects in distinguishing arrivals and departures, advanced sensory technology has not yet been implemented. However, with the intention of identifying the intensities of pedestrians (and therefore visitors), a pilot project was implemented in 2020 aimed at comparing the technologies of counting sensors. The pilot project Intensity of Pedestrian Traffic in Public Space aims to monitor the intensity of pedestrian traffic, especially concerning the concentration of crowds in a public space, and in this respect partially deviates from the intention to count visits (inputs). However, due to the thematic similarity, it was included in the indicator. A total of three technologies were pilot-tested at five exposed locations (i.e. open spaces). Among the pilot sites are e.g. Charles Bridge (Old Town Bridge Tower), Rytířská Street (Můstek), Prague Exhibition Grounds (U Viaduktu), Stromovka (entrance from the Exhibition Grounds) and Rašínovo nábřeží (by the railway bridge), for which continuous statistical data collection is still expected.

The indicator will be adjusted in the future and used to display the number of locations where the visitor counting will be operated based on information from cash register systems in connection with the use of the Prague Visitor Pass tourist card.

According to PCT information, visitor statistics are currently calculated using the entrance fees obtained. Currently, therefore, Prague does not have monuments or tourist sites equipped for automatic sensor counting and data collection on the number of visitors.

Tourist Card – Indicator I (Number)

The tourist card serves as a means to offer tourists various discounts on admission to monuments, cultural facilities, sports grounds, relaxation and entertainment facilities or other tourist attractions and provides discounts on transport fares, accommodation or meals. Tourist cards can differ in many parameters, such as territorial with time validity, transferability to other persons, technology used (paper cards, plastic barcode cards, mobile apps), prices and method of distribution. The Prague Card (with the Prague Cool Pass app) and Prague City Pass are currently operated in Prague by private companies. A tourist card operated by Operátor ICT, a. s. (Plc.) called Prague Visitor Pass is now being prepared.

Market research for the Prague Visitor Pass project revealed a qualified estimate of a potential of approximately 50,000 cards sold annually, with a year-on-year increase of approximately 1,000. This is a probable estimate for the Prague Visitor Pass, which should also be met thanks to the advantages of the product combining discounts on admissions and public transport.

Tourist Card – Indicator I (Number)

	2017–2019	2020
Resulting indicator value *	**50,000–52,000**	**53,000**
Calculation	Number of tourist cards sold / year	
Number of PVP cards sold – 48 h	N/A	0
Number of PVP cards sold – 72 h	N/A	0
Number of PVP cards sold – 120 h	N/A	0

SOURCE: The exact data are not known - these are qualified estimates of Prague City Tourism, a. s. (Plc.)
* Approximate data, the tourist card service is privately operated.

Real data, including a breakdown by card type (2, 3 and 5 days) will be known after the launch of the Prague Visitor Pass. The shares of 2-, 3- and 5-day cards will be evaluated to determine the number of cards used.

Tourist Card – Indicator II (Type)

	2017–2019	2020
Resulting indicator value	**N/A**	**0**
Calculation	Number of discounted cards sold / Total number of tourist cards sold in a given year	
Number of adult PVP cards sold	N/A	0
Number of child PVP cards sold	N/A	0
Number of students PVP cards sold	N/A	0

SOURCE: OICT internal resources.

Currently available products are privately operated, so the exact data are not known. Related to Prague Visitor Pass: 2-, 3- and 5-day cards are planned. The exact sales figures will be known once the project is launched. The shares of the individual types of cards (standard and discounted) will be evaluated to determine the type of card used.

Tourist Card – Indicator III (Days)

	2017–2019	2020
Resulting indicator value	**N/A**	**0**
Calculation	Number of days sold by tourist card / year	

SOURCE: The tourist card service is privately operated. Precise data are not available.

Currently available products are privately operated, so the exact data are not known. The data concerning the total number of tourist "days" sold through the Prague Visitor Pass will be known for the period after its launch.

Tourist Card – Indicator IV (Use)

	2017–2019	2020
Resulting indicator value	**N/A**	**0**
Calculation	Number of tourist card uses in specific locations	

SOURCE: The tourist card service is privately operated. Precise data are not available.

Information on the overall use of the tourist card at specific locations (ideally, in the future with a distinction between more and less exposed tourist locations) will be known after the launch of the Prague Visitor Pass tourist card.

4.4.4 Other Relevant Information

Other relevant indicators use statistics to describe the current situation and the long-term development of tourism in the capital city. For example: information on how tourism is reflected in the state's economy, numbers of tourists visiting the capital city, types of accommodation they choose, and how they use collective accommodation facilities.

Tourism Productivity

This indicator aims to provide additional information about tourism productivity, using indicators related to tourism expenditures, divided into expenditures by foreign visitors (foreign inbound tourism) and expenditures by domestic visitors (tourists from the Czech Republic). It then compares these indicators giving the proportional productivity of the two groups of tourists to the overall result.

	2017	2018	2019	2020 *
Resulting indicator value	**56.4 % / 43.6 %**	**57.1 % / 42.9 %**	**57.4 % / 42.6 %**	**N/A**
Calculation	Ratio of inbound / domestic tourism expenditures in total expenditures			
The share of tourism in GVA	2.8 %	2.8 %	2.8 %	N/A
The share of tourism in GDP	2.9 %	2.9 %	2.9 %	N/A
The share of tourism in employment	4.5 %	4.4 %	4.4 %	N/A
Total expenditure on tourism	292.5 billion CZK	295.0 billion CZK	308.0 billion CZK	N/A
Expenditure by foreign visitors	164.9 billion CZK	171.5 billion CZK	176.9 billion CZK	N/A
Expenditure by domestic visitors	127.6 billion CZK	126.4 billion CZK	131.4 billion CZK	N/A

SOURCE: CZSO. The stated values are for the whole of the Czech Republic. The Capital City of Prague accounts for approximately 1/3 of the total sum of the above expenditures. | * Data for 2019 will be available after the finalization date of this publication. Data for 2020 were published on February 28th, 2020.

For illustration, both the year-on-year and percentage share of tourism in gross value added (GVA) and gross domestic product (GDP) are also given.

Gross value added (GVA) is the value newly created by institutional units (enterprises) using their own production capacities, i.e., above input costs. Simply put, GVA is calculated as the difference between output and intermediate consumption (input costs). It can be determined as the difference between total output, valued at basic prices, and intermediate consumption, valued at purchasers' prices. It is usually calculated for individual industries or institutional sectors/sub-sectors. GVA is the so-called "net indicator of economic performance".

Gross domestic product (GDP) includes GVA plus net taxes on products. It is a summary figure for all sectors in the national economy or all institutional sectors/subsec-

tors plus net taxes on products. GVA actually makes up approximately 90 % of GDP and the balance is net taxes on products – GDP is essentially GVA, only in purchase prices. These two statistical indicators usually develop similarly, but they differ when taxes rise or fall significantly.

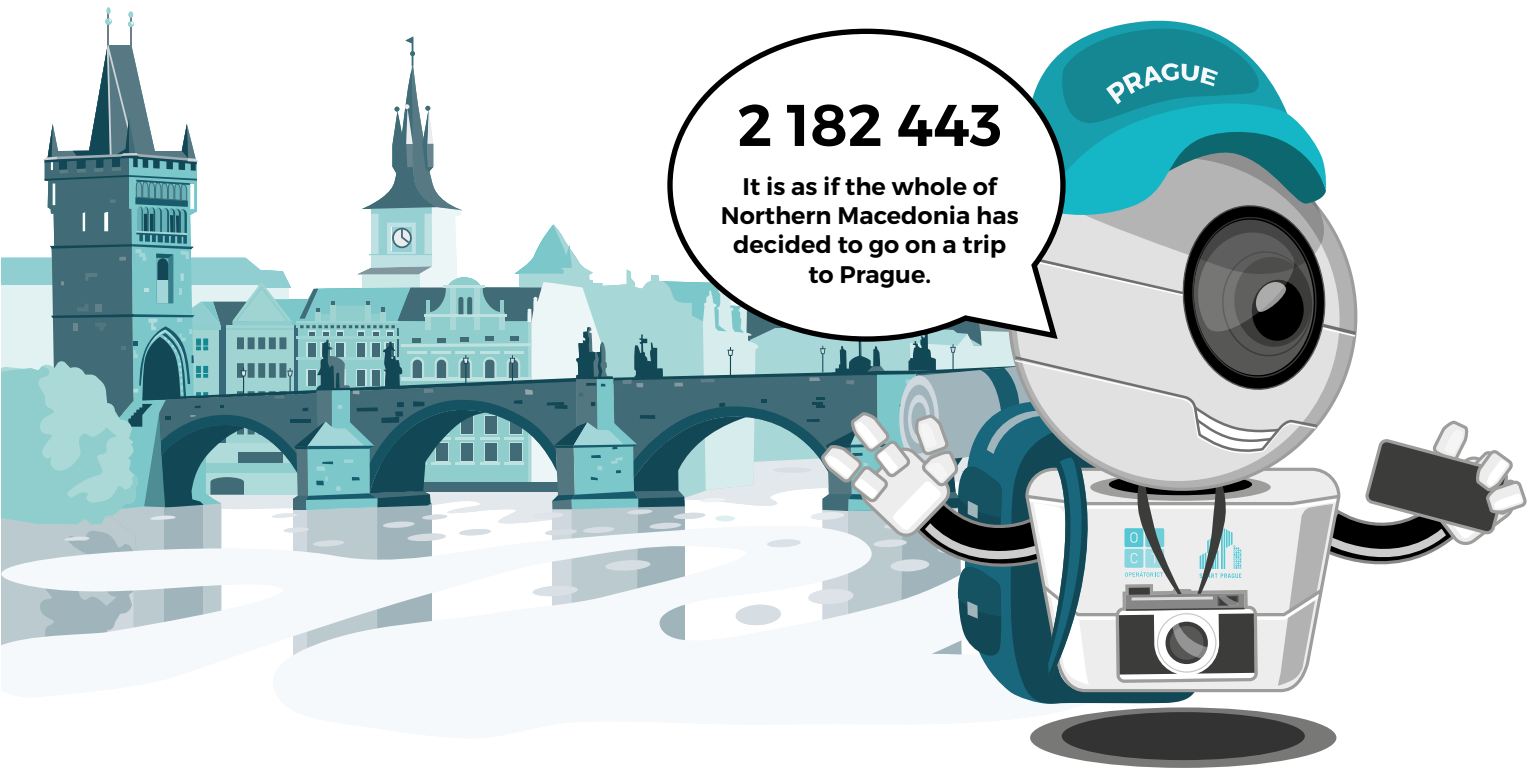
Macroeconomic indicators in tourism are quantified annually with a certain time lag. The data for individual regions have not been quantified for a long time, which is why in this indicator, we present data in the format currently available to provide an idea of tourism productivity – where Prague has a significant share in the result. The CZSO decided to comply with the requests from the public and began publishing some indicators for the regions retroactively, starting in 2017. The regional satellite account of tourism in the Czech Republic was published by the CZSO for the regions on May 25th, 2021. In the Czech Republic, there are 239,600 persons employed in the field of tourism. Prague accounts for 27.6 % of total employment in tourism (66,200 persons) and to total GVA by 36.9 % (52.7 billion CZK).[56/]

Number of Visitors

The indicator monitors the total number of visitors to the Capital City of Prague. A resident is a visitor from the Czech Republic. The total number of guests coming from abroad has been increasing every year since 2012. In 2020, the number of visitors decreased due to the COVID-19 pandemic by 73 %; the number of tourists visiting Prague declined by approximately 5.8 million.

	2017	2018	2019	2020
Resulting indicator value	**7,652,761**	**7,892,184**	**8,029,110**	**2,182,443**
Calculation	Total number of visitors (including residents)			
Number of foreign visitors	6,562,518	6,670,706	6,786,151	1,453,530
Number of domestic visitors	1,090,243	1,221,478	1,242,959	728,913

SOURCE: Czech Statistical Office.[57/]



SOURCE: **56/** Regional Tourism Satellite Account CZSO (czso.cz), check on 26 June 2021.
57/ Tourism – Region CZSO in Prague Capital City (czso.cz), check on 26 June 2021.

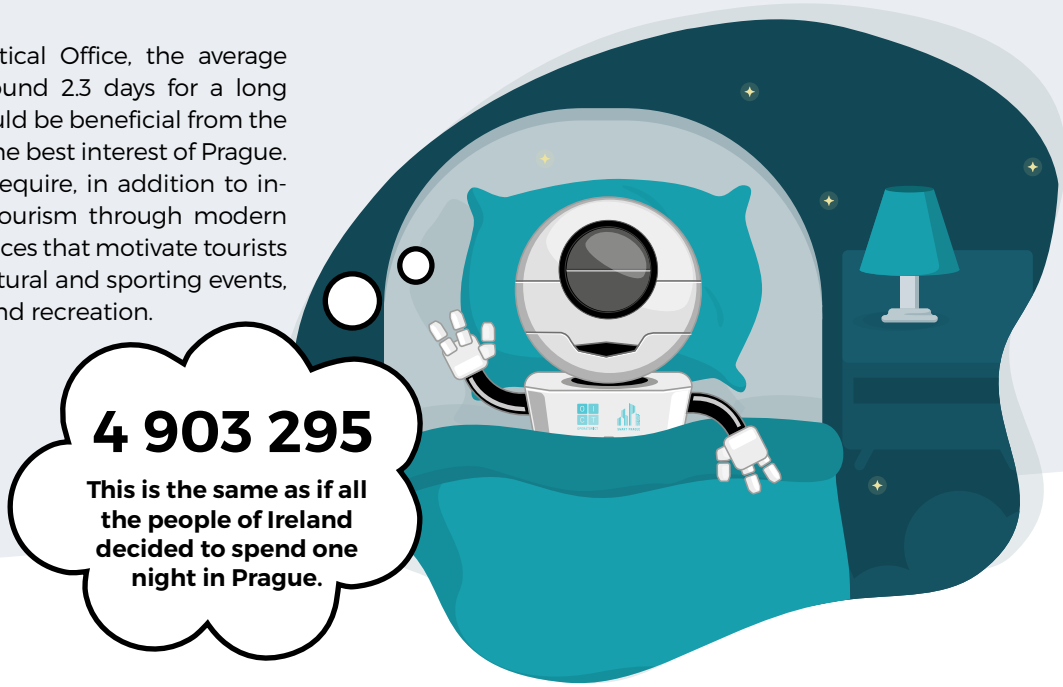
Number of Nights

The indicator value is based on the total number of overnight stays by guests in mass accommodation facilities in the Capital City of Prague.

	2017	2018	2019	2020
Resulting indicator value	**18,055,838**	**18,249,084**	**18,456,261**	**4,903,295**
Calculation	Total number of overnight stays			
Total number of overnight stays	18,055,838	18,249,084	18,456,261	4,903,295
Average overnight stay (number of nights)	2.4	2.3	2.3	2.2

SOURCE: Czech Statistical Office.[58/]

According to the Czech Statistical Office, the average overnight stay has hovered around 2.3 days for a long time. Extrending this period would be beneficial from the point of view of tourism and in the best interest of Prague. However, this would generally require, in addition to increasing the attractiveness of tourism through modern technology, the provision of services that motivate tourists to stay longer, such as major cultural and sporting events, conferences, sports, relaxation and recreation.



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This is the same as if all the people of Ireland decided to spend one night in Prague.

Number of Rooms and Beds

	2017	2018	2019	2020
Resulting indicator value	**41,617 / 90,891**	**42,487 / 93,169**	**42,997 / 94,444**	**44,599 / 102,118**
Calculation	Number of hotel rooms / Number of beds			
Number of hotel-type rooms	35,066	35,508	35,960	38,949
Number of non-hotel type rooms	6,551	6,979	7,037	5,650
Total number of rooms (all accommodations)	**41,617**	**42,487**	**42,997**	**44,599**
Number of beds in hotels	73,811	74,982	76,602	86,239
Number of beds in other accommodation facilities	17,080	18,187	17,842	15,882
Total number of beds	**90,891**	**93,169**	**94,444**	**102,118**

SOURCE: Czech Statistical Office.[59/]

This indicator compares the number of hotel-type rooms (rooms in 5* to 1* hotels and garni hotels) and the number of rooms in other accommodation establishments (bed-and-breakfasts, camps, cottage settlements, tourist hostels and other collective accommodation establishments) and compares these data with the number of beds in both groups of accommodation establishments for the given year. The number of beds has shown a year-on-year increase in capacity. Despite the unfavourable situation in 2020, the number of rooms in collective accommodation establishments increased by 3.6 % and the capacity of beds increased by 7.5 %.

SOURCE: **58/** Tourism – Region CZSO in Prague Capital City (czso.cz), check on 26 June 2021.
59/ Tourism – Region CZSO in Prague Capital City (czso.cz), check on 26 June 2021.

Room Occupancy

This indicator monitors the net occupancy of beds and rooms in hotels and other collective accommodation establishments in Prague. The Czech Statistical Office states that the net occupancy of beds is determined as the share of the number of overnight stays in the monitored period and the product of the average number of available beds with the number of operating days.

The occupancy of rooms is determined as a proportion of the number of realized "room days" (i.e. number of occupied rooms for individual days of the monitored period) and the product of the average number of available rooms with the number of operating days.

	2017	2018	2019	2020
Resulting indicator value	**67 % / 69.5 %**	**66.3 % / 69.2 %**	**67.8 % / 70.2 %**	**23.8 % / 27.4 %**
Calculation	Net use of beds [%] / Net use of rooms [%]			
Net occupancy of beds	67.0 %	66.3 %	62.0 %	23.8 %
Net occupancy of rooms	69.5 %	69.2 %	70,2 %	27.4 %

SOURCE: Czech Statistical Office.

This sample of 2017–2019 shows a partially fluctuating trend, which will probably be better interpreted only in a longer stable period of time. For 2020, there is again a noticeable decline due to global travel restrictions due to the COVID-19 pandemic.

4.5 PEOPLE AND THE URBAN ENVIRONMENT

People in Prague live in the largest protected monument reservation in the Czech Republic, which makes the city a unique space combining historical and modern tendencies. Prague has 866 hectares of city space on its territory inscribed on the UNESCO World Cultural and Natural Heritage List.[60/] More than 460 business entities (entrepreneurs and trades) are also registered in Prague as well as central state offices and many other institutions.

As of the last day of 2020, Prague had a population of 1.3 million, a year-on-year increase of 1.2 % and by 2050, according to estimates, its population could rise up to 2 million.[61/] In the future, as the CZSO statistics suggest, the increase in population will probably be mainly due to the migration of the population from the countryside to the cities and the immigration of foreigners.

In 2020, people and cities experienced a pandemic caused by the SARS-CoV-2 virus causing COVID-19. Measures to combat the virus have had a direct impact on the shape and functioning of both people and cities. The urban environment of Prague has often changed from the lively busy streets of the capital city to completely empty; the vast majority of shops and cultural facilities have been temporarily closed. People often eliminated their normal movement around the city to the necessary minimum, wearing face masks, respirators, etc. became the standard. For these reasons, there has been a strong focus on safety and health.

Communication and interaction with residents will be developed using mobile apps with functions corresponding to the current needs of life and movement in the city. The safety of citizens in public spaces will be increasingly strengthened through automated detection and prediction of risk phenomena using intelligent camera systems and a dense sensor network. The lifestyle of the population has been affected by changes in the performance of work, the use of means of transport, the distances travelled, as well as the digitization of the economy and new patterns of consumption. Lifestyle changes also significantly affect the health of the population. In cities, the demands for the support of active life, accessible sports, but also assistive care will increase with the help of the latest technologies to improve the quality of life of the city's inhabitants. An equally important aspect is the support of planting greenery and urban agriculture, which contribute to improving the environment of the capital city and food self-sufficiency of Prague. Innovative technologies also bring non-traditional ways of using public spaces and their equipment. Urban furniture can offer citizens and visitors of Prague their access by combining the traditional useful features of furniture with added functions, e.g. they can serve as a flexible source of information and data. With the support of digitization and public participation in the development of the city, the creative potential of the inhabitants is used, trust is built and such projects are implemented that are missing in the given urban environment or need to be solved. Modern technologies allow the city to use appropriate methods of public participation and improve the quality of life of citizens.

Thematic areas include:

- **Urban Environment in Mobile Phones**
- **A Safe City for People**
- **City for a Healthy Lifestyle**
- **Technology for Municipal Greenery**
- **Innovative Gadgets and Sensors**
- **Digitization and Participation in Public Administration**

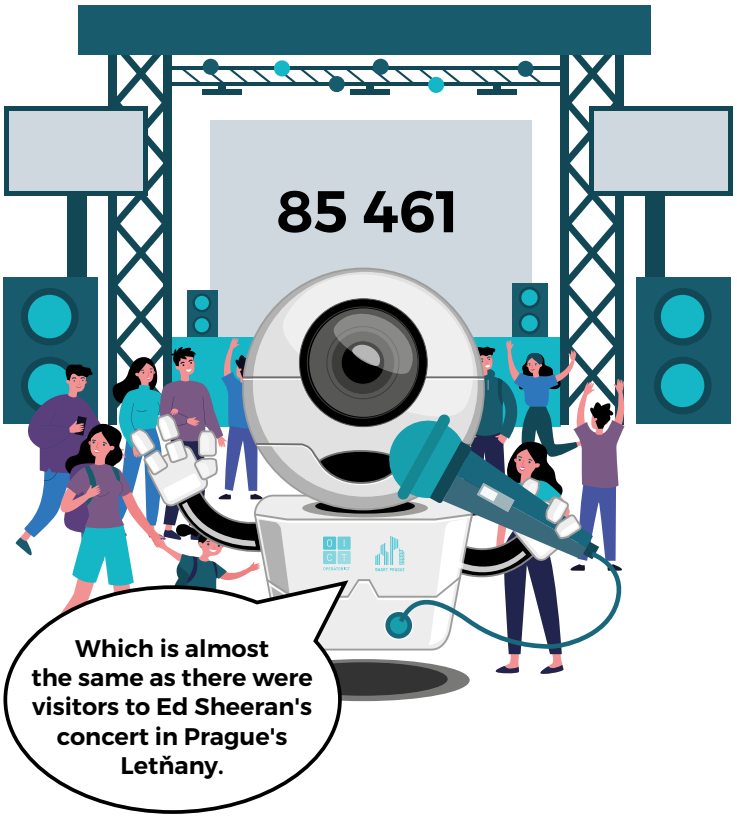
4.5.1 Urban Environment in Mobile Phone

The use of mobile apps began a little before the very concept of smart cities expanded. Their great added value is connecting people with people. Therefore, cities today use data obtained from individual solutions (sensors, platforms, IoT technologies, communication technologies, etc.) and create smart urban apps. The use of mobile apps has thus become a common part of the urban environment in recent years.

SOURCE: **60/** UNESCO – Prague (mistopisy.cz), check on 26 June 2021.
61/ Population – Region CZSO in Prague Capital City (czso.cz), check on 26 June 2021.

The aim of this area is to monitor the increase and changes in the functions that people have available in Prague, such as reporting faults, suggestions, searching for transport connections, etc. It can be expected that the services and functions available in the city's mobile apps will increase significantly in the future. For example, apps will reduce costs, effectively manage the use of resources and physical infrastructure, and increase communication and information sharing between citizens and city management.

This could be, for example, a feature in an app that will support the citizens in a greener lifestyle, such as measuring the ecological footprint of transport, which the city can use to promote sustainable modes of transport, clearer air and physical condition of the citizens and thus reduce its environmental and health care costs while fulfilling its long-term environmental commitments.



My Prague Mobile App

The aim of the Moje Praha mobile app is to make it easier for all citizens to find their way around the urban space. The app is developed to offer as much relevant and up-to-date information as possible, which will make life in Prague as easy as possible for users. Therefore, the app offers essential information from public spaces about parking zones and parking payment options, traffic information, cultural news, but of course also contacts and opening hours at offices and other practical information.

What can you find in the My Prague App?

- Parking zones and the possibility of convenient payment for parking
- Overview of P+R carparks and traffic cameras
- Contacts and opening hours of municipal authorities in Capital City of Prague.
- Lists of city police headquarters
- Contacts and opening hours of collection yards
- Cultural events offer
- Lists of pharmacies, playgrounds, parks and public toilets
- The most important telephone numbers for crisis situations
- Naturally, it is possible to search and display the map with the possibility of navigation and the ability to save individual places to favourites
- The app also serves as a signpost to other apps under the auspices of the Capital City of Prague

This indicator monitors the total number of downloads of the My Prague Mobile App.

My Prague Mobile App

	2017	2018	2019	2020
Resulting indicator value	**0**	**78,420**	**88,054**	**85,461**

SOURCE: OICT internal resources.

The My Prague mobile app was launched in January 2018. The average number of active users per month is 10,000 using the Android platform and 2,000 using the iOS platform. In 2020, no development work took place for the My Prague app; those are planned for this year.

In 2020, a development plan for 2021 was prepared. It is mainly a redesign of the app and a change in functionality to increase the added value for users and to support its increasing use in the future.

Změňte.to (Change.It) City Mobile App

Změňte.to is a unified way for users to send transportation-related ideas and suggestions to employees of Prague City Hall and its subordinate organizations. A suggestion is localized directly on the map via the Změňte.to mobile app or website – it is also possible to attach a photo with a short comment and send it instantly. Emergencies are resolved immediately; in other cases, the user receives a response within 30 days at the latest. The authorities themselves can now be evaluated. The Změňte.to mobile app was taken over by OICT in July 2019.

This indicator monitors the total number of users of the Změňte.to mobile app.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**N/A**	**0,4**	**0,46**
Calculation	Number of submitted proposals / Number of app users			
Number of app users	0	20 984	28 993	30 421
Number of submitted proposals within the app	N/A	N/A	5 895 / 11 790 *	14 113

SOURCE: OICT internal resources. | * Data recalculated for the whole year 2019. The available data on the number of submitted proposals is 5,895 dated on July 1st, 2019 since that is when the app began to be managed by OICT.

There was a further increase in 2020 as well as an increase in the number of submitted proposals within the app. On average, both the level of users and the level of their involvement is growing.

City Website Mám nápad (I Have an Idea)

I have an Idea is a long-term project, thanks to which OICT collects ideas for new projects from citizens and visitors of Prague. Literally everyone can participate in the development of Prague with their smart idea. All you have to do is to fill out the form of I Have an Idea website and hit send.[62/]

Each accepted idea is evaluated by the OICT internal committee. If the idea passes this first round, it is then submitted for assessment to representatives of academia, which are representatives of Prague universities (CTU in Prague, Charles University, CULS, etc.), who evaluate the technical and socio-economic benefits of the idea. The idea then returns to the OICT, where the internal committee assesses the ideas again together in the context of academic statements. The ideas are further consulted with other city organizations, or the idea is developed into a so-called Project card, which is further assessed within the Commission of the Capital City of Prague for the development of the Smart Cities concept. The Commission will then assess whether it is appropriate to implement the idea and issue recommendations for further action.

This indicator monitors the ratio of the number of all received ideas and ideas that were accepted in the mentioned first round of the OICT internal commission. The goal of OICT is to achieve the highest possible percentage of success of relevant projects, i.e., that as many accepted ideas as possible be approved with a vision of subsequent implementation.

	2017	2018	2019	2020
Resulting indicator value	**53 %**	**26 %**	**48 %**	**79 %**
Calculation	Number of ideas approved / Number of ideas received [%]			
The number of all ideas received	72	70	27	47
Number of ideas received	38	18	13	37
Mobility of the Future	18	12	8	11
Waste-free city	1	0	0	3
Smart Buildings and Energy	0	1	2	2
Attractive Tourism	0	0	0	0
People and the City Environment	17	4	3	20
Data Area	2	1	0	1

SOURCE: OICT internal resources.

SOURCE: **62/** "Write us your idea", SmartPrague, available from https://www.smartprague.eu/mam-napad, check on 26 June, 2021.

In the first two years of the I have an idea project, about 70 ideas were received from citizens each year. In the first year, most of them were successful, however, in the second year there was a decline in the success of ideas. In 2019 and 2020, the number of accepted ideas was not reached compared to previous years, but their success is growing, which can be perceived as the main benefit.

In a year-on-year comparison, it can be stated that most of the ideas concern the area of Mobility of the Future. The second area in the order is People and the City Environment. It can be concluded that these are the most visible areas and their development is supported by the public. At the same time, in these areas, the ideas often lead to the development of new technologies and approaches, thus creating space for unique projects.

The number of ideas received represents ideas that the OICT internal committee has positively accepted and continues to work with (it sends them to academic staff for evaluation or develops into project cards or passes on to organizations that can better process and evaluate ideas). However, it is important to mention that the idea that OICT received at the end of 2019 is further processed in 2020, however, its statistics belong to the year when the idea was adopted (i.e. in this example the year 2019).

Unsuccessful ideas, on the other hand, are those that are repeated/already exist, do not represent the ideas of citizens (they come from companies) or it is not an idea for a project, but rather a change/repair of an existing process or city equipment, property or space.

However, each individual idea is evaluated and its author receives a relevant answer.

Two successful ideas from 2019 can be cited as examples of the successful ones. It was a matter of creating a map of the energy potential of solar and wind energy. These ideas were positively evaluated by the academic sphere and based on their recommendations, they were further consulted with various authorities, departments of the City Hall and other municipal companies. Based on these consultations, we obtained a picture of the limitations that may accompany the topic (for example, the issue of the monument zone, prices and other criteria). With regard to the next procedure, the ideas were merged into one, which was presented to the Commission of the Prague City Council for the development of the Smart Cities concept, which adopted this idea. Currently, the idea is being developed into a project plan.

4.5.2 A Safe City for People

The long-term goal in this area is the commissioning of an intelligent system that would automatically draw attention to crisis phenomena and crime in the city in real time. By applying machine learning technologies and artificial intelligence systems in general in combination with the use of collected data from interconnected subsystems as well as other sources (e.g. information on planned mass events, records of crimes and crisis situations in the Capital City of Prague), the system would be able to identify places and times with a high probability of crime and other crisis phenomena and recommend timely security measures (e.g. in the field of crisis communication). Thanks to these technologies, it would be possible to prevent and take risk measures against risk phenomena, not only to deal with their consequences retrospectively.

SOS Buttons with Communicator

This indicator captures the equipment of the city with SOS communicators.

	2017	2018	2019	2020
Resulting indicator value	**289**	**310**	**316**	**305**
Calculation	Number of places with SOS buttons with communicators			
Number of SOS communicators for passengers in the subway	11	11	11	0
Number of SOS communicators for tram passengers	278	299	305	305

SOURCE: Internal communication with DPP.

This indicator included SOS communicators in the metro area and in the transport areas of trams, specifically in the 14T and 15T types, which are equipped with these devices. The stated number of SOS communicators for passengers in the metro corresponds to the end of 2019 but since 2020 all 11 information columns in the metro have been switched off and disabled. The reason is the decision that these information columns were already technologically obsolete and a significant part of their functions in terms of information was replaced by new ticket machines (145 new machines in 33 metro stations).

Among the project ideas for the future, there is a vision of adding some suitable urban furniture (parking systems, public transport stops, etc.) with functions for emergency communication, as most of these elements already have communication HW in them. A possible procedure would be to further modify it and add the possibility of its use in emergency situations for emergency communication.

Smart Camera Systems

The indicator monitors the expansion of automated camera systems.

	2017	2018	2019	2020
Resulting indicator value	**72 %**	**72 %**	**72 %**	**75 %**
Calculation	Number of cameras connected to analytical software / Number of TSK cameras in MKS			
Number of cameras connected to the analytical software	**607**	**607**	**607**	**639**
Video detection in tunnels	479	479	479	479
Comprehensive telematics transport system	128	128	128	160
Number of TSK cameras in IKS	**843**	**843**	**843**	**847**

SOURCE: Internal communication with TSK, a. s. (Plc.), IKS - Integrated camera system, i.e. city camera system of the Capital City of Prague with integrated third party camera systems

Based on software definition of potential events that may occur in the camera's field of view, the analytical video detection system in tunnels is able to evaluate the following situations: stationary vehicle, slow moving vehicle, emerging convoy of vehicles, object on the road reduced visibility.

A complex telematics transport system can detect basic characteristics of the traffic flow, such as average speed, traffic status and traffic intensity. In 2020, there was an increase in the integration of cameras from other investors.

AI for Risk Phenomena Detection

The Municipal Camera System (MKS) of the Capital City of Prague is being built and is constantly being expanded as a tool to increase security in the territory of the Capital City of Prague.

With the adoption of the Concept of Construction of the ICC in 2000, Prague Capital City preferred the extensive development of this metropolitan system by increasing the number of cameras in places with the largest concentration of potential perpetrators of misdemeanours and crimes.

The expansion and operation of the ICC was also in accordance with the Program Statement of the Prague City Council for the period 2006–2010 with the aim of ensuring the expansion of the camera system to places with high crime and increasing the efficiency of the camera system by introducing modern software applications.

MKS has been operated as a technically open metropolitan system into which the cameras of other operators can be integrated. The municipal camera system of the Capital City of Prague is a part of the Integrated Camera System (IKS), which as a technological unit connects it with integrated camera systems of third parties. It processes image information from public spaces with the main goal of increasing the safety of citizens and visitors to the Capital City of Prague. The system monitors traffic flows and has integrated software to identify the registration plates of stolen vehicles; cameras from vehicle speed measurement sections (including red light violation checks) are also connected, and the system also protects selected monuments through the so-called electronic fence concept.

	2017	2018	2019	2020
Resulting indicator value	**4,679 / 98**	**4,712 / 99**	**4,742 / 99**	**4,765 / 117**
Calculation	Number of cameras integrated into the municipal camera system (MCS) / Number of client workplaces			
Number of cameras integrated in the Integrated Camera System (ICS)	**4,679**	**4,712**	**4,742**	**4,765**
Cameras of the Capital City of Prague	1,098	1,131	1,161	1,184
City district of Prague 8	783	783	783	783
Electronic fence (protection of monuments) – Prague 1	31	31	31	31
Dopravní podnik, a. s. (Plc.)	1,825	1,825	1,825	1,825
Technical administration of communications, a. s. (Plc.)	846	846	846	846
Administration of services for the Capital City of Prague	96	96	96	96
Number of client workplaces	**98**	**99**	**99**	**117**

SOURCE: Internal communication with the Security Department of the Security Infrastructure Department of the Capital City of Prague.

There was a year-on-year increase in the number of cameras in the Capital City of Prague, and another 30 cameras were installed.

From the Municipal Camera System of the Capital City of Prague and even more so from the Integrated Camera System, has become an important tool in the years of use in the field of:

- **Prevention** – reducing the occurrence of adverse events in areas covered by installed cameras.
- **Repression** – perpetrators of anti-social behaviour are identified based on images from cameras.
- **Gathering information** – monitoring demonstrations and other mass events in the city. The information can be used to guide actions and prevent unnecessary disputes and conflicts, as well as to retrospectively analyse the situation in the event of security interventions.
- **Reducing crime and theft, e.g. in the field of property crime focused on vehicles.**
- **Monument protection** – violation of the protection zone around the monitored cultural monument is detected in real time.
- **Road traffic control and monitoring** – using integrated TSK and DP cameras.

safety in the Capital City of Prague a source of information for security and crisis management staff, a means to collect related data, an assistant for the components of the Integrated Rescue System and for the components of the Rescue Security System.

The IKS system is used at 99 client workplaces of Capital City of Prague – the Police of the Czech Republic, the Municipal Police of the Capital City of Prague, the Fire and Rescue Service of the Capital City of Prague, Rescue Medical Service of the Capital City of Prague, Operational Centre of the Crisis Staff of the Capital City of Prague, the Technical Administration of Roads of the Capital City of Prague and the Transport Company of the Capital City of Prague.

For its operation, MKS/IKS requires a secure infrastructure and professional administration ensuring cyber security and compliance with legal regulations governing the operation of large-scale camera systems. The network must therefore be continuously modernized and developed with regard to developments in the field of CCTV (closed television security systems), IT (computer technology), SW and HW.

The Department of Informatics Infrastructure of the Capital City of Prague ensures uninterrupted operability and gradual modernization based on contractual relations. The primary supplier of service services is the municipal company Technologies of the Capital City of Prague, a. s., another municipal company focused on information technology management, the ICT Operátor, a. s. (Plc.)

In contrast to the extensive development since 2000, when the main aspect was the number of installed cameras, there is a gradual transition to intensive development, i.e., the strengthening of infrastructure and data storage.

Further development of the camera system will take place in accordance with the Concept of Development and Operation of the Municipal Camera System of the Capital City of Prague for a period of 10 years, which was approved by the Prague City Council on October 20th, 2016 by resolution no. 20/51. The application of AI in the camera system will take place in accordance with the development of European and national legislation. Special attention will be paid to ensuring the protection of processed personal data.

In the future, the indicator will monitor and evaluate the qualitative aspect of the development of MCS/ICS.

4.5.3 Healthy Lifestyle City

With the development of knowledge in individual areas of smart cities, the goals of individual areas are also developing. The aim of this area is to develop solutions with a positive impact on the physical and mental health of the capital's inhabitants. By using the potential of advanced technologies, it is possible not only to help people with reduced self-sufficiency, but also to promote a healthy lifestyle and sport for all city residents.

In 2020, cities were exposed to the COVID-19 pandemic. In addition to the impact on the physical health of people, the illness also affected the mental state (working from home, curfew, reduction of contact with loved ones, etc.). Thanks to this experience, solutions will be developed in the future that will support a positive effect on the physical and mental condition of people.

Number of Smart Solutions Supporting Health in the City

The indicator monitors the total number of health-promoting solutions in the city. The indicator consists of smart health-promoting solutions in terms of emergency and health care, the use of artificial intelligence and health-promoting information tools.

	2017	2018	2019	2020
Resulting indicator value	**1**	**1**	**1**	**2**
Calculation	The total number of smart solutions supporting health in the city			
Emergency and health care	1	1	1	1
Use of artificial intelligence	0	0	0	0
Health promoting information tools	0	0	0	1

SOURCE: OICT internal resources.

Emergency and health care, as one of the health-promoting measures, monitors the number of people using client devices with an SOS button, which are permanently connected to the emergency care control system, which evaluates and resolves alarms and crisis situations. The most common causes of an application for emergency care are a fall, nausea, weakness, assault, fear of loneliness, loss, or forgetting keys. The Metropolitan Emergency and Health Care System (MSTZP) was launched in October 2018 and was divided into several stages. Its main goal was to introduce a higher standard of care services for the elderly and people with reduced self-sufficiency using new, more modern technologies. Thanks to the new possibilities, these people are thus able to live a full life without fear and in a domestic environment, even at an advanced age or with disabilities.

In 2020, in connection with the coronavirus pandemic, a portal focused on COVID-19 a portal aiming at sampling sites was created and launched. The goal of the portal

is to easily and quickly guide users to places performing COVID-19 testing. The application provides users with information on all Prague collection points in one place and makes it easier to find a suitable collection point with information on the nearest available date, test price, distinction of self-paying income and doctor's request, opening hours and all service options at the collection points. Some collecting points offer the possibility of an express test or, for example, testing from a car (drive-in). In 2020, the covid.praha.eu website had on average 4,000 users, and the most in December.

Number of Smart Technologies Supporting Sports and Leisure Activities

The indicator monitors the total number of smart technologies supporting both the sustainability of sports and leisure activities, as well as solutions supporting a healthy lifestyle of the population through artificial intelligence and other information tools.

	2017	2018	2019	2020
Resulting indicator value	**1**	**1**	**1**	**2**
Calculation	The total number of smart technologies supporting sports and leisure activities			
Sports field with smart technologies	0	0	0	1
Use of artificial intelligence	0	0	0	0
Information tools supporting sport	1	1	1	1

SOURCE: OICT internal resources.

In two cases, smart technology was introduced within the Prague sports grounds. Technology has been installed in the area of the Šutka aqua centre, which will return part of the water to the swimming pool after cleaning, and thus it will not be discharged into the sewer.

As part of information tools supporting sports, Prague has a Prague Sports website,[63/] which was created to support all sports and leisure activities offered by the capital city. Starting with invitations to traditional and non-traditional events, interesting things from the sports environment, reports and videos from Prague's stadiums and playgrounds, to an extensive practical database of clubs or sports venues that Prague Sports has at its disposal.[64/]

As with the indicator of the number of smart solutions supporting health in the city in the implementation of artificial intelligence, there is still a room for improvement for Prague.

4.5.4 Technology for Municipal Greenery

Few of us deal with the ecological (carbon) footprint of food. Long-distance food imports are mostly, especially in Europe, carried out by road freight transport, which, in addition to the considerable amount of fuel consumed, also produces a significant amount of carbon dioxide. As a rule, the shorter the distance the food travels from the farmer, the better. Urban farming can help in several ways, greenery in cities prevents the formation of heat islands, it also has a retention capacity and there is a gradual evaporation of rainfall. Gardens – whether classic, shared (or community) or the most modern – is another, less common way to contribute towards food self-sufficiency for the city. So-called vertical farms offer the opportunity to grow significantly more food products in layers, allowing agricultural resources to get closer to the cities or to compensate for the lack of arable land in a hostile environment. Plants obtain nutrients from a prepared solution. In 2018. Prague first software-controlled municipal farm was established to use modern hydroponic processes for growing vegetables and other crops. The startup Herba Fabrica based in Holešovice, for example, focuses on this method of growing crops in Prague.

Creating so-called green roofs can also help save space. A green roof is considered to be a space where the roof is partially or completely covered by vegetation and soil or a growing medium. In 2018. Operátor ICT prepared an analysis of the potential of green roofs in Prague. The aim of this analysis carried out by the data platform

SOURCE: **63/** "Prague Sports - Sports and leisure activities", available from https://prahasportovni.eu/, check on 26 June 2021.
64/ https://prahasportovni.eu/.

department was to quantify the maximum capacity of suitable green roofs, where conversion under certain conditions made the most sense. The data showed that Prague has large and untapped potential and that, for example, it would be possible to install up to 143 ha of green roofs on buildings owned by the city and the city districts (812 buildings in total), which approximately corresponds to the size of two Stromovka parks. The potential would be considerably higher if privately owned buildings were used for installing green roofs. The analysis also generated a list and description of buildings on which green roofs could be built. Flat roofs in cities continue to represent untapped potential, and Prague has a lot of room for change in this area, also in the area of cultivation activities or state-of-the-art farming.

Among the project ideas for the future with regard to sustainability, the use of the so-called hydroponics or aquaponics. This is a form of agriculture where the classic substrate (clay) is not used to grow plants. In hydroponics, another medium is used instead of a substrate, such as water, as the name suggests, by which the nutrients that plants need is transferred. This solution is then applicable in greenhouses and places with otherwise poor-quality soil. In aquaponics, wastewater from fish farming is then used as a source of nutrients, which suitable bacteria convert into nutrients usable for plants.

Number of Urban Green Areas with a Smart Solution

In Prague, nature and greenery are almost all around us. Greenery and trees perform important social and environmental functions and contribute to public health. Green areas among others increase the humidity of the air, reduce and dampen temperature fluctuations, capture dust particles, reduce noise and, last but not least, perform an aesthetic function.

	2017	2018	2019	2020
Number of urban green areas with sensors *	1	1	2	6
Number of urban green areas with sensors and smart irrigation system **	2	2	4	6

SOURCE: Internal communication with the district. | * Out of the total number of 57 districts, 50 provided the data in 2017: 39; 2018: 39; 2019: 41; 2020: 41. | ** Out of the total number of 57 districts the data were provided in 2017: 38; 2018: 38; 2019: 40; 2020: 40

With regard to increasing the efficiency of management and care of green areas in Prague, the implementation of projects focused on sensory monitoring of the state of green areas is slowly expanding and in some cases a system of smart irrigation has already been implemented in Prague (for example in 2019 it was Granátová park in Slivenec and in 2020 Kaizlovy sady and Karlínské square).

Area of Urban Greenery with a Smart Solution

The following indicator shows the area of green space, where smart solutions have been implemented so far in relation to the total area of greenery in Prague.

	2017	2018	2019	2020
Resulting indicator value	**0.002 %**	**0.002 %**	**0.009 %**	**0.023 %**
Calculation	Share of green area with a smart solution / Total green area			
Green area with a smart solution * [m²]	6,165	6,165	23,165	55,965
Total green area in Prague[65/] [m²]	249,120,000	248,820,000	248,660,000	248,240,000

SOURCE: Summary overviews of the land fund from the data of the Real Estate Cadastre of the Czech Republic for the given years (ČÚZK), internal sources of the OICT. | * Out of the total number of 57 districts, 50 provided the data in 2017: 38; 2018: 38; 2019: 40; 2020: 41

The data on green areas show that overall greenery forms a very significant part of the total area of Prague (496 km²). The area of greenery, which is equipped with a smart solution, is relatively small in this comparison, however, in the year-on-year comparison, a growing trend is evident, which can be expected to continue in the future. The smart equipment of parks, which contributes to the long-term sustainability of quality care for greenery, continues to develop successfully in the urban environment.

SOURCE: **65/** It is the sum of agricultural land (arable land, gardens, orchards, vineyards, permanent grasslands) and forest area according to ČÚZK yearbooks. See: https://www.cuzk.cz/Periodika-a-publikace/Statisticke-udaje/Souhrne-prehledy-pudniho-fondu/Rocenka_pudniho_fondu_2021.aspx.

Number of Vertical Gardens in the Built-up Area of Prague

Average daily temperatures in cities are even a few degrees higher in the hot summer months than on the outskirts of suburbs or in the countryside. The expanding concrete development is to be blamed, accumulating a huge amount of heat due to the absence of greenery and natural drainage points. In agglomerations, heat islands are created to prevent condensation and the formation of rain.[66/]

Vertical gardens in urban areas contribute to reducing the negative impacts of climate change. Thanks to the evaporation of water, the greenery is able to dampen summer temperature fluctuations, maintains the natural moisture of the soil and air and has the ability to capture various harmful gases and dust from the air.[67/]

	2017	2018	2019	2020
Resulting indicator value	**1**	**2**	**4**	**5**
Calculation	Number of vertical gardens in the built-up area of Prague			

SOURCE: OICT internal resources.

In 2017, the first vertical garden was installed as part of a smart bench on Pushkin Square in Prague 6. The bench was placed here as part of a pilot project with the aim of creating shade and contributing to the cooling of the surroundings. The smart bench has the ability to charge mobile phones or internet connections and also monitors pressure, humidity, air temperature or noise. The benches are powered by solar panels.[68/]

In 2018, the building with the largest vertical garden in Central Europe was located in Karlín. It is an administrative building of AFI Karlín. Using 41 plants, 584 small gardens were created, all on an area of 1,500 square meters. Green irrigation is provided by an intelligent irrigation system that monitors the amount of water in the system and automatically releases it as needed.[69/]

In 2019, a second bench with a vertical garden was introduced in the CULS campus. The sitting area acts as an aesthetic, but above all as a mitigating element against the consequences of climate change in cities. The vertical cultivation wall is complemented by a smart bench with sockets for recharging mobile devices powered by solar panels, which also serves as a weather station.

Another example of a building with a vertical garden within Prague 1 is the DRN multifunctional building in the Národní třída. The exterior of the seven-storey DRN Palace is formed by a glass facade, in front of which there are wooden galleries on which greenery grows. The building was awarded the title of Building of the Year in 2019.[70/]

In 2020, a hop wall was created within the Prague 6 district in cooperation with the CULS. The wall was created as one of the measures to improve climatic conditions in the city. The green hop wall was intended to help reduce dust. The stated advantage of hops is that it grows very quickly and creates a large volume of green matter, which well shields the spaces from each other.[71/]

SOURCE: **66/** https://www.obnovitelne.cz/clanek/539/v-boji-proti-horku-ve-mestech-pomahaji-zelene-strechy-a-fasady/, check on 26 June 2021 **67/** https://www.ekocentrumkoniklec.cz/vertikalni-zahrada/ check on 26 June 2021. | **68/** https://www.idnes.cz/praha/zpravy/chytra-lavicka-magistrat-zahrada-uschla-vyrobce-zaleval-na-vlastni-naklady.A190823_154552_praha-zpravy_rsr, check on 26 June 2021. | **69/** https://www.idnes.cz/bydleni/stavba/vertikalni-zahrady-spolecnost-nemec-afi-karlin.A181116_104546_stavba_rez Business centrum Karlín, check on 26 June 2021. **70/** http://www.stavbaroku.cz/printDetail.do?Dispatch=ShowDetail&siid=1756, check on 26 June 2021. | **71/** https://www.denik.cz/regiony/na-viteznem-namesti-roste-chmelova-stena-sestak-ochrani-pred-prachem-a-horkem-20200501.html, check on 26 June 2021.

Urban Farming in Public Space

This indicator focuss on the area of space provided for urban food production.

	2017	2018	2019	2020
Resulting indicator value	**approx. 22,000 m²**	**N/A**	**40,000 m²**	**N/A**
Calculation	The total area of community gardens in the Capital City of Prague			

SOURCE: Internal communication with KOKOZA, o. p. s.

Data in 2017 and 2019 show an increase in the area designated for urban crop production. Unfortunately, no data are available for 2018 and 2020 as no survey was conducted. Nevertheless, according to the current course, a continuing growing trend can be inferred.

Grower Communities

The indicator captures the number of grower communities in the Capital City of Prague.

	2017	2018	2019	2020
Resulting indicator value	**18**	**27**	**43**	**55**
Calculation	Number of community gardens in the Capital City of Prague			

SOURCE: Internal communication with KOKOZA, o. p. s.

It has been shown that there are more and more active people who are setting up gardens and growing communities. In recent years, companies and city districts have also begun to establish community gardens. Currently, up to 5 growing communities with their own gardens are created every year. The gardens of the Czech Union of Allotment and Leisure Gardens are not included in the indicator. In 2020, a further increase of growing communities by twelve new entities was identified.

An overview of grower communities is also available on the website with a map of community gardens.[72/] The map is also a community project and individual grower communities can add their own profiles there (for this reason, the overview may not always contain completely up-to-date data).

Community Gardeners

This indicator captures the number of community gardeners.

	2017	2018	2019	2020
Resulting indicator value	**251**	**N/A**	**836**	**N/A**
Calculation	Number of community gardeners farming in community gardens			

SOURCE: Internal communication with KOKOZA, o. p. s.

Unfortunately, no survey was conducted in 2020 and therefore the final number of community gardeners is not precisely quantified. Given the significant increase in this number in recent years, further growth can be estimated in the future.

SOURCE: **72/** "Map of community gardens and composters | Mapotic ", available at https://www.mapko.cz/, check on 26 June 2021.

4.5.5 Innovative Gadgets and Sensors

This area deals with the extension of the functionality of urban furniture using network connections, sensor systems, IoT functionalities and urban mobile apps. It is an effort to make the installed technologies energy self-sufficient (e.g. due to the power supply via solar panels, and their functionality was not conditioned by the connection to the power supply. By measuring the quality of Prague's air and collecting accurate and up-to-date information on its status using stationary and mobile sensors built into urban furniture, as well as involving Prague residents in active data collection, the capital city will provide a valuable platform of accurate data to help effectively target urban interventions. The aim of this area is also to introduce and provide people with new functions in the urban space (e.g. information board on the state of the air, the possibility of recharging mobile devices or a publicly available Wi-Fi network).

Measuring the State of the Environment in Public Space

Using this indicator, a number of measuring stations providing information on the quality of the environment are monitored. Data from measuring stations and sensors provide information value to the city and its citizens or visitors. Data serves as an open data source.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**100**	**104**	**69**
Calculation	Number of sensors or stations measuring the state of the environment in public space			

SOURCE: Internal communication with TSK and THMP, a. s. (Plc.), internal OICT resources and other available resources.

The indicator monitors sensory measurements of environmental variables in public space, including those where the sensor carrier is, e.g. a public lighting pole, urban furniture and such.

For the year 2020, the indicator includes:

- 3 smart public lighting columns by the railway in Žižkov
- 1 piece of enviro-box (sensory box) in Karlín operated by THMP
- 8 pcs of smart benches with function of measuring the state of environment
- 11 pcs of SMIGHT smart lamps operated by PRE
- 30 weather stations operated by TSK
- 16 pcs of CHMI automated stations

The decrease was due to the replacement of smart lamps in Karlín and the uninstallation of noise sensors in Prague 3.

Coverage of the city by stations measuring the quality of the environment

This indicator monitors the density of the network of stations measuring the quality of the environment.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**0,2016**	**0,2097**	**0,1391**
Calculation	Number of measuring stations for evaluating the environmental quality of stations in relation to one km² in the Capital City of Prague			

SOURCES: Own calculation from previously available indicators.

The indicator monitors the sensory measurement of environmental variables (e.g., air pollution, pollutants, etc.) in public spaces, where the carrier of sensors are, for example, public lighting poles, urban furniture and the like. The resulting value corresponds to the number of stations in relation to one km² in the Capital City of Prague (total of 496 km²). A prerequisite for further expansion of the sensor network of stations measuring environmental quality in the future is the elaboration and application of the concept of placing environmental sensors in public space. Data on the number of stations focused on meteorological precipitation is provided by the indicator Use of Rain Gauges listed in the Waste-free City area.

Number of Localities Equipped with Technologies for Automatic Counting of Cyclists and Pedestrians

For a city, pedestrian and cyclist transport is as important for public transport as public and car transport. Cyclists and pedestrians, in addition to being a sustainable and healthy form of transport, are also an important element in increasing the city's attractiveness by reviving the character of the streets. The intensity of pedestrian movement depends on the length of the road, especially on its attractiveness. Capital City of Prague, with 866 hectares of UNESCO World Heritage Site, has great potential to support pedestrian and bicycle traffic, thanks to which the city will continue to develop and prosper economically. The street character, when the buildings are close to each other and one has time to focus on details and faces, is personal and friendly for a person and connects the route e.g., with shopping, services, cafés and networking.[73/]

The indicator monitors the number of sites adding cyclists and pedestrians.

	2017	2018	2019	2020
Resulting indicator value	**26**	**27**	**30**	**35**
Calculation	Number of localities equipped with technologies for automatic counting of cyclists and pedestrians			
Sites with cycle counters	26	27	30	30
Locations with pedestrian sensors	0	0	0	5

SOURCES: OICT internal sources.

Bike counters provide useful real-time data on bike path occupancy. It is an indirect support for cycling in the city and serves as one of the tools for monitoring the implementation of the Concept of the Development of Cycling and Recreational Cycling in Prague and as a support tool for other initiatives related to the development of cycling and its infrastructure in the Capital City of Prague. Intensity monitoring is performed using the so-called of cycle counters located on the backbone network of cycle paths in Prague. The directional passages of cyclists directly at the measuring point with the resolution of the direction of travel are recorded by a suitable technology. The data also record the current temperature and are collected in real time (respectively 5-minute intervals) to the data platform of Capital City of Prague named Golemio. The data do not reveal where cyclists go and where they end their routes, but it is a good source of information for extrapolating the total number of cyclists throughout Prague. In 2020, there was no development of cycle counters. Currently, there are 29 localities equipped with technologies of induction loops or radars (or their combination) within the project Monitoring the Intensity of Bicycle Traffic, which is provided by the company ICT Operátor, and one census totem within the initiative https://www.cistoustopou.cz, which it works on the principle of heat detection with the help of a PIR sensor and visualizes the data in the resolution of cyclists and pedestrians.

Another similarly focused project on pedestrian counting is the pilot project Pedestrian Traffic Intensity implemented since 2020. The aim of the pilot project is to test technologies for determining the intensity of pedestrian mobility in public space using sensors and advanced video analysis providing motion detection. The obtained statistical data, from which it is not possible to identify persons (from individual sensors and from advanced video analysis), are transferred to the data platform of the Capital City of Prague (Golemio), where they are stored and further processed according to the requirements of individual partners. As part of the pilot phase of the project, 5 census sites were put into operation in the capital city:

- **Rašínovo nábřeží** – mbankment by the Vyšehrad railway bridge
- **Královská cesta** – Na Můstku / Rytířská street
- **Charles Bridge** – at the Old Town Bridge Tower
- **Stromovka** – trail to stromovka U Výstaviště
- **Exhibition Grounds** – sidewalk by the railway viaduct U Výstaviště

SOURCE: **73/** https://www.vutbr.cz/www_base/zav_prace_soubor_verejne.php?file_id=44018, check on 26 June 2021.

Number of Smart Pieces of Furniture

The indicator describes the number of smart pieces of furniture in the city. The importance of intelligent solutions in urban furniture extends the primary functions of the element by other functions, such as the propagation of the Wi-Fi signal, enabling the charging of personal electronic devices or using sensors to collect data. Smart furniture is an added value not only for city users (citizens and tourists), but also for the city, to which it provides data and information for further development.

	2017	2018	2019	2020
Resulting indicator value	**0.17**	**1.29**	**1.25**	**2.16**
Calculation	Number of pieces of smart furniture / City area			
Total number of pieces of smart furniture	**82**	**639**	**620**	**1 070**
Smart lamps	3	100	100	549
Smart benches	10	10	10	11
Smart trash cans *	69	529	509	510
Smart signs	0	0	0	0
City area	496 km²			

SOURCE: Internal communication with individual districts, zoos. The data are based on the number of pieces of smart furniture operated by OICT, MHMP and other city districts of the Capital City of Prague.
* Out of the total number of 57 districts, 50 provided the data in 2017: 41; 2018: 41; 2019: 44; 2020: 44

Resulting indicator value shows that in Prague, there are currently more than 2 pieces of smart furniture per 1 km². The largest increase was recorded for smart lamps. This is an increase in smart lamps implemented by THMP, when the company implemented the renewal of the public lighting infrastructure after a successful pilot test.

OICT is currently implementing the project Innovative Technologies for Traffic Signs, the aim of which is to test the acquisition of new data, such as GPS position, position relative to the Earth's geomagnetic field/compass, change of position from the initial state, etc. The project tests the placement of 163 sensors and 2 variable traffic signs.

Public Wi-Fi Hotspots

This indicator monitors the availability of the city's internet connection using public Wi-Fi hotspots.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**172**	**172**	**142**
Calculation	Number of public Wi-Fi hotspots			

SOURCE: The data come from the website of the supplier VERB Group and from the smart furniture operated by OICT.

The value did not change year-on-year; no new development activities took place in this area last year. Most recently, in 2018 the number of access points to the public Wi-Fi network in Prague expanded to include the Petřín area, the Zoological and Botanical Gardens of the Capital City of Prague and Karlín.

There are 12 access points to the public Wi-Fi hotspot in Petřín, 83 in the Prague Zoo and 38 in the Botanical Garden. In the case of smart benches, there are 9 access points. As part of the completion of the pilot project in Karlín, there was a year-on-year decrease of a total of 30 public Wi-Fi hotspots.

Coverage of the Prague Metro by Signal and Internet

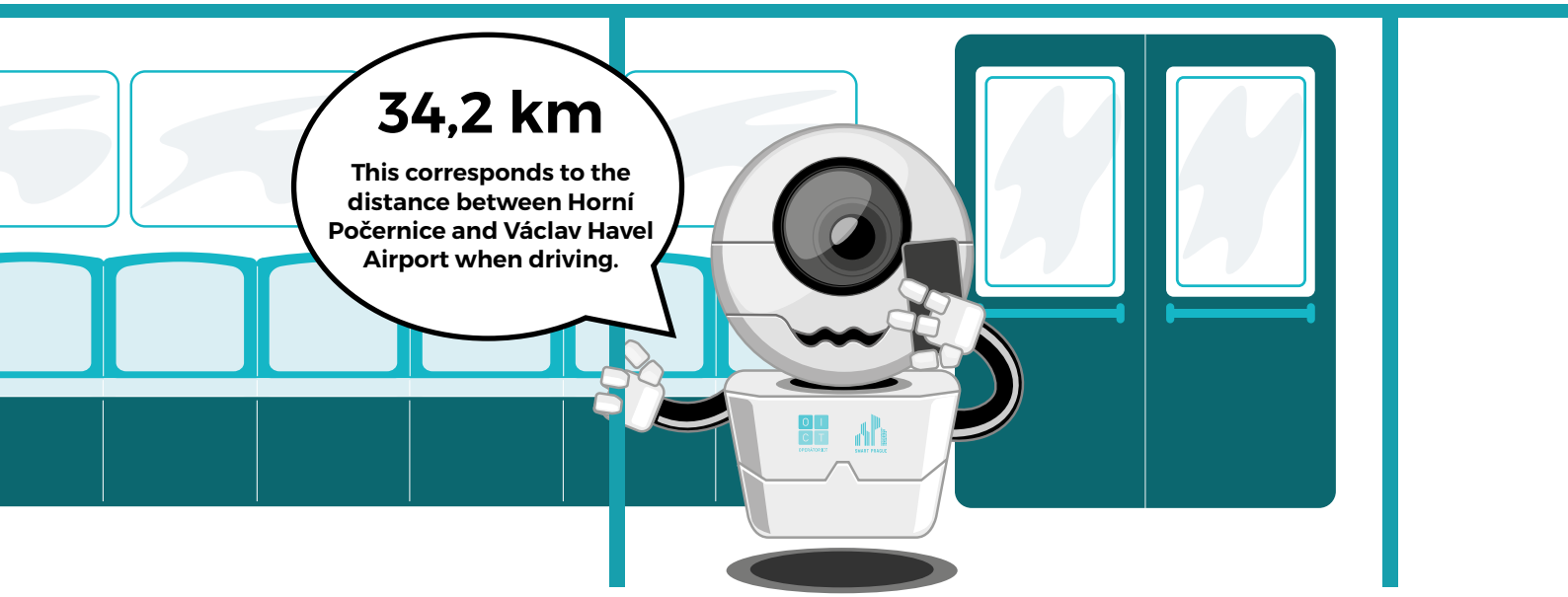
The transport company, in cooperation with a consortium of operators (O2 Czech Republic, T-Mobile Czech Republic, Vodafone Czech Republic) and CETIN, has been working since 2018 to cover the Prague metro with the signal of the high-speed LTE (4G) network.

The coverage of the metro tunnels consists in the installation of an approximately 5 cm wide radiating cable along the entire length of the Prague metro, except for the newest section of line A - Bořislavka, Nádraží Veleslavín, Petřiny and the Motol Hospital. In this section, LTE technology providing telephony and high-speed data connection was installed during construction.[74/]

The indicator monitors the proportions of metro coverage by the signal both, the number of stations and with respect to the length of the metro line.

	2017	2018	2019	2020
Resulting indicator value (share of the number of stations)	**6.55 %**	**19.67 %**	**26.22 %**	**59.01 %**
Calculation	Number of metro stations / Number of metro stations covered by the signal			
Number of metro stations	61	61	61	61
Number of metro stations covered by the signal	4	12	16	36
Resulting value of the indicator (share of metro length)	**9.83 %**	**20.43 %**	**25.65 %**	**52.53 %**
Calculation	Subway length / Subway length covered by the signal			
The total length of the subway	65.1	65.1	65.1	65.1
The total length of the subway covered by the signal	6.4	13.3	16.7	34.2

SOURCE: Internal communication with DPP.



In 2020, there was a significant increase in the number of stations covered by the signal. The increase of 20 other stations compared to 2019 transferred the final value of the indicator over 50 % of the total coverage (59 %). Further coverage will continue in 2021.

In terms of the indicator monitoring the length of the metro covered by the signal, the share of coverage increased to 53 i.e. to 34.2 km.

4.5.6 Digitization and Participation in Public Administration

The area of digital services brings citizens the opportunity to address their issues towards the Capital City of Prague districts and city companies easily and online. Typically, these situations used to be difficult or virtually unrealistic to process online.

The area of participation in public administration is moving from the traditional possibilities of involving the population in the city (for example, public discussions, questionnaire surveys, involvement in specialized asso-

SOURCE: **74/** https://www.dpp.cz/cestovani/mobilni-signal-v-metru, check on 26 June 2021.

ciations) to the online environment, and thus offers the possibility of involving the general public. The main benefit of online participation is to increase user friendliness and reduce the time required to engage in participation. Participation as such is an important element for the city to support the development of the city in accordance with the views of the city's inhabitants. One of the most widespread examples of good practice at the moment is participatory budgeting, which enables the inhabitants of a given area to decide on a certain percentage of the allocated budget. In the future, the effort will be to strengthen digital participation and use the data obtained to develop the capital in accordance with its inhabitants. One of the possibilities to support participation is the creation of a tool for measuring the quality of life in Smart City, which will reflect the impacts of implemented smart measures and the information obtained will also be the basis for further project development.

Digital Services for Citizens

This indicator monitors developments in the field of digitized services for citizens, especially the number of agendas that can be handled online, and the actual number of submitted applications and the number of users of the new Prague Portal, which should become the centre of the city's digital services.

	2017	2018	2019	2020
Resulting indicator value	**N/A**	**N/A**	**N/A**	**3**
Calculation	Number of processed applications / Number of digitized agendas			
Number of digitized agendas	0	0	0	4
Number of processed applications	0	0	0	12
Resulting indicator value	**N/A**	**N/A**	**N/A**	**0.48**
Calculation	Number of processed applications / Number of users of digitized services			
The average number of daily users of digitized services during the month	0	0	0	25

SOURCE: OICT internal resources.

In the autumn 2020, the Prague Portal was launched. The portal offers the citizen the following options:

- to settle the fee for municipal waste
- to fill in and submit electronic forms
- to book their time visiting the office
- to edit residential parking

In 2021, its further development and gradual implementation of other agendas of both the Capital City of Prague as well as city districts and city companies is expected. In 2021, for example, the following agendas are being prepared:

- settlement of a fine by the auditor in case of a forgotten PID Lítačka card
- settlement of the fee for the dog and its records
- voting in polls
- submission of grant applications

The average number of requests per agenda is based on 3 requests per agenda during the pilot period. In the future, the distribution of processed applications between agendas will also be monitored in order to find out which agenda is the most used.

For the purpose of monitoring user involvement, an indicator was introduced, which reached 0.48 in the pilot period. This value is expected to increase in the future.

Participatory District Budget

This indicator monitors the share of city districts with a participatory budget in the total number of city districts of Prague. Overall, 88 city districts filled in the data.

	2017	2018	2019	2020
Resulting indicator value	**17.5 %**	**21.1 %**	**19.3 %**	**22.8 %**
Calculation	District with participatory budget / All Prague districts [%]			
Share of districts with participatory budget *	10	12	11	13
Total number of districts	57			

SOURCE: Internal communication with the district, internal OICT resources.
* Out of the total number of 57 districts, 50 provided the data in 2017–2020.

In 2020, the highest number of districts with an established participatory budget was in the monitored period 2017 to 2020. In total, it currently involves citizens in the development of roughly one quarter of Prague city districts. Several districts have expressed an interest or plan to introduce a participatory budget in the future.

Funds for Participation

The indicator monitors the share of the budget allocated to participation in relation to the total budget of the city districts of the Capital City of Prague. Budgets are evaluated cumulatively for all involved districts. 48 % of city districts participated in the measurement in 2020.

	2017	2018	2019	2020
Resulting indicator value	**0, 36 %**	**0, 38 %**	**0, 40 %**	**0, 36 %**
Calculation	The share of the district budget allocated for participation in the total district budget			
District funds allocated to the participatory budget*	CZK 35,547,000	CZK 40 ,640,900	CZK 38,486,000	CZK 31,686,000
Municipal funds (total budget)	CZK 9,753,567,112	CZK 10,557,921,693	CZK 9,678,397,054	CZK 8,852,775,791

SOURCE: Internal communication with the district, internal OICT resources. | * Out of the total number of 57 districts, 50 provided the data in 2017: 24; 2018: 24; 2019: 25; 2020: 25 Out of the total number of 57 districts, data were provided in 2017–2019: 28; in 2020: 30.

Resulting indicator value does not change much in the monitored years. Compared to 2020, almost CZK 7 million more was allocated in 2019. Budgets are normally planned a year in advance, so the covid pandemic did not affect the lower allocation for 2020 however, some districts stopped submitting projects during the year due to the pandemic. Based on available information[75/] from AGORA CZ, in 2013–2015 CZK 50 million were allocated in selected cities in neighbouring Poland with CZK 129,000 and 120,000 inhabitants (1.2 % of the budget) and CZK 25 million. In comparison, Prague has the potential to increase the shares of the participatory budget in the future.

Participatory Budget Success

This indicator monitors the share of selected projects for implementation in relation to the total number of projects proposed by the inhabitants of the Capital City of Prague 42 % of city districts participated in the measurement in 2020.

	2017	2018	2019	2020
Resulting indicator value	**30 %**	**28 %**	**45 %**	**37 %**
Calculation	Number of projects selected for implementation / Number of proposed projects [%]			
Number of proposed projects within the participation	145	151	170	146
Number of selected projects for implementation within the participation	44	42	76	54

SOURCE: Internal communication with the district, internal OICT resources. Out of the total number of 57 districts, data were provided in 2017: 24; 2018: 24; 2019: 26; 2020: 26 Out of the total number of 57 districts, data were provided in 2017: 23; 2018: 23; 2019: 24; 2020: 24

The principle of a participatory budget is, in addition to the actual submission of project proposals by citizens, also the possibility of voting. Selected projects for implementation can thus be selected based on the preferences of the population who vote on them in a certain period of time. The submission of proposals is usually conditional on the fulfilment of certain conditions (e.g., in the form of submission, fulfilment of content conditions, territorial delimitation for the given district, minimum number of applicants, maximum amount for the project, etc.).

The number of submitted proposals decreased in 2020 due to the effects of the coronavirus pandemic on the activities of the population. Some districts had to suspend or restrict the submission of projects due to a pandemic.[76/] The overall ratio of submitted and selected projects decreased compared to 2019.

SOURCE: **75/** https://www.participativni-rozpocet.cz/wp-content/uploads/2017/05/Participativni_rozpocet-CZ.pdf, check on 26 June 2021.
76/ Questionnaire survey for SPI 2020.

5.

DATA AREA

"A smart city must make decisions based on quality data"

Mgr. Ing. Jaromír Beránek

Chairman of the IT and Smart City Committee of the Capital City of Prague, representative of the Capital City of Prague.

2020 will probably not be remembered as the happiest years in history. After the unexpected and sharp onset of the pandemic, weak points of many world capitals, including Prague, were revealed. The public has rightly begun to ask, why many basic services have not been working, as we have been used to until then. Why the intervals in public transport are being extended, even though it is not easy to maintain safe distances, why there are outages in the delivery of postal items, although we have to stand in line at the branch, why playgrounds close after schools and kindergartens, even though many families live in small flats it is difficult to find a replacement program for their offspring. None of us were prepared for the COVID-19 pandemic, and at the beginning of 2020 probably few could have imagined what impact it would have in our lives. The importance of current, accurate and reliably available data proved to be even greater.

For the fourth year in a row, an exceptional project of the Golemio urban data platform has been successfully developed under the wings of the ICT Operátor, which is used to collect, analyse and, in some cases, evaluate or further utilize urban data. Golemio integrates information from more than a hundred data sets and provides over a hundred live or statistical data dashboards that serve the management and residents of Prague.

During the COVID-19 pandemic, the data platform team led by Benedikt Kotmel was able to quickly orientate himself in the situation and was a huge support to the city by ensuring the transmission of reliable data on the development of the number of infected. At the same time, it offered citizens a clear guide for booking testing dates across hospitals and collection points at covid.praha.eu. From the very beginning, the Vaccination Strategy of the Capital City of Prague also included support for the data and information portal for vaccination ockovani.praha.eu. It was then possible to designate an online model for simulating hospital occupancy as a technical finesse.

The data platform is indeed a valuable source of information for the city, and although many are not yet aware of it,

it gives future city and city management a unique opportunity to apply modern methods of data management and decision-making (in the world known as data-driven policy making, or specifically decision making). Thanks to increasingly advanced models using artificial intelligence and machine learning tools, in just a few years, large cities will not only be able to control traffic flows very accurately and predict traffic impacts on other parts of the city (we know this today), but also more accurately estimate new construction and infrastructure projects on noise and air pollution in the city or on the prices and availability of new flats. It will also tell us about the need for civic amenities or transport services, even taking into account future trends in the number of passenger cars in the city, and thus the needs of the spatial distribution of streets will change.

Plenty of information allows you to have things under control. In the case of the capital city, it should be more and more Prague inhabitants themselves. That is why, in 2020, we launched a new information and popularization portal Pragozor,[77/] representing a visually attractive form of Prague in numbers. The user-friendly website is accompanied by the character of an animated golem, who tries to bring new and new data every month. We believe that in the future it could find application, for example, in school teaching.

The greatest benefit to Prague residents is undoubtedly the already completely available data on the positions of public transport connections. In the search engines for connections or clearly on the mapa.pid.cz website, everyone can find out information about the arrival of their bus or tram today and plan the best connection. In the coming years, passengers will also receive live information about on-screen transfers directly in vehicles thanks to the Unified Information System project.

I am very happy that there is a growing interest in city data and Golemio, as the imaginary heart of the Smart Prague concept, is pulsating with life. I believe that the emphasis on accurate and reliable documents will help us not only in more effective management of the city and better planning of future projects, but will also enable Prague to better withstand crisis situations in the future. The importance of data is also well perceived by young people, as shown by the communication with schools or the applications for the data call within the Prague Innovation Marathon at www.nakopniprahu.cz. I also believe that in the future, city data will give rise to completely new start-ups and help develop new business opportunities, as for example, the London experience shows.

There is no need to talk at length about the importance of international cooperation and drawing inspiration from abroad, but Prague is no longer an outlaw in this regard. Thanks to the Golemio, in addition to winning several national awards, the metropolis also made it to the finals of the Taiwanese GO SMART competition. I wish we would hear more and more about similar successes in the future. If Prague is to be successful and compete with other cities, in addition to its historical legacy, it must offer a clear vision of an educated and just society and bet on advanced technologies.

SOURCE: **77/** "Prague in numbers", available from https://www.pragozor.cz/, check on 26 June 2021.

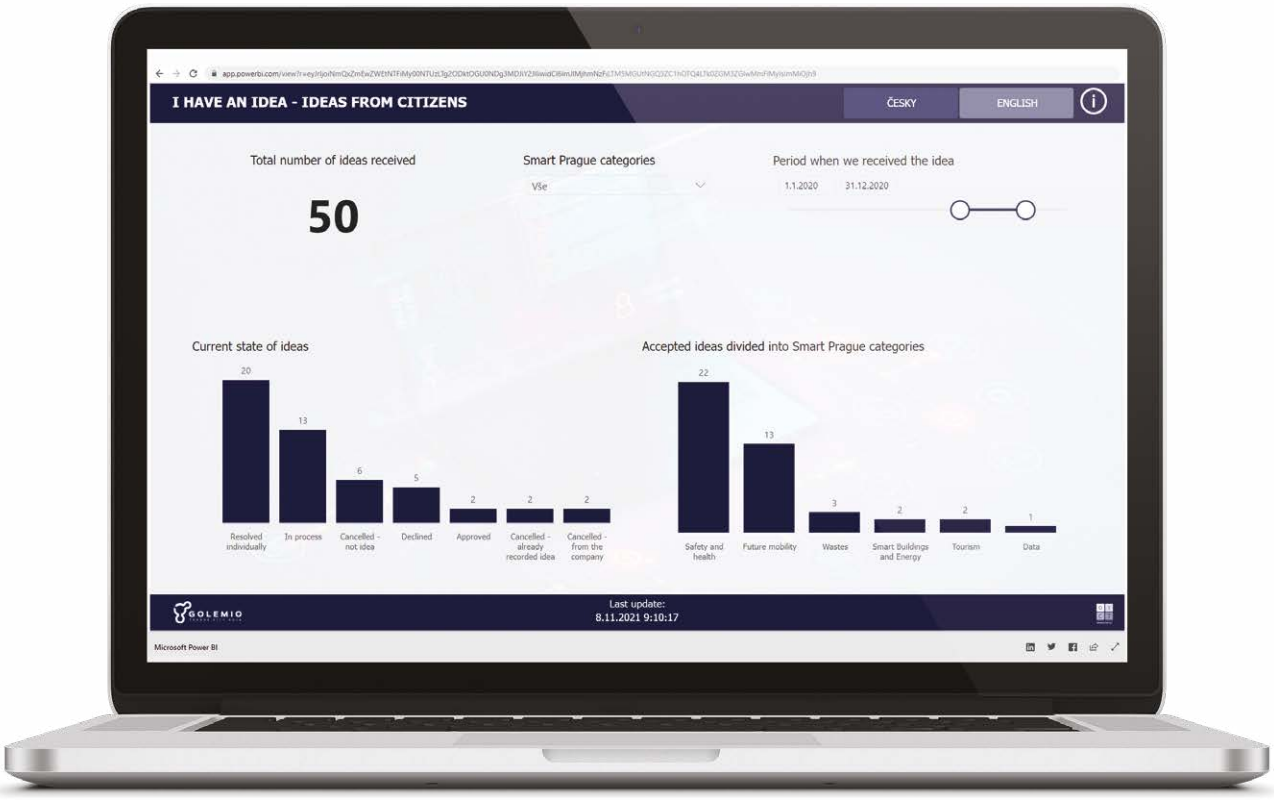


FIGURE: Example of a dashboard in the BI service bi.golemio.cz. | SOURCE: Operátor ICT, a. s (Plc.)

5.1 GOLEMIO DATA PLATFORM

There is no single comprehensive smart solution in Prague that will help with all the challenges facing cities today. Everything is much more a question of the overall approach to city management and city life in general. Above all, comprehensive data should then be available for all decision-making.

The OICT tool for working with data in the city environment, the Golemio data platform, is therefore intended for anyone who is looking for or needs up-to-date and reliable information about the city. It is the effort of the entire Golemio team to make the outputs of the platform as good as possible. Golemio provides IT services to the municipality, city districts and municipal companies in the field of data processing, such as securing data, their integration, storage and visualization.

The great advantage of the data platform is that it is able to work with any type of data that may occur in the smart city area. That is, both smart city data and general data, which in a way illustrate the functioning of the city. Smart city data includes those in the background of information on air quality, waste, numbers of cyclists and pedestrians, energy intensity, vehicle location, parking occupancy, weather and much more. General data capture the status and course of various processes, as well as data generated by state institutions or data obtained on patients with COVID-19 inpatient hospital capacity or data on vaccines and vaccinations.

The data platform also enables the provision of various services, such as receiving or active downloading of data, their storage, transformation, management and access according to defined conditions (open data, accessible free of charge to the general public for their own use), visualization, reporting and alerting, only after the deployment of the Golemio BI (Business Intelligence) service. BI enables a better understanding of what is happening in the city, when information is obtained from the provided operational data of information systems, which subsequently serves the city for strategic and operational decision-making.

Through the Golemio data platform, a team of experienced experts provides technical consultations in all relevant areas, is able to advise on the creation of assignments and tender documentation, design metrics and KPIs,[78/] and provide analysis and other data-related services.

The Golemio data platform is an ideal complement to standard supplier systems (e.g., collection is provided by the supplier, the platform then integrates, stores and enables other operations. The Golemio data platform is already an integral part of the city's infrastructure.

The data platform enables the concentration of data from various providers across Prague and subsequently makes it available to other parties, both to city representatives through the bi.golemio.cz service and to the public, for example through the Moje Praha and PID Lítačka applications or data analysis on golemio.cz. Data can also be used by developers through the API.[79/] During the COVID-19 pandemic, the data platform team also began working with government agencies such as the Institute of Health Information and Statistics, the Central Management Team, and others. Related to this is the operation of a number of services over state data or health care providers, which brings another dimension to the functioning of the Golemio data platform and new services and opportunities for the city and its inhabitants.

Last but not least, the Golemio data platform is also open-source software, the source code of which has been freely available on the public repository on GitHub.com – Prague Data Platform Golemio since October 2019.[80/]

5.1.1 Priorities for 2020 – Development and Pandemic of COVID-19

The Golemio data platform was launched by the city company OICT at the beginning of 2018 but over time the way it works has changed so that it is as beneficial as possible for the city. In 2018, Golemio started on the Cisco Kinetic for Cities SaaS platform, but in the same year, based on experience and analysis, it began developing its own open-source solution. In 2019, we put this solution into production[81/] and in the autumn we released the platform as open source under the MIT license.

The solution provides the city with far greater flexibility not only in integrating new datasets and creating projects over this data, but also in the operation and further expansion of the platform within the city, where individual city components use the data platform solution as a basis for their own data warehouses. Thanks to a wide range of data platform tools, it is possible to provide various services ranging from receiving or active downloading of data, their storage, transformation, management and access according to defined conditions (open data) through visualization, reporting and alerting to the deployment of BI solutions.[82/]

In 2020, planned functions were put into operation, such as the new Golemio BI service bi.golemio.cz, which combines in one place and makes available data visualizations, analysis, applications and data exports for the purposes of city officials, municipal officials, city districts and city companies and organizations. All general and specialized outputs of the data platform can be easily found in one place, and make better use of data for city management.

At the same time, in 2020 greater emphasis was placed on working with city data, which provides a better insight into the functioning of the city from a procedural or economic point of view. Moreover, since 2019, the Golemio data platform team has also been the coordinator of open data within the City Hall. Another significant novelty in 2020 was the availability of online information on the positions of DPP vehicles (buses and trams) in cooperation with ROPID and DPP, which is a significant extension of smart city services to residents and visitors of Prague.

The COVID-19 pandemic fundamentally affected the functioning of the city in 2020. The Golemio data platform thus began to offer the public and officials and political representation a wide range of information on the impact of COVID-19 on the city's functioning, as well as visualization and analysis of patient numbers or hospital capacities (simulation of hospital bed occupancy based on current patient numbers). Along with the launch of vaccination against COVID-19 the platform expanded its offer to include visualizations and analysis of the course of vaccination. In 2020, in connection with the COVID-19 pandemic, 14 data sets were processed, 22 dashboards[83/] and visual outputs were created, and one web app simulating the course of bed occupancy.

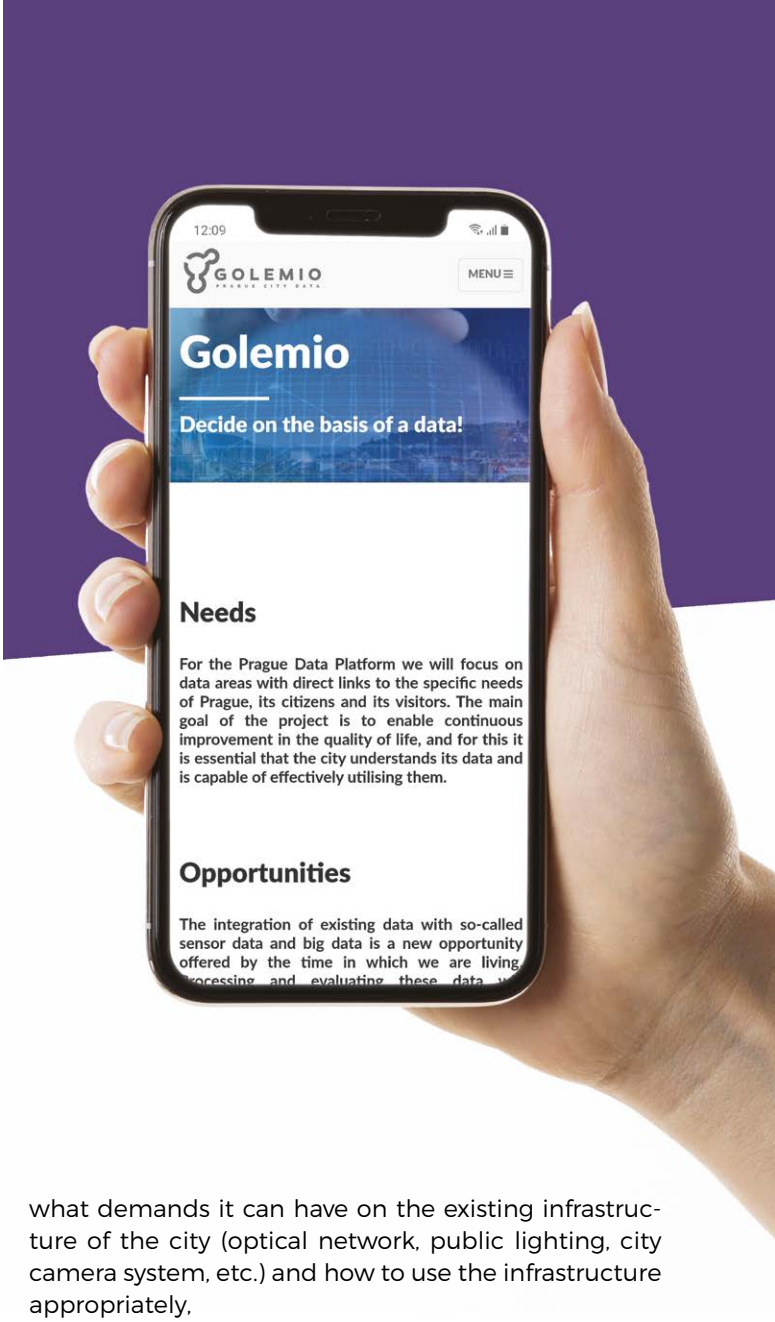
The covid.praha.eu project has become a very important public service, offering in one place an overview of test sites for PCR and antigen tests at COVID-19 in Prague and the Central Bohemian Region, together with information on the nearest available dates. Since its launch in early October 2020, the project has helped more than half a million users find a suitable point of purchase and has been published as open source, while point and date data is published via an open API. It is great that the team of experts behind the data platform has been fully involved in improving the crisis situation caused by the COVID-19 pandemic in the capital city.

SOURCE: **78/** Metrics – in the IT sphere, in general, quantitative measurement of a certain indicator, KPI (Key performance indicator) usually monitor the most important metrics, e.g. attendance, number of passengers, quantity of products sold, etc. **79/** API – Application programming interface | **80/** OICT, Prague Data Platform Golemio, GitLab, 2019. https://gitlab.com/operator-ict/golemio, check on 2 June 2021. | **81/** That means from the test environment to the official live version. | **82/** BI or business intelligence, a more advanced form of data processing and interpretation, usually in the form of visualizations so that people outside the data fields can understand and interpret the relevant data themselves. | **83/** See for instance: Image no. 8; dashboard is a visual user environment giving a basic overview of the key indicators of a given visualization, usually allowing some form of interaction.

Same as in previous years, also in 2020, the Golemio data platform project succeeded in the Golden Crest competition, in the 22nd annual round won first place in the category of Best Electronic Service and Smart City.[84/] The covid.praha.eu project also succeeded in the Together We Open Data 2020 competition organized by the OSF Foundation, where it won in the special COVID-19 category.[85/]

Pragozor

In 2020, an information data website was launched for the general public – Pragozor.cz. The website presents verified and decorated information about our city in a simple and understandable form. Illustrated by the golem Pragozor, site visitors are guided through various areas of urban life from transport and the environment through housing, tourism, security or health, including data on the current epidemic situation. The Pragozor website contains more than 120 graphs, of which more than 40 of them are active, based on live data, which are updated at regular intervals, and 15 graphs are also thematically illustrated. Pragozor processes data from traffic sensors, PID Lítačka application, Smart Prague Index, as well as parking houses, statistics of the Police of the Czech Republic, the Czech Hydrometeorological Institute or statistical yearbooks, and often offers international comparisons. In addition to ongoing updates with new data, the content of the website also expands as new datasets become available.



5.1.2 What exactly does Golemio provide?

The Golemio data platform and its team of consultants and analysts provide the Capital City of Prague, city districts, city organizations, contributory and other organizations with a number of services in the field of smart city data processing. These services include, for example:

- consultation before and during the project,
- integration and storage of data from existing supplier platforms,
- processing and providing data to other partners or in the form of open data,
- data visualization – BI dashboard, visualization over the map base, graphs, etc.

By involving the Golemio data platform team in a smart city project, it is possible to:

- to consult the partner's own intention – what he wants to achieve, what will be beneficial for the inhabitants or the city, or to draw attention to the risks and typical shortcomings of the data, when the intention seems efficient, effective and economical, but experience shows that this is not the case,
- to participate in the definition of the technical solution – what technologies can be used to fulfil the plan, what demands it can have on the existing infrastructure of the city (optical network, public lighting, city camera system, etc.) and how to use the infrastructure appropriately,
- help carry out a pilot test of technologies to assess their ability to meet the required requirements,
- help define the terms of reference in two areas:
  - / proprietary technology (e.g. HW) fulfilling the objectives of the contracting authority,
  - / data access requirements for the client and subsequent connection to the data platform and data transfer (SLA, API, vendor lock),
- consult with the supplier the details of the data connection to the Golemio data platform,
- integrate data, process them, create visuals, reporting, alerting, store history (data warehouse).

The importance of the Golemio data platform lies not only in the provision of services, but also in the methodological area, which is based on the good practice of our team. The methodology includes not only the acquired knowledge and specifications regarding general requirements or anti-vendor lock-in, but also requirements for access to data or general interface specifications.

SOURCE: **84/** Prokop Kanopa, "Results of the National Round 2020", Golden Coat of Arms, 11/2020, https://www.zlatyerb.cz/vysledky-celostatniho-kola-2020/d-1598/p1=1755, check on 6 June 2021.
85/ OSF Foundation, "We open the 2020 data together competition", OSF Foundation, accessed 2. May 2021.https://osf.cz/programy/ziva-demokracie/nas-stat-nase-data/soutez-spolecne-otevirame-data-2020/, check on 2 June 2021.

5.1.3 Golemio BI

Another novelty in 2020 is the Golemio BI application (bi.golemio.cz), which was created for employees and representatives of the municipality, the mayor's office, the city district or the city organization. The application displays data from the Golemio data platform in one place in the form of dashboards or on a map base and in almost real time. It also offers available analyses, applications and data exports. Access to individual outputs is controlled on the basis of user accounts, users can see here not only outputs available within Prague to all, but also specific outputs for certain groups of users. The predecessor of Golemio BI was the Golemio Client Panel.

Number of Golemio Client Panel / Golemio BI users

	2019	2020
Resulting indicator value	**68**	**768**
Calculation	Sum of users for individual months	

SOURCE: Internal OICT resources – Golemio data platform.

Number of Dashboards and Other Outputs in the Golemio Client Panel / Golemio BI app

	2019	2020
Resulting indicator value	**60**	**110**
Calculation	Number of available dashboards and other outputs	

SOURCE: Internal OICT resources – Golemio data platform.

5.1.4 Golemio Data Platform Catalogue

The catalogue of the Golemio data platform was launched on the Golemio.cz website in June 2018 while a part of selected data sets is also the processing of expert analysis on the given issue.

As an example of the analysis that formed the basis for professional debate, we can mention the Airbnb Shared Economy Analysis, where we monitored the development and use of services, which allows the user to find out numbers on percentage occupancy, median or average price per night, number of new, and vice versa terminated accommodation offers, etc. In 2020, thanks to cooperation with Seznam.cz, we supplemented data on leases and sales of apartments in Prague.

The main topic of public outputs in 2020 was, of course, COVID-19 when we made a number of dashboards, including accompanying explanatory information, available to the general public.

The catalogue of public data is available at golemio.cz/cs/oblasti.

5.1.5 Golemio Website Traffic

The ongoing COVID-19 pandemic had a major impact on the number of visitors to the Golemio.cz website in 2020. Given the number of outputs that were prepared, whether directly related to information on the disease or the impact on the city's operations, it is not surprising that the public focused mainly on these areas. (Visitors to the Golemio.cz website do not include individual projects, such as Golemio BI or the Pragozor.cz website and an overview of covid.praha.eu consumption points.)

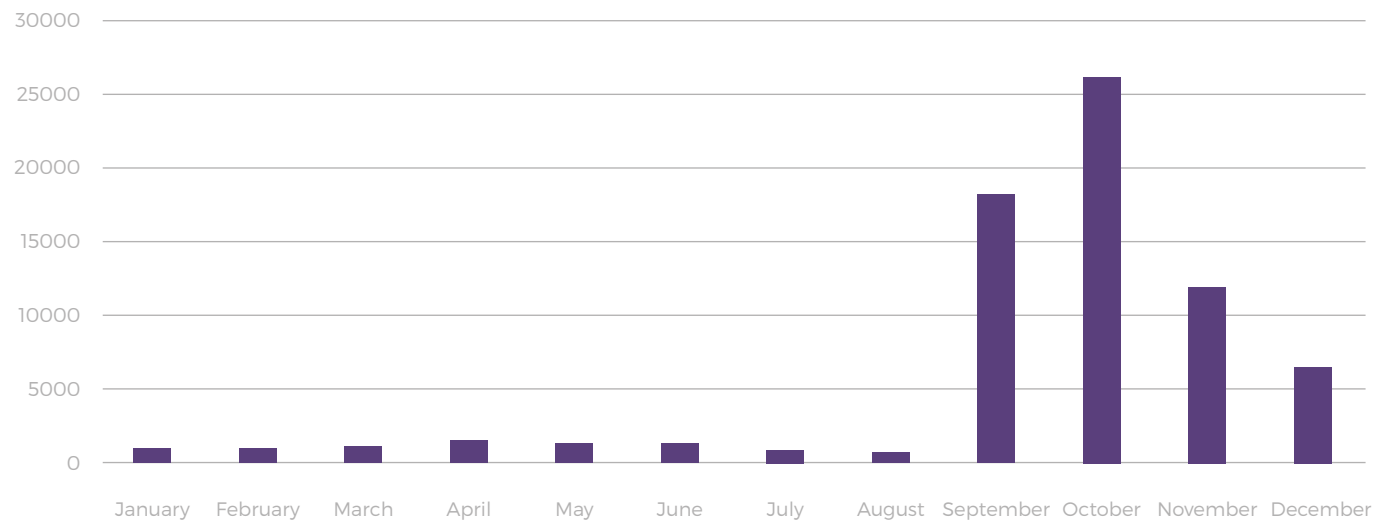
Golemio Access Statistics

Resulting indicator value shows the total number of visits in 2020. A visit is a period during which the user is actively engaged in a website, app, etc.

	2018	2019	2020
Resulting indicator value	**9,840**	**11,806**	**72,094**
Calculation	Sum of visits for individual months		

SOURCE: Google Analytics.

TRAFFIC TO THE GOLEMIO.CZ WEBSITE IN 2020



Traffic to the Pages of Individual Datasets on the Golemio Website

From the statistics of the Golemio website for individual data sets, it is clear that in 2020, there was a clear interest in data related to COVID-19. There was also interest in data on public transport, bicycle transport (which experienced strong growth during the COVID-19 pandemic in 2020 and information on shared accommodation (Airbnb experienced a sharp decline in 2020).

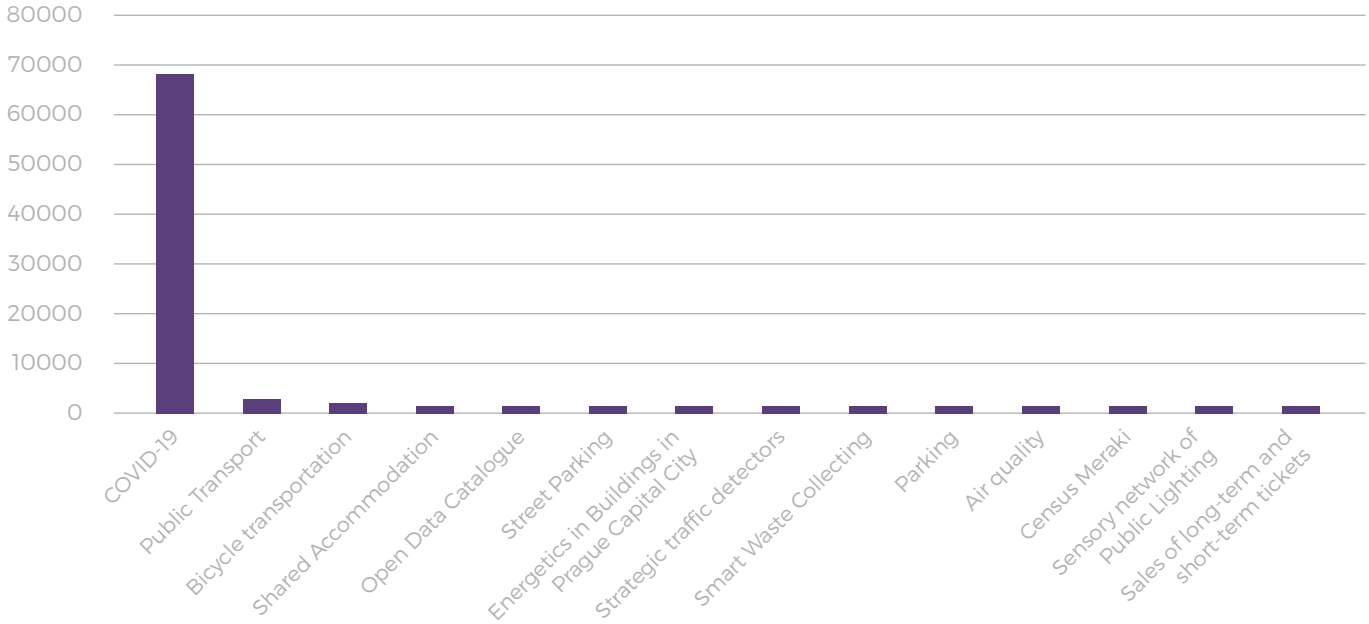
The site traffic data for each dataset for 2020 shows us unique pageviews and represents the number of visits during which a particular page was viewed at least once. A unique pageview is calculated for each combination of page URL and page title.

	2018	2019	2020
Resulting indicator value	**6,950**	**6,991**	**77,146**
Calculation	The sum of unique visits		

SOURCE: Google Analytics.

WEBSITE TRAFFIC OF INDIVIDUAL DATA SETS ON THE WEB FOR THE YEAR 2020

SOURCE: Google Analytics.



Number of Golemio Open API Users

Some of the data sources are also available in the form of a REST API via the Golemio portal. The public API was launched in the fall of 2019.

	2018	2019	2020
Resulting indicator value	**93**	**101**	**170**
Calculation	Sum of users for individual months		

SOURCE: Google Analytics.

5.1.6 Opening Data at the Prague City Hall

Based on a contractual relationship, the Golemio data platform ensures the role of coordinator of data opening for the Capital City of Prague. In 2020, the City Portal published a total of 63 data sets from 9 areas:

- received invoices,
- budget and its execution,
- financial relations between the capital and city districts,
- municipal waste charges,
- traffic offenses and temporary traffic changes,
- free non-residential premises,
- street lighting
- voting of the city council the Capital City of Prague
- data on the housing stock.

At the same time, we have greatly contributed to setting up a new process of opening data through the elaboration of an internal regulation, which clearly defines individual roles, procedures and the creation of a publication plan. The publication plan is also available on the Open Data Portal of the Capital City of Prague and is being updated during the year. At the end of 2020, an e-mail address opendata@praha.eu was set up for the public, through which it is possible to communicate with the coordinator and send feedback on published data or ideas for opening new data sets.

Our main goal when opening data at the City Hall is to make as much information as possible available to the public, so that people can use this data in real time, monitor the performance of local government or get involved in improving services themselves. Due to the fact that open data is not yet mandatory for the local government, it is necessary to exert constant pressure to move things forward, as this area is still largely unknown to most employees of the office. That is why we are pushing for the inclusion of the aspect of assessing the possibility of opening data in 2021 in the internal IT architecture, within the individual projects of digitization of the office, which will help a more systematic and better publication of information.

Opening data at the City Hall

	2019	2020
Resulting indicator value	**0**	**63**

SOURCE: Internal communication with the Prague City Hall.

5.1.7 Prague City Data Congress 2020

Prague City Data Congress 2020 focused on three thematic blocks: Circular City, Open Source, Data Innovation, a total of 17 speakers from 10 European countries and representatives of the world organization UN-Habitat spoke at the event. Keynote speech[86/] was delivered by the Taiwanese Minister for Digitization, Audrey Tang.

At the Facebook event of the PCDC, we recorded 350 registered participants and 270 on the LinkedIn platform. Due to the COVID-19 pandemic, this year's conference took place online. The event stream had 6.5 thousand when it ran simultaneously on Facebook and Vimeo and reached the total of 1.5 thousand views.

	2018	2019	2020
Number of speakers	21	33	17
Number of visitors	130	280	620

SOURCE: Internal OICT resources – Golemio data platform.

5.1.8 Prague Virtualization Project

The Prague Virtualization pilot project was successfully completed during 2020 and subsequently put into routine operation. The virtual model of Prague enables the interconnection of data in a virtual 3D model, and is thus informationally complex, which facilitates decision-making during the processes of preparation, implementation, operation and maintenance of the city's infrastructure. Both in terms of space and time, as well as in financial terms.

The system also offers spatial analysis of individual projects. The analysis itself then allows the analysis of individual steps of the project over time, their retrospective analysis and view from many viewing angles. The virtual model also provides prediction of models and allows you to change their parameters.

The advantage is that the virtual model of Prague can also be used by security forces for simulations of various crisis situations and the definition of scenarios and rules of coordination of individual entities. Crisis situations include, for example, floods, security actions, evacuation of areas, patterns of crowd behaviour, etc.

In 2020, we lent the virtual model of Prague to the Faculty of Transport of the Czech Technical University in Prague. For further development within the framework of a close partnership between the Faculty of Transport, the city district of Prague 6 and the city company Operátor ICT, a. s., however, we continue to monitor its development.

In addition, in 2020, the Laboratory of Smart Cities of the Faculty of Medicine of the Czech Technical University began to be established at the Faculty of Transport, which also included a virtual model of Prague. It is on the campus that the virtual model of the city has great potential for development and use. Drones, for example, will be part of the laboratory based on the Smart Cities concept due to their wide range of uses in the city. Otherwise, the laboratory will serve academic purposes, teaching, project analysis (e.g. Smart European) and will become part of the cooperation with the American University UTEP (University of Texas at El Paso).

SOURCE: **86/** The main lecture or contribution in a public performance.

6.

IESE CITIES IN MOTION INDEX

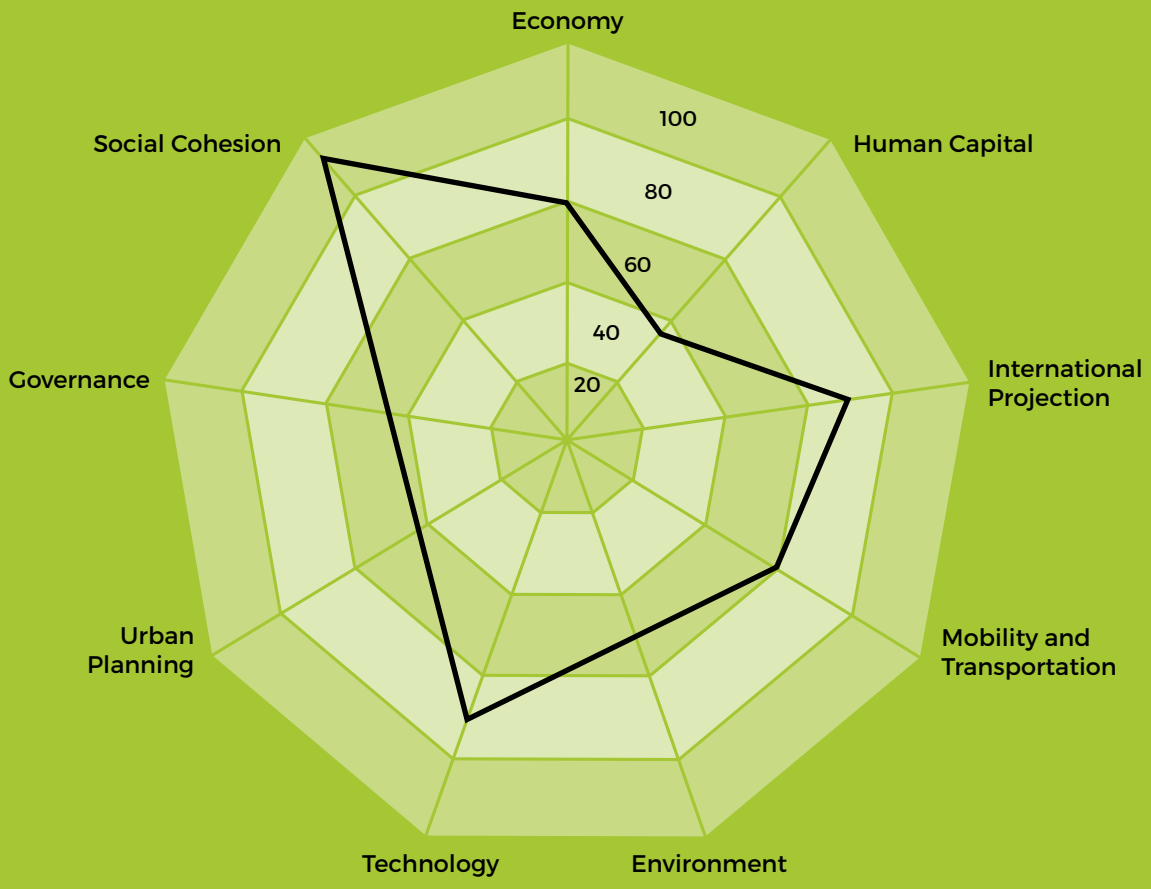
Since 2014, the IESE Cities In Motion Index (CIMI) has been published by the Centre for Globalization and Strategy together with the Department of Strategy[87/] at the IESE Business School, University of Navarra. CIMI is used to compare the sustainability and quality of life of citizens in cities, which are evaluated based on mutual comparison of individual defined indicators divided into nine thematic areas. The overall evaluation of a city for all these areas will determine its relative position in comparison with other cities and thus the overall position of the city in the ranking. It is a very comprehensive, world-famous and widespread indicator of urban maturity, which has been associated with the measurement of urban smartness since its inception. In 2020, Prague ranked 39th out of 174 evaluated cities from 80 countries, of which 79 were major capital cities. Compared to 2019, it thus improved by 8 places in the ranking of smart cities, the CIMI rating increased year-on-year from 64.97 to 65.36. Prague continued to maintain its leading position in the TOP 5 of Eastern Europe, followed by Warsaw, Tallinn and Bratislava, followed by Vilnius, replacing Budapest with the capital of Lithuania. Prague also ranked in the TOP 30 in the field of Social Cohesion.

In 2018, a new indicator was added regarding the introduction of ISO 37120 certification in urban processes. The city's certification means its determination to improve its services and increase the quality of life of its inhabitants. The essence of the complexity of CIMI is the balance of all its components. This can be understood as meaning that cities that perceive modern technologies as a major part of Smart City and do not take into account other important topics and individual needs of the city can hardly become smart.

In parallel with the development of cities, the CIMI is also developing, the number of indicators has increased by 5, thus increasing to a total of 101 indicators. A ray graph was created for each of the 174 cities, which visually shows its evaluation against the created classification for individual thematic areas, which were assigned weights according to the CIMI methodology. The exact wording is given in the English original of the IESE CIMI document: Methodology and Modelling of the Index from 2014.[88/]

SOURCE: **87/** In orig. La dirección estratégica, in ENG then The Strategic Management Department, which is why we translate it as the Department of Strategy, although partial variants may appear in the official documents.
88/ IESE Business School of the University of Navarra, IESE Cities In Motion Methodology And Modelling Index 2014. 2014. https://media.iese.edu/research/pdfs/ST-0335-E.pdf.

RAY GRAPH – PRAGUE [89/]



The picture shows that in the areas of Mobility and Transport, Environment, Technology and Spatial Planning, Prague is around average values. It reaches low values for Human Capital, while it reaches high values in the International Impact and the highest values in the case of Social Cohesion. In the area of Administration, Prague has significantly improved compared to 2020.

The table below shows the location of the Capital City of Prague according to the evaluation of the set indicators within the individual topics from 2017 to 2020. The most significant improvement was achieved in Governance, where Prague moved by 47 places without changing the indicators. There was also a significant improvement, a shift of 20 places, in Human Capital, where only the indicator Leisure and leisure expenses was adjusted, which in 2019 was calculated as an amount in millions of dollars (prices from 2016) and in 2020 the calculation was based on the percentage of GDP. In the area of Technology, the ranking of the capital city decreased from the 46th position down to the 79th place. The reason for such an assessment is mainly a repeated change in the monitored indicators. Indicators have been added regarding internet coverage and the use of online services. The number of registered Twitter and LinkedIn users was unified into one indicator called Social Networks. In 2019, the indicator Mobile Phones expressing the number of mobile phones in the city was based on an estimate of national data, in 2020, it was already the ratio of mobile phones, i.e. the number of fixed lines per 100 inhabitants. The following indicators have been added: 3G coverage – percentage of the population having at least 3G coverage, Online banking – percentage of the population using Internet banking services, Online video calls – percentage of the population using video calls over the Internet; LTE / WiMAX – percentage of the population that has coverage of at least one LTE / WiMAX mobile network.

SOURCE: **89/** IESE Business School of the University of Navarra, IESE Cities In Motion 2020, 2020, p. 93 available at https://media.iese.edu/research/pdfs/ST-0542.pdf, check on 6 April, 2021

Location of Prague Capital City between 2017 and 2020[90/]

PRAGUE	2017	2018	2019	2020	YEAR-ON-YEAR CHANGE
Economy	93	82	96	88	↑ 8
Human capital	73	61	57	37	↑ 20
Social Cohesion	5	31	29	22	↑ 7
Environment	14	23	26	30	↓ 4
Governance	114	60	82	35	↑ 47
Landscape Planning urban planning	21	94	81	90	↓ 9
International projection	16	27	20	23	↓ 3
Technology	105	18	46	79	↓ 33
Mobility and Transfer	67	66	57	44	↑ 13
Overall Ranking	**41**	**40**	**47**	**39**	↑ **8**

SOURCE: **90/** Compare see IESE Business School of the University of Navarra, IESE Cities In Motion 2017. 2017. p. 61. IESE Business School of the University of Navarra, IESE Cities In Motion 2018. 2018. p. 71. IESE Business School of the University of Navarra, IESE Cities In Motion 2019. 2019. p. 82 and IESE Business School of the University of Navarra, IESE Cities In Motion 2020, 2020, p. 93.

7.

SUMMARY 2020

7.1 MOBILITY OF THE FUTURE

Mobility has experienced dynamic development in recent years, aided by the advent of new technologies. At the same time, the year 2020 brought certain specifics with regard to the COVID-19 pandemic. Measures related to the restriction of mobility have contributed e.g. to reduce the number of vehicle kilometres travelled by public transport vehicles, tickets sold and text message tickets or also the time spent in congestion.

The dynamics of the development of mobility and related infrastructure is evident especially regarding electromobility. There has been a sharp increase in the number of electric cars over the last year, which is putting pressure on the development of charging infrastructure and an increase in the number of publicly available charging stations. The plan for their development over the decades should proceed in the direction prepared by the ICT Operátor in cooperation with municipal companies and departments of the Capital City of Prague in a document entitled General Development of Charging Infrastructure in Capital City of Prague by 2030. However, the construction of infrastructure has been running for several years and by 2020 there were 315 charging stations in the Capital City of Prague. On average, there was one charging station on an area of 1.57 km². There was also a significant shift in the level of e-carsharing, when there was a more than threefold increase in the number of shared electric cars. In the case of public transport, the trend in the development of electromobility is slower. Dopravní podnik of the Capital City of Prague has implemented a number of pilot projects in order to test specific technologies. In 2020, the share of electric buses in the DPP fleet was still low. However, with regard to the gradual renewal of the vehicle fleet and the fulfilment of new PID quality standards, an increase in the number of electric buses can be expected in the coming years.

Transport at rest, which is an important part of transport systems, is developing on the basis of the use of sensors that ensure the monitoring of the current occupancy of individual car parks (e.g. P+R). The future development of intelligent parking may also aim at parking space reservations. Over the last year, the share of traffic lights connected to the Main Traffic Control Centre has increased slightly to 75 %. The number of intersections equipped with traffic lights with a preference for public transport and smart elements of transport infrastructure is also growing slightly. Regarding autonomous mobility, no significant progress has been made to change the position of autonomous management. The share of automatic control of a metro train with a driver has shifted to 84 % of the total number of sets. In the future, this share will be strongly influenced by the planned metro line D, where the deployment of a fully autonomous train set is expected.

In the area of air pollution, there has been no significant deviation from the situation in recent years. One of the major sources of pollution is older cars with diesel engines, which do not yet have a particulate filter and whose exhaust gases contain a number of small dust particles caused by imperfect combustion of diesel. In the conditions of the Capital City of Prague, a number of interventions are being implemented to detect such polluters directly in operation and thus contribute to the reduction of air pollution. However, long-term problematic localities continue to show above-limit values. Typically, these are sites that are highly frequented (e.g. Prague 2 – Legerova).

7.2 WASTE-FREE CITY

The year 2020 was very specific. The COVID-19 pandemic has also affected waste management and changed traditional patterns of waste management. Despite this difficult period, the Capital City of Prague did not lag behind and introduced several innovations in the waste sector. All are based on the Smart Prague 2030, action plan, which is a concept based on the use of state-of-the-art technologies in order to improve the lives of Prague residents and the sustainable development of Capital City of Prague. The plan is to purchase a new sorting line for plastic

waste, which should be installed in 2021. Thanks to the ability to separate several types of plastic waste, including PET bottles and by colour, the line will enable the sale of waste to specialized companies and thus better recycling.

Starting on the January 1st, 2020, the fee for municipal waste was increased by 30 % first in 15 years and a fee for the collection of biological waste was newly introduced in the conditions of Prague. The difference between costs and revenues for municipal waste has thus narrowed. Revenues covered 66 % of costs, an increase of 10 % compared to 2019. In addition to the aforementioned fee from citizens, a higher remuneration from EKO-KOM and a fee for the collection of biowaste and edible oils also contributed to the increase in income.

The total amount of municipal waste shows a slight increase compared to previous years. In 2020, a total of 451,800 tons of municipal waste was produced, which is almost 12,000 tons more than in 2019. However, the increase in mixed municipal waste was not so significant (SKO totalled 257,000 tons) and its share in the total amount of municipal waste decreased by almost one percent (to 57 %) compared to the previous year.

Biowaste is also being newly sorted in Prague. Pražské služby started offering the collection of biowaste of plant origin at the end of 2019 and since then both the number of brown containers placed in the streets of Prague and the total production of biowaste have been growing. Biowaste is then transported to composting plants in Prague and the Central Bohemian Region for the production of quality compost. Used edible fats and oils can be handed over by citizens in all collection yards and, since 2020, also into special containers located in the streets of Prague.

The year 2020 was very important in the area of re-use or "use it again", when during the second half of the year a pilot project of re-use points was launched in three collection yards. They are equipped with a special closed large storage container for storing bulky items (such as furniture, sports equipment, strollers, medical aids, etc.) and a separate place for storing small items (dishes, books, toys, etc.).

In 2020, the Capital City of Prague has started the routine operation of the innovative Smart Waste Collection project, which consists in the installation of sensors for measuring the filling level in waste containers for sorted waste with a bottom dump. The sensors, together with a specially developed software tool, will enable city employees to monitor the yield of containers and more efficiently plan the waste collection schedule. Modern and innovative tools can purposefully reduce the environmental burden, effectively use the capacity of currently available waste containers, and thus respond operationally to changes.

Despite the pandemic, Prague did not slow down last year and took further steps towards sustainable development and modernization of waste management. It has been a challenging year for all cities and industries, but the difficult period has helped to reveal the strengths and weaknesses that need to be worked on. The Capital City of Prague believes that by combining the use of state-of-the-art technologies and a circular economy, a sustainable and circular city can be achieved and the lives of its citizens in Prague improved.

7.3 SMART BUILDINGS AND ENERGY

Ensuring energy needs for the Capital City Prague is one of the key areas, which is crucial to aim at today and in the future. Due to the approved climate commitment, it is necessary to set up energy processes so that in 2030 in the Capital City of Prague will produce by 45 % less CO_2 emissions compared to 2010. The first step towards this goal was taken by the Capital City of Prague by the establishment of the energy manager's department, which started its operation at the end of 2020. At the same time, a climate plan was prepared in 2020 which will define the areas and activities on which it is necessary to focus in order to meet the climate commitment.

The Capital City of Prague will have to focus on consumption and the methods of electricity production. At present, electricity production from fossil fuels continues, which needs to be changed in the future. This, of course, is not just an issue of the Capital City of Prague, but it is about setting the energy concept of the whole Czech Republic.

If we look more closely at the events in the energy sector in 2020, we can say with certainty that in 2020 the energy sector was also strongly affected by the ongoing COVID-19 pandemic. In 2020, electricity consumption in the Czech Republic reached a five-year low of 71.4 TWh.[91/] Electricity consumption decreased especially in the corporate sector, where there was a significant reduction in traffic, while electricity consumption in households increased as many more people used home offices or cared for children. The annual consumption of electricity, heat and gas in buildings owned by the Capital City of Prague decreased compared to 2019 by 7 %. In the buildings owned by the Capital City of Prague, there was mainly reduced consumption of electricity and heat. Decrease in energy consumption and issuance of a new decree no. 264/2020 Coll., on the energy performance of buildings, there are two main factors why the consumption of primary non-renewable energy also decreased by 20 %. Among other indicators, it is also good to mention the continuing growing trend of installation of remote energy readings at all energy distributors in 2020 as well.

In the area of Smart Building and Energy, a decrease was recorded for all indicators related to energy and water

SOURCE: **91/** https://www.eru.cz/-/vyroba-elektriny-byla-loni-nejnizsi-za-18-let-spotreba-klesla-na-petilete-minimum, kontrola 26. 6. 2021.

consumption in 2020. On the contrary, the growing trend for indicators related to the development of smart solutions and services continues. For example, THMP implemented several pilot projects in 2020, which resulted in a significant increase in smart lamps in the Capital City of Prague.

7.4 ATTRACTIVE TOURISM

Despite the unfavourable situation with regard to the restriction of tourism during the COVID-19 pandemic, the Capital City of Prague continues to maintain the reputation of an important tourist destination. In the prestigious comparative rating of Travellers Choice by the travel server TripAdvisor, it took the 14th rank among the popular destinations from around the world in 2020, among the most popular destinations in Europe.

Prague welcomed only 2.2 million tourists due to the restrictions associated with the COVID-19 pandemic, so its attendance decreased by 73 % compared to 2019. when it welcomed almost 8 million tourists. Foreign and local visitors spent a total of 4.9 million nights in Prague's mass accommodation facilities. The average overnight stay in 2020 was 2.2 nights, and it can be concluded that this figure remained relatively comparable year-on-year. To illustrate the previous, tourist-exposed year, it was 2.3 nights. The very definition of mass accommodation means that guests staying in other types of official and unofficial accommodation (e.g., individual accommodation, Airbnb or accommodation in unpaid accommodation – stay with friends and relatives) are not included. It is important to point out that the information is only available from official accommodation facilities, according to unofficial estimates, the real values can be up to double.

In the year-on-year comparison due to the aforementioned restrictions, due to the COVID-19 pandemic, the number of interactions in information centres decreased significantly by around ¾ from more than 2 million to less than half a million.

Innovative technologies continue to form one of the important pillars for the coordinated and even development of tourism. The long-term need to sensitively channel tourist flows in order to relieve congested locations in favour of less busy and attractive tourist sites remains as an incentive for the development and implementation of new ideas for tourism projects.

The Prague Tourist Card, which is now being pilot-tested and will be introduced for public pilot-operation after the return of normal tourist traffic to Prague, has great potential in this respect. For this reason, unfortunately, relevant data for 2020 are not available. In the future, it will be possible to create tourist-oriented heatmaps based on data from the Prague Tourist Card. In the field of tourism, the unused potential of Big Data for the development of tourism is evident. Unfortunately, the deployment of AI and the automation of data collection and processing related to tourism and augmented reality remain at the level of reflection and ideas.

Currently used data sources for managed development include work with social networks and the web (e.g. Google Analytics) and newly Prague has been testing work with statistical data from payment card providers.

An interesting fact is that despite the unfavourable situation in tourism, the number of beds and rooms in accommodation facilities continued to increase slightly year-on-year. The data from the Czech Statistical Office showed that between 2019–2020 there was an increase of almost 2,000 rooms and more than 8,000 beds.

7.5 PEOPLE AND THE URBAN ENVIRONMENT

An area of People and urban environment is the key area in terms of direct interaction and contact between the city and its inhabitants. The area thus reflects the development of the city's influence on its visitors and residents, both in terms of the environment in which they move and in terms of services and participation. From the experience with the COVID-19 pandemic from 2020 it will be possible to draw ideas for projects that would enable Prague to successfully face future challenges, reconcile often conflicting interests of different groups, maintain and develop Prague's public environment safe and pleasant to live in the future. This can be achieved through the use of modern technologies and the development of urban mobile apps.

In 2020, the values of the indicators of the My Prague mobile apps, and Změňte.to and the web form I Have an Idea increased. The apps are used by more people (e.g. increase of less than 1,500 users Změňte.to), more proposals are submitted (e.g. an increase of 2,323 suggestions in the Změňte.to) and also more submitted proposals are being implemented.

Automated camera systems, or those of them that are connected to the analytical system (video detection in tunnels and a complete telematics transport system), were expanded last year by 32 new cameras (a total of 639 cameras). Gradually, there is a transition from intensive development and increasing the number of cameras in the city to strengthening the qualitative aspects, e.g. development of infrastructure, data storage, etc.

Data for the subcategory City for a healthy lifestyle are now being monitored. The aim of the area is to map and develop smart solutions with an impact on the physical and mental health of the population. The main step in this area was the creation of the COVID portal, which helps people get oriented during the pandemic. The website had an average traffic of 4,000 users per day in 2020, and the most in the month of December.

In 2020, there was a further increase in the number of technologies for urban greenery, for example, urban green areas with smart solutions were registered in 2020 by 4 more than in 2019 (6), there was an increase in the number of vertical gardens in Prague (5) and an increase of growing communities by 12 compared to 2019 (43).

In the area of innovative furniture pedestrian counters were introduced in five localities compared to 2019. There was also a significant increase in the number of pieces of smart furniture to 1,070 pieces. This increase was due to the installation of 449 new smart lamps. In 2020, there are currently more than 2 pieces of intelligent furniture per 1 km² in Prague. Another significant increase in 2020 is the coverage of the metro by mobile signal by 20 stations (36 in total).

The second newly monitored area is the area of Digitization and Participation. Launching the Prague Portal in the autumn 2020 was a significant achievement. Four agendas were put into operation in 2020; a waste fee, filling in and sending electronic forms, booking a visit to the office and arranging residential parking. In terms of participation, the participatory budget of individual city districts was monitored. In 2020 it was introduced by 13 Prague districts (22.8 % of all districts) with an allocation of approx. CZK 31.7 mil. (0.36 % of the total budget). The success of the participatory budget, i.e., the share of selected projects for implementation in relation to the total number of projects proposed by the inhabitants of Prague Capital City, decreased by 8 percentage points year-on-year from 45 % to 37 %.

7.6 DATA AREA

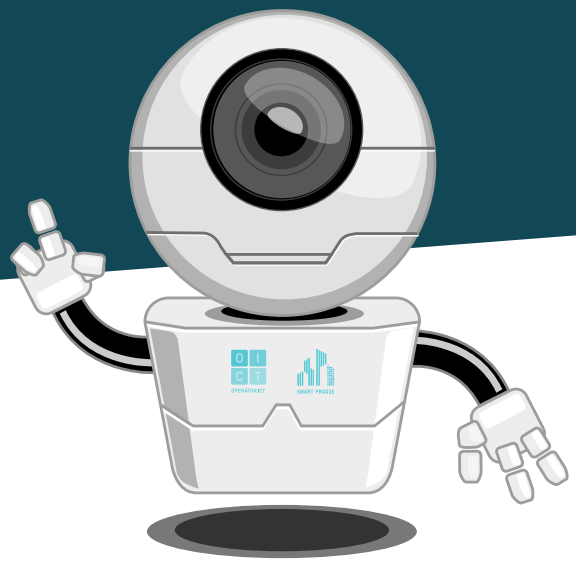
The Golemio data platform continued its development in 2020 and at the same time became an important tool for the city in coping with the course and consequences of the COVID-19 pandemic.

Of course, the COVID-19 pandemic significantly affected most of 2020, but even then, a number of projects were developed, such as the development of the Golemio BI platform for making information available to city officials, city districts and city companies. Together with the advancing COVID-19 pandemic, the data platform, through analysis and dashboards, continuously expanded the group of data on the COVID-19 pandemic, published by the Ministry of Health and UZIS, so that the city could better respond to the development of current situation. The tools provided include, for example, simulations of hospital bed occupancy or tools for vaccine distribution. The covid.praha.eu project became an important help, providing information on available sampling points for various types of tests in connection with the COVID-19 pandemic, including information on the nearest available dates, in an easy-to-use form.

Up-to-date information on the positions and delays of DPP buses and trams was also made available, which significantly expanded the comfort provided to passengers within the PID.

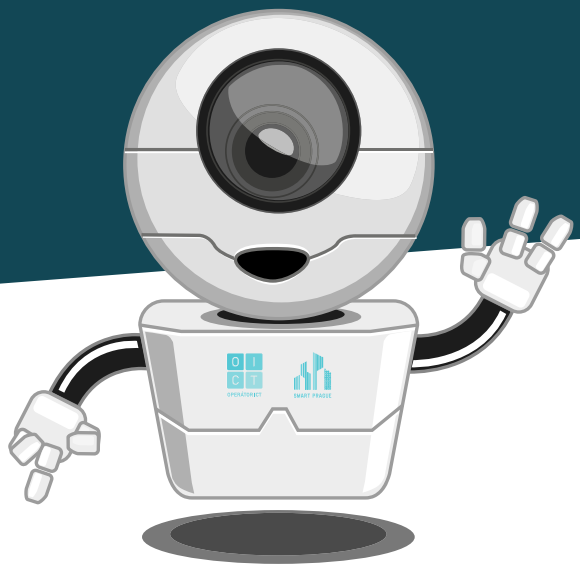
In 2020, the annual Prague City Data Congress took place online, which facilitated the participation of many personalities from around the world, as well as the involvement of more spectators.

8. SET OF MONITORED INDICATORS



9. LIST OF **ABBREVIATIONS USED AND EXPLANATION OF TERMS**

ABBREVIATION	TITLE	EXPLANATION
AC	Alternating Current	Alternating current
AI	Artificial Intelligence	Artificial intelligence is a field of informatics dealing with the creation of machines solving complex tasks, for example, in the fields of logistics, robotics, natural language processing or big data processing.
API	Application Programming Interface	Application Programming Interface
AVE, a. s.	AVE Pražské komunální služby, a. s.	
BEPC	Building Energy Performance Certificate	The building energy performance certificate is used to evaluate the energy performance of the building – it quantifies all energy consumed in the standardized operation of the evaluated building and (similarly to the energy label of the appliance) classifies the building in the appropriate class in the range A – G. The certificate evaluates all the energy needed for the operation of the building, ie energy for heating, hot water preparation, cooling, air treatment by ventilation and air conditioning and energy for lighting. The certificate can be processed for any building or its integral part.
BEV	Battery Electric Vehicles	
BI	Business Intelligence	
BREEAM	British Research Establishment	
BSI	British Standards Institution	The British Standards Institution is the national standards body of the United Kingdom. BSI develops technical standards for a wide range of products and services and also provides certification and standards-related services to companies.
BTS	Base Transceiver Station	The base transfer station is a transmitter and receiver of radio signals (e.g. mobile phones).
BW	Bulk waste	
C-ITS	Cooperative Intelligent Transportation Systems	Cooperative ITS systems allow direct communication between a vehicle unit and a unit located in another vehicle or equipment on the transport infrastructure.
CCS	Combined Charging System	
CCS	City camera system	
CCTV	Closed Circuit Television	Closed television security system
CIMI	Cities in Motion	
CNG	Compressed Natural Gas	Compressed Natural Gas (Methane). It is used as a fuel to power motor vehicles and is considered a cleaner alternative to petrol and diesel.
CPS	Cyber-Physical-System	A cyber-physical system is a computer system in which the mechanism is controlled or monitored by computer algorithms.
ČD	České dráhy, a. s.	
ČHMÚ	Czech Meteorological Institute	
ČOV	Čistírna odpadních vod	
ČR	The Czech Republic	
ČSÚ	Czech Statistical Office	
ČÚZK	Czech Office for Surveying and Cadastre	
ČVUT	Czech Technical University in Prague	
ČZÚ	Czech University of Life Sciences in Prague	



DC	Direct Current	Direct current
DEP CCP	Department of Environmental Protection of the City of Prague	
DH	Thermal energy supply system (District Heating)	
DoT	Department of Transport	
DP	Datová platforma	
DPP	Dopravní podnik hl. m. Prahy, a. s.	Transport Company of the Capital City of Prague (Plc.)
DUN	Rainwater Reservoirs	Rainwater reservoirs are designed to capture the main share of rainwater pollution flushed from the terrain into the rainwater drainage system in order to reduce water pollution in watercourses.
e-bus	An electric bus	An electric-powered bus. This also includes trolleybuses, which are otherwise considered as rail vehicles under valid legislation.
EERW	Equipment for energy recovery of waste	The incinerator in Malešice, operated by Pražské služby, a. s. (Plc.)
EPC	Energy Performance Contracting	A comprehensive service that includes the design of cost-saving measures, preparation, implementation and financing of a project leading to energy savings in buildings.
ETI	Equipment for traffic information	Light board on the road providing the necessary information about the traffic situation and warnings for drivers
EU	The European Union	
EV	Electric vehicle	A vehicle with a purely electric power unit.
EY	Ernst & Young, s.r.o.	
FCD	Floating Car / Cellular Data	A method that uses a fleet of vehicles to give the most accurate picture of the traffic situation. This is based on collecting location data, speeds, the direction of travel and time information from mobile phones in vehicles in operation.
GDP	The gross domestic product	
GPS	Global Positioning System	It is a global satellite positioning system. This system can determine the position of the signal receiver based on the signal received from the satellites.
GS	Grammar school	
GVA	Gross value added	
HDŘÚ	Main traffic control panel	The main traffic control centre provides central supervision of the traffic situation, central coordinated traffic management in the territory of the Capital City of Prague and provides current and verified traffic information. The sources of this data are, for example, telematics devices, the systems of the Police of the Czech Republic, the Fire and Rescue Service and the Medical Rescue Service, or also the Central Registration Register system. All information about the traffic situation is processed by the MTCC Control System, which automatically responds to the given traffic situation by invoking the so-called control scenarios. The individual scenario steps then result in changes in the state of telematics devices to ensure smooth traffic flow
HW	Hardware	
ICS	Integrated camera system	
IEEE	Institute of Electrical and Electronics Engineers	An international non-profit professional organization striving for the rise of technology related to electrical engineering

IoE	Internet of Energy	A technological term that refers to the modernization and automation of electricity infrastructure for energy producers and processors. As a result, energy production can proceed more efficiently and cleanly with as little waste as possible.
IoP	Internet of People	The Internet of People is about digitizing human relationships and collecting, processing and using personal data. It creates a network of collective intelligence and stimulates interactive communication between our digital selves through digital devices, the Internet and data sharing.
IoS	Internet of Services	Within the Internet of services, everything needed to use software applications is available as a service on the Internet, including the software itself, tools for its development and platforms (servers, storage and communications) for its operation.
iOS	iPhone Operating System	Apple Inc. mobile phone operating system
IoT	Internet of Things	Internet Of Things
IPR	Institute of Planning and Development	
IRS	Integrated Rescue System	The IRS includes: police, fire brigade, rescue service and others (mountain service...)
ISO	International Standard Organization	International organization for normalization is the world federation of national organizations resident in Geneva.
IT	Information technology	
ITS	Intelligent Transportation Systems	Intelligent transport systems include, for example, variable traffic signs, camera systems and much more.
kt	kilo-ton	A thousand tons
LAT	Lower Assessment Threshold	The lower assessment threshold is a value lower than the limit value and is defined as a percentage of the limit value for a specific pollutant. When this limit is exceeded, measurement in the given locality is mandatory, but it can be performed at longer time intervals.
LEED	Leadership in Energy and Environmental Design	
LTE	Long Term Evolution	
LV	Limit Value	The limit value refers to the limit values for pollutants.
LZA	Line train protection device	Line train protection device with automatic guidance of metro trains
MaaS	Mobility as a Service	
MD	Municipal District	
MIT	Massachusetts Institute of Technology	Massachusetts Institute of Technology
MW	Municipal waste	
MOS	Multi-channel check-in system	
MEHCS	Metropolitan emergency and health care system	
MoE	Ministry of Environment	
N/A	Not available	
NB-IoT	Narrowband IoT	Low Power Wide Area Network radio technology standard developed by 3GPP for a wide range of mobile devices and services
OBU	On-Board Unit	On-board unit in the vehicle
OICT	ICT operator, a. s.	
OSF	Open Society Foundations	
P+R	Park & Ride	Parking lots located near public transport hubs, where the driver parks his vehicle and continues to the city by public transport.
pc	Piece	
PCDC	Prague City Data Congress	
PCH	Prague City Hall	
PCR	Polymerase Chain Reaction	
PCT	Prague City Tourism	
PHEV	plug-in hybrid	
PIT	Prague integrated transport	
PPZ	Paid parking zones	
PM 10	Particulate Matter	Particulate matter (PM is the abbreviation of the English term "particulate matter") is a term for microparticles several micrometres (μm) in size. Particles have their specific size designation – for example, PM10 refers to airborne dust with a size of 10 micrometres.

PRE	Pražská energetika, a. s.	
PREdi	Pražská energetika distribuce, a. s.	
Public transport	Public transport	
PVK	Pražské vodovody a kanalizace, a. s.	
PVS	Pražská vodohospodářská společnost, a. s.	
QoL	Quality of Life	According to Britannica, quality of life is the degree to which an individual is healthy, comfortable and able to participate in or enjoy life events.
RDS – TMC	Radio Data System – Traffic Message Channel	It is a system designed for the transmission of additional information about traffic in the networks of VHF FM radio transmitters. Using this system, traffic information is projected on car navigation maps.
ROPID	Regional organizer of Prague integrated transport	
RSU	Road site unit	Devices supporting radio communication with vehicles on the road. It is an infrastructural stationary device located next to or above the road.
RTCC	Regional traffic control Pragers	
RZ	Vehicle registration plate	Vehicle registration plate (formerly license plate – state license plate)
S-CPS	Socio – Cyber-PhysicalSystem	
SBToolCZ	Sustainable Building Tool	
SC	Smart City	A way of organizing a city using information and communication technologies for more efficient management of urban space
SKO	Mixed municipal waste	
SOS	Save Our Souls	The most famous international distress / distress signal in the Morse code
SP	Smart Prague	Strategic framework for the reconstruction of the capital in the spirit of the Smart Prague 2030 Concept
SPI	Smart Prague Index	
SUMP	Sustainable Mobility Plan	Sustainable mobility plan
SW	Software	
TAČR	Technology Agency of the Czech Republic	It is an organizational unit of the state, which was established in 2009 by the Act on the Support of Research, Experimental Development and Innovation. The Technology Agency of the Czech Republic centralizes state support for applied research and development, which until then had been fragmented among a large number of providers.
TCO	Total Cost of Ownership	Total cost of ownership is a financial estimate designed to help buyers and owners determine the direct and indirect cost of a product or service. It is a concept of managerial accounting that can be used in full cost accounting, or even in ecological economics, where it includes social costs.
THMP	Technologie hlavního města Prahy, a. s.	Prague Technologies (Plc.)
TL	Traffic light	A system of devices used to control traffic on roads. The signalling part of the system is called the traffic light.
TSK	Technická správa komunikací hl. m. Prahy, a. s.	Technical Administration of Roads (Plc.)
UAT	Upper Assessment Threshold	The upper limit for assessment is a value lower than the limit value and is defined as a percentage of the limit value for a specific pollutant. When this limit is exceeded, measurement in the given locality is mandatory.
URL	Uniform Resource Locator	
ÚČOV	Central wastewater treatment plant	
V2I	Vehicle to Infrastructure	Communication and exchange of information between the vehicle and the infrastructure element
V2V	Vehicle to Vehicle	Communication and exchange of information between two vehicles
Vehicle category M1		Vehicles max. for 8 persons (except the driver) with the total weight up to 3.5 tons
VHD	Public passenger transport	
VO	Smart Lighting	
WCCD	World Council on City Data	
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58/ Tourism – Region CZSO in Prague Capital City (**czso.cz**), check on 26 June 2021.

59/ Tourism – Region CZSO in Prague Capital City (**czso.cz**), check on 26 June 2021.

60/ UNESCO – Prague (**mistopisy.cz**), check on 26 June 2021.

61/ Population – Region CZSO in Prague Capital City (**czso.cz**), check on 26 June 2021.

62/ "Write us your idea", SmartPrague, available from **https://www.smartprague.eu/mam-napad**, check on 26 June, 2021.

63/ "Prague Sports – Sports and leisure activities", available from **https://prahasportovni.eu/**, check on 26 June 2021.

64/ **https://prahasportovni.eu/**

65/ It is the sum of agricultural land (arable land, gardens, orchards, vineyards, permanent grasslands) and forest area according to ČÚZK yearbooks. See: **https://www.cuzk.cz/Periodika-a-publikace/Statisticke-udaje/Souhrne-prehledy-pudniho-fondu/Rocenka_pudniho_fondu_2021.aspx**

66/ **https://www.obnovitelne.cz/clanek/539/v-boji-proti-horku-ve-mestech-pomahaji-zelene-strechy-a-fasady/**, check on 26 June 2021.

67/ **https://www.ekocentrumkoniklec.cz/vertikalni-zahrada/**, check on 26 June 2021.

68/ **https://www.idnes.cz/praha/zpravy/chytra-lavicka-magistrat-zahrada-uschla-vyrobce-zaleval-na-vlastni-naklady.A190823_154552_praha-zpravy_rsr**, check on 26 June 2021.

69/ **https://www.idnes.cz/bydleni/stavba/vertikalni-zahrady-spolecnost-nemec-afi-karlin.A181116_104546_stavba_rez** Business centrum Karlín, check on 26 June 2021.

70/ **http://www.stavbaroku.cz/printDetail.do?Dispatch=ShowDetail&siid=1756**, check on 26 June 2021.

71/ **https://www.denik.cz/regiony/na-viteznem-namesti-roste-chmelova-stena-sestak-ochrani-pred-prachem-a-horkem-20200501.html**, check on 26 June 2021.

72/ "Map of community gardens and composters | Mapotic ", available at **https://www.mapko.cz/**, check on 26 June 2021.

73/ **https://www.vutbr.cz/www_base/zav_prace_soubor_verejne.php?file_id=44018**, check on 26 June 2021.

74/ **https://www.dpp.cz/cestovani/mobilni-signal-v-metru**, check on 26 June 2021.

75/ **https://www.participativni-rozpocet.cz/wp-content/uploads/2017/05/Participativni_rozpocet-CZ.pdf**, check on 26 June 2021.

76/ Questionnaire survey for SPI 2020.

77/ "Prague in numbers", available from **https://www.pragozor.cz/**, check on 26 June 2021

78/ Metrics – in the IT sphere, in general, quantitative measurement of a certain indicator, KPI (Key performance indicator) usually monitor the most important metrics, e.g. attendance, number of passengers, quantity of products sold, etc.

79/ API – Application programming interface.

80/ OICT, Prague Data Platform Golemio, GitLab, 2019. **https://gitlab.com/operator-ict/golemio**, check on 2 June 2021

81/ That means from the test environment to the official live version.

82/ BI or business intelligence, a more advanced form of data processing and interpretation, usually in the form of visualizations so that people outside the data fields can understand and interpret the relevant data themselves.

83/ See for instance: Image no. 8; dashboard is a visual user environment giving a basic overview of the key indicators of a given visualization, usually allowing some form of interaction.

84/ Prokop Kanopa, "Results of the National Round 2020", Golden Coat of Arms, 11/2020, **https://www.zlatyerb.cz/vysledky-celostatniho-kola-2020/d-1598/p1=1755**, check on 6 June 2021.

85/ OSF Foundation, "We open the 2020 data together competition", OSF Foundation, accessed 2. May 2021.**https://osf.cz/programy/ziva-demokracie/nas-stat-nase-data/soutez-spolecne-otevirame-data-2020/**, check on 2 June 2021.

86/ The main lecture or contribution in a public performance.

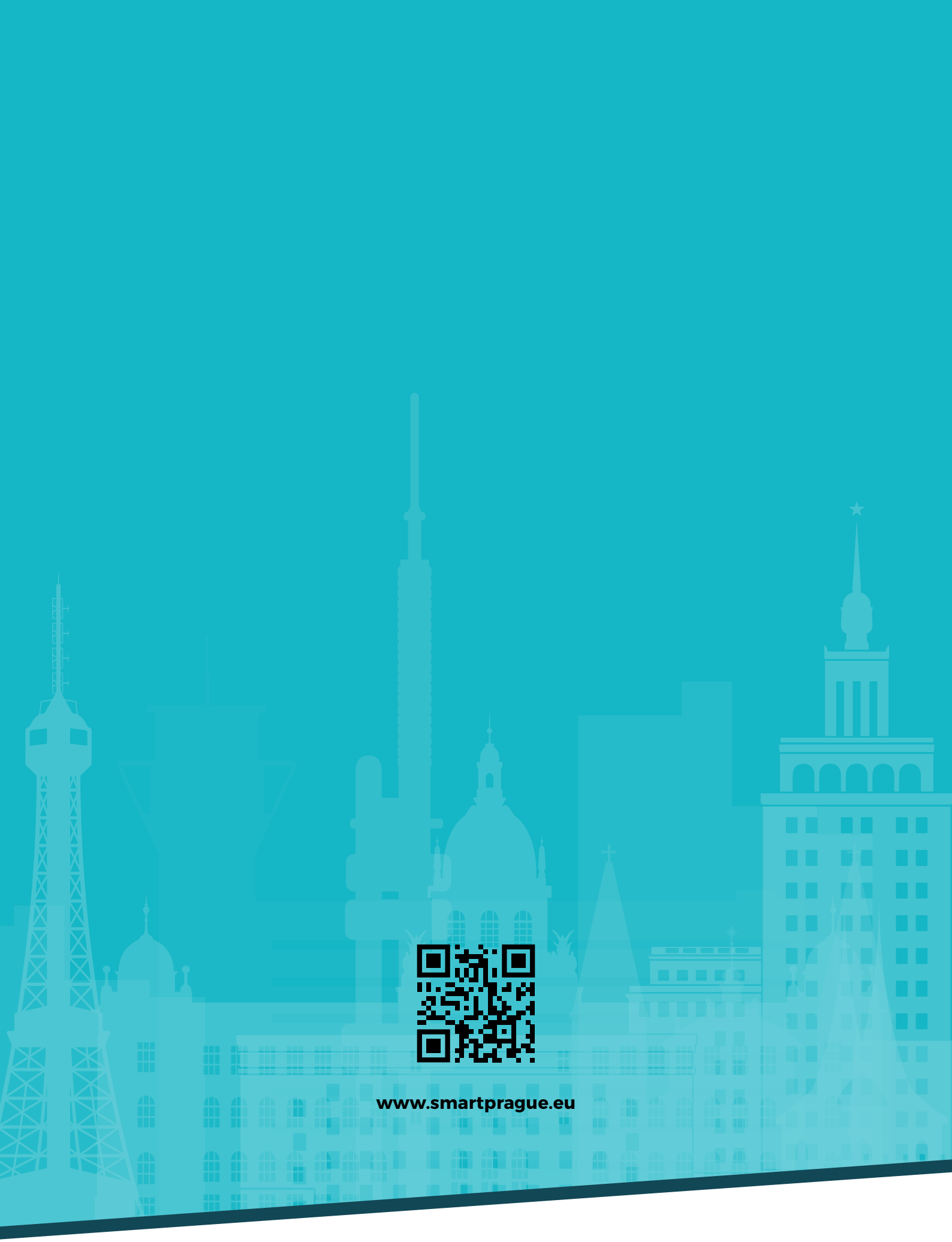
87/ In orig. La dirección estratégica, in ENG then The Strategic Management Department, which is why we translate it as the Department of Strategy, although partial variants may appear in the official documents.

88/ IESE Business School of the University of Navarra, IESE Cities In Motion Methodology And Modelling Index 2014. 2014. **https://media.iese.edu/research/pdfs/ST-0335-E.pdf**.

89/ IESE Business School of the University of Navarra, IESE Cities In Motion 2020, 2020, p. 93 available at **https://media.iese.edu/research/pdfs/ST-0542.pdf**, check on 6 April, 2021.

90/ Compare see IESE Business School of the University of Navarra, IESE Cities In Motion 2017. 2017. p. 61. IESE Business School of the University of Navarra, IESE Cities In Motion 2018. 2018. p. 71. IESE Business School of the University of Navarra, IESE Cities In Motion 2019. 2019. p. 82 and IESE Business School of the University of Navarra, IESE Cities In Motion 2020, 2020, p. 93.

91/ **https://www.eru.cz/-/vyroba-elektriny-byla-loni-nejnizsi-za-18-let-spotreba-klesla-na-petilete-minimum**, check on 26 June 2021.



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