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Operational energy Efficiency for Users (OEU); KPIs for Smart Cities

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Operational energy Efficiency for Users (OEU).

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.

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 D1.4 [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 14001: "Environmental management systems -- Requirements with guidance for use".

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.

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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.

3 Definitions and abbreviations

3.1 Definitions

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

CITYkeys: European project funded by European Union, programme H2020

3.2 Abbreviations

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

CO_2	Carbon dioxide
GDP	Gross Domestic Product
ICT	Information and Communications Technology
ITU	International Telecommunications Union
KPI	Key Performance Indicators
PM	Particule Matter

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], 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 paragraphs, 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.
- 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.

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

Two indicators are defined for "Health" domain:

- Access to basic health care services:
  - Share of population with access to basic health care services within 500 m.
- Encouraging a healthy lifestyle:
  - The extent to which policy efforts are undertaken to encourage a healthy lifestyle.

4.2.2 Safety

Four indicators are defined for "Safety" domain:

- Traffic accidents:
  - Number of transportation fatalities per 100 000 population.
- Crime rate:
  - Number of violence, annoyances and crimes per 100 000 population.
- Cybersecurity:
  - The level of cybersecurity of the cities' systems.
- Data privacy:
  - The level of data protection by the city.

4.2.3 Access to (other) services

Eight indicators are defined for "Access to services" domain:

- Access to public transport:
  - Share of population with access to a public transport stop within 500 m.
- Access to vehicle sharing solutions for city travel:
  - Number of vehicles available for sharing per 100 000 inhabitants.
- Length of bike route network:
  - % of bicycle paths and lanes in relation to the length of streets (excluding motorways).

- Access to public amenities:
  - Share of population with access to at least one type of public amenity within 500 m.
- Access to commercial amenities:
  - 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 WiFi:
  - Public space Wi-Fi coverage.
- Flexibility in delivery services:
  - The extent to which there is flexibility in delivery services.

4.2.4 Education

Three indicators are defined for "Education" domain:

- Access to educational resources:
  - The extent to which the city provides easy access (either physically or digitally) to a wide coverage of educational resources.
- Environmental education:
  - The percentage of schools with environmental education programs.
- Digital literacy:
  - Percentage of target group reached.

4.2.5 Diversity and social cohesion

No indicator is identified at city level.

4.2.6 Quality of housing and the built environment

Five indicators are defined for "Quality of housing and the built environment" domain:

- Diversity of housing types Simpson Diversity:
  - Index of total housing stock in the city.
- Preservation of cultural heritage:
  - The extent to which preservation of cultural heritage of the city is considered in urban planning.
- Ground floor usage:
  - 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:
  - Square meters of public outdoor recreation space per capita.

- Green space:
  - Green area (hectares) per 100 000 population.

4.3 Planet

4.3.1 Energy and mitigation

Four indicators are defined for "Energy and mitigation" domain:

- Energy consumption/demand:
  - Annual final energy consumption:
    - Annual final energy consumption for all uses and forms of energy.
- Renewable energy production:
  - Renewable energy generated within the city:
    - The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption.
- CO2 emissions:
  - CO2 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

Eight indicators are defined for "Materials, water, land" domain:

- Materials:
  - Domestic material consumption:
    - The total amount of material directly used in the city per capita.
- Water:
  - Water consumption:
    - Total water consumption per capita per day.
  - Grey and rain water use:
    - Percentage of houses equipped to reuse grey and rain water.
  - Water Exploitation Index:
    - 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:
    - Percentage of water loss of the total water consumption.
- Land:
  - Population density:
    - Number of people per km^2.

- Local food production:
  - Share of food consumption produced within a radius of 100 km.
- Brownfield use:
  - Share of brownfield area that has been redeveloped in the past period as percentage of total brownfield area.

4.3.3 Climate resilience

Two indicators are defined for "Climate resilience" domain:

- Climate resilience strategy:
  - The extent to which the city has developed and implemented a climate resilient strategy.
- Urban Heat Island:
  - Maximum difference in air temperature within the city compared to the countryside during the summer months.

4.3.4 Pollution and waste

Six indicators are defined for "Pollution and waste" domain:

- Air quality:
  - Nitrogen dioxide emissions (NO_2):
    - Annual nitrogen dioxides emissions per capita.
  - Fine particulate matter emissions (PM 2,5):
    - Annual particulate matter emissions (PM 2,5) per capita.
  - Air quality index:
    - Annual concentration of relevant air pollutants.
- Miscellaneous:
  - Noise pollution:
    - Share of the population affected by noise >55 dB(a) at night time.
- Waste:
  - Recycling rate:
    - Percentage of city's solid waste that is recycled.
  - Municipal solid waste:
    - The amount of municipal solid waste generated per capita annually.

4.3.5 Ecosystem

Two indicators are defined for "Ecosystem" domain:

- Share of green and water spaces:
  - Share of green and water surface area as percentage of total land area.

- Native species:
  - Percentage change in number of native species.

4.4 Prosperity

4.4.1 Employment

Two indicators are defined for "Employment" domain:

- Uneployment rate:
  - Percentage of the labour force unemployed.
- Youth unemployment rate:
  - Percentage of youth labour force unemployed.

4.4.2 Equity

Two indicators are defined for "Equity" domain:

- Fuel poverty:
  - The percentage of households unable to afford the most basic levels of energy.
- Affordability of housing:
  - % of population living in affordable housing.

4.4.3 Green economy

Four indicators are defined for "Green economy" domain:

- Share of certified companies:
  - Share of companies based in the city holding an ISO 14001 [3] certificate.
- Share of Green Public Procurement:
  - Percentage annual procurement using environmental criteria as share of total annual procurement of the city administration.
- Green jobs:
  - Share of jobs related to environmental service activities that contribute substantially to preserving or restoring environmental quality.
- Freight movement:
  - Freight movement is defined as the number of freight vehicles moving into an area (e.g. the city).

4.4.4 Economic performance

Three indicators are defined for "Economic performance" domain:

- Gross Domestic Product:
  - City's gross domestic product per capita.

- New business registered:
  - Number of new businesses per 100 000 population.
- Median disposable lncome:
  - Median disposable annual household income.

4.4.5 Innovation

Five indicators are defined for "Innovation" domain:

- Creative industry:
  - Share of people working in creative industries.
- Innovation hubs in the city:
  - # of innovation hubs in the city, whether private or public, per 100 000 inhabitants.
- Accessibility of open data sets:
  - The extent to which the open city data are easy to use.
- Research intensity:
  - R&D expenditure as percentage of city's GDP.
- Open data:
  - # of open government datasets per 100 000 inhabitants.

4.4.6 Attractiveness and competitiveness

Six indicators are defined for "Attractiveness and competitiveness" domain:

- Congestion:
  - Increase in overall travel times when compared to free flow situation (uncongested situation.
- Public transport use:
  - Annual number of public transport trips per capita.
- Net migration:
  - Rate of population change due to migration per 1 000 inhabitants.
- Population Dependency Ratio:
  - Number of economically dependent persons (net consumers) per 100 economically active persons (net producers).
- International Events Hold:
  - The number of international events per 100 000 inhabitants.
- Tourism intensity:
  - Number of tourist nights per year per 100 000 inhabitants.

4.5 Governance

4.5.1 Organization

Four indicators are defined for "Organization" domain:

- Cross-departmental integration:
  - The extent to which administrative departments contribute to "smart city" initiatives and management.
- Establishment within the administration:
- The extent to which the smart city strategy has been assigned to one department/director and staff resources have been allocated.
- Monitoring and evaluation:
  - The extent to which the progress towards a smart city and compliance with requirements is being monitored and reported.
- Availability of government data:
  - The extent to which government information is published.

4.5.2 Community involvement

Three indicators are defined for "Community involvement" domain:

- Citizen participation:
  - The number of projects in which citizens actively participated as a percentage of the total projects executed.
- Open public participation:
  - Number of public participation processes per 100 000 per year.
- Voter participation:
  - % of people that voted in the last municipal election as share of total population eligible to vote.

4.5.3 Multilevel governance

Three indicators are defined for "Multilevel governance" domain:

- Strategies and policies:
  - Smart city policy:
    - The extent to which the city has a supportive smart city policy.
- Budget:
  - Expenditures by the municipality for a transition towards a smart city:
    - Annual expenditures by the municipality for a transition towards a smart city.
- Multilevel:
  - Multilevel government:
    - The extent to which the city cooperates with other authorities from different levels.

4.6 Conclusions

Based on the inventory of indicators from 43 existing indicator frameworks, a set of indicators for assessing smart city performance has been designed for ICT users. The majority of indicators in the set are derived from existing urban indicator frameworks.

The majority of these indicators concern energy use, emissions from CO_2 and air pollutants, and waste generation, with some possibilities in the people and prosperity themes. The resulting indicator selection responds to the wishes of cities and citizens for the coverage of their priorities and reflects city goals. The ICT users indicator set, described in the present document, focuses on impact indicators as these can be used for all types of interventions. A number of generalized input, output and outcome indicators have been added that reflect the degree of smartness of a city.

History

Document history		
V1.1.1	August 2017	Publication