# SMART PRAGUE INDEX

SMART PRAGUE

OPERÁTOR ICT

OPERÁTOR ICT

## We create a technological future for a better life in Prague

### Smart Prague and innovations

### IT services

### Mobility as service


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The Smart Prague Index was developed in cooperation with the consultants Ernst & Young, s.r.o. (EY).

Publisher:
Operátor ICT, a.s.
Dělnická 213/12, 170 00 Prague 7
1st edition, Prague, 2020
ISBN 978-80-270-8011-3

OPERÁTOR ICT

SMART PRAGUE

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# 1. LIST OF ABBREVIATIONS USED AND EXPLANATION OF TERMS

| ABBREVIATION | NAME | EXPLANATION |
|---|---|---|
| AC | Alternating current | An electric current that periodically reverses direction |
| API | Application Programming Interface | An interface used for apps and their programming |
| BTS | Base transceiver station | A base transceiver station is a radio signal transmitter and receiver (e.g. for mobile phones). |
| CIIRC | Czech Institute of Informatics, Robotics and Cybernetics | |
| CNG | Compressed Natural Gas | Methane stored at high-pressure CNG is used as fuel for motor vehicles and is considered a cleaner alternative to petrol and diesel. |
| DH | District heating | |
| WWTP | Wastewater treatment plant | |
| CHI | Czech Hydrometeorological Institute | |
| CZSO | Czech Statistical Office | |
| DC | Direct current | An electric current that flows uniformly in one direction |
| DP | Data platform | |
| DPP | Dopravní podnik hl. m. Prahy | |
| RST | Rainwater sedimentation tank | A rainwater sedimentation tank is designed to capture most suspended particles in rainwater flushed from the ground into the rainwater drainage system to reduce water pollution in watercourses |
| e-bus | Electric bus | An electrically powered bus. This also includes trolleybuses, which are otherwise considered as rail vehicles under valid legislation. |
| EV | Electric vehicle | A vehicle with a purely electric power unit. |
| EVSE | Electric vehicle supply equipment | A charging station for electric vehicles. For this yearbook, a charging point means a geographical point on a map that usually includes several different types of charging socket for different EV types. |
| 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. |
| MTCC | Main traffic control centre | The main traffic control centre provides centralized traffic monitoring, central coordinated traffic management in Prague Capital City, and provides up-to-date and verified traffic information. The data sources include telematics equipment, the systems of the Police of the Czech Republic, the Fire Rescue Service and the Medical Rescue Service, and the Central Registration of Road Closures system. All traffic information is processed by the MTCC Control System, which automatically reacts to a given traffic situation by invoking so-called control scenarios. The individual scenario steps then result in changes in the state of telematics devices to ensure smooth traffic flow. |
| HEV | Hybrid electric vehicle | A vehicle with a combined electric motor and internal combustion engine drive systems. |
| PCC | Prague Capital City | |
| FRS | Fire Rescue Service | |
| IoT | Internet of Things | Internet of Things |
| IPR | Institute of Planning and Development | |
| MW | Municipal waste | |
| LAT | Lower Assessment Threshold | The lower assessment threshold is a value lower than the emissions limit and is defined as the percentage of the emissions limit for a specific pollutant. When this limit is exceeded, measurement is mandatory at the given locality but can be performed over longer time intervals. |
| LV | Limit Value | The limit value refers to pollutant emission limits. |
| MaaS | Mobility as a Service | |
| CD | City district | |
| PT | Public transport | |
| PCH | Prague City Hall | |
| MIT | Massachusetts Institute of Technology | Massachusetts Institute of Technology |
| MHS | Multi-channel Handling System | |
| MoE | Ministry of the Environment | |
| OBU | On–board unit | A dashboard unit in a vehicle |
| WM | Waste management | |
| OICT | Operátor ICT, a.s. | |
| BEPC | Building energy performance certificate | A building energy performance certificate is used to evaluate the energy performance of a given building - it quantifies all the energy consumed when the building is operating as normal, and (as with energy labels for appliances) classifies the building from A to G. The certificate evaluates all the energy needed for the operation of the building, meaning energy for heating, hot water preparation, cooling, ventilation and air conditioning, and lighting. These certificates can be issued for any building or part thereof. |
| PCT | Prague City Tourism | |
| PID | Prague Integrated Transport | |
| PM 10 | Particulate Matter | Particulate matter (PM) is the term for microparticles several micrometres (μm) in size. The particles are designated according to their size - for example, PM10 refers to airborne dust 10 micrometres in size. |
| PREdi | Pražská energetika distribuce, a.s. | |
| PVK | Pražské vodovody a kanalizace, a.s. | |
| ROPID | The regional operator of Prague Integrated Transport | |

| ABBREVIATION | NAME | EXPLANATION |
|---|---|---|
| **RDS – TCM** | Radio Data System – Traffic Message Channel | A system that transmits supplementary traffic information over networks of VHF FM radio transmitters. This system is used to send traffic information to vehicle navigation systems. |
| **RSU** | Road Site Unit | Devices supporting radio communication with vehicles on roads. These are stationary infrastructure devices next to or above the road. |
| **SC** | Smart City | A method for organizing a city using information and communication technologies for more efficient management of the city space. |
| **CY** | Collection yard | |
| **MMW** | Mixed municipal waste | |
| **SP** | Smart Prague | The strategic framework for the redevelopment of the capital in the Smart Prague 2030 Concept spirit. |
| **SPI** | Smart Prague Index | |
| **LSD** | Light signalling devices | A set of devices used to control traffic on roads. The signalling part of this system is called a traffic light. |
| **TSK** | Technická správa komunikací hl. m. Prahy, a.s. | |
| **UAT** | Upper Assessment Threshold | The upper assessment threshold is a value lower than the emissions limit and is defined as the percentage of the emissions limit for a specific pollutant. When this limit is exceeded, measurement at the given locality is mandatory. |
| **CWWTP** | Central wastewater treatment plant | |
| **V2I** | Vehicle to Infrastructure | Communication and exchange of information between a vehicle and an infrastructure element. |
| **Category M1 vehicle** | | A vehicle for up to 8 people (excluding the driver) with a total weight of up to 3.5 tonnes. |
| **VP** | Virtualization of Prague | A tool for working with spatial data in augmented reality. |
| **ERF** | Energy recovery facility | The incinerator in Malešice, operated by Pražské služby, a.s. |
| **DOI** | Devices for operational information | An illuminated road sign providing necessary traffic information and warnings for drivers. |
| **PPZ** | Paid parking zones | |

# 2. INTRODUCTION BY THE MAYOR OF PRAGUE CAPITAL CITY

# MUDr. Zdeněk Hřib

Mayor of Prague Capital City

**Dear Readers,**

I am very happy that you have received the new Smart Prague Index for 2019, which maps out the Smart Prague 2030 strategy objectives in detail using a precise methodology for measuring specific indicators for the individual "Smart Prague" projects.

This is because the Smart Prague 2030 strategy is not at all intended merely to introduce futuristic technological solutions without a deeper meaning: Prague wants to build everything around precise and measurable indicators. For this reason, our OICT colleagues are monitoring all the "smart" projects through the Smart Prague Index. This has been tailor-made for the Czech capital by transforming globally used Smart City Index principles to the specific conditions and needs of our capital.

Our objective is to reach a position where we can take political decisions based on the real data available to the city. It is precisely the Smart Prague Index that provides us with these valuable data, and I hope that our way of working - based on the use of "hard data" - will become a widespread way of thinking throughout the country soon.

For example, the Smart Prague Index 2019 will show you developments in projects in the six areas on which the Smart Prague 2030 concept focuses - Mobility of the Future, Waste-free City, Smart Buildings and Energy, Attractive Tourism, and People and the Urban Environment. You will learn, for example, that the number of fast-charging stations on Prague streets has increased by over 160% compared to 2018. Or that we have more shared vehicles (919) than trams (830) in Prague.

I wish you pleasant and informative reading and hope that this year's Smart Prague Index will help our city maintain its successes in the field of Smart Cities, as Prague was ranked the 11th smartest city in Europe and the 19th smartest city in the world in 2019 in the first-ever Smart City Index yearbook.

# 3. INTRODUCTION BY THE CHAIRMAN OF THE BOARD OF DIRECTORS OF OPERÁTOR ICT, A.S.(PLC.)

# Michal Fišer, MBA

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

**Dear Readers,**

We have prepared this, the third edition of the Smart Prague Index, for you. This comprehensive document monitors our success in fulfilling the Prague Capital City Smart Cities strategy in 2019. Prague has now approved the Smart Prague 2030 concept, laying out a precise path for the city in terms of innovation and modern technologies. Their implementation into the operation of the city will bring improvements and thus create a technological future for a better life in Prague.

We use an extensive methodology that measures specific indicators - the same ones every year - to monitor the fulfilment of these long-term goals. The Smart Prague Index thus provides accurate analysis and demonstration of Prague's success in transforming itself into a smarter and more sustainable city with the help of Smart City elements. This is because deeper knowledge of the state, needs and behaviour of the city is of key importance for better planning. I believe this year's Smart Prague Index yearbook will be of benefit to our city's representatives in terms of helping them make more effective decisions, and will also help the expert public broaden their horizons regarding the functioning of Prague in the Smart City area.

Using this precise method, tailor-made for Prague, means we can monitor the progress of projects over time in all six areas under the Smart Prague 2030 concept. The areas where the introduction of modern technologies has the highest potential for positively impacting the daily life of the inhabitants of Prague are Mobility of the Future, Waste-free City, Smart Buildings and Energy, Attractive Tourism, and People and the Urban Environment and, last but not least, Data. This is because data are both the source and the foundation stone for the majority of our projects.

The municipal company Operátor ICT collects and analyzes data, and also offers them to the public on an open-source basis through the Prague Golemio data platform. Prague is thus setting an example to both other cities and other administrative entities in data sharing. I am convinced that managing the city through data has proved successful in Smart City terms and more and that this trend will therefore only strengthen in the future.

The use of data and digitization in Prague also extends into the area of mobility - Operátor ICT focuses precisely on high-quality public transport and intelligent passenger systems. Since the end of last August, when the PID Lítačka regional transport system was launched, digitizing and liberalizing the public transport handling system, passengers have been travelling around Prague and the Central Bohemia Region more easily and comfortably. Besides, the system was fully digitized in the autumn of 2019, enabling passengers to identify themselves during transport inspections via the PID Lítačka mobile app alone. These and other measures are simplifying the lives of the inhabitants of Prague and making our city a better place in which to live.

I hope you, dear readers, find inspiration in this yearbook, and that it helps make all our lives as pleasant as possible in our city.

# 4. INTRODUCING SMART PRAGUE

## THE EMERGENCE OF THE SMART CITY CONCEPT

The term Smart City first started appearing in scientific publications in the mid-1990s. The number of cities launching their own Smart City strategies is increasing every year, as is the quantity of professional literature seeking to define the Smart City concept and addressing issues related to Smart Cities. There are many different definitions and interpretations of the term Smart City, yet the basic idea is similar: Smart Cities are those in which information and communication technologies (ICT) serve as tools for solving complex sustainable development issues.

Amsterdam is considered a Smart City pioneer, adopting a stance concerning the Smart Cities concept based on the strategic principles of urbanism and choosing an approach based on strategic thinking, cooperation and inclusion principles. The city representatives focused on carefully setting the direction of its development before the actual start of the Smart City concept implementation activities - the emphasis was placed on the human factor as well as on the use of modern technologies. The aim was to prevent a directive approach from above and to make the most of the innovation potential of activities from below. Smart City can, therefore, be understood as a strategic management concept for a city, where technology serves to achieve goals yet is not the goal itself. The SMART Česko project was created in the Czech Republic, addressing the following areas: Energy, Financing, Education and Schools, eGovernance, Information and Communication Technologies, Social Services and Health, Water and Waste Management/Circular Economy, Transport and Mobility. This project is intended to help cities and municipalities implement local "Smart City strategies".

## SMART CITY MEASURING

VSmart City evaluation is very difficult because, as with attempts to create a uniform definition, there are several obstacles hindering efforts to implement a comprehensive measuring system. Every city has its specific interests, problems and needs, and city officials must take these into account when implementing the concept. Smart City benefits include improving the efficiency of operation of the city and increasing the satisfaction and quality of life of its inhabitants, so these specific needs must also appear in the measuring system in the form of suitable criteria tailor-made for each city. The creation of a uniform measuring system for different cities is therefore practically impossible, as some index criteria may vary on each side of a border or in different regions, so any proposed solution will never be fully transferable. To achieve a relevant comparison, these indices are applied to cities with somewhat similar characteristics (geographical location, size, population, etc.), meaning they are often very general as a result.

Many projects are developed - and innovative and smart solutions created - under the "Smart City" umbrella, yet their practical implementation is sometimes very time-consuming. The impacts of Smart City solutions are not always objectively verified, which has led to the creation of a common framework in Europe to accelerate the transition to low-carbon and sustainable Smart Cities by making it easier for cities to monitor progress, build trust in solutions, and to learn from each other. The European CITYkeys project proposed a set of 92 indicators for assessing Smart City projects divided into five basic groups: people, planet, prosperity, public administration and promotion. There are already many Smart City evaluation indicators, and their numbers continue to grow; they are the work of different companies, and we have provided examples of them in the Smart City Competitions chapter. One important index - to which the sixth chapter is devoted - is the Cities in Motion Index, which is not geographically limited and whose criteria are rather more general. Another example is the Smart City Index from Ernst & Young, where the criteria list is individual for each country.

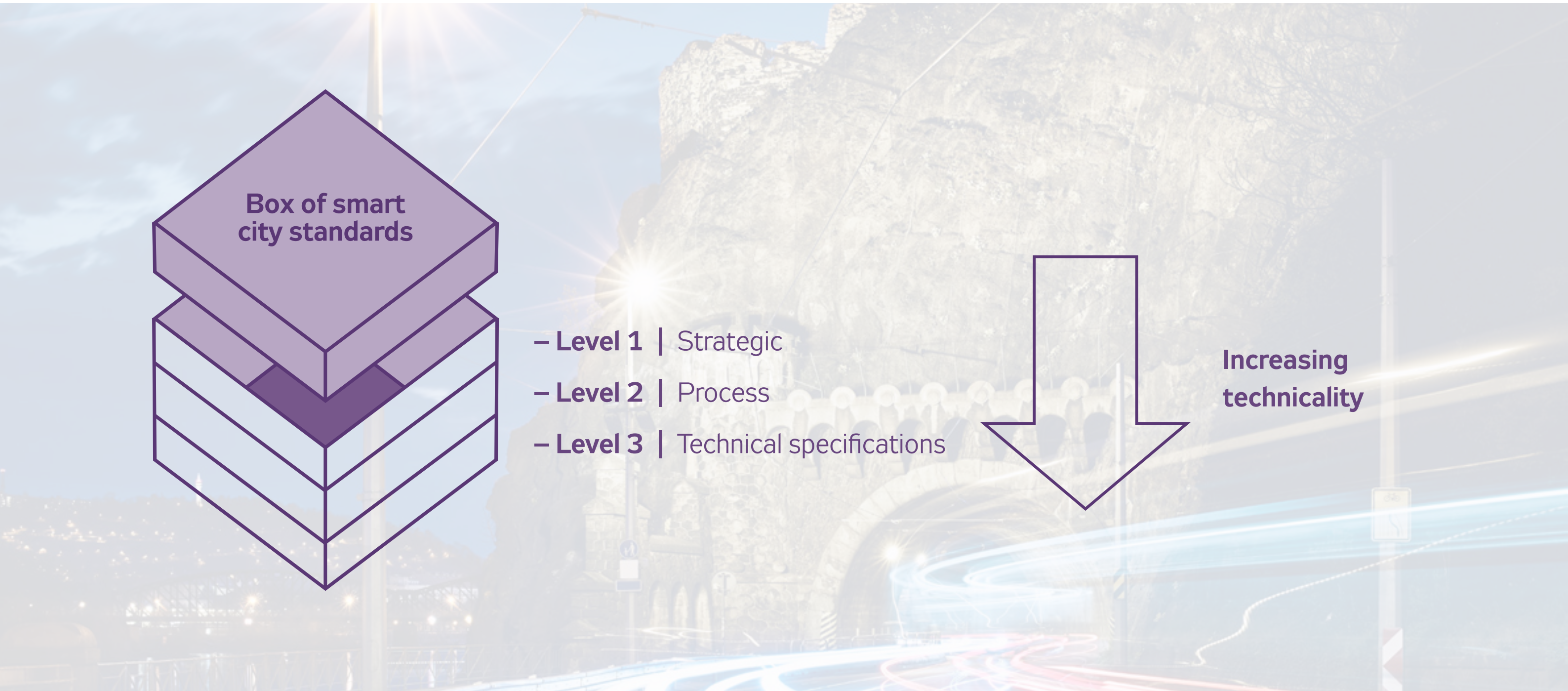
In general, smartness measurements are standardized through international ISO standards, defining the level of smartness as a city's ability to use all its resources to achieve its goals. It defines how effectively different city districts, people and organizations work together in a city - both individually and through creating synergies. In terms of Smart City measuring, the primary emphasis is placed on the ability to interconnect and integrate subsystems. There are two main reasons for measuring smartness. The first is the desire to measure the changes after the implementation of smart solutions. The second reason is the creation of a system for comparing individual cities, where their representatives and inhabitants can monitor the evolution of their position in the overall ranking.

The Ministry of Regional Development of the Czech Republic is responsible for the application of the Smart Cities concept in the Czech Republic, and in 2018 updated the document Methodology for the Preparation and Implementation of the Smart Cities Concept at City, Municipality and Regional Level. This methodology aims to support the planning and decision-making of cities and municipalities about the introduction of modern technologies and innovative approaches; it should also aid planning based on objective data. It is based on the motto, "if I want to control, I first need to measure", and states that the final indicator of successful implementation of the Smart Cities concept is satisfied inhabitants and users of the city, including companies, something difficult to measure in practice. It emphasizes that when evaluating one's results, one must take into account one's situation and problem-solving priorities, and set appropriate and feasible indicators at the level of the specific city, municipality or region. A team of experts from the University Center for Energy Efficient Buildings (UCEEB) at the Czech Technical University in Prague and the Ministry of Regional Development developed the Methodology for assessing the sustainability of Smart Cities in early 2019. This methodology describes the basic principles of the Smart City concept, including goal determination and an explanation of how they were created - and above all, an evaluation set of indicators for the city. The methodology can be used to assess the sustainability, innovation level and technological development of a city or municipality.

## SMART CITY STANDARDS

Creating an overview of Smart City standards is difficult, as it is still a relatively new issue that permeates many areas. Rodger Lea (CEO of an Internet of Things (IoT) startup, Sense Tecnic Systems Inc.) tried mapping them in his January 2016 post on the UrbanOpus blog: Trying to make sense of Smart City standardization activities. This post was then converted into an article for the online IEEE Communication Standards Magazine: Making sense of the Smart City standardization landscape. The author states that "the breadth and range of activities under the smart city umbrella are so large." This, in his view, is due to the wide range of these activities - from water pipes to the inhabitants themselves - also because it is a relatively new phenomenon and most standardization organizations are at the stage of just trying to find their place and how to best contribute.

The author used a categorization framework promoted by The British Standards Institution (BSI), founded at the start of the 20th century as the Engineering Standards Committee. This framework for classifying standards and categorizing them into three levels is shown in the figure.




**The city will put together the particular combination of standards it needs to fulfil its smart city vision in a piece-by-piece Duplo block approach.**

Smart City standards are not the work of a single standardization organization, as there are several major players active in the field. Organizations addressing Smart City standards include:

- **ISO: International Organization for Standardization**
- **CEN: European Committee for Standardization**
- **CENELEC: European Committee for Electrotechnical Standardization**
- **ETSI: European Telecommunications Standards Institute**
- **ITU: International Telecommunication Union**
- **IEC: International Electrotechnical Commission**
- **BSI: British Standards Institution**


Standards play a key role in the introduction of new technologies and are important for global Smart City growth. Selected standards that form the basis of the Smart City concept are shown below. This list is far from final, and a more comprehensive list of standards can be found in the BSI documentation Mapping Smart City Standards.

## LEVEL 1: STRATEGIC

This category of standards focuses on the process of developing a Smart City strategy and seeks to provide city leaders with guidance on the 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**
- **ISO 37101: Sustainable development & resilience of communities – Management system**
- **ISO 37102: Sustainable development & resilience of communities – Vocabulary**
- **BS 8904: Guidance for community sustainable development**

## LEVEL 2: PROCESS

Standards in this category are focused on procuring and managing Smart City projects. These offer best practices and associated guidelines 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 focuses on the implementation of Smart City projects. This level covers the myriad technical specifications that are needed to implement Smart City products and services so that they meet the overall objectives.

- **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)**

In the Czech Republic, the Smart Cities concept is mainly addressed by the Ministry of Regional Development of the Czech Republic, which participates in the publication of documents (methodologies) related to the Smart Cities concept. In 2016, the Government Council for Sustainable Development approved the Smart City Working Group, the purpose of which is to supplement the methodology, organize expert seminars, promote the implementation of the SC concept, etc. This working group has been tasked with creating materials for strategic documents; it is composed of representatives of the relevant ministries and institutions. Experts and representatives of the academic sphere, the non-profit sector, the private sector, and representatives of cities implementing the Smart Cities concept are invited to meetings. The national SMART Česko – Udržitelné Česko (SMART Czech Republic - Sustainable Czech Republic) concept was also created, as part of which in 2019 the Association of Towns and Municipalities continued in the Smart City area with the elaboration of the "Strategic framework of the Association of Towns and Municipalities in the Smart City area", which defines the addressed area within the framework of the concept and issues documents related to the Smart City edition.

## THE EMERGENCE OF THE SMART CITY CONCEPT

Prague Capital City has been involved in activities related to the implementation of the Smart City concept since 2014. At that time, a leading position was taken by the Prague City Council Commission for the development of the Smart Cities conceptin Prague Capital City (the "Commission") and the Prague Institute of Planning and Development ("IPR") which created the Morgenstadt City Lab study (2015–2016) in cooperation with the Fraunhofer Institute. The main benefits of this study included the creation of a profile of the capital and, together with it, defined the strengths and weaknesses, and the potential and current obstacles standing in the way of the transformation of Prague into a Smart City. Using this analysis, an individual sustainable development plan was created, taking into account the specific conditions of the city.

In 2016, a series of conferences dedicated to the theme of Smart Prague (SP) was held, and the Commission began approving the first project plans, entrusted to Operátor ICT, a. s. (Plc.). for implementation. In 2017, Prague City Council created and approved the Smart Prague 2030 concept, following on from the existing city priorities given by the Strategic Plan of Prague Capital City and sectoral concepts, which were later examined with 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 the Urban Environment, and Data. Each of these key areas is further elaborated into visions to 2030 regarding best available practice, and subsequently into thematic circles for each key area. These are not isolated solutions for the individual key areas, but rather a system linked to a city-wide data platform enabling inhabitants and companies to evaluate and interpret data. In 2019, greatest emphasis continued to be placed on the last of these mentioned areas which, in its final form, represents the existence of a unified data platform known under the name Golemio. The data platform manages and evaluates city-data as a whole and provides city representatives with a structured overview of its operation.

As mentioned above, Operátor ICT, a. s.(Plc.) acts as project manager for the whole Smart Prague concept, using innovative technologies to address Prague's challenges and proceeding respecting the neutrality of jurisdiction to the maximum possible extent. Smart Prague projects are implemented by Operátor ICT, a. s. (Plc.) through the globally recognized PRINCE2 project management method, which in practice means that the project implemented and the customer are defined. After the end of the pilot phase, Operátor ICT, a. s. (Plc.) hands over the projects for the operational phase to the materially competent Prague Capital City entity.

From the organizational point of view, the project implementation is ensured through five levels of concept management. The highest level is represented by Prague City Council and its former Smart Cities Agenda Committee, now the IT and Smart City Committee. The concept steering committee, which sets the direction, is Prague City Council and its competent Prague City Council Commission for the development of the Smart Cities concept. The Operátor ICT, a. s. (Plc.) advisory bodies are the Smart Prague Council, consisting of representatives of Operátor ICT, a. s. (Plc.), representatives of the Czech Technical University in Prague, Charles University, and representatives of public institutions (representatives of Prague City Hall, the Ministry of Regional Development, the Ministry of Industry and Trade, the Ministry of the Interior, the Ministry of the Environment, the University Center for Energy Efficient Buildings of the Czech Technical University in Prague, the Technology Agency of the Czech Republic, the Union of Towns and Municipalities of the Czech Republic, the National Center for Energy Savings and the Czech Smart City Cluster), which address Smart City projects. 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 the future strategic direction of the concept and thematic units. Another supporting body is the Smart Prague Working Group, made up of representatives of municipal companies such as Technical Road Administration, The Prague Public Transport Company, a.s. (Plc.), components of the Prague Integrated Rescue System, ROPID, Technologie hl. m. Prahy, Prague City Tourism and others. This less formal platform is primarily used for universal information purposes, familiarization with others' projects, sharing ideas, and specific cooperation-related steps in the concept. In the autumn of 2019, it was decided that for sharing project information it would be desirable to supplement the working group with subgroups divided according to the individual Smart Prague areas. 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 as Prague Capital City needed to clarify the planned Smart City projects across municipal organizations and Prague Capital City. The Smart Prague Action Plan follows on from the Smart Prague 2030 concept of June 2017 and generally focuses on the Smart Prague 2030 concept SWOT analysis and its consequences, definition of the action plan, the definition of Smart Prague projects, their evaluation, organizational structure, and other areas. The key part of the Action Plan is devoted to individual project intentions and ideas in the Smart Prague area implementable by 2030, and at the same time sets the rules for evaluating the success of their implementation. The Action Plan thus allows the aggregation of projects and ideas into a single document for all municipal organizations that participated in its creation. This will make it possible to gain a general overview of individual Smart Prague projects that Prague Capital City and individual municipal organizations are planning or considering implementing. The Smart Prague 2030 Action Plan contains both a list of individual projects and ideas and also selected measurable indicators for determining whether or not the Smart Prague concept is being implemented successfully. These measurable indicators are set for areas where there is currently sufficient information to enable them to be set.

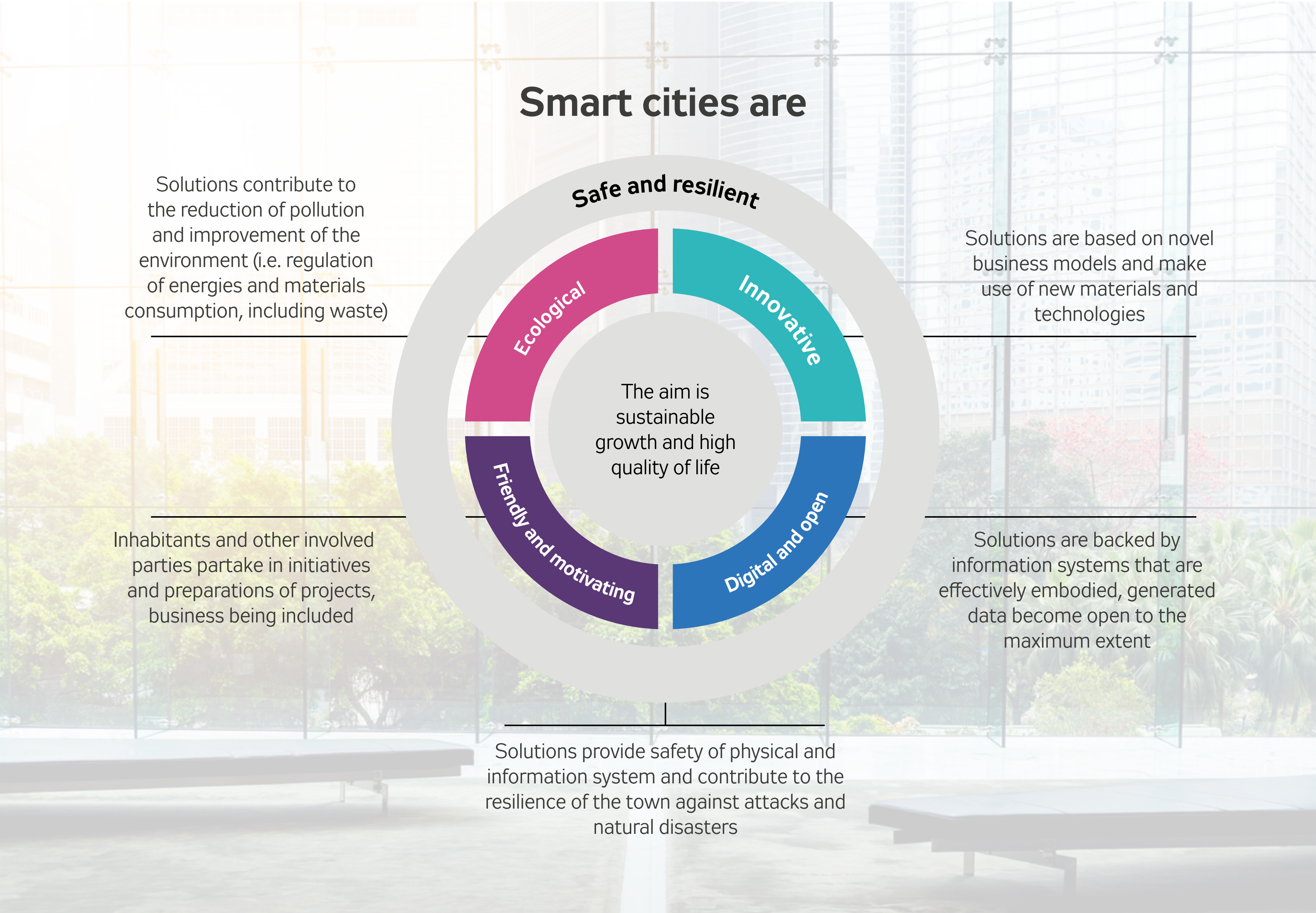
## SMART PRAGUE INDEX

The Smart Prague 2030 concept sets out the basic requirements for implemented projects, however do not sufficiently cover the need for an overall assessment of the potential of the projects and their subsequent impacts, nor do they precisely define their real contribution in terms of successful SP strategy implementation. For this reason, in 2017 it was decided to create a tool that would be able to apply such an evaluation for Prague Capital City needs.

Ernst & Young ("EY"), a global provider of consulting services focusing on audit, tax, transaction and corporate consultancy, participated in the creation of the Smart Prague Index. EY has already had experience in implementing the Smart City Index, which uses indicators to "measure the state of a city, its resources and its impact on its ecosystem from the perspective of basic Smart City principles to identify weaknesses and possible approaches to problem solving while improving the quality of life for its citizens." Italy had the first experience with the creation of the Smart City Index, with a total of 471 indicators being created and applied to 116 Italian statutory cities. This index is now used on a global scale, yet is always slightly re-calibrated given the specific needs of the measured areas. This modification of the global Smart City Index to the specific conditions and goals of the capital resulted in the creation of the Smart Prague Index based on the above-mentioned Smart Prague 2030 concept.

Knowing a city perfectly is a prerequisite for its effective management. The Smart Prague Index will thus enable Prague Capital City to map out the initial state, monitor changes over time, monitor the impact and assess the success of implemented projects from the viewpoint of the Smart Prague concept principles, identify weaknesses, and assess new approaches to problem-solving. The regular monitoring of the indicators used to measure the smartification of the city will expand the base of readily available data used for planning the development and sustainability of the city.

One can generally say that all Smart City solutions should be based on five basic principles, namely that the city should be: ***Environmentally friendly, Innovative, Friendly and motivating, Digitized, and Safe and resilient.***



**The Smart Prague Index provides:**

- **An independent, comprehensive and transparently structured method**
- **A tool for monitoring the successful implementation of Smart Prague projects**
- **A source of information for planning (guiding) suitable future projects**
- **An overview of the implementation of the Smart Prague vision**

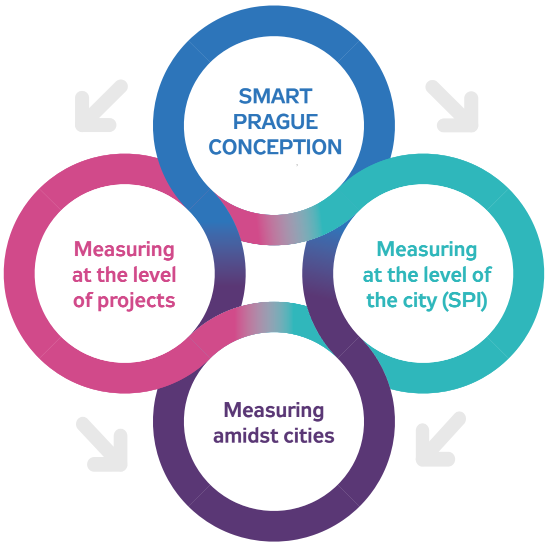
The starting point when creating a methodology for the Smart Prague Index (SPI) was the 5 + 1 strategic areas of the Smart Prague concept, whose suitable development is described through specific, quantitatively set, strategic aims. These aims are interpreted as general expressions of smartness reflecting the trends in Smart Cities in the relevant area. Each of the defined strategic aims is, as a part of SPI, described through specific, quantifiable indicators.

The methodology for assessing individual projects follows on from the SPI. The assessment is set for both the pre-and post--implementation phases. The assessment parameters reflect the type of project (pilot vs. standard), weights are also allocated to the parameters following their strategic importance. The assessment is also connected to qualified indicators of the city's smartness, meaning that the more the project can influence the indicators, the higher its points score. This approach allows a relative comparison of different projects, both concerning their potential and its subsequent confirmation. This facilitates the identification of weaknesses in a project. The higher the project score, the greater the positive impact that can be anticipated by assessing the city through the SPI and therefore in the achievement of the Smart Prague concept.

About the leading position of Prague in the European and global network of cities, there is also a recommendation for a procedure for its comparison with other cities that are dealing with similar challenges and are comparable with Prague.
To ensure consistency and also simplicity, the use of key indicators from the annual Cities in Motion Index ("CIMI") has been proposed. Movement on the ranking of cities in selected CIMI areas also indirectly expresses movement in the relevant SPI areas, as there is a correlation between the CIMI and SPI indicators in these areas.

Like the CIMI, the Smart City Index has a wide scope and covers all areas of the city's operation. However, unlike the CIMI, this EY Smart City Index is one of the few that directly deals with Smart City measurements, and this is also reflected in the relevant indicators.

**Interconnection of indicators:**




SPI and CIMI assessments are performed annually. Concerning data availability, the recommendation is to perform an evaluation approximately in the middle of the calendar year, when all the necessary statistical information is already known. Projects are assessed in an ongoing fashion per current requirements and the level of their preparedness and implementation.

**Through the SPI, Prague Capital City gained a set of tools allowing it to:**

- Independently, comprehensively and transparently measure the success of the implementation of the Smart Prague concept
- Identify weaknesses and trends in the city's development, including mapping technological developments
- Effectively plan additional suitable projects for implementation of the strategic aims of the Smart Prague concept
- Independently, comprehensively and transparently measure the potential of project plans and the success of the actual implementation of Smart Prague projects
- Compare how successful Prague is in dealing with challenges in comparison with other global cities

**List of indexes by publisher:**

| Index | Index Publisher | Publisher type |
|---|---|---|
| IESE Cities in Motion Index | The IESE Business School | Publisher type |
| 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 Cities™ 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 |

*Most indices were created by private companies. Exceptions are the IESE Cities in Motion Index, which originated in academia, the Innovation Cities™ Index from the 2thinknow agency, and the European Digital City Index and the CITYkeys indicators for Smart City projects and smart cities, created under the auspices of the European Commission.*

## SMART CITY COMPETITIONS

The promotion of the Smart City and smart solutions concepts serves to increase general awareness of the benefits of Smart Cities and familiarize the public with the concept. The development of the Smart City concept is also accompanied by a growing need to compare individual cities or sub-projects and share applied solutions - the mutual comparison of cities is made possible through Smart City competitions. Today there are many such events, with prizes for the most interesting and innovative implemented Smart City ideas and projects. Another purpose of these competitions is to establish the state of the art in implementing smart solutions, as well as to provide lessons and inspiration for the leadership of other cities. Some competitions in the Czech Republic serve to make smart solutions accessible to citizens and enable the direct assessment of sub-projects by the inhabitants of a specific city. Most competitions are focused on methodological support and the sharing of good practices, as is the case, for example, with Smart Cities for the Future. This year, we also present the placement of Prague in the Smart Cities Index from Easy Park and the newly created IMD Smart City Index, based on the evaluation of cities by their inhabitants.

### Smart Cities for the Future 2019

This competition is run 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 national Smart City models. In the third Smart Cities for the Future national competition, Prague Capital City came first in the Smart City 2019 over 200 000 inhabitants category with its Smart Waste Collection project. This project also won the Smart City Project 2019 category. The expert jury especially appreciated the use of the latest technologies in city waste management. The project consisted in the creation and testing of a tool for the online monitoring of the fullness of selected collection containers for sorted waste. For the majority of waste containers, this meant equipping them with sensors to measure fullness, while some had sensors to detect if the input shaft in underground containers was clogged. Data on current waste levels were sent every four hours to the city's Golemio data platform.

**Opening 2019 Data Together**

The OSF Foundation, originally part of the multinational Open Society Foundations network, announced the 7th annual competition for the best apps based on open data. Over 26 apps were registered in a total of five categories. The Golemio data platform from Operátor ICT, Plc. won the Open Source category intended for apps combining the use of open data and open source.

**Best Upcoming EPC Project of 2019**

The Association of Energy Service Providers award prizes in the 9th year of the competition Best Upcoming Energy Saving Project Using the EPC Method (Energy Performance Contracting). This method means that investments into the modernization of heating, cooling and lighting are paid for by the solution provider and the customer then repays the amount from the money they save, while the savings are contractually guaranteed for the customer. Czech Technical University in Prague won first place, with the expert jury especially appreciating the comprehensive nature of its project. Nine Czech Technical University in Prague halls of residence have launched the construction and energy-saving measures designed to reduce energy consumption by CZK 20 million a year from next year. The Prague 14 city district came third - the goal of its upcoming EPC project being to revitalize the buildings used by the authority at a cost of over CZK 100 million. The result will be a 48% saving in primary energy. Besides, both administrative buildings will meet the requirements for buildings with almost zero energy consumption.

**IT Project of the Year 2019**

2019 saw the 17th year of the IT Project of the Year competition, announced by the Czech Association of Information Technology Managers. Due to the current situation and measures against the spread of the COVID-19 virus, the planned ceremonial announcement of the competition results on 26 March 2020 did not take place, and the results will be listed in the Smart Prague Index yearbook 2020.

**Zlatý erb (Golden Crest) 2019**

The twenty-first year of the Golden Crest competition for the best websites and electronic services of cities and municipalities was held under the official auspices of the Ministry of Regional Development of the Czech Republic, which also participated in the conception and evaluation of the popular category - the Award of the Minister of Regional Development for the Best Tourism Presentation. In addition to municipalities, cities, regions, counties and tourism attractions, certified destination management organizations also competed in this category in 2019. In the regional round in the Smart City and the Best Electronic Service category, Operátor ICT took 1st and 3rd place - Prague's Golemio data platform won, with the Regional Transport System (PID Lítačka) coming third. 435 websites and projects by municipalities and cities, including electronic services and tourism presentations, were entered into the national round. The Special Award of the Minister of Regional Development for the Best Tourism Presentation in the Regions category was awarded to the Prague Capital City Tourist Portal, with the Prague presentation taking first place. In the national round, Prague placed 4th in the Best Electronic Service category with its Golemio data platform.

**Smart Cities Index 2019**

The challenges facing cities vary significantly and are specific to each area. This is why the company EasyPark created the Smart Cities Index 2019. 500 cities from all over the world with a medium to the high rating (0.5 and higher) according to the Human Development Index (HDI) were analyzed. This index was created as an effort to express the quality of human life and is calculated as follows: HDI = average life expectancy + 2/3 literacy + 1/3 combined school attendance + GDP. The Human Development Index for the Czech Republic was calculated as 0.891. Under Smart Cities, 24 factors determining the Smart City level were analyzed and the first 100 cities determined. Experts took many criteria into account in the areas: transport and mobility, sustainability, public administration, innovative economy, digitization, cybersecurity, and living standards. Each of the factors was rated from 1 to 10. The final score was calculated using a formula that assigned a weighting to each category. Prague ranked 91st with a total score of 4.63. This evaluation by EasyPark took place for the third consecutive year, and more factors were included in the evaluation compared to the preceding year.

**IMD Smart City Index 2019**

The IMD Smart City Index is a newly created index that evaluates the performance of a city in comparison with others based on its perception by its inhabitants, with 120 inhabitants of each city being contacted. Cities were assigned to one of four groups based on their HDI values. Within each HDI group, cities are assigned a "rating scale" (AAA to D) based on the perception score of that city compared to the scores of all other cities within the same group. Two pillars were evaluated: "Structural", relating to existing urban infrastructure, and "Technological", describing technological measures and available services. Within each pillar, five key areas are defined: health and safety, mobility, activities, opportunities and public administration. The resulting city profiles contain ratings for each pillar and an overall ranking of 102 cities. Prague placed 19th - ahead of London and Madrid. For comparison, Stockholm was 25th, Berlin 39th, Budapest 83rd and Bratislava 84th. Prague ranked 11th of European cities.t.

# Mgr. Ing. Jaromír Beránek

Chairman of the Prague City Council IT and Smart City Committee, representative of Prague Capital City

Over the last few years, activities under the Smart Prague brand have become synonymous with the development of the Smart City concept in Prague. There is perhaps no area of human life that colleagues from the Smart Prague Project Office at Operátor ICT are not addressing, and the result is an impressive catalogue of over thirty implemented or piloted project plans. The goal of improving and facilitating everyday life in the city for its citizens and visitors lies at the heart of the Smart Cities philosophy. In addition to supporting innovation and the development of new services, this often means the difficult setting of priorities and choosing from several possible solutions. At the same time, long-term data collection and analysis is vital for responsible and informed decision-making. This is also why we closely monitor activities that take place outside the Smart Prague Project Office, whether at other municipal companies, at the city district level, in the private sector, or at universities and research institutions.

Three interesting pieces of news over the last year have pleased the significant share of Prague residents who regularly use public transport to travel around the city. The first and most visible is the continued expansion of 4G signal coverage in the stations and tunnels of all three metro lines. By the end of 2020, the central sections of lines A and C should be fully covered, as will the youngest line B, where so far passengers could only connect via a free Wi-Fi network in a few stations. One obvious advantage of the classic mobile signal is the ability to make calls, send SMS messages and, of course, the provision of a stable data connection even in tunnels without passengers having to configure anything. The second major innovation launched is the display of precise information on delays and anticipated arrival times of city buses at stops that had been promised for many years - a common solution was finally found in 2019, enabling the service to be launched from the beginning of 2020. Anyone can easily check whether their connection is running on time by using the most popular PID Lítačka and iDOS apps. However, it is also worth mentioning a less conspicuous tram project, successfully tested last year, namely an anti-collision system using onboard cameras with advanced detection of pedestrians and other unanticipated obstacles. Together with the previously tested satellite navigation system, this will hopefully contribute towards further increases in safety and reliability.

Prague Capital City also financially supports the independent Smart City activities of city district town halls, which promise to provide acquired data for the Golemio data platform. Of the newly supported plans, it is worth mentioning the project for intelligent adaptation measures in the Havlíček's Orchards park in Prague 2, prepared in cooperation with the Czech University of Life Sciences and implemented as part of the broader "Smart Landscape" project framework; the "Virtual Power Plants" project in Prague 3, including the installation of a larger quantity of photovoltaic power plants on city district buildings and their smart central control; and the Prague 6 project aimed at increasing pedestrian safety in exposed sections of Evropská Street, which is part of the broader "Smart Evropská" project in which Czech Technical University in Prague and the Academy of Sciences are also participating.

Some great news from the past year was the successful evolution of cooperation with the academic sector in artificial intelligence and machine learning, areas previously neglected by the city. In mid-2019, the capital, together with Czech Technical University in Prague, Charles University and the Academy of Sciences of the Czech Republic, founded the prg.ai association (https://prg.ai/en/), which is helping transform Prague into a global artificial intelligence centre. Through research, education, promotional and popularization activities, it attracts top foreign experts to the city, helps local companies introduce advanced artificial intelligence technologies, and supports the emergence of new startups in related areas. The prg.ai initiative is already helping the city itself, whether in terms of addressing the consequences of the coronavirus crisis and preparing international events, or in the municipal company Pražské služby and, of course, with Operátor ICT in testing and implementing new technologies. Connecting key players across the innovation ecosystem and the judicious use of technology in areas where it can best and most effectively help is a genuinely invaluable contribution towards the Smart City development.

If I had to summarize the progress made in 2019, I would say I am very pleased to see we are succeeding in further expanding cooperation between the city and Operátor ICT on the one hand, and other municipal companies and city districts on the other, in terms of publishing new datasets for experts and the general public on the Golemio data platform and, finally, changing how Prague residents perceive the Smart City concept - the original impression of it being merely a disparate range of technological toys and gadgets has changed and it is now seen as a useful set of measures contributing towards better city leadership and resilience. Hence I am all the more pleased with your interest in this publication and hope you enjoy some inspiring reading. To close, let me thank all those helping Prague on this long and difficult journey.

# JUDr. Matej Šandor, Ph.D

Deputy Chairman of the Board of Directors and Director of the Project Management and Funds Department, Operátor ICT, a.s.

Operátor ICT, a. s. (Plc.) is one of the main municipal organizations involved in the development of Smart City projects in Prague. OICT prepares and subsequently operates Smart Prague projects in the IT and mobility and services areas, such as the Golemio data platform, the My Prague and Změňte.to apps, the PID Lítačka transport app, and the upcoming Portál Pražana and Prague Visitor Pass. Also, OICT is involved in the development and pilot testing of projects outside the IT and mobility areas, i.e. smart buildings, intelligent waste management, attractive tourism, mobility of the future, and modern public space - with this not being limited to only city residents. Currently, OICT has over 30 Smart Prague projects in various stages of development in the indicated areas. The implementation of individual OICT projects in the Smart City area is based on the Smart Prague 2030 concept for Prague Capital City. Prague's climate commitment - under which Prague undertakes to reduce $CO_2$ production by 45% by 2030 and to be production neutral by 2050 - is also taken into account in our projects.

We smoothly transferred from project preparation to implementation in several areas in 2019.

We are significantly contributing to energy savings in Prague, where we have launched several projects in this area. One of these is a project that includes six buildings and is being implemented using the EPC method - the implementation part of the work was carried out in 2019. The project will provide guaranteed savings of 11% of energy costs, or CZK 7.2 million per year, giving a total of CZK 86 million for the 12 years over the project lifespan. We will thus reduce our environmental impact from $CO_2$ by over 3 000 tonnes every year, meaning by over 37 000 tonnes over the 12 years of the project.

Other successfully implemented projects include the Smart Waste Collection project, which took first place in the Smart Cities for the Future competition in the Smart City with over 200 000 Inhabitants category. The project demonstrated that data provided by sensors can be used to identify problem areas and then set the optimal waste collection frequency to better match their level of use. Data on their current fullness were also integrated into the My Prague city-wide public mobile app. Some city districts already used new information obtained through the Smart Waste Collection pilot project during the project, and submitted proposals to change the frequency of collection for several containers. There are currently approximately 500 of these sensors in use in Prague.

One specific example is the Prague 1 district, with 75 sensors installed, leading to a long-term unused site being moved to another address and the subsequent changing of the collection frequency giving an annual saving of approx. CZK 300 000 without VAT. These funds can then be used to increase the frequency of collection for containers that are fully used. It is results like these that lead us to believe we are doing our jobs well and that city residents are seeing benefits.

One experimental project we finalized in 2019 was the Metropolitan Emergency and Health Care System project; what clients and their families most appreciated from this project were the increase in safety together with a feeling of greater peace, quiet and security - not only from the health perspective but in terms of safety in general. The benefits of better mental well-being were often mentioned in qualitative research.

Another project to test the given solution was the System for Automated Entry and Exit of Vehicles from a City Car Park, which contributed towards expanding the range of payment services and thus increased comfort for users of the selected car park.

At the end of 2019, Prague commissioned OICT to develop the General Development of the Public Charging Network concept. The preparation of the concept follows on from the city's efforts to support the development of electromobility and at the same time plan the steps that need to be taken by 2030 to help prevent possible negative impacts associated with that development.

In 2019, OICT succeeded in completing the four oldest Smart Prague projects. These were the Škoda Palace Interior Navigation project, which uses a mobile app to help visitors to Škoda Palace find their way around inside the building, navigates them to individual workplaces, and also contains up-to-date information on opening hours. Another project is the Automatic Answering Machine, testing chatbot artificial intelligence. The technology proved itself successful when deployed on the PID Lítačka app website, where the main benefits include a reduction of the customer line workload. The Smart Benches project was intended to test modern and technologically innovative urban furniture elements. Users of the bench features, such as phone recharging and a shared Wi-Fi Internet connection, were very positive about these improvements. As part of the Smart Lighting PLUS project, the phase of the modernization of 92 lamps and the sensor network in Karlín was completed in 2019, enabling the testing of remote lamp management, the monitoring and measurement of environmental values and electronic communication with citizens through access to the city network and the Internet. The main project benefits include savings through remote lighting intensity control, data collection for further use, and public space optimization.

Detailed information on Smart Prague projects implemented by OICT can be found on the website www.smartprague.eu, where the expert and general public can read about the progress of individual projects and get recommendations for their implementation throughout the city.

We will continue with innovative projects that will be of the greatest benefit to the inhabitants of Prague in 2020. Given that the third year of the Smart Prague Index is already here, we have much more comprehensive data available for Prague and can use the generated data in our decision-making on projects. In some areas, for example, we find that there is a complete lack of data. resulting in de facto white areas on the map. This indicates a need to focus on these areas and look for potential in the Smart Cities is not just about our company, but the city as a whole - all municipal companies and individual city districts. We want to continue in the same vein in 2020 and work to fulfil Prague's unified approach to Smart Cities and innovative technologies.

On this occasion, I would sincerely thank both the project team - which contributed towards the preparation of this publication and in general towards the development of the Smart Prague concept - and all OICT employees. I would also like to thank the officials of City Hall, municipal organizations, the academic sector, city districts and everyone involved, for their help compiling this yearbook every year, and especially for their partnership on Prague's path towards becoming a modern metropolis. This journey would make no sense without them.

# 5. SPECIFIC INDICATORS

## MOBILITY OF THE FUTURE

The overall Mobility of the Future vision is a response to the identified challenges facing Prague Capital City, primarily the growth of the population of Prague and its surroundings. This will mainly result in increased commuting to work and for services, accompanied by a growing degree of motorization, increasing pressure to ensure a sufficient quantity of car parks, increasing mobility of residents, increasing levels of transport, increasing transport of goods throughout the agglomeration, changes in transport types (modal split), changes in society (growth in the spending power of the population, increased preference for a healthy lifestyle and technological development), the unsatisfactory state of the transport infrastructure and, last but not least, lengthy processes related to the preparation and subsequent implementation of transport-related construction. All the above will create challenges related in particular to traffic congestion, air pollution from internal combustion engines, high noise levels, traffic accident rates and the degradation of public spaces in the city with low priority for pedestrians and cyclists. These factors not only have negative impacts on air quality and global climate change but also directly impacts on the life and health of Prague's residents and visitors. Over 70% of solid pollutant emissions and nitrogen oxide emissions are generated by road transport. The result is nitrogen oxides (mainly nitrogen dioxide), dust particles (suspended $PM_{10}$ and $PM_{2.5}$ fraction particles), carbon monoxide and hydrocarbons entering the surrounding environment. All the above pollutants have negative impacts on human health and vegetation, and major impacts on the quality of life in the capital.

The Sustainable Mobility Plan for Prague and its Surroundings (SMPPS), approved in 2017 by Prague City Council, forms the key list of solutions to the transport issue and defines the direction for the development of mobility to 2030 in Prague and its adjacent surroundings. As part of this plan, SWOT analysis of the transport system was created and Strategic Objectives and Priority Axes determined. Strategic goals include: reducing the spatial intensity of transport, reducing the carbon footprint, increasing efficiency and reliability, improving safety, improving financial sustainability, improving human health, and improving transport accessibility. The priority axes include: reducing air pollution, noise pollution and the carbon footprint, reducing the spatial requirements of transport, and reducing traffic accident levels. The analysis also defined weaknesses regarding the environment, mainly the following areas: the negative impact of road transport on air quality and noise pollution, greenhouse gas emissions from road transport, fragmentation and reduction of landscape permeability, loss of agricultural land in the metropolitan area, insufficient support for physical activity by the population, high spatial demands of road transport in the city, and the degradation of public street spaces through vehicle traffic at the expense of pedestrians and cyclists.

Following up from the projects summarized in the Sustainable Mobility Plan for Prague and its Surroundings, the Smart Prague concept for Prague mobility brings a vision of modern, technologically advanced, cleaner, safer and more efficient transport, resting on several pillars. The main pillar is the motivation to use the public transport network more intensively, which provides more environmentally friendly modes of transport (metro, tram, electric bus, train). Increasing the motivation to use public transport is associated with a continuous increase in passenger comfort and awareness using the latest technologies. As part of the Smart Prague concept, a modern passenger handling system was built in the summer of 2018, providing passengers with more payment channels for purchasing tickets. Passengers can use mobile apps and the PID Lítačka web interface, offering fully electronic passenger handling in the public transport network. The mobile apps will continue to expand their services to the travelling public to include payments for fares and parking and, as part of the fulfilment of the Smart Prague concept, will also create the necessary conditions for directing the Mobility as a Service (MaaS) portfolio and the use of alternative modes of transport (carsharing, bike-sharing, etc.). Another pillar is the promotion of shared mobility and electromobility, ideally using small urban electric vehicles. The conceptual construction of a network of charging stations is being supported as part of the development of electromobility. Prague will also make more use of real-time data for adaptive traffic light control at junctions, which will enable the efficient use of road capacity and the active management of traffic flows to reduce traffic congestion, reduce time spent in traffic jams - especially for public transport vehicles, and reduce the generation of pollutants. Transport-related decision-making and management processes will work with data that should be continuously analyzed, and thus obtain relevant information that will then be provided to users through mobile apps and a web interface using Prague's Golemio data platform concept. The next pillar is support for the development of autonomous mobility in terms of both means of transport and transport infrastructure.

**The thematic areas include:**

- **Shared Electromobility**
- **Clean Buses**
- **Intelligent Transport**
- **Self-driving Vehicles**
- **Mobility as a Service**

# SHARED ELECTROMOBILITY

The promotion of shared mobility that will be cheaper than actually owning a private car yet still less advantageous than public transport is an important tool for reducing the burden on Prague´s roads and the environment from transport and traffic at rest. The shared vehicles will ideally be electric, so it will be necessary to build a publicly available charging station network. This will require sufficient penetration into the city by shared (electric) vehicles, preferential access to parking for shared and electric vehicles, and sufficient charging stations. To this, of course, will be added the general advantage of carsharing over car ownership, i.e. no worries about insurance, servicing, and technical inspections, maintenance and repairs. Essential and support activities will include the building of a network of ultra-fast chargers and opening the network to private electric vehicles. It should be emphasized that a high number of shared vehicles in a city can only be considered a success if there is a concurrent reduction in the number of unshared vehicles - yet this cannot be evaluated today. Increasing the number of shared vehicles above a certain limit will be counterproductive, and this limit will have to be set taking into account the number of available parking spaces on the streets, which is significantly limited. For the future, therefore, there is a plan to introduce a concept that would set key parameters and a system for carsharing management.

## Number of EVs Per Capita

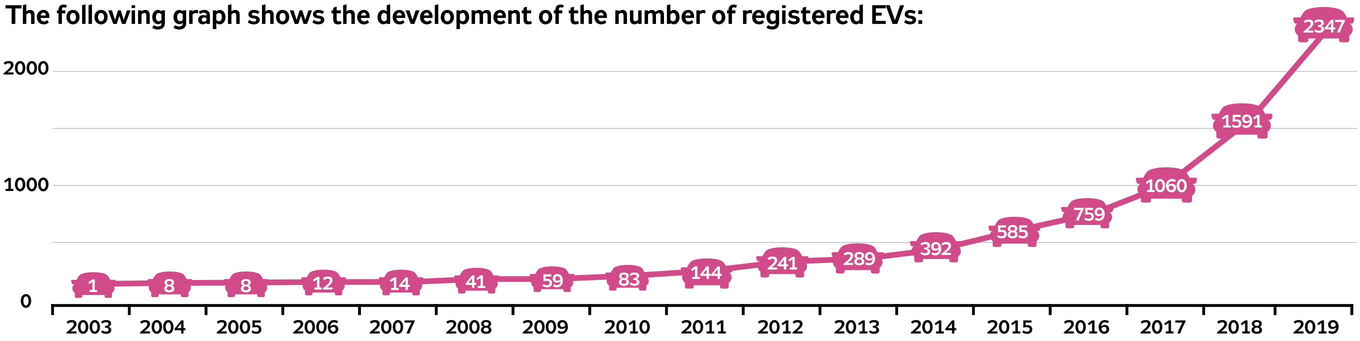
This indicator shows the number of electric vehicles (EVs) registered in Prague Capital City per 1 000 inhabitants. Electric vehicles registered outside the territory of Prague yet permanently operated in the capital are not included in the calculation. This indicator, therefore, does not express the absolute level of electric vehicle penetration into the vehicle fleet in the capital, but will primarily show the long-term trend in electric vehicle use in the capital and capture the impact of policy decisions promoting individual electromobility (e.g. the building of a network of fast-charging stations, providing cheaper parking in paid zones, etc.). All these measures can only be implemented until EV numbers reach a certain penetration value. Favouring electric vehicles should, therefore, take place following efforts to curb individual vehicle use.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,824** | **1,226** | **1,772** |
| Calculation | Number of EVs/1 000 inhabitants | | |
| Number of registered electric vehicles* | 1 060 | 1 591 | 2 347 |
| Population of Prague** | 1 294 513 | 1 308 632 | 1 324 277 |

**Data provided by the Department of Transport Administration of Prague City Hall and valid as of 31 December; **CZSO - data always as of 31 December of the given year*

756 more electric vehicles were registered in Prague Capital City compared to 2018. There are now almost 2 electric vehicles per 1 000 inhabitants on average, and this number is growing every year.
In the future, it is assumed that the number of EVs can be verified using a different methodological procedure that will, depending on the available monitoring technology - for example existing camera systems - capture the number of EVs operating in the city on backbone roads.

**The following graph shows the development of the number of registered EVs:**



### Number of parking permits for EVs

Based on Resolution of Prague City Council No 1709 of 18 July 2017, according to the "Price List of Parking Permits and Cards in Paid Parking Zones for Areas in Prague Capital City Defined as the Territory of Entire City Districts," electric vehicles were permitted to use all paid parking zones for only a handling fee. In 2018, hybrid vehicles were also included in this group of vehicles exempt from parking fees. Resolution of the Council of Prague Capital City No 803 on the Intention to Favor the Parking of Hybrid Vehicles in Paid Parking Zones in Prague Capital City of 17 April 2018 defines the requirements for hybrid vehicles that can enjoy the same benefits as EVs if the conditions are met. Due to the growing number of hybrid vehicles, registration under the original conditions is no longer possible. Since April 2019, owners of electric vehicles, hydrogen-powered vehicles, and selected hybrid vehicles have had the opportunity to apply for vehicle registration plates beginning with "EL". To reduce bureaucracy and support the owners of more environmentally friendly vehicles, the city leadership has decided that cars marked in this way can park in Prague's paid parking zones without registering with a parking permit issuer. All these decisions have significant positive impacts on the motivation to use electric vehicles and hybrid vehicles in Prague Capital City.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **742** | **1 311** | **1 282** |
| Calculation | Number of issued parking permits for electric vehicles | | |

*Data provided by the Transportation Department (TD) of Prague City Hall, valid as of 31 December of the given year*

The indicator value for 2019 consists of the number of parking permits for EVs (987) and vehicles that have "EL" in their registration plates (295), and therefore do not have a registration obligation - the monitoring system automatically registers their parking as authorized. The number decreased compared to 2018 due to a change in the categorization of vehicles. The category of parking permits for EVs previously also included Integrated Rescue Service vehicles, hybrids and others. Hybrid vehicles and Integrated Rescue Service vehicles were transferred to their categories in 2019. It is important to emphasize that the EV group includes all vehicles that meet the conditions of Section 7b(6) of Act No 56/2001, on the conditions of operation of vehicles on roads, i.e. also vehicles with the hybrid drive if they have $CO_2$ emissions of under 50 g/km.

A significant increase in car-sharing can be anticipated in the future thanks to the general trend in the popularity of the sharing economy, more convenient service available through mobile apps, and also generational change, as the younger generation - which shows greater interest in new transport alternatives - is already earning and can afford it. It can be anticipated that the growing trend in shared mobility will also lead to a reduction in problems with traffic at rest, which is reflected in the city space, especially through the disproportionate occupation of streets by parked vehicles. The evolution of shared mobility will reduce the number of second cars in households and will further reduce the need to own a car for one-off trips, especially in the city.

### Number of Shared EVs

The definition of a shared vehicle is addressed in the publicly available Resolution of Prague City Council No 1548 on the Implementation of Carsharing in Paid Parking Zones in Prague Capital City of 21 June 2016. The most fundamental requirements for city-supported carsharing include operation of the service 24/7 and short-term rental - including under 1 hour. Vehicles must be equipped with self-service pick-up and return technology. Within 2 years of signing the contract, service providers must deploy vehicles in at least ten geographically different areas of the city - each vehicle must always be at least 500 meters away from other vehicles. Uniform service marking on vehicles and an average fleet age of under 4 years is required. Vehicles with internal combustion engines must meet at least the Euro 5 emissions standard.

A significant increase in car-sharing can be anticipated in the future thanks to the general trend in the popularity of the sharing economy, more convenient service available through mobile apps, and also generational change, as the younger generation - which shows greater interest in new transport alternatives - is already earning and can afford it. It can be anticipated that the growing trend in shared mobility will also lead to a reduction in problems with traffic at rest, which is reflected in the city space, especially through the disproportionate occupation of streets by parked vehicles. The evolution of shared mobility will reduce the number of second cars in households and will further reduce the need to own a car for one-off trips, especially in the city.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0343** | **0,1230** | **0,1391** |
| Calculation | Number of shared EVs/city area | | |
| Number of shared EVs | 17 | 61 | 69 |
| City area | 496 $km^2$ | 496 $km^2$ | 496 $km^2$ |

*Data provided by TD PCH, valid as of 31 December of the given year*

The indicator value is determined as the number of EVs compared to the area of the capital. It expresses the number of shared EVs related to the area, i.e. how many shared electric vehicles there are per 1 $km^2$. In 2019 there was one shared electric vehicle per approximately 7.2 $km^2$.

## Number of shared EVs per capita

This indicator follows on from the previous indicator concerning the number of shared electric vehicles, with the difference that it is tied to a population sample, not the area of the capital.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,013** | **0,047** | **0,052** |
| Calculation | Number of shared EVs/1 000 inhabitants | | |
| Number of shared EVs* | 17 | 61 | 69 |
| Population of Prague** | 1 294 513 | 1 308 632 | 1 324 277 |

*Source: *TD PCH - data valid as of 31 December of the given year; **CZSO - data valid as of 31 December of the given year*

The increase in the number of shared EVs in 2019 was not as significant as in 2018, which could partly be due to the increase in the number of shared hybrid cars, as shown in the following indicator. In general, the number of shared EVs is increasing together with the population of Prague. In 2017, there was one shared EV per over 76 000 inhabitants of Prague Capital City; in 2018 there was one per about 21 500 inhabitants, and in 2019 there was one shared EV per approximately 19 200 inhabitants of the capital.

## The character of the Sharing System Fleet

This indicator follows on from the previous indicator but expresses the share of shared EVs in the overall fleet of shared vehicles.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0642** | **0,0938** | **0,1839** |
| Calculation | Number of shared EVs and hybrid cars/total number of shared cars | | |
| Number of shared EVs | 17 | 61 | 69 |
| Number of shared hybrid cars | 0 | 0 | 100 |
| Total number of shared cars | 265 | 650 | 919 |

*Data provided by TD PCH, valid as of 31 December of the given year;*
**Value valid as of 17 March 2020*

**There are more shared vehicles (919) than trams (830) in Prague.**

This indicator is sensitive to the quantities of EVs and hybrid cars in the vehicle fleet, meaning that even while the total number of shared vehicles is maintained, the replacement of regular drive systems with alternative ones in the vehicle fleet is recorded. Given that the critical penetration value for shared vehicles in Prague (set by EY at 479) was significantly exceeded in 2018, a more significant increase in the value of this indicator can be anticipated in the future. This statistic can also be interpreted as meaning that while the total number of shared vehicles increased 2.4-fold between 2017 and 2018, the number of shared EVs increased 3.5-fold. This difference is even more pronounced between 2018 and 2019 - while the number of shared cars increased only 1.4-fold, the number of EVs and hybrid vehicles grew 2.7-fold. Between the end of 2017 and the end of 2019, the number of shared hybrid cars grew by 100% and the number of shared cars by 654, over double the original value recorded in 2017. This probably partly reflects the gradual replacement of the vehicle fleet with a trend towards a higher level of EV representation. The year-on-year increases in the number of shared vehicles testify to the growing popularity of carsharing and within it the trend of switching to alternative drive systems.

However, according to the representatives of some carsharing companies, building a network of fast-charging stations is also very important to support growth in the share of shared electric vehicles in the overall fleet of shared vehicles. Increasing the number of shared hybrid vehicles will depend on the introduction of new mobility providers in the capital whose fleets exclusively comprise hybrid vehicles.

## E-carsharing in personal transport

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,002 %** | **0,007 %** | **0,008 %** |
| Calculation | Number of shared EVs/number of registered category M1 vehicles | | |
| Number of shared EVs | 17 | 61 | 69 |
| Number of registered category M1 vehicles | 844 613 | 882 717 | 911 844 |

*Data on the number of registered vehicles from the Central Vehicle Register of the Ministry of Transport, always valid as of 31 December of the given year. Note: In 2017, the value of the number of shared EVs from the EY study (36) was replaced by data from the Transportation Department. Data on the number of registered category M1 vehicles for 2018 were elaborated.*

This indicator expresses the share of shared EVs in the total number of registered category M1 vehicles in Prague Capital City. The resulting value is multiplied by 1 000 for better readability. The number of shared EVs in 2017 included vehicles from one provider that ceased operation on 3 November 2017. More providers were added in 2018 and the absolute number of shared EVs increased 3.5-fold. The year-on-year increase in the number of registered vehicles decreased by approximately 10 000. About 40 000 more vehicles were registered in 2018 than in 2017, and another about 30 000 vehicles in 2019.

### Use of E-carsharing

This indicator captures direct values related to the use of e-carsharing vehicles.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Distance travelled or time for shared EVs/number of shared EVs | | |
| Number of shared EVs | 17 | 61 | 69 |
| Distance travelled or time for shared EVs | N/A | N/A | N/A |

*Source: TD PCH*

It is not currently possible to determine this indicator because information on vehicle distance travelled or usage times is a trade secret of the service provider. Carsharing operators generally protect the distance travelled/time data of shared EVs and these are therefore not monitored, while a change of approach in this regard is desirable but unlikely in the future. The use of other monitoring technologies could also be considered, for example using existing CCTV systems on backbone roads to monitor the number of private EVs vs. those shared and operated in the city. In the future, better quality statistical data should also be provided by the urban app for intermodal traffic planning and especially its extension towards MaaS (Mobility as a Service) services. In the longer term, it will be possible to use MOT data.

### Accessibility of Shared EVs

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0355** | **0,1273** | **0,1441** |
| Calculation | Number of shared EVs/critical penetration value | | |
| Number of shared EVs | 17 | 61 | 69 |
| Critical penetration value of shared cars in Prague Capital City | 479 | 479 | 479 |

*The data are based on the EY study described above and on values provided by the Transportation Department of PCH*

According to a study on shared cars prepared by EY, the critical shared cars penetration value in Prague Capital City is 479. This value expresses the minimum number of shared cars needed in Prague Capital City for the service to become generally available. Given that this number has already been significantly exceeded for the entire fleet of shared vehicles, including EVs, in 2018, a further increase in this indicator can be anticipated in the future in connection with replacements in the shared vehicles fleet in favour of EVs. Compared to 2017 and 2018, the year-on-year increase in the indicator value was not so significant in 2019. The number of EVs in Prague Capital City is constantly increasing, with hybrid drive vehicles also appearing more and more often. The number of shared EVs increased by 8 in 2019. The resulting value, namely the share of shared EVs in the critical penetration value, is still in the order of tenths.

### The popularity of E-carsharing within Car-Sharing Systems

This indicator will capture the popularity of EVs in the total fleet of shared vehicles. This indicator will provide feedback to the city with support for electromobility. It can be concluded that a high value for this indicator will mean the absence of problems in the use of EVs compared to regular drive systems.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Distance travelled or time for shared EVs/distance travelled or time for shared cars | | |
| Distance travelled or time for shared EVs | N/A | N/A | N/A |
| Distance travelled or time for shared cars | N/A | N/A | N/A |

It is not currently possible to determine this indicator because information on vehicle distance travelled or usage times is a trade secret of the service provider. Data on the distance travelled/time of shared vehicles is protected by the carsharing operators, so these values cannot currently be ascertained - this situation will probably not change in the future. The use of other monitoring technologies could also be considered, for example using existing CCTV systems on backbone roads to monitor the number of private EVs operated in the city compared to all shared vehicles. In the future, better quality statistical data should also be provided by the urban app for intermodal traffic planning and especially its extension towards MaaS (Mobility as a Service) services. In the longer term, it will be possible to use MOT data.

### The popularity of Car-Sharing Systems in Personal Transport

This indicator will capture the popularity of shared vehicle services in general.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Average distance travelled per person in shared cars/average distance travelled per person in their cars | | |
| Average distance travelled per person in shared cars | N/A | N/A | N/A |
| Average distance travelled per person in their cars | N/A | N/A | N/A |

It is not currently possible to determine this indicator because information on vehicle distance travelled or usage times is a trade secret of the service provider. It is similarly not possible to establish distance travelled in privately owned vehicles. The use of other monitoring technologies could also be considered, for example using existing CCTV systems on backbone roads to monitor the number of shared EVs operated in the city compared to all shared vehicles.

### Maturity of Carsharing Systems

The purpose of this indicator is primarily to capture the extent to which individual car-sharing services can be integrated into a single user platform. The scale is viewed from the perspective of system integrability, i.e. the use of a single user interface for access to only one or more integrated apps.

This indicator shows technological readiness for the integration of single registration, payment, reservation, sales services (check-in, check-out, unlock, etc.), shared customer service, and shared loyalty and benefit programs. One point is added for each defined category that meets the technological readiness requirements for integration into a single service. The resulting indicator value is determined as the sum of these points.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Registration | N/A | N/A | N/A |
| Payment | N/A | N/A | N/A |
| Reservation | N/A | N/A | N/A |
| Sales services | N/A | N/A | N/A |
| Shared customer service | N/A | N/A | N/A |
| Shared loyalty and benefit programs | N/A | N/A | N/A |

It is not currently possible to determine the values as the evaluation of this indicator is conditional on the emergence of unifying platforms, such as an intermodal route planner or a Mobility as a Service type mobile app integration platform.

### Penetration of the Public Charging Infrastructure

The Smart Prague 2030 concept defines support for electromobility as a key activity. The development of city-wide electromobility is fundamentally influenced precisely by the availability of the necessary charging infrastructure. Charging stations (EVSE) are generally divided into fast and regular types. Fast chargers have an installed power of over 40 kW, which for a regular electric vehicle represents sufficient charge for 200 km of range in about 40 minutes (depending on the battery capacity, charging management and consumption of the specific EV). These stations are usually direct current (DC). Regular charging stations operate on alternating current (AC) and take many hours to charge an electric vehicle battery, compared to fast chargers that can charge one in tens of minutes.

Public charging stations (according to the evmapa.cz website) in Prague Capital City are divided into the following types:

- **16 A 230 V - standard AC charging connector providing about 3.7 kW of power, similar to domestic sockets**
- **16 A 400 V - standard AC charging connector providing around 11 kW of power**
- **32 A 400 V - standard AC charging connector providing around 22 kW of power**
- **Mennekes Type 2 - standard AC charging connector providing about 22 kW of power**
- **CHAdeMO - fast-charging DC connector providing up to 62 kW of power**
- **CSS - fast-charging DC connector providing around 50 kW of power**

It is very important that planning the suitable type of charging station for a specific location takes into account the assumed parking regime in addition to the available electrical connection capacity. Higher power should be installed in places with anticipated short-term parking, and vice versa.

This indicator monitors the effective coverage of the entire city with EVSE points.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,1169** | **0,3649** | **0,5302** |
| Calculation | Number of EVSE points/city area | | |
| Number of EVSE points | 58 | 181 | 263 |
| Area of Prague Capital City in km$^2$ | 496 | 496 | 496 |

*Source: PRE, ČEZ, innogy, Pražská plynárenská*

The above table shows that there were 123 more charging points in 2018 than in 2017. Another 82 EVSE points were added in 2019 so that there is now one recharging point per under 2 km$^2$.

For this yearbook, an EVSE point means a geographical point on a map. Although one EVSE station usually has multiple charging points, the spatial availability of EVSE points in the city is crucial for this yearbook. There is also a service available on the evmapa.cz website  and through a mobile phone app that enables the following functions throughout the Czech Republic, and therefore also in Prague Capital City: navigation to charging stations using selected filters, online payment, and also availability for some stations.

## Prevalence of Fast Public Charging Infrastructure

This indicator shows the share of fast-charging stations in the total number of charging stations. This is an indication of the readiness of the public charging infrastructure for high electric vehicle turnover (for example taxis, shared vehicles, goods delivery, etc.). There are also increasing numbers of charging stations in shopping centres, motivating customers to purchase EVs, which they can then charge while shopping or watching a film. It is precisely the availability of places that allow EVs to be charged in 30 minutes to at least 80% of battery capacity that is a key parameter for the development of electromobility as a whole.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,2759** | **0,1934** | **0,3498** |
| Calculation | Number of EVSE DC points/total number of EVSE points | | |
| Number of EVSE DC points | 16 | 35 | 92 |
| Number of EVSE AC points | 42 | 146 | 171 |
| Total number of EVSE points | 58 | 181 | 263 |

*Source: PRE, ČEZ, innogy, Pražská plynárenská*

The city's support for the proliferation of fast-charging stations is an essential and key component for the development of the Mobility of the Future area of the Smart Prague 2030 concept. Most charging stations in Prague Capital City 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

This indicator compares the number of EVSE points to the number of registered EVs. It is important to take into account the Public Charging Infrastructure Penetration indicator when interpreting this indicator. The mentioned indicator shows the distribution of EVSE points, which should be evenly distributed over the entire territory of Prague Capital City, and whether the main areas of EV occurrence are sufficiently covered.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0547** | **0,1138** | **0,1121** |
| Calculation | Number of EVSE points/number of registered EVs | | |
| Number of EVSE points | 58 | 181 | 263 |
| Number of registered EVs | 1 060 | 1 591 | 2 347 |

*Source: TD PCH, PRE, ČEZ, innogy, Pražská plynárenská*

The recommended target value for charging infrastructure availability is 10 EVs per EVSE point. This indicator value should, therefore, oscillate around a value of 0.1 over the long term. To ensure the development of electromobility, the charging infrastructure must motivate mass EV usage, and therefore the density of coverage of Prague Capital City with charging stations is also important.

### Use of Charging Infrastructure (Number of Charges)

This indicator shows the level of use of the charging infrastructure compared to the number of registered EVs.

| | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|
| Station type | Fast charging station | Regular charging station | Fast charging station | Regular charging station | Fast charging station | Regular charging station |
| **Resulting indicator value** | **16,7** | **12,0** | **16,9** | **6,9** | **31,0** | **11,7** |
| Calculation | Number of charges/number of registered EVs | | | | | |
| Number of charges | 17 650 | 12 723 | 26 946 | 10 942 | 72 787 | 27 548 |
| Number of registered EVs | 1 060 | | 1 591 | | 2 347 | |

*Source: PRE, ČEZ, innogy, Pražská plynárenská*

The indicator values show an increase in the use of the public charging infrastructure by almost twofold. Even so, this is a fraction of the number of charges, as vehicles are still primarily charged through private stations. When comparing the usage of fast-charging stations to regular charging stations, use of fast charging stations is dominant - of which there are of course fewer. This highlights an infrastructure deficit in terms of coverage of the city with public fast-charging stations.

### Charging Infrastructure Use (Quantity of Energy Consumed)

This indicator shows the loading on the charging infrastructure in terms of energy consumed.

**i The energy consumed at the fast--charging stations could power an electric car for around 4m km.**

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Fast charging stations (DC) | 224 509 kWh | 324 116 kWh | i 818 133 kWh |
| Regular charging station (AC) | 141 174 kWh | 121 281 kWh | 268 615 kWh |

*Source: PRE, ČEZ, innogy, Pražská plynárenská*

The indicator values highlight a significant jump in energy consumed, corresponding to the increase in the number of charges. The increase is thanks to the expansion of the charging station network and the development of electromobility in the capital, i.e. the increase in the number of registered EVs

## CLEAN BUSES


The city air is significantly affected by exhaust gases, and one way to eliminate pollutants - especially in larger cities - is the transition of public transport to alternative propulsion. This Mobility of the Future sub-area focuses on the migration of the fleet of urban and suburban buses to environmentally friendly propulsion, and thereby the health of citizens. These are mainly electric buses.

## Buses Powered by Electric Motors

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0017** | **0,0017** | **0,0017** |
| Calculation | Number of electric buses/total number of buses in the fleet | | |
| Number of electric buses* | 2 | 2 | 2 |
| Total number of buses in the DPP fleet** | 1 170 | 1 162 | 1 144 |
| Total number of buses of other PID operators | 934 | 1 022 | 1 350 |

***/**For 2017: includes 1 battery trolleybus. Data as of 31 December 2019 for DPP and ROPID*

Only vehicles in the DPP bus fleet are included in the resulting indicator, as they provide the vast majority of bus transport in Prague Capital City. Other carriers in the PID system provide transport services mainly on the 3xx and 4xx routes. The 3xx routes are suburban buses, meaning that in most cases these vehicles do not penetrate deeply into the city but rather transport passengers to the outskirts - especially to metro stations. The 4xx routes are operated in PID tariff zones but do not pass through the territory of Prague Capital City. The year-on-year increase in the number of buses not including DPP is due to the tenders for routes within the PID system, and thus the purchase of additional vehicles for their operation; Prague's integrated transport system has also expanded deeper into the Central Bohemia Region.

There are one SOR NS 12 electric bus and one SOR TNB 12 battery trolleybus in the DPP fleet. Under current legislation, a trolleybus is not a road vehicle but a rail vehicle.

Another 2 electric buses are regularly operated in the capital by Arriva. These electric buses are outside the PID system because they are contracted transport for BBC Brumlovka. One of these electric buses can cover 130 km to 150 km on a single charge carrying passengers in normal operation. They can carry 73 passengers, who can also use a Wi-Fi connection in both vehicles.

An improvement in this indicator can be anticipated only through the gradual renewal of the internal-combustion-engine bus fleet after the end of their planned service life, and this is, therefore, a long-term trend and needs to be monitored.

## E-bus Distance Travelled

This indicator complements the previous Electric Buses indicator with information about the actual deployment concerning distance travelled.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0008** | **0,0006** | **0,0015** |
| Calculation | E-bus distance travelled (km)/total bus kilometres travelled | | |
| E-bus distance travelled (km) | 60 755 | 45 940 | 116 660 |
| Total bus kilometers travelled | 72 450 000 | 75 632 100 | 75 577 309 |
| Number of vehicle kilometres by DPP buses in Prague Capital City | 64 683 000 | 67 900 000 | 67 540 000 |
| Bus vehicle kilometres on city routes, not DPP, in Prague Capital City | 7 767 000 | 7 732 100 | 8 037 309 |

*Data for the period 1 January to 31 December 2019 for DPP*

The several-fold increase in the number of vehicle kilometres by electric buses is caused by the inclusion of distance travelled by five vehicles in pilot operation.

The total number of bus kilometres is calculated as the sum for DPP and other PID operators in Prague Capital City.

The increase in the indicator value is caused by the inclusion of electric buses outside the PID system in the total number of kilometres driven by electric buses.

The increase in the number of vehicle kilometres by city buses, not including DPP, in Prague Capital City, is caused by the tendering of routes to private operators in the Prague Integrated Transport system.

The purpose of implementing Intelligent Transport elements in cities is to make use of available technologies to improve transport performance and safety in the existing infrastructure. A key Intelligent Transport aspect is the interconnection of individual (intelligent) transport systems. A fundamental indicator for the level of intelligent traffic in a city is the introduction of adaptive traffic light control at intersections to optimize intersection capacity and reduce transit time using sensors and online control of real traffic flows (the connections of existing intersections will be upgraded to ensure high-quality and rapid duplex data transmission from detectors, controllers and traffic exchanges, thus enabling the deployment of predefined traffic management scenarios, including adaptive management at local, regional, city and suburban levels). In addition to managing transport nodes and monitoring the current situation, information and navigation systems are also among the key smart transport areas. Parking - or transport at rest - is an important part of the transport system, and sensors can be used to determine current fullness with the information provided to drivers who can then be navigated to available parking spaces. In the future, the reservation of parking spaces may be considered, especially in parking areas with limited entry/exit options such as P+R parking. In city street networks, modern technologies are being applied more in connection with the paying of parking fees (cashless payment by credit card, payment via mobile app, SMS, etc.), or fullness is monitored and this information passed to drivers via a mobile phone app or website. The development of systems for informing other transport participants, public transport passengers, and the further streamlining of traffic flows, is also an integral part of Intelligent Transport.

## Number of Smart Parking Spaces

Smart parking spaces are individual parking spaces equipped with sensors (individual measuring, for example, a puck located on the road surface, or collective measuring, such as a camera system). If a car park is equipped with such parking spaces, drivers can be guided directly to specific available parking spaces. This will save time and reduce the emissions generated when drivers search for available parking spaces.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0000** | **0,0656** | **0,0648** |
| Calculation | The number of functional P+R parking spaces equipped with intelligent sensors/total capacity of P+R car parks in PCC | | |
| The number of functional P+R parking spaces equipped with intelligent sensors | 0 | 260 | 260 |
| The total capacity of P+R car parks in Prague Capital City | 3 709 | 3 966 | 4 010 |

*Data provided by TSK hl. m., Plc., valid as of 31 December 2019*

**The equivalent of 19 km of end-to-end parking spaces in streets.**

In 2018, a P+R car park was put into operation at Prague Congress Center with a capacity of 260 spaces equipped with camera systems. These camera systems monitor the occupancy of individual parking spaces. Prague's P+R car parks are equipped with entrance/exit barriers that count the current number of vehicles in the car park. For this reason, sensors at the individual parking spaces are not essential. The recording of vehicles at the entrance/exit is a significantly less financially demanding option and is sufficient for collecting data on current fullness, and so no significant change in the indicator value is anticipated in the future.
The entrance camera systems at P+R car parks are being upgraded to read vehicle registration plates. This system will enable faster handling when leaving the car park, and will also allow users to pay parking fees using the PID Lítačka and My Prague apps. These apps can also be used to monitor the current fullness of individual P+R car parks.

## Intelligent Light Signalling Devices

Intersections controlled by light signalling devices (whether light signalling devices or traffic lights) are equipped with a controller. This includes software for controlling the light signals, meaning it sends pulses to the individual light signalling devices that then convey the given instruction to drivers.

Light-controlled intersections do not work independently of others but are connected to a control centre (the Main Traffic Control Centre - MTCC - in Prague) as the higher organizational unit ensuring the flow of traffic in the city. Light-controlled intersections are designed to ensure smooth traffic flows at predetermined intersections.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,706** | **0,719** | **0,726** |
| Calculation | Number of light signalling devices connected to the MTCC/total number of light signalling devices in PCC | | |
| Number of light signalling devices connected to the MTCC | 466 | 478 | 484 |
| Total number of light signalling devices | 660 | 665 | 667 |

*Data provided by TSK, valid as of 31 December 2019*

These indicators show the degree of integration of traffic management in Prague Capital City. The basic traffic control unit is the number of intersections equipped with light signalling devices controlled by intersection controllers. These intersection controllers are integrated into automated ATCCs (Area Traffic Control Centers). These are then integrated into the highest level - the Main Traffic Control Center (MTCC) - which acts as the controlling station. This provides central supervision of the traffic situation and central coordinated traffic management in Prague Capital City. Data for the creation of traffic incidents at the MTCC are obtained from various sources: traffic intensity detectors, the road weather system, high-speed scales, the surveillance camera system, light signalling devices, tunnel control systems, the national traffic information centre, and the Rudná control centre.

Light signalling devices connected to the MTCC can be directly controlled through decisions taken by dispatchers according to the current traffic situation to ensure safe and smooth traffic flow. The further development of systems to support dispatchers' decision-making or system automation also depends on the availability of artificial intelligence ("AI") technologies in the given area, and the centralization of information from other sources such as the online navigation sensor systems of cars, autonomous vehicles, etc.

As regards the development trend, four new light signalling devices were constructed in 2019, two were cancelled, and six light signalling devices were newly connected to the MTCC system.

## Degree of Preference for Public Transport at Intersections

This indicator shows the degree of integration of the public transport preference system at light-controlled intersections. Giving public transport preference at traffic lights shortens the time public transport vehicles need to wait, thus improving the timekeeping of these vehicles. This indicator is divided into a preference for trams and buses.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,7944 / 0,3515** | **0,8306 / 0,3579** | **0,8508 / 0,3673** |
| Calculation | Number of preference-giving light signalling devices on the tram network/total number of light signalling devices on the tram network; Number of preference-giving light signalling devices on the bus network/total number of light signalling devices | | |
| Number of preference-giving light signalling devices on the tram network | 197 | 206 | 211 |
| Total number of light signalling devices on the tram network | 248 | 248 | 248 |
| Number of preference-giving light signalling devices on the bus network | 232 | 238 | 245 |
| Total number of light signalling devices | 660 | 665 | 667 |

*Data provided by TSK, valid as of 31 December 2019*

Two preference types are used on the tram network - absolute and conditional. Absolute preference means all trams pass through the light-controlled intersection without stopping (except when multiple trams arrive concurrently). Conditional preference is when tram delays at traffic lights are reduced compared to the situation without preference. In 2019, five light-controlled intersections with the tram preference system were newly equipped on the tram network.

There are also two types of preference on the bus network - active and passive. Active preference is a system whereby the vehicle logs in and logs out to the light-controlled intersection controller using radio signals at specified points. Infrared beacons or a satellite navigation system (GNSS) are used to locate buses. Passive detection means that the right of the bus to priority is identified by conventional vehicle detectors when passing through an induction loop built into the road itself or employing a so-called virtual loop. This solution is mainly used in dedicated lanes. In 2019, seven light-controlled intersections were newly equipped with the bus preference system on the bus network.

It is important to mention that the total number of light-controlled intersections on the bus network is not monitored. The reason for this is the flexibility of bus connections and routes, which can be changed relatively easily, for example in the case of roadworks. For this reason, the total number of all light-controlled intersections in Prague Capital City is used to calculate the indicator.

## Smart Transport Infrastructure Elements

This indicator is determined based on the number of RSUs (roadside units). An RSU is a road infrastructure element used for two-way communication between a vehicle and the infrastructure (V2I - Vehicle-to-Infrastructure). These infrastructure elements allow the exchange of information such as speed, direction, route and so on, and can be connected to, for example, an intersection controller which sends vehicles information about the time to the next green light, or can be connected to a weather service that sends current information to the vehicle infotainment system.

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

*Data provided by TSK, valid as of 31 December 2019*

RSUs are units of cooperative systems. It is precisely such units that are also installed in Prague Capital City. V2I communication means a platform enabling the exchange of information between an infrastructure object and a vehicle and which concurrently ensures the redistribution of that information among vehicles. Vehicles must be equipped with on-board units (OBUs) for this type of communication.

RSUs communicate with OBUs on 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

This indicator focuses on assessing traffic flow on major transit roads. It provides long-term monitoring of the success of the implementation of the city's strategies to ensure traffic flow, mainly through the deployment of traffic telematics measures.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Peak speed (km/h) | 33,8 | 35,4 | 35,4 |
| Off-peak speed (km/h) | 43,5 | 43,5 | 41,8 |
| Free flow speed (km/h) | 51,5 | 51,5 | 51,5 |

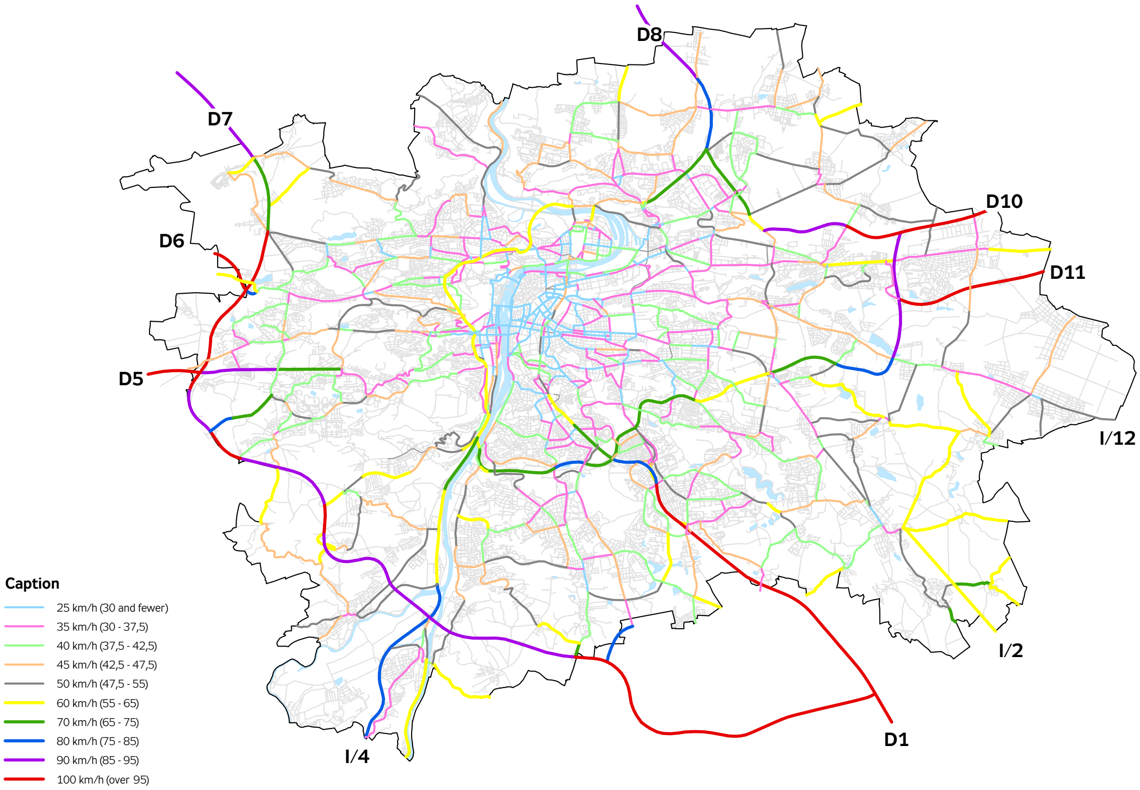
*Source: INRIX Global Traffic Scorecard*

This indicator is not systematically monitored at the Prague-wide level. These data come from available studies conducted by INRIX, evaluating congestion in over 975 cities on seven continents. Speeds barely changed over the monitored years, while the average off-peak speed fell by almost 2 km/h in 2019.

However, in the urban road network system, the average speed varies considerably from one locality to another. For an illustration of the spatial differentiation see the figure below, which shows data from the FCD system - localization data collected on speed, the direction of travel and time information from mobile phones in moving vehicles. This was a one-time study for 2017 and has not yet been repeated due to cost restraints.

**ORIENTATIONAL AVERAGE DRIVING SPEED**

THE YEAR 2017, ALL VEHICLES, AN AVERAGE WORKING DAY




## Bus Flow

The indicator below shows the average speeds of Dopravní podnik hl. m. Prahy, a.s. (DPP) buses in Prague Capital City. It also provides long-term monitoring of the effectiveness of the public transport vehicle preference system at light-controlled intersections.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **25,16 / 16,70** | **25,01 / 16,80** | **24,98 / 16,90** |
| Calculation | Average cruising speed km/h/average orbital speed km/h | | |

*Data provided by DPP*

The values express the average speeds of DPP buses by year. The routes in question are the 1xx, 2xx and 3xx.

Cruising speed is a comparison of the distance travelled and the driving time of public transport buses. For a given route, the cruising speed mainly depends on the length of the route, the number of stops and so on. Breaks at end stations are not included in the cruising speed calculation. The average cruising speed expresses the average cruising speed of vehicles on routes in Prague Capital City.

Orbital speed is a comparison of the distance travelled and the orbital time of one circuit of a given route. Direct dependence consists of cruising speed and indirect dependence the standing time at end stops. Orbital speed is an important operating characteristic as the number of vehicles needed on a route depends on it.

Data for 2019 show a similar trend as in 2018, i.e. a decrease in cruising speed but an increase in orbital speed.

## SELF-DRIVING VEHICLES

The main purpose of this sub-area is to establish a strategy for the transition to self-driving for individual types of transport (e.g. trams, passenger cars, metro, etc.). The city was to primarily initiate pilot projects and collect data to provide comprehensive support for the introduction of self-driving vehicles in Prague, respectively in the Czech Republic. The experience and data obtained through the pilot projects will serve as the basis for proposing 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 case of autonomous vehicles, the aim is for them to be capable of operating in the current environment and to keep the need for road modifications to a minimum. Technologies are already available - albeit at a high cost - however, legislation to address the operation of autonomous vehicles is not yet ready. The Czech Republic is involved in testing cooperative intelligent transport systems within the pan-European C-ROADS project, the goal of which is to test communication between vehicles themselves and between vehicles and units installed on the transport infrastructure. By providing up-to-date information to drivers directly in their vehicles, the project represents the first steps towards intelligent mobility. There is a plan to deploy an autonomous train on the planned metro line D in Prague Capital City. It is generally considered easier to introduce self-driving vehicles in rail transport, as vehicle movement is limited and - especially in the case of underground transport - the environment remains almost unchanged, and there is a low risk of obstacles on the line. One condition for autonomous metros is that the tracks and platforms are completely physically separated - the train must stop so that its doors are always in the same place to allow passengers to embark and disembark.

### The readiness of Roads for the Use of Autonomous Vehicles

This indicator provides information on the number of kilometres of roads eligible for autonomous driving. For this indicator, eligible means, in particular, that the infrastructure features communication units and other technologies enabling completely autonomous vehicle travel. This is based on the Smart Prague 2030 concept framework, which sets the goal of developing the potential for autonomous driving. This indicator arose from the need to have a range of test polygons and roads to attract partners from the automotive industry.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Number of kilometres of roads allowing autonomous driving/total number of kilometres of roads in the territory of Prague Capital City managed by TSK | | |
| Number of kilometres of roads allowing autonomous driving | 0 | 0 | 0 |
| Total number of kilometres of roads in the territory of Prague Capital City managed | 2 327 | 2 365 | 2 327 |

*Data provided by TSK*

The indicator value 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 existing infrastructure without structural modifications being necessary - the only limiting element being the technical equipment installed. One prerequisite is the creation of a virtual 3D model of the road and its surroundings for the needs of autonomous operation testing. The aim is to adapt selected roads for test scenarios for the deployment of autonomous vehicles from representatives of the automotive industry, which will sign a memorandum with Prague Capital City. We are currently only seeing an increase in the total number of km of roads in Prague Capital City managed by TSK concerning the expansion of the communication network.

### Autonomous Vehicle Testing

NásThe following indicator follows on from the previous indicator Readiness of Roads for the Use of Autonomous Vehicles. It indicates the number of scenarios for the use of eligible roads for autonomous traffic testing.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Number of autonomous mobility test scenarios** | **0** | **0** | **0** |
| Calculation | Number of autonomous mobility test scenarios | | |

*Data always refer to the current year*

The test scenario describes the operational situation on a selected road section under a special mode of operation, in this case, the operation of autonomous vehicles. The test scenario describes a test scheme for the selected situation. There are thus several scenarios for different situations - an example of such a situation may be the passage of a vehicle with the right of way (an Integrated Rescue Service vehicle) through a light-controlled intersection.

The test scenario is a description of the operational situation on a given road section under a special mode of operation. It describes a test scheme in a given situation, for example, the reaction of an autonomous vehicle to the passage of a vehicle with the right of way (an Integrated Rescue Service vehicle). In the future, a Prague Capital City expert group will be established, and this will operate as an executive body for permitting the testing of autonomous vehicle operation.

## Share of Autonomous Road Vehicles

This indicator will be used to monitor the share of autonomous vehicles. It is calculated as the share of autonomous road vehicles from level 3 and above to the total number of registered category M1 vehicles.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Number of autonomous vehicles/number of registered category M1 vehicles | | |
| Number of autonomous vehicles | 0 | 0 | 0 |
| Number of registered category M1 vehicles | 844 613 | 882 717 | 911 844 |

*Data on the number of registered vehicles are from the Central Vehicle Register of the Ministry of Transport and are always valid as of 31 December of the given year*

| Defined autonomous vehicle levels: | |
|---|---|
| **Level 0: No automation** | the vehicle is controlled exclusively by the driver, and vehicle systems do not interfere in the operation |
| **Level 1: Driver support** | vehicle systems make driving easier but are not interconnected |
| **Level 2: Partial automation** | vehicle systems are combined and cooperate. The driver must be able to take control at any time and must have their hands on the steering wheel most of the time |
| **Level 3: Conditional automation** | the driver must be able to take control, but no longer has to have their hands on the steering wheel |
| **Level 4: High automation** | the driver takes control only in unusual situations |
| **Level 5: Full automati** | completely autonomous driving |

## Use of Autonomous Operation in the Metro

Autonomous vehicles need not be limited to roads, where their implementation is very complicated - they can also be used on rails. Closed special rail systems (for example the metro) are some of the easiest systems for implementing autonomous control.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,6438** | **0,6438** | **0,6438** |
| Calculation | Number of autonomously controlled metro trains/total number of metro trains | | |
| Number of autonomously controlled metro trains according to automation level 2 | 94 | 94 | 94 |
| Total number of metro trains | 146 | 146 | 146 |

*Data provided by DPP, valid as of 31 December 2019*

**If all the trains were parked end-to-end, they would stretch out around 14 km.**

The indicator value is calculated from automation level 2 in the sense of the IEC 62267 standard.

**Automation level 1: manual operation by a driver with automatic train protection.**

**Automation level 2: automatic train operation with a driver in the cab.**

**Automation level 3: automatic train operation without a driver but with the presence of an attendant.**

**Automation level 4: automatic unattended operation.**

Automation level 2 was chosen for the indicator, as it is already implemented in the Prague metro, specifically on line A (green) and line C (red). On line A, all 41 trains are equipped with this technology and all 53 trains on line C. 52 trains run on line B (yellow).

The automated operation primarily brings savings in the energy required for operation thanks to the optimization of consumption when starting and stopping. The future introduction of level 4 automation for metro line D is being considered.

### Use of Autonomous Operation in Public Transport

This indicator shows the level of autonomous operation of Prague metro trains converted to distance travelled in kilometres.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| 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 |
| Total number of vehicle kilometers driven by public transport/DPP vehicles - metro | 58 128 000 | 59 244 000 | 60 894 000 |
| 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 |
| Total number of vehicle kilometers driven by all public transport/DPP vehicles | 177 904 000 | 215 894 645 | 224 556 313 |

**Semi-autonomous mode also included - automation level 2; Data provided by DPP, valid as of 31 December 2019*

The vehicle kilometres value is calculated for each wagon on a train. The train kilometres value can be used for the whole train.

The increase in the number of vehicle kilometres in autonomous mode is due to the gradual automation of line B of the Prague metro. The increase in the number of vehicle kilometres is generally due to the increased operating performance of DPP.

## MOBILITY AS A SERVICE

This area addresses the integration of all information from the different modes of transport (e.g. B+R, P+R, taxi, bicycle/car sharing and public transport) into a single platform (e.g. mobile app, internet) to make this information clearer for users and also for the creation of materials for the intermodal planning of their trips around Prague. Integrated Mobility as a Service (MaaS) services will enable innovative solutions to the problem of transport services based on Big Data operations. Passenger information may include information about delays and the location of connections, while the automatic counting of passengers in a vehicle would also make it possible to have an overview of current fullness and to take this information into account when making decisions. Modern systems will thus make route planning and transfers at individual nodes more efficient, thus saving passengers time when commuting.

### Access to Traffic Information

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **3** | **3** | **3** |
| RDS–TMC (Radio Data System – Traffic Message Channel) | working | working | working |
| Active devices for operational information (DOI) | 71 units | 71 units | 71 units |
| Urban mobile transport app | not met | not met | not met |
| Open traffic data updated in real-time | Available at http://dic.tsk-praha.cz/ | www.dic.tsk-praha.cz, www.dopravapraha.cz | www.dic.tsk-praha.cz, www.dopravapraha.cz |

*Data provided by TSK, a.s., valid as of 31 December 2019*

The resulting indicator value is determined using a scale with values from 1 to 4 (each degree adding another identified layer; if all the previous layers are not filled, one point should be deducted for each unfilled layer).

1. **RDS–TMC (Radio Data System – Traffic Message Channel)**
2. **Digital panels on main roads (roads with high traffic levels)**
3. **(Effective and functional) mobile app**
4. **Open traffic data updated in real-time**

RDS–TMC is a radio system to provide information about the current traffic situation. This system provides data transmitted by radio waves for vehicle navigation infotainment systems. Traffic information devices are vertical information panels along main roads through which traffic information is provided to drivers.

Selected open data concerning transport in the city is available through Prague's Golemio data platform. This means, for example, parking data like the fullness of P+R car parks. The PID Lítačka app works in Prague and all PID zones and can be used to find public transport connections, pay for a time-based ticket, while also making it possible to monitor the fullness of P+R car parks. In the future, this app will be expanded to include other urban mobility services.

## Maturity of Public Transport Payment Systems

This indicator monitors the maturity of public transport payment systems in connection with the digitization of passenger handling.

In 2018, a new transport handling system was launched for Prague and the Central Bohemia Region at Prague Integrated Transport (PID). The system was successfully put into full operation in 2018. This completed the main stage of the PID handling system transformation. In 2019, OICT continued to work on improving this system and incorporating new functionalities to make travel in the PID system even easier and more comfortable. The main priority is the massive advent of new payment technologies and, in particular, the society-wide interest in using mobile phones as payment, identification and navigation tools on a daily basis. The majority of system development is therefore directed towards the mobile platform - the PID Lítačka app. In 2019, the mobile app began providing information about passengers' time-based coupons and also allowed passengers to identify themselves about their time-based coupons, i.e. to use the mobile app as another card, eliminating the need to use a plastic card; the complete functionality of the web-based e-shop was also transferred into the mobile app.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **4** | **5** | **5** |
| Number of paper tickets sold | 39 477 388 | 36 897 108 | 29 880 022 |
| Number of Lítačka/Opencard users | 602 000 / 249 000 | 757 270 / 133 433 | 904 719 / 157 496 |
| Number of SMS tickets sold | 18 969 763 | 18 956 145 | 17 689 319 |
| Number of tickets purchased using a contactless payment card in vehicles/using new ticket machines for contactless cards | 57 912 / 5 087 423 | 66 244 / 7 025 294 | 1 956 019 / 12 426 991 |
| Number of tickets purchased through the PID Lítačka mobile app | N/A | 227 792 | 1 932 038 |
| Number of coupons purchased through the PID Lítačka mobile app | N/A | 0 | 0 |
| Implemented MHS | Implementation under preparation | Full operation | Full operation |
| Number of registered bank cards in the PID Lítačka system/with coupon | N/A | 26 234 / 11 708 | 71 395 / 28 208 |
| Number of registered In Karta ČD (Czech Railways) cards in the PID Lítačka | N/A | 5 816 / 3 743 | 12 046 / 7 681 |
| Number of registered PID Lítačka users (accounts created in the e-shop) | N/A | 204 955 | 524 356 |
| Use of desktop/mobile devices/tablets to access the website | N/A | 321 / 16 592 | 1 487 / 15 602 |
| Podíl přístupů na web desktop / mobilní zařízení / tablet | N/A | 57,5 % / 39 % / 3,5 % | 51,66 % / 46,75 % / 1,59 % |

*Data provided by DPP, ROPID and OICT, valid as of 31 December of the given year*

The indicator value is calculated on a scale of 1 to 5 (each degree of maturity represents one point) and includes the following parameters and functionalities within the Multi-channel Handling System:

1. **paper ticket**
2. **electronic time-based ticket**
3. **SMS ticket**
4. **contactless payment terminals in vehicles**
5. **Apple Pay/Google Pay payment**

## Maturity of Public Transport Handling Systems

The indicator value is calculated according to the handling method, with each degree of maturity representing one point. The following parameters and functionalities within the Multi-channel Handling System are included.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **2** | **3** | **4** |
| Handling using paper tickets and coupons | Yes | Yes | Yes |
| Handling using electronic tickets and coupons on a specific carrier | Yes | Yes | Yes |
| Handling using electronic tickets and coupons with an identifier (not necessarily a carrier) | No | Yes | Yes |
| Handling using virtual tickets and coupons (in the mobile app) | No | No | Yes |

*Source: Operátor ICT, a.s.*

In 2019, the MHS system - publicly known as PID Lítačka - entered normal live operation. The system has been and is still being developed, and is dynamically responding not only to the requirements of the organizers of Prague Integrated Transport (PID) but also to suggestions from end-users, i.e. passengers using the PID system. In the monitored year, it was possible to observe the growing dominance of the pid.litacka.cz e-shop, which gradually took over most of the online sales of time-based electronic tickets. Passengers have gradually adapted to the alternative fare carriers supported by the system. We observed a stable linear growth rate for the new carriers, i.e. bank cards and In Karta ČD together with the Lítačka card; while at the end of 2019 it was already possible to identify oneself with time-based tickets using the PID Lítačka mobile app. This new functionality has eliminated the need to own a plastic card and has made it possible to travel within the PID system only using a mobile app for both long-term and short-term fares. Talking Numbers At the end of 2019, the system registered almost 30 000 bank cards connected to long-term coupons and 8 000 in the case of In Karta České dráhy. The new functionality, i.e. the mobile app as a time-based ticket carrier, was used by over 20 000 people. One can see the future trend and preferences of passengers in the mobile app. Although this functionality was only available for a few days in 2019, its share reached two-thirds of the use of bank cards, something that has been available in the system since the beginning of the operation, i.e. from August 2018. The number of downloads of the mobile app shows a similar trend, as does the analysis of the number of accesses to the website from individual devices, with these figures growing month-on-month in favour of the mobile app. Operátor ICT is planning to continue to support this development and is preparing several development innovations for 2020 that will further enhance not only the popularity of the PID Lítačka mobile app but also other MHS system sales channels, thus helping simplify travel using Prague Integrated Transport.

Strategic development and business team are now dedicated to developing the project. At the same time, Operátor ICT is planning to offer its experience, infrastructure, development capacities and project management to other regions. The goal of Operátor ICT is to contact other regions and offer them the implementation of the transport-handling system, including travel card innovations, e.g. in a pre-paid form in connection with mobile city apps, the clear and rapid management of city fees, and services connected with e-government development and strategy. Operátor ICT plans to offer a new transport handling standard to the widest possible public throughout the Czech Republic. The Operátor ICT project team is ready to modify this revolutionary handling system for the needs of other regions. It is also offering cooperation in the implementation of innovations and the provision of development capacities, for example, the introduction of mobile apps related to transport or city administration.

The above table also shows a significant increase in the number of registered bank cards, which increased approximately 2.7-fold. The numbers of In Karta ČD registrations and shared accounts also increased significantly. The share of web app access from mobile phones also increased.

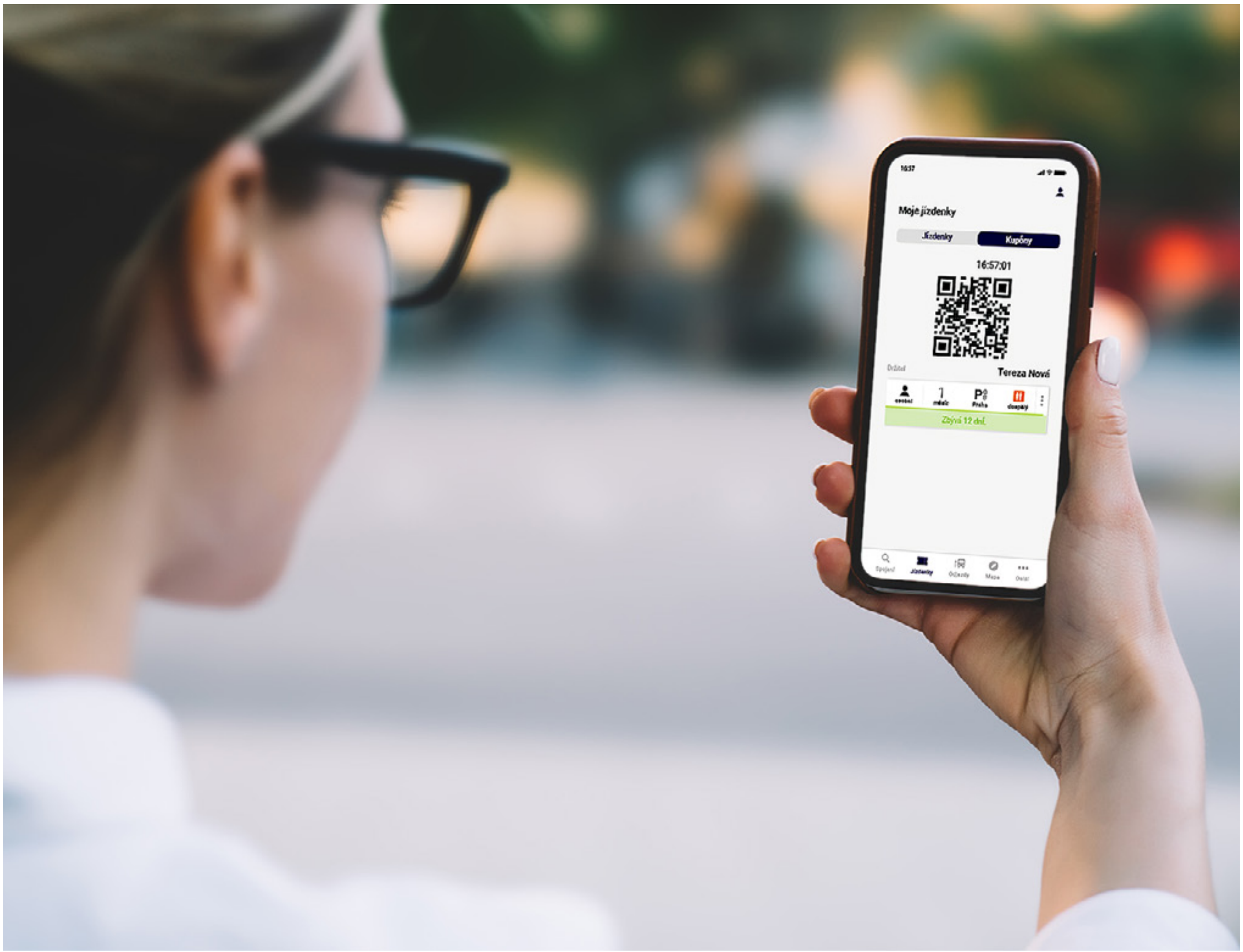
## Use of the City App for Transport Around the City

This indicator shows the actual use of the PID Lítačka city app, which focuses on transport around the city.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **66,34** | **101,81** |
| Calculation | Number of connection search requests and ticket purchases/number of unique app downloads | | |
| Number of connection search requests | N/A | 13 968 000 | 19 854 728 |
| Number of ticket purchases | N/A | 227 800 | 1 932 038 |
| Number of unique app downloads: Android/iOS | 50 613 / 7 814 | 186 000 / 28 000 | 242 456 / 48 512 |

*ROPID provided the data for 2017 and they are valid for the "PID info" mobile app, while since 2018 these are OICT data for the PID Lítačka mobile app*

The indicator value illustrates the development of PID Lítačka app usage; the table shows the significant increase in the values of all monitored items. The app is gaining in popularity and this also more users - partly thanks to the stronger promotion and public awareness efforts. The PID Lítačka app has also served as a travel document identifier since the end of 2019. An expansion of app functionality (and subsequent elaboration of this indicator) is anticipated as part of the further development of the PID Lítačka project in the coming years.



### Information Panels at Transport Stops

This indicator shows the degree of digitization of transport stop signs. These signs are the key carriers of information about public transport operations directly in public spaces. The indicator value shows the relative degree of coverage with online information panels for the provision of up-to-date information to passengers.

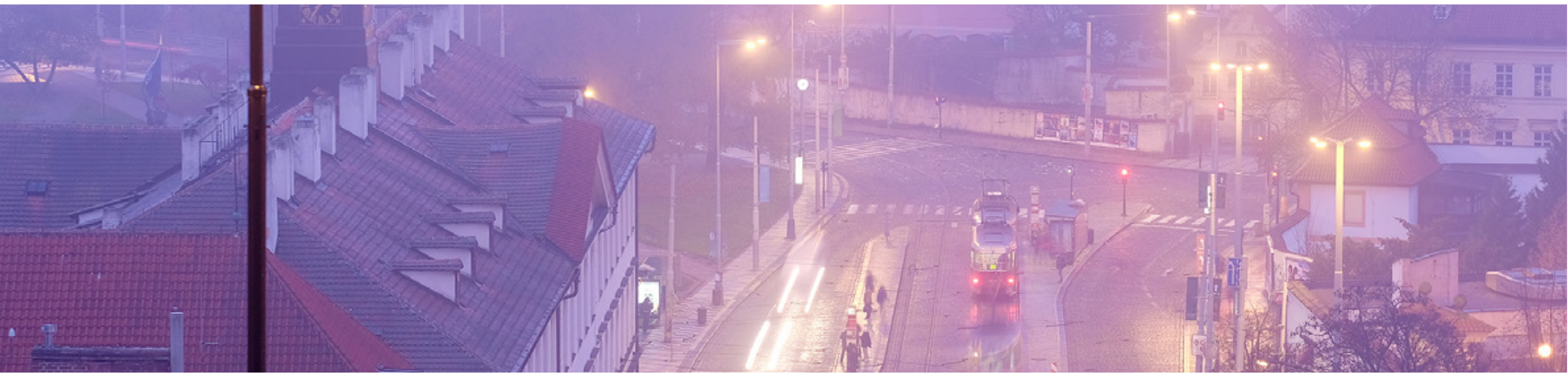
| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,0375** | **0,0556** | **0,0605** |
| Calculation | Number of transport stop signs providing real-time information/total number of PID transport stops in Prague Capital City | | |
| Number of transport stop signs providing real-time information, including information panels providing departure information outside the signs | 125 | 189 | 203 |
| Total number of PID transport stops in Prague Capital City | 3 331 | 3 401 | 3 354* |

*Data provided by ROPID and DPP, valid as of 31 December of the given year; *Data valid as of 18 December 2019*

The total number of PID stops includes stops in PID zones only in the territory of the capital. Transport stops usually have more than one sign. Information panels other than the transport stop signs provide information, including departure times, for example in the lobbies of metro stations (connections with the tram and bus networks). Of this number, 122 signs are placed on metro platforms and 14 new ones have been added at the ticket validity line in the metro lobbies since last year.

The number of transport stops in Prague Capital City has decreased, although their number has increased according to a ROPID representative. This confusion could be caused, for example, by the impact of diversions on the day/week the calculation was performed. The value includes transport stop columns at metro and cable car platforms, train stations and mooring berths as of 18 December 2019; in the case of the metro, each platform is counted separately, i.e. as 2 stops.

## OTHER RELEVANT INFORMATION



This sub-area uses indirect indicators to supplement information about the application of the Smart Prague concept in the area of mobility. Other Relevant Information indicators focus primarily on the quality of life and air pollution, in which transport plays a significant role.

### Premature Deaths Due to Air Pollution

This indicator monitors the numbers of premature deaths due to air pollution. This indicator helps in monitoring the success of solutions to address the challenges set by the Smart Prague 2030 concept. This relates to city-wide shared mobility, the implementation of which through electromobility should, together with the implementation of the Clean Buses area, reduce air pollution caused by traffic. Air quality is also significantly affected by intelligent traffic management, which reduces the impact of traffic by optimizing traffic flows.

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

**Population data are from official CZSO statistics and always refer to the last day of the given year. Source: available reports on air pollution in 2016, 2017 and 2018 from the Ministry of the Environment and CZSO*

VThe air we breathe outside is polluted with harmful substances from a wide range of sources. The most significant air pollution sources in human settlements include combustion processes in the industry, energy generation (including domestic heating), and transport. It has been shown that air pollution can have significant health effects, such as premature death and worsening of the symptoms of various diseases and health problems, especially associated with the cardiovascular and respiratory systems. The increased risk of cancer is also not negligible.

The concentration of $PM_{2.5}$ aerosol particles plays a key role in estimating the number of premature deaths, while their quantity is determined as a proportion of the $PM_{10}$ pollution measured in our country. An increase in the annual $PM_{10}$ concentration by 10 μg/m$^3$ above 13.3 μg/m$^3$/year increases the estimate of the total premature mortality of the exposed population by 4.65%.

### Time Spent in Traffic Congestion

Besides, the number of hours spent by Prague residents (and visitors) in traffic due to traffic congestion is another indirect indicator reflecting the success of the implementations proposed in the Smart Prague 2030 concept in the Mobility of the Future strategic area. The indicator value thus expresses the wasted potential of the population in hours per year.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **119** | **119** | **128** |
| Calculation | Number of hours spent in traffic congestion | | |

*Source: TomTom Index – Prague*

**Enough time to watch almost 74 football matches.**

The indicator value captures the difference between the time needed to complete a route without being affected by traffic congestion and the real transit time, both values being measured at peak times on weekdays. Both the capacity limits of the unfinished infrastructure and the reconstruction of the backbone roads in Prague Capital City are working against a reduction in this value. In the future, it would also be appropriate to monitor the extent of ongoing reconstruction work, such as the total duration of traffic restrictions, to remove their impact from this indicator.

To ensure consistent monitoring of the development series, the data were retrospectively corrected according to newly available TomTom Index data (the newly available INRIX data for 2019 appear inconsistent with data for previous years, probably due to a change in the measurement methodology).

According to the TomTom Index, in 2019 Prague ranked 136th out of 416 cities worldwide with a 29% level of traffic congestion, a slight deterioration compared to its 149th ranking of 403 cities and 27% congestion level in 2018. Compared to 2018, the level of congestion in the capital increased by 2% and drivers in Prague spent an additional average of 128 hours (i.e. over 5 days) in peak traffic

## Age of Registered Vehicles

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **12,6 – 18,9 – 13,5 – 12,5** | **11,6 – 17,3 – 12,6 – 11,8** | **10,6 – 17,3 – 11,4 – 11,1** |
| Calculation | The average age of vehicles registered in Prague Capital City in categories M1 - M2 - M3 - N1 | | |
| M1 - vehicles that can carry a maximum of eight passengers (excluding the driver) and multi-purpose vehicles with a maximum permissible weight not exceeding 3.5 tonnes | 12,6 years | 11,6 years | 10,6 years |
| M2 - vehicles that can carry over eight passengers (excluding the driver) and whose maximum permissible weight does not exceed 5 tonnes | 18,9 years | 17,3 years | 17,3 years |
| M3 - vehicles that can carry over eight passengers (excluding the driver) and whose maximum permissible weight exceeds 5 tonnes | 13,5 years | 12,6 years | 11,4 years |
| N1 - goods vehicles with a maximum permissible weight not exceeding 3.5 tonnes | 12,5 years | 11,8 years | 11,1 years |

*Data provided by the Department of Transport Administration of Prague City Hall*

Category M1 vehicles are usually passenger cars, while N1 category vehicles are multi-purpose passenger vehicles (usually vans up to 3.5 t). Category M2 and M3 vehicles are buses. These categories were chosen because they have the greatest impact on the environment in the city. Large goods vehicles usually operate outside the city in transit traffic. The same can be said about buses, which are very often used for intra-city transport (DPP) or often go into the centre of the city - tourist transport. Motorcycles were not considered because they do not account for significant transport performances.

Given the updating of the input data from preceding years, which are now more accurate thanks to improvements in the differentiation of vehicle states "operated", "no longer operated", "in transfer" and "temporarily not operated (in transfer)" the data in the tables for 2017 and 2018 have also been retroactively adjusted. In contrast to the trend for the Czech Republic as a whole, there is a clear year-on-year rejuvenation of the vehicle fleet in Prague.

This indicator is largely influenced by the overall economic situation and possible future measures at a national level (e.g. higher taxation of vehicles that do not meet the latest emission limits). Surveys suggest that the problem, in fact, is not old cars, but cars in poor condition. For example, poorly maintained engines without particulate filters increase emissions by hundreds of per cent. One-tenth of cars generate about two-thirds of the most harmful emissions from transport, i.e. very small particulate and nitrogen oxides.

## Pollution - Particulates

This indicator shows the degree to which the city is impacted by airborne particulate. A reduction in the above values can be anticipated in the long term thanks to the implementation of measures in the Mobility of the Future strategic area. Unlike the previous indicators, this and subsequent indicators work with available data with a delay of over a year.

| Locality | 2016 | | | 2017 | | | 2018 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Median PM$_{10}$ [μg.m$^3$] | Average PM$_{10}$ [μg.m$^3$] | Number of days when the daily average LV - 50 [μg/m$^3$] is exceeded | Median PM$_{10}$ [μg.m$^3$] | Average PM$_{10}$ [μg.m$^3$] | Number of days when the daily average LV - 50 [μg/m$^3$] is exceeded | Median PM$_{10}$ [μg.m$^3$] | Average PM$_{10}$ [μg.m$^3$] | Number of days when the daily average LV - 50 [μg/m$^3$] is exceeded |
| Prague 1, náměstí Republiky | 18 | 22,8 | 24 | 19,7 | 26,4 | 33 | 26,9 | 30,087 | 38 |
| Prague 2, Legerova | 20,3 | 23,2 | 13 | 18,5 | 23,8 | 25 | 28,3 | 30,127 | 40 |
| Prague 2, Riegerovy sady | 19,1 | 21,8 | 11 | 17 | 23,6 | 27 | 23,45 | 26 | 22 |
| Prague 4 – Braník | 16,7 | 20,1 | 7 | data not available | N/A | N/A | N/A | N/A | N/A |
| Prague 11 – Chodov, listed as Prague 4 – Chodov | 17,3 | 19,4 | 1 | 14,8 | 20,9 | 25 | 19,25 | 21,58 | 12 |
| Prague 12 – Libuš, listed as Prague 4 – Libuš | 17,1 | 19,5 | 7 | 15,8 | 21,2 | 25 | 20,05 | 22,53 | 16 |
| Prague 5 – Smíchov | 24,7 | 26,5 | 14 | 26 | 31,1 | 41 | 30,7 | 32,58 | 38 |
| Prague 13 – Řeporyje, listed as Prague 5 – Řeporyje | N/A | N/A | N/A | N/A | N/A | N/A | 27,4 | 30,29 | 31 |
| Prague13 – Stodůlky | 17,3 | 20,4 | 11 | 15,3 | 20,9 | 23 | 21,4 | 23,68 | 17 |
| Prague 6 – Břevnov | 17,3 | 19,4 | 9 | 15,5 | 22 | 25 | 21,75 | 23,98 | 16 |
| Prague 6 –Suchdol | 17,9 | 20,6 | 7 | 15,95 | 23,08 | 28 | 21,1 | 23,88 | 22 |
| Prague 8 – Karlín | 23 | 26,1 | 25 | 22,1 | 28,48 | 35 | 30,9 | 32,204 | 46 |
| Prague 8 – Kobylisy | 16,5 | 19,3 | 7 | 16,5 | 22,15 | 23 | 21,3 | 24,337 | 19 |
| Prague 9 – Vysočany | 22,2 | 24,7 | 21 | 19,75 | 26,83 | 39 | 26,2 | 28,803 | 28 |
| Prague 15, Průmyslová, listed as Prague 10 | 23,4 | 26,8 | 23 | 21,5 | 28 | 36 | 26,35 | 29,79 | 33 |
| Prague 10, Šrobárova | 17,5 | 20,4 | 6 | data not available | N/A | N/A | 19,85 | 19,84 | 2 |
| Prague 10 – Vršovice | 22 | 25,3 | 27 | 23,6 | 30,78 | 47 | 29,5 | 33,75 | 53 |
| Prague 6 – Letiště Praha | N/A | N/A | N/A | 23,4 | 27,73 | 32 | 31,75 | 35,018 | 49 |

*Data from the Czech Hydrometeorological Institute, valid for 2016, 2017 and 2018. The Braník locality has no data available, the Řeporyje locality was new in 2018 and so data are available for the last four months of 2018, while data for the Šrobárova locality are also available for the last four months of 2018*

The emissions limit for the annual average PM$_{10}$ concentration is 20 μg/m$^3$ for the LAT - lower assessment threshold. The UAT or upper assessment threshold is 28 .mg/m$^3$. The limit value (LV) is 40 μg/m$^3$. Stricter measurement requirements are put in place if this value is exceeded.

The calculation of the number of days when daily LV averages were exceeded is based on the value50 [μg/m$^3$] – daily averaging. This value may be exceeded a maximum of 35 times at a station.

Air pollution limits are based on Act No 201/2012, on air protection, as amended, and Decree No 330/2012, on the method of assessing and evaluating the level of pollution, and informing the public about the level of pollution and smog situations. The LV was not exceeded in 2016, 2017 or 2018.

In 2018, the UAT was exceeded at 9 stations - Prague 1, náměstí Republiky; Prague 2, Legerova; Prague 5 – Smíchov, Prague 13 – Řeporyje; Prague 8 – Karlín; Prague 9 – Vysočany; Prague 15, Průmyslová; Prague 10 – Vršovice; and Prague 6 – Prague Airport.

In 2018, the LAT was exceeded at 15 stations out of 16, i.e. at all except the Šrobárova station, for which, however, data are available only for the last four months of 2018.

Older cars with diesel engines are a significant source of particulates as they do not have particulate filters and their exhaust gases contain a range of particulates caused by imperfect fuel combustion.

### Pollution - Benzo(a)pyrene

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

| | 2016 | 2017 | 2018 |
|---|---|---|---|
| Locality | Average annual concentration [µg.m³] | Average annual concentration [µg.m³] | Average annual concentration [µg.m³] |
| Prague 2, Riegrovy sady | 0,0007 | 0,0009 | 0,000725 |
| Prague 12 – Libuš | 0,0008 | N/A | 0,000741 |
| Prague 13 – Řeporyje | 0,0029 | N/A | 0,002325 |
| Prague 10 | 0,0008 | 0,0009 | 0,000708 |

*Data from the Czech Hydrometeorological Institute, valid for 2016, 2017 and 2018.*

The LV is 0.00014 µg/m³. Between 2016 and 2018, this value was not exceeded at any of the measuring stations except for Prague 13 - Řeporyje. The LAT and UAT were exceeded at all stations in 2018.

Benzo(a)pyrene is also found in coal tar, in automotive exhaust gases (especially from diesel engines), and all smoke generated by the combustion of organic materials.

### Pollution $NO_2$

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

| | 2016 | | | 2017 | | | 2018 | | |
|---|---|---|---|---|---|---|---|---|---|
| Locality | Median $NO_2$ [µg.m³] | Average $NO_2$ [µg.m³] | Number of days when the daily average LV - 50 [µg/m³] is exceeded | Median $NO_2$ [µg.m³] | Average $NO_2$ [µg.m³] | Number of days when the daily average LV - 50 [µg/m³] is exceeded | Median $NO_2$ [µg.m³] | Average $NO_2$ [µg.m³] | Number of days when the daily average LV - 50 [µg/m³] is exceeded |
| Prague 1, náměstí Republiky | 23,2 | 25,7 | 34 | 29,2 | 31,1 | 56 | 31,8 | 33,03 | 77 |
| Prague 2, Legerova | 53,5 | 53,7 | 274 | 47,5 | 48,24 | 227 | 53,5 | 54,38 | 290 |
| Prague 2, Riegerovy sady | 24 | 25,4 | 34 | 21,9 | 24,8 | 29 | 22,5 | 24,17 | 28 |
| Prague 4 – Braník | 30 | 31,34 | 45 | N/A | N/A | N/A | N/A | N/A | N/A |
| Prague 11 – Chodov, listed as Prague 4 – Chodov | 18,2 | 19,5 | 3 | 17 | 19,7 | 20 | 16,7 | 18,16 | 6 |
| Prague 12 – Libuš, listed as Prague 4 – Libuš | 15,9 | 17,7 | 9 | 14,2 | 17,5 | 18 | 16,8 | 18,57 | 10 |
| Prague 5 – Smíchov | 40,9 | 43,5 | 197 | 40,2 | 42,8 | 185 | 39 | 40,16 | 174 |
| Prague 13 – Řeporyje, listed as Prague 5 – Řeporyje | N/A | N/A | N/A | N/A | N/A | N/A | 22,2 | 22,46 | 3 |
| Prague 6 – Břevnov | 23,2 | 24,2 | 25 | 19,9 | 23,5 | 30 | 22,4 | 23,76 | 29 |
| Prague 8 – Karlín | 31,4 | 32 | 79 | 29,6 | 31,6 | 64 | 28,7 | 30,4 | 71 |
| Prague 8 – Kobylisy | 15,7 | 17,9 | 15 | 18,1 | 21,16 | 23 | 18,9 | 20,75 | 20 |
| Prague 9 – Vysočany | 34,7 | 35,5 | 114 | 34,4 | 35,5 | 101 | 33,9 | 35,02 | 113 |
| Prague 15, Průmyslová, listed as Prague 10 | 31,3 | 32 | 85 | 31 | 32,4 | 85 | 29,3 | 30,34 | 79 |
| Prague 10, Šrobárova | 23 | 25,6 | 29 | N/A | N/A | N/A | 24,25 | 25,53 | 9 |
| Prague 6 – Letiště Praha | N/A | N/A | N/A | 16,55 | 19,61 | 21 | 21,7 | 23,24 | 23 |

*Data from the CHMI. The Braník locality has no data available, the Řeporyje locality was new in 2018 and so data are available for the last four months of 2018, while data for the Šrobárova locality are also available for the last four months of 2018*

The emissions limit for the annual average $NO_2$ concentration is 26 μg/m³ for the LAT - lower assessment threshold. The UAT or upper assessment threshold is 32 μg/m³. Limit value LV 40 μg/m³. Stricter measurement requirements are put in place if this value is exceeded.

Air pollution limits are based on Act No 201/2012, on air protection, as amended, and Decree No 330/2012, on the method of assessing and evaluating the level of pollution, and informing the public about the level of pollution and smog situations.

The limit value (LV) was exceeded as an average per year at two locations - Prague 2, Legerova and Prague 5 - Smíchov in 2016, 2017 and 2018.

The upper assessment threshold UAT for 2018 was exceeded at four stations: Prague 1, náměstí Republiky; Prague 2, Legerova; Prague 5 – Smíchov; and Prague 9 – Vysočany. The LAT for 2018 was exceeded at six stations – Prague 1, náměstí Republiky; Prague 2, Legerova; Prague 5 – Smíchov; Prague 8 – Karlín; Prague 9 – Vysočany; and Prague 15, Průmyslová.

## Pollution NO

This indicator follows on from the indirect indicators showing the level of air pollution in the Prague agglomeration mainly from internal combustion engines. It can be assumed that the successful implementation of the measures listed in the Mobility of the Future strategic area in the Smart Prague 2030 concept will cause these values to fall 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.

| | 2016 | | | 2017 | | | 2018 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Locality** | **Median NO [μg.m³]** | **Average NO [μg.m³]** | **Number of days when the daily average LV - 50 [μg/m³] is exceeded** | **Median NO [μg.m³]** | **Average NO [μg.m³]** | **Number of days when the daily average LV - 50 [μg/m³] is exceeded** | **Median NO [μg.m³]** | **Average NO [μg.m³]** | **Number of days when the daily average LV - 50 [μg/m³] is exceeded** |
| Prague 1, náměstí Republiky | 10 | 14,9 | 38 | 10,7 | 16,2 | 45 | 14,8 | 18,88 | 23 |
| Prague 2, Legerova | 9 | 49,4 | 243 | 32,75 | 41,8 | 196 | 36,1 | 44,33 | 159 |
| Prague 2, Riegerovy sady | 42,3 | 6,5 | 11 | 2,1 | 5,6 | 12 | 2 | 5 | 3 |
| Prague 4 – Braník | 2,75 | 10,1 | 16 | N/A | N/A | N/A | N/A | N/A | 0 |
| Prague 11 – Chodov, listed as Prague 4 – Chodov | 6 | 4,3 | 2 | 1,5 | 3,8 | 5 | 1,4 | 3,04 | 0 |
| Prague 12 – Libuš, listed as Prague 4 – Libuš | 2,4 | 4,4 | 7 | 1,7 | 3,9 | 5 | 1,8 | 3,79 | 0 |
| Prague 5 – Smíchov | 2 | 39,7 | 208 | 34,4 | 40,1 | 200 | 24 | 31,78 | 106 |
| Prague 13 – Řeporyje, listed as Prague 5 – Řeporyje | N/A | N/A | N/A | N/A | N/A | N/A | 6,6 | 13,23 | 9 |
| Prague 6 – Břevnov | 33,8 | 6,9 | 9 | 2,6 | 6,4 | 14 | 2,55 | 5,39 | 2 |
| Prague 8 – Karlín | 3,5 | 13,4 | 39 | 8,6 | 13,6 | 33 | 7,45 | 12,38 | 19 |
| Prague 8 – Kobylisy | 8,2 | 6,6 | 9 | 2,6 | 5,9 | 10 | 2,1 | 4,63 | 1 |
| Prague 9 – Vysočany | 3,17 | 25,7 | 94 | 14,9 | 21,4 | 71 | 13,1 | 20,36 | 44 |
| Prague 15, Průmyslová, listed as Prague 10 | 20,9 | 26 | 120 | 20,5 | 24,9 | 99 | 16,2 | 21,76 | 52 |
| Praha 10, Šrobárova | N/A | N/A | N/A | N/A | N/A | N/A | 6,3 | 11,77 | 8 |
| Prague 6 – Letiště Praha | N/A | N/A | N/A | 3,2 | 5,46 | 4 | 4 | 5,75 | 1 |

*Data from the CHMI website, always valid as of 31 December of the given year. The Braník locality has no data available; the Řeporyje and Šrobárova localities were new in 2018 and data are only available for the last four months of 2018*

The limit value for annual average NO concentration in relation to the protection of ecosystems and vegetation is 19.5 μg/m³ for LAT - the lower assessment threshold. The UAT - upper assessment threshold - is 24 μg/m³. The limit value (LV) is 30 μg/m³. Stricter measurement requirements are put in place if this value is exceeded.

Air pollution limits are based on Act No 201/2012, on air protection, as amended, and Decree No 330/2012, on the method of assessing and evaluating the level of pollution, and informing the public about the level of pollution and smog situations.

The LV was often exceeded during the year, especially at two locations - Prague 2, Legerova, and Prague 5 - Smíchov - in 2016, 2017 and 2018.

The UAT upper assessment threshold was also exceeded in 2017 at the stations Prague 2, Legerova; Prague 5 - Smíchov; Prague 10, Průmyslová; and in 2016 also at the station Prague 9 - Vysočany. This only occurred at the following stations in 2018: Prague 2, Legerova and Prague 5 – Smíchov. The LAT lower assessment threshold was exceeded at four stations in 2018 - Prague 2, Legerova; Prague 5 - Smíchov; Prague 9 - Vysočany; and Prague 15, Průmyslová.

### Pollution CO

Data are only available from two stations - Prague 2, Legerova and Prague 4 - Libuš. Only daily averages are available, while limit values are calculated for the CO pollutant using an eight-hour daily moving average. The evaluation methodology will be consolidated in the coming years.

### Cases when air pollution limits were exceeded

The indicator value reflects the relative value of cases when air pollution standards were exceeded concerning the number of days when value measurements were performed.

| | 2016 | 2017 | 2018 |
|---|---|---|---|
| **Resulting indicator value** | **0,1423** | **0,1437** | **0,1242** |
| Calculation | The absolute number of days with exceeded LV values/number of measured days | | |
| Total number of days with exceeded limit values of $PM_{10}$, $NO_2$ a NO | 1 952 | 2 015 | 1 841 |
| Total number of $PM_{10}$, $NO_2$ and NO measurement days at weather stations | 13 714 | 14 018 | 14 825 |
| Number of days with exceeded $PM_{10}$ emission values | 213 | 464 | 482 |
| Number of $PM_{10}$ measurement days at weather stations | 5 337 | 5 374 | 5 657 |
| Number of days with exceeded $NO_2$ emission values | 943 | 857 | 932 |
| Number of $NO_2$ measurement days at weather stations | 4 310 | 4 322 | 4 584 |
| Number of days with exceeded NO emission values | 796 | 694 | 427 |
| Number of NO measurement days at weather stations | 4 067 | 4 322 | 4 584 |

*Data from the Czech Hydrometeorological Institute*

The indicator value can be interpreted as meaning that the ideal final indicator value is equal to 0, and the indicator value would equal 1 if the environment remained very bad. It can, therefore, be said that the permitted air pollution limit value was exceeded on 12 out of 100 days in 2018. This is an improvement over both 2016 and 2017 when it was approximately 14 days out of 100.

As pollutant concentration is not measured at all stations every day, for example, due to technical reasons such as faults, etc., the number of actual measuring days is determined for all stations. A calculation of only the number of days when the concentration was exceeded would otherwise not be consistent for comparisons in subsequent years.

The EU has embarked on a stronger fight against waste through legislation. Its goal is to redirect more waste from landfills to recycling and reuse. In the area of landfilling, the EU has set itself the primary goal of significantly reducing the volume to 10% of total municipal waste generation by 2035. There should, therefore, be more material use of waste, from 50% by 2020 and up to 65% by 2030.

The thorough separation of waste and its subsequent recycling follows waste prevention and material reuse to ensure maximum reuse. The correct handling of waste can significantly reduce environmental pollution, contribute to economic growth, create new jobs, protect valuable resources and, last but not least, improve health protection for the population.

Households play an important role in waste management - not only does household waste make up a significant part of a city's total waste generation, but they can also influence the overall sustainability of the city through their activities and decisions. Most household waste is collected as mixed municipal waste (MMW). These collection systems contaminate various material flows and ultimately reduce opportunities for material circulation that retain high values.

Waste management is also constantly evolving and it is important to adapt to the current needs of citizens and the market. New technologies and innovations increase the efficiency of sorting and recycling and also support waste prevention. Together with Pražské služby, Plc., Prague Capital City is striving to set up the most efficient network of collection containers for both separated components of municipal waste and mixed municipal waste. Other developed cities in Western Europe are also involved in such efforts and can be compared to Prague.

A new Circular City Scan for Prague was published in October 2019 to help analyze and evaluate the current situation, highlight opportunities, propose action plans and projects that will contribute towards a friendlier, cleaner and healthier city, and ensure that waste is treated as a material suitable for further use. Prague has recognized the potential of the circular economy and considers it a means to achieve its ambition to become a prosperous, healthy and resilient city. It has committed to offering its citizens a more sustainable way of life and to provide opportunities for business innovation. The Circular Scan mainly covers the construction sector, which is the most resource-intensive economic sector and accounts for up to 65% of total municipal waste generation. The share of secondary raw materials used in construction is only 10% and there is huge room for a shift to circularity. The Circular Scan also focused on households with a pilot project proposal for circular reuse centres. This decentralized network of circular centres can use residual flows from households not only to create value for the local economy but also to inspire and support citizens to adopt and support the circular lifestyle. The last area of focus of the Circular Scan was the conversion of waste biomass into BioCNG and its use in the public services sector. This resulted in a recommendation to build a facility for the conversion of waste biomass into biogas, which can then be converted into high-quality biofuel for vehicles, e.g. for waste collection.

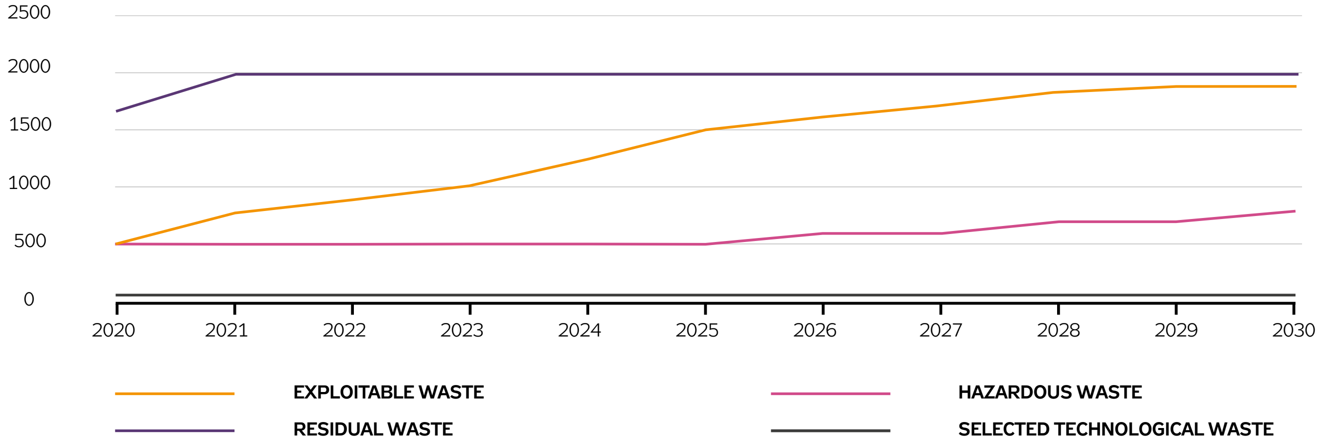
## Prague Capital City Waste Management Economics

The total costs for comprehensive municipal waste management in Prague amounted to approximately CZK 1.6 billion in 2019. The management of mixed waste accounted for the largest part of the costs (approx. CZK 989.2 million for collection and other management, including the operation of contact points), followed by costs associated with the management of sorted waste (CZK 473.6 million) and the operation of collection yards (CZK 93.4 million). Revenues from mixed waste, respectively revenues from municipal waste fees collected from citizens, reached CZK 725.8 million in 2019, while the contribution from EKO-KOM for sorted waste amounted to CZK 172.0 million. Total revenues thus covered just under 60% of total waste management (WM) costs, and therefore the city had to cover almost half the costs from its budget. In 2019, Prague was forced to provide almost CZK 300 million only to subsidize the collection and disposal of mixed municipal waste.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Total costs for WM (CZK million) | 1 487,18 | 1 530,02 | 1 600,53 |
| Total revenues including the EKO-KOM contribution (CZK million) | 862,02 | 883,79 | 899,38 |
| Costs recalculated per capita (CZK) | 1 148,83 | 1 169,16 | 1 208,60 |
| Revenue recalculated per capita (CZK) | 650,45 | 658,72 | 679,15 |

*Source: Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998–2019*

**Landfilling fee**




*Source: Ministry of the Environment, Waste Management Plan of the Czech Republic*

The fee from the generators, i.e. municipalities and companies, is collected by the landfill operator when waste is deposited at the landfill site and is currently 500 CZK. The new draft Waste Act proposes an increase in the landfill fee to motivate municipalities to reduce the generation of mixed municipal waste in their territory and increase the share of recycling. No usable waste should be landfilled from 2030. However, the fee for the disposal of hazardous waste should not change and is likely to remain at CZK 2 000 per tonne.

**Communication Campaign**

Citizen motivation and education are considered the first steps towards success, as people's behaviour significantly affects the generation and cleanliness of individual components of municipal waste. To obtain feedback and also to maintain public interest, communication should already commence in the implementation phase of the project. Social media is an effective way to highlight the options through an attractive and thematically focused display.

**The Thematic Areas Include:**

- Material use of waste
- Intelligent waste collection and storage system
- Use of wastewater and rainwater for energy and raw material purposes

## SORTING AND USE OF MUNICIPAL WASTE

In the Prague metropolis, collection companies create their plans and continuously adjust them according to the city's requirements to take into account current waste collection needs throughout the city. A fixed schedule is used for waste collection, and this is continuously updated according to the requirements of the city and city districts. Requests to change collection frequency are submitted by the city districts to the Prague City Hall Waste Department, which then assesses the application and potentially incorporates it, as funds for waste collection are allocated in the budget chapter of the Prague City Hall Waste

Department. The total annual costs for the collection of usable components were approximately CZK 473.7 million in 2019. It is therefore important to coordinate all the activities into a common responsible waste management strategy that will efficiently collect the generated waste and use it for material and energy purposes.

Waste collection using modern technologies can ensure more efficient waste management from both the technical and economic points of view. In addition to WM, these technologies can also help in other areas, such as the use of wastewater and rainwater.

In 2019, Operátor ICT, Plc. implemented a pilot project called Smart Waste Collection, which ran for 12 months - its main goal was to create a tool for the online monitoring of the fullness and yield of selected containers for sorted waste (paper, plastic, clear and coloured glass, beverage cartons and metal packaging) in selected localities and thus streamline waste collection investment expenditure. Illustrations of this tool in figures [1] and [2].

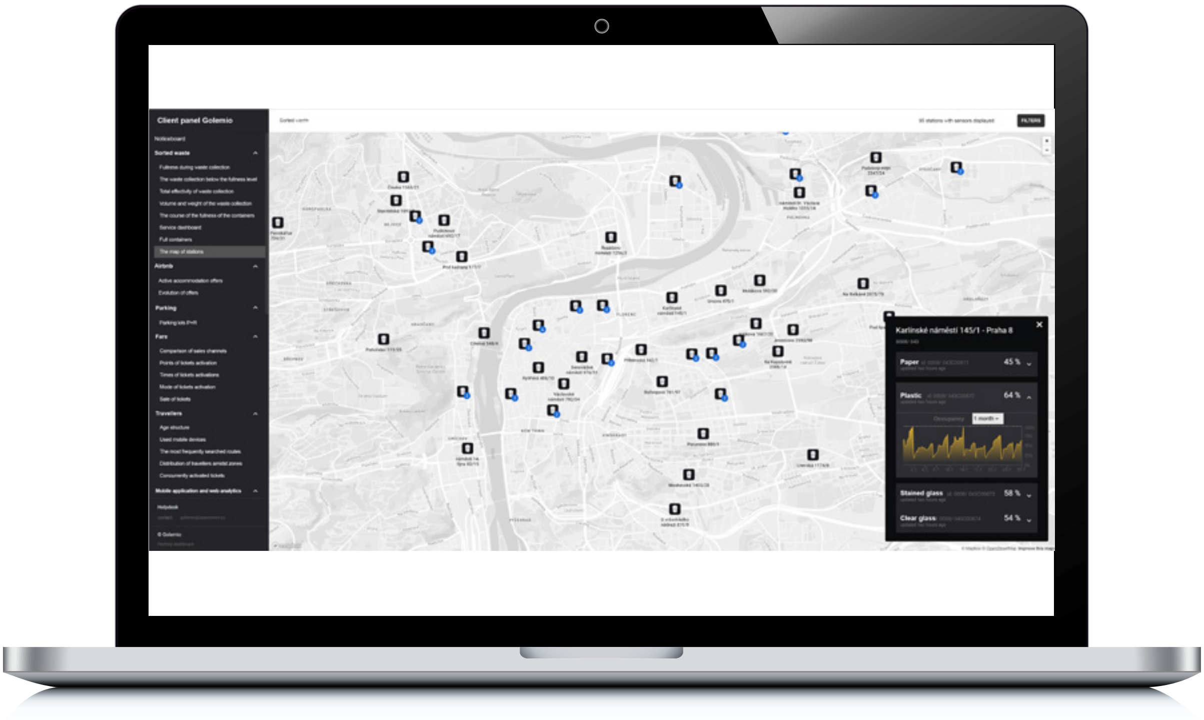



*Figure 1 – Illustration of the client panel. Source: Operátor ICT, a.s.*

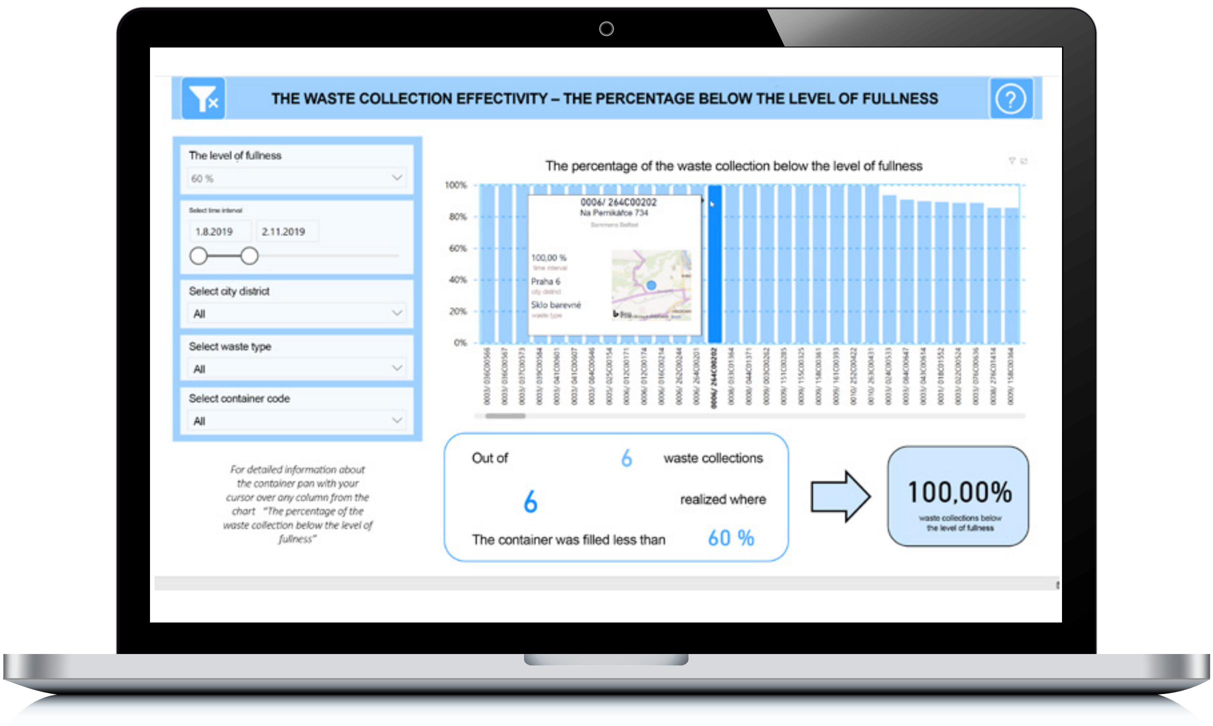



*Figure 2 – Illustration of the report Collection Efficiency – Collections Made from Partially Empty Containers. Source: Operátor ICT, a.s.*

## Total Municipal Waste Generation in Prague

This indicator monitors the evolution of mixed municipal waste (MMW) generation. The aim is to reduce the value through rules for waste prevention, reuse and recycling, i.e. material waste recovery. These aims are based on the Strategic Waste Management Objectives for 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 the Following Strategy:**

1. **Prevent waste**
2. **Prepare waste for reuse**
3. **Recycling**
4. **Energy use**
5. **Safe disposal (landfill)**


| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Total municipal waste quantity (kt) | 430,3 | 432,8 | 440,9 |
| Mixed municipal waste (kt) | 250,2 | 253,8 | 255,5 |

*Table 3: On the recommendation of the CEI, since 2016 the total waste quantity has included waste generated through the activities of natural persons in a city district, while this waste was generated by services provided to citizens by the city district from its budgets over and above the services provided by Prague City Hall. Source: Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998–2019*

The mixed municipal waste value shows the quantity of waste generated by Prague Capital City inhabitants and placed in household or street waste containers. The aim is to further reduce this quantity, which has been steadily increasing since 2015. The year-on-year increase in a mixed municipal waste generation was 0.67% in 2019, while the increase was even 2.1% compared to 2017. This increase is partly due to the population increase. This value can be reduced by the consistent application of the first three principles. This waste was subsequently used for energy or landfilled in 2019, as shown by another indicator - Energy Use of MMW - later in this document. Because of the growth of this indicator, it is highly desirable to establish detailed data and analyze them to define the causes of this growth and propose appropriate countermeasures.

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

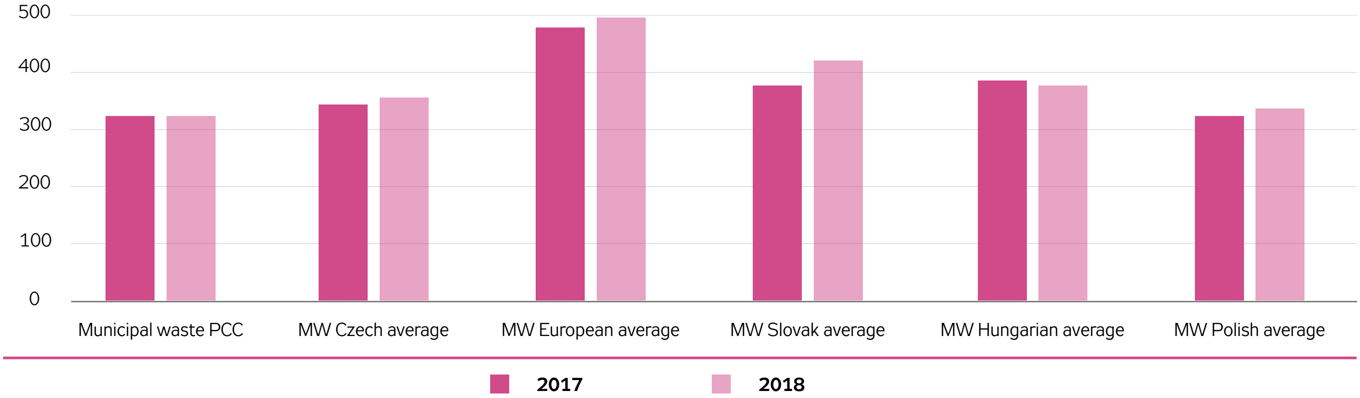
Not all waste generated in Prague is treated within the city itself. It is estimated that only about 30% of the total waste generated is treated in the area bounded by the city limits, with the remaining approximately 70% treated outside the city boundaries (source: Circular Scan Prague 2019).

## MW generation per capita

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Municipal waste PCC (kg) | 332,40 | 330,73 | 332,94 |
| MW Czech average (kg) | 344 | 351 | N/A |
| MW European average (kg) | 490 | 492 | N/A |
| MW Slovak average (kg) | 378 | 414 | N/A |
| MW Slovak average (kg) | 385 | 381 | N/A |
| MW Polish average (kg) | 315 | 329 | N/A |

*Source: CZSO, Eurostat. Data for 2019 will be available after the finalization of this publication*

**Average waste generation per capita (kg)**




Prague households generate a relatively low quantity of waste per capita, on average around 333 kg/year of MW per capita. This was 20 kg less per capita compared to the national average in 2018, and even 150 kg under the European average.

Each Prague Capital City inhabitant sorted a converted total of 45.23 kg of paper, glass, plastics and beverage cartons in 2019. Household waste is collected in various ways. Of the total quantity of 440 900 tonnes of waste generated by Prague households, mixed waste continues to have the highest share, accounting for approximately 58%, although its share is gradually declining. The remaining approx. 42% is collected separately. The municipal waste collection as mixed waste collection contaminates the quality of residual streams and reduces the potential value that can be extracted from the stream - hence the efforts to reduce this quantity.

Most household waste is incinerated to obtain energy. Approximately 249 000 tonnes of household waste is processed for energy recovery, which in the case of municipal solid waste (approximately 56.5%) is the most common waste management activity. This applies to large proportions of mixed waste that is collected and subsequently incinerated. In Prague, the main waste energy utilization facility is ERF Malešice, which annually processes over 200 000 tonnes of waste.

## MMW Energy Use

This indicator monitors the percentage of energy use of MMW in Prague Capital City. During the MMW incineration process, the released energy is converted into heat and electricity in a cogeneration unit.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| MMW energy use | 92,17 % | 93,08 % | 94,08 % |
| MMW landfilling | 7,83 % | 6,92 % | 5,92 % |
| Quantity of iron scrap captured at ERF Malešice | 4 293,58 t | 4 162,20 t | 4 881,23 t |

*Data provided by PCH EPD and Pražské služby, a. s.*

The indicator value is affected by the number of operational outages, of which there were either less year-on-year or they did not affect deliveries.

Prague Capital City set the maximum ratio of landfilling to the energy use of MMW at 10%. The residual slag can be used as a building material and increased use of it in this area is planned for the future. At the same time, iron scrap is separated from the residues, the quantity of which captured from the slag after the energy recovery of the waste is also shown in the table. The quantity of scrap collected depends on the composition of the incoming mixed waste - it cannot be influenced by ERF processes, however, its reduction may indicate positive trends in the sorting of waste during its collection.

### Sorting Trends in Prague Capital City

At present, the following municipal waste components are sorted in Prague Capital City:

- **paper**
- **mixed glass**
- **mixed plastics**
- **bulky waste**
- **mixed waste**
- **hazardous waste**
- **ferrous and non-ferrous metals; since 1 August 2016 there have been containers available for this purpose at**

- **1 061 sorted waste collection sites for the sorting of so-called metal packaging**
- **building rubble**
- **take-back products**
- **wood waste**
- **tires**
- **bio-waste**
- **gastro waste (in pilot operation)**
- **beverage cartons; containers have already been placed at 2 918 sites**
- **clear glass; placed at 1 776 sites**
- **worn textiles, clothing and footwear**
- **used edible oil and fat**

In 2019, a project was completed in Prague Capital City in cooperation with the T. G. Masaryk Water Research Institute, the goals of which were:

- **To increase self-sufficiency in raw materials by substituting primary resources with secondary raw materials**
- **To support innovations in the acquisition of secondary raw materials in a quality suitable for further use in industry**
- **To support the use of secondary raw materials as a tool to reduce the energy and material intensity of industrial production while eliminating negative impacts on the environment and human health**

The project included an evaluation of the state of waste management in selected parts of Prague, monitoring of the cleanliness of sorted MW components, the cleanliness of the areas around collection sites, and also an analysis of the mixed municipal waste. The issue of establishing new collection sites was mentioned here due to the lack of such places in the city. Containers for paper and plastic are the most frequently overfilled, despite the very frequent collection of waste (up to 7 times a week in some parts of the city). This most often occurs with containers near restaurants or main roads. Another problem was observed in housing estates further from the centre, where bulk waste is often disposed of next to the containers. On the other hand, this project shows that all the monitored collection sites are well designed and also correspond to the local population levels. Prague City Hall and Pražské služby, Plc. are working together to increase the capacity of containers for separated municipal waste components, and are also considering reducing the space required for container sites by merging containers for plastic waste and beverage packaging into one.

In 2019, Prague City Hall launched a pilot project for the multi-commodity collection of sorted waste, through which it will be possible to place multiple commodities in one container. The collection will be through a door-to-door system and the collection containers will, therefore, be placed directly inside the buildings of the project participants. This collection method is being tested in connection with the planned construction of a new sorting line with an optical sorting system able to sort individual packaging components according to customer requirements. This project will be completed and evaluated around the middle of 2020.

## Quantity of Separate Collection per Capita

This indicator is a very important parameter that can be used to compare the performance of separate collection - the so-called yield - which indicates the quantity of sorted waste in kg per capita per calendar year.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Paper (kg)* | 17,37 | 18,04 | 18,65 |
| Glass (kg)* | 12,84 | 13,29 | 13,92 |
| Plastic (kg)* | 10,74 | 11,22 | 11,84 |
| Beverage carton (kg)* | 0,76 | 0,76 | 0,82 |
| Metals (kg)* | 0,11 | 0,20 | 0,32 |
| Population of Prague** | 1 294 513 | 1 308 632 | 1 324 277 |

*Source: *Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998–2019. **CZSO - population data always available as of 31 December of the given year*

In 2019, Prague inhabitants sorted a total of 24 702 tonnes of paper, or approximately 18.65 kg per capita, 18 428 tonnes of glass, or just under 14 kg per capita, and 15 676 tonnes of plastic packaging, or just under 12 kg per capita. Prague inhabitants separated a total of 1 502 tonnes of beverage cartons and metal packaging. Prague Capital City wants to work on waste prevention, which will be the focus of an extensive information campaign in 2020.

### Waste Sorting Efficiency

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Sorting efficiency (material use only) | 27,10 % | 26,90 % | 27,10 % |
| The proportion of waste used (material and energy recovery) | 83 % | 84 % | 84 % |

*Data provided by PCH EPD*

### Waste management method (percentage share of total MW generation)

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Material use | 27 % | 28 % | 27,1 % |
| Biological use | 2,17 % | 2,05 % | 2,4 % |
| Incinerated (energy use) | 56 % | 57 % | 56,5 % |
| Landfilled | 13 % | 14 % | 14,5 % |

*Source: Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998-2019*

Landfilling is showing a declining long-term trend in Prague. Compared to 2013, when the share of landfilled waste was almost 20% of total waste generation, this method has decreased by over 5% (14.5%). A large proportion of waste is still incinerated (56.5%) at ERF Malešice. A small but increasing trend can be observed in the biological use of waste, where more and more waste is being used at a biogas plant.

In 2019, a pilot project was launched in the Prague 5, 6 and 7 districts for the collection of the kitchen (so-called gastro-) waste (under cat. No 200108), to minimize recyclable and usable components in mixed municipal waste. Gastro-waste from the project is thus transported to a biogas plant for further use (biogas, digestate).

### Construction and Demolition Waste

Construction and demolition waste is everything that remains after the reconstruction or demolition of a building, including, for example, cabling and piping. According to a waste management plan analysis, this accounts for approximately 46% of waste generation, thus making up almost half the total waste generation in the Czech Republic. The greatest complication is the possibility of using recycled material, with downcycling being largely used - meaning reuse with a reduction in the volume of waste.

This indicator shows a year-on-year comparison in the generation of construction and demolition waste in Prague Capital City. The latest data for this indicator does not show any significant fluctuation in the quantity of waste.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Construction and demolition waste (t) | 11 547,5 | 11 016,3 | 11 124 |

*Source: Pražské služby a.s.*

**Bio-waste**

Bio-waste - or waste subject to anaerobic or aerobic biodegradation - becomes a source of hazardous methane when landfilled. It, therefore, should not end up in landfills. It is, however, a raw material very rich in several nutrients and organic matter, which can be obtained through composting, and the resulting product - compost - can be applied back to the soil and thus return nutrients to nature.

It is important to realize that bio-waste makes up a substantial part of municipal waste. It sometimes makes up over 50% of mixed municipal waste, and consists mainly of kitchen waste of plant origin, and waste from gardens and the maintenance of municipal greenery. Bio-waste can also be managed in the context of waste prevention, when it is processed in the form of domestic composting, with a corresponding significant reduction in the generation of mixed municipal waste. In 2018 and the beginning of 2019, Prague City Hall distributed 1 750 domestic composters to citizens through the project "Support for Domestic Composting in Prague Capital City", which was subsequently followed by individual city districts offering their inhabitants more composters.

In addition to domestic composting, there is also the possibility of community composting, intended for larger groups of people. Such a composter is suitable for community gardens or courtyards, where it provides people who live in apartments the chance to engage in composting. Vermicomposting has also become very popular recently - this is the decomposition of plant residues into high-quality organic fertilizer with the help of earthworms. The ever-expanding community composting network has given rise to the "Mapko" map app, which collects information about existing community gardens and composters. This provides people with an overview of their surroundings, enabling them to decide what to get involved in. This is a community project, and community gardens can add their own profiles themselves, so the data may not always be completely relevant.

Bio-waste that cannot be managed through waste prevention can be collected separately, and the valuable material subsequently recovered. However, it is anticipated that the implementation of this collection method will be demanding both financially and timewise. Nevertheless, this is the collection of material that can be anticipated to provide clean and high-quality raw materials with a reduced contamination risk. Separate collection can be performed either through collection containers or by a door-to-door collection system (i.e. from building to building), as well as through containers at collection sites for sorted waste, mobile large-volume containers, and delivery to collection yards. The level of purity of sorted bio-waste is related to the level of awareness and cooperation from individual inhabitants.

Separate collection cannot be considered as another option for bio-waste treatment, as it is collected together with MMW and its processing uses mechanical-biological treatment technology, the aim of which is to reduce the volume of MMW and stabilize it to prevent the leaching of hazardous substances or methane, and fires, after landfilling. This, however, degrades the material component of biodegradable waste and valuable raw materials cannot then be extracted. This method is also regulated in the Czech Republic through Decree No 294/2005, on the conditions for placing waste in landfills and their use on the surface, which limits the share of the biological component of MMW deposited in landfills to 35% for 2020.

Interest in sorting bio-waste is also growing in the capital, which is also confirmed by Pražské služby, with around one thousand new composter users being added every year. These are special containers for bio-waste with a specific structural design that accelerates the process of converting bio-waste of plant origin into quality compost. These containers are equipped with ventilation openings on the container side and a grid separating the solid part of the bio-waste from the liquid component, which subsequently evaporates. Prague expanded the options for the collection of bio-waste of plant origin at the end of 2019. This currently accounts for up to 40% of MMW in the metropolis. The leadership of the capital wants to separate plant bio-waste and then use it for compost generation in Prague and the Central Bohemia Region. In Prague, a composting plant has been operating since the beginning of 2017 in the Prague-Slivenec district. The construction of a biogas plant is also being considered, which should assist in the proper processing and use of biodegradable waste from citizens, self-employed people and industry. The final product of the biogas plant is BioCNG biofuel suitable for utility vehicles in urban traffic (public transport vehicles, collection vehicles, city district and City Hall vehicles) and biogas for the municipal network. Bio-waste collection is optional for property owners and the bio-waste collection fee is set similarly to that for mixed municipal waste, i.e. the property owner is the fee payer. When this service is taken over by the city, the price of the bio-waste collection service for property owners who already use a bio-waste container is reduced by 50% compared to the prices charged by Pražské služby, Plc. for 2019.

In December 2019, the "Pilot Project for the Collection of Gastro-waste" was launched in the Prague 5, 6 and 7 districts, mainly focusing on animal and vegetable waste from households. This now means that the citizens of the selected districts can also sort bones, meat, leftover food and food past its sell-by date. Such materials are not suitable for energy use due to their relatively high water content, which reduces their calorific value. The collected material will, therefore, be transported to a biogas plant (BGP) to be converted into energy in the form of biogas. The primary aim of the year-long project is to establish citizen interest in sorting gastro-waste from households and to monitor its quantities and composition. All the project costs are covered by Prague City Hall (the initiator and client of the pilot project), meaning that collection containers, its collection, the provision of an above-standard delivery/collection service, including the washing of the container, will be provided free of charge to all those participating. More information is available at the website https://gastro.praha.eu/.

The city is also highlighting the importance of waste prevention because the best waste is waste not generated. It is therefore important to learn to shop prudently and not waste food. With this initiative in mind, Prague is supporting the Save Food project (https://zachranjidlo.cz/), which consists mainly of information campaigns and happenings to educate the public about food waste reduction. They also collect so-called "crooked" vegetables – "paběrkování" – which would otherwise be left on the field after the harvest, frequently for aesthetic reasons, and donate them for example to food banks. One innovative waste prevention solution can be found in Great Britain, namely the Olio project - a mobile app enabling people to offer any extra food they have and no longer want - but which is still good quality - to others in the neighbourhood to prevent wastage.

The facts described above are captured through the indicators below, which focus on the overall bio-waste generation and use.

## Total Bio-waste Generation

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Total bio-waste generation (t) | 9 368 | 8 855 | 10 600 |
| Of which composted (t) * | 140 | 411 | 631 |
| Bio-waste generation per capita (kg) | 7,24 | 6,77 | 8,00 |

*Source: Evaluation of a comprehensive municipal waste management system in Prague Capital City 1998-2019. * This is the quantity of waste transported to the Slivenec composting plant*

## Use of Bio-waste as a Raw Material

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **97 369 t** | **86 453 t** | **96 057 t** |
| Bio-waste received at the city's collection yards (t) | 6 976 | 6 477 | 7 466 |
| Bio-waste received at mobile collection yards (t) | 35 | 43 | 42 |
| Bio-waste - bulk containers in the streets (t) | 1 202 | 1 058 | 1 280 |
| Prague composting plant in Slivenec (t) | 140 | 411 | 631 |
| Permanent bio-waste collection point in Prague 10 Malešice (t) | 1 016 | 866 | 1 181 |
| Sanitized dewatered wastewater sludge (t) | 88 000 | 77 598 | 85 457 |

*Source: Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998–2019*

## Energy Use of Bio-waste

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

According to Decree No 341/2008, as amended, bio-waste means biodegradable waste. In the case of Pražské vodovody a kanalizace (PVK) operations, this mainly means liquid waste received and processed by wastewater treatment plants in Prague Capital City. Heat and electricity are generated from the waste in cogeneration units. Residual stabilized sludges are modified using technological measures for reuse in agriculture. The generation of usable biogas takes place only at the Central Wastewater Treatment Plant.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **10 094,43 t** | **2 532,57 t** | **14 766,68 t** |
| Liquid wastes received and processed by WWTPs in Prague Capital City | 10 094,43 t | 2 532,57 t | 14 766,68 t |
| Biogas generation at the Central Wastewater Treatment Plant* | 14 810 698 $Nm^3$ | 16 285 510 $Nm^3$ | 17 358 766 $Nm^3$ |

**$Nm^3$ = normal cubic meter. Data provided by PVK*

The preceding two years had lower waste intake and biogas generation due to outages. In 2019, the operation of the WWTP was continuous, and waste was accepted throughout the year without technological restrictions (no outages, unlike in the preceding years), which is why there was an increased quantity of waste received at the WWTP.

### Edible Oils and Fats

From 1 January 2020, municipalities have a year-round obligation to provide sites for the separated concentration of edible oils and fats. The separated collection of edible fats is important to protect the sewer network, which can become clogged and its flow rate reduced when there is a large quantity of fat in the sewer. In Prague, citizens can dispose of used edible fats and oils at all collection yards in Prague Capital City (CY list) and through the mobile waste collection service. In addition to collection yards, new black containers with brown lids are gradually appearing in the streets of Prague, intended for edible oils and fats. Their distribution and emptying are at the discretion of each district.

## Bulky waste

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Total quantity (t) | 30 846 | 34 205 | 37 585 |
| Quantity per capita (kg) | 23,83 | 26,14 | 28,40 |

*Source: Evaluation of the comprehensive municipal waste management system in Prague Capital City, 1998–2019*

Bulky waste can be disposed of by citizens at collection yards or in large-volume containers (LVC). As the number of collection yards is increasing, Prague Capital City is reducing the number of LVC, and 5 274 containers were placed in 2019.

# MATERIAL USE OF WASTE

This waste recovery method is in third place in the waste hierarchy immediately after waste prevention and reuse. Waste material is returned into circulation as a secondary raw material that often does not differ in terms of quality from primary raw materials. This sub-area is based mainly on modern, high-capacity automated technology for sorting a single stream of mixed municipal waste and sorted waste (e.g. using sensors, mechanical and physical methods) able to separate e.g. the organic component, metals, paper, plastics and glass and residual waste. In the future, the implementation of more innovative approaches to support the material recovery of waste can be anticipated. This method largely depends on the behaviour of citizens, as their activity directly affects the rate of municipal waste sorting and subsequent recycling. Emphasis is therefore also placed on educating and motivating citizens to sort waste at home.

## Product Take-back Points

This indicator shows the degree of penetration of Prague Capital City by electrical equipment take-back points for further material use. It thus shows the level of availability of electrical equipment take-back points. Discarded electrical equipment is a valuable source of raw materials - especially precious metals - which would otherwise be disposed of ineffectively.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Number of electrical equipment take-back points per km²** | **0,5907** | **0,5968** | **0,6028** |
| **Number of inhabitants using a single take-back point** | **4 418** | **4 421** | **4 429** |
| Number of electrical equipment take-back points - red containers* | 293 | 296 | 299 |
| Area of Prague Capital City (km²) | 496 | 496 | 496 |
| Population of PCC** | 1 294 513 | 1 308 632 | 1 324 277 |

*Source: *Environmental Protection Department (EPD) of Prague City Hall. **CZSO - always as of 31 December of the given year*

The number of red containers for the take-back of electrical equipment (placed on streets) increased by 3 in 2019. Their number is increasing year-on-year, so there will likely be over 300 in 2020. There are also 19 permanent collection yards and three collection yards operated by city districts for the take-back of electrical waste (see the map of collection yards on the Prague Capital City environment portal).

The product take-back system significantly increases the quantity of electronic waste recovered from consumers for further material recovery. However, probably, there is still potential to increase this quantity, as physical analysis of the composition of mixed municipal waste indicates that some Czech households still dispose of small electronic appliances into mixed municipal waste containers.

## Utilization of Take-back Points

The practical impact of the use of electrical equipment take-back points from the previous indicator is quantified in the following table:

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Quantity of collected electrical equipment by category (t):** | | | |
| TVs and monitors | 819,60 | 805,70 | 970,40 |
| Other ASEKOL equipment | 415,64 | 377,10 | 365,50 |
| Light sources | 22,80 | 20,70 | 19,70 |
| Cooling group | 882,41 | 880,80 | 916,90 |
| Large and small appliances ELEKTROWIN | 1 228,39 | 1 296,60 | 1 527,60 |
| Batteries | 272 | 287 | 276 |
| **Stationary red containers:** | | | |
| Batteries | 30,85 | 37,23 | 32,26 |
| Small electrical equipment | 224,90 | 330,03 | 306,10 |

*Source: PCH EPD, ECOBAT, s. r. o.*

The evolution of the values captured in this indicator confirms the greater use of take-back points. This is also indicated by the increasing numbers of visits to take-back and hazardous waste points, namely 49 357 visits in 2019, 1 000 times more than in 2018. Products that have reached the end of their useful life can thus be further recycled, especially important in the case of batteries and small electrical equipment that are harmful to the environment if landfilled.

The values for batteries for 2017 and 2018 have been retroactively adjusted and updated in this table. The most important collection points for Prague are companies and stores, which were not originally included. This is why the new values are many times higher. There was a slight decrease in the number of batteries taken back in 2019. This could be due to a lower level of sorting or less motivation for their take-back. On the other hand, people may be now preferring batteries with longer lives or rechargeable batteries that last longer than single-use batteries.

To give an idea, precious metals worth over CZK 1 billion are built into mobile phones alone. If an old phone is landfilled, this potential is lost forever. On average, electrical waste is about 95% reusable, especially for material reuse. 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 generate the raw metal. To implement the concept of a Waste-free City, it is essential to maintain the availability of take-back points and not waste the material potential in electrical waste. Nevertheless, it is important to realize that decreases or increases in the values of this indicator cannot be unambiguously (i.e. without a detailed analysis of the connections, e.g. the trend of purchases of new appliances) described as either positive or negative.

## Collection Yards

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Number of CY per km$^2$** | **0,1794** | **0,1653** | **0,2036** |
| **Number of inhabitants using a single CY** | **14 545** | **15 959** | **13 111** |
| Number of collection yards* | 89 | 82 | 101 |
| Area of Prague Capital City (km$^2$) | 496 | 496 | 496 |
| Population of PCC** | 1 294 513 | 1 308 632 | 1 324 277 |

*Source: *PCH EPD, **CZSO - always as of 31 December of the given year*

This indicator shows the density of collection yard coverage. This number of collection yards includes 19 permanent collection yards of Prague Capital City, 3 collection yards of city districts, and the operation of mobile collection yards in the relevant year. On the Prague Capital City portal (praha.eu) there is a map of collection yards and other selected waste management facilities in Prague Capital City.

The construction of new collection yards is hindered in some parts of the city mainly by the presence of historic buildings and layout possibilities. In these areas, so-called "mobile collection yards" can continue to be used as a possible alternative - i.e. the placement of several large-volume containers with a professional waste sorting service. 79 mobile collection yards were set up in 2019, increasing convenience for citizens and reducing the distance to a collection yard.

### Reuse Centers

Reuse or "use it again" - reuse centres have been created for this purpose. The goal of reuse is not to throw something away when it can be fixed or can serve others. This is the second strategic goal immediately after waste prevention in the waste management hierarchy. In terms of reducing waste quantities, reusing things is more important than reducing or recycling waste. 2019 was the year of reuse when reusing things became fashionable all over the world. The belongings of many people also carry personal memories that they do not want to throw away as waste. They would prefer such things to continue to serve others and thus pass on their value.

The establishment of Prague reuse centres is a supportive measure for the gradual fulfilment of the goals associated with preventing waste and reducing its quantity in the capital. A European Directive of 2008 required Member States to set up national waste prevention programs. The Czech Republic's Waste Prevention Program was approved in 2014 and is a multi-annual conceptual document with one main strategic goal, 12 sub-goals and 26 measures, all of which should be continuously evaluated and revised according to the European directive (in the evaluation report of the new Waste Management Plan for 2015-2020), but no later than six years after its approval. The vast majority of measures should be fulfilled by 2020.

*Figure 5: Reuse centre and shared workshop in Prague. Here old furniture is rescued, repaired and put back into circulation. There are also courses in furniture renovation and upholstery.*

Electrical waste has been a problematic issue to date. It means tonnes of electrical equipment discarded in a still functional state and ending up at electrical waste collection points. Citizens are constantly exposed to advertisements and presentations of new, more powerful products that encourage them to buy new electrical appliances before their current equipment is damaged. Consumers are also discouraged by high repair prices, outdated functionality and appearance. Therefore, one of the efforts of the Waste Prevention Program is to put such functional electrical appliances back into circulation so that they can continue to serve other people and prevent loss of value. From the economic point of view, the reuse of a thing reduces the costs associated with waste disposal and reduces the total volume of waste generated. The indicator presented here, therefore, monitors the circulation of objects that people dispose of and hand over to reuse centres, where they are subsequently provided to other people for a symbolic fee.

It was also planned to establish cooperation with charitable organizations, children's homes, shelters, museums and the like, to which it will be possible to provide collected material for further meaningful use.

In addition to reuse, there is also the concept of remanufacturing, which means repairing or modifying a product to make it fully functional again. The HYB4 Circular Workshop has been part of Prague Capital City since 2018, and is intended to highlight the possibilities for recycling and resource sharing, and draw the attention of residents to the possibilities of reuse and remanufacturing. The workshop was established as part of the cooperation between Prague Capital City, the Library of Things and the Institute of Circular Economics and is intended to support the use of valuable but older furniture that would otherwise end up in a landfill. Workshops are also regularly held there, at which those interested can try to repair or manufacture various types of furniture free of charge and under the guidance of professional instructors. At the same time, cooperation was established with collection yards in Prague Capital City, where people can place unneeded furniture in designated containers. The contents of these containers are then sent to the Circular Workshop and, after repair or remanufacturing, get a new chance to be of use.

*Figure 6: HYB4 Circular Workshop. Here, people have the opportunity to try repairing or manufacturing furniture under the guidance of professional instructors.*

This indicator thus shows the level of utilization of the handed over material. The composition of the material will also be monitored after the launch of the reuse centres.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Given (sold) material volume / Obtained material volume | | |
| Given (sold) material volume | 0 | 0 | 0 |
| Obtained material volume | 0 | 0 | 0 |
| Total number at the CCP | 0 | 0 | 0 |

*Source: PCH EPD*

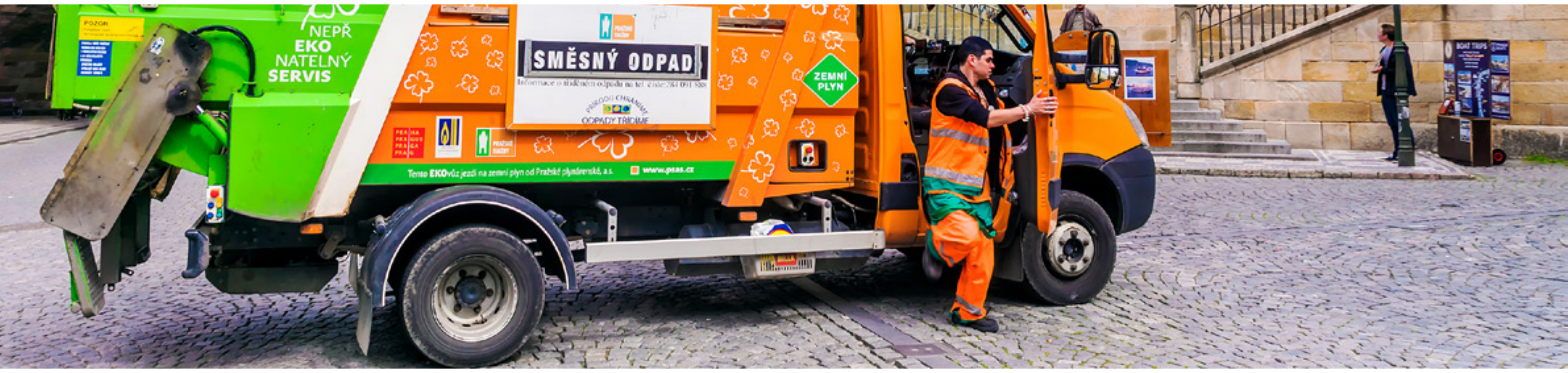
As of 31 December 2019, there was no reuse collection yard in Prague Capital City. However, unneeded items are often reused through commercial apps on the Internet or through regular flea markets (e.g. in Hloubětín). There is also the City Hall web app praho.nevyhazujto.cz, which offers inhabitants of the capital a virtual marketplace for used things for free. In the area of furniture reuse, for example, there is the community activity From Room to Room - Spojené hlavy, z. s., based in Karlín.

On the other hand, the situation provides for the possibility of setting up a special location where only second-hand products or products made from recycled materials would be sold for reuse. The location can support and demonstrate the viability of circular business models such as renting, repairing and selling second-hand items. At the same time, these locations can arouse greater public interest in the culture of reuse, repair and the circular lifestyle, thus helping preserve the value of products and materials for as long as possible.

One example is from France, where a network of reuse centres called "Ressourceries" has appeared that operates throughout Paris. These centres support the reuse of over 3 000 tonnes of items and materials that would otherwise be discarded.

In the case of Prague, which covers an area of almost 500 km$^2$, an important part of this strategy would be the creation of a decentralized network of reuse centres to which all citizens would have access. Reuse centres in Prague could take different forms to suit the different spatial characteristics of the city. The strategy is elaborated in the Action Plan: CIRCULAR REUSE CENTER contained in the Circular Scan Prague.

# INTELLIGENT WASTE COLLECTION AND STORAGE SYSTEM




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

## Call-outs of MMW Collection Companies

This indicator has been created for the long-term evaluation of the number of shifts (call-outs) of MMW collection vehicles in a given calendar year.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 32 184 | 33 338 | 35 374 |
| Calculation | Number of shifts (call-outs) of collection vehicles | | |

*Source: Pražské služby, a. s. (Plc.), AVE, a. s. (Plc.), Komwag, a. s. (Plc.) and Ipodec, a. s. (Plc.)*

In the coming years, it will be possible to determine the success in fulfilling the set strategic goals of waste management in the Czech Republic that define the waste management strategy, such as waste prevention, waste reuse and recycling (material separation) through monitoring decreases or increases in the number of shifts (call-outs) of collection vehicles.

It will be possible to monitor the evolution of this value by comparing it with the indicator Call-outs of Collection Companies for Recycled Waste and comparing these two groups of waste. In comparison with the total volume of MMW and the volume of sorted waste, both the efficiency of waste collection will be evaluated in the future and especially the practical impact of the implemented circular economy elements.

## Distance Travelled by MMW Collection Companies

This indicator provides additional information on the number of collection vehicle shifts (Call-outs of MMW Collection Companies).

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 3 296 077 km | 3 014 255 km | 3 262 574 km |
| Calculation | Number of vehicle kilometres by collection company vehicles for MMW and trade waste | | |

*Source: Pražské služby, a. s., Ave, a. s., Komwag and Ipodec, a. s. In 2017, no value was available for Komwag, a. s., which performs MMW collection in Prague 2 as part of the Prague Waste Consortium 2016–2025.*

Over four journeys to the Moon and back.

The distance travelled by vehicles in 2019 did not change rapidly compared to the preceding years. The long-term goal is to reduce the number of kilometres travelled by collection vehicles. In principle, this can be achieved in two ways - by optimizing vehicle call-outs and through lower waste generation. However, it is important to understand that, for example, excessive efforts to optimize call-outs, especially for sorted waste, without intelligent monitoring of the fullness of the waste containers, can lead to overfilled sorting containers, pollution of public space through waste being dumped outside the containers, and can demotivate citizens to sort waste.

## Dynamically Adjusted Collection Routes for MMW

This indicator is focused on the long-term monitoring of the application of advanced waste collection depending on the optimization process for collection routes, which are adjusted according to how full the waste containers thanks to built-in sensors actually are.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Number of dynamically controlled call-outs (shifts) of collection vehicles/total number of call-outs (shifts) of collection vehicles (SW, MMW) | | |
| **Number of dynamically adjusted collection routes** | **0** | **0** | **0** |
| **Total number of call-outs of collection vehicles - the sum of the categories below** | **53 266** | **53 311** | **63 843** |
| Number of call-outs (shifts) of collection vehicles for MMW and trade waste | 32 184 | 33 338 | 35 374 |
| Number of call-outs (shifts) of separated waste collection vehicles | 21 082 | 19 973 | 28 469 |

*Data on the number of call-outs (shifts) of collection vehicles for recyclable waste was available in 2017 only for the companies Pražské služby, a. s., and Ipodec, a. s., while in 2018 information was available from Pražské služby, a. s., Ipodec, a. s., Komwaq, a. s., and AVE, a. s.*

The total number of call-outs increased in the last year, mainly due to the newly added collection of gastro-waste and new collection routes. Nevertheless, there is primarily potential for the introduction of sensor-controlled optimization in the case of separated waste, particularly glass. Its ability to evenly fill waste containers, the gradual compaction of glass shards and long collection intervals (up to 6 weeks in some areas) mean it has great potential for collection frequency optimization using sensors. Separated waste collection is currently performed through a fixed schedule according to the contract between Prague Capital City and the "Prague Waste 2016–2025" consortium. It is thus not possible to directly introduce the dynamic collection, but it is possible to adjust the frequency of collection according to the loading on individual containers.

### Call-outs of Separated Waste Collection Companies

This is a similarly oriented indicator as to the Call-outs of MMW Collection Companies, but with the difference that it monitors call-outs for separated waste.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **21 082** | **19 973** | **28 469** |
| Calculation | Number of call-outs (shifts) of separated waste collection vehicles | | |

*Data for 2019 apply for the companies Pražské služby, a. s, Komwag, a. s., Ipodec, a. s., and Ave, a. s.; for 2017, there was no information available for Ave, a. s., and Ipodec, a. s.*

In 2019, distance travelled increased due to the introduction of the gastro-waste collection service.

### Distance Travelled by Separated Waste Collection Companies

This indicator provides additional information to the Call-outs of MMW Collection Companies indicator.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **1 433 940 km** | **2 175 285 km** | **2 381 559 km** |
| Calculation | Number of vehicle kilometres by vehicles of separated waste collection companies | | |

*Source: Pražské služby, a. s., Komwag, a. s., Ave, a. s., and Ipodec, a. s.; for 2017, there was no information available for Ave, a. s. and Ipodec, a. s., and hence (among other influences) in the comparison the number of km is significantly lower*

### Purpose of Call-outs of Collection Vehicles

This indicator describes the share of call-outs of collection vehicles in terms of their purpose. It thus reflects the practical impacts of Act No 352/2014 on the Waste Management Plan of the Czech Republic for the period 2015–2024, which prioritizes higher forms of waste recovery through material recycling over energy recovery of waste.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,655** | **0,599** | **0,805** |
| Calculation | Number of call-outs (shifts) of separated waste collection vehicles/number of call-outs (shifts) of MMW collection vehicles | | |
| Number of call-outs (shifts) of separated waste collection vehicles | 21 082 | 19 973 | 28 469 |
| Number of call-outs (shifts) of collection vehicles for MMW and trade waste | 32 184 | 33 338 | 35 374 |

*Source: Pražské služby, a. s., Komwag, a. s., Ave, a. s., and Ipodec, a. s.*

This indicator compares the number of call-outs for separated waste to those for MMW (together with trade waste). The higher the indicator value, the higher the share of separated usable waste in total waste generation. In 2019, this share came even closer to the value of 1, and in the future, we can expect a further increase, which would mean a reduction in call-outs for MMW. The number of both call-outs (for MMW and separated waste) also increased. It should, therefore, be noted that the indicator is not sensitive to reductions in the waste generation (thanks to the desired increase in product reuse, waste prevention and changes in consumer behaviour reducing the quantity of waste generated). It will provide information on the success of efforts to increase the separation of waste for material recovery of waste. Nevertheless, the effect it has on reducing the indicator value (i.e. an unfavourable development at first glance) may also be since the collection companies better optimize the numbers of call-outs for sorted waste than for MMW. The development of this indicator can, therefore, be evaluated only after a longer monitoring period.

## Smart Waste Containers

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.

| | 2016 | 2017 | 2018 |
|---|---|---|---|
| **Resulting indicator value** | **0,0021** | **0,0056** | **0,0033** |
| Calculation | Number of smart waste containers/total number of waste containers | | |
| **Total number of smart waste containers** | **41** | **110** | **67** |
| Number of smart OICT waste containers | 30 | 30 | 0 |
| Number of smart waste containers - Prague 1 city district | 9 | 9 | 0 |
| Number of smart waste containers - Prague 11 city district | 0 | 4 | 0 |
| Number of smart waste containers - Prague 16 city district | 0 | 3 | 3 |
| Number of smart waste containers - Prague 17 city district | 2 | 28 | 28 |
| Number of smart waste containers - Prague Zoo | 0 | 36 | 36 |
| **Total number of waste containers** | **19 175** | **19 769** | **20 071** |
| City district waste containers | 10 887 | 10 887 | 10 887 |
| Dopravní podnik, Plc. waste containers | 715 | 768 | 1 079 |
| Pražské služby, Plc. waste containers | 5 972 | 6 244 | 6 230 |
| Prague City Hall Environmental Protection Department waste containers | 1 050 | 1 050 | 1 050 |
| Waste containers operated by JCDecaux | 820 | 820 | 825 |

*Source: 2017 – Basic documentation for waste containers of OICT, a. s. Other years – individual city districts, PCH EPD, DPP, Pražské služby, a. s., JCDecaux*


Smart waste containers are containers equipped with sensors monitoring status and operating information, such as how full they are. Smart containers located in city districts and Prague Zoo are from Verb Group, s. r. o. (Ltd.) These are BigBelly solar--powered compacting containers.

In 2018, the pilot smart container project run by Operátor ICT,. (PLC) ended. The project was evaluated as successful and the widespread introduction of compacting containers in Prague Capital City is currently being addressed. In 2019, Prague 1 terminated its cooperation with VERB and all BigBelly containers were removed from the streets. At the end of 2019, the

Prague 1 and Prague 11 city districts did not have any smart containers. Hence the total number of smart waste containers fell by 43 year-on-year.

The number of DPP containers increased in 2019 - 421 containers out of the total number of 1 079 are located in the metro system, and the remaining 658 are operated for surface transport. The total number does not include waste containers at bus stops, as these are not operated by DPP. The total number of waste containers increased by 302 in 2019.

## Digitization of Waste Collection and Processing

This indicator relates to new forms of waste collection and recycling, where waste is collected as mixed and recycled in sorting plants with the application of sophisticated sorting technologies.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **685** | **913** | **1 471** |
| Calculation | Total number of sensors used in waste collection | | |
| Number of GPS sensors in collection company vehicles | 685 | 913 | 1 043 |
| Number of filling sensors in waste containers | 0 | 0 | 424 |

*Source: Pražské služby, a. s., Komwag, a. s., Ave, a. s., and Ipodec, a. s.*

This indicator captures the potential for the full digitization of the waste collection, including dynamic optimization of collection routes; there were no dynamically modified collection routes for MMW in 2019. The value captures the numbers of GPS units installed in collection company vehicles. All collection companies participating in the Prague Waste Consortium 2016–2025 have equipped their collection vehicles, cleaning vehicles and service vehicles with reference GPS units.

The year-on-year increase cannot be exhaustively interpreted as a net increase. The comments of the collection companies show that the situation is continuously changing in connection with the regular replacement of collection vehicles.

At the beginning of 2019, a total of 424 sensors for sensing fullness in waste containers for separated waste were installed as part of an Operátor ICT, a.s. pilot project. Given the positive outcomes of this pilot project (e.g. adjustments to the frequency of collection based on sensor data and increases in yields from waste containers), the final report recommended the use of these sensors in all separated waste containers with bottom emptying (all underground containers and above-ground containers for glass, beverage cartons and metals). We can thus anticipate a gradual expansion of the application of this technology.

## Use of the Door-to-door System

This indicator relates to new forms of waste collection and recycling, where waste is collected as mixed and recycled in sorting plants with the application of sophisticated sorting technologies.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,2878** | **0,3079** | **0,3550** |
| Calculation | Number of collection points connected to the door-to-door system or another alternative system/total number of separation points | | |
| **Number of collection points connected to the door-to-door system or another alternative system** | **1 362** | **1 511** | **1 890** |
| **Total number of separation points** | **4 732** | **4 907** | **5 324** |
| Number of outdoor separation points | 3 370 | 3 396 | 3 434 |
| Number of separation points in the interior of buildings | 1 362 | 1 511 | 1 890 |
| Number of places with a delivery service | 10 587 | 10 351 | 8 970 |

*Data on the number of separation points for the entire territory of Prague Capital City provided by Pražské služby, a. s. Numbers of locations with a delivery service provided by Pražské služby, a. s., Komwag, a. s., AVE, a. s., and Ipodec. a. s.*

This indicator captures the level of use of alternative systems for sorted waste collection. These include, for example, the door-to-door system, where citizens put sorted waste in bags in front of their building, or the pay-as-you-throw system, where citizens pay only for the waste they generate. The number of locations with a door-to-door service includes the total number of door-to-door locations - only a fraction of the stated value is made up of door-to-door points for sorted waste - the majority is a mixed waste.

The potential for the door-to-door system can be captured by recording the number of points where the door-to-door service is operated. This is a service where a collection company offers the option to collect waste containers from the interior of a building. 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.

## Ecological Collection Vehicles

This indicator expresses the number of ecologically powered collection vehicles in the fleets of the collection companies (including CNG, for example).

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **49** | **41** | **49** |
| Calculation | Number of collection vehicles using alternative fuel for propulsion | | |
| Pražské služby a.s. | 44 | 37 | 45 |
| Komwag, a. s. | 2 | 1 | 0 |
| Ipodec, a. s. | 2 | 2 | 3 |
| AVE, a. s. | 1 | 1 | 1 |

*Source: Pražské služby, a. s., Komwag, a. s., Ave, a. s., and Ipodec, a. s.*

The numbers of collection equipment using alternative (ecological) propulsion are constantly changing as the equipment is purchased and disposed of. Monitoring over a longer period of time is necessary for the correct interpretation of this indicator.

## Utilization of Collection Vehicles Running on Alternative Fuels

The active use of environmentally friendly vehicles for waste collection in the context of the overall distance travelled by collection vehicles.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,1098** | **0,1159** | **0,0977** |
| Calculation | Number of vehicle kilometres travelled by alternative-fuel vehicles/number of vehicle kilometres travelled by all collection vehicles | | |
| **Number of vehicle kilometres travelled by alternative-fuel vehicles** | **558 317** | **601 550** | **551 615** |
| AVE, a. s. | 18 000 | 10 500 | 15 000 |
| Ipodec, a. s. | 43 708 | 45 779 | 43 270 |
| Pražské služby, a. s. | 496 609 | 503 646 | 493 345 |
| Komwag, a. s. | N/A | 41 625 | 0 |
| **Total number of vehicle kilometres driven by all collection vehicles** | **5 086 017** | **5 189 540** | **5 644 133** |
| Vehicle kilometers for separated waste | 1 789 940 | 2 175 285 | 2 381 559 |
| Vehicle kilometres for MMW together with trade waste | 1 294 513 | 3 014 255 | 3 262 574 |

*Source: Pražské služby, a. s., Komwag, a. s., AVE, a. s., and Ipodec, a. s.*

This 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 indicator value, implying a reduction in the use of vehicles running on conventional fuels that are an environmental burden on the city.

## 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 resource (e.g. biopolymers, phosphates, nitrogen, ammonia, synthesis gas, carbon dioxide, sulfur and cellulose), energy sources (e.g. sewage sludge and sewage heat) and purified water sources for further use (e.g. watering, flushing, returning water to the countryside). Follow-up activities will also support the retention and further use of rainwater in the city.

Since 2017, the Dešťovka program, run under the Ministry of the Environment and the State Environmental Fund of the Czech Republic, has been providing subsidies for the use of rainwater and wastewater in the home and the garden to natural and legal persons, respectively the owners or builders of family houses and apartment buildings, who want to contribute towards sustainable water management. With this program, the Ministry of the Environment wants to support both the accumulation of stormwater and the use of treated wastewater, with the possible use of rainwater. More information is provided on the official website https://www.dotacedestovka.cz/

### Use of Rain Gauges

The number of rain gauges providing real-time data and their coverage of the territory of Prague.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value (rain gauges)** | **0,1008** | **0,1048** | **0,1048** |
| Calculation | Number of rain gauges/city area | | |
| Area of Prague Capital City | 496 km$^2$ | 496 km$^2$ | 496 km$^2$ |
| Rain gauges operated by PVK | 23 | 23 | 23 |
| Rain gauges operated by CHMI* | 27 | 29 | 29 |
| **Resulting indicator value (meteorological sensors)** | **0,0605** | **0,0423** | **0,0444** |
| Calculation | Number of meteorological sensors/city area | | |
| Meteorological sensors on TSK roads | 30 | 21 | 22 |

*Source: PVK and TSK. *Data on CHMI rain gauges from the hydro.chmi.cz website*

The indicator of city coverage with rain gauges expresses the level of penetration by the physical measuring infrastructure for establishing information on precipitation, especially for hydrological purposes. Information from rain gauges provides a database for engineering operations related to sewerage. Rain gauges also provide essential input data for the hydrology of urban catchment areas. This information will also be used in activities aimed at increasing the use of rainwater. This is a significant source of water generated in the capital. Sensors with real-time measurement are included. Real-time rainfall data can also be obtained from other sources, such as weather radar data. So far, on an experimental basis, these data are also obtained from measurements of attenuation of microwave connections in telecommunications networks.

TSK meteorological sensors provide basic real-time information on the meteorological situation and its impact on traffic. Both the air temperature and road temperature are measured.

## Permeable Surfaces

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

A larger surface area than the Orlík reservoir when full (2 545 ha).

| | 2017 | | 2018 | | 2019 | |
|---|---|---|---|---|---|---|
| **Resulting indicator value** | **27 831 ha** | **56,17 %** | **27 771 ha** | **55,88 %** | **27 724 ha** | **55,80 %** |
| Crop-growing land | 2 605 ha | 5,25 % | 2 689 ha | 5,41 % | 2 672 ha | 5,38 % |
| Forested land | 5 504 ha | 11,09 % | 5 498 ha | 11,06 % | 5 496 ha | 11,06 % |
| Non-forested land | 3 928 ha | 7,92 % | 3 993 ha | 8,03 % | 3 983 ha | 8,02 % |
| Natural recreation | 3 003 ha | 6,05 % | 3 067 ha | 6,17 % | 3 074 ha | 6,19 % |
| Active recreation | 1 004 ha | 2,10 % | 1 151 ha | 2,32 % | 1 149 ha | 2,31 % |
| Resources and waste | 147 ha | 0,30 % | 148 ha | 0,30 % | 148 ha | 0,30 % |
| Agricultural land | 11 640 ha | 23,46 % | 11 225 ha | 22,59 % | 11 202 ha | 22,54 % |

*Data based on spatial analysis data prepared by the Institute of Planning and Development of Prague Capital City*

The above indicators are derived from the basic structure of land use. The percentage expression of the area is calculated from the base area of Prague Capital City, which is 49 616 ha. The context of rainwater management was applied for the choice of these basic land use structures. These areas form the retention potential of land until the moment the profile is saturated with water. The total area of these surfaces remained almost unchanged for 2019. 44.20% of the territory still has the potential for the efficient use of rainwater that cannot be absorbed. The replacement of concrete and asphalt surfaces with ones offering greater permeability, such as paving, stone carpets, etc., will also contribute towards increasing water retention in Prague Capital City.

A comparison of the stated values shows a slight permanent decrease in agricultural land of 0.05% compared to 2018. On the other hand, there has been a recorded increase in the natural recreation land type, which has increased by 0.14% since 2017.

## Rainwater Reservoirs

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

| | 2016 | | | 2017 | | | 2018 | | |
|---|---|---|---|---|---|---|---|---|---|
| Category | Number of elements | Surface area ($m^2$) | Reservoir volume ($m^3$) | Number of elements | Surface area ($m^2$) | Reservoir volume ($m^3$) | Number of elements | Surface area ($m^2$) | Reservoir volume ($m^3$) |
| **Resulting indicator value - total** | **101** | **2 621 894,5** | **4 471 810,0** | **165** | **2 829 364,0** | **6 947 625,0** | **165** | **2 949 483,0** | **7 191 984,0** |
| Fish ponds | 65 | 1 133 580,5 | 1 551 166,0 | 81 | 851 020,0* | 1 903 937,0* | 81 | 971 139,0 | 2 148 296,0 |
| Retention reservoirs | 28 | 471 139,0 | 314 399,0 | 36 | 760 242,0 | 1 430 724,0 | 36 | 760 242,0 | 1 430 724,0 |
| Rainwater sedimentation tanks (RST)** | N/A | N/A | N/A | 39 | N/A | N/A | 39 | N/A | N/A |
| Dry polders | 5 | 448 175,0 | 856 245,0 | 5 | 385 842,0 | 873 639,0 | 5 | 385 842,0 | 873 639,0 |
| Water works | 3 | 569 000,0 | 1 750 000,0 | 4 | 832 260,0 | 2 739 325,0 | 4 | 832 260,0 | 2 739 325,0 |

*Data from the records of the Lesy hlavního města Prahy forestry organization, valid as of 31 December 2018. *... more than. ** RST values were not available at the time of finalization of this publication*

Fish ponds are water reservoirs used mainly for fish farming and recreation. They also have a landscaping and ecological function and can cool the microclimate on a local scale.

Retention reservoirs are used to retain stormwater. The stormwater is then discharged into the sewer system in a controlled manner so that the flow rate does not overload the sewer capacity and does not damage the sewer structure. Without retention reservoirs, the sewer profile could be filled and the free surface flow could become a pressure flow, causing damage to the sewer network, or water could start gushing out in the lower-lying places on the network and cause local flooding. Therefore, unlike fish ponds, retention reservoirs are never filled during normal operation.

Rainwater sedimentation tanks (RST) are designed to capture the majority of pollution in rainwater coming from the ground into the rainwater drainage system to reduce water pollution in watercourses They were mainly built in the 1980s 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 Center for Watercourses at 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.

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 Prague Capital City - Džbán, Hostivařská přehrada, Jiviny and N4.

**The division of Prague reservoirs according to Decree No 471/2001, 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 |
|---|---|---|---|
| **Resulting indicator value** | **0,0483** | **0,0483** | **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 |
| Total number of relief chambers in the capital | 145 | 145 | N/A* |

*Source: PVK. *Data 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 oversized sewers to carry 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.

The amendment to Act No 254/2012, on waters, with effect from 1 January 2019, states that if wastewater and stormwater are drained together through a common sewer system, stormwater becomes wastewater upon entering the sewer system. Stormwater discharged to rainwater separators is already considered wastewater. From the beginning of 2019, the Ministry of the Environment began to differentiate relief chambers on the sewer network from relief chambers at wastewater treatment plants. WWTPs are still obliged to have a valid permit for wastewater management and to pay for the discharge of pollution if the conditions for exemption from the payment of fees set out in Section 89c of the Water Act are not met. From 2023, it will no longer be necessary to have a permit to discharge wastewater from relief chambers if they are located in a sewer network. However, relief chambers in a sewer network that do not meet technical requirements will continue to be charged for any pollution they discharge.

This indicator expresses the share of relief chambers equipped with sensory measurement (so-called emergency monitoring) of the level of diluted wastewater flowing to the recipient compared to the total number of relief chambers.

Sensor 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.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Recycled water consumption/total water consumption in public sector buildings | | |
| Recycled water consumption | 0 | 0 | 0 |
| Total water consumption in public sector buildings (hot utility water and cold water) | 1 506 823,820 m³ | 1 187 699,670 m³ | 1 385 154,701 m³ |

*Data apply to the 1 175 registered buildings in the Energy Broker system that are owned by Prague Capital City. For 2018, not all data for consumption points had yet been entered into the Energy Broker system*

Total water consumption in public sector buildings is calculated from the sum of water abstraction at abstraction points registered in the Energy Broker system, which registered 1 175 abstraction points as of 31 December 2017, with an increase to 1 243 abstraction points as of 31 December 2018.

The difference in water consumption of about 320 000 $m^3$ between 2017 and 2018 was large because not all the values had originally been entered into the Energy Broker system. These values have been gradually added to the system and elaborated.

The Recycled Water Consumption indicator is not quantified. All the public buildings that use recycled water are not currently known.

From 2020, however, grey water will be accumulated and used at Českobrodská Secondary School. Gray water is the term for wastewater from households and other non-industrial buildings that do not contain toilet waste. Gray water is therefore created primarily through the use of bathrooms, washbasins and washing machines.

In the field of wastewater management, we have information provided by PVK. The table shows the quantity of reused water in the indicated premises.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Central Wastewater Treatment Plant | 873 051 m³ | 869 566 m³ | 658 611 m³ |
| Subsidiary wastewater treatment plants (20 plants) | 20 058 m³ | 20 391 m³ | 21 036 m³ |

*Data provided by PVK*

A reduced technological requirement for utility water was observed in 2019. This was mainly related to the launch of a new Central Wastewater Treatment Plant water line during the year - the result was that the inflow of wastewater to the existing water line was reduced by up to 52%.

### Use of Recycled Water - Private Sector

This monitors the involvement of the private sector in the use of recycled water.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Number of enterprises using recycled water | | |

*At the end of the indicated years, the number of companies using recycled water was unknown*

## Use of Wastewater Sludge

This indicator captures the quantity and proportions of the processed mass of stabilized sanitized sludge from wastewater.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Sanitized dewatered sludge from wastewater | 88 000 t | 77 598 t | 85 457 t |
| Placement on agricultural land | 89 % | 94 % | 89 % |
| Composting | 7 % | 3 % | 11 % |
| Energy use | 4 % | 3 % | 0 % |

*Data provided by PVK*

Stabilized sludge is considered sludge that does not cause environmental damage and does not cause problems (e.g. unpleasant odour) when worked with. Sanitized sludge is generally considered sludge for which the pathological organism indicators have been reduced to determined values.

Wastewater treatment separates pollution from water. This is then returned to a recipient - a river or stream - as clean water. During the stabilization process, biogas is captured from the sludge and used in cogeneration units installed at the CWWTP. These units generate electricity and heat from the biogas. In heat generation, the CWWTP is fully self-sufficient and in electricity generation, the self-sufficiency rate reaches 56%.

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

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

The Waste Act obliges the sludge generator, unequivocally a WWTP, to ensure the use of sludge through a sludge recovery program.

**Sanitized sludge can be processed in the following ways according to the valid Waste Act:**

- **Application on agricultural land**
- **Composting**
- **Pre-treatment of waste for application under the designations R1 to R11**
- **Recovery/regeneration of organic substances**
- **Disposal of waste as a technological material for securing a landfill**
- **The energy use of sludge**

The share of sludge placed on agricultural land has not changed rapidly. and was 89% in 2019. The application of sludge from WWTPs onto agricultural land is governed by Act No 185/2001, on waste, and further by Decree No 437/2016, 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 quantity of organic matter and nutrients back to the soil and thus provide protection against erosion and water retention by the soil. There was a more significant change in the share of sludge transported to composting plants, which increased to 11% (2018: 3%).

## Thermal energy from WWTPs

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 100 % | 100 % | 100 % |
| Calculation | Heat self-sufficiency of CWWTPs as a percentage | | |

*Data provided by PVK*

A CWWTP is fully self-sufficient in terms of heat generation. 93.1% of all wastewater in Prague Capital City is treated at the CWWTP.

## Electricity from WWTPs

This indicator describes the electricity consumption balance at the Central Wastewater Treatment Plant.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 56 % | 56 % | 87 % |
| Calculation | CWWTP electricity consumption self-sufficiency as a percentage | | |

*Data provided by PVK*

The percentage of electricity covered by its generation increased in 2019. This increase was linked to the commissioning of a new water line.

# OTHER RELEVANT INFORMATION

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

## Raw Materials in Wastewater

This indicator monitors the raw materials obtained from wastewater apart from wastewater sludge.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 14 810 698 Nm³ | 16 285 510 Nm³ | 17 357 124 Nm³ |
| Calculation | Biogas volume | | |

*Data provided by PVK*

Biogas is extracted at the Central Wastewater Treatment Plant during the wastewater treatment process. No other materials - such as phosphates, polymers, ammonia, nitrogen, $CO_2$, sulfur, or cellulose - are recovered from the wastewater.

## Energy from Wastewater

Indicates the ability of wastewater treatment plants to use wastewater for energy generation.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **57 165 MWh** | **68 094 MWh** | **66 387 MWh** |
| Calculation | Quantity of electricity and thermal energy generated by WWTPs | | |

*Data provided by PVK*

Thermal and electrical energy is generated in wastewater treatment plants through cogeneration with the use of biogas from treatment plant sludge. Cogeneration units generate electricity and also generate thermal energy from waste heat.

## Retention of Treated Water in the Land

Water from the wastewater treatment process is not retained in the land but is returned to a recipient - in this case to the Vltava River. The indicator value cannot be determined/is not quantified.

## SMART BUILDINGS AND ENERGY

Energy is considered one of the key Smart Prague areas and must be perceived as a complex of areas and activities with impacts on current and future energy consumption. It is important to think about ensuring the reliability of the energy supply. Now and in the future, Prague Capital City has to cover the vast majority of its energy needs from external sources located outside its territory, and this could contribute to serious economic and societal impacts in the event of any long-term outages - especially of the power supply, but also of other forms of energy supplies (e.g. heat, gas).

Electricity consumption in the Czech Republic reached 74 TWh in 2019, equal to the value from 2018. It is essential to continue to monitor and evaluate electricity consumption, as new office and retail space are always being built and telecommunications and data services are evolving; the number of electric vehicles that will need a suitable charging infrastructure is growing; and the most varied types of electrical appliances continue to be added to households. In the event of a power failure, major problems can be anticipated within 5 hours and the situation will become critical after 18 hours. The Smart Prague 2030 concept responds appropriately to these challenges in the form of energy-efficient and sustainable energy in healthy and intelligent public buildings.

New technologies, i.e. optimized and modern heating, ventilation and cooling systems, will help reduce energy consumption in buildings and improve user comfort. It is estimated that up to 22% of energy generation may be saved by 2030 by combining different measures. It is estimated that savings of at least 10% can be achieved merely by introducing energy management. An intelligent approach to energy management in public buildings will ensure efficient and thereby lower energy consumption, but also the ability to generate their own energy from renewable sources and efficiently consume or store it. Another problem identified in Prague is the outdated housing stock. The average age of the housing stock in Prague is over 63 years, the highest in the Czech Republic. According to the Czech Statistical Office's Energo 2015 statistics, the consumption of fuels and energies in households in Prague - irrespective of the purpose - consists of 65.2% natural gas and 62.9% purchased heat, while renewable energy sources make up 1.8% of the total quantity. This is the lowest of all the regions. Only 6% of newly started construction was to the passive standard in the Czech Republic in 2019. The Energy Performance of Buildings Directive requires that all new buildings be built for almost zero energy consumption from 2020.

Public lighting is also an integral part of energy consumption. At present, Prague - like other Czech cities - is struggling with uneconomical public lighting. The public lighting system is over 30 years old on average, and hence Prague is planning and implementing its replacement. There are around 135 000 lamps powered by electricity and over 400 posts for gas lamps to preserve the cultural character of old Prague.

The energy in Prague must be economical in the future - lower and more efficient energy consumption, sustainable - own generation, storage and management of energy consumption from renewable sources. Public buildings in Prague will have to be intelligent and healthy - public buildings will automatically provide a healthy environment

### The Thematic Areas Include:

- **Prague Clean Energy Fund**
- **Healthy and smart public buildings**
- **Smart lighting**
- **Smart independent local networks**

## PRAGUE CLEAN ENERGY FUND

Prague Capital City aims to support financial savings for its inhabitants related to heating and hot water by using clean and sustainable energy sources. The sustainability of the city's energy supply through the use of autonomous clean energy sources will also be strengthened. The massive use of financial instruments for the implementation of smart solutions can be anticipated, such as partial subsidies and long-term interest-free loans for owners' associations/cooperatives/owners and other entities. Financial support will thus also be available for promising projects aimed at sustainability, independence and reducing harmful effects arising from the use of energy resources.

The massive application of sensors in public buildings is anticipated to monitor the condition of the buildings in terms of pollution in their indoor and outdoor environments (e.g. air in schools and kindergartens, room temperature, etc.) and energy management. Advanced ventilation and recuperation of indoor air are increasingly used in public buildings, and we anticipate this trend will increase with the gradual sharing of positive experiences with these installations - this will ultimately help improve the comfort and productivity of the people in those buildings, while also extending the lifespan and increasing the value of the buildings.

### Energy Consumption in Public Buildings (Energy Performance)

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Annual energy consumption (MWh) in public buildings/m² of an energy reference area | | |
| **Annual energy consumption (MWh) in public buildings owned by PCC** | **265 509,8** | **272 051,5** | **280 451,5** |
| Recalculated energy consumption by degree days (MWh) | 292 410,4 | 328 800,1 | 340 937,9 |
| Number of degree days | 2 939,3 | 2 678,4 | 2 662,8 |
| The long-term average number of degree days | 3 237,1 | | |
| Public buildings owned by PCC registered in the information system - number of buildings | 1 289 | 1 243 | 1 279 |
| m² of an energy reference area | N/A | N/A | N/A |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*

The 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 a 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. Also, however, data is only available for a small number of buildings in 2019 and therefore would not be sufficiently representative - for this reason, they are not reported here.

1 279 public buildings (addresses) owned by Prague Capital City were registered in the information system at the end of 2019. The information system provides an overview of annual energy consumption (MWh) from all 1 279 buildings. This means the consumption of electricity, gas and heat. 36 more buildings were added to the system compared to 2018. We assume that this number will continue to grow going forward as the database is constantly supplemented and refined.

The average long-term number of degree days is 3 237. This average is considered for the Prague-Karlov station for the period 1961-1990. The basis for the degree-day method is knowledge of the course of outdoor temperatures using meteorological data. The degree days calculation is used to determine the characteristics of the heating period - the number of degree days and the number of heating days. This 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. For more information, see https://vytapeni.tzb-info.cz/teorie-a-schemata/2592-denostupne-teorie-k-vypocetni-pomucce.

Total energy consumption in public buildings owned by Prague Capital City (MWh) was 3% higher than in 2018. This small increase is due to higher consumption of electricity and thermal energy. A qualitative comparison can be performed after recalculation using the degree-day method, and the results are shown in the table above.

Energy consumption data are available from meter readings. This information is most often available in billing for energy consumption. These data are listed in the database for all public buildings registered in the database.

The situation is more complicated in the case of the energy reference area. These data are available for a very small sample of buildings with prepared BEPCs, energy audits, etc. As data per m$^2$ of energy reference area are not currently available, it is not yet possible to calculate the final indicator value. This indicator will capture the energy consumption of public buildings for the last 12 consecutive months. This will be the specific energy consumption of the entire building, i.e. for heating, hot water, lighting and ventilation, but also the operation of the building.

## Consumption of non-renewable primary energy in public buildings

This monitors the energy performance of buildings in terms of one of the two basic parameters of the concept of buildings with almost zero consumption. The consumption of non-renewable primary energy is one of the three main indicators of a building's energy performance, and the building cannot get an occupancy permit if it is assessed as being too high. Energy consumption is monitored here for gas, electricity and heat.

**i About as much energy as the Dlouhé Stráně pumped storage hydro power plant produces in a month**

| | | 2017 | 2018 | 2019 |
|---|---|---|---|---|
| **Resulting indicator value** | | **N/A** | **N/A** | **N/A** |
| Calculation | | Annual consumption of non-renewable primary energy (MWh) in public buildings / m$^2$ of an energy reference area | | |
| Number of buildings owned by Prague City Hall | | 1 289 | 1 243 | 1 279 |
| Electricity | Annual energy consumption (MWh) in public buildings | 76 620,0 | 70 274,6 | i 79 029,5 |
| | Annual consumption of non-renewable primary energy (MWh) in public buildings | 229 861,1 | 210 823,9 | 237 088,6 |
| Gas | Annual energy consumption (MWh) in public buildings | 108 883,8 | 118 725,1 | 105 276,9 |
| | Annual consumption of non-renewable primary energy (MWh) in public buildings | 119 772,2 | 130 597,7 | 115 804,59 |
| Thermal energy | Annual energy consumption (MWh) in public buildings | 80 005,6 | 83 051,7 | 96 145,0 |
| | Annual consumption of non-renewable primary energy (MWh) in public buildings | 80 005,6 | 83 051,7 | 96 145,0 |
| Total consumption | Total annual consumption of non-renewable primary energy (MWh) in public buildings | 429 638,9 | 424 473,3 | 449 038,3 |
| | Total annual consumption of non-renewable primary energy (MWh) in public buildings after conversion to degree days | 473 168,5 | 513 016,2 | 545 884,7 |
| Number of degree days | | 2 939,3 | 2 678,4 | 2 662,8 |
| The long-term average number of degree days | | 3 237,1 | | |
| m$^2$ of an energy reference area | | N/A | N/A | N/A |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*

The consumption of non-renewable primary energy is based on energy consumption. We will achieve it using knowledge of energy consumption through individual energy carriers and subsequent recalculation according to the table below, based on Decree 78/2013, on the energy performance of buildings.

| Palivo / energie | F [kWh/kWh] |
|---|---|
| Natural gas, black coal, brown coal | 1,1 |
| Propane-butane, LPG, fuel oil | 1,2 |
| Electricity | 3,0 |
| Wood pellets | 0,2 |
| Chopped wood, wood chips | 0,1 |
| Environmental energy (electricity, heat) | 0,0 |
| Electricity - supply from outside the building | −3,0 |
| Heat - supply from outside the building | −1,0 |
| 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 |
| Other unlisted energy carriers | 1,2 |

Data relate to consumption points registered in the Prague Capital City information system.

The consumption of primary non-renewable energy increased compared to 2018. This was caused by an increase in the consumption of non-renewable primary energy for electricity by 12% and for thermal energy by 15%. Natural gas consumption, however, decreased by 11%. The increased consumption was mainly due to the addition of new buildings to the information system. In the case of thermal energy, the share of renewable energy sources (RES) is not known for individual consumption points, and so it was calculated using the least favourable coefficient value F = 1.0. For natural gas, the coefficient value F = 1.1 was considered. For electricity, the coefficient value was F = 3.0.

Due to the unavailability of the necessary data (especially energy reference area), this indicator cannot currently be determined.

## Carbon Footprint of Public Buildings

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **131 117,69 tonnes** | **115 213,36 tonnes** | **124 610,91 tonnes** |
| **Resulting indicator value recalculated by degree days** | **144 402,095 tonnes** | **139 246,257 tonnes** | **151 486,399 tonnes** |
| Calculation | $CO_2$ emissions in public buildings related to energy consumption | | |
| Number of buildings owned by Prague City Hall for which statistics are calculated | 1 289 | 1 243 | 1 279 |
| Number of degree days | 2 939,3 | 2 678,4 | 2 662,8 |
| The long-term average number of degree days | 3 237,1 | | |
| $CO_2$ emissions in public buildings related to energy consumption - electricity energy carrier | 89 645,792 tonnes | 71 089,826 tonnes | 79 946,296 tonnes |
| $CO_2$ emissions in public buildings related to energy consumption - gas energy carrier | 21 776,782 tonnes | 23 678,549 tonnes | 20 996,425 tonnes |
| $CO_2$ emissions in public buildings related to energy consumption - thermal energy carrier | 19 695,117 tonnes | 20 444,988 tonnes | 23 668,191 tonnes |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*

Data relate to consumption points registered in the Prague Capital City information system. The carbon footprint is based on energy consumption. We will achieve it based on knowledge of energy consumption of individual energy carriers and subsequent recalculation according to the table below, which is based on Decree 309/2016, on energy audit and energy assessment.

| Palivo nebo energie | | 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% sulfur content) - low sulfur | 77,4 |
| | other liquid fuels | 76,6 |
| | TOEL | 73,3 |
| | benzine | 69,2 |
| | gas oil (up to 0.1% sulfur content) | 73,3 |
| Gaseous 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 |

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

This long-term average is considered for the Prague-Karlov station and the period 1961-1990.

The resulting indicator value saw an increase in $CO_2$ emissions due to increased electricity consumption.

## Energy Costs

This indicator monitors regular energy costs in public buildings calculated per $m^2$ of the energy reference area.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | | Energy costs/$m^2$ of an energy reference area | |
| Energy costs* | 453 072 677 Kč | 512 151 965 Kč | 553 649 412 Kč |
| Number of buildings to which the data relates - from the PCC information system | 1 175 | 1 243 | 1 279 |
| $m^2$ of an energy reference area | N/A | N/A | N/A |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*
**Cost prediction is applied for some buildings as billing information is not yet available. This is usually caused by a different billing period and these data will only be available after the finalization of this publication. For the time being these data are recorded by an individual user, but in the future records will be automatically based on data directly from the energy supplier.*

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

Compared to 2018, there was an increase in total energy costs - this is only partly due to higher energy consumption as a larger number of buildings are included in the data. The availability of the data needed to compile this indicator has generally improved.

As these data are also based on cost forecasts where the costs have not yet been recorded, it would be appropriate to establish a specific methodology for calculating this indicator in the future (assuming data availability) so that the indicator is accurate and eliminates data seasonality and price increases due to inflation.

The energy reference area is currently determined by an energy specialist based on a BEPC calculation or an energy audit or assessment. These data are not machine-readable, so their collection is a gradual process. The data are currently only available for a small number of buildings and therefore would not be sufficiently representative - for this reason, they are not reported here.

## Energy Performance Classes for of Public Buildings

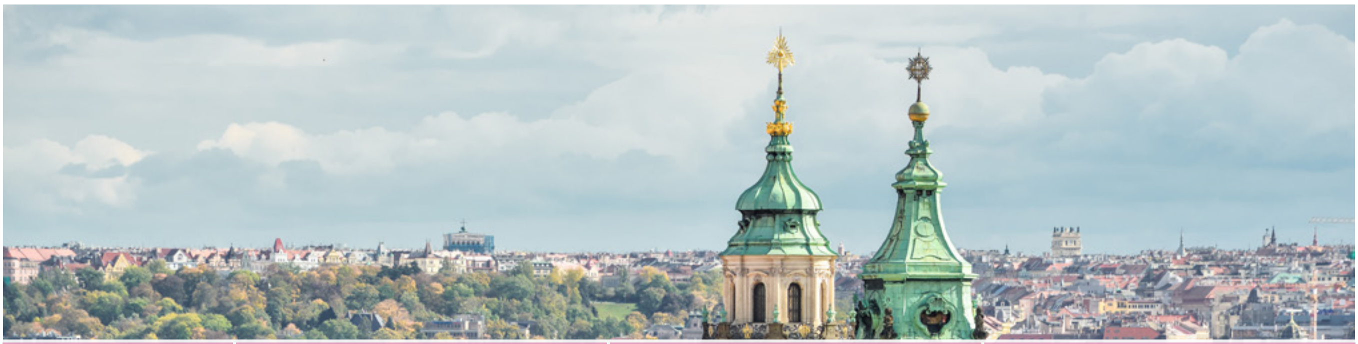
This indicator can be determined based on BEPCs prepared for buildings owned by Prague Capital City. These can be processed based on the obligation under Act No 406/2000, on energy management, to obtain a certificate for a building used by a public authority with an energy reference area:

- **greater than 500 m$^2$ (from 1 July 2013)**
- **greater than 250 m$^2$ (from 1 July 2015)**
- **or when constructing new buildings or performing major alterations to completed buildings**

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **5,32** | **5,32** | **4,26** |
| Calculation | The weighted average of energy performance classes of public buildings owned by Prague City Hall | | |
| Total number of public buildings owned by Prague City Hall with prepared BEPCs | 492 | 492 | 510 |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*

The energy performance class is designated A to G, where the designation A is given to extremely economical buildings and the designation G to extremely uneconomical buildings. To quantify the indicator, each energy class has been assigned a numerical value, see the table below. The resulting indicator value of 4.26 indicates the extent to which the building stock owned by Prague Capital City is obsolete in energy terms. The energy sources for buildings owned by Prague Capital City are gradually being replaced, the building envelopes are being reconstructed and the BEPCs are being updated. For this reason, the indicator has and will have an improving trend.



| Classification class | Verbal expression of classification classes | 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** |

## Public Buildings with Almost Zero Consumption

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0** | **0** | **0** |
| Calculation | Total number of public buildings with almost zero consumption/total number of public buildings | | |
| Total number of public buildings with almost zero consumption | 0 | 0 | 0 |
| Total number of public buildings owned by Prague Capital City | 7 819 | 7 819 | 7 819 |

*Data provided by the Sustainable Energy Department of the Prague City Hall Environmental Protection Department*

In the case of buildings with almost zero energy consumption, two specific requirements set out in Decree 78/2013, on the energy performance of buildings, as amended by 230/2015 (hereinafter only the Decree) apply. The first of these is "very low energy consumption" and the second is that the energy consumption of such a building will be "covered to a significant extent from renewable sources".

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 evaluation of energy performance of buildings was carried out utilizing an amendment to Act No 406/2000, on energy management, as amended, and these requirements are technically specified in Implementing Decree No 78/2013.

A building with almost zero energy consumption is - more simply put - a building with stricter quality requirements for the building envelope, well-regulated heating, ventilation and lighting, technical systems that consume energy very efficiently, while such building will be supplied partly from renewable energy sources or actually generate its own energy (electricity, heat).

This indicator is also evaluated for existing buildings that would meet the requirements placed on new buildings, i.e. buildings with almost zero energy consumption. All buildings for which BEPCs were 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 m$^2$ (from 1 January 2016)**
- **greater than 350 m$^2$ (from 1 January 2017)**
- **lower than 350 m$^2$ (from 1 January 2018)**

There are currently no public buildings recorded with almost zero energy consumption. In the coming years, however, complex reconstruction projects are being prepared so that these requirements will be met. There are at least 12 such projects for schools and administrative buildings. These will also undergo SBToolCZ green building certification and so other, stricter, requirements are placed on them.

### Public buildings with a Green Building Certificate

Certification systems are used to assess and evaluate buildings in terms of their sustainable construction. A series of such tools have already been developed in various countries around the world. Their importance is constantly increasing from the ecological and marketing points of view, as well as that of operating costs and life cycle costs in general. Certification provides a comprehensive assessment of the building and can provide potential investors or tenants with an idea of possible operational savings and marketing benefits, thereby serving as a motivating factor. A certification is also a suitable tool for the public sector as it enables efficiency requirements for both new and existing buildings to be met.

Globally, the most widespread methodology is the LEED (Leadership in Energy and Environmental Design) certification system originally from the USA. The most well-known methods in Europe include BREEAM (British Research Establishment) - Great Britain, DGNB (Deutsches Gütesiegel Nachhaltiges Bauen), (Deustche Gesellschaft für Nachhaltiges Bauen) - Germany.

The Czech certification tool for expressing building quality is SBToolCZ (Sustainable Building Tool) - this incorporates sustainable construction principles, i.e. takes into account a set of environmental, social and economic criteria. The certification system was created at the CIDEAS research centre. The SBToolCZ methodology is based on a multicriteria concept, with a set of different criteria taking into account sustainable construction principles included in the evaluation. The range of criteria that enter into the evaluation process differs according to the type of building (residential buildings, office buildings, schools, etc.) and the life cycle phase being assessed (building design quality evaluation phase, building quality evaluation phase).

All the certification methodologies pursue a similar goal, i.e. the need to meet demanding requirements for sustainable building construction. The most widespread methodology is LEED as it is required by multinational companies, which primarily use office buildings. On the other hand, local certification systems are used for public buildings, as they not only take into account the required standards but also respect local conditions. They are also localized, so it is easier and cheaper to issue a certificate.

Only a single SBToolCZ certificate was issued in 2019, which shows that Grant Call No 30 "Energy Savings in Urban Buildings - Smart Buildings", which no longer accept any applications in 2019, had a significant impact on the preparation of low-energy buildings in the previous period. For comparison, 12 certifications (2 gold, 4 silver and 6 bronze) were issued in 2018.

## Energy Monitoring

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Total number of public buildings with energy monitoring and intelligent control at a high level of automation/total number of energy-active public buildings | | |
| Total number of public buildings with energy monitoring and intelligent control at a high level of automation | 6 | 22 | 29 |
| Total number of energy-active public buildings | N/A | N/A | N/A |

*Source: Operátor ICT, a. s.*

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

Basic prerequisites for successful energy management implementation are consumption measurement and key parameter monitoring. The goal of consumption measurement is to provide a comprehensive set of correct and objective data at the required level of detail. The measurement of key variables provides essential information for the subsequent implementation of energy management activities.

**Category:**

**0 Manual meter readings**

Energy management is not performed, readings are performed 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 min.), while data are stored centrally and 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 a fault very quickly and thus prevent the occurrence of damage.

**2 Remote meter readings with energy consumption regulatione**

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

Smart buildings are buildings with integrated management, i.e. with unified management systems (environment, 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.

7 buildings with implemented energy monitoring systems were added compared to 2018. 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. In 2019, Operátor ICT, a. s. (Plc.) established closer cooperation with the owners of energy meters and distribution companies, which should significantly increase remote energy consumption readings in the future over what was previously possible.

No energy-active building with intelligent control at a high level of automation has yet been registered.

## Degree of Digitization of the Electrical Distribution System

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **<0,01** | **<0,01** | **<0,02** |
| Calculation | Number of smart meters/total number of all meters within the PREdi distribution network | | |
| Number of smart meters | <1 % | <1 % | <2 % |
| Total number of all meters within the PREdi distribution network | 791 000 | 791 000 | 810 000 |

*Data provided by PREdi*

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 a basic assumption for the function of services related to smart grid possibilities.

Energy distribution companies are generally investing more and more in the installation of smart meters, and this has already been reflected in the increased value of this indicator.

## 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 |
|---|---|---|---|
| **Resulting indicator value** | **0,011** | **0,012** | **0,016** |
| Calculation | Number of smart meters/total number of all meters in the PREdi, Pražská plynárenská distribuce, PVK, and Pražská teplárenská, a. s. distribution networks. | | |
| **Number of smart meters** | **14 621** | **15 853** | **21 215** |
| Number of PREdistribuce, a. s. smart meters* | 7 000 | 7 000 | 10 000 |
| Number of Pražská plynárenská, a. s. smart meters | 2 120 | 2 150 | 2 971 |
| Number of PVK, a. s. smart meters | 5 501 | 6 703 | 8 244 |
| **Total number of meters** | **1 327 958** | **1 326 935** | **1 345 221** |
| Total number of PREdistribuce, a. s. meters* | 791 000 | 791 000 | 810 000 |
| Total number of Pražská plynárenská, a. s. meters | 424 742 | 423 215 | 421 373 |
| Total number of PVK, a. s. meters | 112 216 | 112 720 | 113 848 |

** Approximate values. Data provided by PREdi, a. s., Pražská plynárenská, a. s., and PVK, a. s.*

In 2019, the number of Pražská plynárenská, a. s. (Plc.) smart meters increased - for both the Medium Consumption category, but especially the Low Consumption category, where several projects were implemented.

The total number of Pražská plynárenská, a. s. (Plc.) meters decreased, mainly related to customers in the Household category, with these most often being customers disposing of their gas cookers and who do not have any other gas appliances in their homes.

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 a basic assumption for the function of services related to smart grid possibilities, this indicator recorded an increase due to the increase in the total number of smart meters at all the distribution companies.

## Water Consumption

This indicator monitors 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 through domestic water mains but also for technological activities as part city management - road cleaning, irrigation, etc. This indicator forms the basis for evaluating the impact of measures to reduce drinking water consumption (recycling, use of rainwater).

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **75,8 m³** | **74,7 m³** | **73,4 m³** |
| Calculation | Quantity of water supplied to the mains in the territory of PCC/number of inhabitants of PCC | | |
| Quantity of water supplied to the mains in the territory of PCC* | 98 097 594 m³ | 97 746 193 m³ | i 97 190 076 m³ |
| Population of PCC** | 1 294 513 | 1 308 632 | 1 324 277 |

**Source: PVK, a. s. **CZSO, data always as of 31 December of the given year;*

i **Approximately 1/3 of the total volume of the Slapy reservoir.**

The quantity of water supplied to the mains in Prague Capital City 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.

The table above shows that the consumption of drinking water in Prague Capital City is constantly declining - in 2019, average water consumption per capita was 73.4 m$^3$ per year. This corresponds to the consumption of 201 litres of drinking water per capita per day, 6.6 litres less than in 2017.

# SMART LIGHTING

The modernization of Prague lighting into smart lighting which, for example, adjusts its intensity depending on the presence of people, allows remote maintenance, will be at least partially powered by its own energy source, and will employ sensors (air pollution, parking spaces, people and traffic flows) remains a significant task for Prague Capital City 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 |
|---|---|---|---|
| **Resulting indicator value** | **3 / 134 000** | **103 / 135 868** | **103 / 135 868** |
| Calculation | Total number of smart lamps/total number of all street lamps | | |
| Total number of smart lamps | 3 | 103 | 103 |
| Number of OICT smart lamps | 0 | 92 | 92 |
| Number of PRE smart lamps | 3 | 11 | 11 |
| Total number of all street lamps* | 134 000 | 135 868 | 135 690 |

**2017, approximate values. Data on the number of smart street lamps and the number of street lamps in Prague Capital City provided by Technologie hlavního města Prahy, a. s. Data valid as of 31 December of the given year*

Part of a pilot project for the installation of smart lighting in Karlín was also implemented and completed through OICT in 2019. This is an area that starts in around Karlínské náměstí square, extends to Sokolovská and Křižíkova Streets, and from the square to the Křižíkova metro station, where smart lighting with remote control technologies was pilot-tested. The lamps were installed on 92 existing public lighting posts. 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. They will also allow residents and visitors to connect to the Internet, and inform them about air quality, traffic intensity and current local weather conditions.

Smart lighting from PRE uses two types of luminary - SMIGHT Base Station and SMIGHT Base Slim. The lamps are fitted with LEDs, offer a Wi-Fi hotspot, an SOS communicator connected to the integrated rescue system, and sensors for noise, temperature, dust and humidity, as well as an information display. Charging stations for electric vehicles are built into 7 of the 11 smart lamps.

## SMART INDEPENDENT LOCAL NETWORKS

Ensuring the partial or full independence of Prague´s critical infrastructure (e.g. hospitals, water treatment, public lighting) using smart grids with their own intelligent generation, storage and management of electricity consumption, is among the strategic security issues facing the capital, Prague.

### Microgrids

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **0** | **0** |
| Calculation | Number of energy microgrids in Prague Capital City | | |

*Source: Operátor ICT, a. s.*

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 Prague Capital City. According to a resolution of Prague City Council of 6 September 2018, a Prague 3 district project will be implemented to create a microgrid in the Pražačka Sports and Recreation Center.

### Decentralized Solar Electricity Generation

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

| | 2017 | 2018 | | 2019 | |
|---|---|---|---|---|---|
| **Resulting indicator value** | **22,927 MW** | **22,823 MW** | | **22,388 MW** | |
| Calculation | Installed solar power plant capacity in Prague Capital City (MW) | | | | |
| Number of electricity sources installed in Prague Capital City | 1 223 | 1 242 | | 1 481 | |
| Average installed solar power | 0,019 MW | 0,018 MW | | 0,015 MW | |
| Total power and number of other electricity micro-sources | N/A | 23,040 MW | 32 zdrojů | 23,129 MW | 12 zdrojů |
| Landfill gas | N/A | 5,552 MW | 7 zdrojů | 5,650 MW | 2 zdroje |
| Sludge gas | N/A | 5,402 MW | 5 zdrojů | 5,402 MW | 1 zdroj |
| Hydro power | N/A | 12,084 MW | 19 zdrojů | 12,075 MW | 8 zdrojů |
| Wind power | N/A | 0,002 MW | 1 zdroj | 0,002 MW | 1 zdroj |

*Source: Energy Regulatory Office and PREdi, a. s.*

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

The average installed capacity per license granted value of 0.015 MW indicates significant decentralization. By nature, there are a large number of private solar cells on the roofs of houses.

According to a resolution of Prague City Council of 13 February 2020, a project will be built in the Prague 3 district aiming to use free space for the installation of photovoltaic power plants and their central control using the virtual power plant principle. The electricity generated will primarily cover electricity consumption in the city district administrative buildings with the possibility of distribution among them as needed.

### Backup Electricity Sources for Prague

This monitors the quantity of available power outage backup energy sources for Prague.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **91 702 kVA** | **91 702 kVA** | **91 702 kVA** |
| Calculation | Total kVA of backup sources installed in Prague Capital City | | |

*Source: Sustainable Energy Department of the Environmental Protection Department of Prague Capital City*

Data are unchanged for 2019.

## OTHER RELEVANT INFORMATION

### Unplanned Water Outages

The reliability of the water supply expressed as the number of water outages compared to the length of the water mains network.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **1,4012** | **1,4716** | **1,4186** |
| Calculation | Number of faults in the water mains network/length of the water mains network (km) | | |
| Length of the water mains network (km) | 3 539 | 3 539 | 3 545 |
| Number of faults in the water mains network | 4 959 | 5 208 | 5 029 |

*Data provided by PVK, a. s.*

**The length of the Prague water mains network is 1.5 times that of the country's border.**

This indicator expresses the reliability of the water supply - there was an average of 1.4186 faults per kilometre of the water mains network in 2019. According to information from PVK a.s., the higher fault rate is attributed to hot weather in the summer months when the soil dried up and exerted pressure on the water pipes. The most common causes were corroded material and soil movement. These two reasons caused almost 95 per cent of all accidents. In contrast, water leakage reached a historical low. Controlling and monitoring the water mains network combined with preventive field research helped reduce water losses.

## Heat consumption from DH

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 80 005,61 | 83 051,74 | 96 145,05 |
| Calculation | Heat consumption from DH in public buildings (GWh/y) | | |

*Source: Sustainable Energy Department of the Environmental Protection Department of Prague Capital City*

DH is the abbreviation for district heating. DH is a way to efficiently supply heat to large agglomerations. This heating method is commonly used here in the Czech Republic and is also very widespread in developed western countries with comparable climates. Austria, Germany, Denmark and Finland, for example. DH reduces both energy consumption and price, is more environmentally friendly, and improves living conditions in cities. As there is a large central source, it is possible to use cogeneration - the generation of both 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 towards 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 as a total but by individual source/heating plant to enable the determination of pollutant emissions. Based on this, it is possible to assess the ecological benefit in the case of economy measures in buildings owned by Prague Capital City, or the 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 are high efficiency, the absence of local pollutant emissions, and maintenance-free operation.
The main disadvantages are the high heat costs and the need to periodically shut down heat supplies.

This indicator shows the increase in heat consumption in public buildings caused by an increase in the number of buildings using DH in the information system.

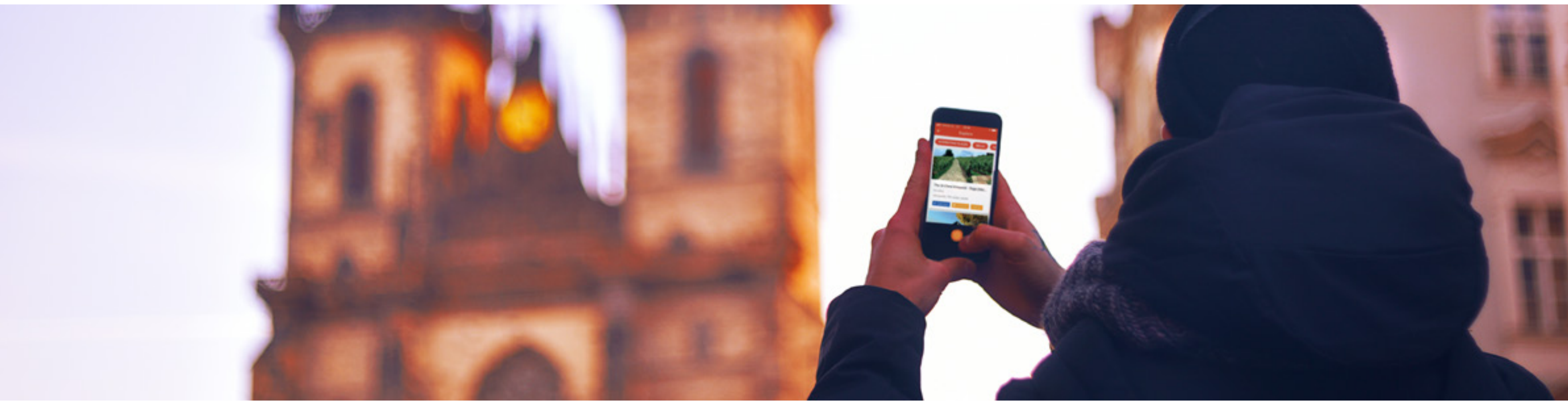
Detailed information on the energy performance of buildings, their consumption and the fulfilment of the climate obligation can be found here:

Prague is an important tourist destination and tourist numbers are increasing year-on-year. In the prestigious Travelers' Choice comparison rating by the TripAdvisor travel server, in 2019 Prague ranked 11th-most-popular global destination after Dubai (UAE), just like last year, and ahead of New York, for example. Tourist numbers in Prague are constantly increasing over the long term, making Prague one of the most visited cities in the world. It welcomes a higher number of tourists than, for example, Venice, and there are approximately five times more visitors than the population of the capital. Over half a million come for Christmas and New Year alone, making tourism an important component of the city's revenues. In 2019, Prague welcomed almost 8.1 million tourists, just under 2% more than in 2018 and about 5% more than in 2017. The visitors spent a total of 18.5 million nights here. In 2019, a total of 6 786 151 foreigners visited Prague, i.e. 1.7% more than in 2018 and 3.4% more than in 2017. There were also 1 243 000 domestic visitors, i.e. 1.8% more than in the previous year. This shows that the trend of recent years, where the number of domestic visitors increased year-on-year by 10-15%, is continuing. Visitors spent a total of 18.5 million nights in Prague, i.e. 1.1% more than in 2018. The average overnight stay duration remained approximately the same at around 2.3 nights. Tourists visiting Prague spend the same number of nights as tourists visiting Barcelona (source: CZSO). However, only the number of guests staying in accommodation facilities providing over 5 rooms or 10 beds is included in the official statistics. The very definition of mass accommodation facilities implies 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, free accommodation (such as staying with friends and relatives). Qualified estimates indicate that the number of tourists in Prague could be twice as high.  Prague Capital City and government officials are searching for a solution to the issue of the legal regulation of platforms for short-term leases like Airbnb. The capital plans to have a housing development strategy to 2050 prepared by June 2020. As regards tourism as an economic commodity, tourism in Prague generates 5% of the total GDP of the capital and 1.1% of the GDP of the Czech Republic.

Tourism in Prague must, therefore, be developed in a coordinated manner using innovative technologies and reliable data on the movement and preferences of visitors to Prague. The burden on the main tourist locations must also be sensitively regulated so that the number of visitors remains tolerable both from the point of view of the protection of monuments and local inhabitants and also from that of the visitors themselves. Directing visitors to equally attractive but lesser-known parts of the wider centre of Prague can be one way to lighten the burden on the most visited locations, such as Prague Castle, Charles Bridge and the Old Town Square.  To support this activity, a Prague mobile tourist app called the Prague Visitor Guide was created in 2017 which, in addition to up-to-date practical information, also motivates visitors to visit attractive places outside the main tourist route through the monument reserve. To do this it uses, among other things, elements of gamification (geolocation games). One of the main medium-term goals is the creation and introduction of an attractive tourist card that will, among other things, be connected to the mobile app and linked to other city services, including public transport. Geographic data, data from social networks (Twitter, Facebook, etc.), and information from the use of credit cards and camera systems have a huge but not yet widely utilized potential in the development of general and urban tourism.  After being properly evaluated, all this information can theoretically be used for more active tourism management and to ensure greater comfort for both residents and visitors. Prague does not currently make significant use of the possibilities offered by modern technologies for the automated collection of aggregated data and to enrich the tourist experience. Augmented reality during sightseeing tours and the use of robots equipped with artificial intelligence should become a natural part of controlled, friendly, safe and fun tourism in Prague in the foreseeable future.

## The Thematic Areas Include:

- **Big Data in Tourism**
- **Mobile-based Tourism**
- **Advanced Technologies for Tourism**



The goal of the Smart Prague concept is to have a functional automatic collection of aggregated data by 2030, which will then be used to evaluate the activities, preferences and experiences of visitors to Prague. It will thus be possible, for example, to adopt measures to direct tourism to the benefit of less frequented or less known localities, including in the peripheral areas of Prague.

## The Use 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 any given time. This information exists thanks to the standard communication between the mobile phone and BTS base stations, while the location is derived through the delay of the signal on its path between the mobile phone and the base station and/or by using triangulation. In combination with other Big Data sources like GPS data, payment card usage data, accommodation statistics, etc., it is a valuable base for obtaining an overview of concentration and other socio-economic characteristics of residents and visitors in specific localities. They can be successfully used in the planning and management of tourism-related activities in bulk and anonymized form. In conjunction with related information, such as the results of analyses of social network user sentiment, it is possible to evaluate the satisfaction of visitors with the services in a given place and possibly also their preferences. In this way it is possible to target the promotion of Prague Capital City to specific groups of visitors, plan the development of tourism - including the related infrastructure - and improve the quality of tourism services.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 1 | 1 | 1 |
| Calculation | Number of actively used data source types for the controlled development of tourism | | |
| Social networks and the web (e.g. Google Analytics) | Ano | Ano | Ano |
| Geographic data (e.g. mobile networks) | Ne | Ne | Ne |
| Sentiment from social networks | Ne | Ne | Ne |
| Data from payment cards | Ne | Ne | Ne |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

At present, when monitoring tourism data, Prague Capital City uses Google Analytics on the official tourism websites (especially https://www.prague.eu/en). It actively communicates with tourists on social networks through a responsible employee.

## 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 is anticipated.

Fulfilment of the indicator is also anticipated in connection with the launch of the Prague Visitor Pass tourist card which, during the pilot phase in 2020 and after the transition to full operation in 2021, will allow entry to about 80 tourist sites (with the assumption that the number of sites will further increase). For lesser-known and less-visited sites, it will be desirable to increase traffic using appropriate - especially marketing - measures.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | N/A | N/A |
| Calculation | Number of visitors to lesser-known areas/Number of visitors to all monitored tourist destinations | | |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

## Tourist Heatmapping

This indicator captures the number of created tourist-focused heatmaps. A 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 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 0 | 0 | 0 |
| Calculation | The number of created tourist-focused heatmaps | | |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

This indicator will be used in connection with the launch of the Prague Visitor Pass tourist card, currently planned for the second half of 2020 in open pilot testing and full operation from the spring of 2021.

## 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 feedback. 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 the further development of the services offered.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Calculation | Number of interactions by information channel | | |
| **Number of interactions in information centers** | 1 233 364 | 1 633 623 | 2 043 093 |
| **Facebook** | 600 | 750 | 850 |
| **E-mail** | 511 | 1 975 | 1 860 |

*Source: Prague City Tourism, a. s., data as of 31 December 2019*

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 e-mail communication. The year-on-year increase in interactions at information centres can be attributed to the overall increase in the numbers of visitors to Prague. 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 also be possible to monitor interactions through the tourist app. This should be an evaluation of tourist sites integrated into the app as part of the development of the Prague Visitor Pass tourist card (following its launch sometime after 2020).

# MOBILE-BASED TOURISM

The intention of the Smart Prague 2030 concept in this area is to gradually develop a modern mobile app for tourism in several language versions. In addition to basic functionality facilitating visitors' orientation around the city by displaying interesting places on the map and navigating them there, it will also enable recommendations for ways to spend a stay in the city, e.g. through thematically designed activities based on the interests of different groups or profiles of people. Another goal is to connect the mobile app and other services for tourists, such as public transport tickets, two- and multi-day tickets to sights and attractions, or other discounts through the tourist card that is currently under preparation.

## Geolocation Games

The aims of the development of this area are to make tours 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 the popular geocaching, something between a sport and tourism, in which tourists search for hidden boxes or collect points using geographical coordinates. In combination with a smartphone, a mobile data connection and location data, this can also be a comfortable, interesting and fun way to plan tours and trips around Prague and its surroundings. The routes are usually chosen so that the visitor is guided through places that are attractive but less well known to tourists.

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

*Source: Operátor ICT, a. s., data as of 31 December 2019*

Geolocation games in Prague are available through the Prague Visitor Guide operated by OICT, as well as the GeoFun game. As the individual routes in the Prague Visitor Guide app are thematically different, the indicator counts each route as a separate game. However, the number and content of routes are still being optimized. 40 of the total of 52 proposed routes were shown in a pilot project in 2018. In 2019 and in cooperation with Prague City Tourism, to make things clearer for tourists, the number of routes was optimized to the existing 10, which can be modified if necessary (e.g. due to seasonality, temporary closures of monuments, etc.).

## The attractiveness of the Main Prague Tourist App

The official mobile app for tourists in Prague offers visitors up-to-date information and many other functions - an extensive list of sights and attractions, routes for different target groups, offered discounts, navigation to places of interest, and current cultural, sporting, social and other activities. The app offers visitors both an "encyclopedia" of sights and also entertainingly provides information and tips. This makes it a friendly guide for tourists visiting Prague.

The app should also use geolocation games to motivate tourists to visit interesting locations outside Prague's historical centre.

It will thus fulfil the function of a mobile guide to interesting locations, focusing on selected tourist groups. The thematic routes (e.g. Prague at night, a trip to viewpoints, a gastronomic experience) change several times a year, and tourists receive special rewards for completing them. Data from OICT statistics.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Calculation | Number of Android and iOS downloads | | |
| **Android** | 465 | 2 428 | 4 921 |
| **iOS** | 95 | 446 | 744 |

*Source: Operátor ICT, a. s., data as of 31 December 2019 Number of downloads in a given calendar year.*

### User evaluation of the main Prague tourist app

Anyone who has the tourist app (Prague Visitor Guide) installed can also rate it at any time through the appropriate app store and write a comment to provide feedback to developers, thus helping improve the app.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Calculation | User ratings on Android and iOS | | |
| **Android** | 4,8 z 5 | 4,3 z 5 | 4,3 z 5 |
| **iOS** | 1,5 z 5 | 3,3 z 5 | 3,3 z 5 |

*Source: Operátor ICT, a. s., data as of 31 December 2019*

The 2017 rating was based on a 12-day operation of the app and is therefore only illustrative. As part of efforts to increase the quality of the services offered, the app has been updated and improved over the following years (e.g. through the addition of language mutations and more content and information).

## ADVANCED TECHNOLOGIES FOR TOURISM

One goal of the Smart Prague 2030 concept is to incorporate 3D virtual or augmented reality. Tours of Prague´s sights will thus better stimulate the interest of tourists. These advanced technologies have even greater potential to support the redirection of tourists to less busy locations. The application of artificial intelligence, for example through guide robots in tourism as a fun interactive form of city tours, should form an integral part.

### Augmented Reality

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

Virtual and augmented reality technologies are gradually transferring from military and industrial use to everyday life. Nevertheless, their mass mobile use can be anticipated only with the approaching development of 5G networks and improvements and reductions in the price of wearable HW (such as glasses for virtual and augmented reality). It will then be possible to anticipate a more significant increase in the numbers of tourism-related apps.

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

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

At the Smart City Expo Barcelona event, held from 18 to 21 November 2018, a new element conceived as a game was introduced in the Prague Visitor Guide app, making it possible to gather information about important 3D structures in Prague in augmented reality. The structures always appeared in front of a QR code sticker. 10 of these QR codes were placed in visible places after the expo. If the user found and collected all 10 structures using the app, they received a small reward at the exhibition stand. This AR game was conceived as a one-time functionality for the presentation at Smart City Expo Barcelona as a demonstration of the possible development of this technology and has also been presented in this yearbook in this informative spirit. Augmentation elements have not yet been practically applied in Prague. Visitors to the monument zone and the monuments themselves will theoretically only be able to enjoy the new augmented reality experience in the future.


## Artificial Intelligence

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 0 | 0 | 0 |
| Calculation | The number of tourist sites using artificial intelligence elements. | | |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

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 a visitor through the monument zone and the 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 app could offer them extra information about the monument or 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 information 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 the provision of routine commentaries and the interactive provision of basic information, 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 |
|---|---|---|---|
| **Resulting indicator value** | 0 | 2 | 2 |
| Calculation | Number of active guide robots | | |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

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 tram number 23 route 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 findings so far, the indicator will need to be adjusted in the future in connection with activities and the implementation of projects focused on innovation in tourism. It is not realistic to expect to obtain all tourist sites and what they offer if they are privately operated.

## 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 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 0 | 0 | 0 |
| Calculation | Number of locations using sensors to count visitors | | |

*Source: Operátor ICT, a. s., and Prague City Tourism, a. s.*

The implementation of counting sensors is currently planned for pilot testing in selected public spaces. The pilot project aims to monitor the intensity of pedestrian traffic, especially concerning the concentration of crowds in a public space, and in this respect deviates from the intention to count visits (inputs) as formulated in this indicator.

The indicator will be adjusted in the future and be used to display the number of locations where 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)

TA 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 and meals. Tourist cards can differ in many parameters, such as the territory covered, time validity, transferability to other persons, the technology used (paper cards, plastic cards with barcode, mobile apps), prices and method of distribution. The Prague Card 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 gave 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 be met thanks to the advantages of a product combining discounts on admissions and public transport.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **50 000** | **51 000** | **52 000** |
| Calculation | Number of tourist cards sold/year | | |
| Number of PVP cards sold - 48 h | N/A | N/A | N/A |
| Number of PVP cards sold - 72 h | N/A | N/A | N/A |
| Number of PVP cards sold - 120 h | N/A | N/A | N/A |

**Approximate data - the tourist card service is privately operated. Exact data are not available - these are qualified estimates by Prague City Tourism, a. s.*

Real data, including a breakdown by card type (2, 3 and 5 days), will be known after the Prague Visitor Pass launch. 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 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Number of discounted cards sold/total number of tourist cards sold in a given year | | |
| Number of adult PVP cards sold | N/A | N/A | N/A |
| Number of child PVP cards sold | N/A | N/A | N/A |
| Number of student PVP cards sold | N/A | N/A | N/A |

*Source: Operátor ICT, a. s.*

Currently, available products are provided by a private entity and so the exact data are not available. 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 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Number of days sold by tourist card/year | | |

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

Currently, available products are provided by a private entity and so the exact data are not available. 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 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **N/A** |
| Calculation | Number of tourist card uses in specific locations | | |

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

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

## OTHER RELEVANT INFORMATION

The monitored indicators included in this sub-area help to elaborate on the tourism situation in Prague. Other Relevant Information indicators mainly relate to relevant statistical data, for example on the number of visitors to Prague, tourism intensity, and the related topic of accommodation capacities.

### Tourism Productivity

This indicator aims to provide additional information about tourism productivity, using indicators related to tourism expenditure split into expenditure by foreign visitors (foreign inbound tourism) and expenditure 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* |
|---|---|---|---|
| **Resulting indicator value** | **56,4 % / 43,6 %** | **57,1 % / 42,9 %** | **N/A** |
| Calculation | Share of inbound/domestic tourism expenditure in total expenditure | | |
| Share of tourism in GVA | 2,8 % | 2,8 % | N/A |
| Share of tourism in GDP | 2,9 % | 2,9 % | N/A |
| Share of tourism in employment | 4,5 % | 4,4 % | N/A |
| Total tourism expenditure | 292,5 mld. Kč | 295,0 mld. Kč | N/A |
| Expenditure by foreign visitors | 164,9 mld. Kč | 168,5 mld. Kč | N/A |
| Expenditure by domestic visitors | 127,6 mld. Kč | 126,5 mld. Kč | N/A |

*Source CZSO. The stated values are for the whole of the Czech Republic. Prague Capital City accounts for approximately 1/3 of the total sum of the above expenditure *Note: Data for 2019 will be available after the finalization date of this publication. Data for 2018 were published on 28 February 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 purchase prices. It is usually calculated for individual industries or institutional sectors/sub-sectors. GVA is the so-called "net indicator of the performance of an economy".

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/subsectors 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 requests from the public and began publishing some indicative indicators for the regions retroactively, starting in 2017. 2018 data for the regions are currently being processed. The shares of the regions are based on a presentation at a CZSO press conference held on 8 November 2019, where the indicative shares were published for the first time. The graphs presented in this presentation showed that Prague Capital City is the region enjoying the greatest tourism-related profits in the Czech Republic. In 2017, Prague accounted for 31% of total employment in tourism for the entire Czech Republic (share of the total number of people employed in tourism in the Czech Republic) and 36% of GVA creation through tourism in the Czech Republic. In other words, we can say that the capital thus contributes over 1/3 towards the creation of the above macroeconomic indicators in tourism.

Tourism accounted for 4% of total GVA in Prague in 2017, while the national average was 2.8%. A higher share was recorded only in the Karlovy Vary region, where it reached 5.9%. Tourism's share in total employment in Prague was calculated at approximately 8%, while the national average of 4.5% was also exceeded by the South Moravia and Karlovy Vary regions. Only the Karlovy Vary region exceeded 5% - its calculated value of 7.9% even approached that of the capital. All the mentioned regional shares are only indicative.

## Number of Visitors

This indicator monitors the total number of visitors to Prague Capital City. A resident means a visitor from the Czech Republic. Measurements show that the total number of guests from abroad has been increasing every year since 2012. The year-on-year increase was 7.4% (or 525 203 people) in 2017, and 3% (239 423 people) in 2018, while the increase decreased to 2% in 2019, when 136 926 more foreign tourists arrived than in the preceding year. The long-term trend, excluding distortions from seasonal fluctuations, will most likely only be observable using a longer time series in the order of several years.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **7 652 761** | **7 892 184** | **8 029 110** |
| Calculation | Total number of visitors (including residents) | | |
| Total number of visitors (including residents) | 7 652 761 | 7 892 184 | 8 029 110 |
| Number of foreign visitors | 6 562 518 | 6 670 706 | 6 786 151 |

*Source: Czech Statistical Office*

Approximately the population of Switzerland.

## Number of Nights

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

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **18 055 838** | **18 249 084** | **18 456 261** |
| Calculation | Total number of overnight stays | | |
| Total number of overnight stays | 18 055 838 | 18 249 084 | 18 456 261 |
| Average stay (number of nights) | 2,4 | 2,3 | 2,3 |

*Source: Czech Statistical Office*

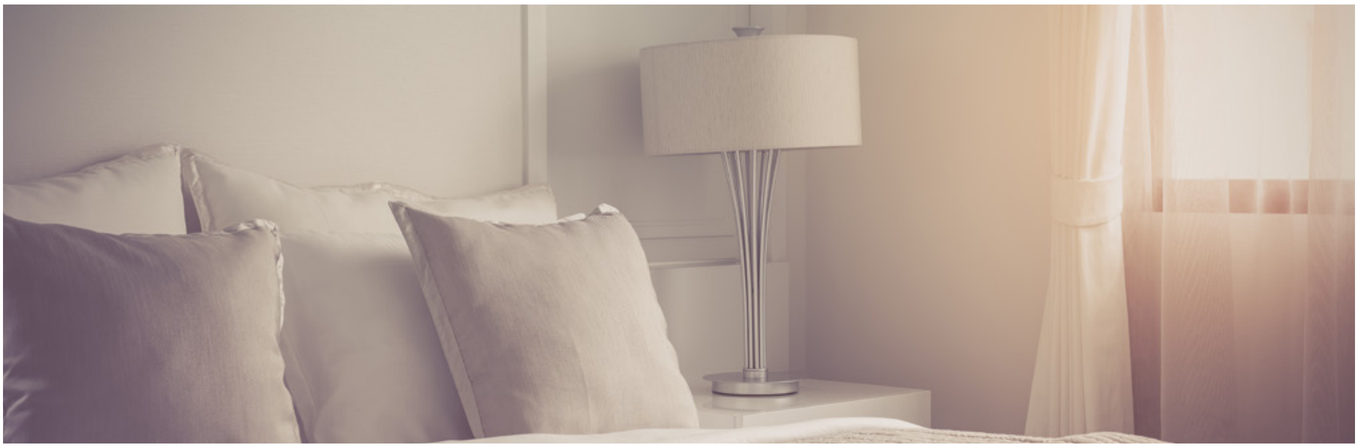
According to the Czech Statistical Office, the average stay has hovered around 2.3 days for a long time. Extending this period would be beneficial from the point of view of tourism and is in the interest of Prague. However, this would generally require - in addition to increasing the attractiveness of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

## Number of rooms and beds

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **41 617 / 90 891** | **42 487 / 93 169** | **42 997 / 94 444** |
| Calculation | Number of hotel-type rooms/number of beds | | |
| Number of hotel-type rooms | 41 617 | 42 487 | 35 960 |
| Number of non-hotel-type rooms | 6 551 | 6 979 | 7 037 |
| **Total number of rooms (all accommodation facilities)** | **41 617** | **42 487** | **42 997** |
| Number of beds in hotels | 73 811 | 74 982 | 76 602 |
| Number of beds in other accommodation facilities | 17 080 | 18 187 | 17 842 |
| **Total number of beds** | **90 891** | **93 169** | **94 444** |

*Source: Czech Statistical Office*

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 facilities (bed-and-breakfasts, camps, cottage settlements, tourist hostels and other mass accommodation facilities), and compares these data with the number of beds in both groups of accommodation facilities for the given year. The number of beds indicates a year-on-year increase in capacity. In the case of rooms, there was an increase in capacity of 2.1% in 2018, while the number of beds increased by 2.5%. 2019 brought an increase in room capacity of 1.2%, with the number of beds increasing by 1.4% over the previous year.



## Room Occupancy

This indicator monitors the net occupancy of beds and rooms in hotels and similar accommodation facilities in Prague. The Czech Statistical Office states that the net occupancy of beds is determined as the number of overnight stays in the monitored period compared to the product of the average number of available beds and the number of operating days.

Room occupancy is determined as the number of "room days" (i.e. the number of occupied rooms on individual days of the monitored period) compared to the product of the average number of available rooms and the number of operating days.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,670 / 0,695** | **0,663 / 0,692** | **0,678 / 0,702** |
| Calculation | Net occupancy of beds %/net occupancy of rooms % | | |
| Net occupancy of beds | 67,0 % | 66,3 % | 67,8 % |
| Net occupancy of rooms | 69,5 % | 69,2 % | 70,2 % |

*Source: Czech Statistical Office*

This sample shows a somewhat fluctuating trend over the years in question, hence the interpretation over a longer period of time will probably be beneficial.

Prague Capital City is the largest protected monument reservation in the Czech Republic and also one of the most popular tourist destinations in the world. The historical core of Prague - with an area of 866 hectares, comprising Prague Castle and Hradčany, the Lesser Town and Charles Bridge, the Old Town with Josefov and the preserved part of the former Jewish Town, the New Town, Vyšehrad and other monuments - is on the UNESCO World Heritage List.

There are over 2 000 listed buildings in the capital. Over 460 000 enterprises are also registered in Prague, and the central state authorities and many other institutions are headquartered here. As of the last day of 2019, Prague had a population of 1.3 million, a year-on-year increase of 1.2%; according to estimates, its population could rise to 2 million by 2050. CZSO statistics suggest that the future population increase will probably be mainly through migration from the countryside and immigration. Properly set smart measures can significantly aid the adaptation of new residents to the urban environment. It will be necessary to deploy modern technologies and develop urban mobile apps to meet these challenges successfully in the future, to harmonize the often conflicting interests of different groups of people, and to maintain and develop Prague's public environment to keep it a safe and enjoyable place in which to live. Innovative technology will also bring unconventional ways to use public spaces and their furnishings. City furniture can offer Prague's citizens and visitors an additional service by combining the traditional utility features of the furniture with added features such as a flexible source of information and data. One distinctive feature of today's Europe - including Prague - is an increasing proportion of people in higher age groups, which will result in an increased number of people with reduced mobility and self-sufficiency. At the same time, there will be increased demands for support for living in a person's natural environment, which will require the strengthening of professional social and health services. Elderly and chronically ill citizens will be provided with assistive care using the latest technologies to improve their quality of life. The safety of citizens in public spaces will be continuously improved through automated detection and prediction of risk phenomena using intelligent camera systems and a dense sensor network. Another equally important aspect is support for planting greenery and urban agriculture, which contribute towards improving the environment in the capital and the food self-sufficiency of Prague.

## The Thematic Areas Include:

- **Assistive and advanced technologies for caring for people with reduced self-sufficiency**
- **Online detection of risk phenomena**
- **New functionality for urban furniture and public buildings**
- **Urban farming**

# ASSISTIVE AND ADVANCED TECHNOLOGIES FOR CARING FOR PEOPLE WITH REDUCED SELF-SUFFICIENCY

Modern assistive technologies will help with caring for people with reduced self-sufficiency (e.g. elderly people living alone and people with disabilities) and contribute towards improving their standard of living and safety in their own social environment. Prague has decided to face the challenge of an ageing population through - among other things - the application of these technologies. Assisted living is both humane and economical, and therefore a desirable alternative to institutional care, whether in a medical facility or a residential social care facility. The application of the potential of advanced technologies will make it possible for elderly people and people with various medical issues to live full lives.

## Assistive Technology

This is an indicator that - since the launch of the Metropolitan Emergency and Health Care System (MEHCS) pilot project - has monitored the number of people using client devices with an SOS button permanently connected to the emergency care control system, which evaluates and resolves alarms and emergencies. The most common causes of emergency care requests are falls, nausea, weakness, assault, fear of loneliness, loss, and forgetting keys. The MEHCS was launched in October 2018 and is divided into several stages. Its main goal is to introduce a higher standard of care services for the elderly and people with reduced self-sufficiency using new, more modern technologies. The new possibilities will enable such people to live full lives in their old age or with medical problems without fear and in their domestic environments.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | 60 | 104 |
| Calculation | Number of people connected to the emergency care control centre under the MEHCS | | |

*Data from the Metropolitan Emergency and Health Care System project*

During the implementation of the Metropolitan Emergency and Health Care System pilot project, the number of users increased to 104 people using client devices as of 31 December 2019.

## Home Care

A significant success factor concerning the implementation of the Metropolitan Emergency and Health Care System will be the number of people for whom preventive monitoring of personal health parameters is deployed - here there is great potential. The launch of this system will aid in the timely detection of health problems and also in the assessment of changes in the lifestyle of clients in their domestic environment and at high risk of deteriorating health. A physician can flexibly react to these changes, for example by adjusting medication or recommending patient treatment at a specialized workplace. The preventive monitoring of personal health parameters stage was launched in the first half of 2019 according to the schedule of the Ministry of Labor and Social Affairs.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | N/A | 5 |
| Calculation | Number of clients with preventive monitoring of selected personal health parameters | | |

*Data from the Metropolitan Emergency and Health Care System project*

The introduction of monitoring for 5 clients was agreed by general practitioners in 2019 as part of the MEHCS pilot project.

### Number of cooperating medical facilities

The involvement of the medical community is an integral part of the successful implementation of the Metropolitan Emergency and Health Care System (MEHCS) project. This indicator evaluates the participation of medical facilities in the system. This primarily means general practitioners, as they are most aware of the health and social backgrounds of their patients and can easily identify when emergency care is needed. This also includes hospitals that release previously hospitalized patients who will need subsequent social care in their home environment.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **7** | **9** |
| Calculation | Number of cooperating medical facilities | | |
| Number of hospitals involved in the MEHCS project | N/A | 2 | 2 |
| Number of general practitioners' surgeries involved in the MEHCS project | N/A | 5 | 7 |

*Data from the Metropolitan Emergency and Health Care System project*

Due to limited capacity, there was no need to involve additional hospitals in the project year-on-year. Two more general practitioners were involved in the project than in the preceding year.

### Number of alarms handled by the Metropolitan Emergency and Health Care System control centre

This indicator captures the number of (potential) emergencies handled by the emergency care control centre. Either the client presses the SOS button on their emergency care device or an alarm is generated automatically using sensor data (e.g. low battery). All communication and alarm handling is provided by a control centre.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **N/A** | **N/A** | **3 271** |
| Calculation | Number of alarms handled by the MEHCS control centre | | |

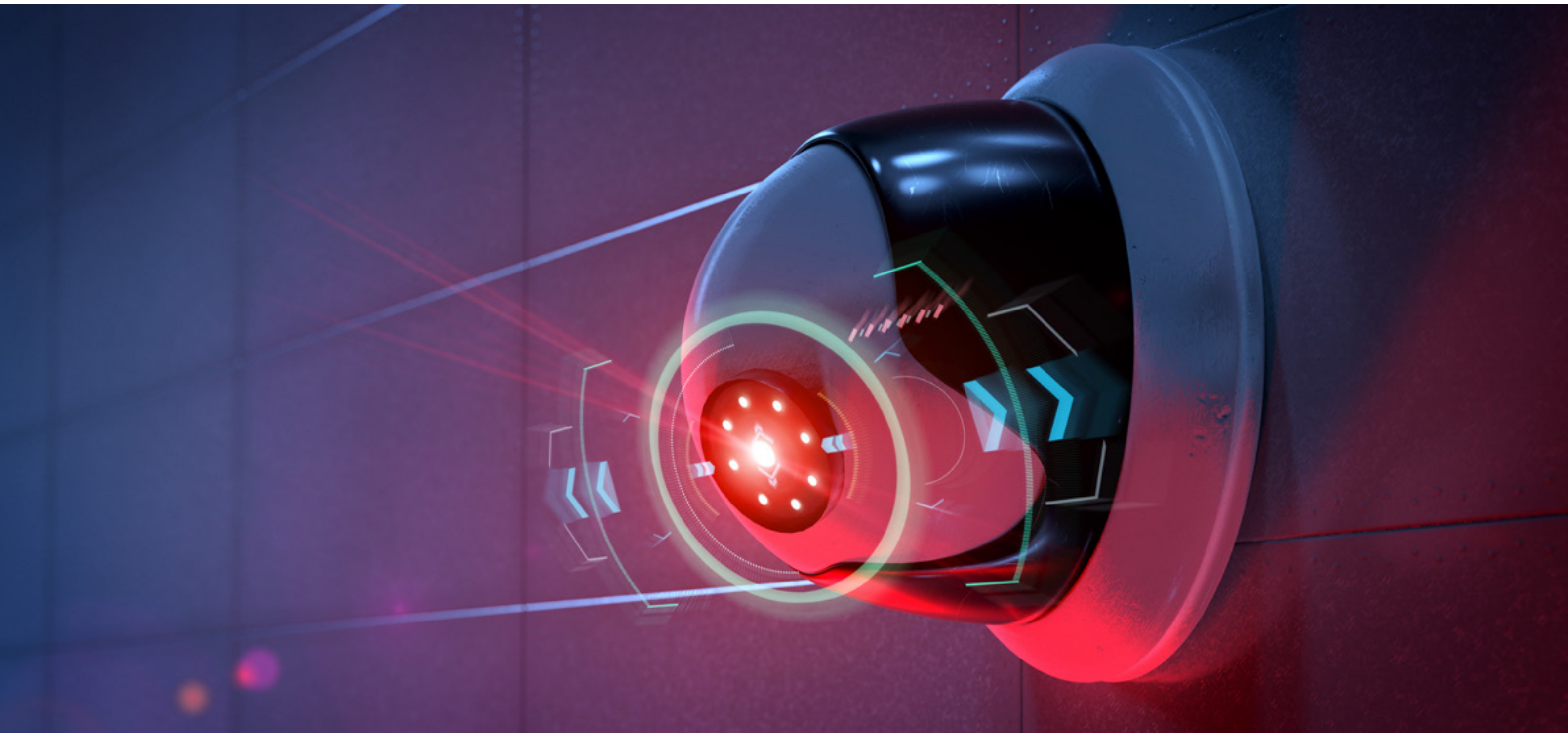
*Data from the Metropolitan Emergency and Health Care System*

Data for this indicator are now available from 2019. The pilot operation of the system began in the autumn of 2018 and there was initially no data collection. The integration of data into the MEHCS took place from May to December 2019. The number of alarms also includes unintentional button presses, device tests and system errors, of which there were 172 in total. Below are the alarm types distinguished under the Metropolitan Emergency and Health Care System.

**Differentiated alarm types:**

- Fall
- Red button
- Low battery
- Regular call to the client
- Data loss
- Connection loss
- Leaving the building
- Leaving a road/path
- Charging time exceeded
- Critically low battery
- Power failure

## ONLINE DETECTION OF RISK PHENOMENA



The longer-term goal in this area is to launch an intelligent system that would automatically provide real-time alerts for crime and other emergencies in the city 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 emergencies in Prague Capital City), the system could determine the places and times with high probability of crimes and other emergencies, and recommend timely safety measures (e.g. in the field of emergency communication). These technologies could make it possible to prevent risk phenomena and take preventive measures - and not only retrospectively address the consequences.

### SOS Buttons with Communicator

This indicator captures the number of SOS communicators in the city.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **289** | **310** | **316** |
| Calculation | Number of places with SOS buttons with communicators | | |
| Number of SOS communicators for passengers in the metro system | 11 | 11 | 11 |
| Number of SOS communicators for passengers on trams | 278 | 299 | 305 |

*Data provided by DPP*

This indicator included SOS communicators in the metro system and on trams - specifically in the 14 T and 15 T trams, which are equipped with these devices. The ongoing delivery of new 15 T trams in 2019 will provide another year-on-year increase. The stated value of the number of SOS communicators for passengers in the metro system is for the end of 2019, but all 11 information columns in the metro have been switched off and disabled since the start of 2020. The reason for this was the decision that these information columns were already technologically obsolete and a significant part of their information provision functionality is provided by the new ticket machines (145 new machines in 33 metro stations).

Project ideas for the future include a vision for supplementing some suitable urban furniture (parking systems, public transport stops, etc.) with emergency communication functions, as most of these elements already have communication HW installed. One possibility would be to further modify them and add the possibility of their use for emergency communication.

### Smart Camera Systems

This indicator monitors the expansion of automated camera systems.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **72 %** | **72 %** | **72 %** |
| Calculation | Number of cameras connected to analytical software/number of TSK cameras in the MCS | | |
| **Number of cameras connected to analytical software** | **607** | **607** | **607** |
| Video detection in tunnels | 479 | 479 | 479 |
| A comprehensive telematics transport system | 128 | 128 | 128 |
| **Number of TSK cameras in the MCS** | **843** | **843** | **843** |

*Data provided by TSK, a. s.*

The data remained unchanged as no new project has been implemented in this area. The analytical video detection system in tunnels can evaluate - based on software definitions of potential events that may occur in the camera's field of view - the following situations: a stationary vehicle, a slow-moving vehicle, traffic jams forming, an object on the road surface, a person in the tunnel, a vehicle going the wrong way, and reduced visibility.

A comprehensive telematics transport system can detect basic traffic flow characteristics such as average speed, traffic flow status and traffic intensity.

## AI in the Public Space

The Prague Capital City Municipal Camera System (MCS) is being built and constantly expanded as a tool to improve safety in Prague Capital City.

With the adoption of the MCS Construction Concept in 2000, Prague Capital City stated its preference for the extensive development of this metropolitan system by increasing the number of cameras in places with the highest concentration of potential criminals. The expansion and operation of the MCS were also per the Prague City Council Program Statement for 2006–2010 aimed at ensuring the expansion of the camera system into places with high crime levels and increasing the efficiency of the camera system through the introduction of modern programs.

The MCS was and is being built as a technically open metropolitan system into which the cameras of other operators can be integrated. It processes image information from public spaces with the main goal of increasing the safety of Prague Capital City citizens and visitors. 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 |
|---|---|---|---|
| **Resulting indicator value** | **4 679 / 98** | **4 712 / 99** | **4 742 / 99** |
| Calculation | Number of cameras integrated into the municipal camera system (MCS)/number of client workplaces | | |
| **Number of cameras integrated into the municipal camera system (MCS)** | **4 679** | **4 712** | **4 742** |
| Prague Capital City cameras | 1 098 | 1 131 | 1 161 |
| Prague 8 district | 783 | 783 | 783 |
| Electronic fence (monument protection) - Prague 1 | 31 | 31 | 31 |
| DPP, PLC. | 1 825 | 1 825 | 1 825 |
| Technical Road Administration, a. s. | 846 | 846 | 846 |
| Administration of Services of the Prague Capital City | 96 | 96 | 96 |
| **Number of client workplaces** | **98** | **99** | **99** |

*Data provided by the Safety System Technical Provision Department of the Prague City Hall IT Department*

There was a year-on-year increase in the number of Prague Capital City cameras, with another 30 being installed.

**Over the past years, the Prague Capital City Municipal Camera System has become an important tool for:**

**Prevention**
reducing the occurrence of undesirable events in areas covered by installed cameras

**Repression**
people engaged in anti-social behaviour are identified using images from the cameras

**Information gathering**
monitoring demonstrations and other mass events in the city. The information can be used to guide actions and prevent unnecessary conflicts and incidents, as well as to retrospectively analyze the situation if safety interventions proved necessary

**Reducing crime and theft, e.g. car crime**

**Monument protection**
interference with the monitored cultural monument is immediately detected

**Road traffic control and monitoring**
using TSK and DP integrated cameras

Through gradual construction and modernization, the MCS is becoming an effective tool to improve safety in Prague Capital City, a source of information for security and crisis management staff, a means to collect related data, and an assistant for Integrated Rescue System and Rescue Safety System components.

The system is used by 99 Prague Capital City client workplaces - the Police of the Czech Republic, the Municipal Police of Prague Capital City, the Fire Rescue Service of Prague Capital City, the Rescue Medical Service of Prague Capital City, the Operational Center of the Crisis Staff of Prague Capital City, Prague City Hall, Technická správa komunikací hl. m. Prahy, a.s., and Dopravní podnik hl. m. Prahy.

The MCS already has a strong and secure infrastructure. However, new trends in CCTV (closed-circuit television security systems), in IT (information technology), and SW and HW, mean the whole network needs to be continuously modernized and developed.

Its uninterrupted operability and gradual modernization are ensured on a contractual basis by the Safety System Technical Provision Department of the Prague City Hall IT Department.

In contrast to the extensive development from 2000, when the main focus was the number of installed cameras, there is now a gradual transition to an intensive development, meaning the strengthening of infrastructure and data storage.

The further development of the camera system will take place following the Development and Operation Concept for the Prague Capital City Municipal Camera System for 10 Years, approved by Prague City Council on 20 October 2016 through Resolution No 20/51 (publicly accessible at www. praha.eu).

In the future, the indicator will monitor and evaluate the qualitative aspect of MCS development.


This area addresses the extension of the functionality of urban furniture through the use of network connections, sensor systems, IoT functionalities, and urban mobile apps.  Work is being carried out to ensure that the installed technologies are energy self-sufficient (e.g. power supplied through solar panels), and that their functionality is not conditional on connection to a power supply. The capital will gain a valuable platform of accurate data to help effectively target urban interventions by measuring the quality of Prague's air and collecting accurate and up-to-date information on it through stationary and mobile sensors built into urban furniture, as well as by involving Prague residents in active data collection. There will also be new functions in the urban space (e.g. Wi-Fi, information boards, mobile device charging).

## Measuring the State of the Environment in Public Space

This indicator monitors the number of measuring stations providing environmental quality information. Data from measuring stations and sensors provide valuable information to the city and its citizens and visitors, and also serve as a source of open data.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | 100 | 104 |
| Calculation | Number of sensors or stations measuring the state of the environment in public spaces | | |

*Data from TSK, from the Prague 5 district website, from the smart furniture operated by OICT, a. s., THMP, a. s., and other available sources*

This indicator monitors sensor-based measurements of environmental variables in public spaces, including where the sensor carrier is, for example, a public lighting post, urban furniture and so on. In 2019, the indicator included 43 sensors in smart lights in Karlín (the Smart Lights PLUS project with a sensor network), 8 smart benches providing environmental measurements, 1 noise sensor in Prague 5– Smíchov, 3 noise sensors in the Prague 3 district, 11 SMIGHT smart lamps, 22 TSK weather stations, and 16 automated CHMI stations.

## City Coverage by Stations Measuring Environmental Quality

This indicator monitors the density of the network of stations measuring environmental quality.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | 0,1855 | 0,1935 |
| Calculation | % coverage of the city with measuring stations for evaluating the environmental quality | | |

*Source: Own calculation from previously available indicators*

This indicator monitors sensor-based measurements of environmental variables (e.g. air pollution, pollutants) in public spaces, including those where the sensor carrier is, for example, a public lighting post, urban furniture and so on. The resulting value gives the number of stations per km$^2$ in Prague Capital City (a total of 496 km$^2$). A prerequisite for the further expansion of the station sensor network measuring environmental quality in the future is the preparation and application of a concept for placing environmental sensors in public spaces. Data on the number of stations focused on precipitation is provided by the Use of Rain Gauges indicator in the Waste-free City area.

## Smart Furniture

This indicator describes the quantity of smart furniture in the city.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | **0,1089** | **0,4435** | **0,3569** |
| Calculation | Quantity of street furniture providing a Wi-Fi signal, enabling the charging of personal electronic devices, and using data collection sensors/city area. | | |
| **The total quantity of street furniture providing a Wi-Fi signal, enabling the charging of personal electronic devices, and using data collection sensors** | **54** | **220** | **177** |
| Smart lamps | 3 | 100 | 100 |
| Smart benches | 10 | 10 | 10 |
| Smart waste containers | 41 | 110 | 67 |
| **City area** | **496 km$^2$** | **496 km$^2$** | **496 km$^2$** |

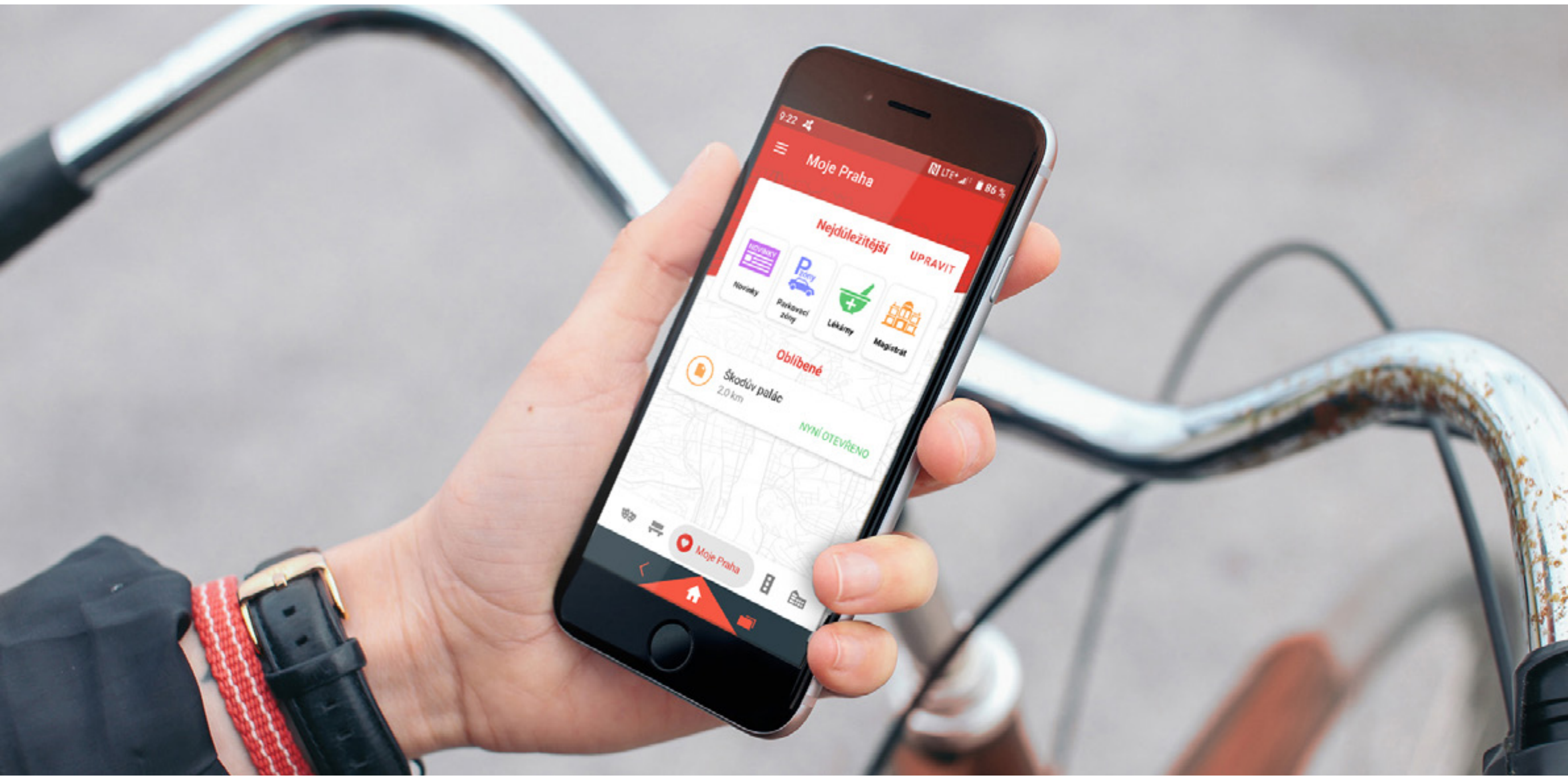
*Data based on the quantity of smart furniture operated by OICT, PCH and other Prague Capital City city districts*

## Energy Self-sufficiency of Furniture

This indicator monitors the ability of urban furniture to generate electricity for its own operation.

Data are not available due to the absence of electricity meters in individual smart furniture units. Separate public surveys of different types of smart furniture have shown that the elements have generally been welcomed by the public. The charging functionality (and e.g. internet connection) was usually used until the installed batteries were completely discharged. Hybrid systems connected to and recharged from the public grid would have greater usage potential.

# URBAN ENVIRONMENT IN MOBILE PHONES




## My Prague Mobile App

My Prague mobile app aims to make it easier for all citizens to find their way around the city. The app was developed to offer as much relevant and up-to-date information as possible to make life in Prague as easy as possible for everyone. Hence the app offers essential information from public spaces about parking zones and parking payment options, traffic information, cultural news, and of course also contact details and opening hours for the authorities, and other practical information.

**What can you find in the My Prague app?**

- **Parking zones and convenient ways to pay for parking**
- **Overview of P+R car parks and traffic cameras**
- **Contact details and opening hours of municipal authorities in Prague**
- **Lists of city police offices**
- **Contact details and opening hours of collection yards**
- **The offer of cultural events**
- **Current weather conditions**
- **Lists of pharmacies, playgrounds, parks and public toilets**
- **The most important emergency telephone numbers**
- **It is of course also possible to perform searches and display a map that enables navigation and can save individual places as favourites**
- **The app also serves as a signpost for other apps offered under the auspices of Prague Capital City**

This indicator monitors the total number of users of the My Prague mobile app

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| Resulting indicator value | 0 | 78 420 | 88 054 |

*Source: Operátor ICT, a.s.*

My Prague mobile app was launched in January 2018. The number of users increased by almost 10 000 between 2018 and 2019.

### Změňte.to (Change.It) Municipal 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, and in other cases, the user receives a response within 30 days. 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 |
|---|---|---|---|
| Resulting indicator value | 0 | 20 984 | 28 993 |

*Source: Operátor ICT, a.s.*

The number of users increased by almost 8 000 between 2018 and 2019.

## URBAN FARMING TECHNOLOGY

Few of us concern ourselves with the ecological (carbon) footprint of food. Food is usually imported over long distances - especially in Europe - by road which, in addition to the considerable quantity of fuel consumed, also generates a significant quantity 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, offers water retention capacity, and contributes towards more gradual evaporation of rainwater. 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's 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 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. According to data obtained from the website KOKOZA, o. p. s., (mapko.cz) there were 6 green roofs (ČSOB Radlická, the OC Nový Smíchov shopping centre, Central Park Praha, Hotel InterContinental Praha, and the National Museum of Agriculture) in Prague in 2019. As of 31 December 2019 there were 43 community gardens in Prague Capital City. In Paris, for example, a roof garden of up to 14 000 m$^2$ for the growing of fruit and vegetables should be created in 2020 - such a garden could generate around a tonne of food a day in the peak season. Flat roofs in cities represent untapped potential and Prague has a lot of room for change in this respect, both in terms of cultivation activities and state-of-the-art farming.

Concerning sustainability, visions of the use of hydroponics and aquaponics appear among the project ideas for the future.

These are forms of agriculture where the classic substrate (soil) is not used for growing plants. In hydroponics, a different medium is used instead of a substrate - such as water, as the name suggests - and the nutrients that plants need are transferred through this. This solution is also applicable in greenhouses and places with otherwise poor quality soil. Aquaponics can also use wastewater from fish farming as a source of nutrients, with suitable bacteria converting it into nutrients usable for plants.

## Urban Farming in Public Spaces

The area provided for urban food generation.

The equivalent of over 5 football pitches.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | Around 22 000 m² | N/A | 40 000 m² |
| Calculation | The total area of community gardens in Prague Capital City | | |

*Data provided by KOKOZA, o. p. s.*

This indicator provides information on the total area of registered community gardens in Prague. The available values clearly show that the area covered by community gardens is increasing. This increase is, among other things, attributed to the trend of temporarily unused land being used in a meaningful way. Czech Union of Allotment and Leisure Gardens land is not included in the indicator.

## Grower communities

This indicator captures the number of grower communities in Prague Capital City.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 18 | 27 | 43 |
| Calculation | Number of community gardens in Prague Capital City | | |

*Data provided by KOKOZA, o. p. s.*

It has been shown that there are more and more active people setting up gardens and grower communities. Enterprises and city districts have also begun setting up community gardens in recent years. Currently, up to 5 grower communities with their own gardens are created every year. Czech Union of Allotment and Leisure Gardens gardens are not included in the indicator.

An overview of grower communities is also available on the website with a map of community gardens at https://www.mapko.cz/. The map is also a community project and individual grower communities can add their profiles there (the overview may not always contain completely up-to-date data for this reason).

## Community Gardeners

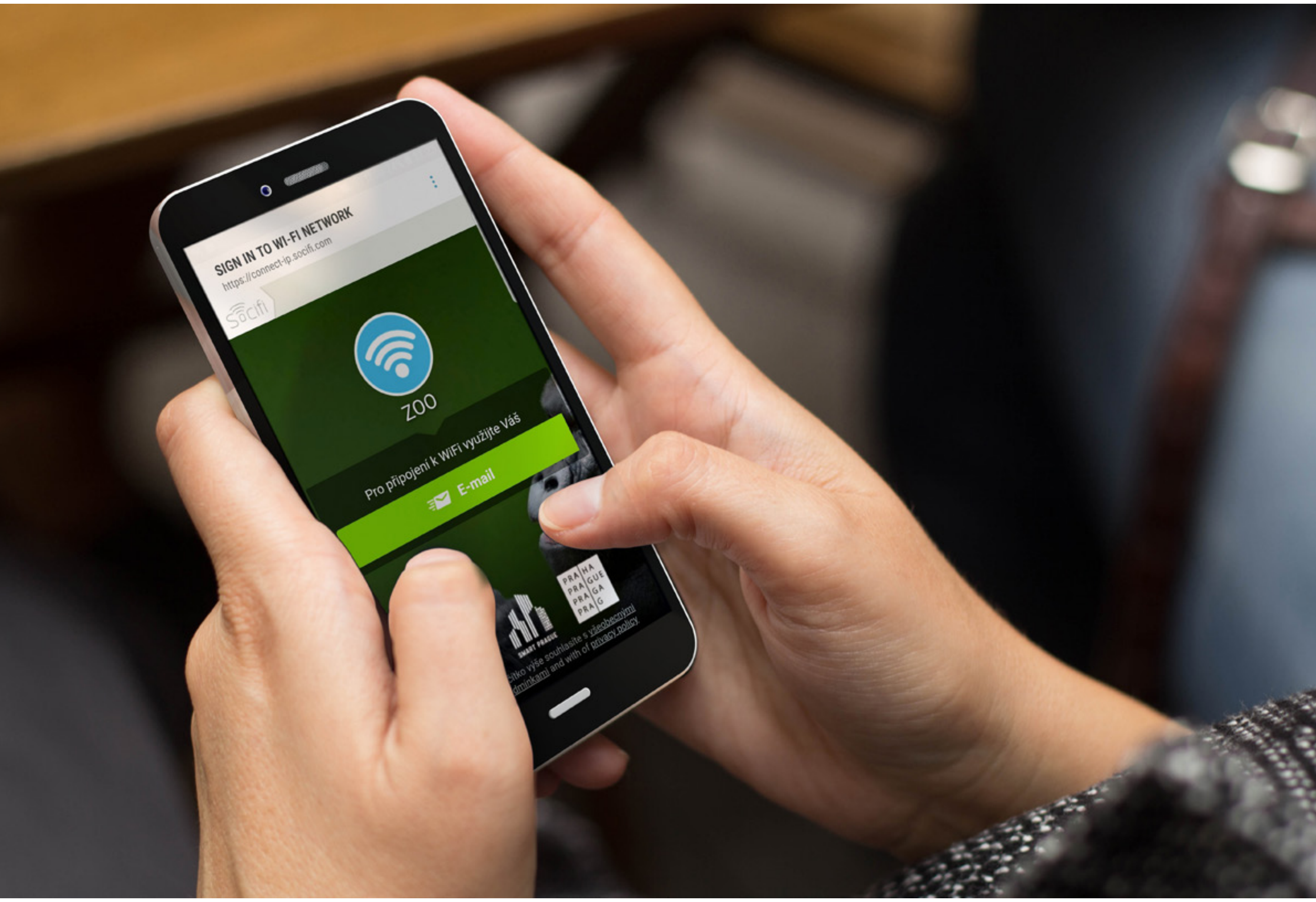
This indicator captures the number of community gardeners.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | 251 | N/A | 836 |
| Calculation | Number of community gardeners farming in community gardens | | |

*Data provided by KOKOZA, o. p. s.*

The increase in the number of community gardeners shows that the demand for community cultivation in Prague is growing, and we can anticipate that this trend will continue in the future. Czech Union of Allotment and Leisure Gardens members are not included in the indicator.

## OTHER RELEVANT INFORMATION




This sub-area includes indicators that help give a comprehensive picture of the urban environment in Prague. It is mainly devoted to indicators related to the possibility of using a public Wi-Fi network.

### Public Wi-Fi Hotspots

This indicator monitors the availability of the city's Internet connection using public Wi-Fi hotspots.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | 172 | 172 |
| Calculation | Number of public Wi-Fi hotspots | | |

*Data from the website of the supplier VERB Group and smart furniture operated by Operátor ICT, a.s.*

The value did not change year-on-year - no new development activities took place in this area last year. The number of access points to the public Wi-Fi network in Prague was last expanded in 2018 to include the Petřín area, Prague Zoo and Botanical Gardens, and Karlín.

12 public Wi-Fi hotspot access points were installed in Petřín, 83 in Prague Zoo and 38 in the Botanical Gardens. The Karlín area was covered with a total of 30 access points located in smart lighting elements. There are also 9 access points installed in smart benches.

### City Wi-Fi Coverage

This indicator monitors the theoretical percentage of the city covered by a public Wi-Fi signal.

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Resulting indicator value** | N/A | 0,34 % | 0,34 % |
| Calculation | % of the city covered by a public Wi-Fi signal | | |

*Source: Own calculation from previously available indicators*

One access point in open space has a range of a square with sides of at least 20 x 20 m, so 172 access points can provide a theoretical range of approximately 68 800 m$^2$ = 0.0688 km$^2$. Prague Capital City, with an area of 496 km$^2$, has achieved coverage of up to 0.34% of its territory through the public Wi-Fi network.

The value did not change year-on-year as no new development activities took place in this area last year.

### Revenue from Commercial Wi-Fi Use

This indicator was created to monitor revenues from the commercial use of Wi-Fi hotspots owned or operated by the city.

However, the indicator has not been quantified for some time and the question remains whether the situation will change in the future in this respect. Public Wi-Fi hotspots are primarily monetized by collecting user data, which can be crucial for the city and its decision-making. The commercial use of hotspots does not play a primary role. Data about connected devices (connection time, platform but also, for example, country of origin, etc.) are monitored. For example, through these devices, it is possible to send information or direct their users appropriately using so-called captive portals. This is a benefit in information terms.

Another influence determining the future of public Wi-Fi networks may be the further development of IoT technologies and, among other things, the planned transition to 5G mobile network technologies.

# 6. DATA AREA

## GOLEMIO DATA PLATFORM

The Golemio data platform is a tool for working with data in the city environment. The data platform is intended for anyone who is looking for or needs up-to-date and reliable information about the city. The goal of the Golemio data platform is to provide quality IT services to City Hall, city districts and municipal companies in the field of data processing (e.g. integration, storage, visualization and provision).


*Figure 8: The Golemio website*

The Golemio data platform can work with any type of Smart City data, such as information on air quality, waste, numbers of cyclists and pedestrians, energy intensity, vehicle location, parking space occupancy, weather and more.

The Golemio data platform enables the provision of various services, such as receiving or the active downloading of data, their storage, transformation, management and access according to defined conditions (open data), visualization, reporting and alerting, through to the deployment of a BI solution. BI (Business Intelligence), for example, enables a better understanding of what is happening in the city, when information is obtained from gathered operational data of information systems, which then enables the city to make better strategic and operational decisions.


With a team of experienced experts, the Golemio data platform can provide technical consultation in all relevant areas, consultation on the creation of assignments and tender documentation, design metrics and KPIs, and provide analysis and other data-related services.

The Golemio data platform is thus an ideal complement to standard supplier systems (e.g. IoT platforms covering sensor networks, etc.), where the primary data collection is provided by the supplier, with DP Golemio then integrating and storing the data and allowing other operations to be performed. Golemio enables the concentration of data from various providers across Prague and then makes them available to other parties (the public) through the My Prague and PID Lítačka apps or data analysis on Golemio.cz, as well as to city representatives, city districts and companies through the client panel. The data can also be used by developers through APIs.

Last but not least, the Golemio data platform is also a label for open source software, the source code of which has been freely available to the public since October 2019 on the server https://gitlab.com/operator-ict/golemio.

## 2019 PRIORITIES


The Golemio Data Platform project was launched on 1 January 2018 on the Cisco Kinetic for Cities platform, with the first phase being primarily verification of the concept and a search for possible uses within the urban environment. An extensive analysis of user requirements was performed in the same year based on experience with the pilot operation. This analysis showed that it was especially necessary to improve variability and modularity to meet the needs of the city, city districts and companies. This also showed the need to create a custom solution, developed in-house based on open source components.

In 2019, the data platform focused on the development of its own software solutions and data analysis for specific users at Prague City Hall, city districts and municipal companies. Since September 2019, the Golemio data platform has been also functioning as an open data coordinator for Prague City Hall, thus helping citizens gain a more detailed overview of the functioning of their city. In October 2019, the Golemio data platform was made available to the public as an open-source solution under the MIT License, and in November 2019 it won the Open Source category in the Together We Open Data 2019 competition held by the OSF Foundation.

**The source code and documentation are available from GitLab:**

https://gitlab.com/operator-ict/golemio https://operator-ict.gitlab.io/golemio/documentation/

The Golemio data platform and its team of consultants and analysts provided Prague City Hall, city districts, municipal organizations, contributory and other organizations with a range of Smart City data processing services. These services include:

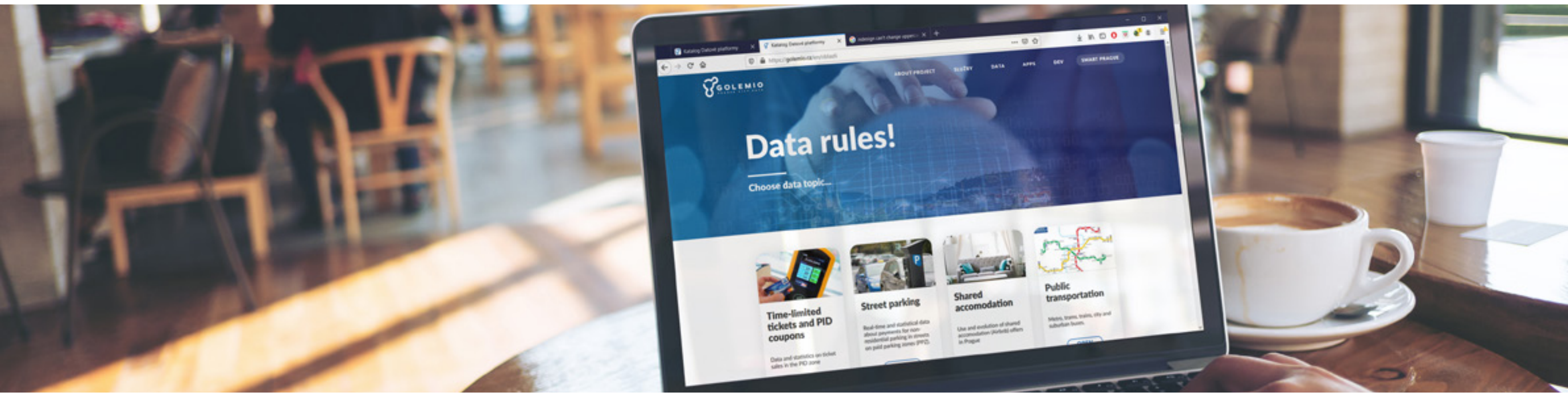
- consultation before and during a project
- integration and storage of data from existing supplier platforms
- processing and providing data to other partners or in the form of open data
- data visualization (BI dashboard, map-based visualization, graphs etc.)

The involvement of the Golemio data platform team in the Smart City project makes it possible:

- to consult the partner's intention - what they want to achieve, what will be beneficial for the inhabitants of the city, and potentially to draw attention to the risks and typical shortcomings of the data in the intention itself if the intention appears functional, effective and economical, yet 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 intention, what demands it may place on the existing city infrastructure (optical network, public lighting, municipal camera system etc.) and how to use it appropriately,
- to help pilot test the technologies to assess their ability to meet the requirements,
- to help define tender conditions in two areas:
  - own technology (e.g. HW) fulfilling the goals of the client,
  - data access requirements for the client, subsequent connection to the data platform, and data transfer (SLA, API, vendor lock),
- to consult the details of the data connection to the Golemio data platform with the supplier,
- to integrate data, process them, create visuals, and to perform reporting, alerting, and history retention (data warehouse).

The importance of the Golemio data platform lies in the provision of services, in the methodological area based on the good practice of the DP team, summarizing not only acquired knowledge and specifications regarding general requirements or anti-vendor-lock-in, and also data access requirements and general interface specification.

## GOLEMIO DATA PLATFORM CATALOG




The Golemio data platform catalogue was launched on 20 June 2018, and some datasets also include the processing of expert analyzes on the issue in question.

As one example of the analyzes that became the basis for expert debates, we might mention the Airbnb Shared Economy Analysis, where the development and use of services were monitored, allowing the user to find numbers on occupancy percentages, median and average prices per night, the number of new or - on the contrary - terminated accommodation offers, etc.

The Green Roofs Analysis was another analysis through which the DP indicated large and untapped potential in the buildings of Prague Capital City. The DP team calculated it would be possible to build up to 140 ha of such roofs on buildings owned by the city and city districts alone, approximately equal to two Stromovka parks. The data shows that under ideal conditions up to 1 659 ha of green roofs could be installed in Prague.

The analyses are available for download at https://golemio.cz/en/oblasti.

## GOLEMIO WEBSITE TRAFFIC

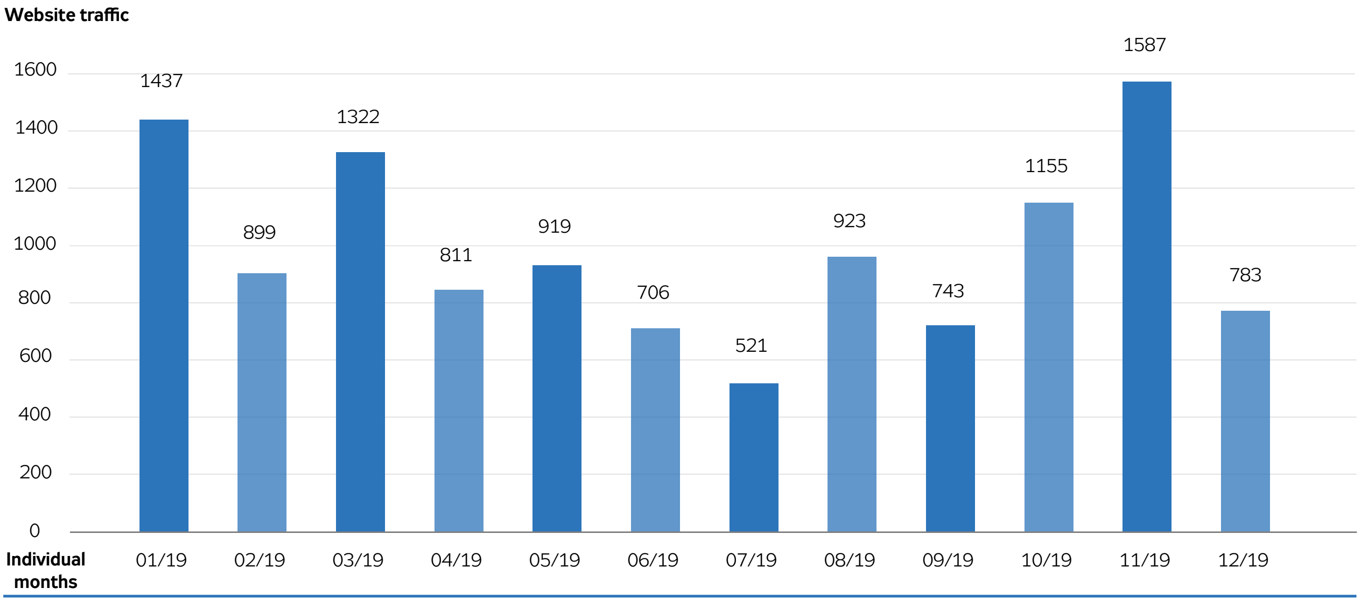
One indicator that significantly affects traffic to the Golemio website is the various data workshops and competitions associated with the development of user (mostly urban) apps that can be created over this data. Selected apps and projects from community users are often created as part of hackfests, in which programmers, analysts, software architects and web designers work on a joint software project. Some outputs using Golemia data related to dashboard or app designs are presented and described on the Golemia website.
More at https://golemio.cz/en/node/203.

### Golemio Website Access Statistics

The resulting indicator value shows the total number of visits in 2019. A visit means a period during which a user is actively engaged on a website, app, etc.

| | 2018 | 2019 |
|---|---|---|
| **Resulting indicator value** | 9 840 | 11 806 |
| Calculation | Sum of visits for individual months | |

## Golemio.cz website traffic in 2019




*Source: Google Analytics*

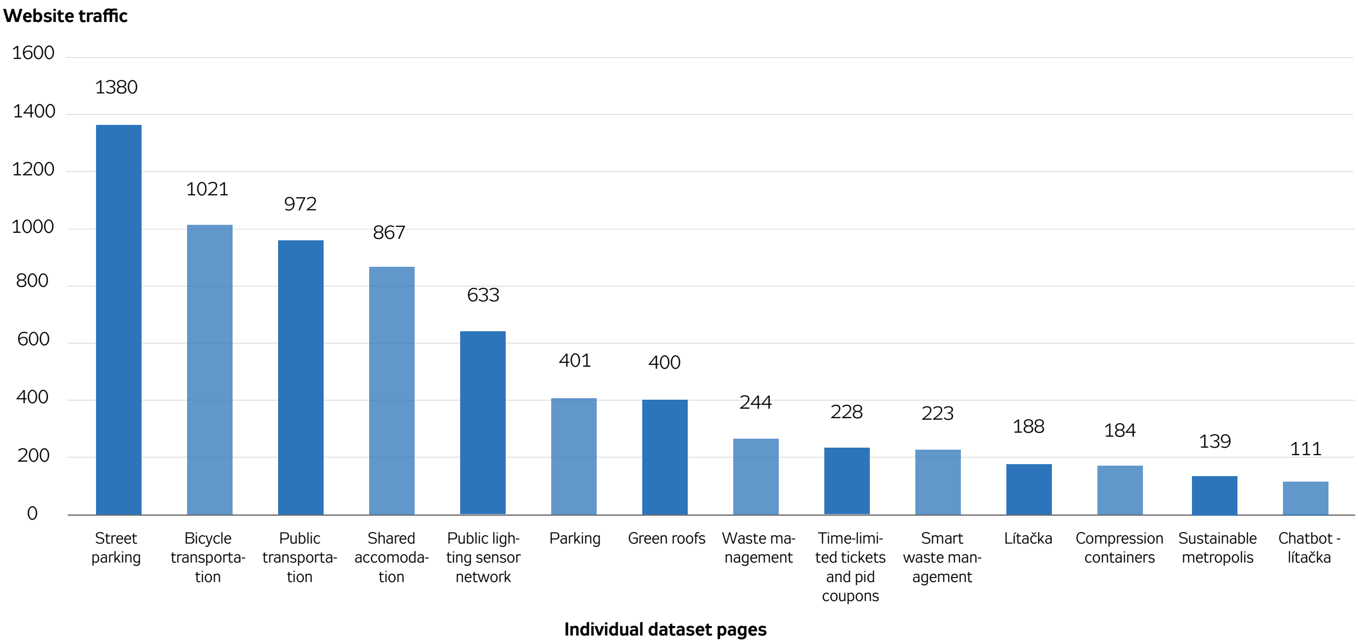
## Traffic to individual pages of the Golemio website

The Golemio website statistics clearly show that there is still most interest in data on mobility, specifically parking, which is a challenge for every city, but also bicycle and public transport.

Data on traffic to individual pages in 2019 show us unique page views and represent the number of visits during which a specific page was displayed at least once. Unique pageviews are calculated for each combination of page URL and page title.

| | 2018 | 2019 |
|---|---|---|
| Resulting indicator value | 6 950 | 6 991 |
| Calculation | Sum of unique visits | |

## Traffic to individual pages of the website in 2019




*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 autumn of 2019.

| | 2018 | 2019 |
|---|---|---|
| **Resulting indicator value** | **93** | **101** |
| Calculation | Sum of visits by month | |

### Number of Golemio Client Panel App Users

The Golemio Client Panel app has been created for some users, especially from Prague City Hall, the mayor's office, city districts and some municipal organizations - this displays data from the Golemio data platform in a single location in the form of interactive dashboards or on a map and almost in real-time. The app was launched in the autumn of 2019.

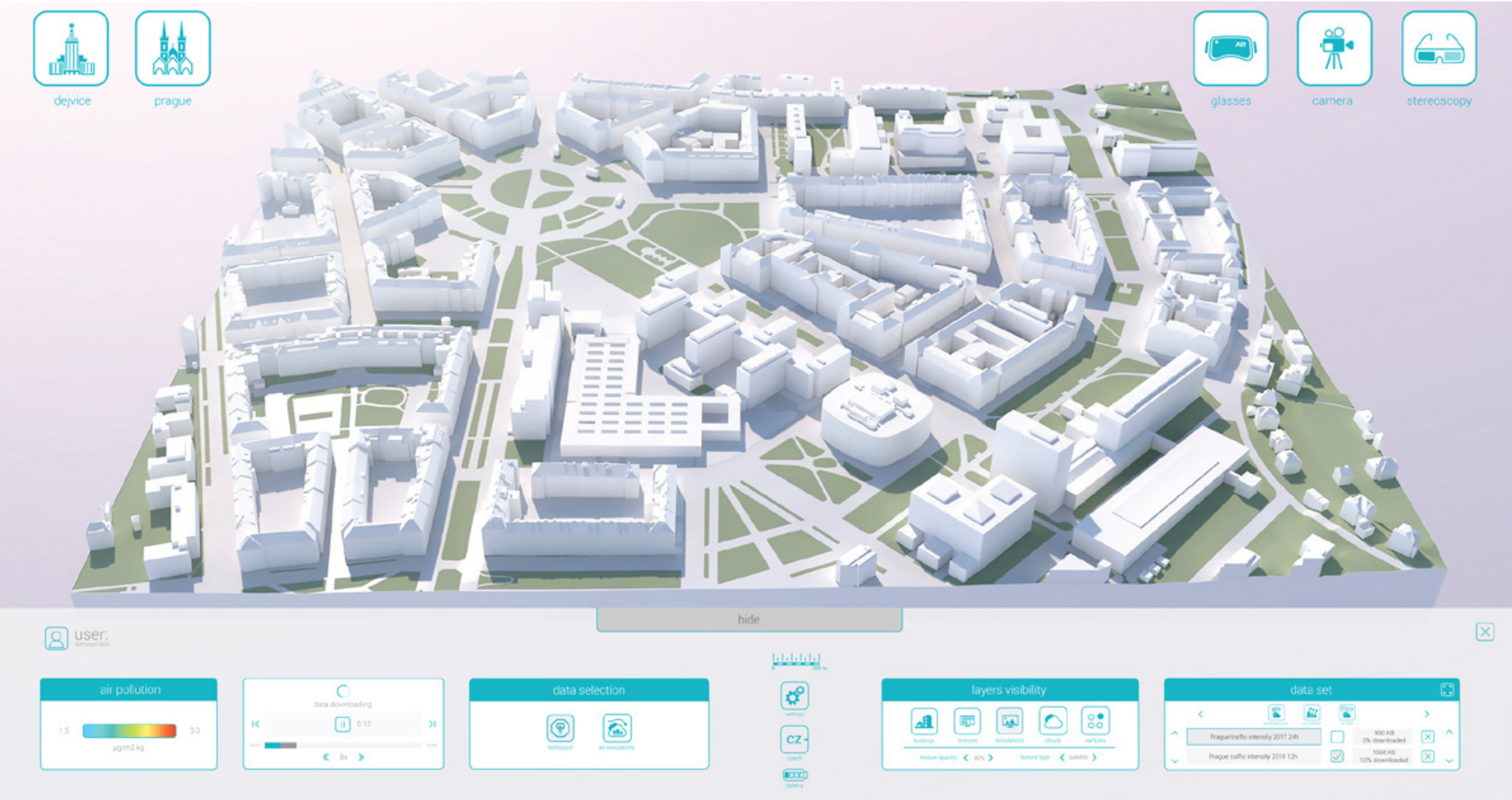
| | 2019 |
|---|---|
| **Resulting indicator value** | **68** |
| Calculation | Sum of visits by month |

## PRAGUE CITY DATA CONGRESS


One of the important Golemio data platform team projects is the Prague City Data Congress expert conference. This focuses on data in the urban environment, both in terms of data generation and their use in the functioning of the city. 2019 was the second year of the project and offered a significantly expanded program, with speakers such as Ira Winder (MIT), Ekim Tan (Play the City), Michael Woodbridge (New Cities), and Ross Douglas (Autonomy, Paris).

| | 2018 | 2019 |
|---|---|---|
| Number of speakers | 21 | 33 |
| Number of visitors | 130 | 280 |

# VIRTUALIZATION OF PRAGUE PROJECT




2019 saw the third phase of the Virtualization of Prague (VP) pilot project, which addressed the connection to the new Golemio data platform solution. The datasets were selected to cover a wide range of different types of graphic display (points, lines, polygons, etc.) so that in the future it will be possible to connect additional datasets without or with only minimal programmer intervention. The visualization of the new datasets in the 3rd phase took place gradually as the datasets were migrated from the original to the new data platform solution.

To promote both the project and Prague, the Virtualization of Prague (VP) system was presented at the following domestic and international events and conferences:

- introduction of the VP system to students at the Faculty of Architecture of CTU in Prague (March 2019)
- presentation of the VP system to foreign students from Tilburg University, the Netherlands (March 2019)
- presentation of the VP system to foreign students from Technological University Dublin, Ireland (March 2019)
- Future City made by IoT conference, CIIRC (April 2019)
- presentation of the VP system to foreign students from the University of Texas at El Paso, USA (March 2019)
- 2020 Cities (May 2019)
- Prague City Data Congress (May 2019)
- Forbes Next Big Thing (September 2019)
- Eastern Partnership Conference at Prague City Hall (November 2019)

The VP system was also gradually introduced to potential users and cooperating entities from the public sector and the academic sphere, e.g. representatives of the Prague 6 city district, the Fire Rescue Service of Prague Capital City, the team for Smart Cities at the National Center of Competence - Cybernetics and Artificial Intelligence, Faculty of Architecture of Czech Technical University in Prague, Faculty of Transportation Sciences of Czech Technical University in Prague, Faculty of Civil Engineering of Czech Technical University in Prague, and Institute of Computer Science of the Czech Academy of Sciences.

Further development of the Virtualization of Prague system depends on the requirements for its use by Prague Capital City, municipal organizations and other potential users. For this purpose, a vision for a routine operation has been prepared, defining the main directions of future use of the Virtualization of Prague system:

- creation of Prague Capital City digital twins in cooperation with IPR
- modelling and simulation in urban planning, transport, environment, energy, etc.
- a tool for communication with the public
- use of the VP system for the Prague Fire Rescue Service
- evaluation of transport quality using outputs from the GLOMODO project - Global Transport Model in Prague
- visualization of Smart Prague project results
- cooperation with the forthcoming Center of Excellence for Smart Cities and Regions
- cooperation in the Chytrá Evropská (Smart Evropská Street) project
- a platform for involving the commercial sector in cooperation with the city (e.g. developers, mobile operators)
- implementation of other use cases

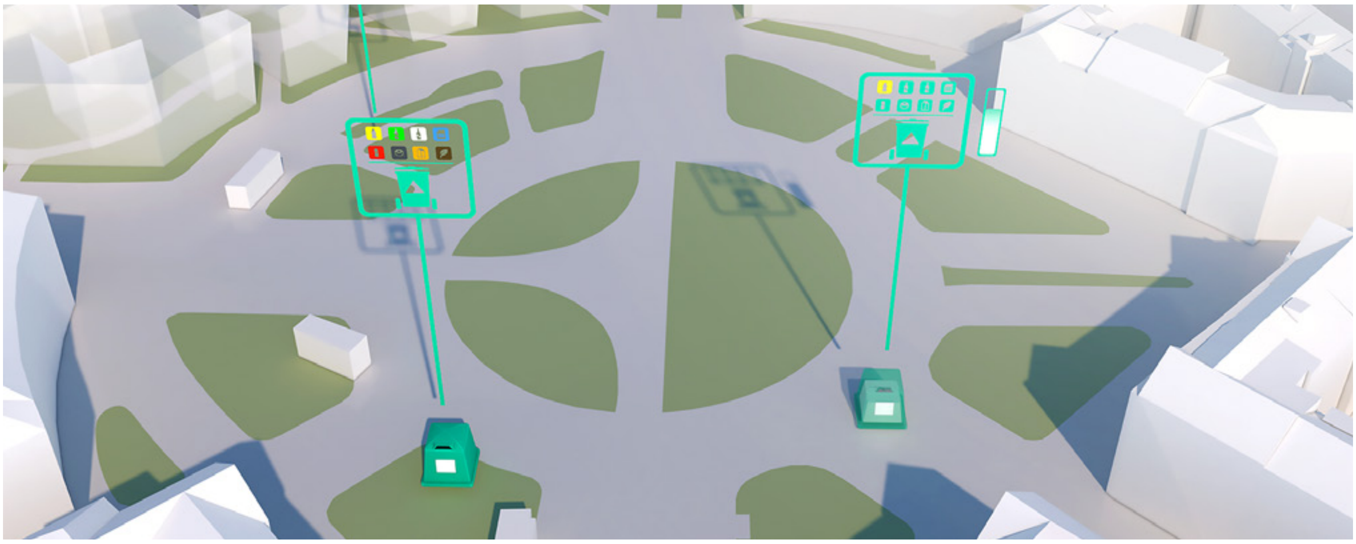
## Visualized Datasets

This indicator expresses the number of implemented datasets showing historical, real-time, predicted and simulated data.

| | 2018 | 2019 |
|---|---|---|
| **Resulting indicator value** | **9** | **18** |
| Calculation | Number of visualized datasets | |
| Total number of datasets | 9 | 18 |
| Historical data | 4 | 6 |
| Real-time data | 3 | 10 |
| Predicted data | 0 | 0 |
| Simulated data | 2 | 2 |

In 2019, the system was connected to the following Golemio data platform datasets:

- meteodata (pollutants, humidity, noise) from sensors in Karlín (real-time and historical data)
- P+R car park capacity (real-time and historical data)
- stills from traffic cameras (updated every minute)
- city administration:
    - Prague City Hall buildings
    - city district offices
    - municipal police stations
- locations and fullness of containers for sorted waste (real-time)



# 7. IESE CITIES IN MOTION INDEX

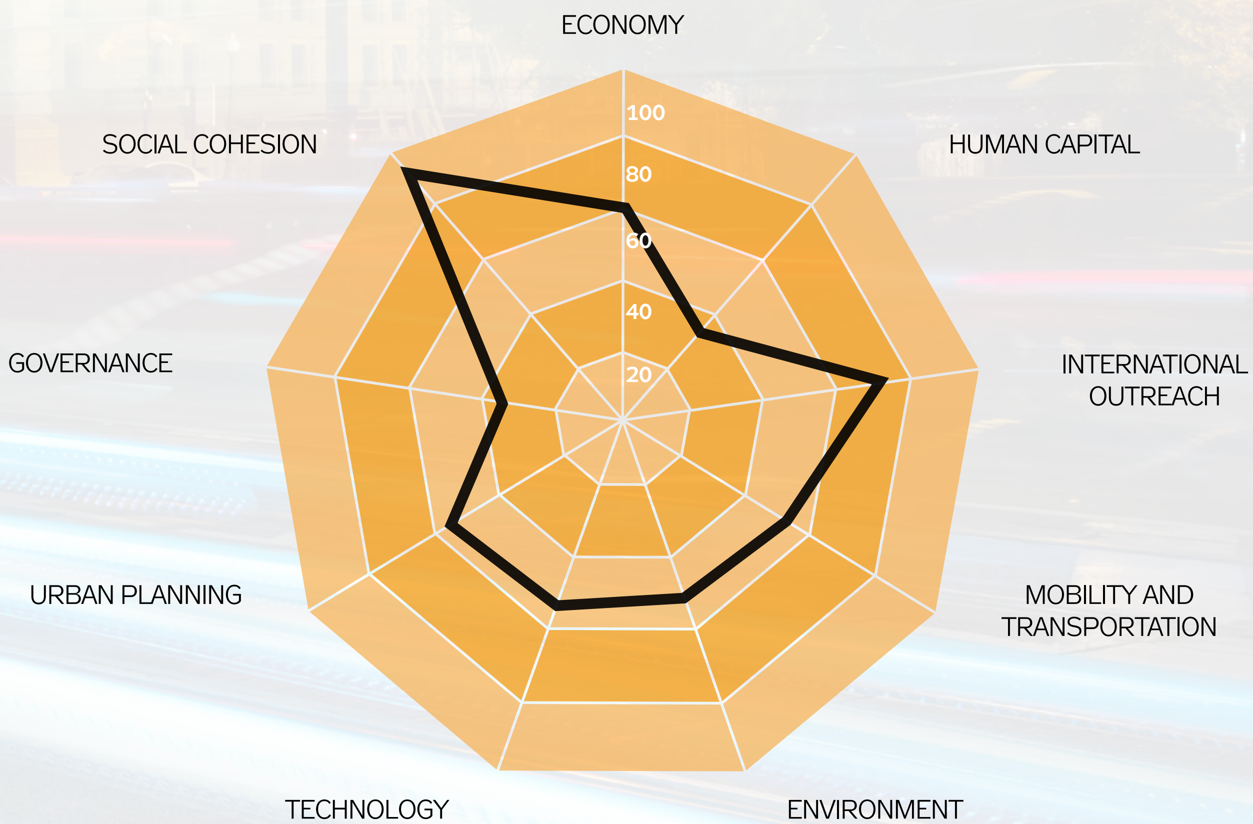
## IESE CITIES IN MOTION INDEX

Since 2014, the IESE Cities in Motion Index (CIMI) has been published by the IESE Business School Center for Globalization and Strategy and the IESE Department of Strategy at the University of Navarra. In this, the project's sixth year, the capital of the Czech Republic ranked 47th out of a total of 174, a slight decline compared to the previous year. Although Prague fell a few places, its CIMI rating rose from 63.85 in 2018 to 64.97. Nine more cities were also included in the evaluation than in 2018. As in previous years, however, Prague retained its first place in the Top Five of Eastern Europe, followed by Tallinn, Warsaw, Bratislava and Budapest.

We would first state that the CIMI compares the sustainability and quality of life of citizens in cities, evaluated on the basis of a mutual comparison of individually defined indicators divided into nine thematic areas. The overall evaluation of a city over all these areas determines its relative position in comparison with other cities and thus the overall rank of that city. The CIMI is a very comprehensive, globally known and widespread indicator of urban maturity, linked to Smart Cities measurements since its inception. A new indicator was added in 2018 relating to the introduction of ISO 37120 certification in urban processes. The city's certification is an indication of its determination to improve its services and improve the quality of life of its inhabitants. The essence of the complexity of the CIMI is the balance it has achieved among all its components. This can be understood as meaning that it will be very difficult for cities to become smart if they perceive modern technology to be the major Smart City element yet do not take other important topics and the individual needs of the city into account.

The CIMI is also developing in tandem with the development of the cities themselves - the number of indicators has again risen, to 96 from 83 last year. For example, the following Social Cohesion indicators have been added: Female-friendly - which measures the friendliness of the city environment for women on a scale of 1 to 5, Suicides - the number of suicides, Murders - the number of murders. The following indicators were added to Economy: Uber - whether the Uber service is operated in the city, Salary - hourly wage, and Mobility and Transportation: Vehicles - the number of commercial vehicles in the city. Some indicators have been replaced with others or slightly modified, for example, the number of AppStore branches in a city is no longer evaluated, unlike in the CIMI for 2018.

A spider chart was created for each of the 174 cities, visually showing 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 Modeling, 2014.




*Source: https://media.iese.edu/research/pdfs/ST-0509-E.pdf?_ga=2.150658550.1753346.1583145012-1976544423.1580990404*

The figure shows that Prague has rather average values in the areas Mobility and Transportation, Environment, Technology and Urban Planning. It has low values in Human Capital and Governance, but high values in International Outreach and the highest values in Social Cohesion.

The table below shows the ranking of Prague Capital City according to the evaluation of the set indicators within the individual themes for 2017, 2018 and 2019. Prague ranked in the top 30 in Social Cohesion, Environment, and International Outreach. A significant improvement compared to the preceding year was achieved in Urban Planning, with Prague moving up 13 places. On the other hand, the largest decline (by 28 places) was recorded in Technology, which could be largely due to a change in the evaluated aspects. The following metrics were no longer evaluated: Facebook - number of registered inhabitants and Apple Store - number of branches in the city. Four new indicators were however added: Web Index - an index that seeks to measure the economic, social and political benefits of the Internet; Telephony - the percentage of households with any type of telephone service; Internet Speed - Internet speed in the city; and Computers - the percentage of households with a personal computer in the city.

| PRAGUE | 2017 | 2018 | 2019 | Comparison between 2019 and 2018 |
|---|---|---|---|---|
| **Economy** | 93 | 82 | 96 | −14 |
| **Human capital** | 73 | 61 | 57 | 4 |
| **Social cohesion** | 5 | 31 | 29 | 2 |
| **Environment** | 14 | 23 | 26 | −3 |
| **Governance** | 114 | 60 | 82 | −22 |
| **Urban planning** | 21 | 94 | 81 | 13 |
| **International outreach** | 16 | 27 | 20 | 7 |
| **Technology** | 105 | 18 | 46 | −28 |
| **Mobility and transportation** | 67 | 66 | 57 | 9 |
| **Overall ranking** | **41** | **40** | **47** | **−7** |

*Source: IESE Cities in Motion Index (2019, 2018, 2017)*

# 8. SUMMARY OF 2019

For 2019, the municipal company Operátor ICT, a. s. (Plc.) prepared the third edition of the Smart Prague Index yearbook which, through almost 130 quantified, tailor-made indicators, provides information on the degree of implementation of innovative projects that contribute to the smartification of Prague Capital City. As in previous years, dozens of partners from the public and private sectors took part in compiling the Index. The result is interesting data that can serve as a basis for decision-making on the direction of other projects falling under the Smart Prague 2030 concept. There are dozens of statistics in Prague, nevertheless, none of them contains summary information that concerns only the Smart Cities area. That is why Operátor ICT, a. s. (Plc.), specifically the Smart Prague Project Office, which is responsible for coordinating activities and implementing Smart Cities projects, has continued to analyze the progress made. The first yearbook, prepared for 2017, provided the first comprehensive set of information on the smartification of Prague. It provided us with the first comprehensive overview of the Smart City area in the capital. We were able to make the first comparisons after the second yearbook, published last year. This year's yearbook builds on the previous ones and gives us useful information on how to move our projects forward. The third edition of the Smart Prague Index confirmed the challenging nature of the collection of disparate data to provide a comprehensive picture of the state of our city. During the 2018 data collection, it was found that many of the values in the 2017 edition were based on one-off studies. The trend also continued in 2019. Data disparateness has also been reported in the most varied competitions and comparisons with other cities within the Smart Cities agenda.

The development of the Smart City concept is also accompanied by a growing need to compare individual cities or sub-projects and share applied solutions - the mutual comparison of cities is made possible through Smart City competitions. There are many such events today, with prizes for the most interesting and innovative implemented Smart City ideas and projects. In the third Smart Cities for the Future national competition, Prague Capital City came first in the Smart City 2019 over 200 000 Inhabitants category with its Smart Waste Collection project. This project also won the Smart City Project 2019 category. The Golemio OICT data platform open source solution was also awarded, winning the 7th annual competition for the best apps based on open data announced by the OSF Foundation. Prague Capital City won recognition in the IMD Smart City Index, which evaluates a city's performance compared to other cities based on the perception of its residents. Prague placed 19th - ahead of London and Madrid. For comparison, Stockholm was 25th, Berlin 39th, Budapest 83rd and Bratislava 84th.

## MOBILITY OF THE FUTURE

As in the preceding year, the area of mobility made great progress. There is clear and significant year-on-year growth in the numbers of electric vehicles. There are now almost two electric vehicles per 1 000 inhabitants on average, and this number is growing every year. The number of shared electric vehicles and hybrid cars is also rising significantly faster than the total number of shared vehicles. The number of fast-charging stations also significantly increased - from 35 in 2018 to 92. However, the ratio of charging stations to electric vehicles fell year-on-year, and there is still a very significant shortage of fast-charging stations. The share of electric vehicles in the total number of registered cars also remains very low. In the future, the creation of an overarching Prague app for intermodal transport and MaaS and activities aimed at significantly increasing the numbers of charging stations should contribute towards increasing the attractiveness and availability of shared mobility. In urban public transport, the share of electric buses in the total number of buses is very low. We can only expect an improvement in this situation through the gradual renewal of the vehicle fleet at the end of the planned service lives of the existing buses. However, the distance driven by electric buses increased more than 2.5-fold year-on-year to 116 660 km. As part of the monitoring of free parking spaces in P+R city car parks, systems recording entry and exit are being expanded, including entry and exit cameras recording vehicle registration plates. This will allow the use of My Prague and PID Lítačka apps for payment. At the end of 2019, the PID Lítačka app became a fully-fledged fare carrier, meaning Prague Integrated Transport passengers can present proof of purchase using only their mobile phones. 290 000 new users installed the PID Lítačka mobile app in 2019. The mobile app became very popular in the very first month after the announcement of the option to transfer long-term coupons to mobile phones, with a record 34 000 users taking advantage of this option. The 72% share of traffic lights connected to the Main Traffic Control Center persists. However, the number of junctions equipped with light signalling devices giving preference to public transport and smart transport infrastructure elements is growing slowly. In 2019 there was once again no progress in the state of readiness of roads for the autonomous driving and testing of autonomous vehicles in Prague traffic. A more significant shift in this area can be anticipated only with the implementation of projects planned for the coming years. The automatic control of metro trains with a driver present remains at 64% of the total number of trains. Fully automatic metro operation is planned for the future line D, which is under construction. Selected open data concerning traffic in the city are available on the Prague Golemio data platform. These are, for example, data for parking, including the fullness of P+R car parks. The ongoing project of an app for intermodal route planning in Prague is building on this foundation to expand the functionality of the connection finder in the PID Lítačka app and, in the future, to also integrate other transport services and payments for them. The estimated number of premature deaths due to pollution increased overall year-on-year. The value for Prague is obtained by converting the estimate for the whole of the Czech Republic to the number of inhabitants in Prague. There was, however, also an increase in the number of days when the highest pollution risk factor - meaning dust particles - was exceeded in Prague, subsequently increasing the risks associated with other factors (NOx, benzo[a]pyrene). Publicly available data from the TomTom index show there has also been an increase in the estimated time spent in traffic congestion. One piece of good news for Prague is the continuing trend in the reduction of the age of motor vehicles registered in Prague.

## WASTE-FREE CITY

The EU has embarked on a stricter fight against waste. It wants to redirect more waste from landfills to recycling and reuse. There should, therefore, be more material use of waste - from 50% by 2020 and up to 65% by 2030. This will be a challenge for Prague, or an opportunity to improve the environment and turn waste into materials while helping economic growth and new job creation. New technologies and innovations will increase the efficiency of sorting and recycling and also support waste prevention. Together with collection companies, Prague Capital City is striving to set up the most efficient network of collection containers for both separated components of municipal waste and mixed municipal waste. Other developed cities in Western Europe are also involved in such efforts and can be compared to Prague. 2019 saw the presentation of the results of the Circular Scan Prague, intended to analyze and evaluate the current situation, and to propose action plans and projects contributing towards a friendlier, cleaner and healthier city. Prague has recognized the potential of the circular economy and considers it a means to achieve its ambition to become a prosperous and resilient city. Households play an important role in waste management - not only because household waste makes up a significant part of a city's total waste generation; they can also significantly influence the generation and cleanliness of individual components of municipal waste through their activities and decisions. The total quantity of municipal waste shows the same growth trend as the number of inhabitants in Prague. In 2019, the total quantity of municipal waste increased by 8 000 t (to 440 900 t) compared to the preceding year. The mixed municipal waste still accounts for a large share of total municipal waste generation, but the growth trend is currently modest. This value can be reduced by consistent application of defined waste hierarchy principles. In 2019, Operátor ICT, PLC. implemented a pilot project called Smart Waste Collection, the main goal of which was to create a tool for the online monitoring of the fullness and yield of selected containers for sorted waste with bottom discharge in selected localities and thus streamline the direction of investment on waste collection. While this project was still running, some city districts already adjusted collection frequency based on the new data, and we can, therefore, anticipate the gradual expansion of this technology. In 2019, mixed municipal waste was mainly used to obtain energy in incinerators (94.08%), while in 2019 the landfilling share was the lowest in the last 3 years (5.92%). A substantial part of MMW often consists of bio-waste (sometimes over 50%), which can be managed both through waste prevention (in the form of composting) and through the separate collection, then processed in biogas or composting plant. In 2019, a pilot project was launched in the Prague 5, 6 and 7 city districts for the collection of kitchen waste (so-called gastro-waste), to minimize recyclable and usable components in mixed municipal waste. Last year, Prague Capital City launched a pilot project for the multi-commodity collection of sorted waste, allowing multiple commodities to be placed in a single container. This collection method is being tested in connection with the planned construction of a new sorting line with an optical sorting system able to sort individual packaging components according to customer requirements. The trend of a slight increase in waste management costs continued in 2019, with these totalling approximately CZK 1.60 billion in 2019. The management of mixed waste makes up the largest part of the costs, followed by the costs associated with the management of sorted waste and the operation of collection yards. Total revenues (including waste fees charged to citizens and EKO-KOM remuneration) covered under 60% of total waste management costs, with the rest paid from the city budget. Another trend is to make maximum use of wastewater as a source of raw materials (e.g. biopolymers, phosphates, nitrogen, ammonia, etc.), energy (e.g. wastewater sludge and heat in sewers) and a source of treated water for further use (e.g. watering, flushing, returning water to the land). Since 2017, the Dešťovka program, run under the Ministry of the Environment and the State Environmental Fund of the Czech Republic, has been providing subsidies for the use of rainwater and wastewater in the home and in the garden to owners or builders of family houses and apartment buildings who want to contribute towards sustainable water management.

## SMART BUILDINGS AND ENERGY

Energy is considered one of the key Smart Prague areas and must be perceived as a complex of areas and activities with impacts on current and future energy consumption. It is important to think about securing energy supply reliability. Most of the energy needs of Prague Capital City are covered through external sources, and long-term outages - especially of electricity - could have serious economic and social impacts. Hence Prague is seeking to cover part of its future electricity consumption with green energy generated, for example, using photovoltaic power plants on roofs and brownfield sites. Electricity consumption in the Czech Republic reached 74 TWh in 2019, equal to the value from 2018. The annual consumption of electricity, heat and gas in buildings owned by Prague Capital City exceeded the consumption of previous years in 2019, reaching over 280 MWh. In buildings owned by Prague Capital City, there was mainly increased consumption of electricity and heat, due - among other things - to the constant updating and completion of the energy management information system. More buildings, more invoices and more data from meters are being registered in the information system. Seven city buildings were added to the energy monitoring system in 2019. In 2019, there was also a significant increase in the numbers of smart meters in energy distributors' networks in Prague Capital City, giving a final quantity of 21 200. Although this is still only a fraction of installed energy meters, the growth trend is still a positive signal for the future of energy management implementation. One problem identified in Prague is the outdated housing stock. The average age of the housing stock in Prague is over 63 years, the highest in the Czech Republic. According to the Czech Statistical Office's Energo 2015 statistics, the consumption of fuels and energies in households in Prague - irrespective of the purpose - consists of 65.2% natural gas and 62.9% purchased heat, while renewable energy sources make up 1.8% of the total quantity. This is the lowest of all the regions. Only 6% of newly started construction was to the passive standard in the Czech Republic in 2019. Public lighting forms an integral part of the energy system of every city. In 2019, the testing of intelligent public lighting continued on projects implemented in the previous period. In 2019, several projects were also planned and prepared, and in the years to come, these will aid the more massive spread of technologies in the field of public lighting. Another trend appropriate to focus on in the area of Smart Buildings and Energy is the reduction of water consumption. Water consumption in Prague Capital City fell to 73.4 $m^3$ per capita per year in 2019. The inhabitants of Prague appear increasingly aware of the value of this commodity and are succeeding in modifying their behaviour accordingly. This trend can be further supported by proper water management and monitoring. In the Smart Buildings and Energy area, an increase was recorded in almost all measurable indicators in 2019, showing that Prague Capital City is paying great attention to energy - technology is gradually being replaced, and the way we work with different types of energy is changing.

## ATTRACTIVE TOURISM

Prague Capital City remains an important tourist destination. In the prestigious Travelers' Choice comparison rating by the TripAdvisor travel server, in 2019 Prague ranked 11th-most-popular global destination after Dubai (UAE), just like last year, and ahead of New York, for example. Tourist numbers in Prague are constantly increasing from the long-term perspective, making Prague one of the most visited cities in the world with around five times more visitors than the actual population of the capital - this makes tourism an important revenue source for the city. Tourist numbers continue to rise year-on-year, but the percentage increase has fallen slightly. Foreign and domestic visitors spent just under 18.5 million nights here in total. The average length of stay was 2.3 nights in 2019, remaining almost unchanged year on year. The very definition of a mass accommodation facility means that guests staying in other types of official and unofficial accommodation are not included (e.g. individual accommodation facilities, Airbnb or free accommodation - staying with friends and relatives). It is important to emphasize that information is only available from official accommodation facilities - unofficial estimates put the real values at up to double this. Tourism requires coordinated and balanced development with the help of innovative technologies. In 2019 there was still a need to sensitively direct tourist flows to relieve congested localities in favour of less busy yet still attractive localities. The Prague Visitor Pass, which has great potential in this respect, should be introduced in the third quarter of 2020 - this is why there are no data for 2019. These data will make it possible to create tourism-oriented heatmaps. The potential of Big Data for the development of tourism is still untapped, as is AI and the automation of the collection and processing of data related to tourism and augmented reality. Currently, the only source of data used for managed development remains work with social networks and the web (e.g. Google Analytics). The number of interactions at information centres increased year-on-year by approximately 400 000, with over 2 million in 2019. The number of beds and rooms in all accommodation facilities is continuously slowly increasing - the number of rooms increased by 1.2% and the number of beds by 1.4% in 2019. The capital thus contributes over 1/3 of the creation of tourism-related macroeconomic indicators in the Czech Republic. In 2018 and 2017 (data for 2019 were not available when this publication was finalized), it had an almost 3% share of GDP.

## PEOPLE AND THE URBAN ENVIRONMENT

Prague Capital City is the largest protected reservation in the Czech Republic and also one of the most popular tourist destinations in the world. The population of Prague is constantly growing - it had 1.3 million inhabitants as of the last day of 2019, a year-on-year increase of 1.2%. The application of modern technologies is proving essential to meet the interests of the population and for the development of the public environment, especially about ensuring safety and keeping the city a pleasant place to live. The rising average age and the related increasing numbers of people with reduced mobility and self-sufficiency mean there is a growing need to provide a better quality of life for people in their natural environment. The city is working to strengthen safety and to automate the detection and prediction of risk phenomena. In 2019, 109 people and 7 cooperating medical facilities were involved in the pilot operation of the Metropolitan Emergency and Health Care System. The number of SOS communicators for public transport passengers also increased year-on-year, specifically in the case of trams thanks to the completion of the delivery of 15 T-type trams. To facilitate orientation in the urban space, OICT continued to manage the My Prague urban mobile app, the user base of which is growing every year. Almost 90 000 users were registered in 2019. OICT took over the Změňte.to mobile app that enables the reporting of problems in the city - the app increased its user base by almost 8 000 year-on-year to 28 000. Automated camera systems or those connected to the analytical system (video detection in tunnels and the complete telematics transport system) have not undergone further expansion in recent years and their number did not change in 2019 (607). The number of cameras in the city's camera system was increased in 2019, with 30 new cameras being installed in Prague during the year. A gradual transition is underway from intensive development and increasing the number of cameras in the city to strengthening qualitative aspects, such as the development of infrastructure, data storage, etc. The development of sensors focused on environmental quality was minimal during 2019. The projects implemented so far - focused purely on monitoring air quality - have also been supplemented with individual activities by some city districts with overlap into the issue of the quality of public spaces and excessive noise in them (busy locations, parks, quiet at night, etc.). Monitoring has shown a significant increase in urban farming in recent years. The number of community gardens in the capital more than doubled between 2018 and 2019, while the area of community gardens almost doubled. In 2019, a total of 43 community gardens with an average size of almost 1 000 $m^2$ were registered in Prague. Furthermore, there is an increasing trend in the establishment of community gardens not only by individuals but also by companies and city districts. Temporarily otherwise unused land is being used for this purpose. There are more and more grower communities, while the number of community gardeners has over tripled in the past two years.

## DATA AREA

As part of the development of work with data in Prague Capital City, new priorities were emphasized for 2019 - in addition to the development of its software solution, this means a targeted focus on specific projects and outputs in the city, its districts and companies. Emphasis is no longer only being placed on the actual data, but especially on the outputs and their benefits for specific users in Prague City Hall, city districts and municipal companies. Golemio (the Prague Capital City data platform) has shown that work with urban data can take place in other ways: with an emphasis on community building. This is one of the reasons why Prague Capital City decided to open source the Golemia source code. Since September 2019, the Golemio data platform has also been functioning as an open data coordinator for Prague City Hall, thus helping citizens gain a more detailed overview of the functioning of their city. As one example of the analyzes that became the basis for expert debates, we might mention the Airbnb Shared Economy Analysis, where the development and use of services were monitored, allowing the user to find numbers on occupancy percentages, median and average prices per night, the number of new or - on the contrary - terminated accommodation offers, etc. The Green Roofs Analysis was another analysis through which the DP indicated large and untapped potential in the buildings of Prague Capital City. The DP team calculated it would be possible to build up to 140 ha of such roofs on buildings owned by the city and city districts alone, approximately equal to two Stromovka parks. The data shows that under ideal conditions up to 1 659 ha of green roofs could be installed in Prague. One of the important Golemio data platform team projects is the Prague City Data Congress expert conference. This focuses on data in the urban environment, both in terms of data generation and their use in the functioning of the city. 2019 was the second year of the project and offered a significantly expanded program, with speakers such as Ira Winder (MIT), Ekim Tan (Play the City), Michael Woodbridge (New Cities), and Ross Douglas (Autonomy, Paris). Compared to the first year, almost twice as many visitors attended this international conference - it is becoming an interesting and sought-after international conference for speakers. The Golemio website statistics clearly show that there is still most interest in data on mobility, specifically parking, which is a challenge for every city, but also bicycle and public transport. 2019 saw the third phase of the Virtualization of Prague (VP) pilot project, which addressed the connection to the new Golemio data platform solution. The datasets were selected to cover a wide range of different types of graphic display (points, lines, polygons, etc.) so that in the future it will be possible to connect additional datasets without or with only minimal programmer intervention.

## CIMI

The sixth IESE Cities in Motion Index, which has been issued since 2014 by the IESE Business School Center for Globalization and Strategy and the IESE Department of Strategy at the University of Navarra, ranked Prague 47th of the 174 cities rated, a slight fall compared to the preceding year. Although Prague fell seven places, being overtaken this year by three American cities (Dallas, Miami and Phoenix) and three European ones (Lisbon, Milan and the newly rated Rotterdam), its CIMI rating rose from 63.85 in 2018 to 64.97. Nine more cities were also included in the evaluation than in 2018. As in previous years, however, Prague retained its first place in the Top Five of Eastern Europe, followed by Tallinn, Warsaw, Bratislava and Budapest, and is ranked 13th overall in ranked European cities.

## CONCLUSION

Data collection and analysis for the Smart Prague yearbook but also for its future annual issues is dependent on the cooperation of many actors - Prague City Hall, municipal companies and, last but not least, private organizations. For Prague Capital City, the data collection itself is an important element in terms of the testing of a unified and functional city. We believe that the current and future issues of the Smart Prague Index will bring their readers a great deal of useful information that will contribute towards the development of our metropolis.

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