FACTSHEETS

SMART EPC

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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 project's objective is to develop standardized energy performance contracting (EPC) documentation for integrating energy and non-energy related services.

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).

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. 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.

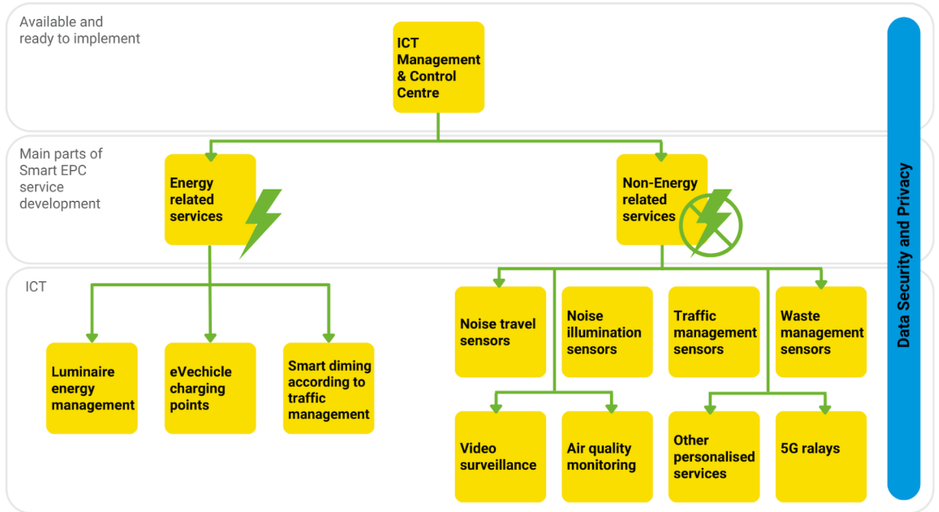


Figure 1 Smart EPC concept with integration of energy and non-energy related services

2. Public lighting system infrastructure fundamentals

Public lighting in general

Public lighting is a utility service provided by local authorities to illuminate public spaces. It ensures 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 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.

Most of the existing infrastructure used today is outdated and energy inefficient. Upgraded and modern public lighting system has many advantages, where some of them are:

- 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 system infrasctructure

Figure 2 shows the disposition of the basic elements of public lighting system. 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)

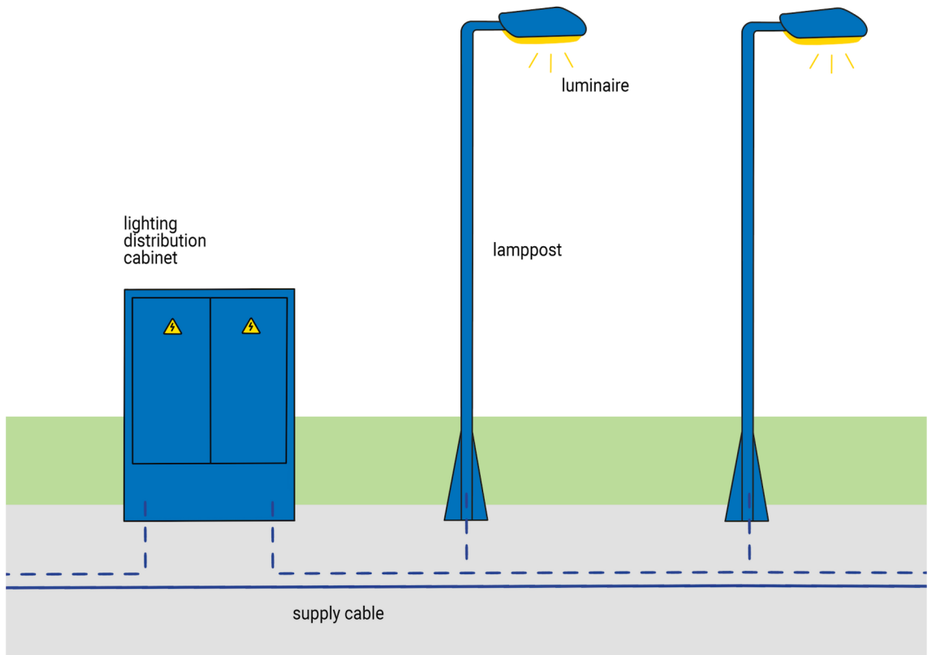


Figure 2 Disposition of the basic elements of public lighting system

Public lighting - challenges

Public lighting can make a positive contribution to safety and security. However, uncontrolled illumination of surrounding surfaces is an undesirable phenomenon. The term used to describe this negative aspect of public lighting is the **light pollution**.
Public lighting contributes to several forms of light pollution: 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 to 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.

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.

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

3.1 Smart City introduction

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.

Smart City – public lighting system infrastructure

Modern public lighting system infrastructure offers an ideal point from which a diverse range of Smart City IoT applications and collecting an array of data can be fostered. Smart lampposts don't just offer instant energy savings and maintenance cost reductions but also play an important role as one of the IoT infrastructures. It can be equipped with a weather station, wireless AP, camera, LED display, helpdesk or advertisement terminal, online speaker, EV charging point and other devices. **Smart lamppost becomes the data-collecting sensors of Smart City, ultimately achieving more efficient and integrated city.**

Public lighting system offers numerous infrastructure benefits, which make them a perfect base for hosting Smart sensors and systems:

- Power source – lampposts have access to an uninterrupted power supply and can easily be adapted to secure power supply to other IoT devices, sensors and systems;
- Location – lampposts are uniformly spread across local authority area. In addition, the height of each lamppost is consistent. Both the

coverage and height of lampposts make them ideal for hosting all sorts of IoT sensors and communication technologies, eliminating the need to set up ad hoc Smart City infrastructures;
- Safety – High above the ground, luminaires are normally out of the reach of pedestrians. In addition, due to the height, data collection (over-the-air) also becomes efficient.

Smart City – challenges

Moving to an integrated lamppost model, there are few major regulatory or policy barriers. However, across Europe, there can be a number of challenges that have to be overcome. Barriers can be summed up to:

- legal barriers: public concerns regarding misuse of collected data and abuse of people-related privacy right / data protection and cybersecurity issues / ownership of the lampposts and operational contracts / legal liability of local authorities if traffic accidents occur when public lighting is dimmed or the equipment malfunctioning;
- policy barriers: conflict between incentives to reduce energy consumption and the promotion of the Internet of Things (IoT) solutions like Smart infrastructure which drives up consumption;
- financial barriers: city budget limitations prohibiting the investment in the transition to Smart connected lighting or integrated Smart lampposts, high costs due to need for additional networks (internet, additional power supply);
- technical barriers: existing infrastructure outdated which requires new lampposts installation to host Smart technologies / structural integrity of lampposts to take the additional equipment / provision of 24-hour power supply / the availability of installed power for EV charging points on lampposts / difficulties in installing new sensors (e.g. noise sensors) / more technical and safety training required for workers.

Smart City - key takeaways

- A Smart City is able to collect and analyze 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

EV charging infrastructure is unevenly developed across EU countries, especially when it comes to fast chargers and installed capacity. Development of EV charging infrastructure is not following the uptake in share of electrical vehicles on roads and for the EU goals to be met EU Commission proposal on Alternative Fuels Infrastructure Regulation (AFIR) suggests that 3.9 million EV charging points are needed by the end of 2030. On the other hand, European Automobile Manufacturers' Association (ACEA) suggests more ambitious goal of at least 7 million new EV charging points across EU by 2030.[1] Additionally, Trans-European Transport Network (TEN-T) significant fact for future EV uptake is that approximately 50% of EU habitants don't have access to private parking.[2] **This results in huge need for development of public operated EV charging points in following years.**

EV charging – public lighting system infrastructure

At-home or near-home EV charging is recognized as the most desired EV charging location for EV drivers. However, in most cities, convenient off-street EV charging is largely unavailable to residents. **Using existing public lighting infrastructure, local authorities can play an important role in the rapid expansion of public EV charging infrastructure.** The need for public EV charging points and the fact that approximately 50% of EU inhabitants have no access to private parking is stressing the need for easy and feasible solutions for providing public EV charging points. Residential urban areas with multiapartment buildings present examples of locations where the lack of private parking spaces (or private garages) leads to limited access to EV charging infrastructure. This problem could be solved through public lighting system infrastructure, as it is already developed throughout urban areas and relatively close to public parking spaces. However, the lamppost upgrade for adoption of EV charging components is needed.

EV charging integration 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;

1. According to ACEA
2. ACEA Position Paper, November 2021

- 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 the 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.

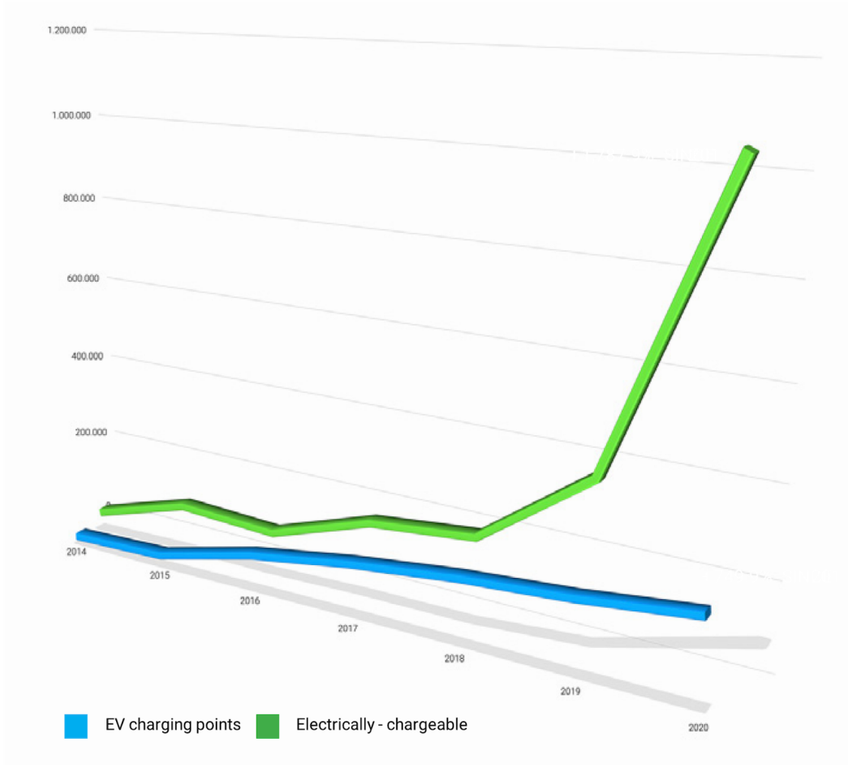


Figure 3 EV charging – need for development
Source: ACEA (presentation on EU Auto industry perspective on AFIR proposal, October 2021)

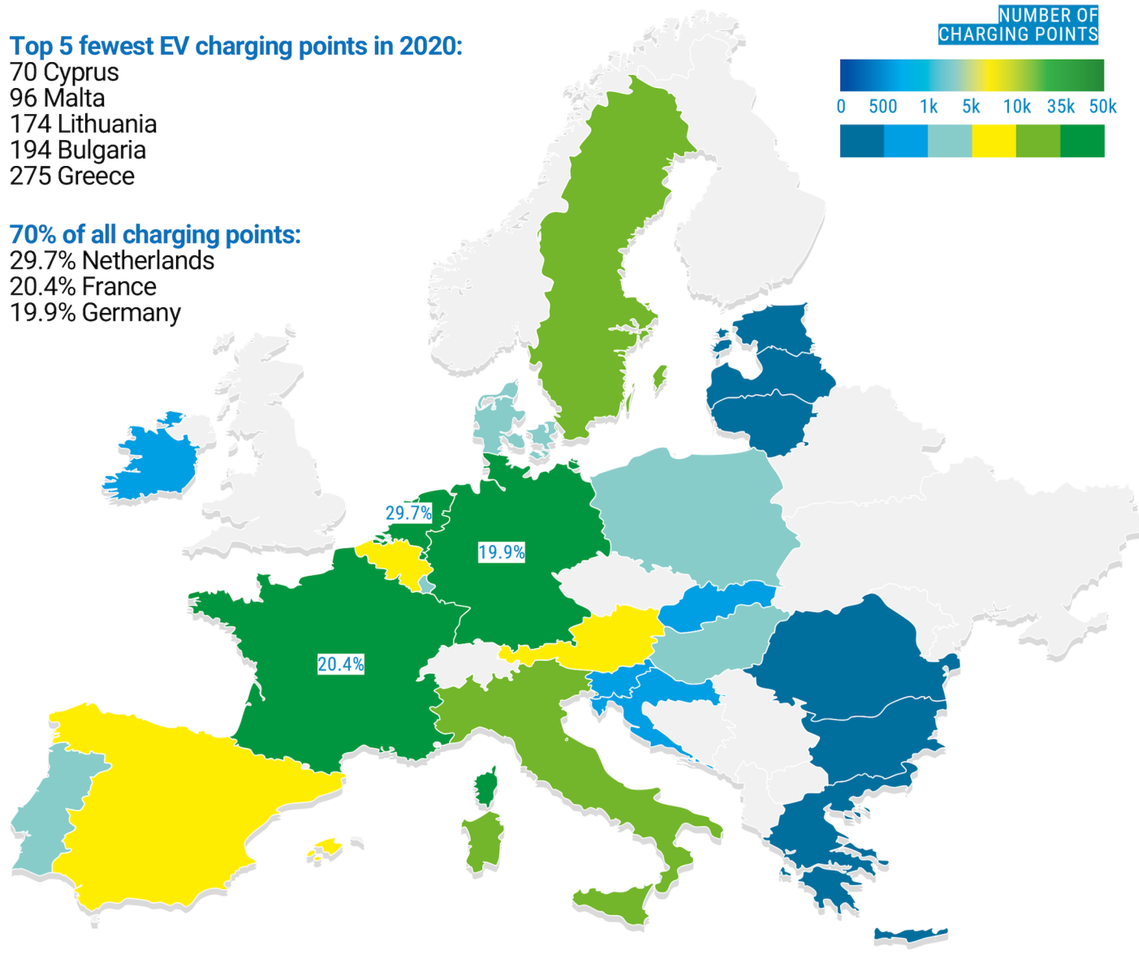


Figure 4 Distribution of EV charges across EU
Source: ACEA Position Paper, November 2021

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 technologies today

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. 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. **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.

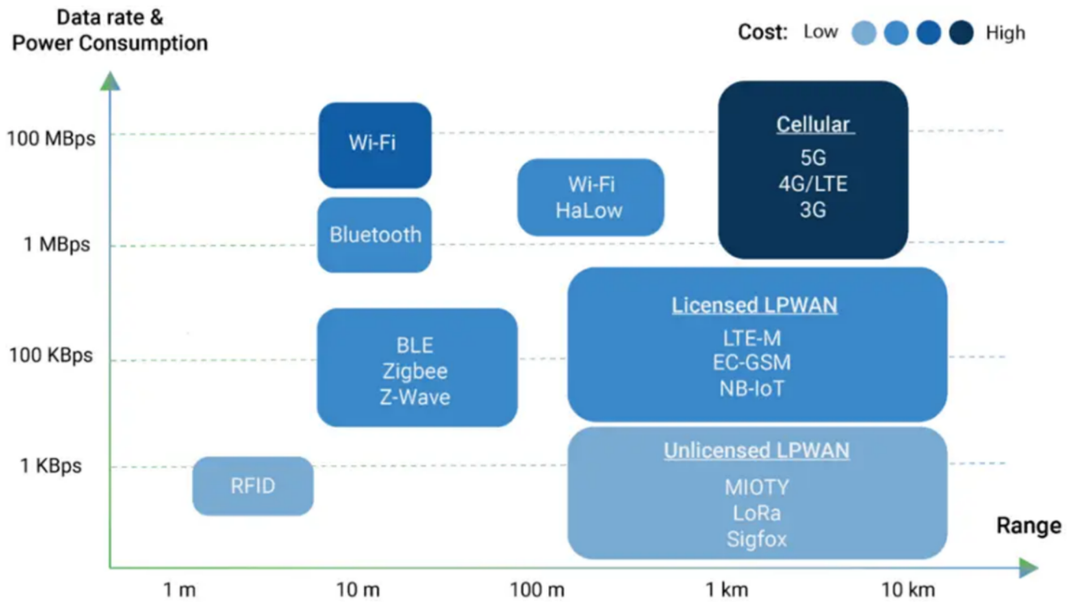


Figure 5 Communication technologies – comparison
Source: https://www.mokolora.com/lora-and-wireless-technologies

LoRa network technology in general

LoRa (short for long range) is wireless communication technology that can be operated on the license free sub-gigahertz bands. LoRa is best suited for applications where there is no need for continuous big data transfers with high bit rates. LoRa provides data transmission at longer ranges compared to technologies like WiFi, Bluetooth or ZigBee. Due to its features, LoRa is well suited for sensors and actuators that operate in low power mode.

5G network technology in general

5G (short for fifth generation of cellular network technology) delivers higher speeds, wider bandwidth, lower latency and more advanced capabilities than its predecessors (4G or 3G). Mobile Network Operators (MNOs) began rolling out 5G networks in 2019 and it is expected to become the primary cellular network in the coming years. 5G networks are vastly improving high-speed Internet connectivity around the globe and opening the door to a revolution on the Internet of Things (IoT).

Communication technologies 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. Financing models - energy performance contracting (EPC)

Energy performance contracting in general

There is a range of financing models in place from traditional city ownership and operation to concessions for lighting and Smart services. Local authorities must consider different business models, financing and funding options to ensure most appropriate one for each service they are providing. **Energy performance contract (EPC or EnPC) presents a contractual model where provider of service** also known as energy service company (ESCO) delivers energy efficiency service to its client. Energy efficiency service can include delivery of works, replacement of equipment, management of energy systems and other actions that are usually collectively called energy efficiency measures. Energy efficiency measures must result in energy savings without influencing “normal” use of the facilities or infrastructure by client.

Energy performance contracts are essentially performance-based contracts since payment to the energy service company is linked to the level of energy savings they have provided to the client during contractual period and not to the direct costs of energy measures they have implemented.

All implemented measures are financed by ESCO and are repaid through regular payments to ESCO by client for energy savings provided during contractual period. This type of contractual model efficiently links desired outcomes to provided payments ensuring that client “pays only what he 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. Possibility of treating EPC projects as Maastricht-neutral or “off balance sheet” is widely seen as one of the key benefits of energy performance contracting.

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;
- 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.

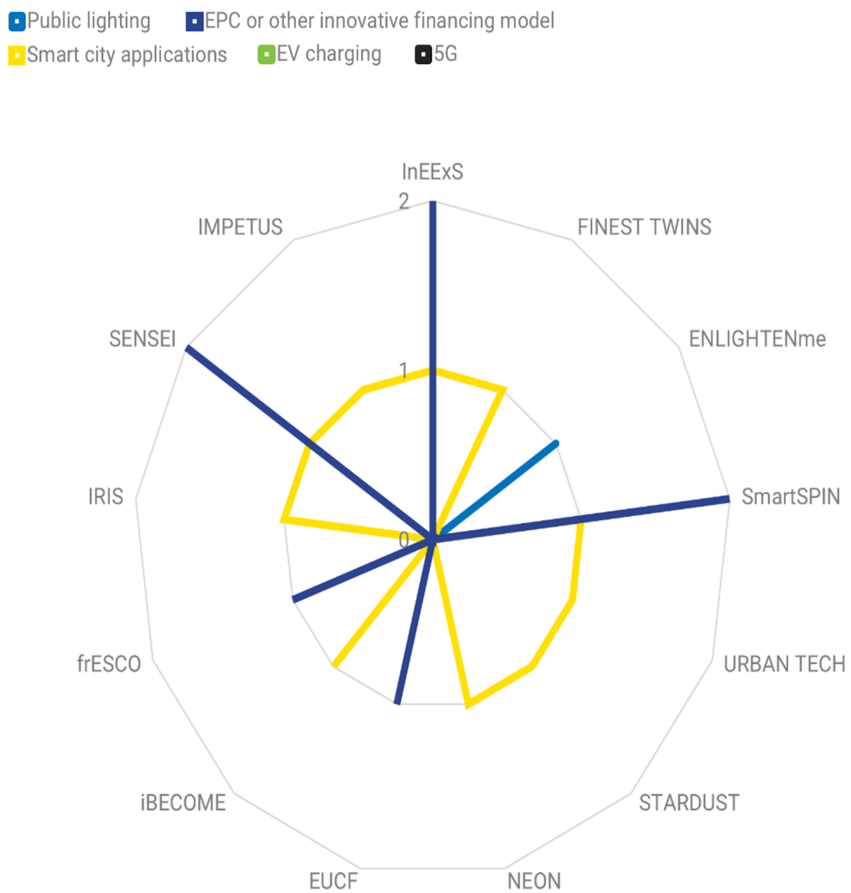
EPC – key takeways

- 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. Smart EPC related EU projects and initiatives

The projects related to Smart EPC are divided into two categories: ongoing and completed projects.

Related EU projects (ongoing)



Related EU projects (completed)