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Sustainable cities and communities — Indicators for smart cities

Villes et communautés territoriales durables — Indicateurs de performance pour les villes intelligentes

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 268, *Sustainable cities and communities*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The indicators in detailed in ISO 37120 have quickly become the international reference point for sustainable cities. ISO/TC 268/WG2 experts have identified the need for additional indicators for smart cities.

This document complements ISO 37120 and establishes indicators with definitions and methodologies to measure and consider aspects and practices that dramatically increase the pace at which cities improve their social, economic and environmental sustainability outcomes.

This document, when used in conjunction with ISO 37120, helps cities to identify indicators for applying city management systems such as ISO 37101 and to implement smart city policies, programmes and projects to:

— respond to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how they engage society;

— apply collaborative leadership methods, work across disciplines and city systems;

— use data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors);

— provide a better life environment where smart policies, practices and technology are put to the service of citizens;

— achieve their sustainability and environmental goals in a more innovative way;

— identify the need for and benefits of smart infrastructure;

— facilitate innovation and growth;

— build a dynamic and innovative economy ready for the challenges of tomorrow.

Sustainable cities and communities — Indicators for smart cities

1 Scope

This document specifies and establishes definitions and methodologies for a set of indicators for smart cities.

As accelerating improvements in city services and quality of life is fundamental to the definition of a smart city, this document, in conjunction with ISO 37120, is intended to provide a complete set of indicators to measure progress towards a smart city. This is represented in Figure 1.

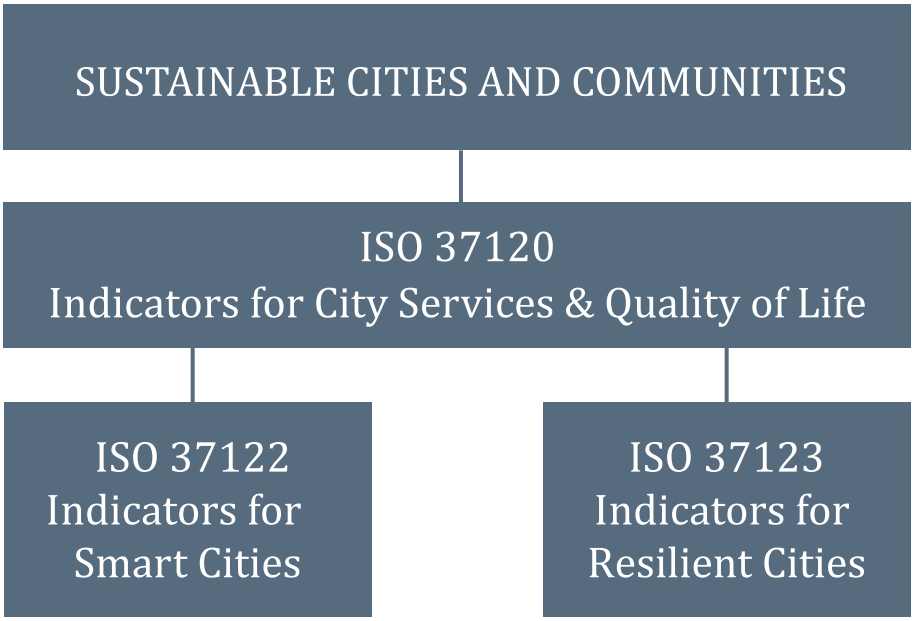

Figure 1 — Sustainable development of communities — Relationship between the family of city indicators standards

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For updated references, the latest edition of the referenced document (including any amendments) applies.

ISO 37101, *Sustainable development in communities — Management system for sustainable development — Requirements with guidance for use*

ISO 37120, *Sustainable cities and communities — Indicators for city services and quality of life*

3 Terms and definitions for cities

For this document, the terms and definitions in ISO 37101 and ISO 37120 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
gigajoule
measure of the energy that is equivalent to 1 billion joules (J), where 1 J is the amount of energy required to send an electrical current of one ampere through a resistance of one ohm for one second

Note 1 to entry: One gigajoule (GJ) is equivalent to 277,8 kilowatt hours (kWh)

3.2
per 100 000 population
for every 100 000 of the city's population

Note 1 to entry: The choice of 100 000 population was made to enable cities of different sizes to compare results with each other relatively easily and effectively. It should be noted that in some countries the statistic per 1 000 capita is collected and a slight mathematical adjustment might be necessary to reflect this difference to obtain an accurate comparison. The measure of per 1 000 population might be a more applicable measure for small cities.

3.3
public building
government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station

Note 1 to entry: Ownership of buildings (public or private) is variously defined according to region and political system. The restrictive definition used here permits global comparability across cities.

3.4
smart city
city that increases the pace at which it provides social, economic and environmental sustainability outcomes and responds to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and modern technologies to deliver better services and quality of life to those in the city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment

Note 1 to entry: A smart city also faces the challenge of respecting planetary boundaries and taking into account the limitations these boundaries impose.

Note 2 to entry: There are numerous definitions of a smart city; however, the definition that is used within TC268 is the official one agreed to by the ISO Technical Management Board.

3.5
biosolid
mixture of water and solids separated from various types of water as a result of natural or artificial processes

[SOURCE: EN 12832]

4 City indicators

This document is designed to assist cities in steering and assessing the performance management of city services as well as quality of life. It considers sustainability as its general principle and "smart city" as a guiding concept in the development of cities. Indicators shall be reported on an annual basis. Depending on their objectives in term of smartness, cities will choose the appropriate set of indicators from this document to be reported.

For data interpretation purposes, cities shall take into consideration contextual analysis when interpreting results. The local institutional environment can affect the capacity to apply indicators. In some cases, services can be delivered by the private sector or the community itself.

The list of indicators is based on the following criteria:

— Completeness: indicators should measure and balance all relevant aspects for evaluation of the smart city.

— Technology neutral: not favouring one technology over another, existing or future.

— Simplicity: indicators can be expressed and presented in an understandable and clear way.

— Validity: indicators are an accurate reflection of the facts and data that can be collected using scientific techniques.

— Verifiability: indicators are verifiable and reproducible. Methodologies are rigorous enough to give certainty to the level of implementation of the criteria.

— Availability: quality data are available, or it is feasible to initiate a secure and reliable monitoring process that will make them available in the future.

When interpreting the results of a particular service area, it is important to review the results of multiple types of indicators across themes; focusing on a single indicator can lead to a distorted or incomplete conclusion. Elements of aspiration should also be taken into consideration in the analysis.

Users can also consider the following aspects which shall be clearly stated in the report and justified: indicators can be aggregated to larger administrative areas (e.g. region, metropolitan area); indicators can be grouped for analysis when taking into consideration the holistic characteristics of a city; and, this set of indicators can be complemented by other indicator sets in order to have a more comprehensive holistic approach for the analysis of smart and sustainable cities.

Furthermore, it is also important to acknowledge potential antagonistic effects of the outcome of particular indicators, either positive or negative, when analysing results.

Data sources can vary depending on the cities and can be different from the ones indicated in this document. However, data shall be verifiable, auditable, trustworthy and justified. Cities might not have access to all data required for indicators within this document as the services are performed by a third party. However, it is still important for cities to obtain this data. An important component of smart cities is the role of public/private partnerships and this collaboration, including sharing of data, should be encouraged.

Cities using this document shall report at least 50 % of the indicators in this document as it is meant to be used in conjunction with ISO 37120. “Smart cities” is a relatively new and evolving concept that cities worldwide are addressing and it is important that cities report progressively more indicators in this document over time.

Moreover, for each indicator, the correspondence with the issues of ISO 37101 is noted [for consistency with Annex A and with the United Nations Sustainable Development Goals (SDGs) (Annex B)].

5 Economy

5.1 Percentage of service contracts providing city services which contain an open data policy

5.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 An open data policy demontrates a city's commitment to better manage business information throughout the information lifecycle. Identifying and making data accessible helps to ensure that the public is informed and engaged through a transparent, accountable and accessible government.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement", "Innovation creativity and research" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness" and "Responsible resource use" purpose of the city as defined in ISO 37101.

5.1.2 Indicator requirements

The percentage of service contracts providing city services which contain an open data policy shall be calculated as the total number of service contracts providing city services which contain an open data policy (numerator) divided by the total number of service contracts in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of service contracts providing city services which have an open data policy.

Open data policy shall refer to data that are to be provided to and used by the city which can be analysed and open to the public, including residents and non-residents of the city.

Service contracts shall refer to agreements with businesses providing city services.

City services shall refer to services provided by the city and typically cover the following areas: utilities, garbage and recycling; public safety; fire department; roads and traffic; recreation; construction; bylaws, violations and enforcement; permits and licences; planning; building; policies, projects and initiatives; rentals and catering of city buildings; water, wastewater and sewers; and property taxes and utilities.

5.1.3 Data sources

Data from service contracts should be sourced from relevant city departments, or market research companies and survey companies.

5.1.4 Data interpretation

A higher percentage of service contracts providing city services which have data openly available leads to greater transparency of city service performance and a technologically forward community. This allows people to review the data and performance of businesses contracted by the city to complete city services that are not normally covered by performance measurements published by the city.

5.2 Survival rate of new businesses per 100 000 population

5.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 New businesses make a positive contribution to local economies, and start-up activity can signal a city's economic potential. New businesses can potentially contribute a substantial number of new jobs to the economy and tend to have faster employment growth rates, especially those in innovation-driven/technologically focused enterprises, such as computer or software development.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Innovation, creativity and research" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" and "Resilience" purpose of the city as defined in ISO 37101.

5.2.2 Indicator requirements

The survival rate of new businesses per 100 000 population shall be calculated as the survival rate of new businesses in the city (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the survival rate of new businesses per 100 000 population.

Survival rate shall refer to those new businesses which have been created during the last two years, registered in the city and still operating during the last year (numerator) divided by the total number

of new businesses which have been created during the last two years and registered in the city (denominator).

Businesses shall refer to companies or enterprises in the city.

These businesses can be considered to have innovative business processes and/or products. Cities reporting on this indicator shall specify the sectors and categories of innovative businesses that are included in this calculation. The enterprise is the smallest combination of legal unit, which is an organisational unit producing goods or services. Business can either be categorised as simple (one operating entity) or complex (multiple operating entities) as stated in ISO 37120:2018, 5.5.2. An innovative business refers to a business that is implementing new ideas, creating dynamic products or improving existing services in any industry.

5.2.3 Data sources

Data on new businesses should be obtained through relevant city departments or ministries that oversee the approval of new business licenses or new registrations of businesses.

5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector

5.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The information and communications technology (ICT) sector is a combination of manufacturing and services industries that capture, transmit and display data and information electronically[8]. With the rapid development of ICT and the mainstreaming of ICT into everyday life, the link between ICT technologies and human development has never been more evident. ICT has long been recognized as a key enabler for bridging the digital divide and achieving the three dimensions of sustainable development – economic growth, environmental balance and social inclusion – as well as promoting innovation in society[7]. Thus, having a labour force to develop the ICT sector will help to drive economic growth, augment labour productivity and enhance international competitiveness via innovative ICT development, including by the wider use of ICT products and services across the economy and society.

NOTE 2 This indicator reflects “Innovation creativity and research”, “Education and capacity building” and “Economy and sustainable production and consumption” issues as defined in ISO 37101. It can allow an evaluation of the contribution to “Attractiveness” and “Resilience” purposes of the city as defined in ISO 37101.

5.3.2 Indicator requirements

The percentage of the labour force employed in occupations in the ICT sector shall be calculated as the number of city residents in the labour force employed in occupations in the ICT sector (numerator) divided by the city’s total labour force (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the labour force employed in occupations in the ICT sector.

The ICT sector shall refer to a combination of manufacturing and services industries that capture, transmit and display data and information electronically. For manufacturing industries, the products of a candidate industry must be intended to fulfil the function of information processing and communication including transmission and display, and must use electronic processing to detect, measure and/or record physical phenomena or control a physical process. For services industries, the products of a candidate industry must be intended to enable the function of information processing and communication by electronic means[8].

More specifically, the ICT sector shall refer to the United Nations Statistics Division’s International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 (https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf) section J (Information and communication) in its entirety, and those subsections of section C (Manufacturing) that align with ICT manufacturing

industries stated above, such as sections 26 (Manufacture of computer, electronic and optical products) and 27 (Manufacture of electrical equipment).

The labour force shall refer to, as defined by the International Labour Organization (ILO), the sum of persons in employment plus persons in unemployment who are legally eligible to work. Thus, working age shall refer to all persons who are the same age or older than the legal working age in the jurisdiction of reference. This indicator shall exclude child labour, which is labour completed by persons 14 years of age or younger.

5.3.3 Data sources

Data on employment by industry should be obtained through labour force surveys or city employment assessments administered by local, regional or national authorities/statistical bodies, or a Ministry or Department of Labour Employment.

5.4 Percentage of the labour force employed in occupations in the education and research and development sectors

5.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 As cities and communities strengthen their focus on the development of their knowledge economy, the role of education and research and development industries is all the more important in the development of human capital. These industries play a critical role in economic development, promoting innovative thought processes to enhance existing products or services or to develop new products and services. Also, the education sector includes those employed in all levels of the educational system, ensuring that citizens have access to education and receive effective services. Thus, the labour force employed in these two industries aids in the development or enhancement of products and services, in addition to ensuring that citizens receive high-quality education to become actively involved in the knowledge economy.

NOTE 2 This indicator reflects "Innovation, creativity and research" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness" and "Resilience" purposes of the city as defined in ISO 37101.

5.4.2 Indicator requirements

The percentage of the labour force employed in occupations in the education and research and development sectors shall be calculated as the number of city residents in the labour force employed in occupations in the education and research and development sectors (numerator) divided by the city's total labour force (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the labour force employed in occupations in the education and research and development sectors.

Cities shall refer to the United Nations Statistics Division's International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4 (https://unstats.un.org/unsd/publication/seriesm/seriesm_4rev4e.pdf) when defining the education and research and development sectors.

The education sector shall refer to organisations primarily engaged in providing instruction and training in a wide variety of subjects. Instruction and training are provided by specialized establishments, such as schools, colleges, universities and training centres. Cities shall refer to any organisations that fall within section P of the ISIC, Rev.4, which is divided into the following subsections: 851 (Pre-primary and primary education), 852 (Secondary education), 853 (Higher education), 854 (Other education) and 855 (Educational support activities).

The research and development section shall refer to organisations primarily engaged in conducting original investigation, undertaken on a systematic basis to gain new knowledge (research), and in the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development). Cities shall refer to organisations that

fall within Division 72 – Scientific research and development of section M – Professional, scientific and technical activities of the ISIC, Rev.4[6].

The numerator of this indicator shall be calculated as the sum of the total number of persons employed in occupations in these two sectors, education and research and development.

The labour force shall refer to, as defined by the ILO, the sum of persons in employment plus persons in unemployment who are legally eligible to work. Thus, working age shall refer to all persons who are the same age or older than the legal working age in the jurisdiction of reference. This indicator shall exclude child labour, which is labour completed by persons 14 years of age or younger.

5.4.3 Data sources

Data on employment by industry should be obtained through labour force surveys or city employment assessments administered by local, regional or national authorities/statistical bodies, or a Ministry or Department of Labour Employment.

6 Education

6.1 Percentage of city population with professional proficiency in more than one language

6.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Foreign language skills are indicative of a diverse, employable workforce. They also suggest highly successful educational programming.

NOTE 2 This indicator reflects the "Education and capacity building" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion", "Well-being", "Attractiveness" and "Resilience" purpose of the city as defined in ISO 37101.

6.1.2 Indicator requirements

The percentage of city population with professional proficiency in more than one language shall be calculated as the total number of people who are able to communicate in more than one foreign language with professional proficiency (numerator) divided by the city's total population (denominator). The result shall then be multiplied by 100 and expressed as the percentage of city population with professional proficiency in more than one language.

A foreign language shall refer to a language spoken with professional proficiency other than one of the official languages of the country in which the city is located. For example, the official language in the United States of America (USA) is English, so a city resident speaking a language other than English at a professional proficiency is counted as a foreign language in the USA. In the case of a country with more than one official language, such as Canada with two designated official languages (English and French), when a person can speak two official languages at professional proficiency level, one official language shall be included in the count of foreign languages and the other language shall be excluded from the count of foreign languages. For example, if a person in Canada speaks both English and French, they would have one foreign language and be counted in the numerator of this indicator. Similarly, if a Canadian speaks only English (only one of the official languages) but also has professional proficiency in Spanish, for example, then that person would be counted as having professional proficiency in more than one language.

Professional proficiency shall refer to the following level of competence:

— able to speak the language with sufficient structural accuracy, vocabulary and cohesiveness in discourse to participate effectively in most formal and informal conversations on practical, social and professional topics;

— understanding is essentially complete;

— can discuss with fluency and ease abstract issues and special fields of competence and interest;

— can support opinions and hypothesize;

— can provide a structured argument that is clear and well organized;

— while the influence of the speaker's first language can be noticed (in pronunciation, grammar and vocabulary), there should not be any patterned errors, and errors should never distract the listener or interfere with communication.

For reference, the above definition of professional proficiency corresponds to level C1 of the Common European Framework of Reference for Languages: Learning, Teaching, Assessment.

6.1.3 Data sources

Data on foreign languages spoken by the city population should be sourced using census data, or local, regional or national surveys pertaining to languages spoken.

6.1.4 Data interpretation

A high percentage of residents who can communicate in more than one foreign language indicates that the city has a well-educated and diverse population that can handle interactions that extend beyond national borders. Globalization, economic growth in developing economies and improved transport infrastructure have resulted in a considerable shift in world trading patterns and a higher proportion of the world’s population being able to visit other countries, whether for business, pleasure or other reasons.

Foreign language skills have the potential to increase one’s mobility, employability and personal development.

6.2 Number of computers, laptops, tablets or other digital learning devices available per 1 000 students

6.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Computer literacy is an essential aspect of professional employability in many sectors, and it allows an alternative form of civic engagement for citizens. The increase in accessibility of electronic devices for students, as well as the exposure to computers, laptops, tablets or other digital learning devices, can enhance a student’s computer literacy. It also allows citizens to access a broader array of information, empowering people in all walks of life to seek, evaluate, use and create information effectively to achieve personal, social, occupational and educational goals.

NOTE 2 This indicator reflects the “Education and capacity building” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Attractiveness” purpose of the city as defined in ISO 37101.

6.2.2 Indicator requirements

The number of computers, laptops, tablets or other digital learning devices available per 1 000 students shall be calculated as the total number of computers, laptops, tablets or other digital learning devices

with Internet access available to primary and secondary school students attending primary and secondary school in the city (numerator) divided by 1/1 000 of the city's total primary and secondary school population (denominator). The result shall be expressed as the number of computers, laptops, tablets or other digital learning devices available per 1 000 students.

Only school owned/provided computers, laptops, tablets or other digital learning devices shall be counted.

Primary school students shall refer to students enrolled in primary education as defined in ISO 37120: 2018, Clause 3.

Secondary school students shall refer to students enrolled in secondary education as defined in ISO 37120: 2018, Clause 3.

The number of computers, laptops, tablets or other digital learning devices available per 1 000 students shall be reported separately for both primary and secondary school students in the table below.

	Number of computers, laptops, tablets or other digital learning devices	**Number of computers, laptops, tablets or other digital learning devices per 1 000 students**
Primary students		
Secondary students		
Total students (primary and secondary)		

6.2.3 Data sources

Data on the number of electronic devices with Internet access should be sourced from local school boards, or a Ministry or Department of Education.

6.2.4 Data interpretation

While computer literature can benefit secondary school students, there are debates concerning the positive impact of the availability of digital devices and technology for primary school students.

Sufficiently fast broadband as defined in 18.1 can also be taken into consideration for analysis of this indicator. When the percentage of city population having sufficiently fast broadband is low, the benefit of accessibility to computers, laptops, tablets or other digital learning devices may be limited. Sufficiently fast broadband shall refer to a network capable of speeds of at least 256 kbit/s in both directions, uploading and downloading. This speed is sufficient for Internet surfing and emails. Sufficient broadband corresponds to basic broadband.

6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population

6.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Receiving higher education provides individuals with a foundation for meaningful participation in the labour force and helps reduce poverty and inequality. This pillar of human development is widely recognized as the main avenue for social mobility. All disciplines taught by higher education institutions benefit society in some way, such as science, technology, engineering and mathematics (STEM) disciplines, which are critical to the technological development and innovation of a city. STEM education helps to create critical thinkers, increase science literacy, and enable the next generation of innovators. Furthermore, STEM is important because science pervades every part of our lives, and the need for STEM degree holders is increasing with the growing demand for innovators of products and processes that will help sustain and promote economic growth.

NOTE 2 This indicator reflects the "Education and capacity building" and "Innovation, creativity and research" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience" and "Attractiveness" purposes of the city as defined in ISO 37101.

6.3.2 Indicator requirements

The number of STEM higher education degrees per 100 000 population shall be calculated as the number of people holding higher education degrees with a specialization or major in a discipline within a STEM subject (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the number of STEM higher education degrees per 100 000 population.

STEM higher education degrees shall refer to higher education degrees specializing in subjects within the fields of science, technology, engineering and mathematics, and is intended to capture a broad field of education and employment opportunities, beyond the more narrow fields of science and mathematics. STEM programmes of study are typically classified based upon several occupational clusters: computer science and technology; mathematical sciences; digital music and digital arts, engineering and surveying; and natural, physical and life sciences.

This indicator shall only include people who comprise the city's total population, and shall not include temporary residents or international students.

Higher education shall refer to the definition of tertiary education stated within ISO 37120: 2018, Clause 3.

6.3.3 Data sources

Data on higher education degrees by subject should be sourced from local tertiary/postsecondary degree-, diploma- or certificate-granting institutions, or the relevant Ministry or Department of Education, if available. If higher education data from these sources are not available, data from surveys or censuses can be used.

6.3.4 Data interpretation

This indicator provides an overview of the skill set of the population. These data can also have an impact on surrounding cities because the population with STEM degrees can work in those cities or, in other contexts, may force lower educated people to move to surrounding cities, creating intellectual ghettos in the city. Although only STEM disciplines are considered for this indicator, social science and other disciplines are also important for the city's labour force and can contribute to the smartness of the city.

7 Energy

7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year

7.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Waste heat is an endogenous energy resource of every city. Waste heat can be obtained from wastewater and solid waste treatment plants or any other industrial processes, as well as from the tertiary and transport sectors (e.g. heat rejected from data centres or the subway ventilation).

Wastewater is a renewable resource that conveys thermal and chemical energy. In some instances, wastewater is found to contain nearly five times the amount of energy needed to process and treat the wastewater. It is important for cities to recognize the potential of wastewater as a sustainable energy source and utilize wastewater in their energy source mix.

Furthermore, wastewater treatment plants use considerable amounts of energy and create greenhouse gas emissions, but they also have the potential to be sources of renewable energy for cities. Wastewater treatment plants can use sewage to generate energy on site, where this energy can then be used to help operate the wastewater treatment plants, thereby reducing a wastewater treatment plant's operating costs, energy consumption and greenhouse gas emissions.

While reduction, recycling and composting can do their part to mitigate the environmental impacts of municipal solid waste, not all types of materials can be practically and economically recycled in an environmentally beneficial manner. This leftover solid waste can therefore present an opportunity to recover energy, using new and possibly cleaner technologies.

Waste heat can be categorised into high enthalpy and low enthalpy. While high enthalpy waste heat allows the production of electricity, low enthalpy heat can be used directly for heating (and even cooling) of buildings, typically through district heating and cooling networks.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" purpose of the city as defined in ISO 37101.

7.1.2 Indicator requirements

The percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources as a share of the city's total energy mix for a given year shall be calculated as the total amount of electrical and thermal energy expressed in GJ produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources (numerator) divided by the city's total end-use energy demand in the same units as the numerator (GJ). The result shall then be multiplied by 100 and expressed as a percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources as a share of the city's total energy mix for a given year.

The term energy mix refers to the combination of the various primary energy sources used to meet energy needs in a given geographic region.

Where possible, data from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources shall be included and listed individually. This shall include on-site use of recovered electrical and thermal energy at the wastewater/waste facilities and off-site use by external parties.

	Thermal energy (% of the total energy mix)	**Electrical energy (% of the total energy mix)**	**Total energy (% of the total energy mix)**
Wastewater resource			
Solid waste treatment			
Other liquid waste treatment			
Other waste heat sources			
Total (%)			

Waste heat shall be considered as all residual thermal energy generated in the city which is not used, as well as potential chemical energy sources that are not valued as energy.

Wastewater shall refer to the physical, chemical and biological processes used to remove, reduce or neutralize contaminants from wastewater before discharging it into a water body. Wastewater treatment can include primary, secondary or tertiary treatment, or wastewater treatment of higher standard.

Solid waste treatment shall refer to the physical, chemical and biological processes used to remove, reduce or neutralize contaminants from solid waste before recycling, recovery or final disposal.

Other liquid waste shall refer to liquid waste such as fasts, oil or grease that are sources of energy.

7.1.3 Data sources

Data on the amount of electrical and thermal energy produced from waste water treatment, solid waste and other liquid waste treatment and other waste heat resources should be sourced from city departments or ministries that oversee such matters, as well as from regulators and local utility providers.

7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year

7.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Wastewater is a renewable resource that conveys thermal and chemical energy. In some instances, wastewater is found to contain nearly five times the amount of energy needed to process and treat the wastewater. It is important for cities to recognize the potential of wastewater as a sustainable energy source and utilize wastewater in their energy source mix.

Furthermore, wastewater treatment plants use considerable amounts of energy and create greenhouse gas emissions, but they also have the potential to be sources of renewable energy for cities. Wastewater treatment plants can use sewage to generate energy on site, where this energy can then be used to help operate the wastewater treatment plants, thereby reducing a wastewater treatment plant's operating costs, energy consumption and greenhouse gas emissions.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" purpose of the city as defined in ISO 37101.

7.2.2 Indicator requirements

The electrical and thermal energy (GJ) produced from wastewater treatment per capita per year shall be calculated as the total amount of electrical and thermal energy expressed in GJ produced from wastewater treatment in the city (numerator) divided by the city's total population (denominator). The result shall be expressed as the amount of electrical and thermal energy in GJ produced from wastewater treatment per capita for a given year.

This shall include the on-site use of recovered electrical and thermal energy at the wastewater facilities and off-site use by external parties.

Wastewater treatment shall refer to the physical, chemical and biological processes used to remove, reduce or neutralize contaminants from wastewater before discharging into a water body. Wastewater treatment can include primary, secondary or tertiary wastewater treatment, or wastewater treatment of a higher standard.

7.2.3 Data sources

Data on the amount of electrical and thermal energy produced from wastewater treatment should be sourced from city departments or ministries that oversee such matters, as well as from regulators and local utility providers.

7.3 Electrical and thermal energy (GJ) produced from solid waste or other liquid waste treatment per capita per year

7.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 While reduction, recycling and composting can do their part to mitigate the environmental impacts of municipal solid waste, not all types of materials can be practically and economically recycled in an environmentally beneficial manner. This leftover solid waste might therefore present an opportunity to recover energy, using new and possibly cleaner technologies. Other liquid waste such as fats, oils and grease are also a source of energy.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" purpose of the city as defined in ISO 37101.

7.3.2 Indicator requirements

The electrical and thermal energy (GJ) produced from solid waste or other liquid waste treatment per capita per year shall be calculated as the total amount of electrical and thermal energy expressed in GJ produced from solid waste and other liquid waste treatment in the city (numerator) divided by the city's total population (denominator). The result shall be expressed as the amount of electrical and thermal energy in GJ per capita for a given year.

This shall include the on-site use of recovered electrical and thermal energy at the solid waste facilities and off-site use by external parties.

This also includes other liquid waste such as fats, oil or grease.

7.3.3 Data sources

Data on the amount of electrical and thermal energy produced from solid waste and other liquid waste treatment should be sourced from city departments or ministries that oversee such matters, as well as from regulators and local utility providers.

7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems

7.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A primary benefit of a more decentralised energy system is the potential for a more reliable electricity system and higher-quality power supply (with the appropriate supporting systems in place). A decentralised electricity production system can be defined as locating electricity production closer to the site of consumption, such as locating electricity production facilities within a city rather than sourcing electricity from a regional electricity production facility that is most likely distant from a city. Although a relatively new approach for the power industry and utility providers, a decentralised system can potentially lead to more optimal use of renewable energy sources, which in turn can reduce fossil fuel use and increase the energy efficiency and sustainability of a region. Therefore, tracking the amount of decentralised electricity production can be used to assess a region's potential for utilizing renewable energy sources and expanding access to clean energy services, such as combined heat and power, that might not otherwise have been available due to the distance from centralised electricity production facilities. The opportunity for combined heat and power is important – but this generally has to be included in the design of these systems and is difficult to install retroactively.

NOTE 2 Besides the environmental issues of decentralised electricity production mentioned before, i.e. adoption of renewable energy sources and reduction of primary energy usage, decentralised electricity production can also be advantageous for the resilience of the electrical grid of the city, particularly during a crisis event such as a large storm.

NOTE 3 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Resilience" purpose of the city as defined in ISO 37101.

7.4.2 Indicator requirements

The percentage of the city's electricity that is produced using decentralised electricity production systems shall be calculated as the amount of electricity produced by decentralised electricity production systems/facilities in GJ (numerator) divided by the total amount of electricity consumed in the city in the same units as the numerator (GJ) – this includes electricity produced by both centralised and decentralised electricity production facilities (denominator). The result shall be multiplied by 100 and expressed as the percentage of the city's electricity that is produced using decentralised electricity production systems.

Decentralised electricity, also referred to as distributed electricity production, shall refer to electricity production at or near the point of use, irrespective of size, technology, or fuel used – both off-grid and on-grid. Also, decentralised electricity production refers to the wide range of technologies that include wind turbines or plants, photovoltaic (solar) panels, micro-turbines and modular internal combustion engines.

7.4.3 Data sources

Data on the amount of electricity produced by both centralised and decentralised electricity production systems/facilities should be sourced from local utilities, and relevant city departments or ministries that oversee energy production. It can be acceptable to use estimates based on energy audits performed on sample sites to address the electricity production that is immediately used as auto-consumption, which sometimes is not communicated to the electrical utilities.

7.4.4 Data interpretation

If one plant produces 100 % of the city's electricity, this is not considered to be decentralised and the indicator therefore equals 0 %.

7.5 Storage capacity of the city's energy grid per total city energy consumption

7.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The peak energy demand is a less spoken vector that increases energy costs and limits the penetration of renewables. Smart grids will accommodate energy storage (typically electrical and thermal storage, but also "clean" fuels such as hydrogen) to reduce demand peaks and transfer energy usage to periods of intermittent renewable energy production. Efficient storage capacity is essential to balance the supply and demand for energy in a region, and it can be achieved by several strategies:

— electricity storage, onsite or nearby, including chemical storage such as hydrogen;

— electrical storage of electrical vehicles (excluding hybrid vehicles);

— thermal storage (e.g. heat and cold storage in nearby district heating and cooling schemes);

— geothermal energy storage (e.g. some heat pump/chiller-driven district heating and cooling schemes);

— thermal mass of buildings considered onsite thermal storage if associated with predictive heat consumption algorithms that allow the reduction of heat and cold peak demand from district heating and cooling schemes;

— other ways of storing renewable energy such as fuels cells, if conveniently justified, including onsite energy storage.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Resilience" purpose of the city as defined in ISO 37101.

7.5.2 Indicator requirements

Storage capacity of the city's energy grids per total city energy consumption shall be calculated as the total amount of energy that can be stored annually on the city's electrical grid and thermal grids (district heating and cooling schemes) in gigajoules (GJ) (numerator) divided by the city's total energy consumption (denominator). The result shall be expressed as the storage capacity of the city's energy grid per total city energy consumption.

Energy storage shall refer to the process of converting energy into a stored form that can later be converted back into energy when needed. Thus, storage capacity shall refer to the amount of energy capable of being stored.

For total end-use energy consumption refer to ISO 37120:2018, 7.1.

Where possible, specify and report the types of energy consumption used in the calculation. Also, if the energy storage facility is not within the city boundaries, the city should report the distance of the energy storage facility.

7.5.3 Data sources

Data for storage capacity should be sourced from relevant city departments or ministries that oversee the energy grid of the city, and local utilities that operate district heating and cooling schemes.

7.5.4 Data interpretation

Having energy storage capacity nearby or within city boundaries (close to the loads) reduces transmission losses and ensures a more reliable power supply. It also allows cities to better manage peaks in energy demand. If energy storage facilities are not located within city boundaries, the city shall report the distance to the energy storage facility.

7.6 Percentage of street lighting managed by a light performance management system

7.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Remotely managed light points contribute to higher energy efficiency and can be optimised and adapted to switch on and off and to dim in any area of the city. Also, remotely managed lights can potentially improve safety in the city, where any failure of a light point which leads to insufficiently illuminated streets can be immediately monitored and localized to ensure fast repair. Lastly, real energy consumption per light point can be measured and reported accurately with the light management system, to better monitor energy cost and CO_2 reduction schemes.

NOTE 2 This indicator reflects "Economy and sustainable production and consumption" and "Safety and security" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" purpose of the city as defined in ISO 37101.

7.6.2 Indicator requirements

The percentage of street lighting managed by a light performance management system shall be calculated as the number of light points that can be controlled by a light performance management system (numerator) divided by the number of total light points in the city (denominator). The results

shall then be multiplied by 100 and expressed as the percentage of street lighting managed by a light performance management system.

Controlled by a light performance management system shall refer to the ability to monitor light points, set schedules for switching off/on and adjust light levels by dimming. This means a light point can be changed individually and remotely with an ICT-based system, which is connected via a communication network to the light points. This system shall also be able to accurately measure the electrical energy consumed by the light point and indicate via the ICT-based system to the operator any occurring failure affecting the light performance of the light point.

7.6.3 Data sources

Data on remote management of lighting should be sourced from city departments or ministries responsible for street lighting inventory and street light management.

7.7 Percentage of street lighting that has been refurbished and newly installed

7.7.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Street lighting can account for 15 % to 50 % of total electricity consumption of municipalities. Refurbishing city street lights and installing new lighting can help improve energy efficiency, thus reducing street lighting energy consumption. In addition, the recent market introduction of energy-efficient technologies for street lighting offers high-cost savings with comparatively short payback times. The annual energy and maintenance cost savings might then possibly cover the investment and capital costs.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" purpose of the city as defined in ISO 37101.

7.7.2 Indicator requirements

The percentage of street lighting that has been refurbished and newly installed within the year shall be expressed as the number of refurbished and newly installed light points (numerator) within the year divided by the total number of light points (denominator). The result shall then be multiplied by 100 and expressed as the percentage of street lighting that has been refurbished and newly installed.

Where possible, cities shall report and indicate separately the percentage of street lighting that is refurbished and newly installed.

	Number of street lighting points	Percentage of street lighting points
Refurbished		
Newly installed		
Replaced		
Untreated		
Total number		

Refurbishment of existing street light systems, for example upgrading ballasts, shall refer to activities that aim not only to decrease energy consumption but also improve energy efficiency of the street lighting system. Newly installed as well as retrofitted street lighting for upgrading to high efficiency technologies shall be included.

A light point shall refer to any single source of public street lighting, such as a street light, light pole, lamppost, street lamp, light standard or lamp standard.

7.7.3 Data interpretation

Cities should consider the lifecycle of the street lighting assets when replacing, refurbishing and installing street lighting. A street lighting lifecycle plan should be developed by cities to better assess the current state of lighting assets of a city and to identify what treatment/material/technology should be used for street lighting.

7.7.4 Data sources

Data on street lighting refurbishment and street lighting systems should be sourced from city departments or ministries responsible for street lighting inventory.

7.8 Percentage of public buildings requiring renovation/refurbishment

7.8.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Buildings are the largest energy consumers in most cities. Reduced and efficient energy use can create substantial savings and can enhance the stability of the energy supply. As such, buildings requiring renovation/refurbishment can hinder progress to reduce energy consumption, thus contributing more to climate change and other negative externalities.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" and "Responsible resource use" purpose of the city as defined in ISO 37101.

7.8.2 Indicator requirements

The percentage of public buildings requiring renovation/refurbishment shall be calculated as the square footage of public buildings requiring renovation/refurbishment (numerator), divided by the total square metres of public buildings (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public buildings requiring renovation/refurbishment.

Public building shall refer to a government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station.

NOTE Ownership of buildings (public or private) is variously defined according to region and political system. The restrictive definition used here permits global comparability across cities.

Renovation/refurbishment shall refer to the remodelling, refashioning and general renovation of a building to gain better energy use, improvements to structural integrity and conformity to safety standards. Buildings requiring renovation/refurbishment shall be assessed by a city's audit and registration of buildings in need of renovation/refurbishment. Renovation and refurbishment of a building shall not include the demolition/removal and replacement of buildings, but does include buildings requiring renewal.

7.8.3 Data sources

Data on public buildings requiring renovation/refurbishment should be sourced from city ministries, departments or agencies that oversee the building and maintenance of buildings in the city.

7.9 Percentage of buildings in the city with smart energy meters

7.9.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Smart energy meters record and display the consumption of energy in real time. Smart meter data can be sent to a central location wirelessly, thus providing energy providers with the means to understand how and when power is being used to better plan and conserve energy. Also, smart meter data help consumers better understand and monitor energy usage.

NOTE 2 This indicator reflects the "Community infrastructure" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Attractiveness" purpose of the city as defined in ISO 37101.

7.9.2 Indicator requirements

The percentage of buildings in the city with smart energy meters shall be calculated as the number of buildings in the city with smart energy meters (numerator) divided by the total number of buildings in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of buildings in the city with smart energy meters.

Data for public and commercial and industrial buildings shall be included and listed individually.

	Number of buildings in the city with smart energy meters	**Total number of buildings in the city**	**Percentage of buildings in the city with smart energy meters**
Public buildings			
Commercial and industrial buildings			

Public buildings shall refer to a government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station.

NOTE 1 Ownership of buildings (public or private) is variously defined according to region and political system. The restrictive definition used here permits global comparability across cities.

Commercial and industrial buildings shall refer to those which have been designated by the city for commercial and industrial use.

NOTE 2 Property assessment methods might vary from one jurisdiction or country to another, including the market-oriented method, the profit-oriented method and the cost-oriented method.

Household buildings are not considered in this indicator.

For smart energy management at the household scale refer to indicator 12.1.

A smart energy meter shall refer to an energy meter that includes real-time digital displays or that is available through a real-time online application, so a customer can better understand their energy usage. Also, a smart energy meter can digitally send meter readings to an energy supplier for more accurate energy bills, and for better planning and conservation of energy by providers.

7.9.3 Data sources

Data on the number of buildings in the city with smart energy meter figures should be sourced from local or regional energy providers, or relevant city departments or ministries that have data on local smart energy meters.

7.10 Number of electric vehicle charging stations per registered electric vehicle

7.10.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Unlike conventional vehicles that use gasoline or diesel-powered engines, electric vehicles (EVs) are powered by electricity from batteries. EVs therefore emit fewer greenhouse gases and tailpipe pollutants than conventional vehicles. EVs are also cheaper to operate because fuel costs are minimal or nil. However, with limited motor and battery capacity (meaning shorter travel range), electric cars need regular and convenient access to vehicle (i.e. battery) charging stations.

NOTE 2 This indicator reflects the "Health and care in the community", "Community infrastructure" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being" and "Attractiveness" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

7.10.2 Indicator requirements

The number of electric vehicle charging stations per registered electric vehicle shall be calculated as the total number of electric vehicle charging stations in the city (numerator) divided by the total number of registered electric vehicles in the city (denominator). The result shall be expressed as the number of electric vehicle charging stations per registered electric vehicle.

Electric vehicle shall refer to any means by which something or someone is carried or conveyed with an engine and wheels (including cars, buses, motorcycles and auto rickshaws, but not trains) and which runs fully or partially on a battery-powered electric motor. Electric vehicles, therefore, require "plugging in" to an electricity source to recharge their batteries. There are two types of electric vehicles:

1) "hybrid" vehicles that are powered from a gasoline or diesel engine as well as an electric motor;

2) "battery electric" vehicles that are powered exclusively from a battery and require no liquid fuels.

Charging station shall refer to publicly accessible equipment (also called "electric vehicle supply equipment" or EVSE) that supplies electric energy for recharging battery electric vehicles. Charging stations are often provided in municipal parking locations by electric utility companies or at retail shopping centres by private companies. Some charging stations have advanced features such as smart metering, cellular capability and network connectivity.

Registered vehicle shall refer to any vehicle that has been officially listed or recorded with a government authority and that displays a vehicle registration plate and/or a vehicle registration certificate.

7.10.3 Data sources

Data for this indicator should be obtained from municipal or state departments or ministries responsible for transportation and vehicle registration in the city.

8 Environment and climate change

8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles

8.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Buildings that are constructed in conformity with green building principles are substantially more sustainable. 'Green' buildings are built with higher design standards which dramatically reduce energy consumption. Green buildings can also be built or refurbished according to green building standards, which offer continual building benchmarking to track environmental performance.

NOTE 2 This indicator reflects the "Community infrastructures" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" "Attractiveness" and "Well-being" purpose of the city as defined in ISO 37101.

8.1.2 Indicator requirements

The percentage of buildings built or refurbished within the last 5 years in conformity with green building principles shall be calculated as the total number of buildings built or refurbished within the last 5 years in conformity with green building principles (numerator) divided by the city's total number of buildings built or refurbished in the last 5 years (denominator). The result shall then be multiplied by 100 and expressed as the percentage of buildings built or refurbished within the last 5 years in conformity with green building principles.

Refurbishment of buildings shall refer to activities that have an aim to not only help to decrease energy consumption but also improve energy efficiency and lessen the environmental impacts of a building. Refurbishment shall not include the removal and/or replacement of buildings.

Green building principles shall refer to a set of guidelines and criteria against which a building can be judged to have been built in conformity to "green building". Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability and comfort. Green building is also known as sustainable or high-performance building.

Green buildings can be buildings that are built or refurbished in accordance with a green building standard and can be classified as a green building under standards such as BREEAM, LEED, CASBEE, HQE, BOMA BEST, BCA Green Mark, DGNB and ASGB. The building need not be certified as a green building, but can simply follow a green building standard throughout the construction process.

8.1.3 Data sources

Data on the number of buildings built or refurbished within the last 5 years in conformity with green building principles should be sourced from city departments and ministries that oversee the construction and maintenance of buildings in the city, or oversee building permits and standards.

8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2)

8.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A remotely operated, real-time air monitoring system can help to assess climate change impacts on the environment (e.g. air quality). Such systems can also provide real-time observations, data processing and analysis, giving people timely information on the city's air quality.

NOTE 2 This indicator reflects the "Health and care in community" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being", "Attractiveness" and "Preservation and improvement of environment" purpose of the city as defined in ISO 37101.

8.2.2 Indicator requirements

The number of real-time remote air quality monitoring stations per square kilometre (km^2) shall be calculated as the total number of real-time remote air quality monitoring stations in the city (numerator) divided by the city's land area (denominator). The result shall be expressed as the number of real-time remote air quality monitoring stations per km^2.

A monitoring station shall refer to a physical structure or device that uses specialized equipment and analytical methods to track pollutant levels, such as fine particles (PM2.5), carbon dioxide (CO_2) and sulfur dioxide (SO_2).

A real-time remote system shall refer to any form of technology that provides instantaneous information such as mobile applications. More specifically, a remote system consists of hardware, software, data and the people who use them. A remote system commonly includes communications technology, such as the Internet.

8.2.3 Data sources

The number of real-time remote air quality monitoring stations should be sourced from city departments or ministries that oversee the air quality of the city.

8.3 Percentage of public buildings equipped for monitoring indoor air quality

8.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Poor indoor air quality affects health, comfort and productivity of building occupants. These impacts can affect a large number of occupants and especially sensitive persons such as children or the elderly. To limit the health and economic consequences of poor indoor air quality, smart cities could measure and identify the sources and factors that influence the quality of indoor air and then propose appropriate solutions.

NOTE 2 This indicator reflects the "Health and care in the community" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Well-being" purpose of the city as defined in ISO 37101.

8.3.2 Indicator requirements

The percentage of public buildings equipped for monitoring indoor air quality shall be calculated as the total number of public buildings within the city that are equipped to monitor indoor air quality (denominator) divided by the total number of buildings in the city (denominator). The result shall then

be multiplied by 100 and expressed as the percentage of public buildings equipped for monitoring indoor air quality.

Public building shall refer to a government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station.

NOTE Ownership of buildings (public or private) is variously defined according to the region and political system. The restrictive definition used here permits global comparability across cities.

The monitoring of indoor air quality shall include primary pollutants (CO, Benzene, formaldehyde, radon, asbestos, Acetaldehyde, Toluene, Ethylbenzene, Xylenes).

8.3.3 Data sources

Data on the number of public buildings equipped for monitoring indoor air quality should be obtained from the local authorities, officials, or the Ministry or Department responsible for public buildings.

9 Finance

9.1 Annual amount of revenues collected from the sharing economy as a percentage of own-source revenue

9.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The sharing economy or peer-to-peer-based sharing of access to goods and services is a growing component of the municipal economy. The inclusion of these economies into existing policy allows for taxation, which supplements municipal capital budgets.

NOTE 2 This indicator reflects the “Economy and sustainable production and consumption” issue as defined in ISO 37101. It can allow an evaluation of the contribution to the “Attractiveness” and “Resilience” purpose of the city as defined in ISO 37101.

9.1.2 Indicator requirements

The annual amount of revenues collected from the sharing economy as a percentage of own-source revenue shall be represented as the total amount of funds collected per year from permit fees, user fees, licensing fees and taxes as permitted by law or legislation from sharing economy transactions (numerator) divided by the city’s total own-source revenue (denominator). The result shall then be multiplied by 100 and expressed as the annual amount of revenues collected from the sharing economy as a percentage of own-source revenue.

Total own-source revenue shall be calculated as the total revenue minus transfers.

The sharing economy shall refer to the use of digital platforms or portals to reduce the scale of viable hiring transactions or viable participation in consumer hiring markets (i.e. 'sharing' in the sense of hiring an asset) and thereby reduce the extent to which assets are under-utilized for accommodation, transportation, consumer durables, labour and human capital, and intellectual property. In a broad approach, the sharing economy is a socio-economic ecosystem built around the sharing of human and physical resources. It includes the shared creation, production, distribution, trade and consumption of goods and services by different people and organizations.

The sharing economy is also known as the on-demand economy, collaborative consumption or peer-to-peer economy.

9.1.3 Data sources

Data on taxes collected from the sharing economy should be sourced from relevant city departments or ministries that oversee municipal finance.

9.1.4 Data interpretation

The sharing economy or peer-to-peer-based sharing of access to goods and services is a growing component of the municipal economy. Although the sharing economy remains a contentious topic, the inclusion of the sharing economy into existing policy allows for taxation which supplements municipal capital budgets.

9.2 Percentage of payments to the city that are paid electronically based on electronic invoices

9.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The use of electronic invoices (e-invoices) and transfer of payments to the city increases security and reduces costs for the city and its businesses and citizens. Cities that combine e-invoice and e-transfers with automatic accounting and control systems can experience a noticeable increase in productivity.

NOTE 2 This indicator reflects "Economy and sustainable production and consumption", "Safety and security" and "Governance, empowerment and engagement" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" and "Responsible resource use" purpose of the city as defined in ISO 37101.

9.2.2 Indicator requirements

The percentage of payments to the city that are paid electronically based on electronic invoices (e-invoices) shall be calculated as the number of payments to the city that are made electronically based on an e-invoice (numerator) divided by the total number of payments made to the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of payments to the city that are paid electronically based on e-invoices.

Electronic invoicing (e-invoicing) shall refer to the exchange of an invoice document between the city and a business or a citizen in an electronic format. The invoice is generated directly from the relevant systems and is not just a scanned paper invoice or a Word/PDF document or paper invoice mailed to a business or citizen. Generating the e-invoice is therefore a natural part of the administrative working process.

Electronic payment is a payment via an electronic medium without the use of cash or cheques.

9.2.3 Data sources

Data on payments to the city that are paid electronically should be sourced from the economic department in the city or from other city departments responsible for payments.

9.2.4 Data interpretation

A high percentage of e-payments is an indication that cities are highly digitised.

10 Governance

10.1 Annual number of online visits to the municipal open data portal per 100 000 population

10.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Open data portals provide a means of increasing public access to data managed by municipalities. It creates greater transparency and allows for innovation by community organisations and citizens. Although many municipalities offer online portals, not all are equally visited.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" purpose of the city as defined in ISO 37101.

10.1.2 Indicator requirements

The annual number of online visits to the municipal open data portal per 100 000 population shall be calculated as the total number of municipal open data portal visits (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the annual number of online visits to the municipal open data portal per 100 000 population.

An open data portal shall refer to a data portal operated by the city and providing access to open data. Open data shall refer to structured, machine-readable and freely shared data that can be used and built upon without restrictions.

An online visit shall refer to an individual visitor who arrives at the city's open data portal online and proceeds to browse and peruse the open data portal. A visit counts all visitors, no matter how many times the same visitor has been to the open data portal.

10.1.3 Data sources

Data on the number of visits to the open data portal should be obtained from websites hosting statistics obtained from the municipality's website administration or provided by the domain host(s).

10.2 Percentage of city services accessible and that can be requested online

10.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Delivering city services that can be requested online through digital portals provide benefits to citizens and local governments. Municipalities can provide services without fixed hours and can provide these services with reduced resources. Moreover, the use of mobile technology, such as geotagging and photos, is aiding the efficiency and effectiveness of city services.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion" and "Attractiveness" purpose of the city as defined in ISO 37101.

10.2.2 Indicator requirements

The percentage of city services accessible and that can be requested online (i.e. via the Internet) shall be calculated as the total number of city services offered to people and businesses through a centralised Internet interface (numerator) divided by the total number of city services offered by the

city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of city services accessible and that can be requested online.

City services shall refer to services provided by the city including those contracted to third parties and typically cover the following areas: garbage and recycling; public safety; fire department; roads and traffic; bylaws, violations and enforcement; permits and licences; planning; building; policies, projects and initiatives; rentals and catering of city buildings; water and sewers; and property taxes and utilities. City services is a broad term encompassing the many "touch-points" cities have with citizens and businesses. Particularly for city services accessible online this term can include, for example, requesting and receiving permits; assessing and collecting taxes; lodging and addressing complaints; and requesting information on services within the city's jurisdiction or authority.

Where possible, cities shall report the percentage of users making a payment through an online e-fine system for traffic violations separately.

10.2.3 Data sources

An inventory of all city services offered must be taken to provide an accurate percentage output. Information on city services should be sourced from city departments or institutions that provide services. Figures on services available through web or mobile should also be obtained from city departments or institutions providing the service, or from the municipal government website administrators.

10.2.4 Data interpretation

As not all services can be requested and delivered online, a value of 100 % is not an objective.

10.3 Average response time to inquiries made through the city's non-emergency inquiry system (days)

10.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A non-emergency inquiry system is an important access point to municipal services. It refers to the response rate of non-emergency access points through various mediums including telephone, apps, Twitter, email and in-person contacts. The access point can be used by citizens as well as businesses.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Living and Working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness" and "Well-being" purpose of the city as defined in ISO 37101.

10.3.2 Indicator requirements

The average response time to inquiries made through the city's non-emergency inquiry system shall be expressed as the total number of hours from initial call/form submission taken to respond to all inquiries made through the city's non-emergency system (numerator) divided by the total number of inquiries received by the city's non-emergency system (denominator). The result shall be divided by 24 and expressed as average response time to inquiries made through the city's non-emergency inquiry system in days.

Inquiries shall refer to inquiries from citizens and business that refer to an existing problem that is economically and practically realistic to address on a shorter-term basis. It is not, for example, a request for a new bike lane or a new park, but it is an inquiry addressing a matter that is urgent and timely, such as reporting a dead animal, requesting the planting, pruning or removal of a tree, or making an accessibility complaint about a city programme or service.

An automatic return receipt shall not be counted as a response. A response should be personalised (e.g. immediate solution, a delay for resolving, or a clear explanation of non-relevance).

A non-emergency inquiry system shall refer to a system that citizens contact when their health, safety or property is not in immediate jeopardy, or there is not a crime in progress. Non-emergency inquiry systems can include hotlines, Internet-based applications (e.g. webpage, social media, mobile applications) that allow residents to submit an inquiry, such as a complaint about unfavourable city conditions or nuisances (e.g. report a pothole, request a street clean-up or graffiti removal, report a broken traffic signal) to a centralised location. The system dispatcher then relays the inquiry to the appropriate city authority.

10.3.3 Data sources

Data on the response time to relevant inquiries made through the city's non-emergency inquiry system should be sourced from records retained by the non-emergency inquiry system and the relevant city department dispatched to address the inquiry.

10.4 Average downtime of the city's IT infrastructure

10.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 In a commercial environment, the cost of downtime during a security incident – from lost sales and revenue to a loss of customer confidence – can negatively impact businesses. The equivalent impact to a city can be estimated on city service performances/commitments.

NOTE 2 This indicator reflects "Community infrastructures" and "Safety and security" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" and "Resilience" purpose of the city as defined in ISO 37101.

10.4.2 Indicator requirements

Average downtime of the city's IT infrastructure during an incident shall be calculated as the number of hours that the city's IT infrastructure is not available due to an incident (i.e. system power outage, scheduled maintenance) (numerator) divided by the total number of incidents causing IT infrastructure outages (denominator). The result shall be expressed as the average downtime of the city's IT infrastructure.

An incident shall include both planned and unplanned system outages of the city's IT infrastructure (i.e. website, payment systems). This can include planned system maintenance outages, as well as outages due to unexpected events such as cyberattacks and power outages.

IT infrastructure shall refer to hardware, software, networks, data centres, facilities and related equipment used to develop, test, operate, monitor, manage and/or support information technology services, for example, but not limited to, municipal data centres, computer servers and computers, multi-function devices and wireless devices.

10.4.3 Data sources

Data on the downtime of the city's IT infrastructure during an incident should be sourced from relevant city departments and ministries response for IT infrastructure.

11 Health

11.1 Percentage of the city's population with an online unified health file accessible to health care providers

11.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The digitisation and centralization of health histories enables health care providers to care for patients using a holistic approach. Health care providers, regardless of their speciality or location, can access the health history of these individuals and provide better care accordingly.

NOTE 2 Although health care is often beyond the jurisdiction of city-level governments, the availability of, and access to, primary health care is one characteristic of cities that has the potential to impact health, therefore representing an important area of focus for cities. Furthermore, city health care providers face enormous pressures and difficulties to reduce the cost of providing health care while improving the quality of that care. Allowing health care providers to access a patient's unified health file online can help overcome these problems.

NOTE 3 This indicator reflects the "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience, and "Well-being" purpose of the city as defined in ISO 37101.

11.1.2 Indicator requirements

The percentage of the city's population with an online unified health file accessible to health care providers shall be calculated as the total number of persons with an online unified health file that can be accessed by any type of health care provider (numerator) divided by the total population in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's population with an online unified health file accessible to health care providers.

A unified health file shall refer to a health file containing all of a patient's health records, which would usually otherwise be spread among multiple health care providers, resulting in fragmented care. The unified health file should show all medication and medical records made by public and private medical doctors. It brings together relevant information from different parts of the health service system, for example hospitals and family doctors, clinics and test centres.

Disclosure of data within a health care system shall be done with care and discretion, taking into consideration the privacy and security measures needed to ensure that the information will be used only to the benefit of citizens.

11.1.3 Data sources

Data on the number of persons with unified health histories that are accessible to health care providers should be sourced from local, regional or provincial health care providers or insurers, or relevant departments and ministries.

11.2 Annual number of medical appointments conducted remotely per 100 000 population

11.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Remote medical appointments provide a vital alternative to traditional walk-in appointments. Consideration could include aging populations, decreased mobility or limited access to transportation.

NOTE 2 This indicator reflects the "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience", "Social cohesion" and "Well-being" purpose of the city as defined in ISO 37101.

11.2.2 Indicator requirements

The annual number of medical appointments conducted remotely per 100 000 population shall be calculated as the total number of medical appointments conducted remotely, such as through online video services or teleconferencing (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the annual number of medical appointments conducted remotely per 100 000 population.

A medical appointment shall refer to a patient visit to a health care facility, in which a patient discusses their health needs and concerns with one or more health care providers. Only official consultations shall be included. Medical appointments conducted remotely shall include those enabled with video and teleconferencing technologies in accessible formats; mobile phones; remote data-collection equipment and telemonitoring (i.e. cardiac monitors). Face to face consultations shall be excluded.

11.2.3 Data sources

Data on the annual number of medical appointments conducted remotely should be sourced from departments or ministries that oversee the health care provided to people of the city and track modes of health care provided to its citizens.

11.3 Percentage of the city population with access to real-time public alert systems for air and water quality advisories

11.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Poor air and water quality affect human health and contribute to human mortality and morbidity in cities. Air quality alert systems provide important information and advice to the public to minimize air pollutant exposure. Similarly, water quality alert systems inform people whether or not the quality of the city's water is suitable for drinking, or use for other activities. Air and water quality alert systems can help to mitigate or lessen the impacts of pollutants on public health.

NOTE 2 This indicator reflects the "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience, and "Well-being" purpose of the city as defined in ISO 37101.

11.3.2 Indicator requirements

The percentage of the city population with access to real-time public alert systems for air and water quality advisories shall be calculated as the number of people with access to real-time public alert systems for air and water quality advisories (numerator) divided by the city's total population. The result shall then be multiplied by 100 and expressed as the percentage of the city population with access to real-time public alert systems for air and water quality advisories.

A public alert system for air and water quality shall refer to a system that reports and notifies the public on levels of pollutants, allergens and particulate matter, and releases to the public real-time data or data based on forecasting methods. It also facilitates early identification of local air and water pollution problems, and issues timely warnings of air and water pollution episodes (reflecting levels of particulate matter and pollutants) to the public via text message, email or pre-recorded voice message. An alert system can be in the form of mobile or online applications.

In some instances, air and water quality can be reported by two separate public alert systems, one responsible for air quality and another responsible for water quality. People registered with more than

one public alert system shall be counted once towards the calculation of this indicator. In addition, the calculation shall only include those people who reside in the city and exclude those that would not be included in the city's total population count, such that they reside beyond the city's administrative boundaries.

11.3.3 Data sources

Data on the number of people with access to real-time public alert systems should be sourced from relevant city departments that are responsible for the management of alert systems.

12 Housing

12.1 Percentage of households with smart energy meters

12.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Smart energy meters record and display the consumption of energy in real time. Smart meter data can be sent to a central location wirelessly, thus providing electricity providers with the means to understand how and when power is being used to better plan and conserve energy. Also, smart meter data help consumers better understand and monitor energy usage.

NOTE 2 This indicator reflects the "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Attractiveness" purpose of the city as defined in ISO 37101.

12.1.2 Indicator requirements

The percentage of households with smart energy meters shall be calculated as the total number of households with smart energy meters (numerator) divided by the total number of households in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of households with smart energy meters.

A smart energy meter shall refer to an energy meter that includes in-home, online visualized real-time digital displays or that is available through a real-time online application so customers can better understand their energy usage. Also, a smart energy meter can digitally send meter readings to an energy supplier for more accurate energy bills, and for better planning and conservation of energy by providers.

Where possible, the percentage of households with smart energy meters by type of energy should be reported separately in the table.

	Percentage of households with smart energy meters (by type of energy)
Electricity	
Gas	
Heat networks (district heating)	

12.1.3 Data sources

Data on smart energy meter figures should be sourced from local or regional energy providers, or relevant city departments or ministries that have data on local smart energy meters.

12.2 Percentage of households with smart water meters

12.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Smart water meters record and display the consumption of water in real time. Smart meter data can be sent to a central location wirelessly, thus providing water providers with the means to understand how and when water is being used to better plan and conserve water. Also, smart meter data help consumers better understand and monitor water usage.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Attractiveness" purpose of the city as defined in ISO 37101.

12.2.2 Indicator requirements

The percentage of households with smart water meters shall be calculated as the total number of households with smart water meters (numerator) divided by the total number of households in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of households with smart water meters.

A smart water meter shall refer to a water meter that includes in-home real-time digital displays with online visualized real-time information or that is available through a real-time online application, so customers can better understand their water usage. Also, a smart water meter can digitally send meter readings to a water supplier for more accurate water bills, and for better planning and conservation of water by providers.

12.2.3 Data sources

Data on smart water meters should be sourced from local or regional water providers, or relevant city departments or ministries that hold data on local smart water meters.

13 Population and social conditions

13.1 Percentage of public buildings that are accessible by persons with special needs

13.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Public buildings that are accessible by persons with special needs create an inclusive city by removing barriers for persons affected by mobility challenges.

NOTE 2 This indicator reflects "Living together, interdependence and mutuality" and "Living environment and working" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion", "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

13.1.2 Indicator requirements

The percentage of public buildings that are accessible by persons with special needs shall be calculated as the number of public buildings within the city that are accessible by persons with special needs (numerator) divided by total number of public buildings in the city (denominator). The result shall then be multiplied by 100 and expressed as a percentage.

The definition of an accessible public building shall be based on the relevant national standard to identify, remove and prevent barriers so that people with special needs have more opportunities in everyday life. Accessible public buildings typically include these requirements:

— accessible parking spaces

— accessible main entrance

— automatic doors

— sufficient light

— accessible washrooms

— elevators to all floors

Public building shall refer to a government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station.

NOTE Ownership of buildings (public or private) is variously defined according to the region and political system. The restrictive definition used here permits global comparability across cities.

13.1.3 Data sources

Information should be obtained from the local authorities, officials, or the Ministry or Department responsible for public buildings.

13.2 Percentage of municipal budget allocated for the provision of mobility aids, devices and assistive technologies to citizens with special needs

13.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Ensuring a city is accessible for all its citizens and visitors promotes an equitable and inclusive society. Allocating a portion of the municipal budget for provision of mobility aids, devices and assistive technologies to citizens with special needs helps to maintain the accessibility of the city for all its citizens and visitors and to support autonomy (and homecare) of persons with special needs, including seniors.

NOTE 2 This indicator reflects the “Governance, empowerment and engagement” and “Living together, interdependence and mutuality” issues as defined in ISO 37101. It can allow an evaluation of the contribution to “Well-being”, “Social cohesion” and “Attractiveness” purpose of the city as defined in ISO 37101.

13.2.2 Indicator requirements

The percentage of the municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs shall be calculated as the sum of the cost of providing mobility aids, devices and assistive technologies the city spends in one fiscal year (numerator) divided by the total city budget allocated for a given year (denominator). The result shall then be multiplied by 100 and expressed as a percentage.

13.2.3 Data sources

Data for the amount of the municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs should be sourced from the municipal budget and audited financial documents, or departments or ministries overseeing municipal spending on the provision of mobility aids, devices and assistive technologies to citizens with special needs.

13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals

13.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Accessible pedestrian signals enable persons with special needs to safely cross intersections and to perform their daily activities.

NOTE 2 This indicator reflects the "Living together, interdependence and mutuality" and "Community infrastructures" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being", "Social cohesion" and "Attractiveness" purpose of the city as defined in ISO 37101.

13.3.2 Indicator requirements

The percentage of marked pedestrian crossings equipped with accessible pedestrian signals shall be calculated as the number of marked pedestrian crossings equipped with accessible pedestrian signals (numerator) divided by the total number of marked pedestrian crossings (denominator). The result shall then be multiplied by 100 and expressed as the percentage of marked pedestrian crossings equipped with accessible pedestrian signals.

Accessible pedestrian signals shall refer to devices that communicate the intervals that a crossing is safe or unsafe to enter either using non-visual communication, usually audible or vibrotactile (i.e. vibrations), or as a complement to visual signals.

13.3.3 Data sources

Data on the percentage of marked pedestrian crossings equipped with accessible pedestrian signals should be sourced from city departments or ministries that oversee public pathways and traffic signals.

13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide

13.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 As cities experience a demographic shift, the need for age-friendly urban design and city services is becoming ever more critical. Cities need to address the consequences of this unprecedented demographic shift through age-friendly planning and city services. Developing programmes (for example, technology classes for senior citizens) is one way to create an environment in which senior citizens, but also people with disabilities, can acquire or improve technological skills to actively participate in a technology-driven society and fight against digital divide. This also empowers citizens to become active users of new technology.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Living together, interdependence and mutuality" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being", "Social cohesion" and "Attractiveness" purpose of the city as defined in ISO 37101.

13.4.2 Indicator requirements

The percentage of the municipal budget allocated for the provision of programmes designated for bridging the digital divide shall be calculated as the sum of the city's annual expenditure on programming designated for bridging the digital divide (numerator) divided by the city's total annual budget (denominator). The result shall then be multiplied by 100 and expressed as a percentage of municipal budget allocated for the provision of programmes designated for bridging the digital divide.

Digital divide shall refer to the economic, educational and social inequalities in access to information and communication technology, such as computers or the Internet. Programming designated for bridging the digital divide can include, but is not limited to, programmes to help lower-income and vulnerable people (e.g. children, youths and seniors) get access to, and learn about, new technologies by providing hardware, software and Internet access.

13.4.3 Data sources

Data on municipal budgets allocated for provision of programmes designated for bridging the digital divide should be sourced from the municipal budget.

14 Recreation

14.1 Percentage of public recreation services that can be booked online

14.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Online recreation booking offers increased accessibility and awareness for the public, as well as data sources for public recreation participation.

NOTE 2 This indicator reflects the "Living environment and working" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being" purpose of the city as defined in ISO 37101.

14.1.2 Indicator requirements

The percentage of public recreation services that can be booked online shall be calculated as the number of public recreation services that can be booked online (numerator) divided by total number of public recreation services that a city offers (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public recreation services that can be booked online.

Recreation services shall refer to services that operate facilities or provide services that enable people to participate in sports or recreational activities or pursue amusement, hobbies and leisure-time interests. Recreational services could include the city providing public recreation space, which is defined broadly as land and buildings open to the public for recreation, such as swimming, sports and skating facilities and fitness centres. Also, city recreation services could include city-run programmes, camps and facility rentals.

14.1.3 Data sources

The percentage of public recreation services that can be booked online should be sourced from relevant city departments or ministries that oversee public recreation, or departments that are responsible for online administration.

15 Safety

15.1 Percentage of the city area covered by digital surveillance cameras

15.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The presence of surveillance cameras is a deterrent against crime and other offences. When incidents do occur, video surveillance offers an accurate representation of the events, as well as key information to solve crimes and other offences. Digital cameras are more reliable than film, and they have higher capacity, better picture quality, and create files that are easily distributed and difficult to tamper with.

NOTE 2 This indicator reflects the "Safety and security" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being" and "Attractiveness" purposes of the city as defined in ISO 37101.

15.1.2 Indicator requirements

The percentage of the city area covered by digital surveillance cameras shall be calculated as the amount of city land area covered by digital video surveillance cameras in square kilometres (numerator) divided by the city's total land area (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city area covered by digital surveillance cameras.

Digital surveillance cameras, sometimes referred to as Internet protocol (IP) cameras, shall refer to video cameras that can send and receive data via a computer network, as opposed to sending a feed to a digital video recorder (DVR) (i.e. disk/USB drive). Measurement of coverage is determined by the technical specifications of the systems in use.

This indicator shall include digital surveillance accessible by the city, such as any digital video surveillance the city or law enforcement can directly access, without the permission of, or request from, private camera owners.

In using digital surveillance camera systems, one should take into consideration how the data/images are used, as well as the privacy and security measures needed to ensure the safety of citizens.

15.1.3 Data sources

Data on the percentage of the city area covered by digital surveillance cameras should be sourced from local law enforcement and safety departments, ministries or agencies.

15.1.4 Data interpretation

The density of surveillance cameras in a city's area should be interpreted together with other safety and security indicators, so that cities can respond if more surveillance cameras are bringing greater benefits for security. Careful interpretation of this indicator is needed because it can be used inappropriately for political reasons or to advance the assumption that more surveillance necessarily brings more safety and security.

16 Solid waste

16.1 Percentage of waste drop-off centres (containers) equipped with telemetering

16.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

Drop-off centre (container) collection is defined as follows: it is a collection mode where the community gives to the population a network of bins that are spread around the city area and are available for all citizens with open access. The citizen does not have a proper bin. He or she should dispose of the sorted materials on a site which is organized by the community, for example a container next to a public road, parking facilities or a commercial centre, or a district collection point.

Collection trucks will collect the bins (containers) from the allocated points in the city. When trucks are equipped with telemetering to optimize their rounds depending on bin filling, this can be considered as access for citizens to drop-off collection with telemetering.

NOTE 1 Many cities have to limit traffic in the city and simplify garbage collection organization. Moreover, many cities have streets that are narrow and substandard and that provide only limited access to households and neighbourhoods. In cities in less developed countries, roads and pathways are not always accessible to garbage trucks for collection. Developing waste drop-off centres with telemetering (where citizens bring their waste) is a local solution that could help cities reach the objective of reducing traffic in the city, overcoming limited access, and simplifying garbage collection and disposal. Telemetering aids in the optimization and efficiency of garbage collection by informing garbage collection trucks on the level of waste currently held in containers at the drop-off centre.

NOTE 2 This indicator reflects the “Community infrastructures”, “Economy and sustainable production and consumption” and “Mobility” issues as defined in ISO 37101. It can allow an evaluation of the contribution to the “Responsible resource use” and “Preservation and improvement of environment” purposes of the city as defined in ISO 37101.

16.1.2 Indicator requirements

The percentage of waste drop-off centres (containers) equipped with telemetering shall be calculated as the number of waste drop-off centres (containers) for garbage disposal equipped with telemetering devices (numerator) divided by the total waste drop-off centres (containers) within the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of waste drop-off centres (containers) equipped with telemetering.

A waste drop-off centre (container) shall refer to a place where people bring waste in accordance with sorting criteria. Drop-off centres can, for example, be placed near a public road or on a parking facility. People who use a drop-off centre do not have a private waste container. Collection trucks will collect the bins at the drop-off centre (container).

Waste drop-off centres (containers) and garbage collection vehicles are equipped with telemetering to optimize garbage collection rounds based on information about bin filling.

Telemetering shall refer to measurement with the aid of intermediate means which permits the measurement to be interpreted at a distance from the primary detector. The distinctive feature of telemetering is the nature of the translating means, which includes provision for converting the measure into a representative quantity of another kind that can be transmitted conveniently for measurement at a distance. If a waste drop-off centre (container) has telemetering, the amount of garbage in a waste drop-off centre (container) can be transmitted to garbage collection trucks remotely.

16.1.3 Data source

Data on the percentage of waste drop-off centres equipped with telemetering should be sourced from city departments that oversee garbage/waste drop-off centres.

16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities

16.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Individual monitoring of household waste quantities provides valuable information for both citizens and cities. Understanding the weight of household waste can help optimize garbage collection and reduce costs. In addition, telemetering reduces street traffic by adapting the number of vehicles to the actual quantity of waste to be collected. Benefits are a more fluent traffic with consequences for the reduction of GHG emissions, better design of collection rounds, and better allocation of human resources with corresponding savings.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

16.2.2 Indicator requirements

The percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities shall be calculated as the number of people living in the city where there is a door-to-door household garbage collection equipped with monitoring device (numerator) divided by the city's total population (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities.

Door-to door garbage collection shall refer to the service of collecting where the container is allocated to an identifiable group of users. The point of collection of selected wastes is located in proximity to the user's home.

Individual waste collection containers and garbage collection vehicles equipped with telemetering to optimize garbage collection based on information about bin filling can be considered as door-to-door garbage collection with an individual monitoring of household waste quantities.

Telemetering shall refer to measurement with the aid of intermediate means which permits the measurement to be interpreted at a distance from the primary detector. The distinctive feature of telemetering is the nature of the translating means, which includes provision for converting the measure into a representative quantity of another kind that can be transmitted conveniently for measurement at a distance.

16.2.3 Data sources

Data on the percentage of the city population that has door-to-door garbage collection equipped with individual monitoring (including telemetering data) should be sourced from relevant city departments that oversee waste collection services and door-to-door garbage collection.

16.3 Percentage of total amount of waste in the city that is used to generate energy

16.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Waste which has significant organic matter content can be a source of energy either directly by recovering heat from energy from a waste plant (incinerator) or by producing energy from the digestion of waste or other new technologies using this energy for cogeneration, biomethane production for injection in the gas network, or for fuel production.

In a context where energy consumption from fossil energy resources should be decreased for sustainable development purposes, it is advantageous to use this source of heat, electricity, gas or fuel for other services across the city (i.e. heating of swimming pools, fuels for city vehicle fleet, energy sales to local industries). It is also a way for the city to achieve a level of energy independence.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

16.3.2 Indicator requirements

Percentage of total amount of waste in the city that is used to generate energy shall be calculated as the total amount of waste utilized to generate energy (numerator) divided by the total amount of waste generated in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the total quantity of waste in the city that is used to generate energy.

Energy generated from the waste treatment plant shall be expressed in GJ per year.

The total amount of waste utilized to generate energy shall refer to waste treatment having a positive net energy production rate.

16.3.3 Data sources

Data on the quantity of waste in the city can be derived from ISO 37120 indicator "collected municipal solid waste per capita" multiplied by the population of the city.

Data on the total amount of waste in the city that is used to generate energy should be sourced from local utilities, or relevant city departments that oversee waste treatment and related energy generation.

16.4 Percentage of total amount of plastic waste recycled in the city

16.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Plastic waste is a global environmental issue. To prevent the dispersion in the environment of plastics the best solution is to limit the production of plastics and develop plastic recycling. Taking into account the potential ecological impacts of microplastics on waterbodies and oceans, cities can promote plastic recycling within their territories. This necessitates the monitoring of plastic production and promotes increased use of recycled plastics within other products.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

NOTE 3 During the procurement phase, communities could consider the percentage of plastics recycled and introduced into products as selective criteria.

16.4.2 Indicator requirements

The percentage of the total amount of plastics waste recycled shall be calculated as the total amount of plastics coming out of sorting plants and recycled (numerator) divided by the total amount of plastics on the market within the city boundaries (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the total quantity of recycled plastics in the city.

16.4.3 Data sources

Data on the quantity of plastics issued from waste sorting plants in the city should be sourced from local utilities, or relevant city departments that oversee waste treatment. Data on plastics on the city market should be sourced from commercial activities, industrial activities and waste collection utilities for household consumption or from the plastic industry.

16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins

16.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Solid waste management and monitoring requires immediate attention in all cities. Sensor-enabled solutions for public garbage bins is one way cities can improve waste monitoring and collection of public garbage bins. Sensor-enabled garbage bins can lead to optimised route planning and scheduling of waste collection, potentially leading to significant cost reductions in solid waste collection.

NOTE 2 This indicator reflects "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

16.5.2 Indicator requirements

The percentage of public garbage bins that are sensor-enabled public garbage bins shall be calculated as the number of public garbage bins that are sensor-enabled (numerator) divided by the total number of public garbage bins in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public garbage bins that are sensor-enabled public garbage bins.

Public garbage bins shall refer to garbage bins provided by the city that are in public spaces, such as on the streets and in public parks.

Sensor-enabled public garbage bins shall refer to public garbage bins that are equipped with a sensor, or sensors, that monitors the level of garbage and that are part of a larger network of sensor-enabled garbage bins connected through telecommunication networks that generate data and allows for remote monitoring of fill levels.

16.5.3 Data sources

Data on public trash bins should be obtained from the municipal departments responsible for municipal solid waste or the primary municipal solid waste company/companies.

16.6 Percentage of the city's electrical and electronic waste that is recycled

16.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 With the rapid increase in the popularity of cellular phones, computers, televisions and other electronic devices, it is increasingly important that cities ensure that electronic waste (or e-waste) undergoes environmentally sound management at the end of its useful life. E-waste recycling programmes help keep electronic devices out of landfills and recover useful resources.

NOTE 2 This indicator reflects "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

16.6.2 Indicator requirements

The percentage of the city's electrical and electronic waste that is recycled shall be calculated as the total amount of the city's electrical and electronic waste that is recycled in tonnes (numerator) divided by the total amount of electrical and electronic waste produced in the city in tonnes (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's electrical and electronic waste that is recycled.

Electrical and electronic waste, commonly referred as e-waste, shall refer to electronics such as computers, printers or fax machines, televisions or computer displays, audio-video equipment (including DVD players, VCRs, speakers and portable digital music players), cellular phones and electronic gaming equipment.

This indicator shall include electrical and electronic waste produced by all property classes: residential, commercial, industrial and public buildings.

Recycling shall refer to diversion, recovery and/or reprocessing of materials from the waste stream, following local government permits and regulations[4].

16.6.3 Data sources

Data on e-waste should be sourced from the municipal departments responsible for municipal solid waste or the primary municipal solid waste company/companies.

17 Sport and culture

17.1 Number of online bookings for cultural facilities per 100 000 population

17.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Cultural facilities and cultural/sporting events play a pivotal role in connecting people and in building a more cohesive and open society. The digitisation of access to cultural institutions helps to increase the availability of cultural resources to a broader audience.

NOTE 2 This indicator reflects the "Education and capacity building" and "Culture and community identity" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion" and "Well-being" purposes of the city as defined in ISO 37101.

17.1.2 Indicator requirements

The number of online bookings for cultural facilities per 100 000 population shall be calculated as the number of online bookings for cultural facilities (numerator) divided by 1/100 000 of the city's total population (denominator).

A cultural facility shall refer to a public or non-profit institution within a city which engages in the cultural, intellectual, scientific, environmental, educational, sporting or artistic enrichment of the people living in a city. "Cultural facilities" includes, without limitation, aquaria, botanical societies, historical societies, land conservation organisations, libraries, museums, performing arts associations or societies, scientific societies, wildlife conservation organisations, sporting facilities (i.e. indoor and outdoor arenas, fields) and zoological societies. "Cultural facilities" should not include educational institutions (i.e. schools) or institutions primarily engaged in religious or sectarian activities.

17.1.3 Data sources

Data of the number of online bookings for cultural facilities should be sourced through relevant ministries and departments that are responsible for cultural facilities and centres.

17.1.4 Data interpretation

This indicator measures how an online booking system can increase the availability of cultural resources to a broader audience.

17.2 Percentage of the city's cultural records that have been digitised

17.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The process of digital preservation, or digitisation, is the formal endeavour of ensuring digital information, such as digital data, is managed to ensure continued access and usability. The digital preservation of cultural records is one form of digital preservation which ensures cultural artefacts are maintained for future users. Furthermore, digital preservation connects and provides people with wider access to heritage materials, which helps to stimulate an innovative information society. Digitisation of a city's cultural record contributes to the conservation and preservation of heritage and scientific resources; it creates new educational opportunities; it can be used to encourage tourism; and it provides ways of improving access by citizen to their heritage.

NOTE 2 This indicator reflects the "Culture and community identity" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience" and "Attractiveness" purposes of the city as defined in ISO 37101.

17.2.2 Indicator requirements

The percentage of the city's cultural records that have been digitised shall be calculated as the number of the city's cultural records that have been digitised (numerator) divided by the total number of cultural records of the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of cultural records that have been digitised.

Digitisation shall refer to the conversion of traditional, analogue materials such as books, maps and other physical (i.e. paper records) items into an electronic, digital copy.

Cultural records shall refer to the tangible cultural heritage, or the legacy of physical artefacts and texts, of a city and include movable cultural heritage (paintings, sculptures, coins, manuscripts); immovable cultural heritage (e.g. monuments, archaeological sites); and underwater cultural heritage (shipwrecks, underwater ruins and cities), if applicable[9]. The cultural record of a city is most likely vast, especially when considering the cultural record in all its myriad forms. Therefore, this indicator shall only include the tangible cultural heritage owned and/or managed by the city to ensure data accessibility, and excludes any privately owned components of a city's cultural record.

17.2.3 Data sources

Data on the cultural record of a city should be sourced through relevant city archives, or relevant departments and ministries.

17.3 Number of public library book and e-book titles per 100 000 population

17.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Libraries help to educate the general population, in addition to providing civic spaces for interaction. Libraries can be considered a local gateway to knowledge, and provide "a basic condition for lifelong learning, independent decision-making and cultural development of the individual and social groups"[10]. Ultimately, as stated in UNESCO's Public Library Manifesto, "the public library [can be thought of as] a living force for education, culture and information, and as an essential agent for the fostering of peace and spiritual welfare through the minds of men and women."

E-books have become popular among the public due to their ease of accessibility, allowing citizens to more conveniently continue lifelong learning and cultural development, and be exposed to a plethora of information.

Furthermore, the availability of e-books indicates the level of digitisation of a community's libraries, and also the ease of access to books via a library's website. Moreover, e-books are comparatively more eco-friendly and promote sustainability, since e-books require less paper and labour to manufacture, and do not require shelf space. E-books have grown significantly in popularity and prevalence within the publishing industry.

NOTE 2 This indicator reflects the "Education and capacity building" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion" and "Well-being" purposes of the city as defined in ISO 37101.

17.3.2 Indicator requirements

The number of library book and e-book titles per 100 000 population shall be calculated as the total number of library book titles and the total number of library e-book titles (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the number of library book titles per 100 000 population.

Public libraries shall refer to libraries within a city's administrative boundaries.

The proportion of e-books within the total number of library books shall be specified.

The city shall include in this indicator the number of library book and e-book titles available to its citizens from public libraries. The city shall count any book titles available and accessible at a public library within city limits, and include both physical books/monographs and e-books, which include those books/monographs that have been digitised and are available for reading on a computer or other electronic device. A public library is any library that has an organized collection of printed or other library materials, or a combination thereof, is supported in whole or in part with public funds and has an established schedule in which services of the staff are available to the public.

	Number of public library book titles
E-books	
Books	

17.3.3 Data sources

Data on the number of library book titles should be sourced through local libraries, library boards or the relevant city departments, or through ministries.

17.4 Percentage of city population that are active public library users

17.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Libraries help to educate the general population, in addition to providing civic spaces for interaction. The number of active library users is a measure of the reach and effectiveness of local libraries providing "a basic condition for lifelong learning, independent decision-making and cultural development of the individual and social groups"[10].

NOTE 2 This indicator reflects the "Education and capacity building" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion" and "Well-being" purposes of the city as defined in ISO 37101.

17.4.2 Indicator requirements

The percentage of the city population that are active public library users shall be calculated as the total number of city residents that are active library users measured as citizens who are registered public library members or measurably use library services (numerator) divided by the city's total population (denominator). The result shall then be multiplied by 100 and expressed as a percentage of city population that are active public library users.

An active public library user shall refer to a registered public library member, or an individual with a user account at a public library who frequently utilizes library services with at least one transaction per month, such as accessing library/online databases to download articles or e-books that require library user privilege, or signing out library books. The active library users accounted for in this indicator shall only include those users who reside in the city.

The city shall include in this indicator the number of active library users who are library members at public libraries, or are measurably known to access the preceding library services. The city shall count any active library users with a public library within city limits. Users from outside the administrative boundaries shall be excluded. A public library is any library that has an organized collection of printed or other library materials, or a combination thereof, is supported in whole or in part with public funds and has an established schedule in which services of the staff are available to the public.

17.4.3 Data sources

Data on the number of active library users should be sourced through local libraries, library boards or the relevant city departments, or through ministries.

17.4.4 Data interpretation

A high number of active library users indicates that the city’s libraries meet the needs of the population and that libraries help to educate the population.

18 Telecommunication

18.1 Percentage of the city population with access to sufficiently fast broadband

18.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Sufficiently fast broadband helps enable individuals to exercise their right to freedom of opinion and expression, and promotes the progress of society through wider access to information. It has most recently become a fundamental human right as identified by the United Nations, and provides citizens with the opportunity to explore and retrieve information that is available on the World Wide Web.

NOTE 2 This indicator reflects the “Community infrastructures” issue as defined in ISO 37101. It can allow an evaluation of the contribution to “Social cohesion and “Attractiveness” purposes of the city as defined in ISO 37101.

18.1.2 Indicator requirements

The percentage of the city population with access to sufficiently fast broadband shall be calculated as the total number of people in the city with access to sufficiently fast broadband (numerator) divided by the city’s total population (denominator). The total shall then be multiplied by 100 and expressed as the percentage of the city population with access to sufficiently fast broadband.

Broadband shall refer to the data transmission capacity associated with a particular speed of transmission and the provision of high-speed Internet access. Broadband provides support to

applications such as web-browsing, video services IP TV, and so forth. Broadly speaking, broadband infrastructure is the underlying communication infrastructure that is deployed to enable the provision of broadband services, that is, Internet access at a certain speed/bandwidth.

Sufficiently fast broadband shall refer to a network capable of speeds of no less than 256 kbit/s in both directions, uploading and downloading. This speed is sufficient for Internet surfing and emailing. Sufficient speed shall take into consideration the potential demands from service providers and their recipients on the network.

18.1.3 Data sources

Data on the number of people with access to sufficiently fast broadband data should be sourced from local broadband service providers, relevant departments or ministries, or companies that oversee broadband services.

18.2 Percentage of city area under a white zone/dead spot/not covered by telecommunication connectivity

18.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Telecommunication enables not only communication without barriers, but access to services such as the Internet. White zones and dead spots are therefore a hindrance to communication and access to basic services.

NOTE 2 This indicator reflects the “Community infrastructures” issue as defined in ISO 37101. It can allow an evaluation of the contribution to “Social cohesion” and “Attractiveness” purposes of the city as defined in ISO 37101.

18.2.2 Indicator requirements

The percentage of the city area under a white zone/dead spot/not covered by telecommunication connectivity shall be calculated as the total city land area classified as being under a white zone/dead spot/not covered by telecommunication connectivity in square kilometres (numerator) divided by the city’s total land area in square kilometres (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city area under a white zone/dead spot/not covered by telecommunication connectivity.

A white zone/dead spot/not covered by telecommunication connectivity shall refer to an area without telecommunication (i.e. Internet, telephone or mobile) connectivity and function, typically due to radio interference or range issues.

18.2.3 Data sources

Data on the city area under a white zone/dead spot/not covered by telecommunication connectivity should be sourced from local Internet service providers, or relevant city departments or ministries that oversee the building of telecommunication infrastructure.

18.3 Percentage of the city area covered by municipally provided Internet connectivity

18.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A public Internet connection allows people who do not have mobile data plans or regular Internet access to connect to the Internet, enabling them to take advantage of the economic and social benefits the Internet can offer. In addition, publicly accessible Internet can help enable municipalities to passively track users for future planning purposes.

NOTE 2 This indicator reflects the "Community infrastructures" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" purposes of the city as defined in ISO 37101.

18.3.2 Indicator requirements

The percentage of the city area covered by municipally provided Internet connectivity shall be calculated as the total land area of the city serviced with Internet connectivity in square kilometres (numerator) divided by the city's total land area in square kilometres (denominator). The total shall then be multiplied by 100 and expressed as the percentage of the city area covered by municipally provided Internet connectivity.

Municipally provided Internet connectivity shall refer to Internet connectivity services provided by the city or third-party providers under license by the city to the public, and shall be accessible by anyone (visitor or resident) within city limits. Municipally provided Internet service shall include connectivity with free, partial or full payment.

Publicly available places for Internet connectivity are defined by location, not by routers. For example, if multiple routers exist within a park, the park would be considered only as one place. Public places shall include, but are not limited to, parks, outdoor spaces, buildings, transport routes and transport hubs and stations.

18.3.3 Data sources

Data on the city area covered by municipally provided Internet connectivity should be sourced from departments or ministries responsible for a city's information technology and managing publicly accessible Internet figures, or can be estimated utilizing GIS tools.

19 Transportation

19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information

19.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The prominence and growth of online civic tools have created a culture of sharing civic data in real time, including online traffic alerts and information. These data can be user-driven by utilizing geospatial crowdsourcing of mobile data, or collected through sensors or cameras installed by road and transportation authorities. The application of such technologies enables authorities to efficiently plan for future conditions, and for users to effectively travel through city streets and thoroughfares.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness", "Well-being" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

19.1.2 Indicator requirements

The percentage of city streets and thoroughfares covered by real-time online traffic alerts and information shall be calculated as the number of street and thoroughfare kilometres within the city covered by real-time online traffic alerts and information (numerator) divided by the total number of street and thoroughfare kilometres within city limits (denominator). The result shall then be multiplied by 100 and expressed as the percentage of city streets and thoroughfares covered by real-time online traffic alerts and information.

Streets and thoroughfares shall refer to all local roads, streets and major and minor arterial roads of the city.

A real-time information system shall refer to any information processing system which shall respond to externally generated input stimuli within a finite and specified period. In the context of online traffic alerts and information, "real-time" corresponds to traffic information that is instantaneously available and reflects current traffic levels at any given time.

19.1.3 Data sources

Data on streets and thoroughfares covered by real-time online traffic alerts and information should be sourced from relevant city departments, or institutions that manage and disseminate online content pertaining to traffic of a particular region.

19.2 Number of users of sharing economy transportation per 100,000 population

19.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Cities are increasingly utilizing sharing economy transportation to supplement existing mobility needs. The extent to which policymakers and planners are aware of the number of users of sharing economy transportation in the city will allow for better development of plans and reconfiguration of a city's transportation system to accommodate for these changes.

NOTE 2 This indicator reflects the "Mobility" and "Living together, interdependence and mutuality" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.2.2 Indicator requirements

The number of users of sharing economy transportation per 100 000 population shall be calculated as the total number of users actively using sharing economy transportation (numerator) divided by 1/100 000 of the city's total population (denominator).The result shall be expressed as the number of users of the sharing economy transportation per 100 000 population.

The sharing economy shall refer to any form of economic activity where platforms enable providers and customers to exchange often underutilized goods and services using information technology (see ISO/IWA 27:2017). The sharing economy consists of marketplaces and platforms that allow individuals and organisations to buy and sell goods and services directly from one another, and rent, share or lend goods or assets on a short-term or time-share basis. Sharing economy transportation for this indicator shall refer to any transportation modes in which individuals can utilize assets owned by another individual or organization, such as ride-sharing services and automobile-sharing services.

19.2.3 Data sources

Data on the number of users of sharing economy transportation should be sourced from relevant city departments or sharing economy transportation service organisations. Given the tensions between

municipal authorities and sharing economy transportation providers in many jurisdictions, it might be difficult for cities to access the required data.

19.2.4 Data interpretation

Although the sharing economy transportation is a reality for many cities, there are potential adverse impacts on public transport. There is an increasing body of evidence that ride-sharing might be cannibalising ridership from public transit.

19.3 Percentage of vehicles registered in the city that are low-emission vehicles

19.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Low-emission vehicles provide an alternative to traditional vehicles operating with internal combustion engines, which expel noxious gasses such as unburned hydrocarbons. Low-emission vehicles have the potential to improve local air quality.

NOTE 2 This indicator reflects the "Health and care in the community" and "Living and working environment" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being" and "Attractiveness" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

19.3.2 Indicator requirements

The percentage of vehicles registered in the city that are low-emission vehicles shall be calculated as the total number of registered and approved low-emission vehicles registered in the city (numerator) divided by the total number of registered vehicles in the city (denominator). The result shall be multiplied by 100 and expressed as a percentage of vehicles registered in the city that are low-emission vehicles.

Low-emission vehicles shall refer to vehicles that emit low levels of emissions and can include electric, hybrid and hydrogen-fuel-cell-driven vehicles. Low-emission vehicles shall be certified under appropriate exhaust emission standards and the vehicle shall meet other special requirements applicable to conventional or clean-fuel vehicles and their fuels.

NOTE Air quality is measured in ISO 37120:2018, 8.1 and 8.2.

19.3.3 Data sources

The number of registered and approved low-emission vehicles should be sourced from city departments, or institutions that oversee vehicle registration.

19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population

19.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Bicycle sharing or a bike-share scheme is a service in which bicycles are made available for shared use to individuals on a short-term basis. Generally, individuals can borrow and return the bike at different locations. Bicycle sharing promotes greater rates of bicycle use in cities by reducing traditional barriers to ridership, including costs, bicycle theft and repair. Bicycle sharing provides an alternative to traditional transportation modes such as public transit or private automobiles. This indicator provides municipalities with a measure of the availability of bicycles in the bicycle share system.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.4.2 Indicator requirements

The number of bicycles available through municipally provided bicycle-sharing services per 100 000 population shall be calculated as the total number of bicycles available through municipally provided bicycle-sharing services in the city (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the number of bicycles available through municipally provided bicycle-sharing services per 100 000 population.

Bicycle-sharing services shall refer to a bicycle sharing system with bicycles available through self-serve docking stations, or person-operated docking stations, located throughout a city, where bicycles can be rented as needed. Users should be able to rent and return bicycles to any docking station within the bicycle-sharing system. Municipally provided bicycle-sharing services shall refer to bicycle-sharing services funded and operated by the city. This shall also include bicycle-sharing services operated under a licence or contract agreement with the municipality, such as public-private partnerships.

19.4.3 Data sources

Data on the number of bicycles available through bicycle-sharing services in the city should be sourced from relevant city departments that oversee and/or collect data on bicycle shares.

19.5 Percentage of public transport lines equipped with a publicly accessible real-time system

19.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Real-time information on public transport lines can be shared with citizens to avoid traffic congestion and long waits for services that are delayed or cancelled. Publicly accessible real-time alerts keep citizens well-informed of the city's public transport services.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.5.2 Indicator requirements

The percentage of public transport lines equipped with a publicly accessible real-time system shall be calculated as the number of public transport lines that are equipped with a publicly accessible real-time system to provide people with real-time operation information (numerator) divided by the total number of public transport lines within the city limits (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public transport lines equipped with a publicly accessible real-time system.

A public transport line shall refer to a portion of the public transport network where a public transport vehicle departs and arrives from two points of the public transport network in a single, continuous, trip and follows a timetable with driving and stopping times, which should be the same at all times. The computation of this indicator shall include both rail-based and road-based public transport, cable car and waterway transport. A public transport line shall be distinguished from a public transport route when computing this indicator, such that a public transport route can include multiple public transport lines.

A publicly accessible real-time system shall refer to any information-processing system that responds to externally generated input stimuli within a finite and specified period, and that provides instantaneous information to users. In the context of public transport lines, a real-time system

provides timely information on transit usage and current volumes of users on public transport lines, so that transportation routes and modes can be planned in the most efficient manner. The information provided should not be limited to users of a specific transport line; it should be available to the public to allow access for all citizens.

19.5.3 Data sources

Data on the percentage of public transport lines equipped with a real-time ICT-based system should be sourced from relevant city departments that oversee public transport and monitor traffic.

19.6 Percentage of the city's public transport services covered by a unified payment system

19.6.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A unified payment system encourages multiple modal transportation across transportation modes such as bus, LRT, subway and trains, and reduces the need for public transport users to stop and pay at multiple transfer points during a single trip. A unified payment system for public transport users is not limited to a specific transport line or mode, but covers all types of public transportation modes.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.6.2 Indicator requirements

The percentage of the city's public transport services covered by a unified payment system shall be calculated as the number of city public transport services connected by a unified payment system (numerator) divided by the city's total number of public transport services (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's public transport service covered by a unified payment system.

Public transport services shall refer to travel services provided locally by the city that allow a number of people to travel together along set routes. The most common public transport vehicles that form a public transport network can include those provided and/or managed by the city, such as buses, boats, subways, trains, shared bicycles and shared vehicles.

A unified payment system shall refer to an integrated mobility payment system that allows transit users to plan, book and pay for multiple modes of transit to get them from point A to point B. A unified payment system should include an ICT/technology-based user interface such as smart cards or mobile ticketing, and unified pricing structures, such that a transit user need not pay at multiple points of transfer when making a single trip.

19.6.3 Data sources

Data on the city's public transport services covered by a unified payment system should be sourced from relevant city departments that are responsible for a city's transit system.

19.7 Percentage of public parking spaces equipped with e-payment systems

19.7.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 E-payment systems offer the public easier methods of payment because they are not dependent on cash or cheques, and they reduce time spent in lineups. An e-payment system also creates opportunities for smart pricing, depending on the time of day or frequency of use.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.7.2 Indicator requirements

The percentage of public parking spaces equipped with e-payment systems shall be calculated as the number of public parking spaces equipped with an e-payment system as a payment method (numerator) divided by the total number of public parking spaces in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public parking spaces equipped with e-payment systems.

Public parking lots shall be counted by their capacity, and street parking shall be counted by individual paid spaces.

An e-payment system shall refer to a way of making transactions or paying for goods and services through an electronic medium without the use of cheque or cash, such as a credit card or online or mobile application.

19.7.3 Data sources

The percentage of public parking spaces equipped with e-payment systems should be sourced from city departments that oversee public parking, as well as any organisations (public or private) that oversee the e-payment systems in the city relevant to public parking.

19.8 Percentage of public parking spaces equipped with real-time availability systems

19.8.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Real-time systems help to distribute information on parking space availability, hours of operation, fee guidelines and accessibility options. Also, real-time systems help people to more efficiently identify available public parking spaces, thus helping to reduce fuel use and vehicle emissions incurred in that process.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness", "Well-being" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

19.8.2 Indicator requirements

The percentage of public parking spaces equipped with real-time availability systems shall be calculated as the number of public parking spaces that are equipped with real-time availability systems (numerator) divided by the total number of public parking spaces in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of public parking spaces with real-time availability systems.

Public parking lots shall be counted by their capacity (i.e. number of public spaces), and street parking shall be counted by individual paid spaces.

Real-time availability systems for public parking spaces shall include any form of technology that provides instantaneous information, such as through mobile and/or online applications, on the availability of public parking spaces (i.e. number of public parking spaces available).

19.8.3 Data sources

Data on the number of public parking spaces with real-time availability systems should be sourced from city departments that oversee public parking.

19.9 Percentage of traffic lights that are intelligent/smart

19.9.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Intelligent/smart traffic lights help to control vehicle and pedestrian flow through streets and intersections in an optimal manner, thereby improving mobility and reducing consumption of transportation fuels. They can also be used to inform the optimal path for emergency responders moving quickly through the city.

NOTE 2 Automobile technology has begun implementing anti-idling systems, which can work more efficiently if they can communicate with intelligent/smart traffic lights to predict light changes and reduce emissions.

NOTE 3 This indicator reflects the “Community infrastructures” and “Mobility” issues as defined in ISO 37101. It can allow an evaluation of the contribution to “Well-being” and “Preservation and improvement of environment” purposes of the city as defined in ISO 37101.

19.9.2 Indicator requirements

The percentage of traffic lights that are intelligent/smart shall be calculated as the number of traffic lights in the city that are intelligent/smart (numerator) divided by the total number of traffic lights in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of traffic lights that are intelligent/smart.

Intelligent/smart traffic lights shall refer to traffic light systems that utilize a combination of lights, sensors and other information and communication technologies, along with algorithms, to control both vehicle and pedestrian traffic flow.

Multiple traffic lights at the same intersection for traffic heading in the same direction shall be counted as a single traffic light.

19.9.3 Data sources

Data on the percentage of traffic lights that are intelligent/smart should be sourced from relevant city departments that oversee transportation and street lights.

19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area

19.10.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Real-time interactive street maps provide up-to-date information for people commuting through the city, or planning to travel in and around the city. This allows people to more efficiently plan their travel times and routes, as well as identify points of access that accommodate persons with special needs.

NOTE 2 This indicator reflects the "Community infrastructures" and "Mobility" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Well-being" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

19.10.2 Indicator requirements

City area mapped by real-time interactive street maps as a percentage of the city's total land area shall be calculated as the total city area mapped by real-time interactive street maps (numerator) divided by the city's total land area (denominator). The result shall then be multiplied by 100 and expressed as city area mapped by real-time interactive street maps as a percentage of the city's total land area.

Interactive street maps shall refer to street maps generated by a geographic information system (GIS) and that contain location labels that respond digitally and immediately to a mouse, web-cursor or touchpad. The labels correspond to business locations or buildings that are accessible to persons with special needs.

Real-time shall refer to the instantaneous updating of information on the interactive street map to reflect current changes to an area, such as road construction or business relocation. Street maps should cover the city's pedestrian and sidewalk network and public transport network.

19.10.3 Data sources

Data on the area mapped by real-time interactive street maps should be sourced from relevant city departments that oversee the pedestrian and sidewalk network and public transport network.

19.11 Percentage of vehicles registered in the city that are autonomous vehicles

19.11.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Autonomous vehicles could reduce traffic fatalities by eliminating accidents caused by human error, which could be the most significant advance in automobile safety history. This could be achieved by shifting focus from minimization of post-crash injuries to collision prevention altogether.

NOTE 2 This indicator reflects the "Mobility" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

19.11.2 Indicator requirements

The percentage of vehicles registered in the city that are autonomous vehicles shall be calculated as the total number of autonomous vehicles registered in the city (numerator) divided by the total number of registered vehicles in the city (denominator). The result shall be multiplied by 100 and expressed as a percentage of vehicles registered in the city that are autonomous vehicles.

Autonomous vehicles shall refer to vehicles that are self-driving (i.e. no need for a human driver).

19.11.3 Data sources

The number of autonomous vehicles registered in the city should be sourced from city departments or institutions that oversee vehicle registration.

19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters

19.12.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A public Internet connection allows people who do not have mobile data plans or regular Internet access to connect to the Internet, enabling them to take advantage of the economic and social benefits the Internet offers. In addition, publicly accessible Internet can help municipalities to passively track users for future planning.

NOTE 2 This indicator reflects "Mobility" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

19.12.2 Indicator requirements

The percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters shall be calculated as the number of kilometres of public transport routes in the city with municipally provided and/or managed Internet connectivity for commuters (numerator) divided by the total number of kilometres of public transport routes in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters.

Municipally provided and/or managed Internet connectivity shall refer to Internet connectivity services provided and/or managed by the city or third-party providers under license by the city to the public, and shall be accessible by anyone (visitor or resident) within city limits.

19.12.3 Data sources

The data regarding the percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters should be sourced from relevant public transportation companies and/or the city's public transportation department.

19.13 Percentage of roads conforming with autonomous driving systems

19.13.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Road conformity with automated driving systems requires databases that accurately define roads (type of road, number of lanes, traffic data) as well as infrastructures that ensure real-time localization of the autonomous vehicles (e.g. availability of communication network infrastructures [GNSS, Wi-Fi, 5g]).

NOTE 2 This indicator reflects "Mobility" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" purpose of the city as defined in ISO 37101.

19.13.2 Indicator requirement

The percentage of roads conforming with autonomous driving systems shall be calculated as the number of kilometres of road conforming with autonomous driving systems (numerator), divided by

the total number of kilometres of road (denominator). The result shall then be multiplied by 100 and expressed as the percentage of roads conforming with autonomous driving systems.

19.13.3 Data sources

Data regarding the percentage of roads conforming with autonomous driving systems should be sourced from relevant city departments.

19.14 Percentage of the city's bus fleet that is motor-driven

19.14.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The deployment of public transport vehicles that are motor-driven instead of engine-driven helps cities to reduce operating costs and vehicle tailpipe emissions, while providing public transport users with an eco-friendly mode of transportation. Furthermore, motor-driven public transport vehicles reduce noise and vibrations originating from engine systems, thereby impoving passenger safety and comfort.

NOTE 2 This indicator reflects "Mobility" and "Community infrastructures" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" purpose of the city as defined in ISO 37101.

19.14.2 Indicator requirement

The percentage of the city's bus fleet that is motor-driven shall be calculated as the number of buses in the city's bus fleet that are motor-driven (numerator) divided by the total number of buses in the city's bus fleet (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's bus fleet that is motor driven.

Motor-driven shall refer to buses propelled by motorized systems (instead of engine-driven systems that burn or otherwise consume fuel to perform mechanical work), and that use motors driven by electricity (magnetic forces), air, hydraulic pressure, heat, photons, electrons or ultrasound. Motors do not change the chemical composition of their energy source. Motor-driven systems include, but are not limited to, battery-powered systems containing fuel cells, and exclude biogas and internal combustion engine-driven systems requiring diesel.

NOTE Storage batteries have a life cycle of over 10 years, while the life cycle of fuel cell batteries has not been confirmed due to insufficient experience with practical use.

19.14.3 Data sources

The data on the city's bus fleet should be sourced from relevant city departments that are responsible for a city's transit system.

19.14.4 Data interpretation

With regards to sustainability, sources of energy that supply the city's bus fleet should be taken into account. Refer to ISO 37120: 2018, 7.2 to characterize the city's energy mix.

20 Urban/local agriculture and food security

20.1 Annual percentage of municipal budget spent on urban agriculture initiatives

20.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Urban agriculture makes an important contribution to household food security, especially in times of crisis or food shortages. Locally produced food requires shorter supply chains and less transportation and refrigeration, and can thus help to conserve energy, water and other resources.

NOTE 2 This indicator reflects the "Health and care in the community" and ""Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Preservation and improvement of environment" purpose of the city as defined in ISO 37101.

20.1.2 Indicator requirements

The annual percentage of municipal budget spent on urban agriculture initiatives shall be calculated as the total amount of the city budget spent on urban agriculture initiatives for a given year (numerator) divided by the city's total municipal budget for the same year (denominator). The result shall then be multiplied by 100 and expressed as the annual percentage of municipal budget spent on urban agriculture initiatives.

Urban agriculture shall refer to the growing of plants and food products from different types of crops (grains, root crops, vegetables, mushrooms, fruits). Urban agriculture also includes trees managed for producing fruit, and small-scale aquaculture. In many cities, the raising of animals (e.g. poultry, rabbits, goats, sheep, cattle, pigs, guinea-pigs) within city limits is prohibited by law. Urban agriculture initiatives or programmes shall refer to any activity connected to the above definition of urban agriculture or supporting urban agriculture activities, such as city grants available to urban agriculture producers and businesses that can support the development of innovative technologies for urban agriculture (e.g. mobile applications to monitor crop yield) or simply provide urban agriculture producers and businesses with resources to support operations in general.

20.1.3 Data sources

Data on amount of municipal budget spent on urban agriculture initiatives should be sourced from financial audited statements of the city's budget or relevant city departments that oversee finance.

20.2 Annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes)

20.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Although food and organic matter are essential for life and healthy soil, significant amounts of food and organic waste end up in the municipal waste stream destined, for example, to a landfill or incinerator. There is recognition both within cities and globally that food and organic wastes are a growing problem, and that current waste management practices are not sustainable. There are environmental consequences to sending food and organic materials to disposal. The environmental benefits of recycling and composting food waste can be significant. Composting transforms food waste into usable products such as fertilizer, which can then be used in agriculture and food production, enhancing food productivity and promoting smart, sustainable growth.

NOTE 2 This indicator reflects the "Economy and sustainable production and consumption" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Resilience" purposes of the city as defined in ISO 37101.

20.2.2 Indicator requirements

The annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) shall be calculated as the total amount of food waste (household and commercial) collected in tonnes (numerator) divided by the city's total population (denominator). The result shall be expressed as the annual total collected municipal food waste sent to a processing facility for composting per capita in tonnes.

Composting shall refer to a natural biological process carried out under controlled aerobic conditions (requires oxygen). In this process, various microorganisms, including bacteria and fungi, break down organic matter into simpler substances and convert waste to a usable organic soil amendment or mulch by providing adequate aeration, moisture, particle size, fertilizers and lime. The effectiveness of the composting process is dependent upon the environmental conditions present within the composting system, i.e. oxygen, temperature, moisture, material disturbance, organic matter and the size and activity of microbial populations. Thus, a processing facility for composting shall refer to a facility that carries out composting.

Food waste refers to discarded, unconsumed food that is recovered from the food supply chain. This can occur along the entire food supply chain, from primary production to end-use consumption (residential and commercial). Food waste is recognized as a distinct part of food loss because the drivers that generate it, and the solutions to it, are different from those of food losses.

20.2.3 Data sources

Data on municipal food waste collected should be sourced from relevant city departments that are responsible for garbage collection, recycling, sanitation and/or composting services.

20.2.4 Data interpretation

A city with a high annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) is indicative of a city that is diverting and reducing the amount of waste that needs to be disposed of and, in turn, mitigating the environmental impacts associated with municipal solid waste. It also indicates a city that is converting food waste into products that are useful for agriculture and improving soil for food production.

20.3 Percentage of the city's land area covered by an online food-supplier mapping system

20.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Maps displaying food suppliers in the city help to connect citizens to food resources. Food maps also provide baseline data on the state of access to nutritious food supplies and assets, allowing cities to take stock of their food resources.

NOTE 2 This indicator reflects the "Health and care in the community" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Resilience" purposes of the city as defined in ISO 37101.

20.3.2 Indicator requirements

The percentage of the city's land area covered by an online food-supplier mapping system shall be calculated as the total land area covered by an online food-supplier mapping system (numerator) divided by the city's total land area (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's land area covered by an online food-supplier mapping system.

A food-supplier mapping system shall refer to information technology used by food and public health agencies to map, visualize and analyse the distribution of food resources. An online food-supplier mapping system shall refer to a food-supplier mapping system that is accessible by the public online.

Food suppliers shall refer to retail food sources, such as food retailers (e.g. restaurants, grocery stores, and convenience stores offering food) and agricultural lands that have food available for residents to purchase.

20.3.3 Data sources

Data on online food-supplier mapping systems should be sourced through municipal departments/ ministries responsible for public health and health and wellness programmes and/or the development of GIS mapping applications.

21 Urban planning

21.1 Annual number of citizens engaged in the planning process per 100 000 population

21.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Citizen engagement is a key attribute in effective planning and policy-making. Successful citizen engagement improves this process because the community has input and influence in the municipal government plan.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Social cohesion" purpose of the city as defined in ISO 37101.

21.1.2 Indicator requirements

The annual number of citizens engaged in the planning process per 100 000 population shall be calculated as the total number of citizens participating in or engaged in the planning process on an annual basis (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the annual number of citizens engaged in the planning process per 100 000 population.

The planning process shall refer to the official plan and other city plans.

The definition of citizen engagement includes in-person attendance or involvement at events such as community consultations, public hearings, pop-up city hall sessions and other participatory practices, for example online hearings and webinars. Citizen engagement can also include virtual attendance or involvement through social media or formal engagement tools such as online or paper surveys.

Cities should report the mode of engagement, if possible.

Mode of engagement	Number of citizens
In-person	
Online	

Online engagement will be assessed through comments, likes, dislikes through social media or formal engagement tools.

21.1.3 Data sources

Data on citizen engagement should be sourced from attendance records of planning process engagements, hearings and events (both online and in-person) frequently noted within planning reports and policy as a prerequisite for approval.

21.2 Percentage of building permits submitted through an electronic submission system

21.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The building permit application and approval process can hinder development feasibility and profitability. Making available the option for a building permit application submission to be completed electronically might help to expedite the process of building permitting by eliminating the need for city staff to perform routine data entry and enabling applicants to submit building permits more quickly.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" issue as defined in ISO 37101. It can allow an evaluation of the contribution to the "Attractiveness" purpose of the city as defined in ISO 37101.

21.2.2 Indicator requirements

The percentage of building permits submitted through an electronic submission system shall be calculated as the number of building permits submitted through an electronic submission system (numerator) divided by the total number of building permits submitted through an electronic submission system and an in-person manual system (i.e. paper application). The result shall then be multiplied by 100 and expressed as the percentage of building permits submitted through an electronic submission system.

An electronic submission system shall refer to an online system that allows an applicant to fill out a web-based application form and submit a building permit electronically. The electronic submission system also allows an applicant to upload any supporting documents directly online.

21.2.3 Data sources

Data on the number of building permits submitted through an electronic submission system should be sourced from relevant city departments that oversee building permit submissions.

21.3 Average time for building permit approval (days)

21.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 The development application and building permit approval process can hinder development feasibility and profitability. This indicator allows municipalities to compare their development application and building permit approval times with other municipalities to improve their internal processes.

NOTE 2 This indicator reflects the "Governance, empowerment and engagement" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Attractiveness" purposes of the city as defined in ISO 37101.

21.3.2 Indicator requirements

The average time for building permit approval shall be calculated as the sum in days of building permits from start to completion (numerator) divided by the total number of building permits (denominator). The result shall be expressed as the average time for building permit approval in days.

Building permit approvals shall include permits for new commercial buildings, commercial building renovations and non-residential construction projects, as well as large residential projects and small residential projects in, for example, detached, semi-detached and townhouse construction and renovation projects.

21.3.3 Data sources

Data on the average time for building permit approval should be sourced from relevant city departments that oversee building permit approval.

21.3.4 Data interpretation

Cities with a relatively low average time for building permit approval can have a more efficient permit approval system in place. However, it should be noted that there can be difficulties in comparing cities directly when considering differences in regulatory environments in which building permit approvals take place and the potential for less stringent or more stringent building permit requirements.

21.4 Percentage of the city population living in medium-to-high population densities

21.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Population density is a fundamental condition of cities and it affects how they function. Urban planners advocate higher population densities for the widely held theory that cities operate more efficiently when residents live in denser urban surroundings. A higher population density can contribute to smart growth, given that other aspects, such as automobile dependency, are less of an issue. The growth is "smart" because it is meant to be sustainable and long-lasting, and not be solely dependent on automobiles.

NOTE 2 This indicator reflects the "Living and working environment" issue as defined in ISO 37101. It can allow an evaluation of the contribution to "Social cohesion" and "Attractiveness" and "Well-being" purposes of the city as defined in ISO 37101.

21.4.2 Indicator requirements

The percentage of the city population living in medium-to-high urban densities shall be calculated as the number of people living in a medium-to-high population density area (numerator) divided by the city's total population (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city population living in medium-to-high population densities.

Cities shall specify and report the range that is used for their calculation of medium-to-high population density.

21.4.3 Data sources

Data on population density should be sourced from relevant city departments that oversee urban planning and population statistics.

22 Wastewater

22.1 Percentage of treated wastewater being reused

22.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Wastewater reuse is a means to save water in areas where scarcity is increasing and lack of water might occur. It is a solution consistent with circular economy principles that help to face climate changes and adaptation challenges. It is also a way to prevent discharge of untreated wastewater into the environment.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" and "Biodiversity and ecosystems services" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

22.1.2 Indicator requirements

The percentage of treated wastewater being reused shall be calculated as the total annual volume of treated wastewater that is reused (numerator) divided by the total annual volume of treated wastewater (denominator). The result shall be multiplied by 100 and expressed as the percentage of treated wastewater being reused.

Treated wastewater that is reused shall refer to wastewater that is reused either following secondary biological treatment ("controlled" reused) or following conventional tertiary treatment (filtration, UV disinfection, chlorination, ozonation), or a high-quality treatment after membrane treatment (MBR, ultrafiltration, ultrafiltration/reverse osmosis microfiltration/reverse osmosis) for agricultural irrigation, urban irrigation (green areas) or other more noble uses such as water recycling and groundwater recharge (see ISO 24511).

22.1.3 Data sources

Data on the percentage of wastewater being reused should be sourced from city departments, ministries or institutions that are responsible for wastewater and wastewater network management. Data can also be sourced from local utility providers, if applicable.

22.1.4 Data interpretation

Data should be analysed in relation to local water scarcity. In cities where water scarcity is not a pressing issue, other techniques might be more appropriate for water reuse, for example rainwater harvesting.

22.2 Percentage of biosolids that are reused (dry matter mass)

22.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Biosolids might have significant content of minerals (i.e. N, P), oligo-elements and organic matter that can be reused either for agricultural fertilising and soil improving, or for calorific value in energy-from-waste plants or digestion facilities to produce biomethane that is reusable for gas injection or fuel production. Biosolids reuse is an important component of the circular economy, helping to reduce discharge or disposal of biosolids into the environment. Some types of biosolids reuse can help to mitigate expected decreases in mineral resources such as phosphorus. Production of new phosphorus resources, such as struvite, will therefore be needed in the future.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" and "Biodiversity and ecosystems services" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

22.2.2 Indicator requirements

The percentage of biosolids that are reused shall be calculated as the total annual quantity of biosolids that are reused in dry matter mass (numerator) divided by the total annual quantity of biosolids produced and measured at site outlets in the city in dry matter mass (denominator). The result shall then be multiplied by 100 and expressed as the percentage of biosolids that are reused in dry matter mass.

NOTE Quantity of biosolids measured at site outlets is expressed in dry matter tonnes (including additives). The quantity reused per year includes all uses except landfilling and incineration without heat recovery.

Biosolids shall refer to residues obtained after wastewater treatment or sanitation. Biosolids characteristics are different from one source to another, depending on the type of initial effluents and type of treatment applied. Solid waste and sand from screening are not included in this definition.

Biosolids considered in the calculation of this indicator can originate from:

— stormwater handling;

— night soil;

— urban wastewater collecting systems;

— urban wastewater treatment plants;

— treating industrial wastewater similar to urban wastewater;

— water supply treatment plants.

However, hazardous sludge from industry is excluded.

22.2.3 Data sources

Data on the annual quantity of biosolids reused and the total annual quantity of biosolids produced in the city should be sourced from relevant city departments, ministries or institutions that are responsible for solid waste, wastewater and sewage system management. Data can also be sourced from local utility providers, if applicable.

22.3 Energy derived from wastewater as a percentage of total energy consumption of the city

22.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Wastewater which has significant organic matter content can be a source of energy either by producing energy from the digestion of wastewater or biosolids or other new technologies using this energy for cogeneration, biomethane production for injection in the gas network, or for fuel production, recovering heat from wastewater within the wastewater network.

With the ongoing need to decrease energy consumption from fossil energy resources, it is advantageous for cities to use this source of heat, electricity, gas or fuel to facilitate delivery of other services in the city (i.e. heating of swimming pools, fuels for city vehicle fleet, energy sales to local industries). If fossil

energy tariffs exist and are disadvantageous, cities can achieve some degree of energy independence with wastewater use.

NOTE 2 This indicator reflects the "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

22.3.2 Indicator requirements

Energy derived from wastewater as a percentage of total energy consumption of the city shall be calculated as the sum of the total annual quantity of energy derived from the network of wastewater and wastewater treatment plants (numerator) divided by the total energy consumption of the city (denominator). The result shall then be multiplied by 100 and expressed as energy derived from wastewater as a percentage of total energy consumption of the city.

Energy derived from the wastewater network and wastewater treatment plants, and total energy consumption of the city, shall be expressed in GJ per year.

22.3.3 Data sources

Data on a city's total energy consumption can be derived from the ISO 37120 indicator 'Energy use per capita' multiplied by the population number of the city. Data on the amount of energy derived from wastewater should be sourced from relevant city departments or wastewater utilities.

22.4 Percentage of total amount of wastewater in the city that is used to generate energy

22.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Wastewater which has significant organic matter content can be a source of energy either by producing energy from the digestion of wastewater or biosolids or other new technologies using this energy for cogeneration, biomethane production for injection in the gas network, or for fuel production, or by recovering heat from wastewater within the wastewater network.

With the ongoing need to decrease energy consumption from fossil energy resources, it is advantageous for cities to use this source of heat, electricity, gas or fuel to facilitate delivery of other services in the city (i.e. heating of swimming pools, fuels for city vehicle fleet, energy sales to local industries). If fossil energy tariffs exist and are disadvantageous, cities can achieve some degree of energy independence with wastewater use.

NOTE 2 This indicator reflects the "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Preservation and improvement of environment" and "resilience" purposes of the city as defined in ISO 37101.

22.4.2 Indicator requirements

The percentage of total amount of wastewater in the city that is used to generate energy shall be calculated as the total amount of wastewater utilized to generate energy (numerator) divided by the total amount of wastewater in the city (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the total quantity of wastewater in the city that is used to generate energy.

Energy generated from the wastewater network or treatment plant shall be expressed in gigajoules (GJ) per year.

22.4.3 Data sources

Data on the quantity of wastewater in the city in total and the total amount of wastewater in the city that is used to generate energy should be sourced from local utilities, or relevant city departments that oversee wastewater treatment and related energy generation.

22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system

22.5.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Equipping a city's wastewater pipeline network with sensor-based technologies allows for continuous measurement of effluent levels in the network, the detection of discharges to storm spillways, and the calculation of flow and volume discharges into the environment and their potential cost reductions. Furthermore, sensor-based systems allow for remote management and operation of sewage networks and rainwater, detecting problems and proceeding with quick and efficient solutions.

NOTE 2 This indicator reflects "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Preservation and improvement of environment" and "Resilience" purposes of the city as defined in ISO 37101.

22.5.2 Indicator requirements

The percentage of the wastewater pipeline network monitored with a real-time data tracking sensor system shall be calculated as the length of the wastewater pipeline network monitored by a real-time data tracking sensor system in kilometres (numerator) divided by the total length of the wastewater pipeline network in kilometres (denominator). The result shall then be multiplied by 100 and expressed as the percentage of the wastewater pipeline network monitored with a real-time data tracking sensor system.

A sensor system shall refer to a network of devices (i.e. sensors) that detect and respond to some type of input from the physical environment. A real-time data tracking sensor system for the wastewater pipeline network shall refer to a sensor system that provides instantaneous data on the wastewater pipeline network.

22.5.3 Data sources

Data on the wastewater pipeline network should be sourced from relevant city departments responsible for wastewater, or public utility organisations.

22.5.4 Data interpretation

As this indicator relates to tools for digitisation, one should consider technological progress in other areas such as network planning, construction and renovation. The ultimate goal of a "smart" city should be to achieve sustainability goals, not just purposeless use of digitalisation tools.

23 Water

23.1 Percentage of drinking water tracked by real-time, water quality monitoring station

23.1.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A real-time ICT-based system for monitoring drinking water quality can help to inform city residents of drinking water quality and to mitigate health impacts from degraded drinking water. An ICT-based system also provides real-time observations, allowing immediate data processing and analysis of water quality information.

NOTE 2 This indicator reflects the "Community infrastructures", "Economy and sustainable production and consumption" and "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use", "Resilience" and "Attractiveness" purposes of the city as defined in ISO 37101.

23.1.2 Indicator requirements

The percentage of drinking water tracked by a real-time water quality monitoring station shall be calculated as the amount of drinking water that has undergone water quality monitoring by a real-time water quality monitoring station in the city (numerator) divided by the total amount of drinking water distributed in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of drinking water tracked by a real-time water quality monitoring station.

A monitoring station shall refer to a physical structure or device that uses specialized equipment and analytical methods to track pollutant levels of the city's drinking water. Tracking shall include more than one point of measurement along the network and cannot be limited to the network point of entry.

A real-time system shall refer to any form of technology that provides instantaneous information such as mobile applications.

23.1.3 Data sources

The amount of drinking water under water quality monitoring by a real-time water quality monitoring station should be sourced from relevant city departments that oversee the drinking water quality of the city.

23.1.4 Data interpretation

As this indicator relates to tools for digitisation, one should consider technological progress in other areas such as network planning, construction and renovation. The ultimate goal of a "smart" city should be to achieve sustainability goals, not just purposeless use of digitalisation tools.

23.2 Number of real-time environmental water quality monitoring stations per 100 000 population

23.2.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 A real-time system for monitoring environmental water quality can help to reduce climate change impacts on the environment and its water ecosystems. Using an ICT-based system in environmental water monitoring can provide real-time observations, giving the city and its citizens timely information on water quality.

NOTE 2 This indicator reflects the "Community infrastructures", "Living and working environment", "Biodiversity and ecosystem services" and "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Attractiveness", "Resilience" and "Preservation and improvement of environment" purposes of the city as defined in ISO 37101.

23.2.2 Indicator requirements

The number of real-time environmental water quality monitoring stations per 100 000 population shall be calculated as the total number of real-time environmental water quality monitoring stations in the city (numerator) divided by 1/100 000 of the city's total population (denominator). The result shall be expressed as the number of real-time environmental water quality monitoring stations per 100 000 population.

Environmental water shall refer to water in a river or wetland that benefits the environment, for example water that is set aside in storage areas such as reservoirs and dams, and that is managed for plants and animals.

A monitoring station shall refer to a physical structure or device that uses specialized equipment and analytical methods to track pollutant levels of environmental water.

A real-time system shall refer to any form of technology or ICT-based system (such as mobile applications) that provides instantaneous information. More specifically, an ICT system consists of hardware, software, data and the people who use them. An ICT system commonly includes communications technology, such as the Internet. It should be noted that ICT and computers are not the same – computers are the hardware that is often part of an ICT system.

23.2.3 Data sources

The number of real-time ICT-based environmental water quality monitoring stations should be sourced from relevant city departments that oversee the water quality of the city's natural water network and the environment of the city.

23.3 Percentage of the city's water distribution network monitored by a smart water system

23.3.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

Cities should consider residential as well as commercial and industrial demand strains on water supplies, to efficiently and effectively manage water supplies. Also, cities should manage the consumption and distribution of water with greater efficiency. Cities, public water utilities and industrial water users manage many different water infrastructure components through a variety of methods, such as supervisory control and data acquisition (SCADA) systems, sensors and meters. A smart water system is an integrated approach to manage water use in cities, and is composed of a network of sensors and meters that provide information on water consumption and water leakage in the distribution network.

NOTE This indicator reflects "Community infrastructures" and "Economy and sustainable production and consumption" and "Health and care in the community" issues as defined in ISO 37101. It can allow an evaluation of the contribution to the "Responsible resource use", "Attractiveness" and "Resilience" purposes of the city as defined in ISO 37101.

23.3.2 Indicator requirements

The percentage of the city's water distribution network monitored by a smart water system shall be calculated as the length of the water distribution network covered by a smart water system in kilometres (numerator) divided by the total length of the water distribution network in kilometres

(denominator). The result shall then be multiplied by 100 and expressed as the percentage of the city's water distribution network monitored by a smart water system.

A smart water system shall refer to a network of sensors and meters that enables the city and utilities to monitor and diagnose problems in the water system network remotely. It also provides the capability to prioritize and manage maintenance issues, using data to optimize all aspects of the water system network of water pipes. Tracking shall include more than one point of measurement along the network and cannot be limited to the network point of entry.

23.3.3 Data sources

Data on water system network and smart water systems should be sourced from local or regional water providers, or relevant city departments or ministries that hold data on the local water system network.

23.3.4 Data interpretation

As this indicator relates to tools for digitisation, one should consider technological progress in other areas such as network planning, construction and renovation. The ultimate goal of a "smart" city should be to achieve sustainability goals, not just purposeless use of digitalisation tools.

23.4 Percentage of buildings in the city with smart water meters

23.4.1 General

Those implementing this document should report on this indicator in accordance with the following requirements.

NOTE 1 Smart water meters record and display the consumption of water in real time. Smart meter data can be sent to a central location wirelessly, thus providing water providers with the means to understand how and when water is being used, and to better plan and conserve its use. Also, smart meter data help consumers better understand and monitor water usage.

NOTE 2 This indicator reflects the "Community infrastructures" and "Economy and sustainable production and consumption" issues as defined in ISO 37101. It can allow an evaluation of the contribution to "Responsible resource use" and "Attractiveness" purposes of the city as defined in ISO 37101.

23.4.2 Indicator requirements

The percentage of buildings in the city with smart water meters shall be calculated as the number of buildings in the city with smart water meters (numerator) divided by the total number of buildings in the city (denominator). The result shall be multiplied by 100 and expressed as the percentage of buildings in the city with smart water meters.

Data for public and commercial and industrial buildings shall be included and listed individually.

	Number of buildings in the city with smart water meters	**Total number of buildings in the city**	**Percentage of buildings in the city with smart water meters**
Public buildings			
Commercial and industrial buildings			

Public building shall refer to a government-owned or leased building that functions as a municipal and administrative office, library, recreation centre, hospital, school, fire station or police station.

NOTE 1 Ownership of buildings (public or private) is variously defined according to region and political system. The restrictive definition used here permits global comparability across cities.

Commercial and industrial properties shall refer to those designated by the city for commercial and industrial use.

NOTE 2 Property assessment methods might vary from one jurisdiction or country to another, including the market-oriented method, the profit-oriented method and the cost-oriented method.

Household buildings are not considered in this indicator.

For smart water management at the household scale, refer to indicator 12.2.

A smart water meter shall refer to a water meter that includes a real-time digital display or that is available through a real-time online application, so customers can better understand their water usage. A smart meter can digitally send its readings to a water supplier for more accurate water bills, and for planning and conservation of water by providers.

23.4.3 Data sources

Data on smart water meters should be sourced from local or regional water providers, or relevant city departments or ministries that hold data on local smart water meters.

24 Reporting and record maintenance

Reports on city indicators should compile the data required in the individual test methods used.

Annex A
(informative)

Mapping of ISO 37122 indicators to ISO 37101 issues and purposes

ISO 37101 issues	Purposes in this document
Governance, empowerment and engagement	Attractiveness (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 10.1 Annual number of online visits to the municipal open data portal per 100 000 population — 10.2 Percentage of city services accessible and that can be requested online — 10.3 Average response time to inquiries made through the city's non-emergency inquiry system (days) — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 21.2 Percentage of building permits submitted through an electronic submission system — 21.3 Average time for building permit approval (days) Social cohesion (ISO 37101) — 10.2 Percentage of city services accessible and that can be requested online — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 21.1 Annual number of citizens engaged in the planning process per 100 000 population Well-being (ISO 37101) — 10.3 Average response time to inquiries made through the city's non-emergency inquiry system (days) — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide

ISO 37101 issues	Purposes in this document
	Responsible resource use (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 21.3 Average time for building permit approval (days) Resilience (ISO 37101) Preservation and improvement of environment (ISO 37101)
Education and capacity building	Attractiveness (ISO 37101) — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 6.1 Percentage of city population with professional proficiency in more than one language — 6.2 Number of computers, laptops, tablets or other digital learning devices available per 1 000 students — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population Social cohesion (ISO 37101) — 6.1 Percentage of city population with professional proficiency in more than one language — 17.1 Number of online bookings for cultural facilities per 100 000 population — 17.3 Number of public library book and e-book titles per 100 000 population — 17.4 Percentage of city population that are active public library users Well-being (ISO 37101) — 6.1 Percentage of city population with professional proficiency in more than one language — 17.1 Number of online bookings for cultural facilities per 100 000 population — 17.3 Number of public library book and e-book titles per 100 000 population — 17.4 Percentage of city population that are active public library users Responsible resource use (ISO 37101) Resilience (ISO 37101) — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 6.1 Percentage of city population with professional proficiency in more than one language — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population Preservation and improvement of environment (ISO 37101)

ISO 37101 issues	Purposes in this document
Innovation, creativity and research	Attractiveness (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy — 5.2 Survival rate of new businesses per 100 000 population — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population Social cohesion (ISO 37101) Well-being (ISO 37101) Responsible resource use (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy Resilience (ISO 37101) — 5.2 Survival rate of new businesses per 100 000 population — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population Preservation and improvement of environment (ISO 37101)
Health and care in the community	Attractiveness (ISO 37101) — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city's water distribution network monitored by a smart water system Social cohesion (ISO 37101) — 11.2 Annual number of medical appointments conducted remotely per 100 000

ISO 37101 issues	Purposes in this document
	Well-being (ISO 37101) — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 8.3 Percentage of public buildings equipped for monitoring indoor air quality — 11.1 Percentage of the city's population with an online unified health file accessible to health care providers — 11.2 Annual number of medical appointments conducted remotely per 100 000 population — 11.3 Percentage of the city population with access to real-time public alert systems for air and water quality advisories — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles Responsible resource use (ISO 37101) — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.3 Percentage of the city’s water distribution network monitored by a smart water system Resilience (ISO 37101) — 11.1 Percentage of the city's population with an online unified health file accessible to health care providers — 11.2 Annual number of medical appointments conducted remotely per 100 000 population — 11.3 Percentage of the city population with access to real-time public alert systems for air and water quality advisories — 20.3 Percentage of the city’s land area covered by an online food-supplier mapping system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city’s water distribution network monitored by a smart water system

ISO 37101 issues	Purposes in this document
	Preservation and improvement of environment (ISO 37101) — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 20.1 Annual percentage of municipal budget spent on urban agriculture initiatives — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population
Culture and community identity	Attractiveness (ISO 37101) — 17.2 Percentage of the city's cultural records that have been digitised Social cohesion (ISO 37101) — 17.1 Number of online bookings for cultural facilities per 100 000 population Well-being (ISO 37101) — 17.1 Number of online bookings for cultural facilities per 100 000 population Responsible resource use (ISO 37101) Resilience (ISO 37101) — 17.2 Percentage of the city's cultural records that have been digitised Preservation and improvement of environment (ISO 37101)
Living together, interdependence and mutuality	Attractiveness (ISO 37101) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 19.2 Number of users of sharing economy transportation per 100,000 population

ISO 37101 issues	Purposes in this document
	Social cohesion (ISO 37101) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 19.2 Number of users of sharing economy transportation per 100,000 population Well-being (ISO 37101) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 19.2 Number of users of sharing economy transportation per 100,000 population Responsible resource use (ISO 37101) Resilience (ISO 37101) Preservation and improvement of environment (ISO 37101)

ISO 37101 issues	Purposes in this document
Economy and sustainable production and consumption	Attractiveness (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy — 5.2 Survival rate of new businesses per 100 000 population — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 7.8 Percentage of public buildings requiring renovation/refurbishment — 7.9 Percentage of buildings in the city with smart energy meters — 9.1 Annual amount of revenues collected from the sharing economy as a percentage of own-source revenue — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 12.1 Percentage of households with smart energy meters — 12.2 Percentage of households with smart water meters — 21.3 Average time for building permit approval (days) — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.3 Percentage of the city's water distribution network monitored by a smart water system — 23.4 Percentage of buildings in the city with smart water meters Social cohesion (ISO 37101) Well-being (ISO 37101) — 20.3 Percentage of the city's land area covered by an online food-supplier mapping system Responsible resource use (ISO 37101) — 5.1 Percentage of service contracts providing city services which contain an open data policy — 7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year

ISO 37101 issues	Purposes in this document
	— 7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year — 7.3 Electrical and thermal energy (GJ) produced from solid waste treatment per capita per year — 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 7.5 Storage capacity of the city's energy grid per total city energy consumption — 7.6 Percentage of street lighting managed by a light performance management system — 7.7 Percentage of street lighting that has been refurbished and newly installed — 7.8 Percentage of public buildings requiring renovation/refurbishment — 7.9 Percentage of buildings in the city with smart energy meters — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 12.1 Percentage of households with smart energy meters — 12.2 Percentage of households with smart water meters — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 20.2 Annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) — 21.3 Average time for building permit approval (days)

ISO 37101 issues	Purposes in this document
	— 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.3 Percentage of the city's water distribution network monitored by a smart water system — 23.4 Percentage of buildings in the city with smart water meters Resilience (ISO 37101) — 5.2 Survival rate of new businesses per 100 000 population — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 7.5 Storage capacity of the city's energy grid per total city energy consumption — 9.1 Annual amount of revenues collected from the sharing economy as a percentage of own-source revenue — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 20.2 Annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) — 20.3 Percentage of the city's land area covered by an online food-supplier mapping system — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.3 Percentage of the city's water distribution network monitored by a smart water system

ISO 37101 issues	Purposes in this document
	Preservation and improvement of environment (ISO 37101) — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 20.1 Annual percentage of municipal budget spent on urban agriculture initiatives — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system

ISO 37101 issues	Purposes in this document
Living and working environment	Attractiveness (ISO 37101) — 7.8 Percentage of public buildings requiring renovation/refurbishment — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 10.3 Average response time to inquiries made through the city's non-emergency inquiry system (days) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 21.4 Percentage of the city population living in medium-to-high population densities — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population Social cohesion (ISO 37101) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 21.4 Percentage of the city population living in medium-to-high population densities Well-being (ISO 37101) — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 8.3 Percentage of public buildings equipped for monitoring indoor air quality — 10.3 Average response time to inquiries made through the city's non-emergency inquiry system (days) — 13.1 Percentage of public buildings that are accessible by persons with special needs — 14.1 Percentage of public recreation services that can be booked online — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 21.4 Percentage of the city population living in medium-to-high population densities

ISO 37101 issues	Purposes in this document
	Responsible resource use (ISO 37101) — 7.8 Percentage of public buildings requiring renovation/refurbishment — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles Resilience (ISO 37101) — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population Preservation and improvement of environment (ISO 37101) — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population
Safety and security	Attractiveness (ISO 37101) — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 10.4 Average downtime of the city's IT infrastructure — 15.1 Percentage of the city area covered by digital surveillance cameras Social cohesion (ISO 37101) Well-being (ISO 37101) — 15.1 Percentage of the city area covered by digital surveillance cameras Responsible resource use (ISO 37101) — 7.6 Percentage of street lighting managed by a light performance management system — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices Resilience (ISO 37101) — 10.4 Average downtime of the city's IT infrastructure Preservation and improvement of environment (ISO 37101)

ISO 37101 issues	Purposes in this document
Community infrastructures	Attractiveness (ISO 37101) — 7.9 Percentage of buildings in the city with smart energy meters — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 10.4 Average downtime of the city's IT infrastructure — 12.1 Percentage of households with smart energy meters — 12.2 Percentage of households with smart water meters — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 18.1 Percentage of the city population with access to sufficiently fast broadband — 18.2 Percentage of city area under a white zone/dead spot/not covered by telecommunication connectivity — 18.3 Percentage of city area covered by municipally provided Internet connectivity — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system — 19.7 Percentage of public parking spaces equipped with e-payment systems — 19.9 Percentage of traffic lights that are intelligent/smart — 19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters — 19.13 Percentage of roads conforming with autonomous driving systems — 19.14 Percentage of the city's bus fleet that is motor-driven — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city's water distribution network monitored by a smart water system — 23.4 Percentage of buildings in the city with smart water meters

ISO 37101 issues	Purposes in this document
	Social cohesion (ISO 37101) — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 18.1 Percentage of the city population with access to sufficiently fast broadband — 18.2 Percentage of city area under a white zone/dead spot/not covered by telecommunication connectivity — 18.3 Percentage of city area covered by municipally provided Internet connectivity — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system — 19.9 Percentage of traffic lights that are intelligent/smart Well-being (ISO 37101) — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system — 19.7 Percentage of public parking spaces equipped with e-payment systems — 19.8 Percentage of public parking spaces equipped with real-time availability systems — 19.9 Percentage of traffic lights that are intelligent/smart — 19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area — 19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters

ISO 37101 issues	Purposes in this document
	Responsible resource use (ISO 37101) — 7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year — 7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year — 7.3 Electrical and thermal energy (GJ) produced from solid waste and other liquid waste treatment per capita per year — 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 7.5 Storage capacity of the city's energy grid per total city energy consumption — 7.9 Percentage of buildings in the city with smart energy meters — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 12.1 Percentage of households with smart energy meters — 12.2 Percentage of households with smart water meters — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.3 Percentage of the city's water distribution network monitored by a smart water system — 23.4 Percentage of buildings in the city with smart water meters

ISO 37101 issues	Purposes in this document
	Resilience (ISO 37101) — 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 7.5 Storage capacity of the city's energy grid per total city energy consumption — 10.4 Average downtime of the city's IT infrastructure — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city's water distribution network monitored by a smart water system

ISO 37101 issues	Purposes in this document
	Preservation and improvement of environment (ISO 37101) — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.8 Percentage of public parking spaces equipped with real-time availability systems — 19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population

ISO 37101 issues	Purposes in this document
Mobility	Attractiveness (ISO 37101) — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.2 Number of users of sharing economy transportation per 100,000 population — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system — 19.7 Percentage of public parking spaces equipped with e-payment systems — 19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters — 19.13 Percentage of roads conforming with autonomous driving systems — 19.14 Percentage of the city's bus fleet that is motor-driven Social cohesion (ISO 37101) — 19.2 Number of users of sharing economy transportation per 100,000 population — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system

ISO 37101 issues	Purposes in this document
	Well-being (ISO 37101) — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.2 Number of users of sharing economy transportation per 100,000 population — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city public transport network covered by a unified payment system — 19.7 Percentage of public parking spaces equipped with e-payment systems — 19.8 Percentage of public parking spaces equipped with real-time availability systems — 19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area — 19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters Responsible resource use (ISO 37101) — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities Resilience (ISO 37101) Preservation and improvement of environment (ISO 37101) — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.8 Percentage of public parking spaces equipped with real-time availability systems — 19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area — 19.11 Percentage of vehicles registered in the city that are autonomous vehicles

ISO 37101 issues	Purposes in this document
Biodiversity and ecosystem services	Attractiveness (ISO 37101) — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population Social cohesion (ISO 37101) Well-being (ISO 37101) Responsible resource use (ISO 37101) — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) Resilience (ISO 37101) — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population Preservation and improvement of environment (ISO 37101) — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population

Annex B
(informative)

Mapping of ISO 37122 indicators to United Nations Sustainable Development Goals (SDGs) (2015)

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 1: End poverty in all its forms everywhere	— 13.2 Percentage of municipal budget allocated for the provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture	— 20.1 Annual percentage of municipal budget spent on urban agriculture initiatives — 20.2 Annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) — 20.3 Percentage of the city's land area covered by an online food-supplier mapping system
Goal 3: Ensure healthy lives and promote well-being for all at all ages	— 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 8.3 Percentage of public buildings equipped for monitoring indoor air quality — 11.1 Percentage of the city's population with an online unified health file accessible to health care providers — 11.2 Annual number of medical appointments conducted remotely per 100 000 population — 11.3 Percentage of the city population with access to real-time public alert systems for air and water quality advisories — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring — 23.3 Percentage of the city's water distribution network monitored by a smart water system
Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	— 6.1 Percentage of city population with professional proficiency in more than one language — 6.2 Number of computers, laptops, tablets or other digital learning devices available per 1 000 students — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 17.3 Number of public library book and e-book titles per 100 000 population — 17.4 Percentage of city population that are active public library users

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 5: Achieve gender equality and empower all women and girls	—
Goal 6: Ensure availability and sustainable management of water and sanitation for all	— 12.2 Percentage of households with smart water meters — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city's water distribution network monitored by a smart water system — 23.4 Percentage of buildings in the city with smart water meters
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all	— 7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste and other liquid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year — 7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year — 7.3 Electrical and thermal energy (GJ) produced from solid waste and other liquid waste treatment per capita per year — 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 7.5 Storage capacity of the city's energy grid per total city energy consumption — 7.6 Percentage of street lighting managed by a light performance management system — 7.7 Percentage of street lighting that has been refurbished and newly installed — 7.8 Percentage of public buildings requiring renovation/ refurbishment — 7.9 Percentage of buildings in the city with smart energy meters — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 12.1 Percentage of households with smart energy meters — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 16.3 Percentage of total amount of waste in the city that is used to generate energy

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	— 5.2 Survival rate of new businesses per 100 000 population — 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 6.1 Percentage of city population with professional proficiency in more than one language — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide
Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	— 5.3 Percentage of the labour force employed in occupations in the information and communications technology (ICT) sector — 5.4 Percentage of the labour force employed in occupations in the education and research and development sectors — 6.3 Number of science, technology, engineering and mathematics (STEM) higher education degrees per 100 000 population — 7.5 Storage capacity of the city's energy grid per total consumption — 10.4 Average downtime of the city's IT infrastructure — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide — 18.1 Percentage of the city population with access to sufficiently fast broadband — 18.2 Percentage of city area under a white zone/dead spot/not covered by telecommunication connectivity — 18.3 Percentage of city area covered by municipally provided Internet connectivity — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.8 Percentage of public parking spaces equipped with real-time availability systems — 19.9 Percentage of traffic lights that are intelligent/smart

Sustainable Development Goal (2015)	ISO 37122 Indicators
	— 19.12 Percentage of public transport routes with municipally provided and/or managed Internet connectivity for commuters — 19.13 Percentage of roads conforming with autonomous driving systems — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.1 Percentage of drinking water under water quality monitoring by a real-time water quality monitoring station — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population — 23.3 Percentage of the city's water distribution network monitored by a smart water system
Goal 10: Reduce inequality within and among countries	— 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.4 Percentage of municipal budget allocated for provision of programmes designated for bridging the digital divide

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable	— 7.10 Number of electric vehicle charging stations per registered electric vehicle — 8.1 Percentage of buildings built or refurbished within the last 5 years in conformity with green building principles — 8.2 Number of real-time remote air quality monitoring stations per square kilometre (km^2) — 8.3 Percentage of public buildings equipped for monitoring indoor air quality — 10.2 Percentage of city services accessible and that can be requested online — 11.3 Percentage of the city population with access to real-time public alert systems for air and water quality advisories — 12.1 Percentage of households with smart energy meters — 12.2 Percentage of households with smart water meter — 13.1 Percentage of public buildings that are accessible by persons with special needs — 13.2 Percentage of municipal budget allocated for provision of mobility aids, devices and assistive technologies to citizens with special needs — 13.3 Percentage of marked pedestrian crossings equipped with accessible pedestrian signals — 14.1 Percentage of public recreation services that can be booked online — 15.1 Percentage of the city area covered by digital surveillance cameras — 17.1 Number of online bookings for cultural facilities per 100 000 population — 17.2 Percentage of the city's cultural records that have been digitised — 17.3 Number of public library book and e-book titles per 100 000 population

Sustainable Development Goal (2015)	ISO 37122 Indicators
	— 17.4 Percentage of city population that are active public library users — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 17.1 Number of online bookings for cultural facilities per 100 000 population — 17.2 Percentage of the city’s cultural records that have been digitised — 17.3 Number of public library book and e-book titles per 100 000 population — 17.4 Percentage of city population that are active public library users — 19.1 Percentage of city streets and thoroughfares covered by real-time online traffic alerts and information — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 19.4 Number of bicycles available through municipally provided bicycle-sharing services per 100 000 population — 19.5 Percentage of public transport lines equipped with a publicly accessible real-time system — 19.6 Percentage of the city’s public transport services covered by a unified payment system — 19.9 Percentage of traffic lights that are intelligent/smart — 19.10 City area mapped by real-time interactive street maps as a percentage of the city's total land area — 19.13 Percentage of roads conforming with autonomous driving systems — 19.14 Percentage of the city’s bus fleet that is motor-driven — 20.1 Annual percentage of municipal budget spent on urban agriculture initiatives — 21.1 Annual number of citizens engaged in the planning process per 100 000 population — 21.4 Percentage of the city population living in medium-to-high population densities

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 12: Ensure sustainable consumption and production patterns	— 7.1 Percentage of electrical and thermal energy produced from wastewater treatment, solid waste treatment and other waste heat resources, as a share of the city's total energy mix for a given year — 7.2 Electrical and thermal energy (GJ) produced from wastewater treatment per capita per year — 7.3 Electrical and thermal energy (GJ) produced from solid waste treatment per capita per year — 7.9 Percentage of buildings in the city with smart energy meters — 7.10 Number of electric vehicle charging stations per registered electric vehicle — 16.1 Percentage of waste drop-off centres (containers) equipped with telemetering — 16.2 Percentage of the city population that has a door-to-door garbage collection with an individual monitoring of household waste quantities — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 16.4 Percentage of total amount of plastic waste recycled in the city — 16.5 Percentage of public garbage bins that are sensor-enabled public garbage bins — 16.6 Percentage of the city's electrical and electronic waste that is recycled — 19.3 Percentage of vehicles registered in the city that are low-emission vehicles — 20.1 Annual percentage of municipal budget spent on urban agriculture initiatives — 20.2 Annual total collected municipal food waste sent to a processing facility for composting per capita (in tonnes) — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy

Sustainable Development Goal (2015)	ISO 37122 Indicators
Goal 13: Take urgent action to combat climate change and its impacts	— 7.4 Percentage of the city's electricity that is produced using decentralised electricity production systems — 16.3 Percentage of total amount of waste in the city that is used to generate energy — 22.1 Percentage of treated wastewater being reused — 22.2 Percentage of biosolids that are reused (dry matter mass) — 22.3 Energy derived from wastewater as a percentage of total energy consumption of the city — 22.4 Percentage of total amount of wastewater in the city that is used to generate energy — 23.3 Percentage of the city's water distribution network monitored by a smart water system
Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development	— 16.4 Percentage of total amount of plastic waste recycled in the city — 22.5 Percentage of the wastewater pipeline network monitored by a real-time data-tracking sensor system — 23.2 Number of real-time environmental water quality monitoring stations per 100 000 population
Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	— 21.4 Percentage of the city population living in medium-to-high population densities
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	— 5.1 Percentage of service contracts providing city services which contain an open data policy — 9.1 Annual amount of revenues collected from the sharing economy as a percentage of own-source revenue — 9.2 Percentage of payments to the city that are paid electronically based on electronic invoices — 10.1 Annual number of online visits to the municipal open data portal per 100 000 population — 10.2 Percentage of city services accessible and that can be requested online — 10.3 Average response time to relevant inquiries made through the city's non-emergency inquiry system (days) — 21.1 Annual number of citizens engaged in the planning process per 100 000 population — 21.2 Percentage of building permits submitted through an electronic submission system — 21.3 Average time for building permit approval (days)
Goal 17: Strengthen the means of implementation and revitalise the global partnership for sustainable development	—

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