INTERREG MED Programme

2014-2020

ESMARTCITY

Enabling Smarter City in the MED Area through Networking

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Priority Axis 1. Promoting Mediterranean innovation capacities to develop smart and sustainable growth

Specific Objective 1.1 To increase transnational activity of innovative clusters and networks of key sectors of the MED area

WP3 – Testing

Activity 3.4 – Assessment of Pilot projects results

Deliverable 3.4.1 – Green Paper for Innovation Policy Change

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1   Introduction

1.1   Scope and objectives of the deliverable

This report has been developed within the ESMARTCITY project of the European program Interreg MED, and serves as a deliverable for the activity A3.4 "Assessment of Pilot projects results". More specifically, it represents D3.4.1 "Green Paper for Innovation Policy Change" and its aim is to develop a Green Paper, which will detail the project proposals for policy improvement/change in the partners' territories existing policies, strategies and structures, so that the sustainability of the project results is ascertained.

Before the development of the policy recommendations, necessary knowledge about the most relevant to the project topics was systematized and recorded. The main topics refer to the digitalization and Open Data as basic factors for the activation of Smart Cities; to Smart Building and Smart Public Lighting applications; and to Green Public Procurement and innovative procurement procedures in the framework of Smart Cities. The deliverable also collects good practices around Europe in the aforementioned topics. It also presents the results of ESMARTCITY usecases in Smart Building and Smart Public Lighting.

Consequently, this Biblehas been built on a two-step process. The first step is to familiarize the reader with the elements involved in the green recommendations for Innovation Policy Change, i.e. with the definition of the elements, the associated benefits and challenges, best practices and existing initiatives valorization of existing knowledge. The second step is to valorize the existing knowledge outlined in the first step resulting to the development of green recommendations for Innovation Policy Change. In this step, concrete recommendations are presented, covering the main topics analysed in the first step.

1.2   Structure of the deliverable

This deliverable is structured in 6 chapters:

Chapter 1, "Introduction"

Chapter 2, "Digitalization as basic factor for the activation of Smart Cities" presents the definition of digitalization and the role that plays in Smart Cities, the associated benefits and challenges, as well as best practices of digitization in Smart Buildings and Smart Public Lighting and existing initiatives.

Chapter 3, "Usecases" presents the results of ESMARTCITY usecases in the two sectors of Smart Building and Smart Public Lighting, emphasizing on the lessons learnt and the experience gained.

Chapter 4, "Open Data in Smart Cities" describes the general framework of Open Data in Smart Cities. It includes good practices and the challenges related with this topic. It also describes the principles of Open Data Governance, including issues such as privacy, data management, standardization, architecture, security, social responsibility and sustainability.

Chapter 5, "Green Public Procurement" deals with the Green Public Procurement (GPP) procedures, how public procurement is shaped in the framework of Smart Cities, innovative types of public procurement, namely Public Procurement of Innovative solutions (PPI) and Pre-Commercial Procurement (PCP). It also presents the benefits and the challenges of GPP, the EU Legal Framework of GPP and good practices of GPP in Buildings and Outdoor lighting.

Chapter 6, "EU Cohesion Policy Framework" describes the current cohesion policy framework, the European Regional Development Fund(ERDF) and the Cohesion Fund (CF). It also presents the 2021-2027 cohesion policy framework changes in the Thematic concentration, ERDF, CF, Sustainable urban development and European territorial cooperation (INTERREG).

Chapter 7, "Policy Recommendations – Action Plan" is the chapter in which the knowledge collected in the previous chapters is valorized. Concrete green recommendations for Innovation Policy Change are presented. Each policy recommendation is categorized per recommendation type, policy level and is related with the UN Sustainable Development Goals.

2 Digitalization as basic factor for the activation of Smart Cities

2.1 Digitalization in few words

Digitalization could be considered as a broader and long-term societal transition, affecting among others the way of how people work and communicate, transportation in the cities, the bureaucracy, energy, manufacturing, healthand retail sectors. From this perspective, digitalization is a game-changer with profound impacts in the economy, society and cities.

The digital change began during the 1990s. The spread of the Internet and the emergence of online service provider companies (e.g. AOL and Compuserve) triggered the start of the digital change. Digitalization was enhanced by the increasing number of Internet connections around the turn of the millennium, while it was further sparked by the high-speed Internet and mobile data access. The even faster 5G mobile Internet is coming soon and in combination with the technologies of the Internet of Things (IoT) and artificial intelligence is expected to make high tech new applications possible and drastically change the future of the economy and smart cities.
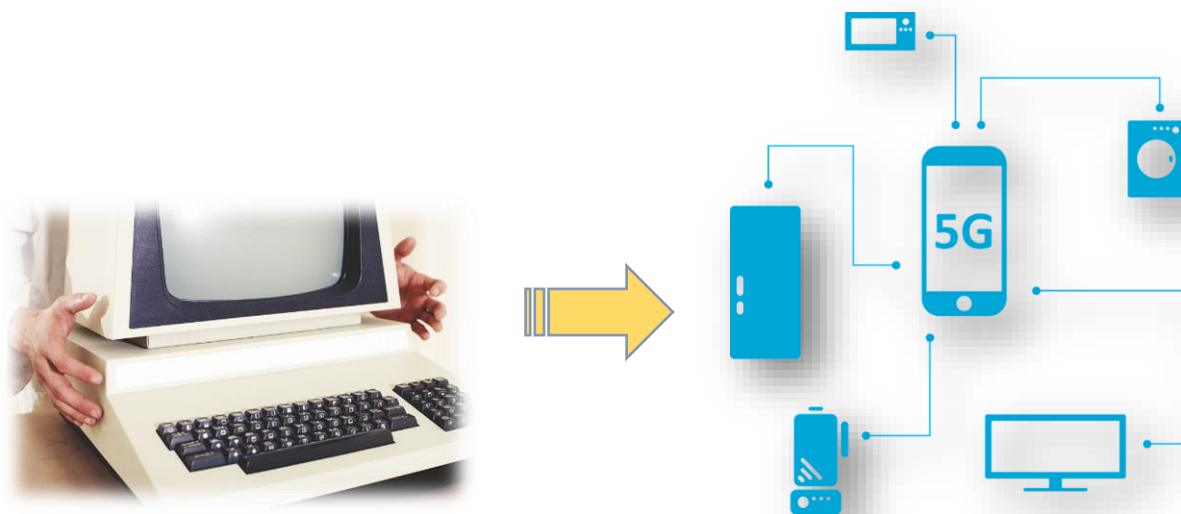
Figure 1 -Digital technology from the 1990s to 2030s

2.2 Digitalization and Smart Cities

For the last two decades, digital innovation is at the heart of discourse around Smart Cities to build more efficient and livable urban environments; by using data and digital technology. A Smart City is quite simply a city that utilizes digitalization and new technology to simplify and improve the life for its residents, its visitors and business. In a Smart City, new smart services are constantly created to make the city even better and sustainable through connectivity, publicly accessible data, IT platforms communicating with each other, sensors and other technologies.

Digitalization has enabled infrastructure to become smarter. The optimum use of physical space and energy, the proactive management of users, assets and processes, the efficient operation of businesses and companies have gradually benefited from the digitalization process. Countries that have introduced digitization not only in the manufacturing sector such as the use of Robotics or Internet of Things (IoT), but also in wider Smart Cities solutions, including Intelligent Zero Energy Buildings, Smart Public Lighting ande-healthcare or Smart Grids, have benefited from an increment of Gross Domestic Product (GDP) due to the reduction of the final Operational Cost. Digitalization can have different roles and functions in different contexts related to the Smart City phenomenon.

Digitalization requires at least three elements in order to lead to smartness:

1. generation of data,

2. interconnection exchange of these data and

3. analyysis of the generated and interconnected data.

Table 1 -Digitalization main elements

generation of data	→ *from all kind of devices*	**Digital Platforms**
interconnection & exchange of data	→ *Through telecommunications infrastructures & Internet*	
analysis of the generated & interconnected data	→ *using sophisticated algorithms*	

The digital platforms combine these three dimensions of digitalization, integrating the different economy sectors, enabling smart cities to have huge potential.

Digitalization is one of several megatrends, including globalization, demographic change and climate change that are reshaping policies from the ground up. While digital innovation remains central to the smart city concept, a key policy question for local and national decision-makers is how to make the most for citizens' well-being of the costly investment in smart technologies, applications and digital innovations.

At the heart of the implementation of digitalization in Smart Cities lies the installation of smart meters at a broad range of buildings, from public and municipality buildings to domestic residencies. A critical factor for the success of this attempt is the easy installation of meters that are small enough to fit even to small electrical panels. Smart metering at high resolution is the first step towards performing multiple analyses that might lead to feasible corrective actions. The acquisition of accurate real-time data from installations in real-world conditions is the key to the deployment of a smart city framework.

Public and private organizations in the energy field across the globe have described the necessary characteristics of submeters with emphasis on the size, cost, and ease of installation. More specifically, the U.S. Department of Energy (DOE) stated that the specifications and attributes of an acceptable wireless metering system should include[1]:

1. Low cost meters
2. Electrical energy measurement units easy to use and quick to install
3. Full compliance with NFPA 70 and UL 61010
4. Wireless data communication success rate greater than or equal to 95%
5. Operation independent from existing building internet and intranet networks
6. All data encrypted using 128-bit or greater Advanced Encryption Standard

Moreover, the Electric Power Research Institute (EPRI) has performed multiple research studies related to the efficiency of the installation of low-cost submeters to commercial and industrial sites[2,3,4]. The objective is that in order to apply energy efficiency actions on buildings, real-time energy monitoring through low-cost submeters is necessary. Again, easy installation along with low cost are critical factors in order to work towards energy efficiency in bigger volumes.

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[1] https://bgintegration.pnnl.gov/highlights/highlight.asp?id=2734
[2] https://www.epri.com/#/pages/product/3002005810/?lang=en-US
[3] https://www.epri.com/#/pages/product/3002016181/?lang=en-US
[4] https://www.epri.com/#/pages/product/3002013337/?lang=en-US

Apart from the above, it is important to mention Greece's center for renewable energy sources & saving directions towards systematic energy audits in buildings to achieve energy efficiency[5]. The guidelines that frame the energy audit procedure include the following:

1. Audits should be based on up-to-date, measurable energy data as well as characteristics related to energy load
2. A detailed overview of energy consumption characteristics of a building should be available
3. Energy audits should be proportionate and sufficiently representative in order to give a reliable picture of overall energy efficiency and identify the most important opportunities for improvement.
4. Data used for energy audits should be stored so as to enable future analysis of energy efficiency.

The same document underlines the necessity for reliable submeters that measure the overall consumption as well as individual loads within each facility. The quality of the submeters is crucial for accurately monitoring the energy loads of buildings.

It is made clear from the aforementioned statements that the first step towards any kind of energy analysis is the installation of appropriate submeters to buildings of interest, able to measure the energy characteristics that can make a difference in energy efficiency plans.

2.3   The Benefits

Digitalization provides many benefits to the cities, being often advocated by governments and industrial players; while enables the activation of Smart Cities and Infrastructure.
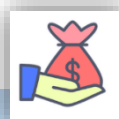
ECONOMIC IMPACT

Digitalization changes the traditional economic activitiesin the cities. Services such as travel agencies, banking, music industry, commerce, etc. have been gradually moving online. Moreover, digitalization affects civil society consumption habits, with the number of people buying online rising fast. It provides shopping convenience to the consumers offering all the necessary information in no time.

The digital change creates new jobs and business opportunities. In fact, during the world economic crisis the ICT sector continued to grow at a high pace, especially in the Smart Cities. Many digital-

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[5]http://www.ypeka.gr/LinkClick.aspx?fileticket=u1Ez6ny5W90%3D&tabid=281&language=el-GR

related startups appeared exploring new digital market niches. In Southern and Eastern Europe, there has been a revival offoreign investment in ICT activities and nearshore investments asfor example, in the more creative braches of the so-called app economy - which is mostly associated with cities. A growth from about 2 million jobs in 2013 to almost 5 million in 2018has been estimated in Europe, out of which 2.6 million were app developers.

In recent years, a growing co-evolution and integration of digital and physical activities has been observed.Nowadays, this is evidentin thefield of the unfolding "Industry 4.0"; including the development of smart factories, powered by automated data exchange, IoT, cloud computing and cyber-physicalsystems. For instance, in the car industry, major innovations in the field of autonomous driving take place. The built quality of the manufactured product, meaning the car itself, still matters a lot, but on top of that, information and data handling become ever more important aspects, not only to makethe drive safe, but also to add all sorts of additional information services to drivers (dynamic traffic information, parking availability, info on nearby restaurants, etc.). This adds new demands on incumbent car producers, especially as newcomers to the industry like Google and Tesla are making inroads very fast.

EFFICIENCY

Digital technologies enhance the way a city runs, improve service provision and reduce operational and maintenance costs. Sensors, computing and data open up many new possibilities that humanity could not even think about a few years ago. They allow tracking and anticipating movements in transportation sector, facilitate urban logistics,support the development of more evidence-based and anticipatory urban management and improve efficiency in city services, i.e. water and energy distribution. Smart Cities embed sensors in urban infrastructure and use smart cameras to track movements; prevent congestion; intervene in natural disasters through warning systemsimproving readiness, response and recovery;reduce waste and become more energy-efficient. Electric cars, bicycles and scooters considerably reduce noise pollution and CO_2 emissions.

The circular economy, a concept that aims to improve economic and resource efficiency, is also enhanced by digital innovation, and leads to a more accurate management of consumption and production processes. As urban populations grow, digitalization is as a way to reduce urban ecological footprints and make sure the city functions in a more efficient and sustainable way.

Digitalization boosts people participation in society, by facilitating access to information, creativity and empowerment. Digital devices and access become ubiquitous,since there are examples of citizens contributing to the development of new ideas to old urban problems (e.g. through smartphone apps), and the development of solutions that are more appropriate to different types of social needs (e.g. digital solutions to facilitate the life of elderly or disabled population). Digital solutions help people with less resources to access shared goods, share their own and gain extra income, or even to facilitate the sense of community in neighborhoods by sharing goods and services (e.g. a reparation, a tool, carpooling, etc.).

Governments increasingly use crowdsourced data to gain real-time detailed information on public service delivery and infrastructure needs, and facilitate appropriate real-time responses. For instance, in many cities, citizens can report and inform city employees through smartphone applications about the location of potholes, broken traffic lights, stray garbage and any other urban challenges they face on a daily basis.

Digital technologies can improve citizen engagement through e-government services and civic technology to facilitate access to information, take better and informed decisions, and express opinions through online platforms, petitions and voting.A greater use of digital technology may also enable innovative and experimental governance in cities and metropolitan areas.

2.4   The Challenges

Digitalization is an on-going socio-technical transition including new technologies and how they become embedded in society. Although digital innovations can contribute to making urban environments more livable, they can bedisruptive and come with a range of challenges, trade-offs and hidden costs.In order to reap the benefits, cities must act proactively, often in articulation with other stakeholders. A key challenge is how to cope with the pace of change, in a context where digital skills and organizing capacities do not abound in many local governments around the world.

Without an integrated, multi-sectoral and government perspective, digitalization can also jeopardize citizen data, privacy and safety; generating trade-offs between disclosing data and perceived impact of smart city services. It is important for the governments to recognize that tech-

driven solutions are as important to the poor as they are to the affluent, and can deepen inequality among digitally marginalized groups. The human element should not be forgotten when embedding digital solutions in order to ensure that digitalization does not widen the gap or contribute to further citizen discontent. In the case of Smart Cities, public and private action have to be viewed through the lens of their value to society since social costs may arise through digitalization, in particular during the transition period. Smarter investment in human resources, such as in life-long learning and more generally ensuring that people have the skills for the future work, including digital literacy, will need to be available in all cities and regions, and should be viewed as an investment and not a cost.
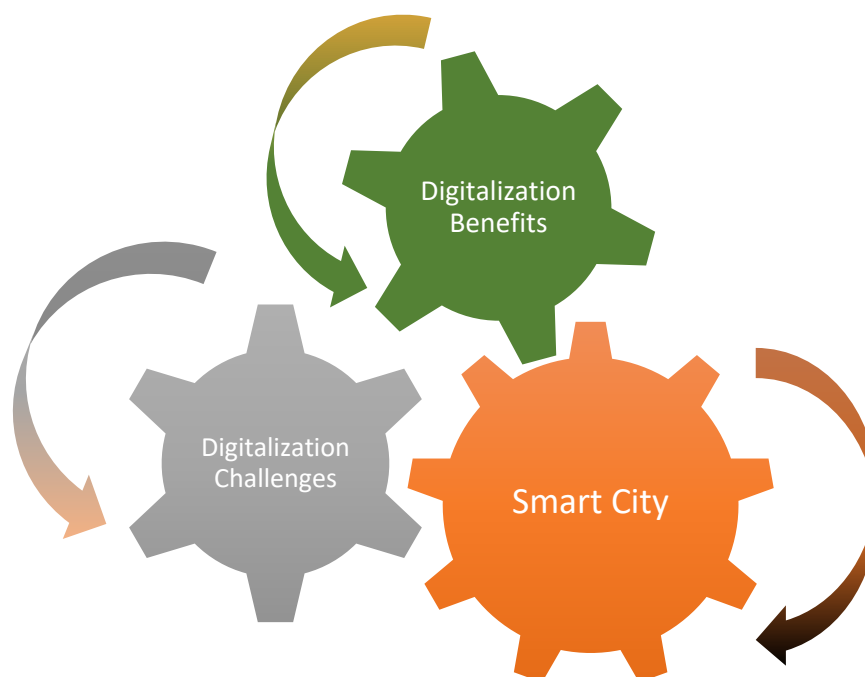
Figure 2 – Digitalization Benefits and Challenges addressed lead to Smart City concept

Regional innovation strategies and local authorities can boost local economies to seize the business opportunities from emerging innovative technologies in order to boost productivity and growth while supporting diversification. This requires strategy development, innovation in firms, access to finance, effective stakeholder engagement, leadership and foresight at all levels of government.

Cities keep innovating and anticipating change in order to deal with the digital urban economy of tomorrow.

More specifically:

- To drive digitalization, cities must be more active to promote an urban startup scene and to connect the startups with existing companies in new ways;
- Digitalization demands a new labor market strategy in which employers, unions and the education system must prepare themselves for an economy with higher job-to-job mobility and a higher need for digital skills;
- Cities need an integrated data strategy urgently;
- The city administration should work to facilitate digital transitions, but also must think deeper about the social and ethical implications of digital technology and data;
- In health care, new collaborations between players (hospitals, elderly homes etc.) is needed to reap the benefits of digital technologies and turn small pilot projects into real implementation;
- Cities must invest heavily in having digitally savvy and socially aware staff that can link the city administration with a growing number of digital civic innovators.
- Cities need an overall vision on digitalization
- Cities and universities must develop digital living labs together to make urban experimentation more diverse and reach wider audiences and users;
- Cities must combine data security with data openness;
- Cities must act more like a "lean startup" and thus need a cultural revolution.

2.5 Best Practices in Smart Buildings and Smart Public Lighting

The city of Yokohama, in Japan, introduced a Community Energy Management System to achieve efficient energy management, including the installation of emergency management systems in 4,200 homes, the introduction of 2,300 electric vehicles and of 37 MW of photovoltaic generation, leading to the **reduction of 39,000 tons of CO$_2$ emissions**.

The Edge is an office building in Amsterdam, the Netherlands, that showcases the benefits of Building Information Modeling (BIM). Completed in November 2014, The Edge was built with the Internet of Things (IoT) as its foundational principle. Its design and construction did not use BIM in the prescribed sense but its implementation of smart technologies enables The Edge to achieve

many of BIM's benefits and it perhaps even serves as an exemplar for a few. Some of these are: automated energy performance visualization, building usage monitoring and post-processing for energy analysis. Since its completion, The Edge has been internationally admired as one of the **smartest buildings in the world** and has also been called *a computer with a roof*. However, the success of The Edge goes beyond its use of cutting-edge technologies and instead lies in effective communication between key drivers (Deloitte, OVG Real Estate, PLP Architecture, Philips, Mapiq and Schneider Electric)who championed diverse and original ideas. This building is forecasted to save **42 million kilograms of CO₂** during its first 10 years' operation, compared to a normal office building, and the estimated energy consumption varies between -0.3 and 40.7 kWh/m^2/year depending on the availability of the renewable energy supply by the PV production.

A good example of a smart building in action is the Duke Energy Center, a LEED Platinum 48-story office tower located in Charlotte, NC. Owned by Wells Fargo & Co., the Duke Energy Center was chosen in 2010 as a grand prize winner of the inaugural Siemens Smartest Building in America Challenge. In the Duke Energy Center, 16 separate building systems, including three building automation systems, are integrated through one routed Internet Protocol network. The 1.5 millionsq.ft. office building also has a Tier IV data center. The complex building automation system was customized to accommodate multiple protocols (BACnet, OPC, LonWorks, Modbus and PLC) to allow for efficient system operation and data collection from diverse building systems. Integrated systems in the center include lighting controls inside and outside of the building, light harvesting blinds, seven 2.25-MW generators and several uninterruptible power supply systems. The center also integrates elevator monitoring, video surveillance from 200 security cameras, emergency intercom systems, digital signage, parking access and revenue control (PARC) system, even a custom underground water filtration system.

"We spend more than 90% of our lives in buildings, so individuals and businesses are right to expect more from their buildings. Smart buildings today should actively contribute to the wellbeing and business success of those who rely on it."

Cedrik Neike

CEO Smart Infrastructure

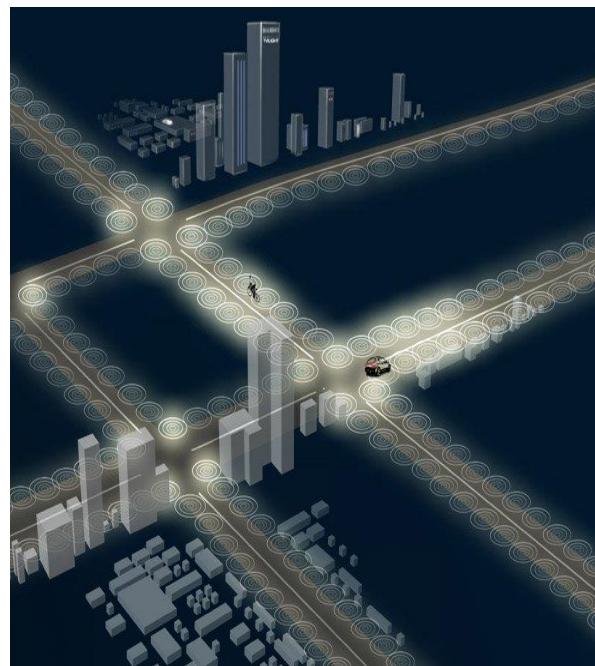**Figure 3 –** *Smart Building Prospect*

In the smart city context, municipalities are no longer the sole customer of smart city services. Citizens and consumers have shifted, from being purely users to being customers and prosumers too. Nevertheless, the initial impact of communication technologies on cities often results in a growing number of vacant shops, whose tenants have been driven out by the attractiveness of online shopping. Such developments have had negative influences on retailers in Veghel, the Netherlands, as well as on the livability and quality of life in the city. To counter these developments, the municipality initiated a project entitled "Veghel behind a digital city wall". In this case, Philips Lighting developed a two-step plan.

First, it sought to create a lighting experience area, where colorful, dynamic lighting scenarios welcome and attract visitors to the city center. Second, they created an experience platform with an interactive lighting design for the two main shopping streets, initiating the project "Veghel turns the light on". The focus for the experience

***Figure 4** – Smart Public Lighting*
(Source: www.tvilight.com)

platform lays on changing lighting content that could invoke particular experiences in the city center. More specifically, Philips Lighting conducted an area analysis and designed both the luminaires as well as the lighting content for different atmospheres. Such lighting experiences improve the visibility of retailers in the city center;it also stabilizes the bond between the city and its citizens and attractsnew visitors. By offering products and services (lighting consultancy,experience platform, and maintenance), Philips Lighting was able to diversify its revenue opportunities. The initial results look promising: there are 22 newly opened shops and 15% more visitors in the city center.

Another trend, powered by digitalization, is "servitization": rather than delivering a finished end product, a manufacturer offers a product as a part of a bundle of services, including maintenance, software updates, online real-time performance monitoring etc.. Philips Lighting is a good example. For its main client Schiphol Airport, rather than selling light bulbs, the company sells a "light solution": it keeps the ownership of the physical materials, and takes full responsibility of

maintenance and recycling. This service orientation requires a new type of thinking and organizing in industry sectors, and also sets new parameters for industrial logistics.

Tvilight provided the city of Helmond, in the Netherlands, with its cutting-edge connected intelligent lighting solution, which includes award-winning street light sensors and wireless lighting controllers capable of adjusting the level of illumination based on real-time human presence. In addition to innovative smart lighting solution, Tvilight offered intuitive, feature-rich light management software which allows theHelmond municipality to collect valuable statistics, such as citizens' activity and energy consumption, creating light profiles that match the illumination requirements of each particular location in the city.

Revolutionary smart street light sensors and versatile lighting controllers from Tvilight enable the 'Pink City' Jaipur, in India, to reduce energy consumption, **72% energy savings**and thereby minimize CO_2 emissions and light pollution; lower maintenance costs; improve safety and quality of life of the citizens; taking a leap towards becoming one of the forefront smart cities in the country.Tvilight's smart street lighting works on Open API; hence, the integration with third-party smart city management software (Cisco Kinetic) and luminaries (Bajaj Electricals) was also easy.

2.6 Existing Initiatives

Selected examples of Smart Cities and Digitalization initiatives across Europe are presented in the next table.

Table 2 – *EU Smart Cities and Digitalization initiatives*

Country	Initiative	Description
Austria	Research and Technology (RTD)programme called "City of Tomorrow"launched by the Austrian Federal Ministryof Transport, Innovation and Technology (BMVIT).	"City of Tomorrow" is based on the previous RTD programmes including "Building of Tomorrow" and "Energy Systems of Tomorrow". It is focusing on the research and development of new technologies, technological systems as well as urban services for future cities.
Denmark	A number of different sector-based initiatives such as the energy Smart GridStrategy (the Danish Ministry of Energy,Utilities, and Climate), digitization in thepublic digitization	"Invest in Denmark" under the Ministry of Foreign Affairs conducted a research with Arup and CEDI on smart cities linking to national prosperity.

	strategy (the Danish Agency for Digitization) and data in the Basic Data Program (a number ofministries).	It highlighted five requirements (municipal capability, investment certainty, skills and research, public acceptance and digital literacy, and sharing of data).
France	- France's research tax credit	Smart grid and connected city companies conducting research and development in France are eligible for France's research tax credit.
	- Smart grids and connected cities are fully integrated into the "Sustainable City" plan aspart of the "New Industrial France (*NouvelleFrance Industrielle*; NFI)" project launched inMay 2015.	Within the framework of NFI, Bpifrance, France's public investment bank is providing financial support. (e.g. EUR 50 million of "City of tomorrow" fund forstart-ups in the smart city sector).
	- "La French Tech" initiative Created inNovember 2013	Innovative companies working with smart grids and smart cities receive business development support through "La French Tech" initiative.
Germany	Smart Cities research cluster, establishedby German Ministry for the Environment,Nature Conservation, Building and NuclearSafety (BMUB) and the Federal Institute forResearch on Building, Urban Affairs andSpatial Development (BBSR)	The Cluster is to understand the impact that societal adoption of digital technologies has on urban development, to repurpose digital and big data methods and instruments for urban development, to rethink action areas in urban policy with digital know-how and to work with professionals from cities, municipalities and businesses.
Latvia	EU Cohesion Fund 2014-2020	EUR 10 billion from EU Cohesion funds are being used for digitalization and smart development.
Luxembourg	City infrastructure projects launched by the Ministry of the Economy and Digital Luxembourg	Luxembourg's Smart City model – an urban development concept designed to optimize daily management of city infrastructure through IT and Internet ofThings technologies. Six main fields are economy, mobility, environment, people, living and governance.

Project co-financed by the European Regional Development Fund

3   ESMARTCITY Usecases

The aim of the ESMARTCITY usecases/pilot activities was to test the Smart City concept in partner´s areas increasing the level of innovation by enriching city infrastructures via smart devices, embedded systems and sensor/actuators and enhancing innovation potential of SMEs allowing them to utilize Smart City infrastructure as test bed for innovative applications/services. Main goal was to decrease the overall energy consumption while maintaining and optimizing the user-required level of comfort. The achievement of this goal has been carried out from different approaches, taking into account the specificity and needs of each territory, the great heterogeneity of the pilots and the existence or not of previous experiences in smart city solutions.

The pilot activities also seek to contribute to the improvement of the innovation capacity of cities, through the creation of an innovation ecosystem involving companies, research centers, academia and public authorities, creating in these territories the necessary conditions for the implementation of the Smart City concept. In this ecosystem, technology is placed at the service of citizens. The implementation of this innovation ecosystem is based on sharing information and knowledge about intelligent systems and aims to enable new products/applications, increase energy management capacity, open opportunities for research, make cities more efficient, communicate energy efficiency values and establish more informed policies. The pilots are:

- ✓ 5 pilots related with Building Energy Efficiency in Smart Cities, with an average life time expectation of 12 years for the equipment installed.
- ✓ 3 pilots related with Smart Pubic Lighting, with an average life time expectation of 15 years for the equipment installed.

A detailed description of the technologies and methods used for each pilot implementation is described in the "*Deliverable 3.4.2 – Testing and Evaluation of Pilot Activity Reports*" developed during EMSARTCITY project.

In general, all pilots are based on scalable systems, 50% of them are easily replicable, 37,5% replicable with minor adaptations and only 12,5% needs relevant adaptations to be replicable. In 62,5% although the process of installation requires high skills, the monitoring systems are quick to install, 13% needs a high qualified team, whereas only 25% of the systems are easy to install. The installed systems tend to be autonomous: 50% don't need any interaction and the other 50% need some (few) information for their right use.

Maintenance is undemanding, 62,5% requires only simple periodic (low frequency) actions and 12,5% requires periodic actions to be taken by a specialized team. 25% of the systems doesn't require any kind of maintenance.

The communication network deployed is mainly stable, 87,5% with minor failures and 25% with no failures.

Data is stored in local servers for 62,5% of the pilots and 37,5% on the web. Despite this, 87,5% allows the full control of the system remotely from the web. For 87,5% of the cases, everybody can use the data if they have the rights' permission.

A total of 319 questionnaires were distributed and analyzed by the ESMARTCITY partners in order to monitor the impact of project's pilots in the involved territories.

3.1 ESMARTCITY pilots in Building Energy Efficiency in Smart Cities

The total amount of monitored buildings in ESMARTCITY was 45, categorized as follows:
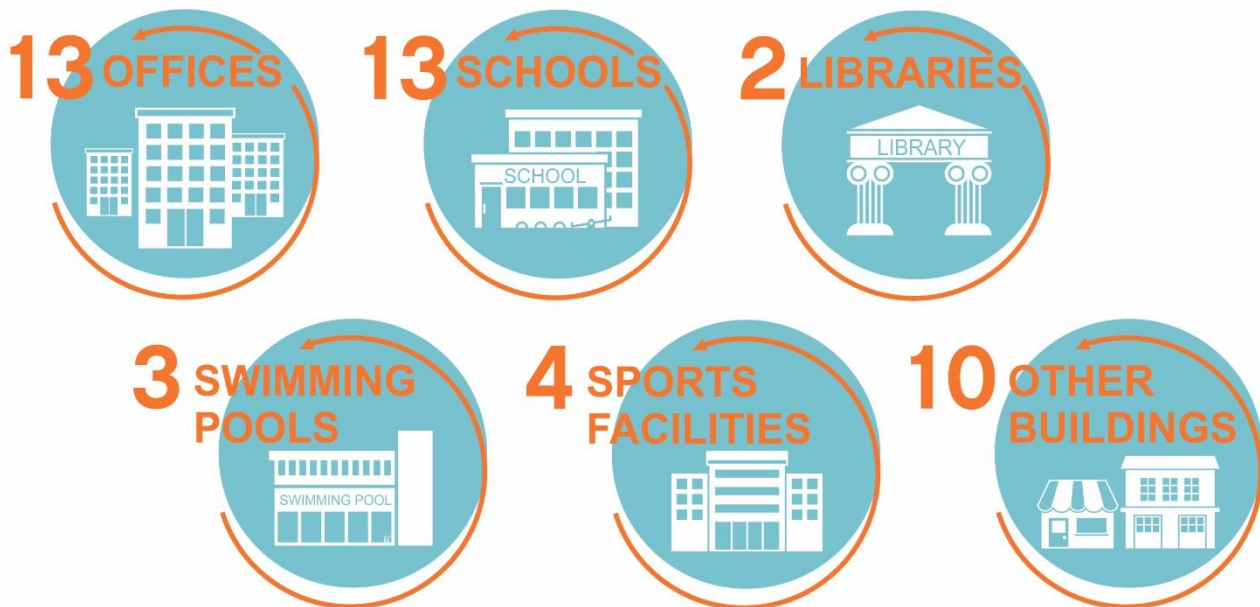
These 45 buildings have 3.093 permanent users and are monthly visited by 132.385 persons.

3.1.1 The pilots' Benefits

In the pilots, 233 physical variables are monitored. Only 3% of the sensors installed have redundancy.

The sampling time varies from 1 second to 1 minute.

The installations allow the continuous data acquisition. In average 130 days of information were already collected with a success acquisition rate over 94,7%.

From the information collected, 24 different indicators were established with sampling periods from 1 minute to one month, with a computation success over than 96,5%.

One of the buildings also has the capability to control the power supply by an ON/OFF control on the main circuit breaker.

3.1.2 Impactof the Building Energy Efficiency pilots in the involved territories

A total of 161 questionnaires were distributed and analyzed by the ESMARTCITY partners in order to monitor the impact of theBuilding Energy Efficiency pilots in the involved territories. The main conclusions obtained are the following:

Impact on everyday activities:
50% of building users had minor changes on their daily activities after the implementation of the pilot, 44% didn't change anything and only 6% felt significant changes.

Impact on privacy:
The privacy of user was not compromised in 74% of the cases, whereas 24% has some concerns and 2% feel that don't have privacy.

Perception on environment benefits:
Most of the people recognize the benefits of installation on the environment (70% referees a positive impact), 29% believes don't change anything and only 1% refers and negative impact.

Perception on economic benefits:
69% of the users believe in a positive impact of the pilot installation on economy, whereas 28% believes that doesn't change anything and 3% refers a negative impact.

Perception on smart building solutions:

73% believes that the ESMARTCITY pilot can become a starting point for the adaptation of smart building solutions for buildings´ owners in the future, 23% believes that nothing has changed and 4% refers that the pilot cannot be a changing point for the future.

Perception on best practices:

58% of the surveyed would suggest the smart building installation to another organizationas a best practice, 34% could consider as a best practice to recommend and 8% don't consider this as a possibility.

3.2 ESMARTCITY pilots in Smart Public Lighting

The ESMARTCITY Smart Public Lighting pilots cover an illumination area of 16.000 m^2, and 81 streetlight points.

3.2.1 The pilots' Benefits

The implementation of these pilots reveal that it is possible to ensure the good quality of the public lighting reducing the average amount of light (average reduction of 5,18 lux), controlling the amount of light available accordingly to the real needs.

The reduction of power installed due the conversion to LED bulbs is 10,1 kW. Adding the light control, we obtained savings of 60% of energy consumed.

Two control strategies where used in street lighting systems.

On the one hand, the reduction steps in the light flux according to operating hours, for instance:

- From 23:00 to 1:00, reduction of 20%
- From 1:00 to 2:30, reduction of 50%
- From 2:30 to 5:00, reduction of 30%

On the other hand, the control of the lighting level according to presence sensors.

3.2.2 Impact of the Smart Public Lighting pilots in the involved territories

A total of 158 questionnaires were distributed and analyzed by the ESMARTCITY partners in order to monitor the impact of the Smart Public Lighting pilots in the involved territories. The main conclusions obtained are the following:

Perception on the light pollution and sleep quality:

30% of population surveyed considers the improvements related to light pollution control and sleep quality significant and visible from first day. 27% considers the light pollution reduction visible but not enough, 17% expects better effects whereas 20% didn't notice any change spontaneously and 6% refers that the situation is the same as before.

Perception on the level of illumination:

41% of the people consider that safety of the citizens has been preserved, through a sufficient level of illumination to allow pedestrians to pass throughout the night without worry, even the level of illumination could be further reduced, 29% consider that illumination is enough when the sensor detects a passage and when the lights come on to the maximum level, while before that they were restrained to walk down that street. 18% consider the illumination is enough but still don't have full confidence in the system. 12% don't consider the illumination enough but still walk on the street.

Perception on the security:

Evaluating from 1 to 5 (where 1 is the lowest level and 5 the highest) the level of perceived security, the perception of the population is the following:

Level of perceived security
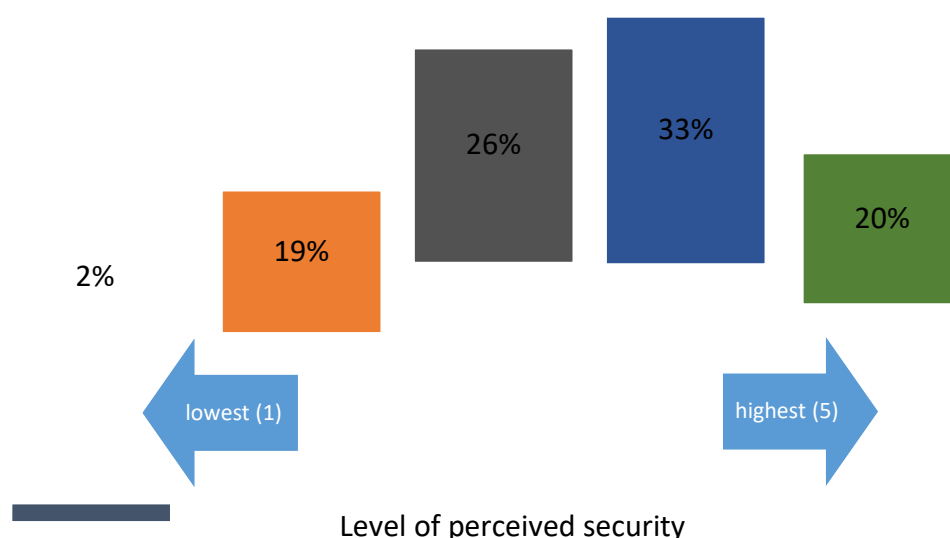
Figure 5 - Level of perceived security

Investments in Smart Lighting projects:

37% of the people consider that one of the top priorities of the city should be to continue investing and seeking external EU funds to expand the existing Smart Public Lighting project. 29% think investing is important as long as the ongoing problems in essential utilities are resolved. 25% consider this investment good but not crucial to improving the quality of life. 9% of the people find it completely unnecessary, waste of energy, money and time.

Solutions applied to other fields:

For 45% of the people surveyed, the implementation of other smart solutions in fields like public transport or waste management is an opportunity for local companies and universities to create economic growth and jobs. 21% agrees with this strategy but not as a priority, whereas 15% agrees with the strategy but think that the quality of the existing service needs to be addressed first. 12% have some doubts since the benefits are long-term and not immediate. 7% disagrees, they feel more comfortable with less technology in daily activities.

3.3   The Challenges in ESMARTCITY pilots' implementation

During the development of ESMARTCITY pilots, partners faced several problems and challenges. In this section, we make a global description of these difficulties found.

Technical challenges

- Difficulties in the communication network due to technical lack of local sites for transferring data in real time.
- Difficulties in the design/optimization of prototypes.
- Difficulties to find the smart solution that fits the specific needs of each community due to the huge variety existing on the market today.
- Inexistence of global solutions valid for every installation. Each street, each building, each neighbourhood, each system needs its own solution adapted to its specific needs.
- Weakness on communications infrastructure and 4G network and fibre.

Involvement challenges

- Lack of engagement of public administrations, what is essential in the management and regulation of smart technologies.
- Hitches to include all the stakeholders of a community, including governments, academia, industry and civil society (Quadruple Helix). Without cohesion, the smart city concept is not

exploited to the full. A smart city has to be based on a holistic vision that provides a common understanding among smart cities stakeholders.

- Lack of communication with citizens results in top-down approaches. Projects have to be developed with input from civil society, taking into account its culture and customs.

Smart-city-culture challenges

- Limits in the introduction of ICT practices in some areas mainly agricultural and depopulated due to lack of knowledge and preparation, especially of the elderly.
- Lack of knowledge in small and medium-sized municipalities about what can be done in the field of smart cities and how it can be applied at their scale. This problem could be an opportunity for development of new smart services/applications related to public lighting, energy efficiency building management or water supply. More capacity building and dissemination is needed about ICT technologies among the municipal staff, in order to familiarize them with it.
- Inexistence of a clear view related to crucial aspects on smart city about the property and management of the collected data (who is the owner of data? how can we provide the access to it? where should we put the limits on the data access? should be the business based on the collected data service-oriented or applications license-based?). It´s extremely relevant to promote a deep reflection about data property with all stakeholders.

Budget challenges

- The limited municipal budget represents a barrier to the implementation of measures involving ICT. The adoption of innovative financing mechanisms to support smart solutions is needed.

3.4   The Lessons Learnt from ESMARTCITY pilots

During the development of ESMARTCITY pilots, partners gained knowledge on specific topics as shown below.

3.4.1   Building Energy Efficiency in Smart Cities

3.4.1.1   *ESMARTCITY Energy Efficient buildings as Living Labs in Patras, Greece*

The ESMARTCITY pilot project at the Industrial Systems Institute premises in Patras, Greece gathers building operation information, performs big data analysis, and acts upon its results. The system detects anomalies in the building operation in real time and acts to remove them, so that

energy efficiency is enhanced without compromising the level of comfort for the building occupants. The pilot project is vendor neutral, exploiting functionalities of diverse IoT devices, ensuring interoperability, and relying on open source solutions. This enables its utilization for further experimentation with innovative ideas and applications associated with real life use cases in a real working environment. The building is transformed into a Living Lab integrating user experience and exploiting ambient intelligence in a co-creation context.

3.4.1.2   ESMARTCITY Energy Efficient buildings in Region of Western Greece, Patras, Greece

The ESMARTCITY pilot project at buildings of Region of Western Greece and at three schools in Patras, involves measurement of electric energy consumption meters in real time using smart energy meters. All data are collected on a server and can be seen on a user-friendly platform. Energy efficiency of the buildings is enhanced through monitoring since any unusual electric consumption can be observed and take immediate measures. Moreover, energy consumption related to heating/cooling can be estimated resulting in actions involving improving occupants' behavior. The system can be upgraded resulting to more concrete data and energy/smart efficient buildings.

3.4.1.3   ESMARTCITY Energy Efficient buildings in Milan, Italy

The pilot of Politecnico di Milano focuses on a 4-floor classroom building and mainly consists in the deployment of an advanced IoT network based on integrated multi-sensors (temperature, humidity, pollution, CO_2, people presence), in order to develop an efficient and scalable control strategy to manage the heating and cooling systems for complex thermal networks of the building. The pilot allowed to develop a performance assessment methodology to describe the building control performances. Then, it is shown how scalable dynamic models of the building behavior can be easily developed, to allow a vast range of investment investigation, from the building structural elements to the thermal network devices and the application of advanced control strategies. In particular, multiple advanced control strategies have been developed which are easy to implement. This increases substantially the comfort while decreasing the consumption thanks to the people occupancy profile.

3.4.1.4   ESMARTCITY Energy Efficient buildings in Metropolitan City of Milan , Italy

The project, born to be sustainable, has managed an energy efficiency process at the Isimbardi Palace which is the Institutional Headquarters of the Metropolitan City of Milan and in a Milan

School making users more aware and increasing the structural safety of the buildings, the quality of the air inside the last one and the contextual monitoring of the artwork, the Tiepolo. We are going to extend the next investments of the use of IoT systems to the new urban which can be developed thanks to all data the analysis of the data collected and processed within this pilot project.

The project is to be considered the proof of the concept for future intelligent service projects and has been implemented by involving all stakeholders of the community, industry, school and civil society, following the Open Innovation model, in every single phase of the implementation of the project.

Moreover the project is influencing several challenges because it is acting on the sphere of safety, protection and quality of life as a whole.

In conclusion, the project has made it possible to promote the intelligent and rational use of resources, to make measurable both the energy efficiency and the environmental sustainability, to contribute to the redefinition of the energy system value chain and to reduce the economic and environmental impact of energy systems on public spending.

3.4.1.5   ESMARTCITY Energy Efficient buildings in Portugal, ENA - Energy and Environment Agency of Arrábida

The Esmartcity Pilot Project developed by ENA in 24 public buildings located in the Municipalities of Palmela, Sesimbra and Setúbal gathers building energy consumption data through a smart energy metering system that allows to monitor, control, optimize and test energy management strategies. This data, as well as the data coming from 5 other public buildings that already had a measurement system, was integrated in the same IT platform that enables municipalities to better understand the real needs of public buildings, making them more energy efficient, improving the provision of services to citizens, and reducing the environmental impact. By using Building Management Systems/technologies this pilot increases energy management capacity (reduction of energy consumption and cost, in an estimated percentage based on real cases that can go up to 25%), but also enables new products/applications, to open up opportunities for research and to communicate energy efficiency values and establish more informed policies. The public usage of the data collected should serve as a trigger for many incoming startups and innovative ideas.

3.4.2   Smart Public Lighting

3.4.2.1   *ESMARTCITY Smart street lighting becomes a Smart City platform in Pescara, Italy*

The ESMARTCITY pilot project smart lighting system, which was deployed in the Pescara's northern waterfront, controls the individual lamps functionalities to enhance citizens' security and optimize electrical consumptions.

The Pescara Municipality has now begun to integrate on it a smart mobility system by installing and managing vehicle counting systems, meteorological stations (with data on temperature, humidity, wind speed, solar radiation, UV rays) and surveillance cameras.

3.4.2.2   *ESMARTCITY Smart street lighting in East Ilidza, Bosnia and Herzegovina*

The ESMARTCITY pilot project smart street lighting in Municipality of East Ilidza, Bosnia and Herzegovina, enhanced the existing conventional lighting system with intelligent light controllers that enable intelligent control of the lamps, as well as remote monitoring and control using a web platform. The project involved all stakeholders in the community, including government, industry, academy and civil society following the Open Innovation 2.0 model, in each single stage of the project implementation. This concept allows the local government to create many sideline projects in the Public-Private Partnership involving the (local) industry and the business sector into the process of the further City development. Besides that, local authorities gained experience for the implementation of Smart City services and increased their level of knowledge in this area which should enable them to be more prepared for expanding Smart City services and implementing similar projects in the future. This is one of the most significant benefits of this pilot project implementation.

3.4.2.3   *ESMARTCITY Energy Efficient Public Lighting in Granada Province, Spain*

The ESMARTCITY pilot project at Public Lighting facilities in Agron and Huetor Tajar small and medium municipalities in Granada Province, involve measurement of electric energy consumption meters in real time using smart energy meters, as well as air quality measurement, real time information to citizens, and programing ability to reduce energy consumption in these facilities. All data is collected on the hosting application for each municipality and can be seen on a user-friendly platform.

Energy efficiency of Public Lighting in Agron municipality has been enhanced as different lighting poles have been changed to LED technology and some programming on intensity of the lights have been placed. Similar thing occurs in Huetor Tajar, but the facilities save less energy as LED

technology was already implemented. Moreover, energy consumption related to programing of the lighting poles can be estimated resulting in actions involving improving facilities behavior. The system can be upgraded to be included in wider platforms later on to integrate different vertical solutions in each municipality. Citizens are quite excited with the improvement of facilities when they learn about the energy and economic savings and see the services improved.

Speaking about lessons learnt on things to improve at municipality level, we see the need of supporting bigger institutions on Smart City areas, since work deriving from data analysis is huge considering municipalities little resources. As well we saw in rural areas problems on the connection of the online platforms to the equipment's as the signal in some rural areas is too low. Moreover, the cost of the sensors/platforms is too expensive for small applications in these kind of municipalities, and the implementation through bigger institutions should help to better share the costs of implementation of the technology. Finally, the innovation searched is difficult to be reached if we speak about SMEs and small contracts, so more tools should be put at the service of SMEs to reach better degrees of innovation.

3.4.2.4   Smart Public lighting benefits

Energy savings & improved sustainability

Using automated intelligent dimming and scheduling of luminaires, we can add up to 30% to energy savings. Cost-savings from energy reduction through smart street lighting can help cities save money for the community.

Affordable Investment/fast and easy installation

Smart street lighting adapts to luminosity and does not require any investment in communications infrastructure, wireline or wireless, because it uses existing proven mobile networks, with guaranteed SLAs. Its plug 'n play luminaire fitting saves installation costs.

Future Proof

Using Smart street lighting municipalities save money and transform existing lighting infrastructure into an intelligent backbone smart city network, connecting future smart city application sensors on an existing and cost-efficient grid.

Real Time Alerts

Smart street lighting services can provide real-time notifications of any change occurring along the grid. The tools for real-time malfunction monitoring and maintenance optimization, increase lighting service satisfaction and can further cut operational costs.

Environment protection/ Reduce city carbon footprint

Smart street lighting drastically reduces city's energy consumption and CO_2 emissions. Smart street lighting can integrate to other smart city services, like environmental monitoring, noise monitoring, measuring air quality, pollution or traffic.

Extra revenue streams from flexibility service

Smart street light could support Municipality to participate in Utilities demand response programs, where dynamically upon utility's demand and on a few seconds response time the street light infrastructure could turn on in power network overload situations. This way the municipality could create an extra revenue stream but also support energy efficiency strategies.

3.5   The Lessons Learnt from ESMARTCITY Study Visits

ESMARTCITY partners conducted studies visits during project lifetime. In this section, we highlight the lessons learnt from two study visits, a) Smart City ecosystem in Franceand b) Doll Living Lab, in Denmark.

3.5.1   Smart City ecosystem in Nice, France

Formulation of an ecosystem at city level involving all relevant quadruple helix stakeholders can act as a catalyst for wide applicability of Smart City solutions. Such an ecosystem is successfully established in Nice, France. A critical element for the proper functioning of this model is the existence of open infrastructures or open data in order to enable the different systems across the city to interoperate and offer a coherent view to the city manager. Entrepreneurship and innovation are enhanced through licencing city infrastructure related data to innovative companies offering new apps and services to the citizens, while also employment in the city is targeted. Following a "breaking the silos" approach across different domains can help better resolve city challenges, and a higher level innovation platform can significantly contribute to this

end. At the governance level, such a platform is employed in Nice by IMREDD, the Mediterranean Institute of Risk, Environment and Sustainable Development.

3.5.2 Doll Living Lab in Albertslund, Denmark

Doll Living Lab focuses on offering demonstration and testing of solutions related to Smart City services in a number of sectors such as Digital Infrastructure, Outdoor Lighting, Environmental Monitoring, Waste Management, Parking and Mobility. A consortium of local stakeholders in Albertslund, Denmark, offers an integrated approach towards facing city challenges instead of following a silo approach. The holistic approach followed can facilitate systems and solutions that offer new innovative services for multiple domains taking into account existing infrastructures. A City System Platform accumulating information and data from underlying systems and applications, can facilitate the role of the city in decision making, system operation and maintenance, following results and reporting, building action plans and enhancing city policies and strategies.

4 Open Data in Smart Cities

4.1 Open Data in few words

Ahuge amount of data is being generated in public and private sectors on an ongoing basis. This data is stored beyond the reach of most people, secured in government or proprietary databases or on individual electronic devices. The types and the depth of this data is growing as new and increasingly technological solutions are implemented to solve the problems of the governments, businesses, and citizens of smart cities. Open Datarefers to information, readable by machines, that is freely available to others and can further be used and republished.However, the notion of Open Dataas a phenomenonis at an early stage.

4.2 Good Practices for Open Data in Smart Cities

4.2.1 Open Data Policies

A well-written Open Data policy will clearly define the commitment of the organization to publishing, sharing and consuming data. It will be used by internal stakeholders to help identify and prioritize releases, and by external stakeholders to understand how an organization will be releasing its data and ways in which they can be involved.

Good practices on drafting new or revised policies:

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*An Open Data policy will include some **general context** that helps to define its scope*

- ✓ **Definition of Open Data** – why it is important to the organization and the reasons for defining a policy.

- ✓ **Outline of the types of data** collected by the organization and whether they are covered by the policy.

- ✓ **General declaration of principles** that should guide the release and reuse of Open Data.

- ✓ **References to any relevant legislation, policies or other guidance** which also apply to the management and sharing of information with third-parties.

Clearly stating the scope of a policy will help all stakeholders to reach a common understanding of how, when and where it should be applied.

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approach to identifying and prioritizing data for release – how will data be inventoried, reviewed and then released?

privacy considerations – ensuring that personal information is not released by mistake and recommending steps to mitigate, e.g. by undertaking privacy impact assessments or approaches to anonymization

data licensing and reuse rights – this will include not only the license under which data will be released, but also the importance of clearing rights during data collection

data publishing standards – ensuring that data is shared in well-structured, machine-readable formats, with clear metadata and documentation

engaging with reusers – how will the organization work with external stakeholders to help guide release of data and ensure it can be easily used

measuring success – what metrics will the organization use to measure whether the policy is successful and how will these measures be shared

approach to consuming Open Data – for organizations that are reusing Open Data, guidance on how to identify high quality datasets and ensure that reuse rights are clear

concrete commitments – what is the organizationcommitting to do, in concrete terms, over the timespan of the policy
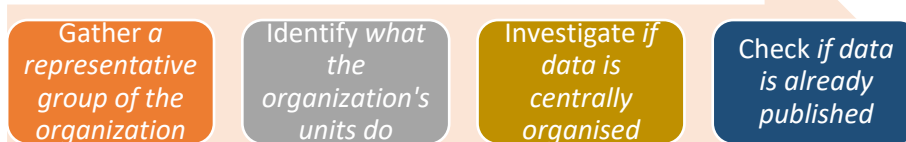
policy transparency – how will the policy and the processes described in it be reviewed based on feedback from stakeholders and lessons learned

A policy document won't necessarily include detailed information on each of these areas, e.g. specific standards or release processes. It will instead focus on general principles that should be followed and which may inform the drafting of more detailed guidance for practitioners.

4.2.2 Open Data Strategies

According to the European Open Data Portal,before starting to publish any Open Datathe organization has to define what it wants to achieve; this is often called "setting the ambition". In order to set the right ambition, the definition of the current situation is really crucial and is called "As-Is situation"; which is described in detail in Figure 6.

Project co-financed by the European Regional Development Fund

| Gather *a representative group of the organization* | Identify *what the organization's units do* | Investigate *if data is centrally organised* | Check *if data is already published* |

Identify key representatives of different sectors, units and departments of your organization that can help you identify the real "As-Is situation"

Which units collect data? Which ones use data? Which ones produce data? What type of data do they gather? In what format? A visualization of the situation might help to create an overview.

When your data is generated by multiple units and they all have their own policies and ways of working, implementing a new way of working becomes more challenging. It is better when data is centrally managed.

If data is already published, it can be a good starting point; since the organization can identify the current policies related to this process and try to implement best practices.If not, the organization can launch the process. In this way it benefits by avoiding former restrictions, processes or wrongly manipulated data that might blur the view on the root of the data.

Figure 6–Defining the "As-Is situation"

The next step is to detail the ambition by thinking of the "To-Be situation" – city's vision:

1. What does the city want to achieve?
2. Where will the city stand in 2 years' time or perhaps in 5 years' time?
3. Discuss this with the group of representatives.
4. Create a clear picture of the"To-Be situation"; better by visualizing it.

Many Smart Cities have followed the 9 key topics shown in the Figure below to set their own Open Data successful strategy; thus they can be considered as good practices. Every policy should cover them in order to have the potential to succeed.

Figure 7 - The 9 key topics every policy should cover (Source: www.europeandataportal.eu)

4.2.3 Ensuring alignment of the stakeholders – Creating an ecosystem

Ensuring alignment of the stakeholders related to Open Data initiatives and implementing it in a sustainable way is essential to the success of an Open Datapolicy. The *Open Data Institute* performed a thorough analysis of change in organizations that publish their data as Open Data. They performed an extensive literature review with regard to change management and tested their findings through interviews with seven countries. Their findings on how to create an Open Data ecosystemare the best example for Smart Citiesand are briefly summarized in the below principles.

- Articulate your vision with clear examples of benefits Open Datawill bring.
- Secure support for your Open Data initiative from both senior/political leadership and government officials within departments before launch.
- Combine top-down leadership for your Open Datainitiative with support for individual or frontline champions in government.
- Build open communication and mechanisms for feedback into your Open Datainitiative from the outset, both inside and outside government.

- Set out some quick wins, e.g. releasing a certain number of datasets, or supporting a pilot use-case, as part of a long-term goal for Open Data.
- Be flexible and responsive to the strengths and needs of different departments and teams.
- Consolidate your change management efforts.
- Ensure there are people with responsibility for change management as part of your Open Datateam.
- Seek out and foster stories of the impact of Open Data, illustrating the benefits of the Open Data initiative.
- Foster external support within industry, civil society and academia to drive continued demand for Open Data.
- Introduce opportunities for civil servants to take part in ongoing learning about Open Data.
- Build metrics to regularly evaluate Open Data activities, analyzing the need for improvement.

4.2.4   Open Data Engagement Model

Publishing Open Data is not just about technology. *Tim Berners-Lee's five stars* of linked Open Data set out a series of approaches that Open Data initiatives, can take to publish data on the web. The following five-star model seeks to add to this, highlighting key steps that Open Data initiatives can take to engage with data users. Each star includes a set of questions to unpack what might be involved in taking that step towards engagement.

★Be demand driven

- Are your choices about the data you release, the way it is structured and the tools and support provided around it, based on community needs and demands?
- Have you got ways of listening to people's requests for data, and responding with Open Data?

★★ Put data in context

- Do you provide clear information to describe what data you provide, including information about frequency of updates, data formats and data quality?
- Do you include qualitative information alongside datasets such as details of how the data was created, or manuals for working with the data?
- Do you link from data catalogue pages to analysis of the data that your organisation, or third-parties, have already carried out with it, or to third-party tools for working with the data?

★★★ Support conversation around data

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Regional Development Fund

- Can people comment on datasets, or create a structured conversation around data to network with other data users?
- Do you join the conversations?
- Are there easy ways to contact the individual 'data owner' in your organization to ask them questions about the data, or to get them to join the conversation?
- Are there offline opportunities to have conversations that involve your data?

★★★★ **Build capacity, skills and networks**

- Do you provide or link to tools for people to work with your datasets?
- Do you provide or link to "How to" guidance on using Open Data analysis tools, so people can build their capacity and skills to interpret and use data in the ways they want to?
- Do you go out into the community to run skill-building sessions on using data in particular ways, or using particular datasets?
- Do you sponsor or engage with capacity building to help the community work with Open Data?

★★★★★ **Collaborate on data as a common resource**

- Do you have feedback loops so people can help you improve your datasets?
- Do you collaborate with the community to create new data resources (e.g. derived datasets)?
- Do you broker or provide support to people to build and sustain useful tools and services that work with your data?
- Do you work with other organizations to connect up your data sources?

4.2.5   Open Data Issues to Deal with before Publishing

Licensing

The data is not freely re-usable if you do not attach a license to it. Thus, rule number one with regard to legally opening up your data set is to attach an appropriate license to it. Unless you have a license, data may be 'publicly available', but users will not have permission to access, use and share it under copyright or database laws.An Open Data license is an explicit permission to use the data for both commercial and non-commercial purposes.There are many different types of licenses you can apply, for instance one of the Creative Commons (CC) licenses. A Public Domain

Dedication is part of the CC licenses and important to attach as it indicates that the public domain is the author of the data.

Quality

The quality of Open Data, next to its discoverability, is one of the largest influencers of the success of Open Data. Open Data becomes usable when a human can understand it and a machine can manipulate it. Users of Open Data need the permission of its publisher, granted by an open license. But the open license alone is not enough to guarantee the usability of data. It is unlikely that people will be able to engage with data to derive insights and demonstrate benefits unless it is usable.

Data should have content qualityand answering the questions:

Is the data *complete*?
Is the data *clean*?
Is the data *accurate?*

Discoverability

It is important to ensure that your data can be found. The term usually applied to this is the discoverability of data. Essential for discoverability is metadata. Metadata describes the data set itself (e.g. date of creation, title, content, author, type, size). This information about the data needs to be added to the catalogues to help discover the data. If it is published as Linked Data, the discoverability of the data is greatly increased. Metadata has a large influence on the re-use of Open Data. It will increase the discoverability and the re-use of your data. Therefore, take the time to inform the re-user about the quality of the data set by providing rich metadata. This will make the usability of the data set better.

4.3   Challenges

Although more and more countries are embracing Open Data, there are still many persisting challenges when developing Open Data initiatives.In literature, there are four typical barriers' categories.

4.3.1   Political barriers

Approximately one third of the countries are facing political barriers. Despite the fact that most countries have a full-fledged Open Data policy in place, the barrier that most countries have to face is the engagement of policy-makers in Open Data. Politicians are not well aware of the benefits of Open Data resulting in the fact that they do not identify Open Data as a priority, but solely see it as a 'nice to have' feature. This sponsorship of Open Data at the highest level could lead to an increase in publishing data at all levels of government, thereby creating peer-pressure among administrations. Another political challenge can be found in countries where Open Data laws are taken to the next level. Such an ambitious legislation or policy agenda is laudable but may take more time to adopt and implement; meeting more resistance than a series of smaller actions.Coordination and cooperation between national and regional public sector bodies, is another challenge that countries face when opening up Open Data. This is strongly dependent on the structure of the country. Norway indicated that their regions are highly independent and are therefore not included in the national programme regarding Open Data. A similar situation occurs in Germany.

4.3.2   Legal barriers

Countries are experiencing three main legal barriers, when working with Open Data.

Firstly, a legal framework related to publishing Open Data is missing: data publishers expect or need one so as to start publishing data. Malta for instance, is a country that has been focusing on providing this legal framework and considers it a key success factor for sustainable Open Data publication. Switzerland plays in the same tune and indicates that data publishers need a legal framework to start publishing the most wanted data. Other countries do have a legal framework, but their government structure results in various frameworks causing inconsistency or lack of clarity.

A second legal barrier countries encounter concerns licenses, which play an important role in Open Data. Without an open license, data cannot be used freely. In some countries, licenses are not regulated nationally. Several countries also believe that by publishing the data and making it openly accessible solve the question of the license, as the data is now free to access. However, this is not sufficient.

The third challenge that countries are facing concern privacy constraints that prevent data publication. Multiplecountries such as Belgium, the Netherlands and Spain,explained that a privacy framework prevents thepublication of Open Data, which is deemed privacysensitive. Privacy is becoming an increasingly hot topic as politicians and citizens fail to understand Open Data on the one hand and the absence of an actionable legal framework as described above on the other.

4.3.3 Technical barriers

Various technical challenges are present when working with Open Data. One barrier indicated most often by countries, is the low quality of the data, for example when Open Data is published in an unstructured or in a non-machine readable format. When the quality of the data is poor, it can prevent citizens or organizations from re-using the data. The quality of the data can be improved by setting up standards for the collection and publication of Open Data.Countries should try to both increase the amount of databeing published and be equally concerned of the quality of the data itself. In Belgium, eachadministration has its own tool to publish Open Data and in Norway, standardization of API's is missing.An explanation for the lack of standardization could be that countries want to make the publication ofOpen Data as easy as possible for data publishers, while setting up standards requires them to do morethan the minimum to open up the data. A best practice country to learn from isItaly, where strong national guidelines are in the process of being set up to ensure high levels ofmetadata quality whilst respecting the autonomy of the different regions. Another approach is the oneundertaken by Greece, where the Ministry responsible for the Open Data policy has trained publicadministrations to publish their data and upload it to the national portal. Despite the fact that thisremains a manual exercise, it is a substantial first step in helping administrations publish their data.

4.3.4 Financial barriers

Many countries indicate that public authorities are used to selling their data. When legislation is forcing them to open up data free of charge, they have to face a loss of revenue. It is therefore necessary to reorganize the funding model of certain public bodies. Benefits of publishing Open Data for free are not clearly documented, making it difficult for administrations to justify the loss of revenue, or more broadly, understand the benefit of publishing data in the first place. The loss

of income by making data available free of charge, strengthens the general view that most public bodies have to prioritize their tasks and revenue sources.

4.3.5   European Single Digital Market

Figure 8 - The need for a EU Digital Single Market (Source: www.quidgest.com)

4.4   Data Priorities

4.4.1   Data audits to capture available data

To effectively manage data holdings and fully realize their potential, an organization must first be aware of the location, condition and value of its assets. Conducting an audit will provide this information, raising awareness of collection strengths and data issues to improve overall strategy. An audit will highlight duplication of effort and areas that require additional investment, allowing an organization to put its resources to best use. It will also highlight inadequacies in data creation and curation practices, suggesting policy change to lessen the risks faced. An organization that is knowledgeable about its data puts itself in a position to maximize the value of its collections through continued use. Broadly speaking, auditing data brings three main benefits:

- prioritization of resources which leads to efficiency savings;

- ability to manage risks associated with data loss and irretrievability;
- realizing the value of data through improved access and reuse.

4.4.2 City level datasets

The City of San Diego is pioneering automation in the use of open data to increase transparency and efficiency for its customers. San Diego's Open Data Policy mandates that all high value public datasets in the City's inventory be released by 2020. Forty-four datasets were released with the launch of the Open Data Portal (https://data.sandiego.gov) in 2016, and 30 more datasets were added in 2017 when City staff recoded the portal to maximize speed and efficiency. Today the City's online open data inventory holds 155 datasets, allowing customers and City staff to avoid otherwise cumbersome searches by locating the City information they need within minutes. Based on this city best practice, the most important categories of data are: *GIS, Public Safety, City Management, City Infrastructure, Economy & Community, Transportation, Culture & Recreation, Energy & Environment*.

4.4.3 National level datasets

According to the "Global open data index: survey" powered by "Open Data Census" (http://global.survey.okfn.org), there are 15 main categories of national level datasets (see table 3). Open Data Census survey calculates the percentage of available open data in this top categoriesin each country.

Table 3 - 15 main categories of national level datasets, defined by "Open Data Census"

Administrative Boundaries	Air Quality	Company Register	Draft Legistration
Election Results	Government Budget	Government Spending	Land Ownership
Locations	National Laws	National Maps	Procurement
National Statistics	Weather Forecast	Water Quality	

4.4.4 High value datasets

Data is created, stored and distributed, covering a large variety of topics and categories. However, not all types of data are of equal relevance. In 2013, the G8 came together to discuss governmental transparency, innovation and accountability. This discussion led to the creation of the "G8 Open Data Charter": a summary of visions and principles for creating a transparent Government, the opening up of data and its quality and quantity. The most relevant and high-quality datasets are summarized in the following table. The purpose of this list of categories is to ensure that Data Holders focus on the release of the right and most relevant types of data. This does not mean that other categories of data cannot be published. The list gives an indication of the topics that should have the highest priority, as these datasets are indicated as datasets with the highest potential value.

Table 4 - The G8 High-Value datasets

Data category (in Alphabetical order)	Datasets Examples
Companies	Company/business register
Crime and Justice	Crime statistics, safety
Earth observation	Meteorological/weather, agriculture, forestry, fishing, and hunting
Education	List of schools; performance of schools, digital skills
Energy and Environment	Pollution levels, energy consumption
Finance and contracts	Transaction spend, contracts let, call for tender, future tenders, local budget, national budget (planned and spent)

Geospatial	Topography, postcodes, national maps, local maps
Global Development	Aid, food security, extractives, land
Government Accountability and Democracy	Government contact points, election results, legislation and statutes, salaries (pay scales), hospitality/gifts
Health	Prescription data, performance data
Science and Research	Genome data, research and educational activity, experiment results
Statistics	National statistics, census, infrastructure, wealth, skills
Social mobility and welfare	Housing, health insurance and unemployment benefits
Transport and Infrastructure	Public transport timetables, access points broadband penetration

4.4.5 Open Data indicators

To monitor the success of the Open Data initiative, the most useful evaluation categories are:

- performance of the data,
- performance of the system,
- collection and preparation performance.

The "*Performance of the data*" includes two indicators:

1. the number of downloads and
2. the click through rate (number of page views).

These are not the same, but both indicate the popularity of the dataset and not the usefulness of the dataset.

The "*Performance of the system*" evaluates

1. whether the system can handle the requests,
2. if there has been any downtime and
3. if there are performance consequences for other systems.

These are the three indicators of this category.

The "*Collection and preparation performance*" includes the following indicators:

1. usefulness,as an indicator caused by the qualitative usefulness (is it helpful for a particular purpose?) and
2. the practical usefulness (is the data described, clean, dense enough, etc.).

The latter is an indicator you can influence, as this reflects the performance of the Open Data Lifecycle.

4.5   Open Data Governance

4.5.1   Open Data Principles

Government data shall be considered open if it is made public in a way that complies with the *8 principles* below, derived from the meeting among 30 open government advocates which took place in California, U.S. in 2007:

1. being **Complete**: all public data is made available. Public data is data that is not subject to valid privacy, security or privilege limitations.
2. being **Primary**: collected at the source, with the highest possible level of granularity, not in aggregate or modified forms.
3. being **Timely**: available as quickly as necessary to preserve the value of the data.
4. being **Accessible**: available to the widest range of users for the widest range of purposes.
5. being **Machine processable**: reasonably structured to allow automated processing.
6. being **Non-discriminatory**: available to anyone, with no requirement of registration.
7. being **Non-proprietary**: available in a format over which no entity has exclusive control.

8. being **License-free**: data is not subject to any copyright, patent, trademark or trade secret regulation. Reasonable privacy, security and privilege restrictions may be allowed.

Compliance with the above principles must be reviewable.

4.5.2 Infrastructure Governance principles and Internet of Things (IoT)

Privacy

Privacy is a key factor in trust relationships. When data is disclosed to others, it automatically means that the publisher is trusting them not to use it in ways that conflict with his interests.In the context of IoT, privacy boils down to two things: either third parties are trusted in not abusing the data generated by the publisher, or the publisher relies on the ability to control the collection and use of that data. In the IoT domain, privacy therefore carries strong implications of trust, transparency and control.

Individuals must be able to control how the information is collected and shared by their IoT devices and determine who has access to the data from devices in their home, car, etc. This means easy ways to blind and mute devices, thus individuals play akey role in how IoT data is analyzed or shared with third parties. IoT devices and their applications should enable the user to find out what information is collected and shared, when and with whom. IoT devices should have the option for pseudonymous or anonymous use in order to let the individuals determine how identifiable they want to be.The user should understand where information about them has gone, and how long it is kept,thus controlling their own digital footprint.

Data management

Traditional data management systems handle the storage, retrieval, and update of elementary data items, records and files. In the context of IoT, data management systems must summarize data online while providing storage, logging, and auditing facilities for offline analysis. This expands the concept of data management from offline storage, query processing, and transaction management operations into online-offline communication/storage dual operations. In this direction, the lifecycle of data within an IoT system proceeds from data production to aggregation, transfer, optional filtering and preprocessing, and finally to storage and archiving.

A promising scenario for applying an open data strategy in smart cities would involve the real time energy & building data acquisition from public/municipality buildings, and therefore the real-time collection of the corresponding measurements in a database owned by the public or municipality authority. Those data would be available on a need to use basis, to stakeholders through a portal, with an easy-to-use API and full description of the dataset's details and legal usage limitations. As

previously discussed, data should be in standardized format that is readable from users and machines as well.

Public authorities owning the data would be able to provide it to various service providers (e.g. ESCOs) offering value added services such as energy efficiency, predictive maintenance etc. Thus, applications that require real time energy and building data will become feasible in a short time period and cost effectively, by decoupling the task of service provisioning from the costly and sometimes legally challenging task of collecting the data.

Standardization

Standardization is necessary to ensure
(i) interoperability across products, applications, and services that preclude vendor lock-in;
(ii) economy of scale, where the three sections of the society -developer (researcher), government (regulator), and the user - get benefited in a reasonable time frame;
(iii) security and privacy of the data and the users;
(iv) space for the researchers to take society to another height; and
(v) interoperation across physical communication systems, protocol syntax, data semantics, and domain information.

Although there is no single body responsible for making IoT standards, considerable efforts are made at national and international level, governmental level, and at different organizational levels for IoT standardization. Alliances have been formed by many domestic and multinational companies to agree on common standards and technology for the IoT. However, no universal body has been formed yet. While organizations such as IEEE, Internet Engineering Task Force (IETF), ITU-T, OneM2M, 3GPP, etc. are active at international level for standardization, Telecommunication Standards Development Society India (TSDSI), Global ICT Standardization Forum for India (GISFI), Bureau of Indian Standards (BIS), Korean Agency for Technology and Standards (KATS), and so on, are active at national level and the European Telecommunications Standards Institute (ETSI) is active at regional level.

Architecture

Internet of Things, as a hot topic in the field of computer networks and wireless sensor networks, requires a standard architecture to provide a competitive environment for business organizations competitors in order to enhance their quality. In addition, detailed evaluation of the traditional Internet architectures needs to be performed to measure its capability to meet the challenges of the Internet of Things. The Internet of Things connects a large number of heterogeneous objects

through the Internet. Hence, theyshould be built in flexible layered architecture. Different architectures can be deployed for the Internet of Things, suchas three-layer architecture, middleware architecture, servicebased architecture and five-layer architecture. The common IoT's five-layer architectureis:
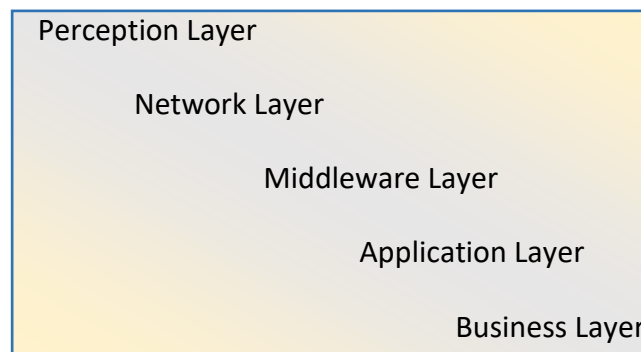
Figure 9 – IoT's five-layer architecture

Security&Social Responsibility

IoT systems are able to gather sensitive data about the consumers and companies are already using lot of Machine Learning (ML) and Artificial Intelligence (AI) tools to extract information about their consumers for marketing purposes. Elaborate systems and policies need to be formed to provide guidance about the exposure and use of private information along with the technology enhancement to ensure that such data are not compromised and mishandled by the malicious users.

4.5.3   Open Data Portals

The term "Open Data portal" is often used synonymously with phrases like "Open Data platform", "Open Data catalogue" and "Open Data repository". This can make describing the nuances of architecture behind "Open Data portals" difficult.

Governance

The governance model for an Open Data portal has to become embedded in "business as usual" government functions, beingable to continue to adapt to changing government priorities in order to become sustainable.Main recommendations to make the governance model more sustainable:

- ✓ Have a business plan and clear governance structure in place.
- ✓ Bring publishers and data users together to address specific challenges, using Open Datafrom the portal.

✓ Build responsiveness to government priority changes into your governance structure.
✓ Create hard levers to set and enforce data quality and metadata standards, and pursue data updates from publishers.
✓ Create a non-ministerial leadership role to champion data publication and respond to issues.

Architecture

As Open Data initiatives mature and data services and technologies evolve, ensuring the Open Data portal architecture is still fit for purpose and able to withstand, service and funding changes becomesharder.Main recommendations to make the portal architecture more sustainable:

✓ Select open source software solutions, and solutions that offer archiving/downloading options for all data published via the portal.
✓ Contribute to the development of standard APIs, that could be used across all Open Data platforms, for sharing, summarizing and presenting data.
✓ Build links to data held in other portals into yours, where they could be relevant for yourlocal users.
✓ Even if not responsible for the publication and maintenance of data, research your user needs and their preferred data formats to drive data improvements.
✓ Build upon recognized standards to foster interoperability and comparability of metadata across Europe.

Operation

In the case of an Open Data portal, the service being operated can go beyond the technical infrastructure underpinning the portal – such as its servers – to the practices and procedures that ensure it provides access to useful, high-quality, discoverable Open Data. Because of the nature of the service an Open Data portal provides, Open Data portal owners are often required to be more open, transparent and adaptive to end-user requests than may be expected of other services. This brings its own challenges to the sustainable operation of an Open Data portal. Main recommendations to make a portal operation more sustainable:

✓ Manage publication operations to support different types of publishers from small- to largescale, enabling automation where possible.
✓ Manage technical operations to include effective monitoring and reporting systems for inaccessible data, preferably through publicly accessible lists for users to track progress.

- ✓ On-board new end-users, publishers and monitors with effective User Experience design, clear publication processes, feedback loops and training.
- ✓ Automate functions to ensure seamless integration of a diversity of data sources, increase user friendliness and limit overheads for stakeholders.
- ✓ Capture and share lessons learned, and be open to best practices and standards developed by other portal operators.

4.5.4 Open Data Management

Open Data management Organizational structure
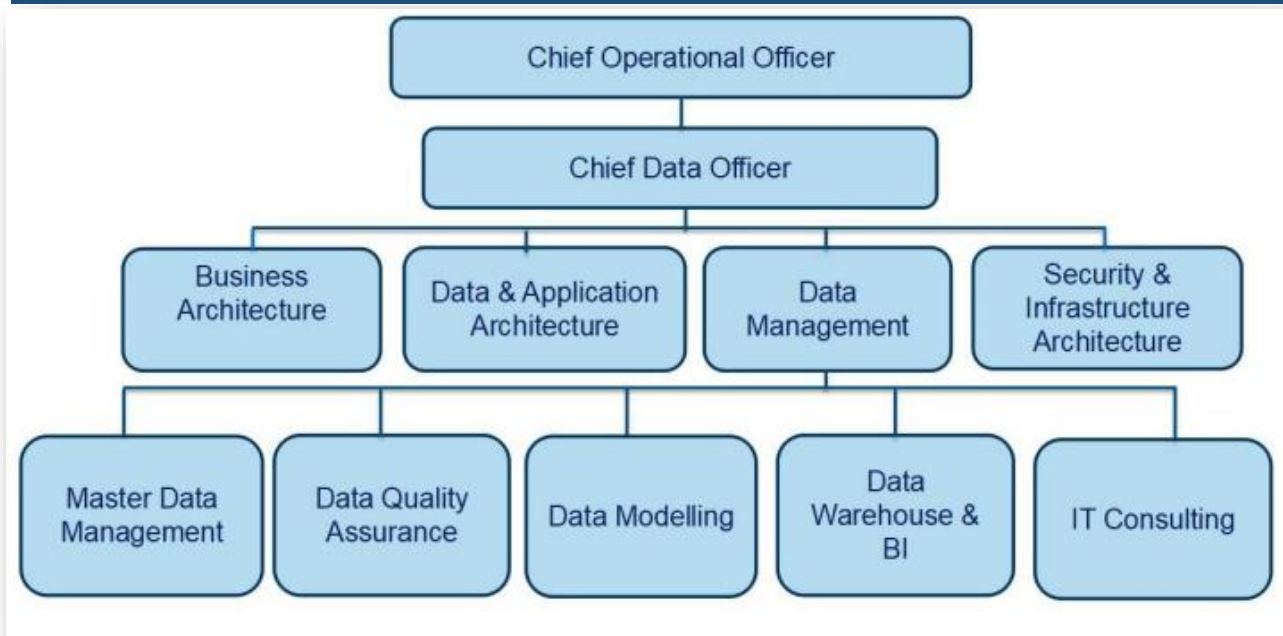
Figure 10 – Open Data management Organizational structure (Source: www.exmacon.net)

Data Protection Officer function

The General Data Protection Regulation (GDPR) defines the role and responsibility of a Data Protection Officer (DPO). The DPO is in charge of monitoring the application of the GDPR within an organization and providing strategic advice to it on how to process personal data while respecting individuals' rights. Local Strategic Planning Statements (LSPs) are usually involving several testbeds or deployments controlled by different partners. Each Data Controller (the partner who has the effective control on the data collection) should have a clearly identified DPO.

As outlined in GDPR Article 39, the DPO's responsibilities include, but are not limited to, the following:

- Educating the staff on important compliance requirements.
- Training staff involved in data processing.
- Conducting audits to ensure compliance and address potential issues proactively.
- Serving as the point of contact between the company and GDPR Supervisory Authorities.
- Monitoring performance and providing advice on the impact of data protection efforts.
- Maintaining comprehensive records of all data processing activities conducted by the company, including the purposes of all processing activities, which must be made public on request.
- Interfacing with data subjects to inform them about how their data is being used, their right to have their personal data erased, and what measures the company has put in place to protect their personal information.

For Public Authorities/Bodies the designation of a DPO is mandatory according to the General Data Protection Regulation.

5 Green Public Procurement

5.1 Defining Green Public Procurement (GPP)

According to the common European definition of Green Public Procurement (GPP) included inthe Communication from the European Commission COM (2008) "Public procurement for a better environment":

> *"Green Public Procurement is a process through which public and semipublic authorities decide to purchase products, services, works and contracts in special sectors (water, energy, transport, postal services) with a reduced environmental impact during their life cycle compared with products, services works and contracts in special sectors with the same basic utility as if they had been purchased in another way".*

Procuringgreen means using renewable raw materials and energy sources,reducing the use of natural resource and waste production, andavoidingthe use of hazardous chemicals. GPP also contributes to the promotion of green economy and stimulation of eco-innovation and resource efficient public services. At the same time, it improves the quality of life of citizens, while ensuring the protection of environmental heritage.

Despite its significant importance, GPP is a ***voluntary*** instrument in European Union, viz. Member States and public authorities may decide on the scope with which they introduce it.

What is important to be said is that public authorities are currently the largest consumers in Europe, with annual expenditure of approximately 1.8 trillion euro annually, representing around 14% of the European gross domestic product. Thus, if these authorities use their purchasing power to choose goods and services with a low environmental impact, they can make an important contribution to sustainable production and consumption. More specifically, they can significantly contribute to the adoption of new sustainable consumption and production patterns and the promotion of regional green growth GPP, i.e. by applying new environmental criteria in tenders.It can help stimulate a critical mass of demand for more sustainable goods and services which otherwise would be difficult to get onto the market. GPP is therefore a strong stimulus for eco-innovation. By the same token GPP has an influence on the market, as it provides incentives for industry to develop green technologies and products. In some sectors such as public transport, construction, health services and education, the public purchasers dominate a large part of the market, and their decisions therefore have a major impact.

Some examples of green contracts of the public sectors would be:
- ➤ Energy efficient IT equipment
- ➤ Electronic and electrical equipment supplies
- ➤ Office furniture made from sustainable timber
- ➤ Sustainable construction works
- ➤ Recycled paper
- ➤ Low energy consumption buildings
- ➤ Electric vehicles, with low consumption and low emissions
- ➤ Cleaning services using environmentally friendly cleaning products

GPP would also enable public authorities to make cost savings, particularly if we consider all life cycle costs of the contract and not only the purchasing price. The purchase of products that save energy or water, for example, could significantly help reduce the cost of basic services and utility bills. The reduction of hazardous substances in products purchased could reduce the disposal costs. Authorities that apply GPP are better equipped to respond to the evolution of environmental problems and to comply with political and binding objectives such as reducing CO_2 emissions, energy efficiency and those corresponding to other environmental policies.

In the framework of GPP, helpful tools and techniques have been developed and are available to help contracting authorities identify environmentally preferable bids. Such tools are life-cycle costing (LCC), specification of sustainable production processes and use of environmental award criteria. Authorities who implement GPP will be better equipped to meet evolving environmental challenges, for example to reduce greenhouse gas emissions or move towards a more circular economy. With GPP, procurement services can:
- ✓ reduce their energy and environmental footprint, contributing to tackling climate change
- ✓ reduce the environmental impact
- ✓ contribute to the eco-friendly use of natural resources
- ✓ promote innovation and competitiveness
- ✓ act as an example for the private sector
- ✓ save public resources, taking into account LCC costs

While GPP seems to be a very effective measure towards eco-innovation and environmental protection, many regions hesitate to implement it. The fact is that, in order to be effective, GPP requires the inclusion of clear and verifiable environmental criteria for products and services in the public procurement process. To facilitate the inclusion of green requirements in public tender documents, the European Commission has developed **EU GPP criteria**. Currently the EU GPP criteria have been developed for 19 sectors (see Table 5), while European Commission keeps updating them by adding new criteria and establishing new categories.

"The EU GPP criteria are based on data from an evidence base, on existing ecolabel criteria and on information collected from stakeholders of industry, civil society and Member States. The evidence base uses available scientific information and data, adopts a life-cycle approach and engages stakeholders who meet to discuss issues and develop consensus."

Also a number of EU countries provide guidance in this area, in the form of national GPP criteria. The challenge of furthering take-up by more public sector bodies so that GPP becomes common practice still remains. As does the challenge of ensuring that green purchasing requirements are somewhatcompatible between Member States - thus helping create a level playing field that will accelerate the single market for environmentally goods and services.

Table 5 – *Sectors of EU GPP criteria*

Sector	Date of publish
Cleaning products and services	2018
Computer and monitors	2016
Copying and graphic paper	2008
Electrical and Electronic Equipment used in the Health Care Sector	2014
Electricity	2012
Food Catering services and vending machines	2019
Furniture	2017
Public Space Maintenance	2019
Imaging Equipment	2014
Office Building Design, Construction and Management	2016
Paints, varnishes and road markings	2018
Road Design, Construction and Maintenance	2016

Sanitary Tapware	2013
Road lighting and traffic signals	2018
Textiles	2017
Toilets and Urinals	2013
Road Transport	2019
Waste Water Infrastructure	2013
Water-based Heaters	2014

5.2 GPP in Smart Cities

The benefits associated with GPP are not limited to environmental impact, but can include everything from social and health to economic and political benefits. In this sense, GPP is totally aligned with the idea of Smart Cities and can contribute to the achievement of Smart Cities goals. During last years, ***technological developments and digitalization*** has been introduced in GPP procedures; thus leading to the electronic GPP (e-GPP). Further, in the framework of Smart Cities, two ***innovative*** types of procurement procedures have been established, Public Procurement of Innovative solutions (PPI) and Pre-Commercial Procurement (PCP).
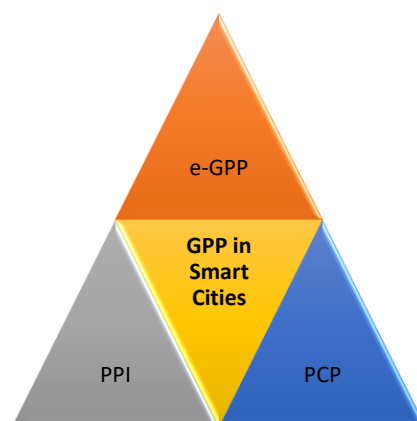
Figure 11 –Different procurement types aligned with the Smart Cities idea

5.2.1 Electronic GPP (e-GPP)

Electronic GPP (e-GPP) involves performing green public procurement using electronic means, from theannouncement (electronic notification), followed by online publication of all documentation (electronic access to the bid documents) and through to submission by bidders of their bids to the public purchasers (the adjudicating powers).

The definition of e-procurement given in the Green paper on expanding the use of e-procurement in the EU (COM (2010) 571 final) is as follows:

"*E-procurement is a catch-all term for the replacement of paper-based procedures with ICT based communications and processing throughout the procurement chain. The procurement involves the introduction of electronic processes to support the different phases of the procurement process - publication of tender notices, provision of tender documents, submission of tenders, evaluation, award, ordering, invoicing and payment. Processes linked to invoicing and payment (post-award) are not procurement-specific and solutions developed for the wider market can be put to work in e-procurement. Some aspects of procurement activity will continue to require non-automated handling. For example, certain phases of complex procurements (designs, works) may be difficult to reduce to standardized formats and may require human intervention. Nevertheless, there is potential for large parts of procurement activity to be shifted to an electronic basis.*"

5.2.2 Public Procurement of Innovative solutions (PPI)

Public Procurement of Innovative solutions (PPI)facilitates wide diffusion of innovative solutions on the market. PPI provides a large enough demand to incentivize industry to invest in wide commercialization to bring innovative solutions to the market with the quality and price neededfor mass market deployment. This enables the public sector to modernize public services with better value for money solutions and provides growth opportunities for companies.

According to European Commission "*PPI happens when the public sector uses its purchasing power to act as early adopter of innovative solutions which are not yet available on large scale commercial basis.*"

As a result, PPI creates a strong and stable demand for innovative solutions through government procurement; modernizes public services with higher quality and more cost efficient solutions; and boosts a particular new market for innovative solutions, helping innovative companies reach economies of scale to grow their business.

PPI is thus complementary with Pre-Commercial Procurement (PCP), as PPI can enable larger scale deployment of solutions that were developed in small quantity in a preceding PCP. PPI can also be

used independently, to bring to the market innovative solutions that do not result from R&D but for example from organizational or process innovation.

5.2.3 Pre-Commercial Procurement (PCP)

Pre-Commercial Procurement (PCP) challenges industry from the demand side to develop innovative solutions for public sector needs and it provides a first customer reference that enables companies to create competitive advantage on the market. PCP enables public procurers to compare alternative potential solution approaches and filter out the best possible solutions that the market can deliver to address the public need.

Public procurers can drive innovation from the demand side by acting as technologically demanding customers that buy the development and testing of new solutions. This enables European public authorities to modernize public services faster and to create opportunities for companies in Europe to take international leadership in new markets. Creating a strong European market for innovative products and services is an important step towards creating growth and jobs in quickly evolving markets such asICT.

According to European Commission "*Pre-Commercial Procurement(PCP)is an approach to public procurement of research and development (R&D) services that is outlined in the PCP communication and associated staff working document. It is an important tool to stimulate innovation as it enables the public sector to steer the development of new solutions directly towards its needs.*"

5.3 Benefits of GPP

The benefits of GPP are not only related to the environment, but also to societal, economic and political aspects.Below the benefits are presented categorized:

➢ **Environmental benefits**

GPP helps public authorities to reach environmental objectives

- GPP can be seen as an instrument focused on solving environmental problems such as deforestation (the purchase of furniture made of wood from sustainable forests), emissions of greenhouse gases (purchase of products with a low carbon footprint), pollution of soils, air and water (restricting the use of toxic substances), the generation of waste (fostering recycling and specifying processes for the packaging of products), high energy consumption (purchase of energy-efficient products), sustainable agriculture (purchase of organic food).

GPP sets an example to private consumers

- By introducing green purchasing policies and reporting their initiatives and the findings obtained, public sector demonstrates that operating in this area is possible and that positive results are also obtained, which encourages the private sector to adopt green criteria in their purchases.

GPP raises awareness of environmental issues

- GPP can act as a useful channel for raising environmental awareness by identifying the environmental impacts of a particular product/service throughout its life-cycle and providing information on the benefits of greener alternatives.

➢ **Economic benefits**

GPP saves money and resources when life-cycle costs are considered

- GPP often leads to savings over the whole life-cycle of a purchase- both for public authorities and for society in general.

Project co-financed by the European Regional Development Fund

GPP incentitives industry to innovate

- Promoting green procurement gives important incentives for industry to develop 'green' technologies and products and promote them in the market place. In particular, SMEs may profit from environmental procurement, as it offers an opportunity to find markets for their innovative solutions and products.

GPP can reduce prices for environmental technologies

- Introducing 'green' tendering criteria can influence the marketplace and result in new entrants in the field of environmental technologies and products - potentially resulting in increased competition and reduced prices.

➢ **Social/health benefits**

GPP improves quality of life

- Policies on GPP can improve services to the public and thus enhance quality of life. Cleaner public transport, for example, improves air quality. Reduced use of toxic chemicals in cleaning products provides a healthier working environment.

GPP establishes environmental standards for products and services

- GPP leads to the creation of high quality standards. New products that have been developed to comply with green procurement requirements will become popular in the private sector, leading to an across-the-board improvement in production standards.

Project co-financed by the European Regional Development Fund

➢ **Political benefits**
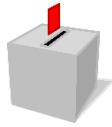
> **GPP demonstrates the commitment by the public sector to protecting the environment and to sustainable consumption and production**

- It shows the public that environmental protection is one of the priorities of the administration or the government in charge, thus improving society's perception of these.

5.4   Benefits of e-GPP

e-GPP has additional benefits as presented below:

1. *Reduction of waste generation*

2. *Simplification of the procurement process leading to improved efficiency and cost savings:* The European Commission has declared that the use of electronic means by purchasing departments enables centralization of the costliest administrative tasks of procurement, yet simultaneously the most routine and repetitive, thus achieving economies of scale from public procurement. Similarly, through these types of platforms, bidders (in particular SMEs) have a communication and management tool with Public Administrations that allows the automation of processes and reduction of costs associated to each process of public procurement, thus increasing competitiveness of SMEs.

3. *Improved transparency and accessibility*:

   E-procurement can help companies have better access to public procurement thanks to the automation and centralisation of the flow of information about specific bidding opportunities. The search for these opportunities online is performed quicker and at a lower cost than analyzing different publications. The procurement systems can usually be configured to alert bidders about specific opportunities and provide immediate access to bid documentation. There is also greater transparency, as the procurement process is more open, better documented and subject to greater dissemination.

4. ***Improved cohesion and integration of European Union markets:***

One of the EU's main objectives is to create a pan-European e-procurement market that enables allEuropean Union Public Administrations and providers to have a central platform that makes itpossible to access information on all public procurement processes within the European Union.The possibility of centralized access to the entire European public procurement market increasesthe possibilities of businesses being able to grow and to become internationalized, in particularthe SMEs, thus increasing national exports.To achieve this goal, the European Union set up the project PEPPOL "Pan-European PublicProcurement Online" midway through 2008, a project targeted at making progress in achieving acentralized platform for EU public procurement online. PEPPOL is not an e-procurement platform, but it provides technical specifications that can beimplemented in the existing e-procurement solutions to make them operable throughoutEurope.

5.5   The Challenges

Lack of political support:
According to the "Green Public Procurement in Europe 2006" report, a high percentage of public authorities say they lack political support, identified as a barrier when it comes to introducing green procurement. This shows that senior management in the public sector is not particularly concerned about green procurement, or at least does not make this explicit to those responsible for public procurement.

Ecological products are perceived as more expensive:
One major goal is to change the behavior of purchasing departments when it comes to deciding between bids. Considering only the initial cost of the product instead of the overall life cycle often affectsthe decision of purchasing green products or not. Even though introducing environmental criteria into public procurement may represent an increase to the initial cost, this is offset by the lower costs associated to operation and maintenance. A study conducted in 2008, "Collection of Statistical Information on Green Public Procurement in the EU" revealed that, in general, GPP not only does not increase costs but in fact reduces them.

Lack of legal experience at applying environmental criteria:
Many purchasers within public authorities do not and should not be expected to know all the environmental and social impacts of purchasing particular products or services.In some cases purchasers still struggle to define what an "environmentally preferable product or service" actually is, and how to include appropriate criteria to identify these in the bidding process.The

ability to accurately assess and verify information submitted by tenderers in response to environmental criteria is also a challenge.

Lack of tools and training:
Systematic information about the available tools and training will be required both for procurers, who need to know about the legal and technical aspects of the GPP, as well as for end users, who need to know how to use sustainable products.

Established environmental criteria are limited for products and services:
For many products and services, the public authorities have no access to clear criteria that enables environmental considerations to be included in their bidding procedures. Furthermore, they also complain about the requirements of the Public Procurement Directives.

Lack of cooperation between authorities:
Most public authorities operate independently, meaning that there is still a lack of systematic implementation of GPP in Europe. The lack of an exchange of good practices and introduction of networks between authorities has been identified as a barrier for better implementation of the GPP.

The need for systematic implementation and integration in management systems:
Decentralized organisations need efficient management systems to guarantee proper application of social and environmental initiatives. The joint purchase is a mechanism that can help solve obstacles of this kind.

5.6 EU Legal Framework of GPP

In 2004, the Council and the European Parliament adopted two directives targeted at clarifying, simplifying and modernizing European legislation on public procurement. The current directives are the following:

- *Directive 2004/17/EC* of 31 March 2004 on coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors.

- *Directive 2004/18/EC* of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.

In contrast to the previous directives concerning public procurement, these directives contain specific references on the possibility of including green criteria in the procurement process. In

December 2011, the Commission proposed a review of the previous directives as well as the take-up of a concession contract directive. The directives were subject to a vote by Parliament on 15 January 2014 and were adopted by the Council on 11 February 2014. Member states have until April 2016 to transpose the new standards into their state legislation (except with regard to e-procurement, where they have until September 2018). The new directives are:

- *Directive 2014/24/EU* of the European Parliament and of the Council of 26 February 2014, on public procurement and repealing Directive 2004/18/EC.

- *Directive 2014/25/EU* of the European Parliament and of the Council of 26 February 2014, on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC.

- *Directive 2014/23/EU* of the European Parliament and of the Council of 26 February 2014, on the award of concession contracts.

In addition to the European directives on public procurement and national legislations on procurement, all Public Administrations must respect the principles of the European Union Treaty, which are: the free movement of goods principle; freedom to provide services principal; non-discrimination principle; fair and equitative treatment principle; proportionality principle; and transparency principle. On the international level, the EU is subject to compliance with the Public Procurement Agreement (PPA) of the World Trade Organisation (WTO)

5.7   Good Practices

In this chapter, good practices on GPP in the sector of Public Buildings and Outdoor Lighting are presented. Good practices are of high importance since they can be transferred and replicated by other Public Authorities that aim to implement GPP in their territories valorizing the lessons learnt and the experience gained.

5.7.1   GPP in Buildings

1. **A low carbon, circular economy approach to concrete procurement, City of Zurich (Switzerland)**

The City of Zurich is the largest city in Switzerland, with 430,000 inhabitants and a public procurement budget of over €1.8 billion. It spends around €370 million (420 million CHF) per year on new public buildings, and around 15-25% (€55-90 million per year) of this cost is related to structural work, including the building's concrete structure and shell.Recycled materials can

replace a portion of one of concrete's main ingredients – aggregate (typically composed of gravel, crushed rocks and sand). The inclusion of recycled aggregates helps close some of the material loops related to concrete, making it more circular, and for over 15 years, the City of Zurich has strived to use as much recycled concrete aggregate as possible in its public building projects. In 2002, Zurich's first public building built with recycled concrete – the "Im Birch" school – was completed. The final building contained 80% recycled concrete and cost €78 million (€11 million of which was structural work).Due to the success of this pilot, in 2005 it became mandatory that all public buildings should be built with recycled concrete in line with SN EN 206:2013 and SIA 2030 standards, meaning that concrete products must contain at least 25% recycled aggregates in total mass.In 2013, Zurich introduced the additional requirement that all concrete used in building construction works procured by the city meet the CEM III/B cement standard.

Results and lessons learnt

"Recycled concrete is now used in public building projects whenever technically feasible, including exposed concrete elements and watertight basement systems. In some buildings, 98% of concrete used, comes from recycled sources."

Zurich's approach to concrete procurement over the last 15 years proves it is possible to build with recycled, CO_2reduced concrete in a way which is safe, inexpensive, and which has no drawbacks from an aesthetic point of view. In some buildings, as much as 98% of concrete used, comes from recycled sources. Between 2005 and 2018, an average 18,400 m^{3}of concrete per year is used in public building projects, of which 90% (or 17,000m^3) is made from recycled aggregate. A sample of the buildings built over this period demonstrate the stretching ambition of Zurich's approach:*The Werdwies housing complex*; *The Leutschenbach school*; *The Triemli city hospital*; *The Kronenwiese housing complex*.

Around 17,000m^{3}of virgin materials (and landfill space) has been saved by Zurich's approach to recycling concrete in buildings alone. In addition, the use of CEM III/B has improved the lifetime energy consumption of concrete by approximately 5%. On the one hand, dismantling and processing of demolition waste requires less embodied energythan mining virgin gravel in quarries. On the other hand, recycled concrete requires more cement, and dependingon the circumstances, must be transported further. For this reason, the use of recycled concrete only makes sense from an energy perspective when it is available from within a 25 km radius of the construction site – which is the case throughout the greater Zurich area using CEM III/B also reduces greenhouse gas emissions per cubic meter by around 25%.

In terms of cost, recycled concrete is around the same price or slightly cheaper than virgin concrete. Costs which are saved on the reduced requirement for virgin sand and gravel are balanced against slightly higher costs related to the higher consumption of energy required during the cracking and production process of recycled concrete.

In Zurich's case, supply follows demand, and since requiring recycled concrete in its public buildings, more and more suppliers have invested in production capabilities to meet these demands, and starting from one supplier, there are now eight to ten suppliers in the area of Zurich offering recycled concrete.

2. Energy Efficient Data Centre, City of Vienna (Austria)

The City of Vienna recognised that the existence of many, small data centres spread across Vienna, used by the City administration, were proving economically and ecologically inefficient and expensive to run. With the goal of bundling staff, resources and infrastructure into a single location, the City of Vienna decided to launch a tender for a larger Data Centre, which would house all of the servers needed by the City administration and that would include the offices of Vienna's ICT Department.Instead of choosing a design and build procedure, the design of the Data Centre was conducted by a planning team designated by the city administration and detailed technical specifications were developed. Following the principles of the Ökokauf Wien Programme, the aim was to build a highly energy-efficient building to house the Data Centre and several city council offices, which would have a lower impact on the environment. For this purpose, the building was designed with an innovative cooling/heating system and the use of energy-saving workplace technologies and products were encouraged.

Results and lessons learnt

"The replacement of numerous small data centres with a centralised green, Data Centre, has allowed the City of Vienna to reduce the carbon emissions of the work places by 100 tonnes a year, and thus reduced its energy consumption by 40%. A further 1,000 tonnes of CO_2 have been saved so far through the consolidation, virtualisation, and concentration of all central ICT resources."

Following a year-long planning phase, the tender was published in April 2011. The construction phase began in February 2012 and the Data Centre was finished by May 2013. The building comprises of nine levels which cover a total ground area of 14,500m². The two lowest levels of the building are dedicated to the Data Centre. These levels are located at a depth of -12m, with the ground water level beginning at -3.5m. The cool ground water provides the data centre,

and the officelevels above, with a free, natural cooling system, while the heat produced by the servers provides the above offices with free heating. In the warmer seasons, the use of innovative technologies in the cooling system makes it possible to use external air and to provide "free cooling".Additional energy savings have been made by using energy-saving workplace technologies and products. Furthermore, thin clients and virtual servers were pushed to their maximum capacity and a follow-me multifunctional printer concept was introduced, which allowed a reduction from 350 different type of printers to ten; which further reduced costs and energy use. The Data Centre was the first in Austria to receive five stars (Star audit 3.0) from the Eco Association of the German Internet Industry (eco Verband deutscher Internetwirtschaft), as well as an additional green star for energy efficiency. After two years of operation, the Star Audit certification was achieved again with 979.5 of possible 1,000 points.

Instead of choosing a design and build procedure, separating the design phase from the construction procurement proved to be the right choice for constructing the Data Centre. The coordination between the design team and the construction team required more time and resources than a traditional design and build procedure, but it lead to very good results. In addition, investing enough time and resources during the design phase, lead to a smooth construction phase, which was finalised on time and achieved the desired quality standards.

3. **GPP indoor lighting in University of Patras, City of Patras (Greece)**

The existent lighting bulbs used in the Cultural Center and the Polytechnic Amphitheater of the University of Patras were energy-intensive, demanding a high maintenance and replacement cost and offering a relatively short lifetime. As a result, it was deemed necessary to adopt a practice that would provide beneficial results for the sustainability of the environment, targeted at increasing energy efficiency, reducing energy consumptions, decreasing the outgoing emissions and protecting the environment.

By replacing the conventional lighting bulbs with cost-effective and economical special fixtures and lamps that use LED technology, these goals can be achieved. Thus, two tenders were procured (one for the Cultural Center and one for the Polytechnic Amphitheater). The contracts were awarded on the basis of the lowest compliant offer. The contractors were required to fully restore any damages caused during the supply phase to the facilities at no extra cost. They were also obliged to remove waste materials without any additional compensation and to deliver clean and ready to use building facilities. Furthermore, a five year at least guarantee was set.

Results and lessons learnt

Both tenders were successful and the contracts with the suppliers were signed in November 2016. The implemented lighting fixtures and LED lamps have been efficiently operating ever since. The success of the inclusion of GPP criteria for tenders as stated above resulted in the University's decision to hold a new tender to upgrade the outdoor street lighting and ambient lighting network at the University' premises with LED lamps and luminaires. This contract is currently in the installation stage.

"The proposed GPP practice is easily transferable to other organisations and has a big potential for transfer and learning."

Needs addressed are common among sectors, organisations and different regions/countries. The organizational resistance risk is predicted to be extremely low, due to the vast majority of benefits offered by this best practice and the very common need of indoor lighting in universities.

4. **GPP internal lighting for the Greek Central Government, Athens (Greece)**

The majority of the buildings used by the Greek Central Government are old and in order to cover their needs they consume high amounts of energy every year. The existent lighting bulbs used in most of them are energy-intensive, have short lifetime and demand a high maintenance, replacement and disposal cost. Thus, in the framework of GRASPINNO project, which was funded by the Interreg MED Programme, the General Secretariat of Commerce and Consumer Protection (GSCCP) of the Greek Ministry of Economy and Development prepared and published a green tender for indoor lighting. More specifically, GSCCP published a Framework Agreement for replacement of the existing internal lighting with new energy efficient ones in terms of the general scope of green public procurement policy (all waste lamps shall be separated and sent for recycling).

For the preparation of the green tender the GRASPINNO Unified Platform was used as a supportive tool. The GRASPINNO Unified Platform includes three different tools: GRASPINNO Database, e-GPP support tool and LCC Calculating tool. During the preparation of the green tender, procurers consult the GRASPINNO Database in order to identify the green products and

services that are available in the market before defining the green criteria. Furthermore, the e-GPP tool supported them during the development of the tender documents including strict green characteristics.

Results and lessons learnt

The tender was published in EU Official Journal on 29.3.2017 and the award criterion was the lowest price, since strict green criteria were already included in the technical specifications. The procurement procedure of the framework agreement is completed. The substitution process has slowly begun and it will be valid till the beginning of 2020. The estimated electricity consumption decrease is 65.8 kW /h. Considering that LED lamps will be in use during the working days and hours of the year, which are 260 days for 10 hours a day, the annual electrical power, which is needed for the internal lighting of the building of the Ministry of Economy and Development on Kaniggos Square in Athens, will decrease by 171080 kW.

"Unpredicted factors, such as bidders' appeals can cause delays and change suddenly the time plan, not only of the whole procurement procedure, but also of the activities that involve the installation of the procured products/services."

The time planning of a procurement procedure has to be done taking into consideration unexpected parameters. The people in charge should not plan based only on the time period of each phase of the procurement procedure, as these periods are described by the national legislation. On the contrary, extended time periods should be taken into account, so as to ensure the successful results of the procurement procedure.

5.7.2   GPP in Outdoor Lighting

1.   **Purchasing energy efficient street lighting, City of Rotterdam (the Netherlands)**

The City of Rotterdam is the second largest city in the Netherlands and has a population of approximately 610,000 people.Each night, approximately 106,500 light sources illuminate the City of Rotterdam's roads, cycle paths, pavements and shopping areas. In the past, maintaining these light sources required the replacement of approximately 4,000 light fixtures at the end of their life cycle each year. Also, as there was little or no consistency as regards the types of light fixtures and lamps installed, carrying out maintenance and repair work was expensive and time consuming. Therefore, the City of Rotterdam published a tender in 2012 for the purchase of standard lighting

fixtures for the whole city for the period 2013 to 2020. The form of the tender was an e-auction in three lots, with one framework agreement for each lot. The City wanted to ensure that sustainability was considered in all aspects of the production process, i.e. from the sourcing of raw materials to the end of the products life, and therefore requested that the light fixtures contain recycled materials and be recyclable at the end of their product life.

Results and lessons learnt

After the registration and evaluation of the delivered documents and samples, six suppliers were admitted to the e-auction. The result of this tendering procedure with an e-auction was that contracts were concluded with two suppliers (one supplierwon two lots). The prices of the LED fixtures were almost the same as previously paid for conventional light fittings, with the advantage of providing optimum performance in the field of lighting, energy consumption and social return. Energy savings will depend on the deployment of the fixtures across the city, with priority given to replacing existing sodium fixtures with higher energy consumption where the savings can be up to 35%. Depending on the use of the fixtures and deployment, the contract value will be between 8-10 million euros.By changing to LED over the course of the framework agreement, the City of Rotterdam hopes to reduce its energy consumption. From 2012 (the baseline year before the framework agreement began) to 2015, the energy consumption from street lighting reduced from 25.6 million kWh per year (2012 baseline figure) to 23.2 million kWh per year, resulting in a cumulative saving of 1,262 tonnes of CO_2emissions in the period.

> *"The tender's preparation requires a lot of time. The expertise and knowledge of needs lies within the relevant city departments, so you have to allow sufficient time to collect this knowledge and transfer it into a quality tender. This includes consideration of specification, models of delivery and the use of external experts."*

2. **Procurement of energy efficient street lighting, Municipality of Župa Dubrovačka (Croatia)**

The Municipality of Župa Dubrovnik is situated in the county of Dubrovnik-Neretva in the south-east of Croatia. In September 2014, the Municipality introduced a Sustainable Energy Action Plan (SEAP) which was established as part of the Covenant of Mayors initiative. The SEAP provides the Municipality with stronger leverage when they wish to implement a green public procurement (GPP) procedure.The Municipality of Župa Dubrovačka recognised the need to improve the quality of street lighting in the Municipality and wished to do so by installing a fixed lighting installation which would achieve that goal and thereby improve public safety, traffic safety and traffic flow at night. The Municipality decided to publish an open tender which would include the replacement of

the existing street light fixtures and high pressure mercury lamps, with a new and more sustainable solution. Župa Dubrovnik decided for the first time to carry out a GPP procedure, as they wished to ensure that the final solution would emit less light pollution and cause less greenhouse gas emissions than the previous system. In May 2014 an open tender was published, the total value of which was estimated at 180,000 euro (excluding VAT).

Results and lessons learnt

By changing to an LED lighting solution, the Municipality was able to significantly reduce its energy consumption in comparison to the previous street lighting system, where high pressure mercury lamps were used. The Municipality calculated the energy and CO_2 emissions saved using the GPP 2020 methodology with an assumed lifetime of 25 years. The new LED lighting solution consumes 210,000 kWh per year and emits 64 tonnes of CO_2 per year.

> *"In comparison to the previous system, which was consuming 330,000 kWh and emitting an average of 100 tonnes of CO_2 a year, the new LED lighting solution has reduced the CO_2 emissions by 36%, saving the equivalent of 900 tonnes of CO_2 over a 25-years period."*

Financially, the new LED lighting solution is saving the Municipality approximately 13,800 euro a year at today's energy price. This figure does not include the savings made from the reduced need to service light fixtures. The new solution is programmed so that the lamps do not switch on until visibility reaches the minimum illumination level for street lightning required by law in Croatia. Furthermore, the new solution reduces the power (wattage) and energy consumption in accordance with the intensity of natural lighting by an automatic controller regulation which is installed in the system. Also, the installation of warm white lamps and the requirement of a CRI > 75 reduced the amount of light pollution created. Bychanging to LED lamps, the Municipality of Župa Dubrovačka reduced air, land and water pollution which is caused by the use of hazardous mercury.

6   EUCohesion Policy Framework

Article 174 of the Treaty on the Functioning of the European Union (TFEU) stipulates that the EU aims to strengthen economic, social and territorial cohesion by reducing regional disparities, with particular attention paid to the least favoured regions and areas with special territorial features. EU cohesion policy helps to address these challenges via the European Regional Development Fund, Cohesion Fund and the European Social Fund. Cohesion policy funding amounts to €351.8 billion in the years 2014-2020, i.e. almost a third of the total EU budget.

6.1   The current cohesion policy framework

The current cohesion policy framework is established for a period of seven years (2014-2020) on the basis of the Common Provisions Regulation1 of 2013, covering the three cohesion policy funds (ERDF, ESF and CF), as well as the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund. These five funds together are called European structural and investment funds – ESI funds – in the current period.

While the Common Provisions Regulation of 2013 sets out the general rules for ERDF and CF, the specific rules are covered by two separate regulations on each of the funds: the ERDF Regulation (Regulation (EU) No 1301/2013 of the European Parliament and of the Council of 17 December 2013 on the European Regional Development Fund and on specific provisions concerning investment for the growth and jobs goal, and repealing Regulation (EC) No 1080/2006), and the Cohesion Fund Regulation (Council Regulation (EU) No 1300/2013 of 17 December 2013 on the Cohesion Fund and repealing Council Regulation (EC) No 1084/2006).

The current framework focuses on investments towards 11 thematic objectives:

1) Research, technological development and innovation;

2) Information and communication technologies (ICT);

3) Small and medium-sized enterprises (SMEs);

4) Low-carbon economy;

5) Climate change;

6) Environment and resource efficiency;

7) Transport;

8) Employment;

9) Social inclusion and poverty;

10) Education and training;

11) Efficient public administration.

6.1.1 European Regional Development Fund

The ERDF (which has existed since 1975) provides funding for all EU regions, categorised into less developed, transition and more developed regions, on the basis of their GDP per capita (less developed regions: GDP/head <75 % of the EU-27 average; transition regions: GDP/head between 75 % and 90 %; more developed regions GDP/head>90 %). The less developed regions receive the highest percentage of funding.

While the ERDF supports all of the current 11 thematic objectives, its main focus are objectives 1-4, i.e. research and innovation, ICT, SMEs and the low-carbon economy. This means that most resources are concentrated on smart growth and environmental measures. In the more developed regions, at least 80 % of ERDF resources at national level must be allocated to two or more of these four objectives and at least 20 % to the low-carbon objective. In the case of transition regions, these proportions are 60 % and 15 %, respectively, and for the less developed regions 50 % and 12 %. Moreover, a minimum of 5 % of the ERDF resources must be allocated at national level to sustainable urban development. As far as details of the investments are concerned, the current ERDF Regulation lists a high number of investment priorities within these thematic objectives.

6.1.2 Cohesion Fund

Since 1994 the Cohesion Fund has supported environmental and transport infrastructure projects in EU Member States with gross national income (GNI) per capita below 90 % of the EU average. In the 2014-2020 period, these 'cohesion countries' are the EU-13 (Member States that have joined the EU since 2004), as well as Greece and Portugal. The Cohesion Fund mainly finances investments in environmental and transport infrastructure projects, contributing to thematic objectives 4-7: 4) Low-carbon economy; 5) Climate change; 6) Environment and resource

efficiency; 7) Transport). As the CF includes a technical assistance component it also contributes to thematic objective; 11) Efficient public administration. The CF covers a relatively long list of investment priorities, mainly in the field of transport, energy and environment.

6.2   The 2021-2027 cohesion policy framework changes

The new regulation on the ERDF and CF outlines the specific policy objectives to be supported by the ERDF and CF (among the five policy objectives established inthe CPR proposal). The regulation also specifies the thematic concentration of ERDF support (i.e. percentages allocations for certain objectives required for the three different groups of regions). In addition, it gives detailed guidance on the scope of support from ERDF and CF, specifying the types of   investments to be supported and excluded. It lays down the common output and result indicators to track progress and performance. The regulation also contains provisions on the treatment of territories with particular territorial features, such as urban areas and the outermost regions. The organisation of the new ERDFand CF regulation is   the two previous separate regulations on ERDF and CF. The main difference is the extension of non-eligible activities, introduction of common result indicators3 (only common output indicators existed in the previous period, while the result indicators were programme-specific), and the disappearance of separate articles on areas with natural or demographic handicaps and the northernmost regions with very low population density. There is also a slight shift as regards the content and required earmarked percentages of thematic concentration of ERDF activities (CF continues to support the same two areas as before, i.e. transport and environment).

6.2.1   Thematic concentration

The 11 thematic objectives from 2014-2020 have been reduced to 5 'policy objectives' (POs):

1. a smarter Europe – innovative and smart industrial transformation;

2. a greener, low carbon Europe – clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention;

3. amore connected Europe – mobility and regional ICT connectivity;

4. amore social Europe – implementing the European Pillar of Social Rights;

5. Europe closer to citizens – sustainable and integrated development of urban, rural and coastal areas through local initiatives

6.2.2 European Regional Development Fund (ERDF)

The European Regional Development Fund (ERDF) will support all these policy objectives; however, the majority of ERDF resources will be concentrated on PO1 and PO2 (i.e. smart and green economy).

As regards the details of investments, the ERDF will support:

- investments in infrastructure;

- investments in access to services;

- productive investments in SMEs;

- equipment, software and intangible assets;

- information, communication, studies, networking, cooperation, exchange of experience and activities involving clusters;

- technical assistance.

6.2.3 Cohesion Fund (CF)

The Cohesion Fund (CF) will continue to provide financial support mainly for environmental and transport infrastructure projects in the cohesion countries. Thus, it will support only PO2 (environment) and parts of PO3 (TEN-T and transport mobility).

The CF detailed support will include:

- investments in the environment, including investments related to sustainable development and energy presenting environmental benefits;

- investments in TEN-T;

- technical assistance.

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Both funds are expected to contribute to the EU's overall 25 % commitment to the climate objective.Investments under the whole ERDF financial envelope are expected to contribute 30 % to climate objectives, while this percentage rises to 37 % under the Cohesion Fund.

6.2.4   Sustainable urban development

The regulation increases the focus on sustainable urban development by dedicating 6 % of ERDF resources to this area (5 % in the previous 2014-2020 period). These actions are to be delivered through territorial instruments, such as community-led local development, integrated territorial investments (ITIs) or other tools under PO5 - A Europe closer to citizens.

Moreover, the regulation provides for ERDF support to the European urban initiative to be implemented by the Commission through direct or indirect management.

The initiative aims to cover all urban areas and contribute to the Urban Agenda of the EU. It will consist of three strands supporting sustainable urban development:

- capacity building,
- innovative actions,
- knowledge, policy development and communication.

6.2.5   European territorial cooperation (INTERREG)

INTERREG will continue to be supported by the ERDF. In this context, for regions with matching 'smart specialisation' assets, pan-European clusters will be built in priority sectors under a new interregional instrument aimed at 'helping those involved in smart specialisation strategies (S3) to cluster together, in order to scale up innovation and bring innovative products and processes to the European market'.

6.3   2021-2027 ERDF and CF related Policy Objectives (POs) and Specific Objectives (SOs)

Table 6 - 2021-2027 ERDF and CF related Policy Objectives (POs) and Specific Objectives (SOs)

Policy Objective	Specific Objective	Fund

PO 1	*Smarter Europe - innovative and smart industrial transformation*	**a1**	Strengthen research and innovation capacities and the introduction of advanced technologies	ERDF
		a2	allow citizens, businesses and public administrations to reap the benefits of digitization	ERDF
		a3	strengthen the growth and competitiveness of SMEs	ERDF
		a4	develop skills for smart specialization, industrial transition and entrepreneurship	ERDF
PO 2	*A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention*	**b1**	promoting energy efficiency measures	CF/ERDF
		b2	promoting renewable energies	CF/ERDF
		b3	developing smart energy systems, grids and storage at local level	CF/ERDF
		b4	promoting climate change adaptation, risk prevention and disaster resilience	CF/ERDF
		b5	promoting sustainable water management	CF/ERDF
		b6	promoting the transition to a circular economy	CF/ERDF
		b7	enhancing biodiversity, green infrastructure in the urbanenvironment, and reducing pollution	CF/ERDF
PO 3	*A more connected Europe - mobility and regional ICT connectivity*	**c1**	enhancing digital connectivity	ERDF
		c2	developing a sustainable, climate resilient, intelligent, secure and intermodal TEN-T	CF/ERDF
		c3	developing sustainable, climate resilient, intelligent and intermodal national, regional and local mobility, including improved access to TEN-T and cross-border mobility	CF/ERDF

		c4	promoting sustainable multimodal urban mobility	CF/ERDF
PO 4	*A more social Europe - implementing the European Pillar of Social Rights*			ESF+
PO 5	*Europe closer to citizens - sustainable and integrated development of urban, rural and coastal areas through local initiatives*	e1	promoting integrated social, economic and environmental development, cultural heritage and security in urban areas	ERDF
		e2	promoting social, economic and environmental development integrated at local level, cultural heritage and security, also for rural and coastal areas, inter alia through participatory local development initiatives	ERDF

7   Policy Recommendations - Action Plan

In this chapter, specific policy recommendations are developed, valorizing the knowledge gained through the previous chapters and the pilot results of the ESMARTCITY project. Also, the recommendations of the Interreg MED Green Growth Community- Horizontal project were studied carefully, so that the present recommendations act complementary to those of the community; thus aiming to suggest concrete recommendations for Innovation Policy change.

The policy recommendations are developed for topics addressed by the project, such as Smart Cities, Smart Buildings, Smart Public Lighting, Digitalization, Open Data, Green Procurement and Circular Economy.

It was chosen to present the recommendations using indications about the *recommendation type* and the *policy level* at which they refer to, as well as using *hashtags* of key words related with the thematic topic, as shown below:

Recommendation types:

Strategy:

strategy

Action Plan:

action plan

Funding:

funding

Platform:

platform

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Policy levels:

Local:
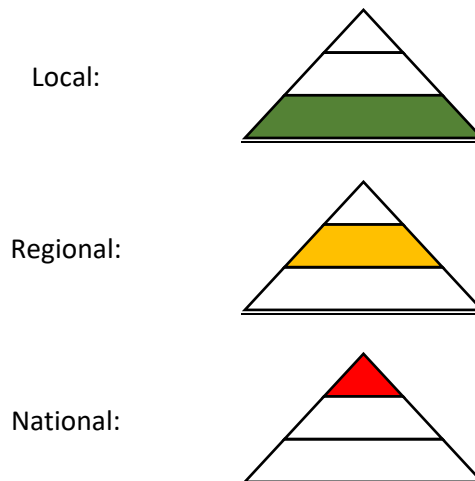
Regional:

National:

Relevance with UN Sustainable Development Goals:

Source: UN in collaboration with Project Everyone

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		#SmartCities
platform Platform	Regional	#OpenData #Governance #Innovation

1. *Open Innovation Platform, a collaborative tool for the implementation of new policy model for regional innovation governance system*

Description

The creation of an Open Innovation Platform by regional public authorities can be a useful tool for them to implement a new policy model for regional innovation governance system. The platform can provide the environment where citizens can play an active role alongside professionals, able to use competences, ideas and solutions in the whole life cycle of the regional research and innovation policy, from the definition of strategic goals to the monitoring and evaluation phase, with a strong focus shift from institutions and organisations to individuals. Members of the platform can be both from the R&I community and from the large public, lending substance to the principle of multi-actor, public engagement. The platform can offer a broad range of tools to inform and engage, promote the competences of local actors, design and manage research and open innovation projects, for the dissemination and valorization of results. In the overall framework of open data, the platforms developed by the Regions could be released under a free, open source license with the specific aim to facilitate its adoption in similar or complementary user scenarios and promote collaboration among interested stakeholders (e.g. other Regions, company networks, clusters, large collaborative projects etc.) and to maximize content sharing and interoperability. The strategic dialog and close cooperation amongst the related stakeholders is crucial for a successful Open Innovation Scheme.

Actors	*Expected results*
public authorities, citizens, researchers, professionals, company networks, clusters, large collaborative projects	Permanent communication channel for all stakeholders to accelerate the innovation process in a quadruple-helix scenario, coordinated by the Regional Government

Connection with 2021-2027 cohesion policy framework

- ✓ The achievement of *PO 1 "Smarter Europe - innovative and smart industrial transformation"* will be reinforced by this ESMARTCITY policy recommendation.

- ✓ The Open Innovation Platform will allow all actors of the quadruple-helix to gain the benefits of digitization; thus reaching *SO-a1* (see Table 6).

- ✓ Calls providing funding opportunities under the *SO-a1* should include the development of collaborative tools for the implementation of new policy model for regional innovation governance system, such as the Open Innovation Platform.

- ✓ Regional public authorities interested in implementing a new policy model for regional innovation governance system and creating the Open Innovation Platform can use the 2021-2027 ERDF dedicated to *SO-a1*.

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| strategy | Strategy | (triangle icon) | Regional | # | #CircularEconomy

#Governance

#CEindicators |

2. *Regional Strategy of Green and Circular Economy, following the EU Action Plan for the Circular Economy – "Closing the loop"*

Description

Circular Economy (CE) has become an issue to be taken into account in many kind of policies, as it is a horizontal topic affecting different governmental departments such as environment, energy, education, culture, employment, health, economy, industry, agriculture.

All European regional governments should develop a *Regional Strategy of Green and Circular Economy* with the aim to align their policies to CE. The Strategy should follow the EU Action Plan for the Circular Economy – "Closing the loop", while *regional CE indicators* should be defined in the framework of the Strategy in order to capture specific CE aspects of each region.

The Strategy should join the existing material and human resources in the region in the search for a greener and more circular society and economy, where natural resources are a permanent source of opportunities for the regional population.The vocation of the strategy should be regional and comprehensive, aiming to bring together all the relevant initiatives in the region. Transferability of the Strategy would be an added value for other regions with similar characteristics and needs.

Actors	*Expected results*
regional governments, researchers, clusters, NGOs, citizens	Alignment of regional policies to Circular Economy

Connection with 2021-2027 cohesion policy framework

- ✓ The achievement of **PO 2 "A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention"** will be reinforced by this ESMARTCITY policy recommendation.

- ✓ The development and implementation of Regional Strategies of Green and Circular Economy will promote the transition to a more circular economy; thus contributing to**SO-b6** (see Table 6).

- ✓ 2021-2027 Regional Operational Plans (ROPs) should be developed in the direction of a Green and Circular Economy on the basis of 2021-2027 cohesion policy framework.

funding	Local	Regional	National	#GreenSmart #PublicBuildings #PublicLighting #OpenData #Innovation

3. *Inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans*

Description

Taking advantage of the technological development and the digital transformation achievements, EU member states and their regions should enhance the investments in Green Smart Public Buildings and Smart Public Lighting. Both public buildings and lighting are two sectors which consume the biggest share of the energy consumed by public sector. Thus, the transition to green and smart solutions is an one-way decision. The existing industry already moves forward with green smart applications, products and services deployed in public buildings and street lighting infrastructure valorizing existing Open Data. Thus having multiplier effect for sustainability and addressing more effectively energy consumption problems. Public authorities at all policy levels should support such efforts by carefully including Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans.

Actors	*Expected results*
National governments, regional governments, local governments, enterprises, business associations, researchers	Greener and SmarterPublic Buildings and Lighting led by Open Data and innovative applications

Connection with 2021-2027 cohesion policy framework

✓ This Policy Recommendation has multiple impact on the 2021-2027 cohesion policy framework contributing to the achievement of

- *PO 1 "Smarter Europe - innovative and smart industrial transformation"*

- *PO 2 "A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention"*

✓ The inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans will clearly

- promote energy efficiency measures, contributing to *SO-b1* (see Table 6)

- enhance the industry of smart-green solutions to develop innovative smart energy systems to be implemented in Public Buildings and Public Lighting, contributing to *SO-b3* (see Table 6); and enhance green infrastructure in the urban environment and pollution reduction, contributing to *SO-b7* (see Table 6)

- support smart specialization, industrial transition and entrepreneurship by providing relevant funds and intensives in the sectors of Green Smart Public Buildings and Smart Public Lighting, contributing to *SO-a4* (see Table 6)

✓ Calls providing funding opportunities under the aforementioned SOs should include the development of Green Smart solutions for Public Buildings and Public Lighting.

✓ Actors interested in Green Smart Public Buildings and Lighting can use the 2021-2027 CF/ERDF dedicated to the aforementioned SOs.

	Strategy		National	#	#Digitization #IsolatedCommunities #LocalPAs #SMEs

4. *National Strategy for supporting local communities with specificities to enter the digital transformation era and face the challenges of technological infrastructure deployment*

Description

Nowadays, technological infrastructure deployment is critical for addressing challenges presented in human communities. However, there is no blueprint for a successful implementation of digital solutions. Different sectors, positions in the global value chain, or sizes of organisations need different approaches. Especially for small local communities with specificities, such as those located in isolated mountain or insular areas, it is difficult to meet the challenges related to the cost and expertise needed for the deployment, the maintenance and the upgrade of such infrastructures. The National Strategy should provide support to both local public authorities and local SMEs in such areas, providing solutions to these issues by offering context-related approaches followed by standardization of solutions so that overall cost decreases and economies of scale are accomplished. The Strategy should define the framework for bringing together researchers, local authorities and SMEs in order to help them proceed on their path of digital transformation, facilitating the mutual learning and exchange of experience.

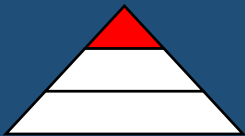| *Actors*	*Expected results*
national government, local public authorities, SMEs	Systematized approach forlocal communities with specificities to enter the digital transformation era.Bridging the gap between areas and support local SMEs.

Connection with 2021-2027 cohesion policy framework

✓ The achievement of *PO 1 "Smarter Europe - innovative and smart industrial transformation"* will be reinforced by this ESMARTCITY policy recommendation.

✓ The development of National Strategies for supporting local communities with specificities to enter the digital transformation era and face the challenges of technological infrastructure deployment leads to the achievement of *SO-a1* and *SO-a2*(see Table 6). The suggested strategies will allow small local communities with specificities, such as those located in isolated mountain or insular areas, to reap the benefits of digitization, while they will promote research and innovation capacities and the introduction of advanced technologies.

✓ Calls providing funding opportunities under the *SO-a1*and *SO-a2*should give emphasis on the transition of local communities with specificities to the new digital era.

✓ Public authorities interested in the topic can use the 2021-2027 ERDF dedicated to *SO-a1*and *SO-a2*.
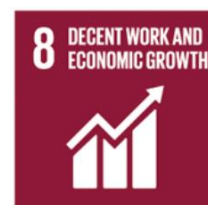
Funding		National	#R&TD #OpenData #Innovative #Green #TechnologyExploitation

5. Mobilising R&TD projects that aim at the creation of new green products and processes with a high knowledge content and innovation

Description

National Governments should mobilise strategic R&TD projects that aim at the creation of innovative green products, processes and services with a high knowledge content and degree of technological innovation, while contributing to environmental sustainability. The projects should be designed to contribute towards their value chain and constitute themselves as focal drivers of capabilities and specific scientific and technological competencies; thus leading to significant impacts at multisectoral level, namely allowing an effective technology exploitation. At national level, funding opportunities should be shaped for researchers and the industry so as to develop such R&TD project ideas. Applicants should set concrete objectives, valorizing existing Open Data and enabling the endogenization of already developed technologies.

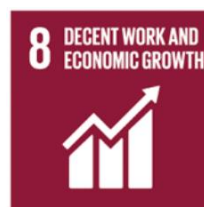| Actors	Expected results
national government, industry, clusters, researchers	Strategic R&TD projectsaimed at creating new green products, processes and services with a strong technology and innovation component

Connection with 2021-2027 cohesion policy framework

- ✓ The achievement of *PO 1 "Smarter Europe - innovative and smart industrial transformation"* will be reinforced by this ESMARTCITY policy recommendation.

- ✓ R&TD projects that create new green products and processes with a high knowledge content and innovation will directly strengthen research and innovation capacities and the introduction of advanced technologies in the market, thus reaching *SO-a1*(see Table 6). Such projects also contribute to the development of skills for smart specialization, industrial transition and entrepreneurship, in line with *SO-a4*(see Table 6).

- ✓ Calls providing funding opportunities under the *SO-a1* and *SO-a4*should prioritize the funding of these kind of projects presented in this Policy Recommendation.

- ✓ Actors interested in developing such projects and ideas can use the 2021-2027 ERDF dedicated to *SO-a1*and *SO-a4*.


Project co-financed by the European Regional Development Fund

Action Plan	Local	Regional	National	#GPP #EUGPPCriteria #compulsory

6. *Compulsory adoption and use of EU GPP criteria from national and regional public authorities*

Description

Public authorities are currently the largest consumers in Europe, with annual expenditure of approximately 1.8 trillion euro annually, representing around 14% of the European gross domestic product. Thus by using their purchasing power to choose goods and services with a low environmental impact, they can make an important contribution to sustainable production and consumption. Some member states have already developed Action Plans for the adoption of the EU GGP criteria at national and regional level and/or have defined minimum environmental criteria. However, the adoption and use of the EU GPP criteria should be defined as *compulsory* when national and regional public authorities procure goods and services. The compulsory use should be defined by national and regional Action Plans, and adjustment based on states' and regions' needs should be taken into account.

Actors	*Expected results*
National public authorities, regional public authorities	National and regional public authorities will implement GPP for their good and services

Connection with 2021-2027 cohesion policy framework

✓ This ESMARTCITY policy recommendation should not be excluded from 2021-2027 cohesion policy framework since the implementation of GPP concretely affects **PO 2 "A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention"**

✓ All public actors involved in CF/ERDF funding should follow and adopt EU GPP criteria in their purchasing procedures.

	Action Plan	Regional	National	#	#LCC #GPP #OpenData

7. *Application ofLife Cycle Cost calculation methods by national and regional public procurers during GPP procedures*

Description

Life Cycle Costing (LCC) is a methodology that can be used to estimate all the costs that will be incurred throughout the lifetime of a product, work or service. By applying LCC, public purchasers can take into account some cost aspects which are not reflected in the purchase price (such as resource use, maintenance and disposal), thus directing their buying decision towards products with increased resource efficiency and longer lifespan, which, in turns, stimulates the offer of innovative and circular solutions on the market.

As a result, national and regional frameworks should be shaped to define the application of LCC calculation methods by national and regional public procurers during GPP procedures. In the national and regional frameworks,existing LCC tools should be suggested (after being evaluated by experts), while legal schemes should force enterprises to disclose relevant information regarding products components.The use of Open Data to feeddatabases with specific item costs would facilitate the application of LCC tools and ensure more precise results.

Actors	*Expected results*
National public authorities, regional public authorities, companies	Use of LCC will lead to increase of procured products and services with low environmental impact

Connection with 2021-2027 cohesion policy framework

- ✓ The achievement of *PO 2 "A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention"* will be reinforced by this ESMARTCITY policy recommendation.

- ✓ The application ofLife Cycle Cost calculation methods by national and regional public procurers during GPP procedures will lead to a more circular economy, thus contributing to the achievement of*SO-b6*(see Table 6).

- ✓ Calls providing funding opportunities under the *SO-b6*is suggested to involve GPP and support the application of LCC tools.

- ✓ All relevant actors can use the 2021-2027 CF/ERDF dedicated to *SO-b6* for being facilitated in using and adopting LCC tools.

Action Plan	Local	Regional	National	#GPP #LCC #CapacityBuilding #training

8. *National Action Plan for training local public authorities in GPP procedures and LCC tools*

Description

Despite the significant environmental benefits of GPP and LCC, most of local public authorities are not yet capable of executing green public procurement and using LCC tools to evaluate the tender's results. This is mainly due to lack of guidance form the higher policy makers, lack of experienced personnel and lack of proper training and educational activities.

To face these challenges, national action plans should be developed including systematized capacity building initiatives for local PAs to improve their knowledge and capacity inGPP and LCC. A short educational programme should be designed for the local PAs, as well as training seminars and workshops. Experts and experienced national/regional public procurers should be involved in the initiatives, transferring their experiences and communicating the difficulties faced and the corresponding solutions.

Actors	*Expected results*
National public authorities, regional public authorities, local public authorities, experts	Increase of local PAs' capacity building in implementing GPP and LCC procedures

Connection with 2021-2027 cohesion policy framework

- ✓ The achievement of *PO 2 "A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy, climate adaptation and risk prevention"* will be reinforced by this ESMARTCITY policy recommendation.

- ✓ The implementation of GPP procedures and the application of LCC tools by local public authorities will lead to a more circular economy, thus contributing to the achievement of *SO-b6*(see Table 6).

- ✓ Calls providing funding opportunities under the *SO-b6* is suggested to involve GPP and support the application of LCC tools.

- ✓ Local public authoritiesinterested in GPP and LCC tools can use the 2021-2027 CF/ERDF dedicated to *SO-b6*.
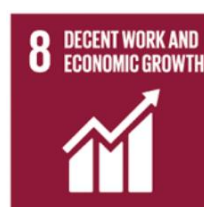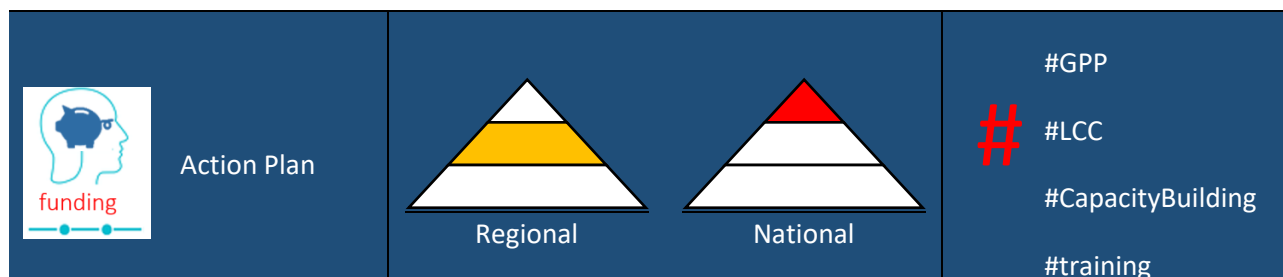
	Action Plan	Regional	National	#GPP #LCC #CapacityBuilding #training

9. Funding the implementation of PPI and PCP through national funding schemes, ROPs and RIS3

Description

Public Procurement of Innovative solutions (PPI) provides a large enough demand to incentivize industry to invest in wide commercialization to bring innovative solutions to the market with the quality and price needed for mass market deployment. Pre-Commercial Procurement (PCP) challenges industry to develop innovative solutions for public sector needs and it provides a first customer reference that enables companies to create competitive advantage on the market. As a result, PPI and PCP enable public procurers to drive innovation from the demand side by acting as technologically demanding customers that buy the development and testing of new solutions; thus covering society's needs with better solutions, while providing growth opportunities for companies.

PPI and PCP procedures are not yet common practice among public authorities, since they demand a lot of effort and time from the side of public procurers. Also the lack of experience worsens the situation. To overcome these difficulties, the implementation of PPI and PCP should be included in national funding schemes, ROPs and RIS3.New taxes incentives for enterprises involved in such procedures would also contribute to the implementation of PPI and PCP.

Actors	*Expected results*
National public authorities, regional public authorities, industry	Increase of public procurers implementing PPI and PCP procedures

Connection with 2021-2027 cohesion policy framework

✓ The achievement of **PO 1 "Smarter Europe - innovative and smart industrial transformation"** will be reinforced by this ESMARTCITY policy recommendation.

✓ The implementation of PPI and PCP through national funding schemes, ROPs and RIS3will

  ▪ strengthen research and innovation capacities and the introduction of advanced technologies,

  ▪ strengthen the growth and competitiveness of SMEs,

  ▪ develop skills for smart specialization, industrial transition and entrepreneurship;

  enhancing the achievement of **SO-a1, a3, a4** (see Table 6).

✓ It is highly recommended that PPI and PCP are included in calls providing funding opportunities under the aforementioned SOs.

✓ Public authorities and industry interested in PPI and PCP can use the 2021-2027 ERDF dedicated to **SO-a1, a3, a4**.

7.1 ESMARTCITY Policy Recommendations in relation to 2021-2027 ERDF/CF Policy Objectives & Specific Objectives

The relation between the ESMARTCITY Policy Recommendations and the 2021-2027 ERDF and CF Policy Objectives and Specific Objectives is presented in the following synoptic table.

Table 7 - ESMARTCITY Policy Recommendations per 2021-2027 ERDF and CF related Policy Objectives & Specific Objectives

2021-2027 ERDF and CF related Policy Objectives and Specific Objectives			Relevant ESMARTCITY Policy Recommendation(s)
Policy Objective (PO)	**Specific Objective (SO)**		
PO 1 *Smarter Europe - innovative and smart industrial transformation*	**a1**	Strengthen research and innovation capacities and the introduction of advanced technologies	**#1** *Open Innovation Platform, a collaborative tool for the implementation of new policy model for regional innovation governance system* **#4** *National Strategy for supporting local communities with specificities to enter the digital transformation era and face the challenges of technological infrastructure deployment* **#5** *Mobilising R&TD projects that aim at the creation of new green products and processes with a high knowledge content and innovation* **#9** *Funding the implementation of PPI and PCP through national funding schemes, ROPs and RIS3*
	a2	allow citizens, businesses and public administrations to reap the benefits of digitization	**#4** *National Strategy for supporting local communities with specificities to enter the digital transformation era and face the challenges of technological infrastructure deployment*

	a3 strengthen the growth and competitiveness of SMEs	**#9** *Funding the implementation of PPI and PCP through national funding schemes, ROPs and RIS3.*	
	a4 develop skills for smart specialization, industrial transition and entrepreneurship	**#3** *Inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans.* **#5** *Mobilising R&TD projects that aim at the creation of new green products and processes with a high knowledge content and innovation* **#9** *Funding the implementation of PPI and PCP through national funding schemes, ROPs and RIS3.*	
PO 2 *A greener, low carbon Europe - clean and fair energy transition, green and blue investment, circular economy,*	**b1** promoting energy efficiency measures	**#3** *Inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans.*	**#6** *Compulsory adoption and use of EU GPP criteria from national and regional public authorities*
	b2 promoting renewable energies		
	b3 developing smart energy systems, grids and storage at local level	**#3** *Inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans.*	

climate adaptation and risk prevention	**b4**	promoting climate change adaptation, risk prevention and disaster resilience	
	b5	promoting sustainable water management	
	b6	promoting the transition to a circular economy	*#2* *Regional Strategy of Green and Circular Economy, following the EU Action Plan for the Circular Economy – "Closing the loop"* *#7* *Application of Life Cycle Cost calculation methods by national and regional public procurers during GPP procedures* *#8* *National Action Plan for training local public authorities in GPP procedures and LCC tools.*
	b7	enhancing biodiversity, green infrastructure in the urbanenvironment, and reducing pollution	*#3* *Inclusion of Green Smart Public Buildings and Smart Public Lighting in national funding schemes, ROPs, RIS3 and local Action Plans.*

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