Project no. 314277

STEEP PROJECT

Systems Thinking for Comprehensive City Efficient Energy Planning

Seventh Framework Programme

Theme Energy

D4.3 List of possible Key Performance Indicators

(v.M24)

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PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1. INTRODUCTION (CONCEPT OF A SMART CITY MONITORING)

A Smart city, to deserve this attribute, should be aware of its compliance with citizens' needs and with higher standards of wellbeing. From the policy makers' point of view it is very important to evaluate the impact of different choices and also to analyse strengths and weaknesses of their territory.

In the STEEP project we aimed at developing Smart city Master Plans focussed on energy and sustainability using an innovative methodology based on the coproduction approach; to measure how these plans perform we need to choose an indicator system which could be able to underline achievements and critical points as well.

The measurement of city performance is one of the critical ways in which we can assess the complexity of urban change, and judge which approaches are successful or not.

The indicators we are looking for are those that provide a unique resource for administrators and plan makers to learn about city strengths and weaknesses, and assess the progress of new policies in a fast-evolving economy.

After a brief diversion about the state of the art, this work defines a group of indexes linked to the STEEP project results and tools (preliminary model sectors of interest from D4.1, Pestel Analysis D2.3&2.4, …).

The database of indicators, agreed by the partners, has supported the creation of the Master Plans and it will be exploited to monitor the achievements. The set will be provided to any other interested city for planning and benchmarking activities through the stakeholder platform based on a wiki system.

1.1 The procedure

The procedure adopted for the selection of indicators is summarized in the steps below:

-*Step 0: Analysis of the state of the art*: measurement systems used by cities with a focus on 'smart' approaches, data availability, …

- *Step 1: Fields of interest*: selection of the thematics to be measured by indicators;

- *Step 2: first draft of the KPI list:* from existing indicator sets and from partners' experience;

- *Step 3: add missing indicators*: through implementation of the preliminary set in the definition of the Smart City Plans;

- *Step 4: agreement on the indicators:* the set has been finalized among partners and a simplified calculation methodology has been developed to provide interested cities with an effective tool;

-*Step 5: publication of the baseline and pilot KPIs*: partners publish on the platform/website their calculations to be shared and compare with other cities together with the guidelines where the list and the methodology is fully explained.

2. EUROPEAN INNOVATION PARTNERSHIP ON SMART CITIES AND COMMUNITIES: OPERATIONAL IMPLEMENTATION PLAN FIRST PUBLIC DRAFT

In the first public draft of the Operational Implementation Plan produced by members of the Sherpa Group, the "Baselines, Performance Indicators and Metrics" issue has been elected as a priority, becoming the subject of one of the twelve working groups.

It sets that a single, broadly-accepted indicator framework is still missing. It should reflect the 'smart city' approach, address cities systemically and be able to help cities understand better the interdependent nature of city systems and services.

The identified actions to support the development and European-wide application of such an indicator system are listed below and are crosscutting among the priority sectors

1 EU smart city Indicator framework:

Develop and pilot an EU-wide smart city Indicator framework as a collaborative exercise; adopting/adapting existing measurement assets; and establish a means to achieve wide-scale adoption.

2 Constituency building

Activities related to the development of indicators, consensus-building, dissemination of results, getting buy-in, e.g. organise a European scientific conference on smart city indicator systems and monitoring tools.

3 Metrics Standards

Develop and align standards for European energy, mobility and ICT data to enable comparison at local levels (within cities over time; and between cities)

4 Smart City Competitions & Awards

With focus on improvements of a city with respect to a baseline, implement competitions and awards to instil a greater emphasis on performance within cities (e.g. between city districts, involving citizens directly), and between cities – all based on a respected measurement framework.

5 Smart City KPI Uptake

Establish a business model that ensures the uptake and sustenance of the smart city indicator framework; particularly for cities with limited resources/capacities.

3. MEASUREMENT SYSTEMS FOR CITIES IN USE WITH A FOCUS ON 'SMART' APPROACHES

There is a wide collection of global city indexes, benchmarks and comparative rankings produced by multi-governmental institutions, business consultancies, research foundations and media at national, regional and global levels.

Several indicator systems and assessment methodologies related to specific aspects of smart cities have been developed on the European level (Covenant of Mayors, the Green Digital Charter, CIVITAS, CONCERTO, Urban Audit, ESPON, the Reference Framework for Sustainable Cities, etc). 'The newly published ISO standard is the only integrated indicator system supporting reliable progress-monitoring in all fields relevant to smart cities, both within a city over time, and in between cities.

Another issue is the efforts required by cities to measure those sets of key indicators: the most complete ones require a huge amount of data which are not often available and it must be said also that a large number of indicators could confuse the evaluation instead of clarifying.

In the following paragraphs the main features of the most common systems are reported and evaluated as a background study for the development of the project indicator set.

3.1 Global indicator systems

3.1.1 The Global City Indicators facility and the ISO 37120 standard

As part of a new series of International Standards being developed for a holistic and integrated approach to sustainable development and resilience under TC268 Sustainable Development of Communities, ISO 37120 establishes a set of standardized indicators that provide a uniform approach to what is measured, and how that measurement is to be undertaken. This International Standard does not provide a value judgement, or numeric thresholds on what a particular city should choose as appropriate targets for the indicators. ISO 37120 establishes definitions and methodologies for a set of indicators to steer and measure. This International Standard is applicable to any city, municipality or local government that undertakes to measure its performance in a comparable and verifiable manner, irrespective of size and location or level of development.

Standardized indicators enable cities to assess their performance and measure progress over time and also to draw comparative lessons from other cities locally and globally. It also helps to guide policy, planning and management across multiple sectors and stakeholders.

In this age of urbanization, city indicators can be used as critical tools for city managers, politicians, researchers, business leaders, planners, designers and other professionals to help ensure policies are put into practice that promote liveable, tolerant, inclusive, sustainable, resilient, economically attractive and prosperous cities globally. Cities need indicators to measure their performance for improving quality of life and sustainability globally. The WCCD and ISO 37120 provide an open source, independently verified data platform which helps to build smart and sustainable cities worldwide

ISO 37120 – Benefits of Standardized Indicators

- More effective governance and delivery of services
- Local and international benchmarking and planning
- Informed decision making for policy makers and city managers
- Learning across cities
- Recognition by international entities
- Leverage for funding by cities with senior levels of government
- Framework for sustainability planning
- Transparency and open data for investment attractiveness

ISO 37120 Sustainable Development of Communities – Indicators for City Services and Quality of Life was published in May 2014 and is the first ISO international standard on city indicators. ISO 37120 was developed using the GCIF framework and input from international organizations, corporate partners, and international experts from over 20 countries. ISO 31720 provides a comprehensive set of indicators and a methodology that will enable any sized city in a developed or a developing economy to measure its social, economic, and environmental performance in relation to other cities. The standard includes 115 core indicators, 31 of which are core, meaning they must be reported on, with the remaining supporting indicators being optional. New additional indicators on sustainable development and resilience are currently being developed within the ISO.

The indicators are structured around 20 “themes” that measure a range of city services and quality of life factors.

CITY SERVICES

- Education
- Energy
- Finance

QUALITY OF LIFE

- Civic Engagement
- Culture
- Economy

- Recreation
- Fire & Emergency Response
- Governance
- Health
- Safety
- Solid Waste
- Transportation
- Urban Planning
- Wastewater
- Water
- Environment
- Shelter
- Social Equity
- Technology And Innovation

City performance relative to each of these themes is measured by a number of indicators, which collectively tell a "story". Overall, 115 indicators have been developed. Recognizing the differences in resources and capabilities between developed and developing world cities, the overall set of 115 indicators has been divided into 31 "core" indicators, which all cities participating would be expected to report on, and 43 "supporting" indicators, which all cities would be encouraged, but not expected, to report on, along with 41 "profile" indicators which provide basic statistics and background information to help cities determine which cities are of interest for comparisons.

This set of global city indicators was selected based on significant input from the partner cities, ensuring that these indicators reflect city information needs and interests, and a rigorous screening process. The indicators must be:

- Available, up to date, and able to be reported annually;
- Readily comparable among cities globally;
- Relevant for public policy decision making and/or linked to established goals (e.g. MDG);
- Cost effective to collect;
- Meaningful to cities across the globe regardless of geography, culture, affluence, size, or political structure;
- Understandable and not overly complex;
- Clear as to whether changes in the indicators are good or bad.

3.1.2 The MetroMatch

MetroMatch is a voluntary effort to link the staff of municipalities from around the world for the purpose of sharing technical information on an identified set of topics, including wastewater management, climate change, public health, disaster response, flood control, and other municipal services.

MetroMatch would work hand-in-hand with the Global City Indicators Facility (GCIF):

- GCIF will provide a common set of indicators and context for monitoring performance.
- MetroMatch will provide a mechanism for municipalities to share technical information on improving performance relative to identified benchmarks.

MetroMatch will enable willing municipal participants to be listed in a web-based, "MetroMatch Directory" with information about their position and the expertise that they possess. Staff listed in the directory may be contacted with requests for technical information and assistance to deal with operational or programmatic problems in the areas of the individual's expertise. Participation in MetroMatch, by both municipalities and individuals, is voluntary. Access to the MetroMatch Directory is limited to active Global City Indicators participants as an incentive to continue updates to City Indicators data.

The list of participating cities is expected to grow significantly with the public release of the Global City Indicators Facility and related website. Cities in the United States, Asia, and Europe have already expressed interest in formally participating in the GCIF and MetroMatch.

The benefits of municipal participation in Global City Indicators Facility and MetroMatch are

- Most municipalities already dedicate significant effort and resources to tracking performance. MetroMatch provides a unique opportunity to share data with similar-sized municipalities in other countries using a common set of indicators, providing a wider context for comparison and exchange of ideas.
- The MetroMatch element will provide a low-cost opportunity for consultation with municipalities which have been particularly effective in meeting a given benchmark (reduction of carbon emissions for example). Because access to MetroMatch is limited to municipalities using and reporting on a common set of indicators, these consultations are more likely to be relevant.
- Best practices for benchmarks and performance measures are evolving. Participation in Global City Indicators Facility and MetroMatch provides opportunities for staff to collaborate with staff from other municipalities who are leaders in this field. Participation would also provide greater visibility and

credibility for the accomplishments of local governments and could be used to ensure greater accountability to both local tax payers and grant funders.

3.1.3 The Green City Index

The Green City Index methodology was developed by the Economist Intelligence Unit (EIU) in cooperation with Siemens. Cities were selected for their size and importance (mainly capital cities and large population or business centres). They were picked independently, rather than relying on requests from city governments to be included or excluded, in order to enhance each Index's credibility and comparability.

The Green City Index series has measured the environmental performance of more than 120 cities throughout the world, with seven more to be included from Australia and New Zealand in late 2012.

The Green City Index series measures cities on approximately 30 indicators across eight to nine categories depending on the region. It covers:

- CO2 emissions,
- energy,
- buildings,
- land use,
- transport,
- water and sanitation,
- waste management,
- air quality
- environmental governance.

About half of the indicators in each Index are quantitative – usually data from official public sources, for example, CO2 emissions per capita, water consumption per capita, recycling rates and air pollutant concentrations. The remainder are qualitative assessments of the city's environmental policies – for example, the city's commitment to sourcing more renewable energy, traffic-congestion-reduction policies and air quality codes. Measuring quantitative and qualitative indicators together means the Indexes are based on current environmental performance as well as the city's intentions to become greener.

The specific indicators differ slightly from Index to Index, taking into account data availability and the unique challenges in each region.

3.1.4 The ELITE cities

China is pursuing the development of Low-carbon Eco-cities with the intent of providing urbanites with a clean environment, a growing economy, and a society that promotes harmonious citizen interactions, while simultaneously limiting carbon dioxide and other GHG emissions. The Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities) was developed by researchers at the Lawrence Berkeley National Laboratory (LBNL) in 2012 to evaluate cities' performance by comparing them against benchmark performance goals as well as rank against other cities in China. ELITE Cities measures progress on 33 key indicators selected to represent priority issues within 8 primary categories. These indicators were chosen based on international commonality and SMART criteria in an extensive review of 16 international indicator systems and 11 domestic Chinese city indicator systems, considering their utility in evaluating both individual cities' progress and applicable to issues faced by all Chinese cities. An excel based tool is then developed to package the key indicators, indicator benchmarks, explanation of indicators, point calculation functions and transparency-oriented data recording instructions.

Indicator name	Units	Benchmark	Actual Value	Score
CO2 Intensity	tons/capita/year	2.19	3	73
Residential Building Energy Intensity	kWhe/m2/year	88	100	88
Public Building Electricity Intensity	kWh/m2/year	70	80	88
Share of Renewable Electricity	% of total electricity purchased	20%	10%	50
Municipal Water Consumption	liter/cap/day	52.1	60	87
Industrial Water Consumption	liter/annual 10,000 RMB	80.3	90	89
Wastewater Treatment Rate	% of total waste water	100%	100%	100

The two primary goals of this tool are to minimize data input requirements to allow for easy self-evaluation by city leaders and policy makers based on benchmarked performance levels, and to present the results of the analysis in a simple format that transparently shows the basis for any city's final score. To minimize problems associated with the use of new software, the tool was developed as a simple Excel macro-enabled workbook featuring a navigation bar, data input sheets, and results outputs in the form of tables and graphs, and a database of underlying parameters and assumptions. ELITE Cities could be a useful and effective tool for local city government in defining the broad outlines of a low carbon eco-city and assessing the progress of cities' efforts towards this goal. ELITE Cities can also be used by higher-level governments to assess city performance and discern best practices.

The strength of this methodology are the availability of the xls tool which is a very friendly interface and the use of selected benchmarks to evaluate the performance of each index.

Table 3
Final ELITE cities indicators and benchmarks.

Primary category	Indicator name	Indicator scope	Units	Benchmark	Source
Energy/ Climate	CO_2 intensity	Total carbon dioxide (CO_2) emissions per capita	tons/capita year	2.19 tons/cap year	UN Habitat State of the World Cities 2008/2009, Part 3, p. 135; Oslo is picked as the benchmark.
	Residential building energy intensity	All residential building average energy intensity per square meter building space	kilowatt-hours per square meter per year (kWh/m² year)	Cold climate: 88 kWh/m² year severe cold climate: 132.7 kWh/m² year hot summer cold winter climate: 69.7 kWh/m² year hot summer warm winter climate: 54.7 kWh/m² year moderate: 50 kWh/m² year	Jiang Yi, China Building Energy Efficiency Development Report.
	Public building electricity intensity	Public building average electricity intensity per square meter	kWh/m² year	70 kWh/m² year	Jiang Yi, China Building Energy Efficiency Development Report. Shenzhen data is set as the benchmark.
	Share of renewable electricity	Renewable energy (excluding nuclear) as a share of total city purchased electricity	% of total electricity purchased	20%	National 12th Five-Year Plan for New Energy Development and Caofeidian Eco-city Indicator System's target.
Water	Municipal water consumption	Municipal water consumption per capita	liter/capita day	52.1 l/cap day	Hamburg (2009).
	Industrial water consumption	Industrial water consumption per industrial GDP	liter/annual 10,000 Renminbi (RMB)	80.5 l/10,000 RMB	World Bank, TRACE tool.
	Wastewater treatment rate	Percentage of wastewater receiving at least primary treatment	% of total wastewater	100%	LBNL expert team decision.
	Drinking water quality	Percentage of total drinking water meeting Grade III or above	% of total drinking water	100%	LBNL expert team decision.
	Recycled water use	Percentage of annual municipal water use sourced from water reclamation	% of total municipal water	30%	MOHURD eco-garden city program standard.
	Energy intensity of drinking water	Energy intensity of drinking water	Kilowatt-hours per liter (kWh/l)	0.10 kWh/l	World Bank, TRACE tool. Sydney (2009).
Air	PM_{10} concentrations	Daily average PM_{10} concentration	Micrograms per cubic meter (g/m³)	20 μg/m³	WHO (2006). 24-h mean.
	NO_x concentrations	Daily average NO_x concentration	g/m³	40 μg/m³	WHO (2006). 24-h mean.
	SO_2 concentrations	Daily average SO_2 concentration	g/m³	20 μg/m³	WHO (2006). 24-h mean.
	Air pollution days	Proportion of days per year that air quality meets Level II standard ("blue sky" threshold)	% of total days per year	100%	LBNL expert team decision.
Waste	Municipal waste intensity	kilograms (kg) of total collected MSW per capita	kg/capita/year	0.29 kg/cap/year	Shanghai target.
	Municipal waste treatment rate	Percentage of collected MSW receiving "harmless" treatment	% of total collected MSW	100%	LBNL expert team decision.
	Industrial recycling rate	Comprehensive industrial waste utilization rate	% of industrial solid wastes	100%	LBNL expert team decision.
Mobility	Public transportation network penetration	Public transport penetration rate as a proportion of total city area	kilometers per square kilometer (km/km²)	4 km/km²	Upper end of national target; code for transport planning on urban road. (GB 50,220-95): 3.2.2
	Public transportation share of trips	Share of public transportation trips in all trips	% of all trips/year	60%	12th Five-Year Comprehensive Plan for Transport System, national target city with 10 million population.
	Access to public transportation	Percentage of built area within 500 meters of public transit	% of built area	90%	MOHURD, Public Transport Demonstration Project, html
	Municipal fleet improvement	Proportion of energy-efficient and new-fuel vehicles (electric, hybrid, biofuel, <1.6 l-and-below cars) in the city vehicle fleet and taxi fleet	% of total vehicles	100%	LBNL expert team decision.
Economic health	Employment	Registered unemployment rate	% of eligible adults	3%	Chinese City Statistic Yearbook, Chongqing 12th Five-Year Plan, 2015 target.
	Environmental protection spending ratio	Ratio of environmental protection spending to GDP	% of annual GDP	3%	National 12th Five-Year Plan for Environmental Protection.
	R&D investment ratio	Ratio of R&D spending to GDP	% of annual GDP	5.5%	Beijing 12th Five-Year Plan

N.Zhou at all/ ecological indicators

3.2 The European level

3.2.1 The Reference Framework for European Sustainable Cities (RFSC)

The RFSC is a joint initiative of the Member States, the European Commission and European organizations of local governments. In 2008 in Marseille the Ministers decided to have a tool created that would translate into practice the common sustainability goals and the Leipzig Charter objectives.

In the tool kit that the RFSC makes available for the cities there is also a monitoring tool with a library of more than 100 indicators and subindicators each city could decide to evaluate. The main categories are economy, social, environment and governance.

The community also offers a list of best practices collected in a showcase and submitted by the users.

3.2.2 The Covenant of Mayors Initiative

The Covenant of Mayors is the mainstream European movement involving local authorities voluntarily committing to increasing energy efficiency in their territories. All the three STEEP partner cities are CoM signatories.

To date some *6.500 cities and regions* have committed to meet and exceed the European Union 20% CO2 reduction objective by 2020 representing over one third of the EU population.

Today already 4.800 local authorities have voluntarily submitted a Sustainable Energy Action Plan (SEAP) to the European Commission.

Despite the economic downturn, cities are not wavering from their commitments and are determined to become more liveable and economically prosperous through sustainable investments.

Indeed the Covenant provides signatories with a *harmonised data compilation and reporting framework which is unique in Europe*, and assists them to follow a systemic energy planning and monitoring process at the local level. Developed together with the European Commission's Joint Research Centre, based on the experience of practicing

municipalities and regions with the intention to align with most common local methodologies, the Sustainable Energy Action Plan (SEAP) and Monitoring templates constitute the standard reporting framework for Covenant Signatories. The SEAP template forms the skeleton of the individual SEAPs. It allows signatories to collect and analyse data in a structured and systematic manner and serves as a basis for good energy management. The Monitoring template focuses on tracking progress in SEAP implementation.

Reporting data via the Covenant allows signatories to demonstrate the EU wide impact of their actions on the ground (see the 'Covenant indicators' factsheet as well as the '6-year Assessment of the Covenant of Mayors Initiative' report available at www.eumayors.eu). Figures reported in the templates are 'translated' into understandable and transparent graphical highlights mainstreamed all over Europe.

In order to submit a SEAP for evaluation, the CoM technical team of each signatory has to compile *an online template of the Baseline Emissions Inventory* that comprises both mandatory and optional entries. The mandatory entries include the figure for total emissions in BEI and the subtotal of emissions per macro-sector of activities:

- buildings, equipment/facilities and industry (small industry, not in the EU ETS);
- transport;
- others, not related to energy consumption (non-mandatory sectors, that possibly may be included in one).

The BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES sector includes the following subsectors:

1. municipal buildings, equipment/facilities;
2. tertiary (non-municipal) buildings, equipment/facilities;
3. residential buildings;
4. municipal public lighting;
5. industries – small industries, not involved in ETS.

The TRANSPORT sector includes the following subsectors:

1 municipal fleet;

2. public transport;
3. private and commercial transport.

These sectors cover all transportation that occurs within the territory of the signatory and that is under the jurisdiction of the local authority, and include urban road transportation on the street network, urban rail transportation (tram, metro, local trains) and local ferries.

The OTHER EMISSIONS sector includes emissions unrelated to energy consumption, such as:

1.waste management;

2.wastewater management;

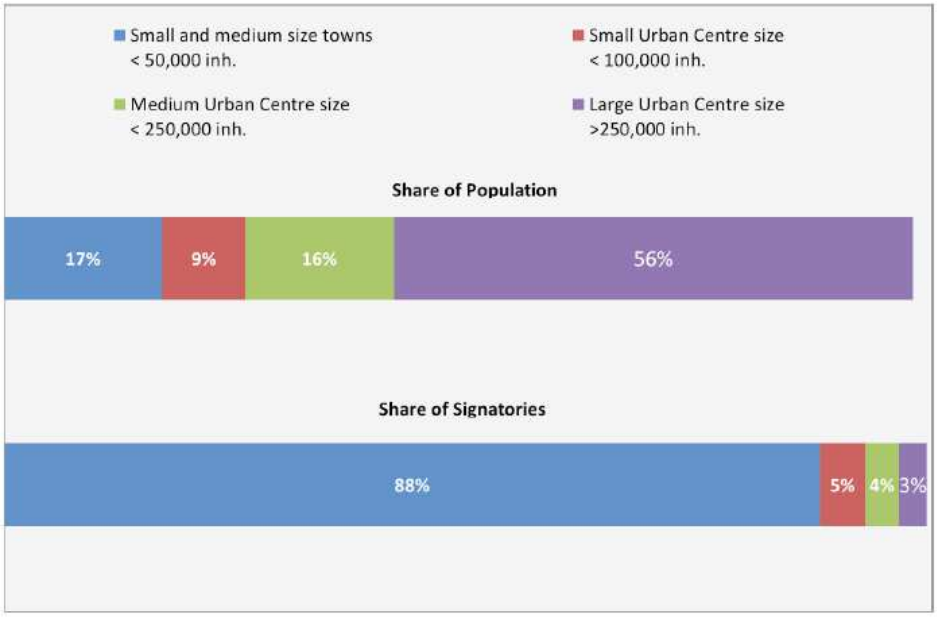
3.other sectors of activities such as agriculture.

For all these fields the *total energy consumption per year* (MWh/y) and the *total CO_2* (t/y or t_{eq}/y) are calculated as absolute values; the conversion to per capita values could be easily done and this is often chosen by municipalities with population growth. The consumption and emission values for each sector are also available for each energy vector in use (electricity, fossil fuels, RES,…).

In the template as well as in the monitoring scheme, some other indicators are requested, such as the financial costs related to the action.

The weak point of this scheme is that the analysis is strictly related to energy issues and it presents limits due to the calculation rules which for example are mandatory related to the geographical boundaries.

The peculiarity of the CoM movement, compared to other GHG mitigation networks, is the engagement of small towns in the effort to reduce greenhouse gas emissions. It is important to highlight that the majority of signatories with a submitted Sustainable Energy Action Plan are small and medium towns, representing 88% of the total number of signatories of the sample.



Share of signatories' category and population in CoM at may 2014 (6 years assessment)

One result, confirming the consistency of the "CoM data set as of 13th of May 2014" is that GHG emissions and energy consumption per capita are compatible with values from international datasets at national level (Eurostat, EEA).

3.2.3 European Common Indicators

The ECI initiative started in May 1999 with the setting up of a Working Group on Sustainable Indicators (by the initiative of and under the supervision of the Expert Group on the Urban Environment and led by the French Environmental Ministry) with the task of developing common (harmonised) indicators for local sustainability, in close collaboration with a wider Group of Local Authorities.

Since the beginning, the aim of the initiative has been to develop and test indicators reflecting local actions towards sustainability in as integrated a way as possible. The outcome of the initial phase was a proposal, suggesting a set of indicators on a limited number of themes, in order to allow the strengthening of some core methodologies through effective implementation.

Thanks to the launch of the ECI initiative, supported by the EU Environment Commissioner, in February 2000 during the Hanover Conference, 80 local authorities signed the "Agreement on the adoption of Towards a Sustainability Profile – European Common Indicators". After that reference point, the number of signatories has continuously increased, including also the STEEP partners cities of Bristol and Florence.

Below the list of the ten European Common Indicators areas of influence and the main indicator per section are shown:

Section	Main indicator
1. *Citizen satisfaction with the local community*	Average satisfaction with the local community
2. *Local contribution to global climate change*	CO2 emission per capita
3. *Local mobility and passenger transportation*	Percentage of trips by motorized private transport
4. *Availability of local public open areas and services*	% of citizens living within 300m of public open areas>5,000 m2
5. *Quality of local air*	Number of PM10 net overcomings
6. *Children's journeys to and from school*	% of children going to school by car
7. *Sustainable management of the local authority and local businesses*	% of environmental certifications on total enterprises

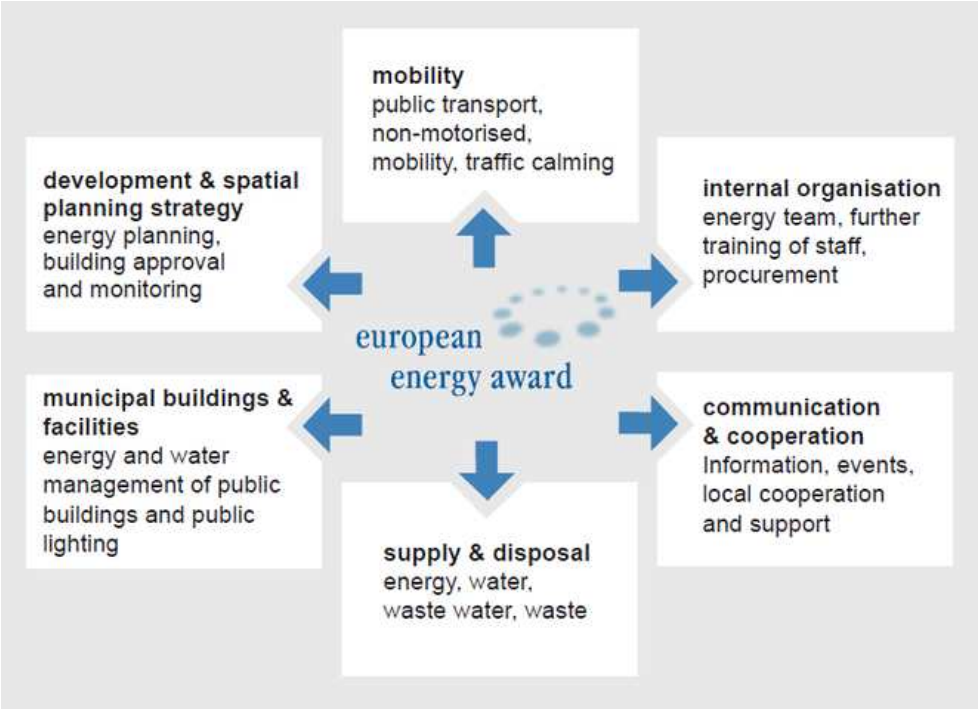
8. *Noise pollution*	% of population exposed to Lnight > 55 dB(A)
9. *Sustainable land use*	Percentage of protected area
10. *Products promoting sustainability*	% of people buying "sustainable products"

3.2.4 The European Energy Award

The European Energy Award® (eea) is a quality management and certification system for municipalities committed to sustainable municipal energy, climate and transport policies. From space planning to energy supply, from mobility to communication and cooperation – the eea comprises all proven energy and climate protection measures municipalities can take. The eea is therefore the most comprehensive quality management system for municipalities in the field of energy efficiency.

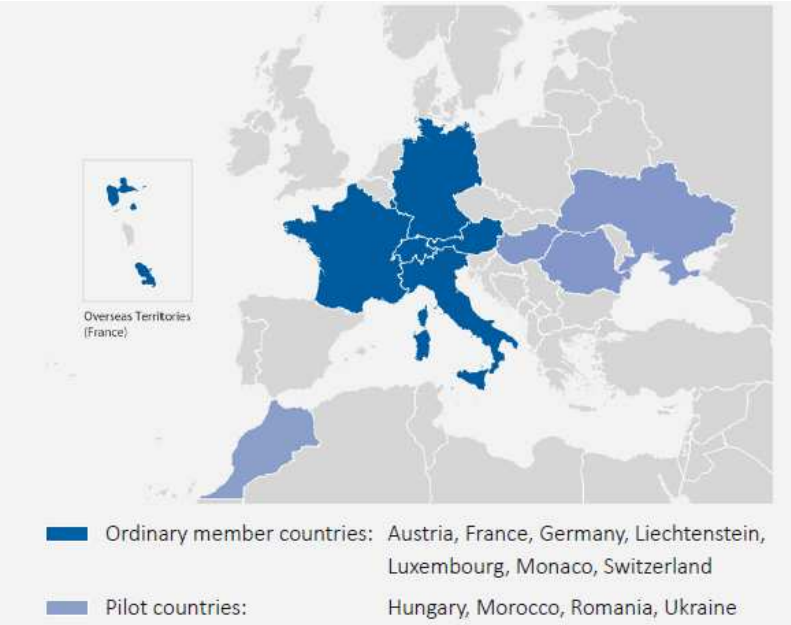
It has been recognised officially as a supporting tool of the Covenant of Mayors.

A municipality's scope of action regarding energy and climate protection policy covers the areas shown below. The eea process ensures that all activities in each of these areas are systematically determined, assessed, continually checked, co-ordinated and precisely implemented.



The European Energy Award® takes particularities of individual countries and regions into account, yet provides for benchmarks to be established between municipalities at

a European level. There are *more than 1,200 municipalities participating today among which there is the STEEP partner Florence as the biggest Italian city in the network*.

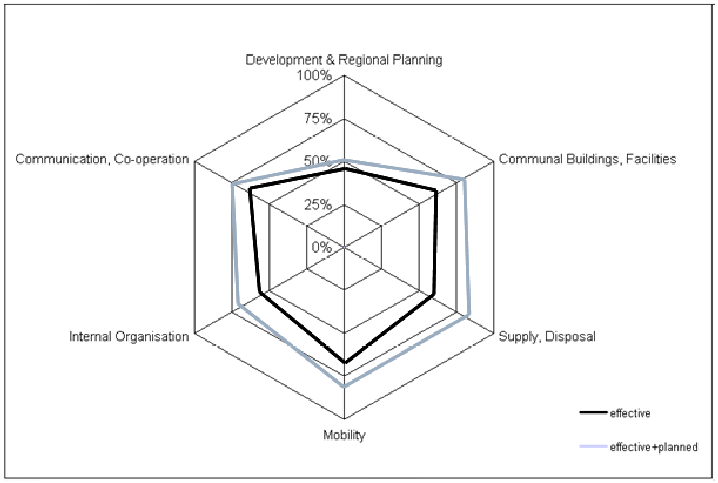


The eea-Management-Tool (EMT) is the core instrument of the European Energy Award®. This online catalogue comprises *79 energy and climate policy measures* grouped into the six municipal areas of activity (see previous picture) which must be quantified and evaluated with the *support of external qualified advisors/auditors*.

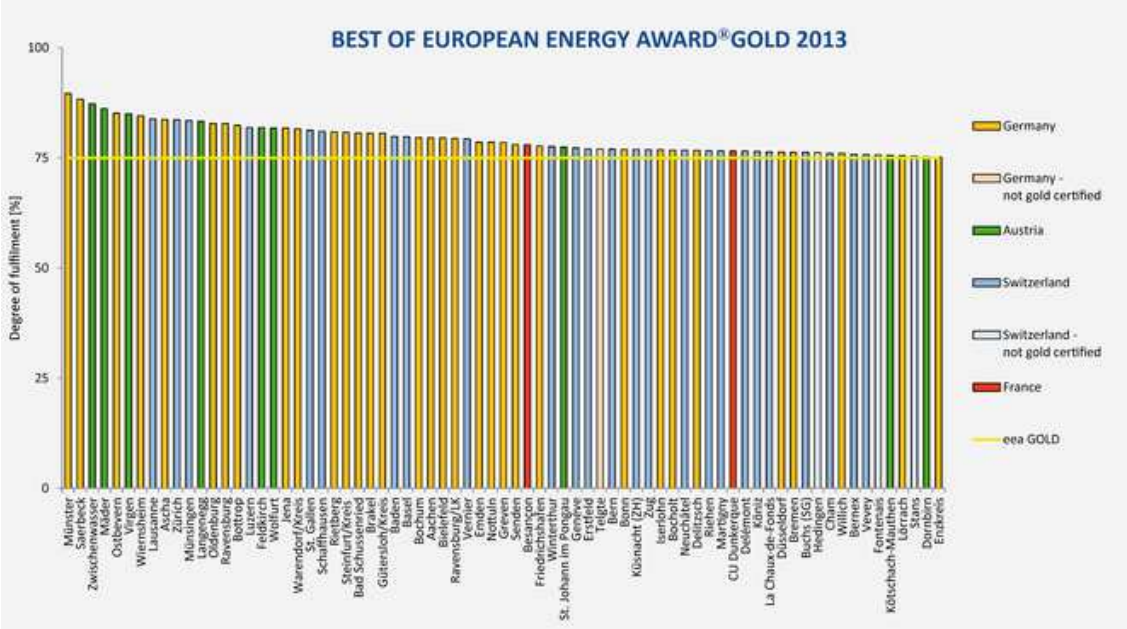
The European Energy Award® Management Tool is also used to collect information on *more than 150 energy and climate policy indicators,* which are internationally comparable.

The EMT offers eea municipalities the following benefits:

- Overview of all of the municipality's past, current and planned energy and climate policy activities
- Ideas for future energy and climate policy activities
- Monitoring of ongoing performance improvements
    - Automatic generation of progress reports
    - Automatic generation of diagrams illustrating the municipality's strengths and weaknesses and development
- Central management of all relevant documentation
- Concurrent processing by internal staff and external trained advisors



The comparison is conducted annually through the eea benchmarking process. Municipalities' results are based on external audits, which are performed every four years. Participating municipalities are therefore able to compare performances and boost their energy efficiency profiles at the European level.



The eea processes and tools have proven successful in 25 years of implementation in the various member states. A bottom-up approach, in which national/regional eea offices submit proposed changes to the Forum European Energy Award e.V., is applied in order to ensure that these processes and tools are continually improved.

3.3 National initiatives

3.3.1 Sustainable UK Cities Index

Sustainable development organisation Forum for the Future created an annual Sustainable Cities Index for the UK's 20 largest cities from 2007 to 2010. It aimed to highlight British cities' environmental performance, quality of life and their preparedness for future urban challenges. The index was intended to encourage healthy competition, and provide an element of accountability.

13 indicators were measured in three broad themes:

8 Environmental impact – the city's impact in terms of resource use and pollution

8 Quality of life – what the city is like for people to live in

8 Future-proofing – how well the city is preparing for a sustainable future.

Future-proofing is an unusual feature of city indexes. The indicators aim to measure how well prepared the city is for the future by examining local authority commitments on climate change – based on nine key criteria. These cover council adaptation and mitigation strategies and commitments to public buildings and those citywide.

3.3.2 ICity Lab

The ICity Lab – "I" means innovation, inclusion, interaction and intelligence – is an initiative of the Public Authorities' Forum aimed at supporting all those people who are working at different levels to make cities Smarter.

The tools provided by the ICity Lab are:

- the annual report "ICity rate"
- the technological platform
- the communication channel FORUM PA, which is able to involve a wide public made of private and institutional stakeholders

ICity Rate is the annual report published by ICity Lab to analyse the state of the art of the Italian cities.

To develop the report, ICity Lab selects and analyses different urban size and, for each one of these, a certain number of indicators. The resulting values, calculated on the basis of available data, are then transformed and aggregated in a unique index for a final summarising classification (ICity index).

The model presents *two kind of ratings*: the base and the Smart rating with additional indicators (see annex2). The indexes are related to six main areas:

1. ECONOMY

2. LIVING
3. ENVIRONMENT
4. MOBILITY
5. PEOPLE
6. GOVERNANCE

A *comparison between cities* is possible in the data platform where data are also represented with georeference.

3.3.3 The Italian Smart City Index

The Smart City Index is between platform analysis on Smart Cities. It is a ranking of "smart cities" based on two elements: what is already smart in the cities and available to citizens (not only existing projects) and the completeness of indicators regarding digital services and sustainable development.

The index measures every year, city by city (all 116 head of provinces), with more than 100 indicators, the presence of:

- "smart" services (from infomobility to eHealth, from digital school to eGovernment, from on-line university to digital justice), on web and tablets/smartphones;
- enabling "infrastructural" conditions (fixed and mobile broadband and ultrabroadband network, electronic payments, digital identity, open data, etc.);
- innovation within sustainable development (from energy consumption to the intelligent use of natural resources);
- institutional, financial and organizational resources which promote innovation (balance sheet, governance of smart cities project, etc.).

This tool is useful to:

- cities which may make an assessmemt of their digital roadmap, may position themselves towards other cities and may support with actual data their nomination to smart cities funding;
- Regions may make a benchmark of their cities or their territory for the digital roadmap of smart regions;

- ICT companies may identify the most progressive cities and market gaps and saturations of single application areas, and may provide a smart city offer customized on single cities features, starting from strengths and filling the gaps.

3.3.4 IDC Smart Cities Index Spain

In 2011 the International Data Corporation (IDC) Spain developed the first IDC Smart Cities Index and then applied in Spain (as well as in other countries such as Germany) to evaluate cities' "smartness." The following year, the same approach was followed to create the new 2012 *ranking of the 44 largest Spanish cities* (those with more than 150,000 inhabitants).

The IDC Smart Cities Index is based on eight building blocks used for the analysis.

They are organized into two macro-groups:

- Smartness dimensions. Smart government, smart buildings, smart mobility, smart energy and environment, and smart services. These are the domains for which initiatives can be developed and deployed.

- Enabling forces. People, economy, and information and communication technologies. While it is true that the population and local economies benefit from the development of smart cities, they also act as enabling factors creating more attractive conditions for successful implementations. Considering IDC's smart city definition — a local entity which declares and makes a conscious effort to adopt information and communication technologies to transform its essential modus operandi — ICT plays a key enabling role. For this reason its relative weighting is higher (40%) than those assigned to people (30%) and economy (30%).

For both the smartness dimensions and enabling forces, relevant and synthetic evaluation criteria were developed and weighted. The *23 criteria included in the model* range from city population dynamics to education level and average population age, local economic composition and dynamism, local government transparency, environment protection policies, access to eservices, residential and commercial building efficiency standards, clean energy development, remote working, traffic management, low carbon mobility, and the level and quality of ICT adoption. To appropriately assess these criteria, the model includes a set of *94 indicators*.

3.3.5 White Paper on Sustainability of Spanish Urban Planning

For many years now, the European Union has been pushing for the model of a compact European city, warning of the serious disadvantages of sprawling or disorderly urban development. These include environmental impact, social segregation, and economic

inefficiency derived from the high energy, building and maintenance costs of huge infrastructures and providing public services.

As the authors of the *White Paper on Sustainability of Spanish Urban Planning* state, "both in Spain and in the rest of Europe, the challenge being faced is that of urban planning which can continue to contribute towards economic growth without ignoring the requirements for sustainable urban development (...). And regulating it calls for a combination of a whole host of diverse factors: the environment, quality of life, energy efficiency, providing services, social cohesion, etc." (Fariña & Naredo, 2010).

Urban planning is responsible for shaping the city's physical support, but in doing so it necessarily influences other spheres. And awareness of this capacity for influence is where sustainability strategies can be integrated into planning. By means of a set of criteria for sustainability in urban planning, the *White Paper on Sustainability of Spanish Urban Planning* identifies the various spheres of influence of planning and the main objectives to be pursued in application of the sustainability strategies in each case. The criteria for achieving sustainability in urban planning are reported in annex.

As a conclusion, Fariña & Naredo indicate that "in practice, urban planning defines a model and a structure for the city onto which different urban uses are laid and developed. In this model, such issues as building types and their relationship with open spaces, the distribution of different uses and their coexistence, and their varying degrees of concentration in the space, may either help or hinder certain lifestyles that are to some degree sustainable. Of course, in a democratic society such as ours the final decision must lie with individual citizens, but it is the task of public authorities, via both planning and other ambits within their remit, to encourage individual habits that are the most beneficial for the community, by offering the most appropriate incentives and disincentives in each case" [1].

3.3.6 System of indicators and conditions for large and medium-sized cities (Spain)

The objective of this project was to develop a system of indicators that could be applied at the municipal and state levels, in addition to being consistent with the Agenda 21 goals and the municipalities belonging to the Spanish Network for Sustainable Local Development [2].

[1] Fariña , J., Naredo, J. (2010). White Paper on Sustainability in Spanish Urban Planning. Ministry of Housing, Government of Spain.

[2] Rueda, S. et al. (2010). System of indicators and conditions for large and medium-sized cities. Ministry of Development, Government of Spain.

The system, developed in 2010 by command of the Spanish Ministry of Development, seeks to measure the degree of sustainability in any municipality in Spain under the same stated criteria.

The result is a document of indicators, which draw a panel of 52 indicators organized into the following areas: land use, public space, urban complexity, sustainable mobility, urban metabolism, social cohesion, green spaces and biodiversity. In each section, the indicator is defined, its relevance is justified, and there is a calculation methodology that city officials can easily follow. Moreover, often sub-indicators accompany the indicators to help outline the sources of information necessary for their calculation.

Axis	Domain	Indicator
Compactness	Land cover	– Density housing – Absolute compactness
	Public space and habitability	– Corrected compactness – Air quality – Acoustic comfort – Thermal comfort – Accessibility of road – Proportion of street – Perception of urban green space – Proximity of the population to basic services
	Mobility and services	– Mode population displacement – Proximity of the population to public transport networks – Cast public road: pedestrian road – vehicle road – Proximity of the population to bicycle parking – Parking for private vehicles off the road – Theoretical infrastructure deficit of parking for private vehicles – Loading and unloading goods off the road – Infrastructure services

Axis	Domain	Indicator
Complexity	Urban complexity	- Urban diversity index - Balance between activity and residence - Near everyday business activities - Dense knowledge activities - Spatial and functional continuity of the corridor street
	Green spaces and biodiversity	- Soil biotic index - Green space per inhabitant - Green roofs - Proximity of the population parks - Index functionality of urban parks - Woodland biodiversity - Connectivity of urban green corridors

Axis	Domain	Indicator
Efficiency	Urban metabolism	- Energy consumption by sector - Local production of renewable energy - Energy self-sufficiency from renewable energies - Water consumption by sector - Regeneration of marginal water - water self-sufficiency - Food self-production - Recovery of waste from construction and demolition - Net separate collection - Provision of recycling containers - Proximity of the population to collection points - Proximity of the population to collection centres - Closing the cycle of organic matter - Emission of greenhouse gases - Light pollution

Axis	Domain	Indicator
Social cohesion	Social cohesion	- Aging index - Foreign population - Graduates of the third degree - Housing with state subsidy - Provision of public facilities - Proximity of the population to public facilities - Efficiency of the urban system

System of indicators and conditions for large and medium-sized cities

(Source: Rueda et al., 2010)

4. OUR GOALS

The STEEP project aims at defining an open-source methodology so that the Smart City Plan Guidelines (D4.1) can be put onto the open-source collaborative web-based stakeholder platform. They need to be supported by a set of Smart City Key Performance Indicators (KPI) to measure the progress of the Smart City Plans.

The indicators have been developed so that they are open-source. They have been made available on the platform/website including the benchmark of the three partner cities.

Depending on the scope of the objectives, the type of indicators selected needed to be different.

The Smart City's KPIs have to be:

- open
- reliable and valuable
- standardized,
- consistent and
- comparable over time, across cities

There is a wide collection of global city indexes, benchmarks and comparative rankings produced. On the other hand we ought to have a limited set of KPIs to support the decisions of policy makers.

The main goals were in conclusion:

- To develop an agreed, valuable and reliable indicator list for the cities to easily evaluate their progress over time.
- To adapt existing measurement assets in order to make data collection and use less onerous.
- To achieve broad acceptance and use of the indicators among stakeholders

4.1 Previous achievements to be capitalised upon

In the STEEP project there has been achievement to be capitalised upon and taken into account.

One important tool to be considered was the Pestel analysis used to evaluate the measures selected in the pilot actions.

Another influencing result consisted in the common preliminary SCP model which integrates all the informations about the fields of action of the master plans, i.e. about the measures to be monitored

4.1.1 Pestel analysis

Pestel analysis is the strategic analysis chosen in the STEEP project to prioritise the interventions included in the master plans.

The objective of the PESTEL analysis is to evaluate the feasibility of each initiative considering the different Political, Economic, Social, Technological, Legal and Environmental implications for each. It can be used to both provide a framework for detailed technical analysis, but also to provide a more qualitative analysis of the feasibility of each initiative beforehand.

The PESTEL analysis is guided by a series of questions that help to assess the strategic viability of the different initiatives.

STEEP partner ARUP has also developed a further strategic analysis tool using SPeAR software, a version of which is available to download via the STEEP website. The SPeAR tool has been developed so that it can be used to monitor and evaluate the performance of a project and support informed decision-making.

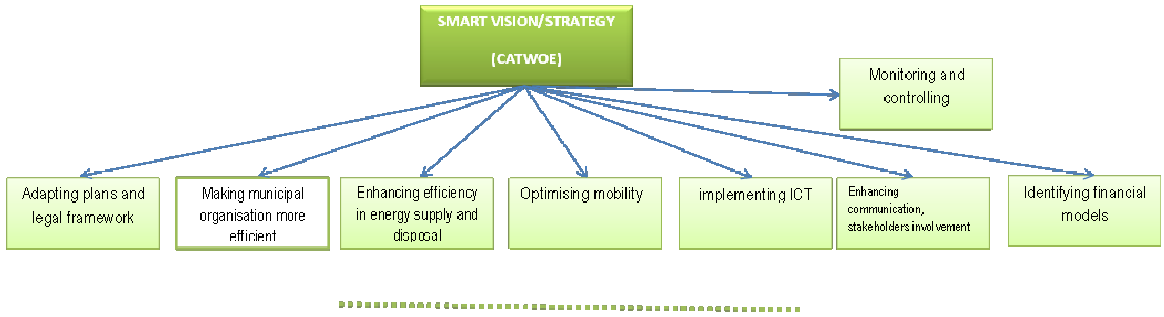
The tool includes a library with sets of indicators and sub-indicators for the evaluation of the sustainability of different interventions from different dimensions; environmental, economic, social, energy, etc.

4.1.2 The pilot models and the city master plan model 0

The indicator set ought to be able to support the evaluation of the master plan model in general as well as the evaluation of the related submodels and actions.

It won't be possible to measure any single action that a plan could include with a limited and previously fixed group of indexes, but all the "branches" of the plan should be linked to several indicators which could underline achievements or critical trends.

The master plan preliminary template developed in STEEP includes submodels which should also be reflected into the indexes set.


SMART VISION/STRATEGY
(CATWOE)
Monitoring and controlling
Adapting plans and legal framework
Making municipal organisation more efficient
Enhancing efficiency in energy supply and disposal
Optimising mobility
implementing ICT
Enhancing communication, stakeholders involvement
Identifying financial models

5. KEY PERFORMANCE INDICATORS SELECTED

Below the STEEP resulting set of indicators is provided. It has been developed following the common methodologies in use previously reported, so that it could be easily exportable to other cities. Energy is the main field of interest of the STEEP master planning activity which on the other hand follows an holistic and integrated approach including many other issues linked with the smart vision. The structure of the set is inherited by the master plan preliminary model to be consistent with the project approach. It has been tested during plans development and reshaped where necessary to obtain a useful and valuable set of open indexes to be published on the platform.

The approach is consistent with the ISO 37120 philosopy: it's not aimed at classifying the Smart cities to gain a podium place, but rather to evaluate their strengths and weaknesses, to cooperate with other cities and mostly to monitor their progress in a continuous improvement process.

The indicators selected (just over 50) are generally easy to work out and they have both mandatory and optional fields. Some other supporting data will be required to enhance the homogeneity of the values and the consequent opportunity for comparison (for example the population, the degree days value, ...).

Each indicator is reported with itsdescription, including requirements, the suggested calculation method and data sources. Moreover a subset of supporting indexes is suggested to add more detail to some of the themes.

5.1 ENERGY

5.1.1 Emissions

5.1.1.1 CO2 emissions (mandatory)

This indicator measures the greenhouse gas emissions which cause climate change. It's related to CO2 because it is a measure of the fossil fuels employed (CO2 is an inevitable consequence of fossil fueluse) .

The main mandatory indicator is the total emissions of the territory, covering energy production and use within the boundaries of the municipality, in tonnes per year.

Another index which can be easily calculated is the amount per capita, while other suggested optional subindicators could consist of emissions per sector (residential, industrial, transport,...).

DATA SOURCE: from energy consumption, applying standard emission factors following the Covenant of Mayors (CoM) guidelines

5.1.1.2 PM10 emissions (optional)

Particulates have an impact on public health in urban environments. Particulate production is due mainly to transport and heating systems. The indicator is measured as a concentration in micrograms per standard cubic meter. The suggested measure is the max value registered in the city during the period in µg/m3; a further monitoring could be made about the number of days above threshold per year.

DATA SOURCE: air samples

5.1.1.3 Noise pollution (optional)

Exposure to noise causes annoyance. The indicator is the percentage of the population living in areas where the noise level Lden (ISO 1996-2:1987) is greater than 55 dB.

DATA SOURCE: air quality monitoring, municipal noise zonisation plans

5.1.2 Electricity and primary energy

5.1.2.1 Total electrical energy use per capita (mandatory)

This indicator aims to support policy makers assessing electricity supply and distribution requirements. It is measured in kWh/year

DATA SOURCE: electricity network manager, providers

5.1.2.2 Total electrical energy use per sector (optional)

This indicator aims to support policy makers assessing electricity supply and distribution requirements The sectors analysed could follow the CoM scheme: residential, tertiary, transport, industrial. It is measured in kWh/year

DATA SOURCE: electricity network manager, providers

5.1.2.3 Total primary energy use (optional)

This indicator measures total primary energy use in the city. It is linked to several other indicators: fuel consumption is a necessary inputs to the calculation of emissions as well as of the share of renewable energy sources, and could be provided in an aggregate way in this measure.

DATA SOURCE: from the fuels consumption applying standard emission factors following the CoM guidelines

5.1.3 Renewable energy

5.1.3.1 Green electricity: production (mandatory)

Electricity has high environmental impact on the environment if it is not generated from renewable sources. The indicator, a percentage, measures how much of total electricity consumed is green due to self production within the city boundaries.

DATA SOURCE: electricity network manager, providers, national electricity managing bodies

5.1.3.2 Green electricity: purchase (optional)

The electricity market allows the users to choose the energy source. The indicator, a percentage, measures how much of total electricity purchased is certified green .

DATA SOURCE: electricity network manager, providers, national electricity managing bodies

5.1.3.3 Renewable heat (Optional)

Heat produced by biomass or biogas, solar plants, waste energy use, etc contributes to GHG emissions savings. This indicator gives the evaluation of renewables contribution as a share of the total municipal heat consumption.

DATA SOURCE: this value is quite difficult to calculate. It can be derived from the buildings authorization procedure.

5.1.3.4 Renewable energy (Optional)

This indicator is aimed at measuring the sustainability of the energy provision in a city. It's a percentage of the total renewable energy used versus the total needed by the territory in a certain year.

DATA SOURCE: from the previous two indicators and the primary energy (5.2.1.3)

5.1.4 Energy efficiency

5.1.4.1 Smart meters (mandatory)

Smart metering is the first step for the collection of reliable data about consumption as well as raising awareness among consumers. This indicator is the percentage of meters which are smart; it could be reported separately for electric, methane or heat networks and water.

DATA SOURCE: electricity and gas network manager, providers, national electricity managing bodies

DATA SOURCE: municipal departments, builders

5.1.4.2 Percentage of buildings being refurbished with energy performance improvement beyond EPBD requirements (optional)

The building stock is responsible for around 30% of total energy consumption. Municipalities through building regulations and urbanisation policies are able to modify consumption trends. This indicator measures the number of buildings subject to refurbishment which improves their energy profile above the EPBD requirements; it is calculated as the share of square meters retrofitted versus the total floor area of the buildings refurbished.

DATA SOURCE: municipal departments, builders

5.2 MOBILITY

5.2.1 Public transport

5.2.1.1 Km of public transport system per 100.000 population (mandatory)

Public transport is the main way of reducing traffic congestion and air pollution in cities. The extent of the public transport network is linked also to interoperability and flexibility. In this indicator both high and low capacity systems are taken into acount, e.g. metro, rails, trams, buses, etc.

DATA SOURCE: municipal transport department, public transport companies

5.2.1.2 Number of annual public transport trips per capita (mandatory)

This is a measure of public transport usage and health of the network. The total annual number of trips originating in the city is divided by the population count. A further suggested information to collect is the average lenght of those trips (optional).

DATA SOURCE: municipal transport department, public transport companies

5.2.2 Private fleet

5.2.2.1 Number of fossil fuelled vehicles per capita (mandatory)

The number of fossil vehicles per capita provides different important information about the need of public transport facilities and the achievements of ecomobility policies. The data could be optimised detailing the vehicle typology (two or four wheels) and the emsissions classification (Euro 0, 1,2,...).

DATA SOURCE: national register for vehicles

5.2.2.2 Number of vehicles > EURO4 (Optional)

This indicator measures the environmental impact of the private fleet and how it improves in years.

DATA SOURCE: national register for vehicles

5.2.3 Alternative transport infrastructure

5.2.3.1 Km of bicycle paths per 100.000 population (mandatory)

Bikes could contribute significantly to the alleviation of both traffic congestion and public health problems. Municipalities can enhance the use of bikes by providing safe and connected lanes and parking places. The length of the paths measures the network availability.

If possible, thanks to the ICT use, another measure consisting in the number of bike lanes users ought to be added to the lenght value to be more and more reliable and detailed, otherwise the concrete improvement in the use of bikes could only be deduced by the offer increase and the vehicles decrease (in number and consumption) taking into account also the use of public transport.

DATA SOURCE: municipal mobility department

5.2.3.2 Number of public recharging stations for electric vehicles (mandatory)

Electric vehicles need a charging infrastructure. The number of charging stations provided by a smart city is a measure of its support for electric mobility.

DATA SOURCE: municipal mobility department

5.2.3.3 Km2 of restricted areas (mandatory)

One of the best ways to promote alternative mobility and public transport use is to restrict access to selected areas (for example, so that buses can enter but private cars cannot). This measure, although it may not be popular with city users at first, could

represent a real change in habits and a big improvement in terms of environmental quality.

The indicator estimates the size of the area influenced by restrictions of different kinds.

Optionally, the indicator could distinguish between pedestrian zones and limited traffic zones.

DATA SOURCE: municipal mobility department

5.3 ICT

5.3.1 Internet connections

5.3.1.1 Number of internet connections per 100.000 population (mandatory)

This indicator measures information access and connectivity to information technology within the city.

DATA SOURCE: internet connections are recorded by internet and telecomunications providers. Other sources could be official estimates, other censuses or telecommunications data

5.3.1.2 WIFI coverage in public areas (mandatory)

Easy internet access for city users enables the diffusion of “intelligent” web based services. This indicator could be reported as a percentage of public areas, or as the number of square km with WIFI.

DATA SOURCE: IT services department

5.3.2 Infomobility

5.3.2.1 Number of public transport stops with a real time information display (mandatory)

ICT applied to public transport needs accuracy and territorial coverage. This indicator evaluates the coverage of real time transport information.

DATA SOURCE: public transport company

5.3.2.2 E-ticketing (mandatory)

This indicator measures the presence of e-ticketing for public transport services. The mandatory field is the presence (yes or no) of the service, while an optional evaluation could be the number of e-tickets versus the total number of trips sold.

DATA SOURCE: public transport company

5.3.3 Ditigal services

5.3.3.1 Number of users of digital services for citizens (mandatory)

By providing digital services, the administration helps citizens to save time and reduces the need for travel. The number of users of these services is an index of their availability.

DATA SOURCE: municipal administration

5.3.3.2 Open data sets available (mandatory)

Open data is fundamental for the development of the territorial system. Open data could be used for the purposes of communication, for the development of new services and for the optimisation of existing services. Transparency on the part of the public authority is important for creating consensus around its policies. This is th enumber of open databases made available by the municipality or with direct influence of the municipal administrations (agreements,..)

DATA SOURCE: web

5.4 GOVERNANCE

5.4.1 Services' efficiency

5.4.1.1 Solid waste production per capita (mandatory)

Solid waste disposal is a big problem in cities where the amount produced is very high. A proper disposal system and waste reduction and recycling policies are very important for the quality of life in cities. This indicator evaluates the waste problem in a way that can be easily compared among different cities. It consists of total tonnes of waste collected every year divided by the population count [t/y per capita].

DATA SOURCE: waste management company, environmental department

5.4.1.2 Percentage of solid waste recycled (mandatory)

This indicator measures the percentage of waste which is recycled .

DATA SOURCE: waste management company, environmental department

5.4.1.3 Liters of water used per capita (optional)

This indicator measures the yearly water consumption per capita, and is one of the indicators which shows resource use.

DATA SOURCE: water management

5.4.1.4 Percentage of losses in the water network (optional)

This indicator measures the percentage of water lost and not distributed to final users, and is one of the indicators which shows resource use.

DATA SOURCE: water management

5.4.1.5 Percentage of waste water receiving secondary and tertiary level treatments (optional)

Waste waters treatment is very important for the environment: water pollution can be minimised by investing in proper systems.

The percentage of waste water treated is a measure of water quality. The different level of the treatments should be investigated and reported in percentage above the total volumes.

DATA SOURCE: water management

5.4.2 Social inclusion

5.4.2.1 Voter participation in last municipal election (mandatory)

The percentage of the eligible voting population that voted in the last municipal election is an indicator of the participation and interest in local government.

5.4.2.2 Social housing stock (optional)

There are many strategic actions that could be taken in order to push for social inclusion in the field of housing policies (rent promotion; fiscal changes; empty dwellings control…) but the existence of a sufficient, well distributed and time stable social housing stock is probably the best guarantee of social cohesion in a city. Interventions in housing stock are strategic because housing is the first factor of social segregation and because there is a direct filter of the rent availability and dwellings prices.

This indicator measures the percentage of dwellings reserved for social housing in percentage versus the total surface of the residential buildings stock or versus the number of flats.

DATA SOURCE: social housing company, buildings management

5.5 PUBLIC ADMINISTRATION

5.5.1 Energy consumption of the public sector (mandatory)

The public sector should play an exemplar role in driving change in the energy sector. It could also influence the market with proper regulation or by starting the implementaion of best practices. Here we want to monitor the public sector's consumption trends.

The indicators set could consist of:

- Energy consumption of public buildings [kWh/y], either as total consumption of the public estate or detailed for each sub sector (offices, health, schools, sport facilities,...) or even for single buildings
- public fleet fuel consumption [kWh/y]
- Electricity consumption of public lighting [kWh/y]. Also in this case there could be many specific calculations regarding the consumption of street lights (taking into account the possibility of widening the network to optimise the service to the citizens), consumption by length of lit streets [kWh/km] or also the percentage of public lighting consumption that comes from green sources.

DATA SOURCE: municipal energy manager, public buildings office, providers

5.5.2 Renewables (mandatory)

As already reported in the energy section, public consumption could be analysed in terms of the share of renewables. The calculation could be carried out for total electricity and heat consumption, electricity consumption per sector or total heat consumption. Regarding renewable electricity, two indexes are needed to distinguish between Green electricity produced locally and certified Green electricity purchased and consumed. Another index could be the total renewable power installed in MW distinguished for PV, biomass, solar thermal, windfarms,...

DATA SOURCE: municipal energy manager, public buildings office, providers

5.5.3 Green public procurement (mandatory)

The public sector should be committed to sustainable consumption and purchase. This indicator is a simple yes/no answer to the question "is there a formal committment to GPP"? Further steps could consist of evaluating the percentage of green expenses as a share of the total purchase of the public body.

DATA SOURCE: administrative office, purchase responsible

5.6 PROSPERITY (SOCIAL/PARTICIPATION & ECONOMY/FINANCE)

5.6.1 City use

5.6.1.1 Population trend

This indicates the size of the city and, if regularly updated, of its demographic trends which could have influence on other previous indicators.

DATA SOURCE: registry office, national statistics

5.6.1.2 Number of city users per year

A city is not used only by residents but it can attract many other users every day (commuters) or occasionally (such as tourists). Those people interact with city services and influence the city profile, especially if the trend is not costant. The value could also be detailed in two fields (commuters and tourists).

DATA SOURCE: tourist office, economic development office, national statistics

5.6.2 Education

5.6.2.1 School aged population enrolled in schools

Education is the most important aspect for human development. This indicator addresses the issue of educational opportunity.

DATA SOURCE: educational and schools department

5.6.2.2 Number of higher education degrees per 100.000 population

This is an indicator of well being and development. It is calculated as the number of higher education degrees (batchelor's) divided by one 100.000th of the total population.

DATA SOURCE: ministry and department for education, censuses

5.6.3 Unemployment rate

This is a classic market growth and health indicator; it is measured as the number of unemployed residents of seeking work divided by the total population eligible for work.

DATA SOURCE: development department, chamber of commerce

5.6.4 Debt service ratio

This indicator shows the municipality's expenditure on debt servicing (only debt costs) as a percentage of its revenue.

DATA SOURCE: finance department

5.6.5 Number of PPP and EPC contracts

The public-private partnership is the way to overcome the shortage of money in public sector. Energy efficiency in particular presents good investment indexes but it needs high investments, a clear baseline and reliable targets to be implemented. Moreover administrative issues often obstacle those innovative contracts. The number of municipality's PPP or Energy efficiency contracts on going is a measure of the flexibility of the administration and of its care about energy or infrastructure related investments. Further interesting informations could be the amount of those kind of contracts in % of the total expenditures.

DATA SOURCE: finance department

5.7 MONITORING AND CONTROL

5.7.1 Frequency of indicator calculation

The indicators described are much more useful if regularly updated and compared to evaluate trends and distortions. The length of time between the calculations is an indication of the efforts and interest of the city in the monitoring and control activity. It is measured in months.

DATA SOURCE: municipality

5.7.2 Resiliance to natural disasters

The attractiveness of a city for citizens and investors is affected by the frequency and magnitude of natural disasters occurring within a city and a city's ability to respond. The number of lives lost in natural disasters in the past can be indicative of a city's potential future exposure and its capacity for resilienc.

DATA SOURCE: disaster management agencies (civil protection).

5.8 SUMMARY

A schematic list of the indicators described is reported in the following table.

Parameter			Mandatory	Supporting measures	Suggested	units
ENERGY	Emissions	CO2 emissions			total	t/y
			per capita			t/y person
					per sector	t/y
		PM10 emissions			concentration	µg/m3 or days above threshold
		noise pollution			people affected	population subject to noise >55 dB
	Energy	electricity use	per capita			kWh/y person
					per sector	kWh/y
		primary energy	total consumption			kWh/y
	RES	green electricity	total produced			%
			purchased			%
		renewable heat			total produced	%
		renewable energy			electricity + heat	%
	Energy Efficiency	smart meters			electric and heat network	%
		refurbished buildings improving energy performance			retrofittings > EPBD	m2 or %

MOBILITY	Public transport	km of PT per 100,000 inhabitants	lenght of PT per 100.000 inh		km/100,000h
		number of annual PT trips per capita		trips per capita	n/y person
	Private fleet	number of fossil fuelled vehicles per capita	cars		n/ person
			motorbikes		n/ person
				> euro 4	%
	Alternative transport infrastructure	km of bicycle paths per 100,000 population	lenght of bike lanes		km/100000
		number of electric charging stations for EV	number of charging columns		n
		km2 restricted areas	total	pedestrian	km2
				others	km2
ICT	internet connections	number of internet connections per 100,000 population			n/100,000h
		WIFI coverage on public areas			m2 or %
	Infomobility	number of PT stops with real time info			%
		e-ticketing			Y/N or %
	Digitalisation	number of users of digital services			n
		open data set available			n
GOVERNANCE	services efficiency	solid waste production per capita	waste production pro capita		t/y person
		percentage of solid waste recycled	% recycled		%
		liters of water used per capita		use of water pro capita	l/y person
		percentage of water losses in the network		% losses	%
		percentage of waste water under 2-3 treatments		treatments quality	%
	social inclusion	voters at last municipal election	% of eligible population		%
		social housing		% of residential buildings	%

PA	energy consumption of PA	public buildings (electricity)	total	sector/building	kWh/m2 y
		public buildings (gas)			kWh/m2 y
		public fleet	total	per vehicle	kWh/y
		low emission vehicles share	percentage of the total		%
		public lighting	total	km/light	kWh/y
	Renewables	percentage of renewable electricity			%
		percentage of renewable heat			%
		RES power installed			MW
	green public procurement	Commitment to green procurement?			Y/N or %
PROSPERITY: SOCIAL AND ECONOMY&FINANCE	city use	population	population commuters + tourists		n
		number of city users per year			n/y
	education	% of school aged population enrolled in schools		% active students	%
		number of high edu degrees per 100,000 population		% high degrees	n/100,000h
	city's unemployment rate				%
	debt service ratio				%
	number of PPP or EPC contracts				n
CONTROL	frequence of indicators recalculation				months
	resiliance to natural disasters				deaths

6. CONCLUSIONS

As already mentioned at the beginning of this document, to measure how the master plans developed perform we need to choose an indicator system which can underline achievements and critical points, judging which approaches are successful and which are not.

The issue is very complex and ambitious, but the targets and objectives of the STEEP project have been clearly expressed: the selection made has resulted in a short but valuable list of indexes which has been tested and tuned in the field.

The benchmarking methodology developed is not meant as a mere "competition", but it's aimed at aiding city planners and policymakers in choosing among different scenarios and combinations of different options to pursue the targets and to help them in the consensus-building process which is the core of the STEEP coproductive methodology.

The monitoring process is also necessary to keep the Smart City Plans of the cities, that are meant to be "living documents", dynamic and open for improvement.

The diffusion of standards for the monitoring is very helpful in terms of policy learning. Reliable, transparent and userfriendly methods of benchmarking are needed to let those cities who are performing better inspire other cities: the indicators set is provided to any other interested city through the stakeholders' platform and project/parters websites.

Main weaknesses of city indexes

The analysis carried out about city indexes pointed out several critical points that have to be overcome in the use of Key Performance Indicators.

- First of all there is the data source: a smart city needs a wide set of data to assess its position and the calculation results are affected strongly by data accuracy, quality, and replicability of the measure. Indicators ought to be developed according to a bottom up approach which is much more reliable than topdown statistics
- another issue regards comparability and benchmarking: the different size of the cities as well as their geographical position and also the period of the assessment make the comparison between cities not reliable in some circumstances
- also the independence of the assessment is very important to obtain useful indicators and to gain the acceptance. Smart cities classifications based on unclear calculations are not what the Steep project requires.

- regarding the usefulness of the indexes to be assessed: it takes some work to calculate indicators and what the project needs is a valuable set which is as small as possible in order to not waste time and energy and most of all not to confuse stakeholders

Not only SMART

The "Smart" definition is not clear but it's generally linked to the technology embedded in urban areas. Now cities are facing other tasks above smartness: there are resilience and flexibility issues, which are fundamental in enabling adaptation to rapid changes (economic, environmental, geo-political, social,…)

Smart cities should be able to adapt themselves as quickly as possible to the upcoming needs of their citizens.

In this optic, new items have been approved by ISO to work at: the "sustainable development and resilience in cities" is going to be the next step in urban sustainability evaluation. The themes to be analysed include issues already taken into account in STEEP KPIs list (see slide below).

STEEP conclusion is that in this adaptation and monitoring process some aspects could play a significant role: there's no unique solution for everyone, but only a suggested path to be adapted to the cities' respecting different priorities and local institutions. Cooperation at any level is the key of our methodology: we use a coproductive

approach and we enhance cooperation among project partners, and outside through the platform.

New challenges

Having to evaluate a dynamic and "living document" also the indicators list couldn't be static but it has to be flexible to adapt the components to the new technologies and new actions to be monitored.
The ICT is improving faster and faster and it can allow new measures and quantifications. Capillary networks, open data and data mapping are growing to support more specific data collection and measures evaluation.
Data which are generally collected at national level will be more and more detailed locally.
Baselines will be available and will cover wider and wider themes also with historic regressions.
The indicators evolution and the standardisation of the measures are ongoing activities that will go on after STEEP project end.
The life of the STEEP KPIs methodology will depend on the cities' interest in adopting it, but as this guide already stated, the set is applicable to any municipality and its assessment could be used by many stakeholders (politicians, planners, city managers, businessman, professionals and citizens).
The implementation is important to measure the performances of the cities but also in terms of transparency between citizens and administration and learning between cities. The benchmark is able to improve the quality of life, to leverage founds for the smart growth and to enhance cost efficiency.

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8. ANNEXES

GCIF indicators tables

GCIF Profile Indicators

	Indicator
_	_
People	Total city population
	Population density (per square kilometer)
	Percentage of country's population
	Percentage of population that are children (0-14)
	Percentage of population that are youth (15-24)
	Percentage of population that are adult (25-64)
	Percentage of population that are senior citizens (65+)
	Male to female ratio (# of males per 100 females)
	Annual population change
	Population Dependency Ratio
	Percentage of population that are foreign born
	Percentage of population that are new immigrants
	Percentage of population that are migrating from elsewhere in the country
Housing	Total number of households
	Total number of occupied dwelling units (owned & rented)
	Persons per unit
	Dwelling density (per Square Kilometer)
Economy	Average household income (US$)
	Annual inflation rate based on average of last 5 years
	Cost of living

	Income distribution (Gini Coefficient)
	Country's GDP (US$)
	Country's GDP per capita (US$)
	City Product (US$)
	City Product as a percentage of Country's GDP
	Total employment
	Employment percentage change based on the last 5 years
	Number of Businesses per 1000 Population
	Annual average unemployment rate
	Commercial/industrial assessment as a percentage of total assessment
Government	Type of government (e.g. Local, Regional, County)
	Gross operating budget (US$)
	Gross operating budget per capita (US$)
	Gross capital budget (US$)
	Gross capital budget per capita (US$)
Geography and Climate	Region
	Country
	Climate Type
	Land Area (Square Kilometers)
	Percentage of non-residential area (square kilometers)
	Annual average temperature (Celsius)
	Average annual rain (mm)
	Average annual snowfall (cm)

GCIF Performance Indicators

	Core Indicator	Supporting Indicator
City Services		
Education	Student/teacher ratio	Percentage of school-aged population enrolled in schools
	Percentage of students completing primary and secondary education: survival rate	Percentage of male school-aged population enrolled in schools
	Percentage of students completing primary education	Percentage of female school-aged population enrolled in schools
	Percentage of students completing secondary education	
Fire and Emergency Response	Number of firefighters per 100,000 population	Response time for fire department from initial call
	Number of fire related deaths per 100,000 population	
Health	Number of in-patient hospital beds per 100,000 population	Number of nursing and midwifery personnel per 100,000 population
	Number of physicians per 100,000 population	
	Average life expectancy	
	Under age five mortality per 1,000 live births	
Recreation		Square metres of public indoor recreation space per capita
		Square metres of public outdoor recreation space per capita
Safety	Number of police officers per 100,000 population	Violent crime rate per 100,000 population
	Number of homicides per 100,000 population	

Solid waste	Percentage of city population with regular solid waste collection	Percentage of the city's solid waste that is disposed of in an incinerator
	Percentage of city's solid waste that is recycled	Percentage of the city's solid waste that is burned openly
		Percentage of the city's solid waste that is disposed of in an open dump
		Percentage of the city's solid waste that is disposed of in a sanitary landfill
		Percentage of the city's solid waste that is disposed of by other means
Transportation	Km of high capacity public transit system per 100,000 population	Number of two-wheel motorized vehicles per capita
	Km of light passenger transit system per 100,000 population	Commercial Air Connectivity (number of nonstop commercial air destinations)
	Number of personal automobiles per capita	Transportation fatalities per 100,000 population
	Annual number of public transit trips per capita	
Wastewater	Percentage of city population served by wastewater collection	Percentage of the city's wastewater receiving primary treatment
	Percentage of the city's wastewater that has received no treatment	Percentage of the city's wastewater receiving secondary treatment
		Percentage of the city's wastewater receiving tertiary treatment
Water	Percentage of city population with potable water supply service	Total water consumption per capita (litres/day)
	Domestic water consumption per capita (litres/day)	Percentage of water loss
	Percentage of city population with sustainable access to an improved water source	Average annual hours of water service interruption per household

Electricity	Percentage of city population with authorized electrical service	Total electrical use per capita (kWh/year)
	Total residential electrical use per capita (kWh/year)	The average number of electrical interruptions per customer per year
		Average length of electrical interruptions (in hours)
Finance	Debt service ratio (debt service expenditure as a percent of a municipality's own-source revenue)	Tax collected as percentage of tax billed
		Own-source revenue as a percentage of total revenues
		Capital spending as a percentage of total expenditures
Governance		Percentage of women employed in the city government workforce
Urban Planning	Jobs/Housing ratio	Areal size of informal settlements as a percent of city area
		Green area (hectares) per 100,000 population

	Core Indicator	Supporting Indicator
Quality of Life		
Civic Engagement	Voter participation in last municipal election (as a percent of eligible voters)	Citizen's representation: number of local officials elected to office per 100,000 population
Culture		Percentage of jobs in the cultural sector
Economy	City product per capita	Percentage of persons in full time employment
	City unemployment rate	
Environment	PM10 concentration	Greenhouse gas emissions measured in tonnes per capita
Shelter	Percentage of city population living in slums	Percentage of households that exist without registered legal titles
		Number of homeless people per 100,000 population
Social Equity		Percentage of city population living in poverty
Technology & Innovation	Number of internet connections per 100,000 population	Number of new patents per 100,000 per year
		Number of higher education degrees per 100,000
		Number of telephone connections (landlines and cell phones) per 100,000 population
		Number of landline phone connections per 100,000 population
		Number of cell phone connections per 100,000 population

Icitylab indicators list

text in italics an blue is related to smart indexes

ECONOMY	**ECONOMY**
PRODUTTIVITA'	PRODUCTIVITY
IMPRENDITORIALITA'	ENTREPRENEURSHIP
QUALIFICAZIONE LAVORO	QUALIFYING WORK
DIREZIONALITA'	DIRECTIONALITY
DISPONIBILITA' DEL CREDITO	CREDIT AVAILABILITY
INTERNAZIONALIZZAZIONE PRODUTTIVA	INTERNATIONALIZATION PRODUCTION
DIFFUSIONE INNOVAZIONE PRODUTTIVA	*SPREADING INNOVATION PRODUCTION*
CONCENTRAZIONE SOGGETTI DI RICERCA E SVILUPPO	*CONCENTRATION OF RESEARCH AND DEVELOPMENT SUBJECTS*
INNOVAZIONE / INTENSITA' BREVETTUALE	*INNOVATION / INTENSITY PATENT*
DIFFUSIONE CONNESSIONE IMPRESE	*DISTRIBUTION BUSINESS CONNECTION*
COMPORTAMENTI INNOVATIVI	*INNOVATIVE BEHAVIOUR*
RELAZIONALITA' INTERNAZIONALE	*INTERNATIONAL RELATIONSHIPS*
LIVING	LIVING
ASSISTENZA SANITARIA	HEALTH CARE
SICUREZZA	SAFETY
CURA INFANZIA	CHILDHOOD CARE
ASSISTENZA ANZIANI	ELDERLY CARE
OPPORTUNITA' DI LAVORO	WORK OPPORTUNITY
COESIONE SOCIALE	SOCIAL COHESION
INFRASTRUTTURE DI CONNESSIONE	*INFRASTRUCTURE CONNECTION*
SERVIZI DI CONNESSIONE RESIDENZIALE	*RESIDENTIAL SERVICES CONNECTION*
SHARING ECONOMY	*SHARING ECONOMY*
ATTRATTIVITA'	*ATTRACTIVENESS*
OFFERTA DI INTRATTENIMENTO	*ENTERTAINMENT OFFER*
INTERNAZIONALIZZAZIONE CULTURALE	*CULTURAL INTERNATIONALIZATION*
ENVIRONMENT	*ENVIRONMENT*
QUALITA' ARIA	*AIR QUALITY*
GESTIONE RIFIUTI	*WASTE MANAGEMENT*
DEPURAZIONE ACQUA	*WATER TREATMENT*
CONSUMO ENERGIA	*ENERGY CONSUMPTION*

DISPONIBILITA' VERDE	*GREEN AREAS AVAILABILITY*
IMPRESE GREEN	*GREEN COMPANIES*
CONTROLLO ARIA	*AIR MONITORING*
INIZIATIVE CONFERIMENTO RIFIUTI	*INITIATIVES FOR WASTE COLLECTION*
DISPERSIONE RETE IDRICA	*WATER PIPES LOSSES*
FOTOVOLTAICO MUNICIPALE	*MUNICIPAL PV PLANTS*
INCIDENZA VERDE	*% GREEN*
ECOMANAGEMENT	*ECOMANAGEMENT*
MOBILITY	**MOBILITY**
ACCESSIBILITA' AEREA	AIR ACCESSIBILITY
ACCESSIBILITA' TERRESTRE	TERRESTRIAL ACCESSIBILITY
FLUIDITA' DELL'ASSETTO TERRITORIALE	FLUIDITY
OFFERTA TPL	PUBLIC TRANSPORT OFFER
INTERSCAMBIO	INTERCHANGE
INCIDENTALITA'	ACCIDENTS
MOBILITA' SOSTENIBILE E INFOMOBILITA'	*SUSTAINABLE MOBILITY & INFOMOBILITY*
MOBILITA' ALTERNATIVA	*ALTERNATIVE MOBILITY*
LIMITAZIONI TRAFFICO	*TRAFFIC RESTRICTIONS*
CICLABILITA'	*CYCLING*
ADEGUAMENTO ECOLOGICO AUTOVETTURE	*ECOLOGICAL ADAPTATION OF CAR FLEETS*
PROPENSIONE ALLA MOBILITA' COLLETTIVA	*PROPENSITY FOR COLLECTIVE MOBILITY*
PEOPLE	**PEOPLE**
LIVELLO ISTRUZIONE POPOLAZIONE	EDUCATION LEVEL OF THE POPULATION
PARTECIPAZIONE SOCIALE	SOCIAL PARTICIPATION
FLUIDITA' MERCATO LAVORO	LABOUR MARKET FLUIDITY
PARTECIPAZIONE SPETTACOLI	PARTICIPATION IN SHOWS
APERTURA MULTICULTURALE	MULTICULTURAL OPENING
EQUILIBRIO OCCUPAZIONALE DI GENERE	OCCUPATIONAL GENDER BALANCE
CONNESSIONE FAMIGLIE	*CONNECTING FAMILIES*
TASSO REGIONALE UTILIZZO INTERNET	*REGIONAL INTERNET USE RATE*
RICERCA LAVORO IN RETE	*WORK WEB SEARCHING FACILITIES*
DIFFUSIONE HOME BANKING	*SPREAD HOME BANKING*
INFORMATIZZAZIONE SCOLASTICA	*COMPUTERISATION OF SCHOOLS*
PRESENZA NON PROFIT SU SOCIAL NETWORK	*NOPROFIT PRESENCE ON SOCIAL NETWORKS*
GOVERNANCE	**GOVERNANCE**

PARTECIPAZIONE ELETTORALE	PARTICIPATION IN ELECTIONS
LIVELLI DI FIDUCIA	LEVELS OF TRUST
STABILITA' ECONOMICA	ECONOMIC STABILITY
CAPACITA' GESTIONALE	CAPACITY MANAGEMENT
PROPENSIONE ALL'ASSOCIAZIONE	PROPENSITY TO ASSOCIATION
EQUILIBRIO DI GENERE NELLA RAPPRESENTANZA	GENDER BALANCE IN REPRESENTATION
LIBERAZIONE DATASET	OPEN DATASET
ADEGUAMENTO SITI TERRITORIALI	ADJUSTMENT TERRITORIAL SITES
COMUNICAZIONE ISTITUZIONI	COMMUNICATION INSTITUTIONS
PENETRAZIONE TWITTER	PENETRATION OF TWITTER
RENDICONTAZIONE SOCIALE	SOCIAL REPORTING
PIANIFICAZIONE AMBIENTALE	ENVIRONMENTAL PLANNING

CoM factors

TABLE A. BASIC CONVERSION FACTORS				
FROM (MULTIPLY BY)	TO			
	TJ	Mtoe	GWh	MWh
TJ	1	2.388×10^{-5}	0.2778	277.8
Mtoe	4.1868×10^{4}	1	11 630	11 630 000
GWh	3.6	8.6×10^{-5}	1	1 000
MWh	0.0036	8.6×10^{-8}	0.001	1

A unit converter is available at the website of the International Energy Agency (IEA): http://www.iea.org/stats/unit.asp

TABLE B. CONVERSION OF FUELS FROM MASS TO ENERGY UNITS (IPCC, 2006)		
FUEL TYPE	NET CALORIFIC VALUE (TJ/Gg)	NET CALORIFIC VALUE (MWh/t)
Crude Oil	42.3	11.8
Orimulsion	27.5	7.6
Natural Gas Liquids	44.2	12.3
Motor Gasoline	44.3	12.3
Aviation Gasoline	44.3	12.3
Jet Gasoline	44.3	12.3
Jet Kerosene	44.1	12.3
Other Kerosene	43.8	12.2
Shale Oil	38.1	10.6
Gas/Diesel Oil	43.0	11.9
Residual Fuel Oil	40.4	11.2
Liquefied Petroleum Gases	47.3	13.1
Ethane	46.4	12.9
Naphtha	44.5	12.4
Bitumen	40.2	11.2
Lubricants	40.2	11.2
Petroleum Coke	32.5	9.0
Refinery Feedstocks	43.0	11.9
Refinery Gas 2	49.5	13.8
Paraffin Waxes	40.2	11.2
White Spirit and SBP	40.2	11.2
Other Petroleum Products	40.2	11.2
Anthracite	26.7	7.4
Coking Coal	28.2	7.8
Other Bituminous Coal	25.8	7.2
Sub-Bituminous Coal	18.9	5.3
Lignite	11.9	3.3
Oil Shale and Tar Sands	8.9	2.5
Brown Coal Briquettes	20.7	5.8
Patent Fuel	20.7	5.8
Coke Oven Coke and Lignite Coke	28.2	7.8
Gas Coke	28.2	7.8
Coal Tar	28.0	7.8
Gas Works Gas	38.7	10.8
Coke Oven Gas	38.7	10.8
Blast Furnace Gas	2.47	0.7
Oxygen Steel Furnace Gas	7.06	2.0
Natural Gas	48.0	13.3
Municipal Wastes (non-biomass fraction)	10.0	2.8
Waste Oil	40.2	11.2
Peat	9.76	2.7

TABLE C. CO_2 EMISSION FACTORS FOR FUELS (IPCC, 2006)		
FUEL TYPE	CO_2 EMISSION FACTOR (Kg/ TJ)	CO_2 EMISSION FACTOR (t/MWh)
Crude Oil	73300	0.264
Orimulsion	77000	0.277
Natural Gas Liquids	64200	0.231
Motor Gasoline	69300	0.249
Aviation Gasoline	70000	0.252
Jet Gasoline	70000	0.252
Jet Kerosene	71500	0.257
Other Kerosene	71900	0.259
Shale Oil	73300	0.264
Gas oil/diesel	74100	0.267
Residual Fuel Oil	77400	0.279
Liquefied Petroleum Gases	63100	0.227
Ethane	61600	0.222
Naphtha	73300	0.264
Bitumen	80700	0.291
Lubricants	73300	0.264
Petroleum Coke	97500	0.351
Refinery Feedstocks	73300	0.264
Refinery Gas	57600	0.207
Paraffin Waxes	73300	0.264
White Spirit & SBP	73300	0.264
Other Petroleum Products	73300	0.264
Anthracite	98300	0.354
Coking Coal	94600	0.341
Other Bituminous Coal	94600	0.341
Sub-Bituminous Coal	96100	0.346
Lignite	101000	0.364
Oil Shale and Tar Sands	107000	0.385
Brown Coal Briquettes	97500	0.351
Patent Fuel	97500	0.351
Coke oven coke and lignite Coke	107000	0.385
Gas Coke	107000	0.385
Coal Tar	80700	0.291
Gas Works Gas	44400	0.160
Coke Oven Gas	44400	0.160
Blast Furnace Gas	260000	0.936
Oxygen Steel Furnace Gas	182000	0.655
Natural Gas	56100	0.202
Municipal Wastes (non-biomass fraction)	91700	0.330
Industrial Wastes	143000	0.515
Waste Oil	73300	0.264
Peat	106000	0.382

TABLE 5. NATIONAL AND EUROPEAN EMISSION FACTORS FOR CONSUMED ELECTRICITY

COUNTRY	STANDARD EMISSION FACTOR (t CO_2/MWh_e)	LCA EMISSION FACTOR (t CO_2-eq/MWh_e)
Austria	0.209	0.310
Belgium	0.285	0.402
Germany	0.624	0.706
Denmark	0.461	0.760
Spain	0.440	0.639
Finland	0.216	0.418
France	0.056	0.146
United Kingdom	0.543	0.658
Greece	1.149	1.167
Ireland	0.732	0.870
Italy	0.483	0.708
Netherlands	0.435	0.716
Portugal	0.369	0.750
Sweden	0.023	0.079
Bulgaria	0.819	0.906
Cyprus	0.874	1.019
Czech Republic	0.950	0.802
Estonia	0.908	1.593
Hungary	0.566	0.678
Lithuania	0.153	0.174
Latvia	0.109	0.563
Poland	1.191	1.185
Romania	0.701	1.084
Slovenia	0.557	0.602
Slovakia	0.252	0.353
EU-27	**0.460**	**0.578**

Note that the year which the data represents varies between countries and between standard and LCA approach (8).

TABLE 6. EMISSION FACTORS FOR LOCAL RENEWABLE ELECTRICITY PRODUCTION

ELECTRICITY SOURCE	STANDARD EMISSION FACTOR (t CO_2/MWh_e)	LCA EMISSION FACTOR (t CO_2-eq/MWh_e)
Solar PV	0	0.020-0.050 (8)
Windpower	0	0.007 (9)
Hydropower	0	0.024

TABLE 7. CONVERSION FACTORS FOR THE MOST TYPICAL TRANSPORTATION FUELS (EMEP/EEA 2009; IPCC, 2006)

FUEL	CONVERSION FACTOR (KWH/L)
Gasoline	9.2
Diesel	10.0

Spain: list of criteria for sustainability in urban planning

Criteria	Objective	Action
Criteria for action in the city surroundings	Preserve, maintain and protect the natural capital	- Preserve existing ecosystems (natural and artificial) - Respect and integrate into the territory - Connect the various protected areas - Respect the landscape - Conserve the land (reduce consumption and preserve its productivity) - Give priority to local production
Criteria for action in urban areas	Define a more sustainable urban structure and model	- Complexity land uses - Foster urban compactness (density, constructability, etc.) - Foster polycentrism
	Foster more sustainable use of the built stock	- Foster intensive and efficient use of the built stock - Favour rehabilitation (over new building) - Adopt bioclimatic criteria for urban development and building - Foster the diversity of housing types - Complexify the uses of buildings

Criteria	Objective	Action
	Foster the diversity, quality and versatility of urban public spaces	- Eliminate architectural barriers - Design multifunctional, legible spaces - Apply bioclimatic criteria to open spaces - Incorporate multipurpose urban furniture - Reduce typologies that favour the privatisation of open spaces
	Favour access to nature (green areas)	- Define a minimum size for green areas (per person, home, etc.) - Define criteria for the form and minimum size of green areas - Foster biodiversity - Introduce green networks on neighbourhood and city scales - Favour public access to green areas - Incorporate trees and plants into public spaces - Connect different green areas ecologically
	Improve access to facilities	- Define an appropriate supply of public facilities and services - Foster proximity to amenities and facilities

Criteria	Objective	Action
Criteria for action on transport	Shorten distances	- Associate home with work - Establish logistics platforms for distribution in each neighbourhood - Reserve spaces for the sale of local products - Reduce the infrastructures necessary for the city to function
	Strengthen non-motorised means of transport	- Integrate pedestrian and cycling networks with green areas - Increase the space available for pedestrians - Build pedestrian and cycling neighbourhood networks - Make bicycle-parking spaces available - Integrate bicycles with public transport
	Reduce private motor traffic by strengthening public transport	- Establish an appropriate supply of public transport on an urban scale - Build integrated transit networks - Reduce the speed of private motor traffic - Reduce the area devoted to private vehicles - Restrict the use of private vehicles - Limit parking spaces for private vehicles

Criteria	Objective	Action
Criteria for action on resources	Optimise and reduce energy consumption	- Foster energy savings and efficiency - Adapt the urban morphology to bioclimatic conditions - Make use of sunlight and wind for housing and outdoor spaces. - Urban structures compatible with central-heating systems - Foster the use of renewable energy sources - Foster local energy production
	Optimise and reduce water consumption	- Reduce losses from mains networks - Foster building types with lower water demands - Foster efficient irrigation and watering systems - Incentivise rainwater collection systems in buildings - Use systems to retain and filter rainwater - Treat and recover natural watercourses - Foster the use of permeable paving
	Minimise the impact of building materials	- Reduce earthworks - Foster the use of local materials - Use building techniques that facilitate reuse - Foster the use of easily recyclable materials - Foster the shared use of service networks

Criteria	Objective	Action
Criteria for action on waste	Reduce waste	- Foster selective collection and separate sewerage networks - Users' proximity to collection systems - Promote reserves for composting and plant-waste processing - Use systems to reuse wastewater - Foster recycling and reuse
	Manage waste to reduce its impact	- Make hazardous-waste treatment compulsory - Management of building and demolition waste - Build environmentally non-aggressive treatment systems - Reduce pollutant emissions and dumping
Criteria for action on social cohesion	Favour the cohesion of the social fabric and prevent exclusion	- Foster grassroot movements - Reserve spaces for non-profit entities - Foster social complexity - Foster people's identification with their surroundings (cultural heritage) - Favour access to housing

Criteria	Objective	Action
	Complexity the social fabric	- Foster a mix of uses in each neighbourhood - Improve the supply of and access to services and facilities in each neighbourhood - Incentivise economic exchange with the rural areas - Promote a minimum percentage of proximity activities - Incentivise activities that favour a diversity of uses
Criteria for action on governance	Foster administrative transparency	- Provide access to information (including technical data and reports) - Provide channels for the two-way flow of information - Establish procedures for cooperation between administrative bodies
	Favour citizens' capacity building	- Devise specific educational materials - Organise courses, workshops and debates on urban planning - Foster environmental education and awareness-building - Support the preparation of Agenda 21 programmes

Criteria	Objective	Action
	Integrate participation into planning	- In the diagnosis process - In strategic decision-making - In drafting the plan - In approving the plan - In the process of monitoring and supervising the plan - Integrate Agenda 21 programmes into planning

(Source: Fariña & Naredo, 2010)