HANDBOOK

SMART CITY & OTHER ICT TECHNOLOGY IN EPC

SMART EPC

SMART EPC

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Contents

1. Smart EPC project introduction

Next generation of energy performance contracting

The main objective of the Smart EPC project is to enable the transition towards smart, sustainable cities and municipalities by utilizing energy efficiency as a key potential of new, emerging technologies and services.

Refurbishment of old and inefficient public lighting units with the integration of IoT technology and Smart City components will pave the way for a wide range of energy and non-energy related services and applications, including public safety ensuring, traffic management, EV charging, environmental monitoring and next generation of cellular communication. **The main goal of the project is to develop standardized energy performance contracting (EPC) documentation for integrating energy and non-energy related services on public lighting system** (i.e. Smart EPC concept – Figure 1).

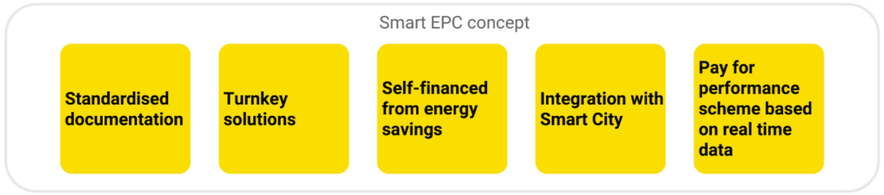

Figure 1 Smart EPC concept with integration of energy and non-energy related services

Smart EPC project outputs are structured around three specific objectives:

- **First project objective is development of standardized Smart EPC documentation for integration of energy and non-energy related services in energy performance contracting (EPC).** The project will test reconstruction of public lighting systems by including other energy and non-energy related services (e.g. Smart City components like EV charging points, 5G relays for data transfer and communication, etc.) thus making EPC more attractive and financially viable to local authorities.
- **Second project objective is demonstration of replication potential of Smart EPC documentation by piloting reconstruction of public lighting systems.** Project goal is to demonstrate viability and effectiveness of project outputs (e.g. developed standardized processes and documentation). This demo actions will be done in three pilot countries across Europe (ES, FR and PL) with different market and regulatory circumstances.
- **Third project objective is capacity building, replication and strong facilitation/dissemination service.** The project will design and deliver a capacity-building program addressed to local authorities and consultants not being part of the project aiming to improve knowledge and skills in the EPC.

Key Smart EPC project activities:

a. **Integration of energy related services (e.g. EV charging) and non-energy related services in the public lighting system infrastructure** (e.g. communication services such as 5G and Smart City infrastructure);

b. **Development of standardized EPC** that includes a pay-for-performance scheme - real time data on performance of public lighting system infrastructure;

c. **Testing of the Smart EPC concept**: piloting reconstruction of existing public lighting systems by using standardized EPC that integrates other energy and non-energy related services).

Generally, refurbishment of old and inefficient public lighting will lead to a reduction of energy consumption, operational costs, greenhouse gas emissions and light pollution. In addition, integration of IoT technology and Smart City components during the public lighting system infrastructure refurbishment unlocks a wide range of energy and non-energy related services to be performed in parallel, using the same infrastructure.

About this Handbook

This Smart EPC handbook is intended to provide detailed guidelines for public lighting operators (i.e. local authorities) on how to modernize old and inefficient lighting infrastructure with the integration of IoT technology, Smart City components, using the advanced financing models. The Smart EPC handbook should be used to help increase the overall understanding of additional energy and non-energy related services to public lighting and act as a catalyst for further action. This handbook also serves as a compass for the organization's policies and procedures on preparing for using energy performance contracting as a financing model of public infrastructure.

2. Smart public lighting - what is it?

Public lighting in general

Public lighting is a utility service provided by local authorities to illuminate public spaces. Most of the existing infrastructure used today is outdated and energy inefficient. In recent years, the concept of Smart Cities has come to the fore and is rapidly gaining momentum and attention of the public sector as a promising response to the challenge of urban sustainability. This transition towards sustainable Smart Cities requires profound changes not only from the economic perspective, such as implementing alternative financial models to overcome financial barriers, but also fostering cooperation between all actors involved, paying particular attention to innovative and market-ready technology providers.

Smart EPC project plans to enable the transition of local public authorities towards sustainable Smart Cities of the future by utilizing existing energy efficiency services as a key for unlocking potential of new, emerging technologies and services. By creating advanced and Smart concepts for modernization of public lighting systems in European cities, Smart EPC project will enable large-scale energy efficiency programs while strengthening know-how of regional/national key stakeholders.

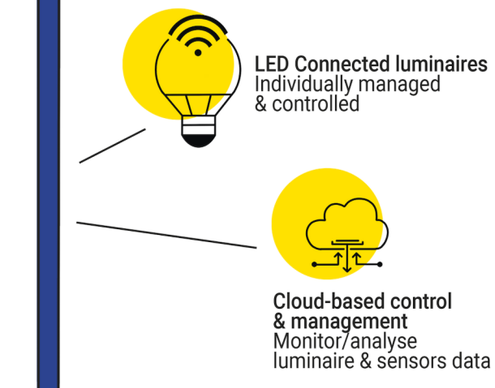

Figure 2 Public lighting - included services

Upgraded and modern public lighting system has many advantages, some of them being:

- enhanced road traffic safety and improved night-time visibility (resulting in decreased criminal activity and an improved sense of security among citizens)
- a reduction in operational costs due to reduced electricity consumption and prolonged life span
- “Smart City ready” infrastructure for enrolment of advanced IoT applications.

Public lighting – what’s it used for

Public lighting illuminates public areas to ensure the safety and comfort of users (pedestrians and drivers) and also a safe and pleasant atmosphere in public spaces. The quality of a public lighting system should be expressed in terms of photometric criteria (influencing visual performance and comfort). Most frequently used photometric parameters are average road-surface luminance, overall and longitudinal uniformity, surround ratio and threshold increment. Recommendations regarding minimum photometric parameters are defined in European Standards such as CEN/TR 13 201-1:2014, EN 13 201-2:2015, EN 13 201-3:2015, EN 13 201-4:2015, EN 13 201-5:2015.

Public lighting can be suitable for many other purposes besides illuminating public areas. Public lighting also plays a pivotal role in the development of most of the Smart City applications by providing physical and electrical infrastructure suitable for most of the Smart City sensors, communication and IoT devices, cameras, loudspeakers, displays etc. In recent years significant development has been invested in public lighting systems to enable maximum energy efficiency, minimum environmental load, high level of connectivity and embedded intelligence, as well as to enable it to function as energy and communications backbone for Smart City applications integrated in its infrastructure.

The basic elements of the public lighting system are:

a. lighting distribution cabinets and supply cables
b. lampposts
c. luminaires with a light source, optics and additional parts (e.g. Smart City components)

a. Lighting distribution cabinets and supply cables

The lighting distribution cabinet delimitates the electricity network and public lighting system. Usually located inside the electrical substation or in a standalone cabinet, it is mostly equipped with a billing metering point, a device for powering on/off and protective equipment. **In terms of energy performance contracting, it is important to know which luminaires are powered from which distribution cabinet, as well as the available electrical power of the cabinet, space in the cabinet and types of protection devices installed.** Supply cables deliver energy to luminaires and are mostly located underground. In some cases, air network supply cables are combined with electricity distribution cables (mostly used in rural areas) and underground networks (usually in urban areas). **In terms of energy performance contracting, it is important to know the type of cable (number of wires, material and cross section) and available power to supply additional devices besides luminaires (e.g. EV chargers).**

b. Lampposts

In most cases, two types of lampposts are generally used. The first type is a lamppost owned by an electricity distributor. This type of lamppost is

usually wooden or concrete and lighting supply cables are mostly joined with the electricity distribution network. The second type of lamppost is owned by a local authority, usually built from galvanized iron or aluminum and exclusively intended for public lighting system. This type of lamppost has its own junction box, as supply cables are mostly placed underground. Where appropriate, consoles on the walls of buildings, suspension cables, etc. can also be used as luminaire fixtures. Sometimes lampposts are used for purposes other than public lighting (traffic lights, tram power cable, etc.). **In terms of energy performance contracting, it is important to know the condition of the lamppost (corrosion, foundation) and available space inside or on the lamppost for possible places for EV chargers and other Smart City infrastructure.**

c. Luminaires

Luminaires are devices that transform electrical energy into visible light. Besides the light source, it consists of additional devices that transform energy from the power supply (AC) to the light source (DC) (drivers, ballasts). Part of the luminaire is also an optical element that directs light in the required direction and angle and other elements like wiring, protective glass and housing. Besides elements for light production, modern luminaires often have additional sockets and powering devices for other Smart City infrastructure (sensors or actuators).

Public lighting system supply power cables could provide electricity while lampposts could provide place for installation of additional infrastructure suitable for providing energy and non-energy related services.

Public lighting – challenges

Public lighting has lower technical and economic complexity than other public infrastructure projects and, in addition, it offers high energy and costs savings potentials, thus making it a suitable learning and testing ground for introducing and developing EPC market in any area. Energy savings and consequences for the ESCO if these are not achieved are contractually guaranteed by the EPC, making the EPC an attractive solution for the end beneficiary. Moreover, technological advancements in the (public) lighting sector offer high energy and cost savings with a relatively short time for investment return. When all the above aspects are combined, the Smart EPC concept proves to be a feasible solution for public lighting refurbishment across Europe.

Improved quality of public lighting integrated with IoT technology and Smart City components (Figure 3) directly affects many factors:

- **reduction of operating costs** (electricity consumption and operational costs) and consequently greenhouse gas emissions,
- **increase of energy and non-energy related services** offered by the local authorities to the citizens and consequently increase on the income

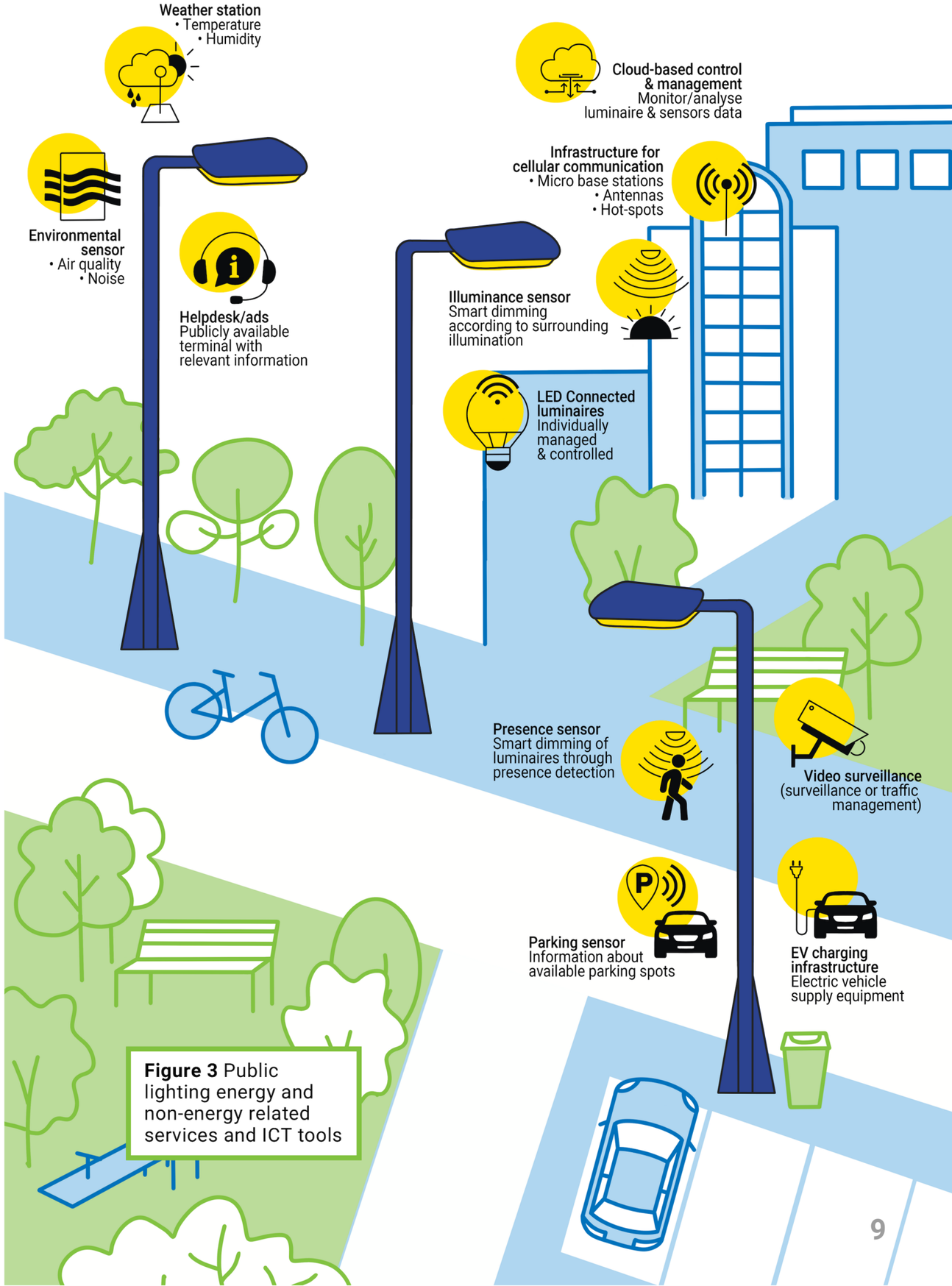

Figure 3 Public lighting energy and non-energy related services and ICT tools

side of the city's balance sheet,

- **increased level of traffic safety** (for both drivers and pedestrians),
- **crime prevention** (reduction of car thefts, burglaries, street attacks, etc.),
- **economic growth** by increasing the amount of time that citizens can spend on dining and outside entertainment after sunset,
- **limiting light pollution** and its impact on the living world due to the use of lamps with better quality reflectors and the application of appropriate correlated light color temperature.

When it comes to light pollution, public lighting contributes to several forms of it: skyglow (a dome-like shield of light pollution over inhabited area), glare (direct visual discomfort caused by excessive brightness), light trespass (light that escapes from source, falling where it is not intended) and clutter (excessive grouping of light sources). Light pollution implies significant energy waste, unnecessary costs and greenhouse gas emissions, damage to ecosystems and negative affect on human health. **The measures to prevent light pollution refer to installing fully shielded and properly directed luminaires, but also implementing new lighting technologies including dimmers, motion sensors and timers.**

The following principles for efficient public lighting should be taken account – it should have a clear purpose, directed only to where needed, no brighter than necessary, controlled to be used only when it is useful and to limit the amount of shorter wavelength light to the least amount needed (to use warmer colors). In most EU countries protection against light pollution is regulated, which usually determines the maximum permissible photometric values, restrictions and prohibitions on lighting, conditions for planning, construction and maintenance of public lighting system. Mostly used restrictions are regarding corelated color temperature (CCT) of the light source (e.g. must be below 3000 K), upward light output ratio (e.g. ULOR = 0%) and maximum average illuminance.

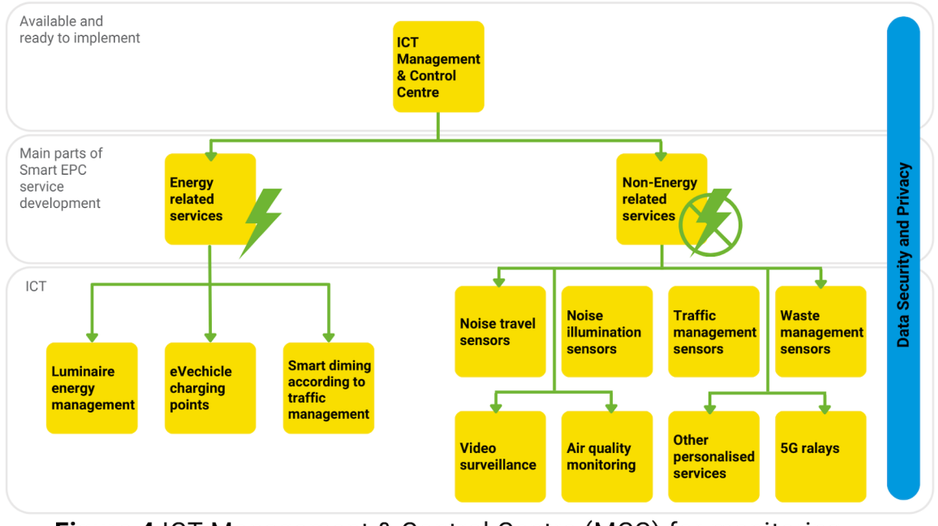

Figure 4 ICT Management & Control Centre (MCC) for monitoring and verification of energy and non-energy related services

Public Lighting - key takeaways

- Utility service provided by local authorities with main role to illuminate public spaces and additional role in ensuring public safety and comfort.
- Older light source technologies are cause of significant electricity consumption, greenhouse gas emissions and light pollution.
- Efficient public lighting has a clear purpose, direction and level of brightness, it is controlled to achieve full usefulness while the amount of shorter wavelength light is limited to the least amount needed (warmer colors are used).
- Besides lower operational costs, prolonged life span, enhanced road traffic safety and improved night-time visibility, upgraded public lighting systems offer infrastructure suitable for Smart City components.
- Possible source of revenue streams (from additional energy and non-energy related services integrated into public lighting system) with great visibility potential.

The key solution to address some of the above-mentioned challenges would be the upgrade of public lighting systems with LED connected luminaires. However, some of the challenges need to be additionally addressed such as citizen well-being, city management and communication services. **Hence, the concept behind Smart EPC is to get the most out of the smart public lighting system infrastructure to be able to monetize on additional services** such as street level 5G base stations (that allow for more connectivity with no need for building and construction permits extraction and additional infrastructure), environmental monitoring (that would allow local authorities to work more efficiently on citizen well-being and to have basis for sustainable urban development plans) and last but not least, EV charging solutions to increase sustainable mobility.

The Smart EPC concept integrates the following:

- connected public system lighting infrastructure powered by the standard grid;
- street side 5G base station solutions for mobile connectivity, mounted on lampposts;
- EV charging points integrated within the lampposts;
- variety of sensors integrated on the lampposts to provide a grid that will give a clear picture (heat map) of air quality, noise level or temperature level (Smart City applications).

With the standardisation of EPC contractual aspects, which includes a pay-for-performance scheme using an ICT Management & Control Centre (MCC) for monitoring and verification, public utility operators will gain an opportunity to create new revenue streams using the existing public infrastructure upgraded to the standards defined in the enhanced EPCs. New revenue streams can be the result of optimised and upgraded parking management systems or waste disposal, charging of e-vehicles, as well as revenue streams from 5G network slicing concessions etc.

3. Energy and non-energy related services in public lighting

3.1 Smart City introduction

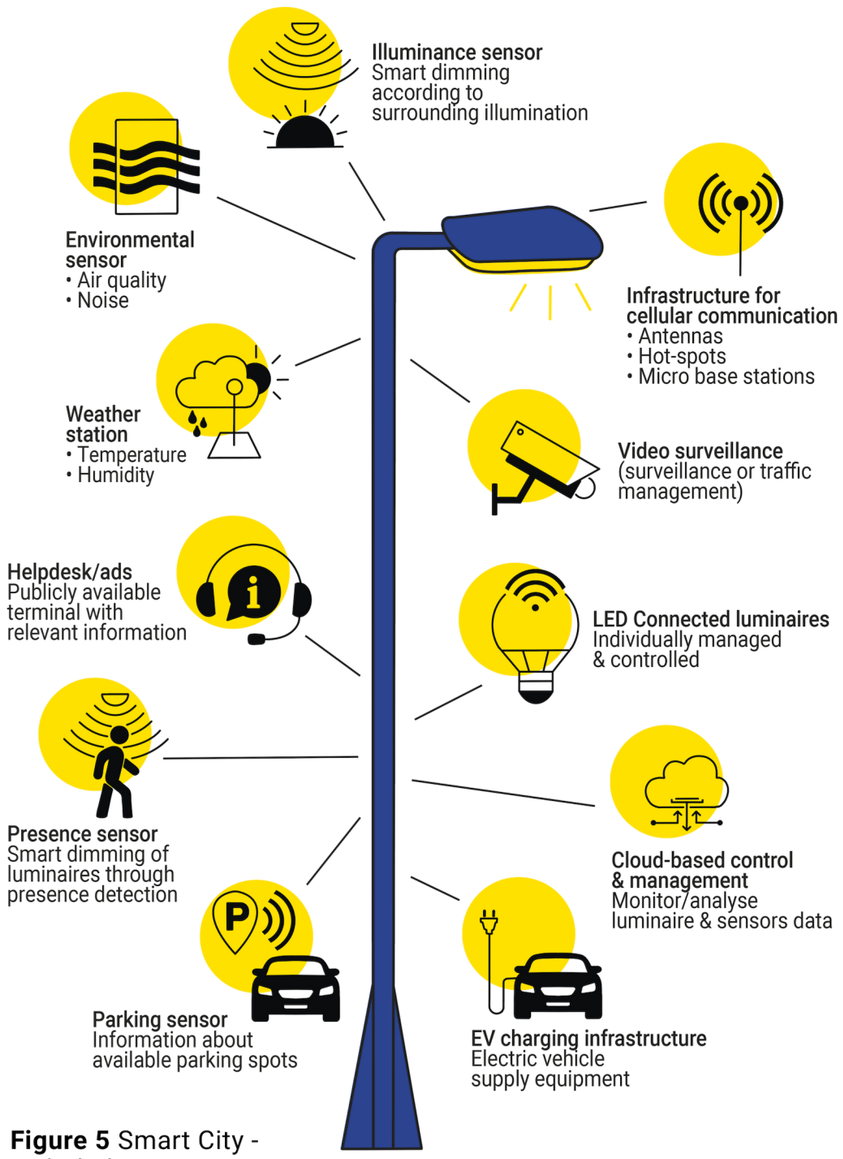

Figure 5 Smart City - included services

Smart City in general

Cities are growing at a staggering rate. As per the United Nations, currently, over half the total world's population lives in urban areas. This number is expected to jump to 68% by 2050. With the growing population, however, new challenges are also emerging for the city administration relating to public services. To overcome these challenges, cities are considering digital transformation. In other words, they are looking to become "Smart Cities". In a nutshell, a Smart City is a city that is able to collect and analyse all sorts of data from a variety of sectors, ranging from urban planning to waste management. **To become a Smart City, a city needs to build and maintain a streamlined network of interconnected sensors, systems and feature-rich software.** Today, most public lighting systems are still reliant on outdated technology based on traditional light sources. Replacing the existing public lighting systems infrastructure with innovative LED solutions and cutting-edge technologies results in saving energy and money, making public spaces safer and improving the life quality.

When thinking about the complete solution (connected lighting with additional services infrastructure) common questions arise:

- how to secure power infrastructure for the additional services?
- how to deploy the additional infrastructure (sensors and 5G antennas) fast and simple?
- how to deploy non-intrusive infrastructure (EV charging points)?

The questions above present a challenge when trying to improve and enrich EPC projects. The case is that every available service, in addition to connected public lighting, has a set of rules for implementation that needs to be followed. Although installation of connected public lighting might seem fairly simple process, as it only envisions the replacement of traditional lampposts, it might be a complex project. **Detailed construction and development plans must meet the regulatory, legal and planning demands.**

Smart City on lampposts – market maturity

The global Smart lampposts market size is expected to expand at a compound annual growth rate (CAGR) of 20% from 2022 to 2030. The market growth can be attributed to the ability of Smart lampposts to prevent accidents and traffic jams, the growing need for energy-efficient public lighting and rising government initiatives for the development of Smart Cities. Additionally, integrating air quality monitoring systems, surveillance cameras, wireless sensor networks, traffic management systems and transport management systems in Smart lampposts has contributed to the demand. The growing adoption of AI and IoT for enhancing the performance of these systems is expected to accelerate market growth further.

Smart City – benefits

To become Smart, luminaires need a light control system, which normally comprises of controllers, sensors and gateways. These components, via a certain network, link to a central management system from where they can be controlled, monitored and managed remotely. Deploying a Smart public lighting control system has somewhat high initial upfront costs. **The savings and other benefits from additional energy or/and non-energy related services make the investment in public lighting reconstruction more attractive.** The benefits of Smart public lighting can be grouped under the four most relevant categories: financial, environmental, public safety and traffic management.

Financial - dynamic dimming and maintenance optimization with more than 50% reduction in operational costs

Smart public lighting controllers help adjust light levels based on the specific times and events. When paired with public lighting motion sensors, light levels further refine based on the human presence. **Dimming lighting levels based on time, event or human presence results in considerable energy savings.** With Smart public lighting, operators get the near real-time status information of each luminaire. **The central management system generates instant notifications in case of faults or errors, enabling the operators to take informed actions and reduce the need for night patrols or frequent truck rolls.**

Public safety - safe circle of light referring to increased safety in public spaces

Smart public lighting motion sensors illuminate luminaires to adequate levels only when they detect pedestrians. When passing by, pedestrians are always surrounded in a safe, warm circles of light, while in their absence, luminaires burn at a low, predefined level, reducing energy wastage, CO2 emissions and light pollution. With luminaires illuminating only during human presence, the crimes level also minimizes, thereby improving overall public safety.

Environmental - reduced air pollution

Smart lamppost plays an important role in solving the problem of urban air pollution, as it can monitor several environmental factors, such as fine particulate matter concentration, temperature and humidity, to provide a complete picture of an area's overall air quality. Also, **environmental information can be displayed on Smart lampposts to help citizens limit their exposure to air pollution, while local authorities can use the gathered data to support decisions that might improve urban air quality conditions.**

Traffic management

The increasing urbanization and increasing use of the personal and public vehicles makes the city traffic congested, pushing the local authorities for better traffic management around the cities. Also, traffic congestion is one of the specific cited reasons for the poor quality of life in cities. **Thus, to reduce traffic jams and prevent accidents, Smart lampposts are gaining traction in the cities, as they can provide traffic management with the following attributes: traffic monitoring, traffic guidance, vehicle monitoring and parking guidance.**

Smart City – challenges

Street side 5G solutions

Communications service providers are challenged on the footprint, rent and OPEX of macro sites and those challenges are even more present at the street level. New street and outdoor small-cell solutions can be mounted on existing infrastructure. They are fast to install, with a subtle footprint and secure the 5G experience. Delivering industry-leading innovations is no small feat in the mobile operators' industry.

The questions that arise with urban 5G roll-outs are:

- How to acquire sites with the minimum rental?
- How to deploy fast and simple?
- How to maximize the 5G user experience?
- How to deploy non-intrusive 5G sites?
- How to utilize all frequency layers in a best way?

As 5G network roll-outs continue globally, the need for network densification will continue to grow. According to the Ericsson Mobility Report 20162, cellular data traffic was expected to grow nine times by 2020, placing a unique demand on mobile network operators to provide the necessary infrastructure and density required to serve the market. On top of this, operators are struggling to acquire new cell sites in public areas to provide the best possible mobile broadband coverage for their customers.

Environmental monitoring

Air pollution, often referred to as the "Invisible killer", is one of the biggest public health risks worldwide. According to Harvard University, the presence of harmful gases and particles in the atmosphere results in 8.7 million premature deaths per year, roughly 20% of all deaths.

Tourism and travelling have become an important part of modern-day life, but they, among many positive, have a number of negative consequences. Environmental impact is probably the most obvious one. It consists of many different aspects, such as the depletion of natural resources like water and land, discharging waste, pressure on endangered species, noise pollution, carbon footprint and many others. One of the aspects, which is hard to notice at first, is the impact on the air quality.

When monitoring environmental parameters in urban areas, the following questions arise:

- How to deploy sensors fast and simple?
- How to secure power infrastructure?
- How to deploy non-intrusive sensors?
- How to utilize existing infrastructure in a best way?

The importance of clean air is obvious when it comes to health and life quality, but research also shows its influence on tourist demand. High levels of SO2, PM2.5, PM10 and NO2 have a strong negative impact on the number of tourists in that area.

EV charging

There are several reasons why the lamppost is in the spotlight for EV charging such as existing infrastructure, ubiquitous and common placement throughout most urban spaces. Public lighting systems are already connected to a power supply and, in residential areas especially, where space is at a premium, it makes sense to utilize street furniture that has already been installed, rather than further adding to street clutter.

A key reason that EV charging facilities are integrated into public lighting system infrastructure is that it is significantly cheaper than new on-street charge points and their connection to the power grid. This, combined with the drive for EV take-up where more electric cars are anticipated on the street, means the necessity for charging infrastructure to support it. Since pavements don't have the capacity to accommodate additional applications, public lighting holds the answer.

The key challenge here is to separate the electric supply used for public lighting, other services and EV charging. The architecture should be done in a way that it protects all the assets in case of failure or overload. Additionally, the EV charging stations should be integrated only at the locations where it makes sense to put a parking place for EVs to charge.

Smart City - key takeaways

- A Smart City is able to collect and analyse all sorts of data from a variety of sectors through a streamlined network of interconnected sensors, systems and feature-rich software.
- Modern public lighting system infrastructure plays an additional role as part of the IoT infrastructure when equipped with additional devices.
- Smart public lighting system results in energy and maintenance cost savings when operated and controlled to be adjusted in light levels based on the specific times and events, at the same time providing the near real-time status information of each luminaire.
- Besides light pollution decrease, Smart lamppost could have positive effect on air pollution, when equipped to monitor environmental factors (e.g. fine particulate matter concentration, temperature and humidity).
- Smart lampposts could also have positive effect on city traffic when equipped with traffic management system providing traffic monitoring, traffic guidance, vehicle monitoring and parking guidance.
- Smart lampposts could improve life quality by enabling EV charging, Wi-Fi hot spots, helpdesk or advertisement terminals and security cameras.

3.2 Smart City - EV charging as commercial energy service

EV charging in general

Awareness about climate change and its repercussions has raised the consciousness of need for decarbonising economies and industries. The transport sector as the leading contributor to EU greenhouse gas emissions alongside increasing mobility needs for people and goods presents the key sector and challenge for reducing gas emissions and meeting the EU's climate neutrality objectives.

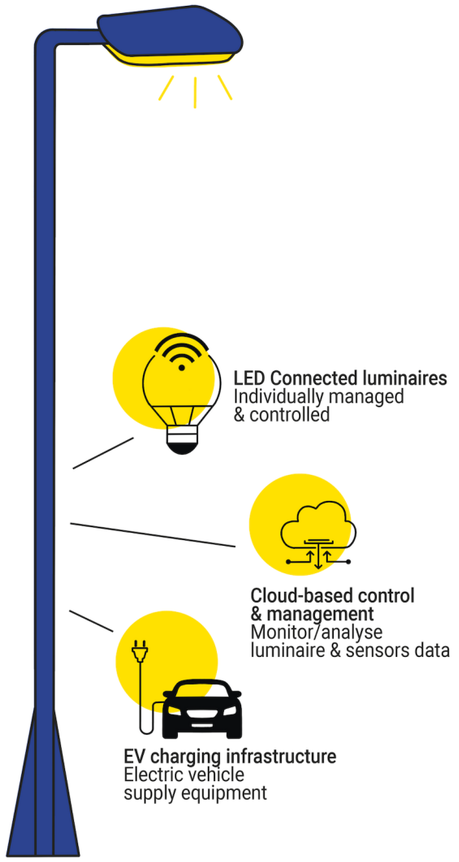

Figure 6 EV charging - included services

The EU goal of reaching climate neutrality by 2050 has led to set proposals of revision and updates of EU legislation (Fit for 55). Fit for 55 proposes to cut CO2 emissions from cars by 55% and vans by 50% by 2030 (EU, 2021) and to cut emissions from newly sold vehicles completely by the end of 2035. Building on the Fit for 55 package of proposals and completing the actions on energy security of supply and storage, the REPowerEU plan puts forward an additional set of actions, introducing the need for a legislative initiative to increase the share of zero emission vehicles in public and corporate car fleets, implying that electrification can be combined with of the use of fossil-free hydrogen to replace fossil fuels. These ambitious goals will lead to an increase of electrical vehicles in transport and will raise the need for faster deployment of recharging infrastructure. Reports on share of electrical vehicles (BEC-battery electric vehicles and PHEV-plug-in hybrid vehicles) amongst newly registered vehicles in EU27 including Island, Norway and United Kingdom show a rapid transformation of vehicle markets. **Uptake of share of electrical vehicles among newly registered cars from 3,5% in 2019 to 11% in 2020 presents huge increase that needs to be followed by increase in recharging infrastructure.**

EV charging on lampposts – market maturity

Number of cities around the world have already tested EV charging technology integrated on lampposts. For example, in City of London there are more than 6.000 EV chargers installed on lampposts while cities like Berlin and Dublin are also piloting this service. Also, there are number of vendors providing different solutions for EV charging on lampposts. **The market is developing fast but still in early stage of maturity for massive adoption.**

EV charging on lampposts – benefits

Public lighting system infrastructure can be used for development of public EV charging points. Lamppost electric cables that supply luminaires secure availability of electric power on each public lamppost. This can reduce the need for additional groundworks and cabling in cities for the purpose of developing public EV charging points. **Modernization of public lighting by replacement of traditional luminaires with LED results in up to 70% reduction in electric power producing the power reserve in power supply cables that can be used for EV charging**.

Using the existing infrastructure of public lighting systems can help speed up deployment of public EV chargers and significantly lower the investment costs oppose to stand alone EV charging points. There is also a great example in the UK about having a dedicated company responsible for ditching the streets and laying infrastructural foundations simultaneously for EV charging, telecom and public lighting purposes.

Integrated EV charging on lampposts – challenges

Not all public lampposts are suited for EV charging. The most recognized technical barriers that present significant obstacles in EV charging infrastructure development are:

- the distance between lampposts and parking lots
- the pedestrian pathways between lampposts and parking lots
- the state and available power reserve of existing power supply cables which can limit the number and power of EV charging points that can be implemented on some parts of public lighting system infrastructure
- public lighting power supply contracts
- public lighting management
- public lighting power supply (e.g. round-the-clock power availability),
- influence or possible disturbance in power network caused by EV charging point integration

Another major challenge for EV charging integrated in public lighting system infrastructure derives from **different ownership and management structures of public lighting systems infrastructure across different EU countries** that in some cases generates needs for rather complex technical interventions.

Integrated EV charging points – key takeways

- EV charging points integrated in public lighting system infrastructure provides space-saving solution with no need for extra “street furniture” and additional infrastructure.
- Public EV charging points are intended to be mostly used by drivers without private parking spaces or personal EV charging spots (e.g. multiapartment areas).
- Integration of EV charging points in existing public lighting system is a relatively fast process without extensive infrastructure works.
- Low investment in EV charging points integration into public lighting system results in highly scalable solution.
- Integrated EV charging points are recognized as market-ready solutions, due to presence of great number of technology providers and different models.

3.3 Smart City - Communication technologies as commercial non-energy service

Communication technology in general

Communication between different types of equipment and central management systems is essential in managing complex systems.

To efficiently use equipment such as luminaires, sensors and other Smart City components, communication is essential. Different types of communication technologies are present on the market today and new types are developing rapidly. By development of new equipment that is becoming “smarter” and gathers more data, today’s communication technologies are becoming obsolete since they cannot provide performance needed to accompany continuously growing requirements for quantity of data being transferred, response times of data transfers etc. Since development of communication network is complex and costly, a detailed analysis needs to be provided to see what present and future needs of public lighting are and if existing communication technologies can be adequate.

Most communication technologies that are present on the market today come with a certain cost for the users. In the Smart EPC project framework, the research will be conducted to investigate if public lighting system infrastructure can be used for licenced or unlicenced communication services to local authorities at no cost or to even provide additional revenue.

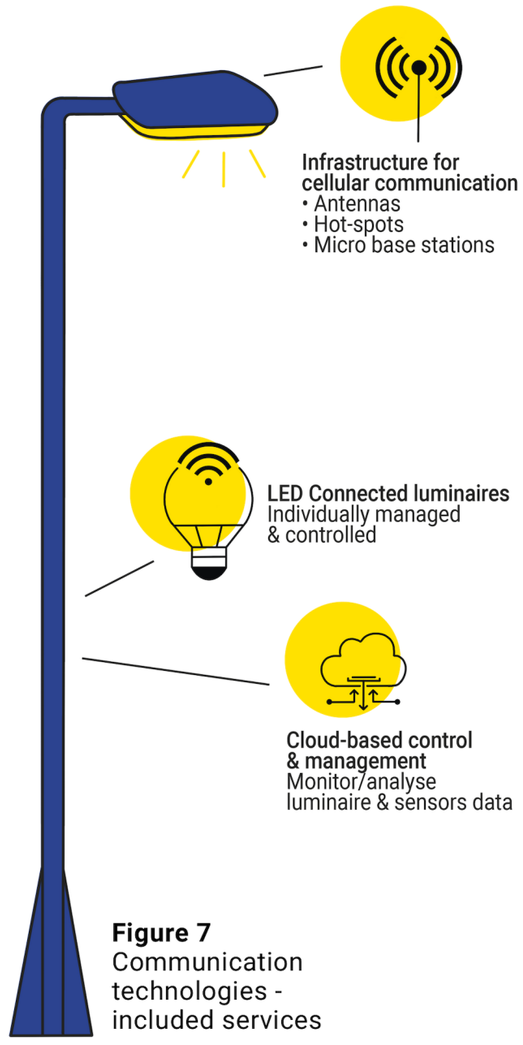

Figure 7
Communication technologies - included services

Of all communication technologies present on the market today (e.g. LoRa, SigFox, NB-IoT, etc.) licenced 5G communication technology that is still under development shows best potential in industry applications. On the other hand, technologies like LoRa or SigFox operating on unlicenced spectrum seem to lead the way in providing communication services today.

Communication technology is rapidly developing while trying to cope with ever growing need for bigger data transfers, higher bandwidth, longer ranges and lower latency. For newly developed communication technology to be fully operational and available, a communication network needs to be developed. **Development of network architecture often comes with quite high costs and time consumption.** This is the reason why newly developed technologies cannot be immediately available in every point in space, when they arise on the market.

Nevertheless, smartification of equipment, automatization and management of public infrastructure is moving forward at paste that is affordable and technically possible in specific urban areas. Due to those reasons, variety of communication technologies is used to service the needs for transferring data and for setting up automatization and management of public infrastructure including public lighting.

Before deciding on communication technology that best fits the needs of certain local authority, a detailed analysis of present and future needs has to be provided. Huge amounts of data and information have no purpose if there is no developed system for management or automatization. **Cost of implementing new communication technologies to serve the needs of Smart public services is often accompanied with cost of restructuring and reorganizing utility companies and public administration offices.** All of this tasks and costs need to be taken in account as well as all benefits that they bring when analysing the optimal solution.

Communication technology - public lighting infrastructure

Higher radio frequencies have shorter wavelengths so they can’t travel as far. This means that the “cells” of a 5G cellular network must be smaller if an MNO wants to provide access to those high-frequency bands. 5G networks require more infrastructure, whilst it offers less coverage, which explains how the public lighting infrastructure could play an important role in deployment of high frequency spectrum 5G. Additionally, higher frequencies have a harder time penetrating buildings, resulting with poor indoor coverage. **5G connectivity is most useful in big cities where there’s a higher concentration of cellular devices (and greater demand for high-speed, low latency Internet).** On the other hand, LoRa can provide more coverage and can penetrate buildings. LoRa can be quite useful for setting up communication network to collect data from sensors used for developing Smart City solutions at cost effective way. Public lighting system infrastructure can provide backbone for both (5G and LoRa) network, covering the whole urban area.

Communication technology on lampposts - market maturity

Most major carriers have already deployed 5G networks, by selling millions of 5G compatible devices. Currently, 5G service is typically available only in larger cities. Some carriers already have 5G coverage in hundreds or thousands of cities, but on low-frequency bands. **Low band 5G coverage will likely be widely available within a couple of years, although the high-speed 5G connections will take more time to roll out.**

Using public lighting to deploy wireless access infrastructure is not new, but it's also not that widespread and is just starting to play a significant role in 5G expansion plans. This development comes when cities are increasingly deploying more efficient LED lighting infrastructure well suited to housing Smart City enabling technology, including small cells and Wi-Fi access points. In Europe, Telefónica Deutschland (O2 Germany), in collaboration with energy services company Mainova, has recently deployed a 5G lamppost in Frankfurt am Main. It reliably supplies its surroundings with 5G while producing light during the night using highly efficient LED technology. In the future, real-time applications such as connected driving can also be realised with 5G at such locations.

As 5G technology sets the pace for the future, the present needs of many Smart City applications can still be fulfilled by existing and fully developed communication technologies such as LoRa or NB-IoT (working on 2G and 3G networks). Ideally, public lighting system infrastructure can accommodate different communication technologies (e.g., 5G and LoRa) for delivering different services to the market (mobile communication network and communication network for developing Smart City solutions).

Communication technology on lampposts - benefits

As mobile operators densify their radio access networks to put their capabilities to their full use, public lighting system infrastructure is set to play an increasingly important role in enabling that, as well as providing lots of other Smart City/IoT capabilities. While the scope of the Smart EPC project features implementation of energy efficiency measures, **project activities will clearly focus on activation of new revenue streams** which can be the result of optimized parking/waste management system, EV charging, concessions on communication networks or revenue from data transfers.

Communication technology on lampposts - challenges

Not all public lampposts are suited for 5G application. Barriers can be summed up to:

- legal barriers: deployment depended on national 5G strategies and concession rules;
- financial barriers: bankability of a larger scale 5G deployment can prolong the wider market presence;
- technical barriers: non-existing infrastructure (power and optic communication cable) for 5G relays can present one of the major obstacles in 5G development.

Based on the above, other communication technologies suitable for Smart City applications (e.g. LoRa, NB-IoT etc.) should be developed in parallel on the same infrastructure, at a cost effective way.

Communication technologies – key takeways

- Public lighting can accommodate different communication technologies (e.g. 5G and LoRa) for delivering different services to the market (mobile communication network and communication network for implementation of Smart City solutions).
- 'Street furniture' such as lampposts will play a key role in deployment of high-frequency bands (as this requires smaller antennas that could be fitted to lampposts) but also in deployment of unlicenced communication technologies mostly used for Smart City applications.
- 5G network slicing concessions for owners/operators of public lighting system infrastructure could bring new revenue streams.
- LoRa is the most used communication technology today for public lighting system management and is a cost-effective solution for developing early-stage Smart City applications.

4. How to finance public lighting projects?

Introduction

Over the last few years, alternative procurement models have become increasingly frequent in the realization of reconstruction of public buildings or public lighting for the purpose of improving their energy efficiency. Fiscal capacities of local and regional units as well as state administration bodies do not allow new debts (long-term liabilities) or loan financing projects. Consequently, **local authority considers alternatives as the implementation of an energy efficiency project financed through energy savings generated by reduced energy consumption** (hereinafter: alternative procurement models) based on the energy efficiency contract, the public private partnership, leasing, etc. These models are basically a type of delivery service or performance-based contract (service level agreements). The basic feature of the performance-based model is that the private party – energy service company (ESCO) is obliged to finance and complete all energy reconstruction works and to guarantee the contracted standards (primary energy savings). In these types of contractual relations, ESCO has been paid in accordance with the standard of the provided service. This means that ESCO is obliged to constantly prove that he has fulfilled a contracted standard (energy savings, minimum illumination standard of roads etc.) and in the case of non-compliance of standards it also results in the reduction of contracted unitary charge by the contracting local authority.

Energy performance contracting in general

The potential of energy efficiency services (e.g. energy performance contracting - EPC) has remained largely untapped throughout EU as ESCOs and cities have not recognized opportunities for bundling and integration of energy with non-energy services. By adapting to market and overall system needs, information and communication technologies (ICT) can enable this integration to reach additional target groups and mobilize financial resources for triggering additional revenue streams. An energy performance contract (EPC or EnPC) presents a contractual model where a provider of service also known as an energy service company (ESCO) delivers energy efficiency service to its client (local authority). Energy performance contracts are performance-based contracts since payment to the energy service company is linked to the level of energy savings they have provided to the local authority during the contractual period and not to the direct cost of energy measures they have implemented.

All implemented measures are financed by ESCO and are repaid through regular payments to ESCO by a local authority for energy savings provided during the contractual period. This contractual model efficiently links desired outcomes to provided payments ensuring that a local authority "pays only what it gets" and allocates performance risks on ESCOs. For efficient transfer of performance risks to energy service company a robust monitoring system needs to be implemented. Measurement and verification of achieved energy savings is crucial to every energy performance contract since it is the basis for the payments.

Energy performance contracting (EPC) is a form of 'creative financing' for capital improvement which allows funding energy upgrades from cost reductions/savings. Under an EPC arrangement, an external organization (ESCO) implements a project and uses the stream of income from the cost savings to repay the costs of the project, including the costs of the investment. The approach is based on the transfer of technical risks from the local authority to the ESCO based on performance guarantees given by the ESCO. ESCO remuneration is based on demonstrated performance, where a measure of performance is the level of energy savings or energy service. **EPC is the way to deliver infrastructure improvements to facilities that lack energy engineering skills, manpower or management time, capital funding, understanding of risk, or technology information.** Cash-poor, yet creditworthy customers are, therefore good potential clients for EPC.[1]

There is an increasing need from local authorities for public lighting system reconstruction to improve security aspects, reduce light pollution and, especially, increase energy efficiency and long-term reduction of operating costs (electricity and maintenance). The primary function of public lighting is the illumination of roads and traffic (pedestrians and vehicles) at night to increase the safety of public spaces. A secondary function of public lighting is the emphasis on space ambience that is not compromised by traffic safety and does not cause light pollution. The analysis conducted within the NEWLIGHT European project, conducted on a sample of 57 cities and municipalities, show that **the cost of maintenance and operating costs of public lighting is up to 10% of the local authority budget. The reason for the high costs lies in ineffective management and maintenance as well as the fact that in recent years relatively little has been invested in systematic reconstruction of the existing infrastructure by using energy-efficient light sources and management systems.**

The great potential of energy savings in public lighting has been recognized by the EU. The European Commission Regulation (EC 245/2009 and its amendments) relating to the requirements for the ecological design of a certain product group light sources will no longer be able to be placed on the EU market and will therefore not be supplied for the purpose of maintaining the existing luminaries. **Product withdrawal groups refer to almost 50% of light sources currently used in public lighting systems, including high pressure sodium and high-pressure mercury light sources**.

1. Norm HRN EN 13 201: 2016 (Official Gazette 122/14). Available at http://www.propisi.hr/print.php?id=9791 [20. July 2018.]

Pursuant to the descriptive restrictions defined by the EC Regulation an intensive need for modernization and reconstruction of existing public lighting systems is expected in the coming years in order to comply with regulations and to adapt to the market inaccessibility of obsolete light sources.

What is specific for energy performance contracting project?

Energy performance contracting (EPC) is the provision of energy services with guaranteed energy savings. The basic principle of the EPC is that all implemented measures are financed through energy savings at no additional cost. In addition, the following can be further emphasized:

- the whole project is **implemented by one company** (ESCO) that takes over most of the related financial and technical risks;
- **the guarantee eliminates the risk**: energy and cost saving (reduction of operating costs) is gradually implemented on the basis of the contract of defined warranties;
- EPC model is suitable for public lighting **where it is possible to reduce energy consumption or the reconstruction of the energy supply system is needed.**

The basic principles of energy performance contracting are listed below:

- The local authority orders and pays the service (account 32398 - energy service fee);
- The ESCO takes into account the operational execution of the service (works on reconstruction and guaranteeing the functionality of the public lighting system);
- The ESCO takes into account the achievement of energy and cost savings (which is proved by measurement and verification at least once a year);
- energy savings must be sufficient to offset the monthly project costs;
- revaluation of assets at the expiration or termination of the contract is not defined (ESCO all assets that were the subject of energy efficiency contract are delivered free of charge upon expiry of the contract).

The picture of financing through realized energy savings is given below (Figure 8):

- Area A refers to the period prior to the project implementation, described with **high energy costs and energy inefficient equipment**;
- Area B refers to the period of guaranteed savings and the duration of the EPC, described with the **reduced energy costs and maintenance costs, energy and cost savings,** while ESCOs are paid from the amount of savings achieved;
- Area C refers to the period of transfer of ownership after the expiration of the EPC, described with **reduced energy cost and maintenance costs, together with long-term financial savings.**

Figure 8
Source: project EES2020

EPC – EU practice and market maturity

Even though beginnings of energy performance contracting can be dated back as far as 30 years ago in United States, practice in EU started to evolve strongly during the last 15 years when energy services and energy performance contracting have been promoted trough Energy Services Directive (2006/32/EC). During that time energy performance contracting evolved in EU countries in many different forms of contract models.

Most differences between these contract models lies mainly in ways how ESCO guarantees savings (performance guarantees, payment mechanisms, guarantees on energy savings, guarantees on energy costs etc.) but essential part of the energy performance contracting or allocation of performance risk to ESCO is present in all cases. Joint Research Centre (JRC) of EU released a report "Energy Performance Contracting in the Public Sector of the EU – 2020" in 2021 in which a comprehensive overview of EPC in EU market has been presented. Findings reveal a very diverse picture when it comes to maturity of national EPC markets across EU as well as predictions of future growth. Also, report identifies several barriers as well as policy recommendations to foster the growth of EPC market across EU. Perception of complexity, administrative and transaction costs of EPC projects is seen as a barrier in stronger growth of EPC market. Standardization of preparatory procedures and analysis as well as standardization of contract documentation can help overcoming this barrier. Also, report identifies structural and regulatory barriers and procurement incompatibilities as challenges to be overcome. Low energy prices due to national subsidies as structural barrier to further growth of EPC projects has been shattered by huge energy prices increase in 2022 making EPCs more and more attractive.

Alternative procurement models benefits

The implementation of public lighting system reconstruction projects for the purpose of improving energy efficiency by contracting energy services or through the energy performance contract (EPC) differs from traditional financing of works by public contracting authorities (municipalities, cities, counties or other state administration). In EPCs, public contracting entities are users of services, while the private company is basically in charge of the project implementation and the provision of services. In accordance with the aforementioned, the financing of EPC projects falls within the scope of project financing where the energy efficiency agreement and the obligation to pay compensation to the private partner (ESCO) are set as the basis for the financing agreements concluded by the lenders and the

private company (service provider). **Cash flows are foreseeable if the service is provided in accordance with the agreed standard and should cover all project costs as well as the profits for the service provider.** The usefulness of contracting EPC projects for the public sector lies in the fact that all projects concluded based on and in compliance with the legislative regulations must be paid from the implemented energy savings and the public sector does not have to provide additional sources of funding (total investment is financed from current operating costs and implemented savings as a result of energy efficiency measures).

The EPC is often concluded for a period of 8 to 15 years. Energy savings generated through energy services should provide contracting authorities with lower operational costs of using reconstructed public buildings or public lighting. **On the other hand, the unitary charge for the service provided should be less than or equal to the implemented cost savings exclusively related to the consumption of energy sources** (no savings are incurred in equipment maintenance costs and elements) as a result of reconstruction (which would keep or reduce total expenditure of the contracting authority). Provided that the energy efficiency agreement is made in accordance with the EUROSTAT guidelines, it is not considered to be an increase in public debt for local authorities (does not increase the rate of debt, long-term liabilities and does not diminish the possibility of additional debts). It is important to point out that the drafting of the contract in accordance with the EUROSTAT guidelines is a relatively professional and complex work that needs to be delegated to experts.

The ESCO performs energy reconstruction projects, including design and selection of technical and technological solutions for energy reconstruction and also finances the performance of works (either alone or through loans), including the cost of financing in the amount of energy service fee (unitary charge). By providing regular services in accordance with standards, ESCO invoices the service, generates revenue and settles all obligations to sources of funding, own operating costs of providing energy services and achieves a certain profit. By the same analogy in energy efficiency contracts, a **possible reduction in contracted compensation is due to higher energy consumption than the contracted (non-provision of guaranteed energy savings).** With regard to financing and ensuring the regular and predictable cash flow of the project and the collection of fees, this risk is considered to be one of the largest. Given the nature of financing such projects, the energy efficiency contract must be clearly defined and recognize the role of the lender as a financier of such projects. Clearly defined risk-sharing as well as clear procedures in case of termination of contracts are necessary to make the contract acceptable to financiers as a third party in such contracts.

Some of the prominent benefits are:

- **guaranteed success of the project** - ESCO guarantees the achieved savings and return on investment;
- **long-term reduction of energy consumption and operating costs;**
- contracting an **ESCO implementing the project from start to finish**: prepares project documentation, implements the planned measures, guarantees the level of realized savings;
- the ability to **finance project implementation** by ESCOs;
- **allocation of technical risks** to ESCOs.

EPC – benefits (Maastricht-neutral treatment)

On 7 August 2015, the European Commission (EUROSTAT) published a guidance on the method of recording EPCs in the country's accounts - Eurostat guidance note the impact of energy performance contracts on government accounts. This refers to the addition to the 2014 Manual of governance deficit and debt implementation of ESA 2010, which provides more detailed guidance on how to record contracts signed by private sector entities with public sector entities for delivering public works and services. **The above guidelines were not entirely clear about the treatment of the EPCs and they went more in the direction of interpreting the EPC as a public debt.**

The issue of statistical treatment of the EPC, with the question of allocating technical and technological risks, was one of the most important issues and advantages of the EPC model for the realization of energy reconstruction of public buildings. Because of the lack of relevance in this sense, the 2015 EUROSTAT guidelines have raised a lot of dust and neglect in various EU countries. Since issuing these guidelines, there has been a great deal of uncertainty about the treatment of existing EPC and their impact on the further possibility of public contracting for the realization of other communal and social infrastructure projects. In this regard, EUROSTAT issues a new document in May 2018 entitled "A guide to the statistical treatment of energy performance contracts", where it gives very clear instructions and examples of how some EPC provisions should look like and what should be defined in EPC to not be treated as public debt. **These guidelines clarify the subject matter and give new impetus to the application of the EPC model while on the other hand specify the minimum conditions that EPCs must meet.** Some of the requirements set forth in the May 2018 guidelines are the minimum duration of the EPC, defining the maximum energy service fee as one that must be less than savings generated only by reduced energy consumption (savings from operating costs such as maintenance savings are not included), definition of minimum terms for termination fees, definition of the method for calculating fees and reductions, introduction of mandatory real measurement and verification of realized savings on a minimum annual level.

The motives of the contracting authority to initiate alternative procurement models and the positive effects of implementation

Using energy-efficient light sources and public lighting regulation (e.g. lighting control by using ballasts in the luminaries) can save up to 50% of the electricity, while the remote control and monitoring system significantly reduce maintenance costs. Modernization of the public lighting system ensures the enhancement of the quality and standards of public lighting up to the standards prescribed by the EN 13201 standard,1 which would contribute to increased public lighting system efficiency and overall energy efficiency improvement, increased traffic safety and environmental protection.

Apart from the prominent energy savings, a systematic approach to the issue of lighting modernization would contribute to the achievement of the following goals:

- **increasing the energy efficiency** of existing public lighting systems to reduce greenhouse gas emissions (CO2);
- **increase the efficiency of the maintenance and management system** of the public lighting system for the purpose of reducing operating costs;
- public lighting with **standard light technical values** in accordance with EN 13201-2: 2016 as a condition of traffic safety;
- **raising the quality of the lighting standards** for public roads, walks and parks as a prerequisite for socialization in the public space and stimulating economic activity;
- **environmental protection** (from light pollution, removal of hazardous substances from light sources (alive, etc.), reduction of greenhouse gas emissions);
- **reduction of crime rates** by lighting;
- **increase revenue** due to the use of Smart City components.

EPC - challenges

Energy performance contracting is often seen as complex model for realization of energy efficiency projects. EPC could be complex and hard to implement due to:

- mixture of financing problems,
- need for sound and detail analysis of existing state of facility or infrastructure,
- need for detailed energy audit,
- legal issues regarding ownership of facilities or infrastructure vs users of that facilities or infrastructure,
- future use of facilities or infrastructure or
- external factor regarding need for energy consumption such as climate changes.

These problems are especially highlighted in EPC projects in building sector. On the other hand, implementation of EPC projects in public lighting is seen as much simpler and can be a steppingstone for broader implementation of EPC. Predefined operating hours of public lighting system, automated or centralized management of operation, relatively easy and simple ways of monitoring energy consumption, clear and concise specifications on required functional characteristics are some of the key factors why EPC in public lighting is easier to implement than EPC in buildings.

EPC – key takeways

- EPC enables energy efficiency reconstructions with no need for upfront investment.
- EPC model provides guaranteed energy savings, while energy savings are regularly measured and monitored.
- Provided payments are linked to desired outcomes, ensuring that local authority “pays only what it gets” and allocating performance risks on ESCOs.
- EPC projects can be developed as “off balance sheet” investments for local authorities.
- EPC in public lighting is simpler than EPC in buildings.

5. How to start planning my public lighting reconstruction?

Basic steps of preparation and implementation of the Smart EPC project

The Smart EPC concept (standardisation of the EPC), enables the bundling of smaller projects and turnkey solutions for potential investors, thus simplifying the procedures, facilitating additional investments in energy efficiency and reducing the energy efficiency gap. EPC documentation developed in Smart EPC project framework is in accordance with EUROSTAT rules to ensure off-balance treatment of the public lighting reconstruction projects. **The usage of standardised documentation proved to be a key success factor in attracting ESCOs to tender for small-scale projects since they could execute due diligence and make offers in a relatively short period.**

Standardised documentation created within the Smart EPC project includes:

a. Standardised methodology for conducting a detailed energy audit of public lighting system;
b. Standardised methodology for selection of lighting classes according to CEN/TR 13201-1:2014;
c. Analytic tool for assessment of reconstruction potentials and financial modelling for ensuring that innovative energy services are reliable and verifiable and that ESCOs are trustworthy and accessible;
d. Action plan for the reconstruction of public lighting system (a document used to present the current state of infrastructure and reconstruction potentials, as well as the optimal territorial coverage of actions and financial modelling primarily for local authority representatives and bodies);
e. Standardised Smart EPC contract with all relevant addendums (such as standardised technical requirements, measurement and verification methodology based on Smart IT solutions and metering (MCC), a draft of financial models/tables etc.) for integration of energy and non-energy related services;
f. Tender documentation (for open and restricted procedures) that includes all needed addendums.

The preparation and implementation of the EPC project is a complex process that requires the expertise and experience of those who lead the project on behalf of the client (local authority). In view of the continuous progress of technology and equipment or innovation that takes place in terms of energy efficiency, **it is necessary to have consultants/experts familiar with the recent developments in the area (building/public lighting) in the process of project preparation and implementation, as well as having experience in preparation and implementation of procurement procedures for energy services.** It is important to ensure that technical specifications, conditions of procurement skills, contract proposals and required guarantees do not eliminate the economic entities (private companies) that are capable of implementing the project. Also, it is important to secure that the local authority obtains a quality solutions and equipment and to be secured from the risks it does not manage during the project. To enable this, procurement procedure and tender documents need to provide sufficient space for the interested entities to deliver a variety of innovative solutions. Such an approach enables the best value for the taxpayer's money to be realized, i.e. it is ensured that through the public procurement the local authority will achieve the purpose of the project in the best possible way.

Workflow for the preparation and implementation of the EPC project

Step 1. Project preparation

- incorporating an experienced consultant/expert to support the implementation of the entire project;
- analysing and defining client (local authority) needs and strategy of development for next 10 years;
- analysing Smart City applications and potential of implementing different solutions in the management of public services;
- analysing EV charging needs and potential;
- analysing existing data and the need for additional information (procuring detailed energy audit);
- analysing possible technical solutions - detailed analysis of different technical solutions, their technical applicability and the cost of technology;
- evaluating and confirming the economic and technical benefits of the Smart EPC model for the intended purpose - savings potential, forecasting investment volumes, forecasting possible additional revenue, etc;
- consulting with potential private entities and potential financiers of ESCOs - market analysis;
- developing initial business/financial plan of Smart EPC project – budget plan.

Step 2. Procurement of energy service providers

- drafting and defining a public procurement documentation and Smart EPC contract for the project;
- defining appropriate criteria for estimating the set of input data for contract documents;

- defining tender criteria to select the most economically advantageous offer/bid;
- selecting ESCOs based on the most economically advantageous offer.

Step 3. Signing an EP contract

- energy efficiency agreements are comprehensive, complex and balanced - they should be given full attention;
- some of the most important contract terms:
    - estimation of initial energy consumption - basic consumption,
    - definition of the guaranteed savings,
    - payment deductions due to unrealized savings,
    - termination fees and methodology how they are estimated,
    - method of measuring and verifying the realized savings,
    - risk allocations and contract guarantees.

Step 4. Implementing EPC Project

- completing the design documentation;
- applying agreed energy saving measures;
- detailed testing of equipment operation and acceptance of measures taken;
- training of personnel to handle the built-in equipment;
- setting up contract management procedures.

Step 5. Energy savings period; monitoring of delivered services and general assessment:

- ESCO is responsible for the efficient operation of the in-built equipment;
- realized savings are most often estimated annually;
- ESCO starts monthly (or maximum annual) monitoring of the measured values and controls deviations from the plan (the local authority controls);
- ESCO is obliged to compensate for the possible difference between guaranteed and realized savings (most often by reducing the contractual fee – unitary charge);
- the local authority controls whether the ESCO fulfils all the contractual obligations and verifies and pays the unitary charge if all the conditions are met.

Possible problems/risks in the implementation of EPC projects

EPC projects are complex and, therefore, they have to be very carefully prepared. For the purpose of minimizing the problems in the preparation or implementation of EPC projects, it is necessary to engage consultants/experts in the EPC project at the beginning of the project. Therefore, it is recommended to hire an experienced consultancy firm to assist in project preparation by:

- developing documentation required for contracting;
- formulating recommendations for technical and commercial goals;

- coordinating the procurement process (call for tenders and selection of best offers);
- using its knowledge of the market to perform the technical and economic evaluation of tenders;
- performing or setting up a monitoring procedure for the contract implementation.

Constrains and specifics of EPC

Generally, some constraints and specifics of EPC projects can be highlighted:

- the EPC model is not universally applicable. Therefore, the assessment of the appropriateness of this energy reconstruction model for each individual building or infrastructure facility is one of the most important steps in the project preparation;
- the ratio of investment volume and potential savings is one of the key factors - a simple pay-back period should be between 6 and 12 years (usually about 10 years);
- generally speaking, the EPC model is not suitable for small buildings or small public lighting systems - the return on investment resulting from savings in operating costs is lowered to lower values for small buildings;
- Major building interventions (deep renovations) or major infrastructure upgrades (changing el. cables and lampposts) are only possible if the local authority is ready to pay additional costs.

Using SMART EPC deliverables to help prepare SMART EPC project

Under Smart EPC project, a number of documents and tools are being developed to help standardize EPC project preparation as well as to help inform local authorities on best practices and real life case studies.
To inform local authorities on Smart EPC concept and possibilities as well as on energy and non-energy services that can be included in EPC project a set of informative documents, besides this handbook, have been created to facilitate project preparation:

- Factsheets - to give local authorities a brief intro in to the Smart EPC concept;
- Case studies – to inform local authorities on real life case studies of implementation of different energy and non-energy services;
- ICT technology market assessment report – to inform local authorities in more detail on technologies used for provision of additional energy and non-energy services;
- Generic ICT Smart EPC concept and technology output specification – a set of technical and functional requirements of services to be delivered under Smart EPC project developed for local authorities to help them specify their needs and preferences.

When local authority comes to a decision that Smart EPC concept is suitable concept for implementation of its project, to help prepare draft of tender documentation and draft of Smart EPC documentation based on best practice from industry, following documentation was developed:

- Standardized methodologies for inventory data collection – to help local authorities gather data in uniform format and to desired level of detail;
- Web-based analytic tool for inventory data analysis – to help local authorities to preform initial economic appraisals of project scope and to test their financial feasibility;
- Public lighting reconstruction action plan draft – to help local authorities prepare a plan of project implementation and to present it to public;
- Standardized procurement (tender, ToR) documentation – to help local authorities develop procurement documentation based on best practice;
- Standardized draft of Smart EPC documentation – to help local authorities to develop contract documentation and contract stipulations that are in accordance with best practices and EUROSTAT guidelines on statistical treatment of EPCs to be treated as "off balance sheet" for local authorities.

PROJECT PREPARATION		PROCUREMENT OF ENERGY SERVICE PROVIDERS	SIGNING AN EPC CONTRACT	IMPLEMENTATION OF EPC CONTRACT	ENERGY SAVING PERIOD
incorporating an experienced consultant / expert to support the implementation of the entire project	detailed analysis on different technical solutions, their technical applicability and cost of technology	drafting and defining a Public Procurement Documentation and SMART EPC Contract for the project;	energy efficiency agreements are comprehensive, complex and balanced - they should be given full attention;	completion of design documentation;	the energy service provider is responsible for the efficient operation of the in-built equipment;
analysing and defining Client needs and strategy of development for next 10 years	evaluation and confirmation of the economic and technical benefits of the SMART EPC model for the intended purpose - saving potential, forecasting investment volumes, forecasting possible additional revenue, etc	defining appropriate criteria for estimating the set of input data for contract documents;	some of the most important contract terms: - estimation of initial energy consumption - basic consumption, - defining the guaranteed savings, - payment deductions due to unrealized savings, - termination fees and methodology how they are estimated, - method of measuring and verifying the realized savings, - risk allocations and contract guarantees,	applying agreed energy saving measures;	realized savings are most often estimated annually;
analysis of Smart city applications and potential of implementing different solutions in management of public services		defining tender criteria to select the most economically advantageous offer/bid;		detailed testing of equipment operation and acceptance of measures taken;	the Energy Service Provider (or the Client) starts monthly (or maximum annual) monitoring of the measured values and controls deviations from the plan (the Client controls);
analysis of EV charging needs and potential	consulting with potential private entities and potential financiers of ESCO companies - market analysis	selection of energy service providers based on the most economically advantageous offer		training of personnel to handle the built-in equipment,	the energy service provider is obliged to compensate for the possible difference between guaranteed and realized savings (most often by reducing the contractual fee – unitary charge);
analysing existing data and need for additional information (procuring detailed energy audit)	Development of initial business/financial plan of SMART EPC project – budget plan			setting up contract management procedures..	the Client controls whether the Energy service Provider fulfills all the contractual obligations and verifies and pays the unitary charge if all the conditions are met.

All developed documents help to standardise the process of project preparation as well as tendering and contract documentation. This helps local authorities to prepare projects that are standardised feasible, bankable and market ready. Standardized Smart EPC documentation is developed in format that enables local authorities to tailor it to their specific needs while remaining uniformity and standardised contract stipulations.