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TECHNICAL SPECIFICATION

**Access, Terminals, Transmission and Multiplexing (ATTM);
Sustainable Digital Multiservice Communities;
Key Performance Indicators for
Sustainable Digital Multiservice Areas;
Part 1: Description of Key Performance Indicators**

Reference
RTS/ATTMSDMC-7

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 1 of a multi-part deliverable covering Key Performance Indicators (KPIs) for Sustainable Digital Multiservice Areas (Smart Areas both urban and rural) expressing sustainability performance in terms of People, Planet, Prosperity and Governance as identified below:

Part 1: "Description of Key Performance Indicators";

Part 2: "Global KPIs for Sustainable Digital Multiservice Areas".

Modal verbs terminology

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Executive summary

The present document describes the selection of indicators for assessing indicators on city level. Starting from the definition of a smart city, indicators have been selected that can function as Key Performance Indicators for tracking the progress towards city objectives.

The indicators for smart cities focus on monitoring the evolution of a city towards an even smarter city. The time component -"development over the years"- is an important feature. The city indicators may be used to show to what extent overall policy goals have been reached, or are within reach. With a starting point in the smart city definition, and taking into account the wishes of cities and citizens with regard to smart city indicators, the indicators are arranged in an extended triple bottom line sustainability framework, including the themes people, planet, prosperity, governance and propagation, and completed with specific smart city indicators. Under the main themes subthemes conforming to major policy ambitions have been identified. Under these subthemes in total 73 city indicators have been selected. The selection has been based on an inventory of 43 existing indicator frameworks for cities indicators. The majority of the indicators in the ICT users selection have been derived from existing indicator frameworks. New indicators have been suggested to fill gaps in existing frameworks.

Annex A of the present document presents the selection of indicators for ICT users.

Introduction

ICT users aim to speed up the transition to low carbon, resource-efficient cities by facilitating and enabling stakeholders in smart cities to learn from each other, create trust in solutions, and monitor progress, by means of a common performance measurement framework. The ultimate goal is to support the wide-scale deployment of smart city solutions and services in order to create impact on major societal challenges related to the cities' fast growth and the Union's 20/20/20 energy and climate targets. The expected benefits for different stakeholders can be summarized as follows:

- Cities will benefit from the ICT users results as they support their strategic planning and allow measuring their progress towards smart city goals. In addition, benefits are created from the enhanced collaboration within and between cities, providing the possibility to compare solutions and to find best practices.

- Policy makers will benefit from the indicators that help to set policy targets and monitor their achievement. ICT users KPI framework's sub-themes are formulated as policy goals and thereby the use of the indicators and therefore the indicators are especially useful to follow progress towards policy goals.

- Solution providers will benefit from better insight into business opportunities for their products and services, and into the possibilities for replication in a different city or context.

- Industrial stakeholders will benefit from the recommendations for new business, e.g. based on open data. Citizens will benefit from the indicators as they may help to get a better understanding of complex projects and their impacts.

All these opportunities should bring environmental benefits such as reduction of CO_2 emissions, increased energy efficiency, increased share of renewables, as well as improve the quality of life through better mobility, better communication between local authorities and their citizens, empowerment of citizens (i.e. smart citizens). For the development of the performance measurement framework, ICT users are building on existing smart city and sustainable city indicator systems. The bases of the ICT users indicator framework (Based on CITYkeys deliverable 1.4 [i.1]) are the traditional sustainability impact categories **People, Prosperity and Planet**, but the performance measurement framework includes specific smart city KPIs that go beyond the traditional categories in showing not only the impact but also indices of the success factors for smart city endeavours and the suitability for dissemination to other cities and circumstances. The transparent and flexible ICT Users 'performance measurement framework will be able to handle different sizes of cities in different smart city development stages and thereby support different development strategies of smart cities and -initiatives over a wide range of characteristics.

1 Scope

The present document defines indicators (KPIs) for Smart Cities expressing city level in terms of People, Planet, Prosperity, Governance and Propagation.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] Recommendation ITU-T L.1440: "Methodology for environmental impact assessment of information and communication technologies at city level".

[2] Recommendation ITU-T L.1430: "Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects".

[3] ISO 1996-2:1987: "Acoustics -- Description and measurement of environmental noise - Part 2: Acquisition of data pertinent to land use".

[4] ISO 37120:2018: "Sustainable cities and communities -- Indicators for city services and quality of life".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] European project CITYkeys deliverable D1.4: "D1.4-CITYkeys-D14-Smart-City-KPIs-Final-20160201".

NOTE: Available at http://citykeys-project.eu/citykeys/resources/general/download/CITYkeys-D1-4-Smart-City-smart-project-KPIs-and-related-methodology-final-WSWE-A7LN3E.

[i.2] ETSI GS OEU 019: "Operational energy Efficiency for Users (OEU); KPIs for Smart Cities".

[i.3] ITU, 2014: "Key performance indicators (KPIs) definitions for smart sustainable cities". ITU focus group on smart sustainable cities.

[i.4] ISO 14000 series: "Environmental management".

[i.5] OECD Frascati Manual 2002: "Proposed Standard Practice for Surveys on Research and Experimental Development".

NOTE: Available at http://www.oecd-ilibrary.org/science-and-technology/frascati-manual-2002_9789264199040-en.

[i.6] Eurostat Urban audit (urb) Reference Metadata in Euro SDMX Metadata Structure (ESMS).

NOTE: Available at http://ec.europa.eu/eurostat/cache/metadata/en/urb_esms.htm.

[i.7] European Environment Agency: "Urban Atlas".

NOTE: Available at https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-urban-atlas.

[i.8] Department of Energy & Climate Change: "Electricity Generation Costs", 2013.

NOTE: Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223940/DECC_Electricity_Generation_Costs_for_publication_-_24_07_13.pdf.

[i.9] ECM: "European Cities Marketing Benchmarking report", 2015.

NOTE: Available at http://www.europeancitiesmarketing.com/.

[i.10] ISO 14001: "Environmental management systems".

[i.11] UNEP 2008 annual report.

NOTE: Available at http://wedocs.unep.org/bitstream/handle/20.500.11822/7742/-UNEP%202008%20Annual%20Report-2009837.pdf?sequence=3&isAllowed=y.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

CITYkeys: european project funded by European Union, programme H2020

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CAQI	Common Air Quality Index
CO_2	Carbon dioxide
DE	Domestic Extraction
DECC	Department of Energy and Climate Change
DMC	Domestic Material Consumption
DMI	Direct Material Input
EC	European Commission
ECM	European Cities Marketing
EEA	European Environment Agency
ESPON	European Spatial Planning Observation Network
GDP	Gross Domestic Product
GERD	Gross domestic Expenditure on R&D

GJ   GigaJoule
GPP   Green Public Procurement
ICT   Information and Communications Technology
ISWA   International Solid Waste Association
ITU   International Telecommunications Union
KPI   Key Performance Indicators
LIHC   London Intercommunity Health Centre
OECD   Organization for Economic Co-operation and Development
PM   Particle Matter
PNP   Private Not-for-Profit institutions
SHP   Shape files (GIS file format)
TOE   Tonne of Oil Equivalent

NOTE: 1 TOE = 41,868 GJ.

UHI   Urban Heat Island
UNEP   United Nations Environment Programme
WEI   Water Exploitation Index
WHO   World Health Organization

4   Indicators for smart cities

4.1   Generalities

From the long list of city indicators, based among others on CITYkeys deliverable D1.4 [i.1] and ETSI
GS OEU 019 [i.2], an indicator was chosen. If several indicators were equally suitable, the preference went to an
indicator that cities already use and/or are familiar with. In the next clauses, the tables of selected city indicators are
shown, discussing the title, the unit, a short description, the source framework(s) and the type of indicator:

- The title of the city indicator is phrased as evaluating a static situation. A static indicator, assessing the
  situation at a certain recurrence in time, will allow monitoring over various time periods.

- Important in the choice for the unit of the indicator is the comparability of indicators across a variety of cities
  differing in size, demography, dominant type of companies/sectors, etc. Here too, absolute values are not
  suitable. Consequently, most city indicators are defined as '%' or use a Likert scale, for instance, the share of
  population with good access to public transport expressed in percentage.

- For the city indicator set the traditional quantitative indicator was judged feasible.

- The short description explains the indicator into more detail. More elaborate descriptions of the city indicators
  can be found in annex A.

- Also for city indicators, existing indicators of already developed frameworks have been used for the ICT users'
  framework when available. For these indicators, the original frameworks are mentioned in the description as
  the 'source framework'. In addition, new indicators have been developed by the consortium members when
  they felt this was necessary for performing a complete evaluation of smart cities. The indicator titles of these
  indicators are marked in red.

Some of these indicators have been defined on current Recommendation ITU-T L.1430 [2], Recommendation
ITU-T L.1440 [1] and ITU deliverables on KPIs definitions for Smart and Sustainable Cities [i.3].

Main indicators defined in the present document are presented as follow:

a)   People:

-       Encouraging a healthy lifestyle.

-       Cybersecurity.

-       Data privacy.

- Digital literacy.

- Ground floor usage.

b) Planet:

- Domestic material consumption.

- Brownfield use.

- Local food production.

- Urban heat island.

c) Prosperity:

- Share of certified companies.

- Innovation hubs in the city.

- Open data.

d) Governance:

- Smart city policy.

4.2   People

4.2.1   Health

Table 1

Indicator title	Indicator unit	Definition
Access to basic health care services	% of people	Share of population with access to basic health care services within 500 m
Encouraging a healthy lifestyle	Likert	The extent to which policy efforts are undertaken to encourage a healthy lifestyle

4.2.2   Safety

Table 2

Indicator title	Indicator unit	Definition
Traffic accidents	#/100 000	Number of transportation fatalities per 100 000 population
Crime rate	#/100 000	Number of violence, annoyances and crimes per 100 000 population
Cybersecurity	Likert	The level of cybersecurity of the cities' systems
Data privacy	Likert	The level of data protection by the city

4.2.3   Access to (other) services

Table 3

Indicator title	Indicator unit	Definition
Access to public transport	% of people	Share of population with access to a public transport stop within 500 m
Access to vehicle sharing solutions for city travel	#/100 000	Number of vehicles available for sharing per 100 000 inhabitants
Length of bike route network	% in km	% of bicycle paths and lanes in relation to the length of streets (excluding motorways)
Access to public amenities	% of people	Share of population with access to at least one type of public amenity within 500 m
Access to commercial amenities	% of people	Share of population with access to at least six types of commercial amenities providing goods for daily use within 500 m
Access to high speed internet	#	Fixed (wired)-broadband subscriptions per 100 inhabitants
Access to public free Wi-Fi	% of m²	Public space Wi-Fi coverage
Flexibility in delivery services	Likert	The extent to which there is flexibility in delivery services

4.2.4   Education

Table 4

Indicator title	Indicator unit	Definition
Access to educational resources	Likert	The extent to which the city provides easy access (either physically or digitally) to a wide coverage of educational resources
Environmental education	% of schools	The percentage of schools with environmental education programs
Digital literacy	% of people	Percentage of target group reached

4.2.5   Diversity and social cohesion

No indicators identified at city level.

4.2.6   Quality of housing and the built environment

Table 5

Indicator title	Indicator unit	Definition
Diversity of housing types	Simpson Diversity Index	Simpson Diversity Index of total housing stock in the city
Preservation of cultural heritage	Likert	The extent to which preservation of cultural heritage of the city is considered in urban planning
Ground floor usage	% of m²	Percentage of ground floor surface of buildings that is used for commercial or public purposes as percentage of total ground floor surface
Public outdoor recreation space	m²/cap	Square meters of public outdoor recreation space per capita
Green space	hectares/100 000	Green area (hectares) per 100 000 population

4.3   Planet

4.3.1   Energy and mitigation

Table 6

Indicator title	Indicator unit	Definition
Energy consumption/demand		
Annual final energy consumption	MWh/cap/yr	Annual final energy consumption for all uses and forms of energy
Renewable energy production		
Renewable energy generated within the city	% of MWh	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption
CO_2 -emissions		
CO_2 emissions	t CO_2/cap/yr	CO_2 emissions in tonnes per capita per year
Local freight transport fuel mix	%	The ratio of renewable fuels in the local freight transport fuel mix

4.3.2   Materials, water, land

Table 7

Indicator title	Indicator unit	Definition
Materials		
Domestic material consumption	t/cap/year	The total amount of material directly used in the city per capita
Water		
Water consumption	litres/cap/year	Total water consumption per capita per day
Grey and rain water use	% of houses	Percentage of houses equipped to reuse grey and rain water
Water Exploitation Index	% of m^3	Annual total water abstraction as a percentage of available long-term freshwater resources in the geographically relevant area (basin) from which the city gets its water
Water losses	% of m^3	Percentage of water loss of the total water consumption
Land		
Population density	#/km^2	Number of people per km^2
Local food production	% of tonnes	Share of food consumption produced within a radius of 100 km
Brownfield use	% of km^2	Share of brownfield area that has been redeveloped in the past period as percentage of total brownfield area

4.3.3   Climate resilience

Table 8

Indicator title	Indicator unit	Definition
Climate resilience strategy	Likert scale	The extent to which the city has developed and implemented a climate resilient strategy
Urban Heat Island	°C	Maximum difference in air temperature within the city compared to the countryside during the summer months

4.3.4   Pollution and waste

Table 9

Indicator title	Indicator unit	Definition
Air quality		
Nitrogen dioxide emissions (NO$_2$)	g/cap	Annual nitrogen dioxides emissions per capita
Fine particulate matter emissions (PM 2,5)	g/cap	Annual particulate matter emissions (PM 2,5) per capita
Air quality index	-	Annual concentration of relevant air pollutants
Miscellaneous		
Noise pollution	% of people	Share of the population affected by noise > 55 dB(a) at night time
Waste		
Recycling rate	% of tonnes	Percentage of city's solid waste that is recycled
Municipal solid waste	t/cap/yr	The amount of municipal solid waste generated per capita annually

4.3.5   Ecosystem

Table 10

Indicator title	Indicator unit	Definition
Share of green and water spaces	% in km²	Share of green and water surface area as percentage of total land area
Native species	% of species	Percentage change in number of native species

4.4   Prosperity

4.4.1   Employment

Table 11

Indicator title	Indicator unit	Definition
Unemployment rate	% of people	Percentage of the labour force unemployed
Youth unemployment rate	% of people	Percentage of youth labour force unemployed

4.4.2   Equity

Table 12

Indicator title	Indicator unit	Definition
Fuel poverty	% of households	The percentage of households unable to afford the most basic levels of energy
Affordability of housing	% of people	% of population living in affordable housing