SMART EPC

ENERGY PERFORMANCE CONTRACTING

NORTH-WEST CROATIA
REGIONAL ENERGY AGENCY

SMART EPC

MAY 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101031639

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Contents

1. Smart EPC project introduction

Next generation of energy performance contracting – Smart EPC

The main objective of Smart EPC project is to enable transition towards smart sustainable cities and municipalities of the future by utilizing energy efficiency as a key for unlocking potentials of new, emerging technologies and services. Refurbishment of old and inefficient public lighting units with integration of IoT technology and Smart City components will pave the way for a wide range of energy and non-energy services and applications, including public safety, traffic management, EV charging, environmental monitoring, and next generation of cellular communications (e.g. 5G).

Key Smart EPC project activities:

a. Integration of energy services (e.g. EV charging) and non-energy services (e.g. 5G and Smart City infrastructure) in the public lighting infrastructure.

b. Development of standardized EPC contract that includes a pay-for-performance scheme (real time data on performance of public lighting infrastructure).

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

Smart EPC project outputs are structured around three specific objectives. First objective is development of standardised Smart EPC documentation for integration of energy and non-energy services in energy performance contracting (EnPC). The project will test reconstruction of public lighting by including other energy and non-energy services (e.g. Smart City components like e-mobility charging stations, 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 EnPC.

DATA SECURITY AND PRIVACY

AVAILABLE AND READY TO IMPLEMENT

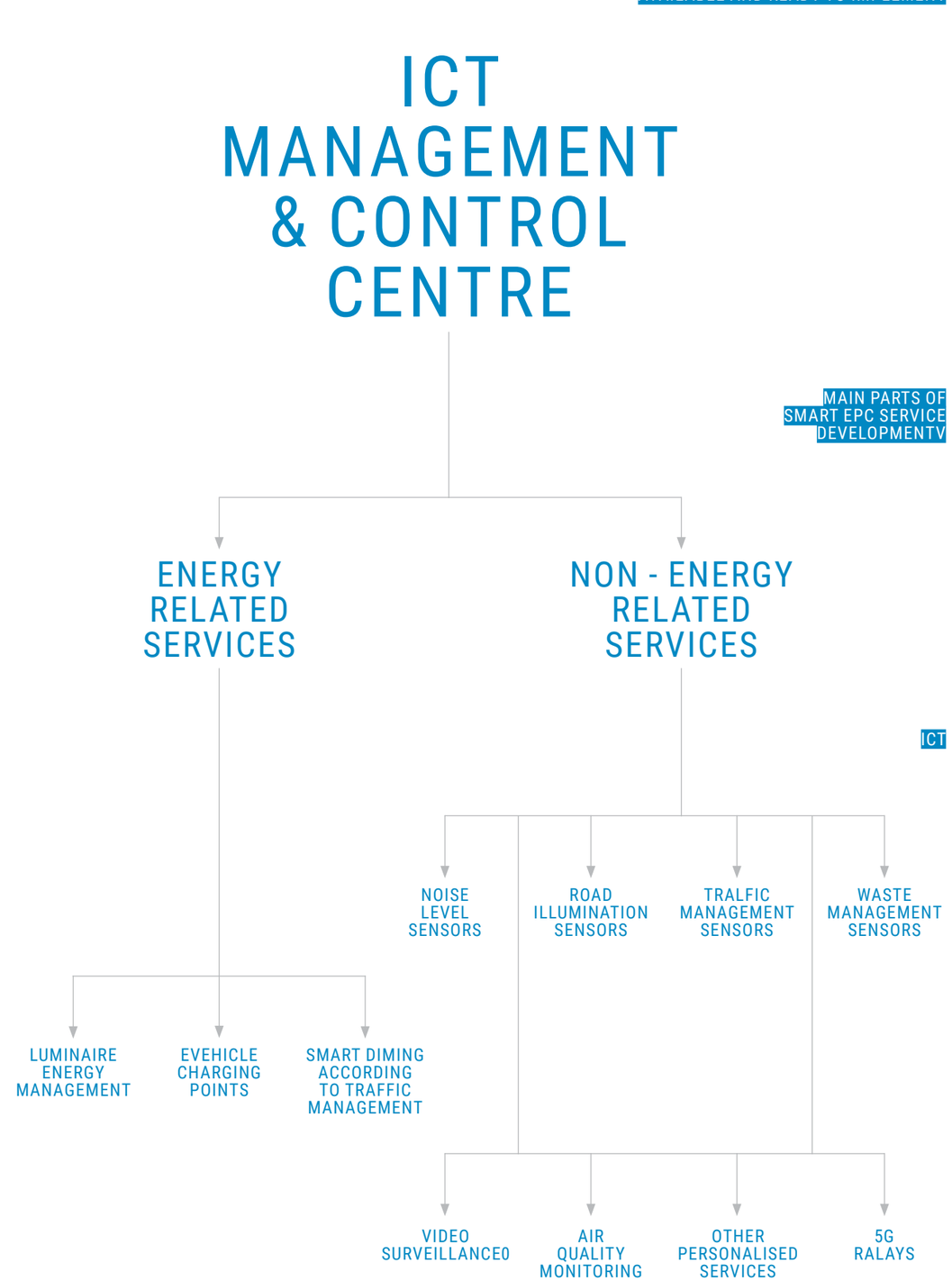


Figure 1 Smart EPC concept with integration of energy and non-energy related services and ICT tools

2. Figure 1 Smart EPC concept with integration of energy and non-energy related services and ICT toolsPublic lighting infrastructure fundamentals

Public lighting in general

Public lighting illuminates public areas to ensure the safety and comfort of users (pedestrians, drivers) but also a safe and pleasant atmosphere in public spaces. Public lighting is a key service provided by public authorities, however, many systems are outdated and energy inefficient. Upgraded and modern public lighting has a lot of advantages, where some of them are:

- enhanced road traffic safety and improved nighttime 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 advance IoT applications

Public lighting –infrastructure

The following figure shows the disposition of the basic elements of public lighting powered with underground supply cable (Figure XX). The basic elements of public lighting system are:

- lighting distribution cabinets and supply cables
- lamppost
- luminaires with light source, optics and additional parts (e.g. Smart City components)

a. Lighting distribution cabinets

The public lighting distribution cabinet delimitate the electricity network and public lighting. Cabinet can be located inside the transformer station or it can be separated in a standalone cabinet. The public lighting cabinet are mostly equipped with billing metering point, management device for turning on/off the luminaires and protective equipment for one or more supply cables. In terms of energy performance contracting it is important to have information which luminaires are powered from which supply cable and distribution cabinet, available electrical power of cabinet, available space in cabinet and types of protection devices installed (all presenting a key baseline data of existing system structure).

b. Supply cables

Supply cables are electricity supply lines that delivers electric energy to luminaire/lamppost, mostly located under ground. In some cases, air network supply cables is combined with the electricity distribution cables (mostly used in rural areas), and underground network (usually in urban areas). In terms of energy performance contracting it is important to know type of the cable (number of wires, material and cross section) and available power to supply additional electric devices beside luminaires (e.g. e-chargers).

c. Lamppost

In most cases two types of lampposts are generally used. First type are lampposts owned by electricity distributor whose primary task is air network carrying. This type of lampposts are usually wooden or concrete and lighting supply cables are mostly jointed with electricity distribution network. Second type of lampposts are exclusively intended for public lighting. This type is usually owned by a local government, and usually built from galvanized iron or aluminum. This type of lamppost has 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. Sometimes lampposts are used for other purposes then electricity distribution or public lighting (traffic lights, tram power, etc.). Parts of the lamppost are also arm / bracket that has the function of fine adjustment of the luminaire position related to the luminated area. In terms of energy performance contracting it is important to know condition of the lamppost (corrosion, foundation), available space inside or on the lamppost for possible places for e- chargers and other Smart City infrastructure but also GPS location of the lamppost in order to be able to decide for placement of necessary Smart City infrastructure (which sensor).

d. Luminaires

Luminaires are devices that transform electrical energy to visible light. Besides light source it consists additional devices that adjust energy from power supply to the light source (drivers, ballasts). Part of the luminaire is also optical element that directs light in the required direction and angle and other elements like wiring, protective glass, housing. Besides electrical power of the light source there are also electrical losses in drivers or ballasts that should also be included in calculations of energy savings. Modern luminaires besides elements for light production often have additional sockets and powering devices for other Smart City infrastructure (sensors or actuators).


TRANSFORMER STATION
LIGHTING DISTRIBUTION CABINET
SUPPLY CABLE
SPART SENSORS
5G
LUMINAIRE
LAMPPOST
EV CHARGER

Public lighting system is very branched infrastructure which can be suitable for many other purposes besides illuminating public areas. Public lighting 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. Examples of additional installation is shown in picture bellow (Figure xx).

Public lighting – benefits

The quality of a public lighting system, besides energy efficient and reliable system, should also be expressed in terms of photometric criteria that influence visual performance and comfort. The exact photometric parameters used in specifying, designing and measuring road lighting installations are average road-surface luminance, overall and longitudinal uniformity, surround ratio, and threshold increment. For the needs of pedestrians, cyclists and residents the parameters are average horizontal and minimum illuminance together with a maximum value of horizontal illuminance, semi-cylindrical and average facade illuminance. Description, instructions and recommendations regarding minimum photometric parameters are defined in 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 – barriers

Public lighting can make a positive contribution to safety and security, however, lighting that lights not only the intended area but that spreads out uncontrolled into the surrounding areas and into the sky is an annoyance to society. The term used to describe this negative aspect of lighting is light pollution. It may be a danger for road users and disturb residents, wildlife and the growth of vegetation. It may also disturb both professional and amateur astronomers in their research work and make it impossible for all of us to see the stars. Professional, carefully designed lighting should bring the light to only where it is really needed, only as much as is needed, and only when it is really needed. Only then can the right balance be achieved between the positive effects of lighting and the negative impacts of that lighting on the environment. In most of the EU countries there is act that regulates protection against light pollution, which usually includes measures for protection against light pollution, determines the maximum permissible photometric values, restrictions and prohibitions on lighting, conditions for planning, construction, maintenance and reconstruction of outdoor lighting. environmental lighting and other issues in order to reduce light pollution and the consequences of light pollution. Mostly used restrictions are regarding corelated color temperature (CCT) of the light source (e.g. must be bellow 3000K), upward light output ratio (e.g. ULOR<3) and maximum average illuminance.

Key Public Lighting takeaways

- Crucial infrastructure for public safety and comfort during nighttime
- Potential significant electricity consumer if non efficient luminaires used
- Branched infrastructure suitable for smart city components and communal standard rising
- Possibility for additional revenue streams from additional energy and non-energy services
- Great visibility potential

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

3.1. Smart City applications

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 analyze all sorts of data from a variety of sectors, ranging from urban planning to waste management. In order 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 is still reliant on outdated technology based on traditional light sources. One of the main goals is to save energy by replacing the current public lighting infrastructure with innovative LED solutions and cutting-edge technologies that save money, make public spaces safer, and improve quality of life for residents.

Smart City – public lighting infrastructure

Existing public lighting infrastructure offer an ideal point from which a diverse range of Smart City IoT applications and collecting an array of data can be fostered. Intelligent lampposts don't just offer instant energy savings and maintenance cost reductions, but play an important role as one of the IoT infrastructures. It can be equipped with weather station, wireless AP, camera, LED display, public help terminal, online speaker, charging pile and other devices. Smart lamppost becomes the data collecting sensors of Smart City, and share to each responsible department, ultimately achieving a more efficient and integrated city management.

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

- Power source –Lampposts have access to an uninterrupted power supply. Therefore, when it comes to supplying electricity to other IoT devices, sensors, and systems, additional setups, such as generators or batteries, are not necessary;

- Location – Lampposts are spread across the city, uniformly. They are like a nervous system of a city. 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 systems, eliminating the need to set up ad hoc infrastructures;

- Safe – High above the ground, lampposts are normally out of the way of citizens. Without hindering people or vice versa, all the intelligent sensors and systems will remain safe at the top of the lamppost. In addition, due to the height, data collection (over-the-air) also becomes efficient.

Smart City on lampposts– market maturity

The global smart lamppost 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, the integration of air quality monitoring systems, surveillance cameras, wireless sensor networks, traffic management systems, and transport management systems in smart lampposts have contributed to the demand. The growing adoption of AI and IoT for enhancing the performance of these systems is expected to further accelerate market growth.

Smart City – benefits

To become smart from ordinary, public lights need a light control system, which normally comprises of controllers, sensors and gateways. These components, via a certain wireless 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 day one from the system, however, make the business case an attractive prospect, with a Return on Investment of between five to seven years.

- Dynamic Dimming – More than 30% reduction in energy consumption

Intelligent 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.

- Maintenance Optimization – Up to 50% reduction in maintenance costs

With the intelligent 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.

- Safe Circle of Light – Increased public safety

Smart public lighting motion sensors illuminate luminaires to adequate levels only when they detect humans. This means, when a pedestrian, cyclist or car passes by, he or she will always be surrounded in a safe, warm circle of light. In the absence of a human, luminaires will burn at a low, predefined level, reducing energy wastage, CO2 emissions and light pollution. With luminaires illuminating only on human presence, the crimes also minimize (lawbreakers refrain committing crimes in well-lit areas), thereby improving the overall public safety.

- Reduced air pollution

Smart lamppost is playing 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, and city planners can use the gathered data to support decisions that might improve urban air quality conditions.

- Traffic management

The increasing urbanization and rising use of the personal and public vehicle makes the city traffic-congested and pushing the various city's municipality or corporation 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 the traffic jams and prevent accidents, smart lampposts are gaining traction in the cities, as they can provide the traffic management with the following attributes: traffic monitoring, traffic guidance, vehicle monitoring, and parking guidance.

Smart City – barriers

There are no relevant barriers to smart connected lighting. Moving to an integrated lamppost model, there are few major regulatory or policy barriers, however, across Europe, there can be a number of regulatory, policy (and technical) challenges that have to be overcome on topics like provision of 24-hour power, the ability of cities to sell power (e.g. eV charging points on lampposts, privacy policy and the usage of data, and the structural integrity of lampposts to take the additional equipment).

Barriers can be summed up to legal people-related (a lack of knowledge amongst the public and (local) governments regarding digital solutions, for citizens the smart lamppost raises primary privacy and surveillance concerns, given the data that could be collected), financial (city budgets are often limited, prohibiting the investment in the transition to smart connected lighting or integrated smart lampposts, the need for additional networks (internet, additional power supply) can lead to high costs), technical (the current infrastructure might be too old to host smart technologies - new posts need to be installed/ more technical and safety training is required for workers /some sensors (e.g. noise sensors) may be difficult to install/data protection and cybersecurity issues need to be considered) and governance/ policy (conflict between incentives to reduce energy consumption and the promotion of the Internet of Things (IoT) solutions like smart infrastructure which drives up consumption/ ownership of the lampposts and operational contracts are a common barrier to the rollout of smart lampposts/cities may have legal liability if traffic accidents occur due to lights that have been dimmed or because of the equipment malfunctioning).

Key Smart City takeaways

- In order to become a Smart City, a city needs to build and maintain a streamlined network of interconnected sensors, systems, and feature-rich software

- Existing public lighting infrastructure offer an ideal point from which a diverse range of Smart City IoT applications

- Smart lamppost is playing 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
- Smart lampposts are gaining traction in the cities, as they can provide the traffic management with the following attributes: traffic monitoring, traffic guidance, vehicle monitoring, and parking guidance
- Intelligent public lighting controllers could help adjust light levels based on the specific times and events and operators get the near real-time status information of each luminaire and so reducing energy consumption and maintenance costs

3.2. EV charging

EV charging in general

Awareness about climate change and its repercussions has raised the consciousness of people and countries of need for decarbonising economies and industries. 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.

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. These ambitious goals will lead to increase in 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 infrastructure is unevenly developed across EU countries especially when it comes to fast chargers and installed capacity. Development of recharging infrastructure is not following the uptake in share of electrical vehicles on roads and for EU goals to be met EU Commission proposal on Alternative Fuels Infrastructure Regulation (AFIR) suggests that 3.9 million charging points are needed by the end of 2030. European Automobile Manufacturers' Association, or ACEA, on the other hand suggest that this goal is not ambitious enough and that goal should be at least 7 million new charging points across EU by 2030. Besides the need for fast EV charging points on TEN-T core network significant fact for future EV uptake is the that approximately 50% of EU habitants don't have access to private parking. This means that there is huge need for public/semi public operated charging points to be developed in next years.

EV charging – public lighting infrastructure

The need for public charging points and fact that approximately 50% of EU inhabitants has no access to private parking is stressing the need for easy and feasible solutions when it comes to providing public charging points. Residential urban areas with multiapartment buildings present example of locations where there of the lack of private parking spaces (or private garages) leads to citizens having limited access to charging infrastructure for charging their vehicles overnight oppose to private parking spaces or garages in houses. Public lighting infrastructure can provide solution to this problem. Public lighting infrastructure is already developed throughout urban city areas and reaches majority of public parking spaces. However, further retrofit for EV charging adoption is needed.

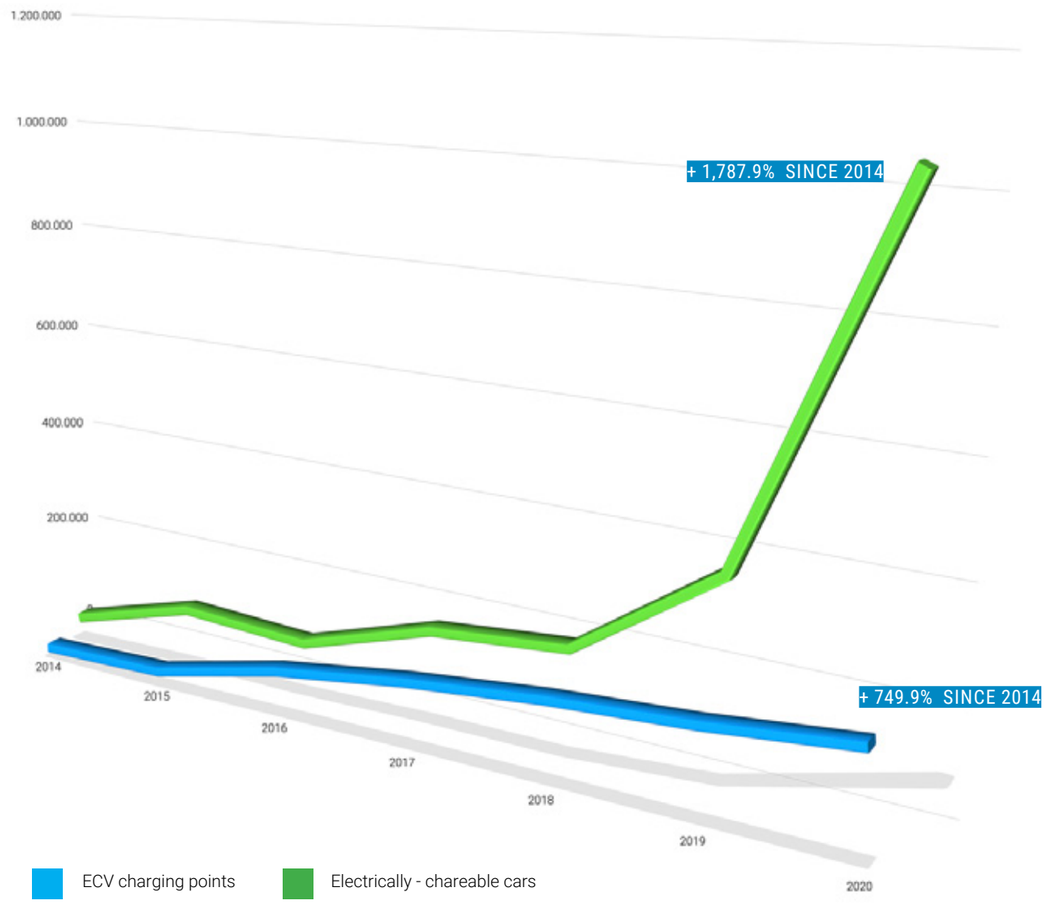


Figure 2 - EV charging – need for development
Source: ACEA (presentation on EU Auto industry perspective on AFIR proposal, October 2021)

[1] https://www.acea.auto/

[2] ACEA, https://www.acea.auto/files/ACEA_Position_Paper-Alternative_Fuels_Infrastructure_Regulation.pdf

EV charging on lampposts– market maturity

Number of cities around the world have pilot tested EV charging on lampposts technology or are in process of piloting. Just in United Kingdom in London there are more than 1300 EV chargers installed on lampposts that are up and running. Also, there are number of technology providers and vendors providing different solutions for EV charging. From EV chargers that are added on existing lampposts (concrete or metal lampposts), EV chargers installed in existing lampposts to new lampposts with integrated EV charging solutions.

EV charging on lampposts – benefits

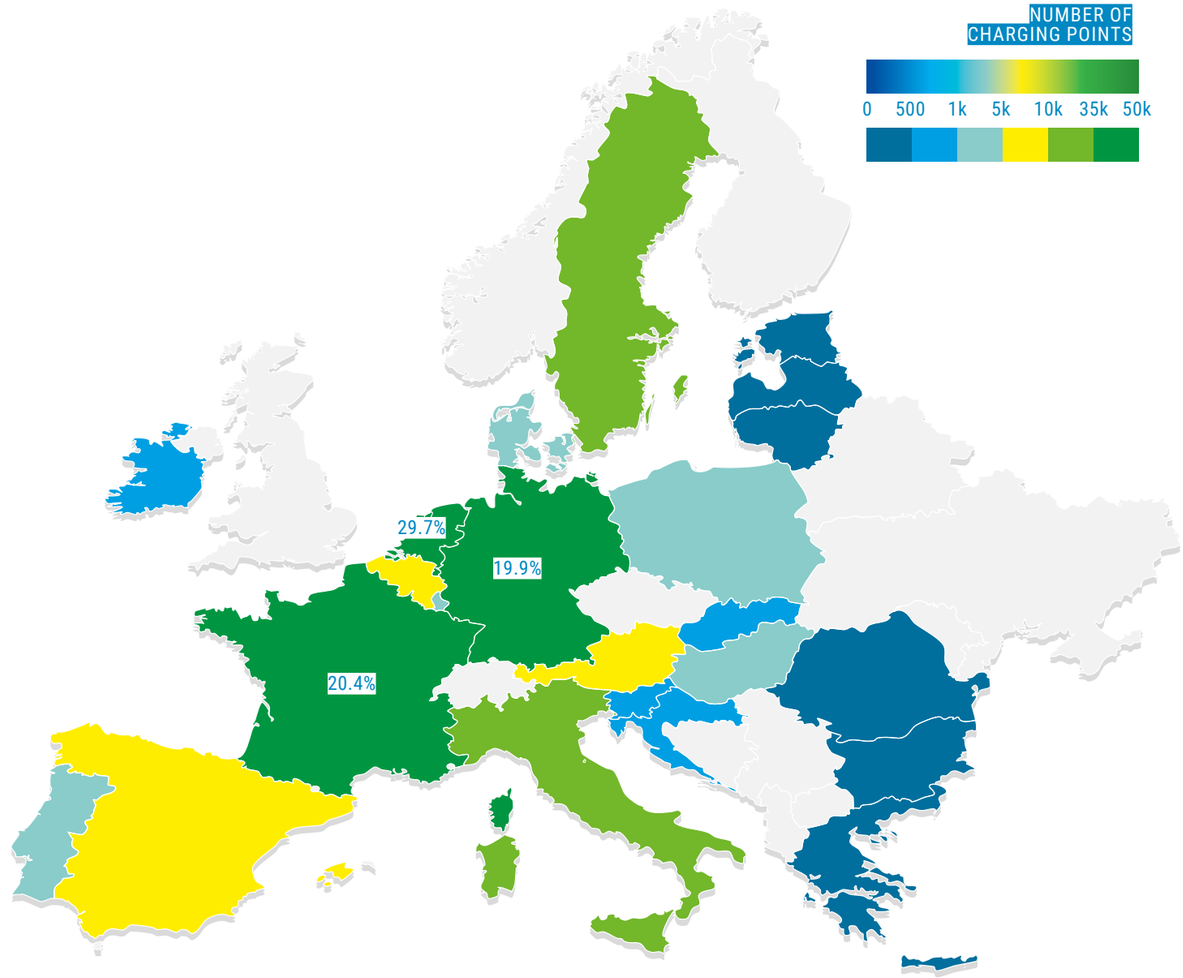
Developed public lighting infrastructure can be used for development of public EV charging points. Electric cables that power up luminaires in public lighting mean that there is availability of electric power on every public lamppost. This can reduce the need for additional groundworks and cabling in cities for purpose of developing public EV charging points. Modernisation of public lighting by replacement of sodium luminaires with LED results in up to 70% reduction in electric power meaning that there is power reserve in power supply cables that can be used for EV charging. Using existing infrastructure of public lighting 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 street lighting purposes .

EV charging on lampposts – barriers

Not all public lampposts are suited for EV charging. Problems like distance between the lamppost and parking lot or pedestrian pathways between lampposts and parking lots can present some of the obstacles in EV charging development. Also, state and available power reserve of existing power supply cables can limit the number and power of EV charging points that can be implemented on some section of public lighting infrastructure. Power supply contracts, management of public lighting and power supply of public lighting, such as round the clock power availability, as well as influence or possible disturbance in power network that can be caused by installing EV charging also need to be analysed. Another major challenge for EV charging integrated in public lighting infrastructure derives from different ownership and management structures of public lighting infrastructure across different EU countries that in some cases generates rather complex needed technical interventions.

Key EV charging takeaways

- EV charging solution that provides space-saving with no extra “street furniture” and infrastructure
- Charging points for drivers without private parking space
- Fast installation without extensive infrastructure works
- Low investment, highly scalable solution
- Market ready solutions (number of technology providers and number of different solutions)



70% OF ALL CHARGING POINTS:

29.7% NETHERLANDS 20.4% FRANCE 19.9% GERMANY

TOP 5: FEWEST CHARGING POINTS IN 2020

70 CYPRUS 96 MALTA 174 LITHUANIA 194 BULGARIA 275 GREECE

Figure 3 – Distribution of EC charges across EU
Source: https://www.acea.auto/files/ACEA_Position_Paper-Alternative_Fuels_Infrastructure_Regulation.pdf

[3] https://www.fleeteurope.com/en/new-energies/europe/analysis/1300-street-lights-converted-ev-chargers-london?a=JMA06&t%5B0%5D=Siemens&t%5B1%5D=EVs&t%5B2%5D=Charging&curl=1

[4] https://libertycharge.co.uk/

3.3.5G cellular network technology

5G network technology in general

5G is the fifth generation of cellular network technology. It delivers higher speeds, wider bandwidth, lower latency, and more advanced capabilities than its predecessors. Mobile Network Operators (MNOs) began rolling out 5G networks in 2019, and it's 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).

How fast is 5G?

5G networks are designed to achieve a peak download speed of 20 Gbps and peak upload speed of 10 Gbps. The average rates are 100 Mbps for downloads and 50 Mbps for uploads. In other words, 5G's average data speed is five times faster than 4G. It also has much lower latency as well (the time it takes to relay requests and responses from one device to another through a network). In a 5G network, the average latency is four milliseconds, and it can be as low as one millisecond for some applications, making 5G's latency more than 10 times lower than 4G. Advanced IoT applications like self-driving cars, smart farming equipment, and remote healthcare will rely on 5Gs low latency and greater bandwidth.

What's the bandwidth of 5G?

5G technology is changing the Internet of Things by offering significantly wider bandwidth and greater flexibility regarding how bands get used, enabling stable connectivity for a far greater number of devices in a concentrated area. 5G networks can facilitate connectivity on low frequencies below 1 GHz, mid frequencies from 1 GHz to 6 GHz, and high frequencies from 6 GHz to over 100 GHz. Additionally, a 5G network can connect devices over both licensed and unlicensed bands, giving providers greater flexibility with how they use the radio frequency spectrum. For comparison, commercial 4G networks can only use bands between 600 MHz and 3 GHz.

5G – 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).

5G on lampposts – market maturity

Most major carriers have already deployed 5G networks, by selling millions of 5G compatible devices. Currently, 5G service is typically only available 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 only just starting to play a role in 5G expansion plans. This development comes at a time when cities are increasingly deploying more efficient LED lighting infrastructure that is 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 and also provides 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.

5G on lampposts – benefits

As mobile operators densify their radio access networks to put 5G's capabilities to their full use, public lighting 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 will feature implementation of energy efficiency measures, project activities will clearly focus activation on new revenue streams which can be the result of optimized parking management system or waste disposal, charging of e-vehicles or 5G network slicing concessions.

5G on lampposts – barriers

Not all public lampposts are suited for 5G. Availability of basic infrastructure (power and communication cable infrastructure for 5G relays) can present one of the major obstacles in 5G development. Barriers can be summed up to legal (deployment depended on national 5G strategies and concession rules), financial (bankability of a larger scale 5G deployment can prolong the wider market presence), and technical (non existing power and communication infrastructure).

Key 5G takeaways

- Network operators will need to densify their 5G networks in near future
- 'Street furniture' such as lampposts will play a key role in deployment of high-frequency bands (only band that requires smaller antennas that could be fitted to lampposts)
- Early examples of 5G high-frequency bands are already operational in few EU countries
- Possible new revenue streams from 5G network slicing concessions for owners/operators of public lighting infrastructure
- 5G network can connect devices over both licensed and unlicensed bands, giving providers greater flexibility with how they use the radio frequency spectrum

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 through to concessions for lighting and smart services. Cities must consider different business models, financing and funding options to ensure that they chart a course that is most appropriate for them. 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 collectively are usually 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 cost 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 really 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 payments rely on achieved energy savings.

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 only 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 company guarantees savings (performance guarantees, payment mechanisms, guarantees on energy savings, guarantees on savings on energy costs etc.) but essential part of the energy performance contracting or allocation of performance risk to ESCO company 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 country 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 and standardization of preparatory procedures and analysis as well as standardization of contract documentation that is one of SMART EPC objectives 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.

EPC – benefits (Maastricht-neutral treatment)

Possibility of treating EPC projects as Maastricht-neutral or "off balance sheet" is widely seen as one of key benefits of energy performance contracting. Possibility of public authorities to mobilize private funding to accomplish ambitious energy efficiency targets without further burdening public debt has been a strong driver for use of EPCs. This led to wide interpretations of Maastricht-neutrality of EPC projects across EU and brought a lot of vagueness in EPC accounting. Following this problem, EUROSTAT and European Investment Bank have worked together and published A Guide to the Statistical Treatment of Energy Performance Contracts in May of 2018 which aimed at clarifying characteristics and contract provisions that EPC contracts should have to be treated as Maastricht-neutral. This helped to bring clarity to EPC market and set the tone for standardizing EPC model contracts. Replacing old sodium luminaires with new and efficient LED luminaires can reduce energy consumption (electric energy) up to 70% and more, especially when combined with smart systems, and since public lighting can account up to 30%-50% of electricity consumption of local authorities, EPC in public lighting is attractive way for public authorities to reach their energy efficiency targets without needing to secure upfront investments. These levels of energy savings, transferred to financial costs are also sufficient for EPC in public lighting to be attractive to ESCO companies since they can achieve interest on their investment in relatively reasonable time periods. Technical know-how and optimization, transfer of performance risks to ESCO, transfer of maintenance (functionality of lamps) risks to ESCO, repayment from energy savings without need for upfront investment and guarantees are benefits which motivate public authorities to implement EPC in public lighting.

EPC – barriers

EEnergy performance contracting is often seen as complex model for realization of energy efficiency projects. Mixture of financing problems, need for sound and detail analysis of existing state of facility or infrastructure, need for detailed energy audits, 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 etc. can make EPC model very complex and in some cases hard to implement when developing energy efficiency projects. 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, 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 key factors why EPC in public lighting is easier to implement than EPC in buildings.

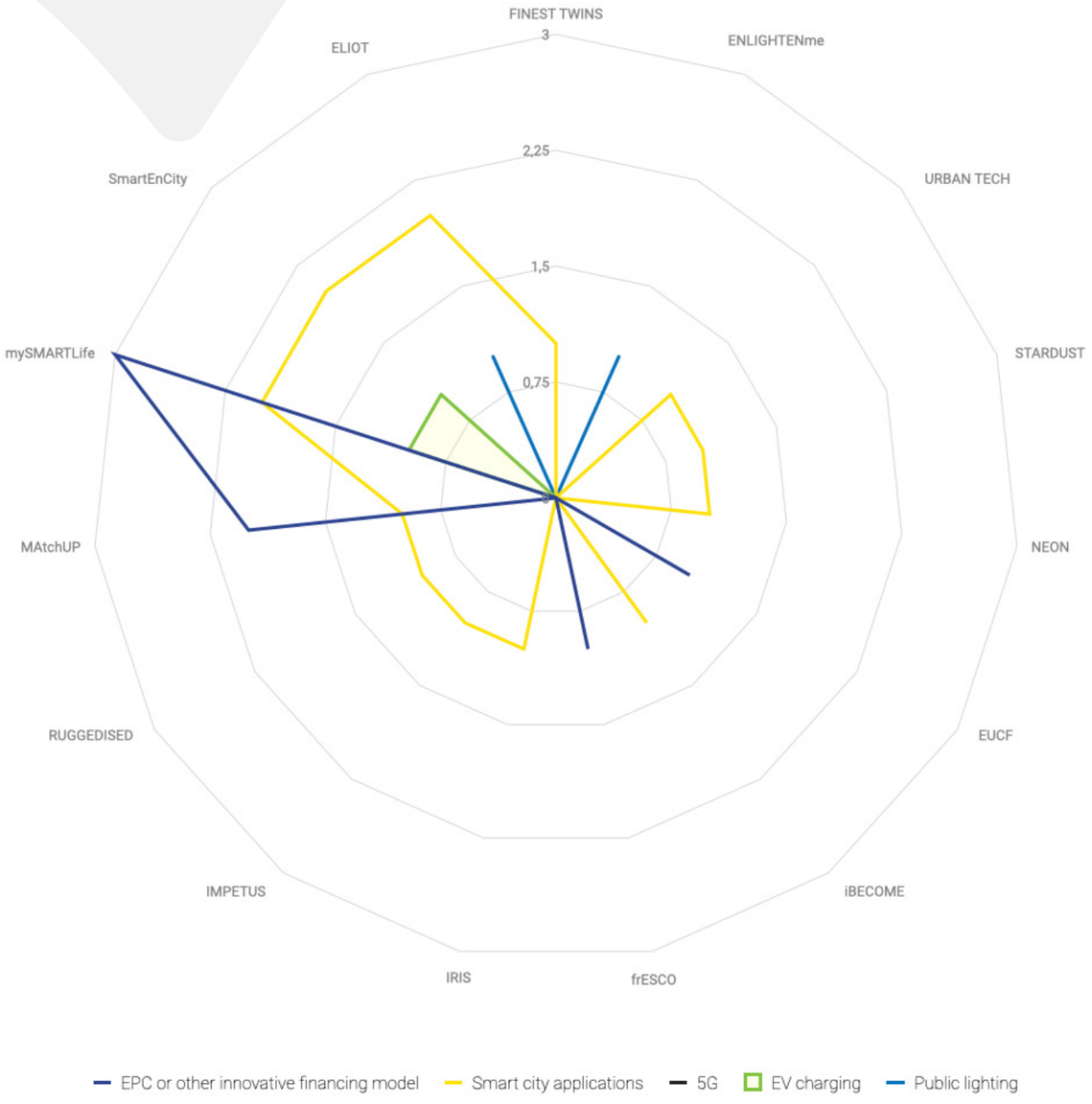
Key EPC takeaways

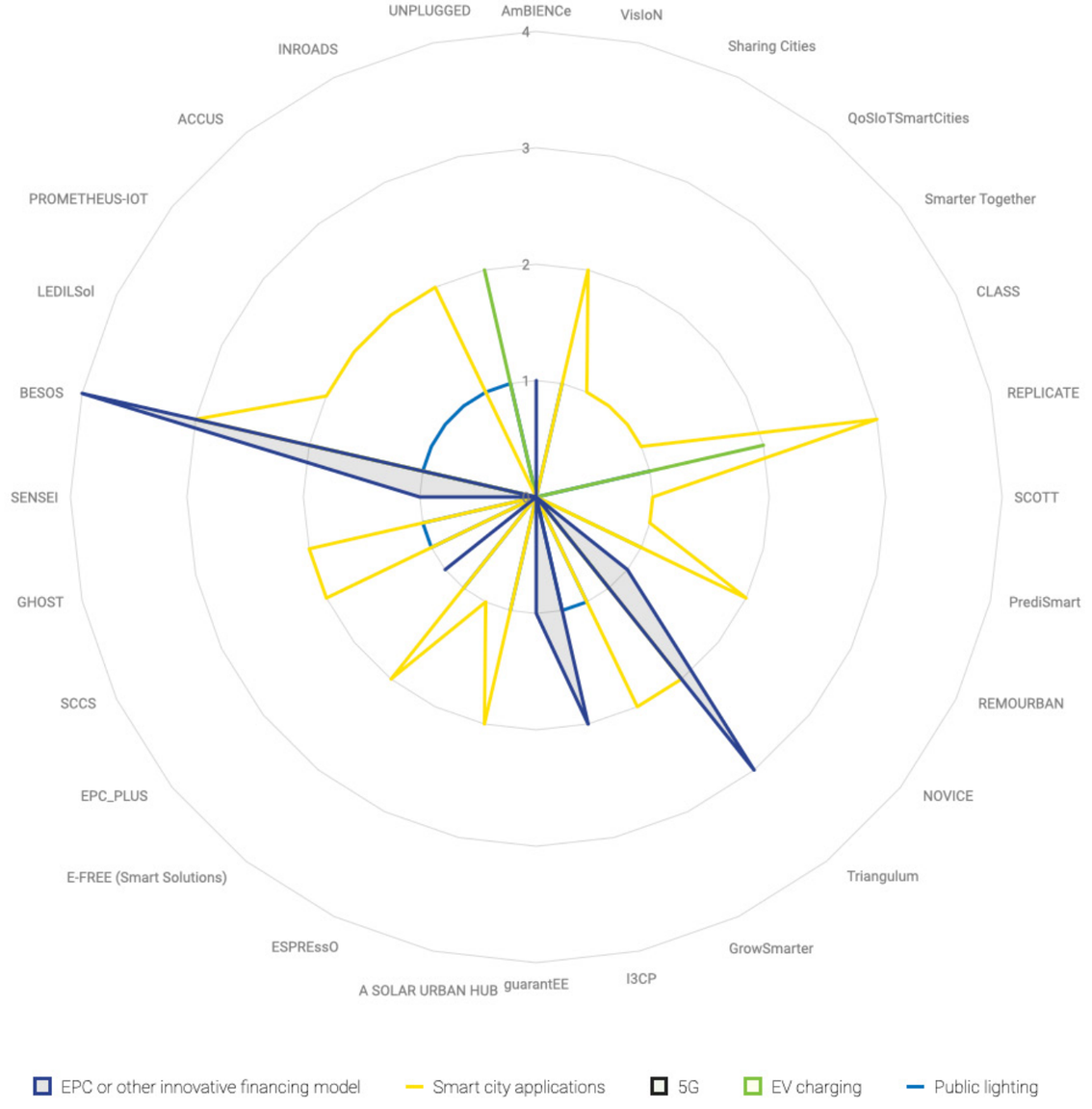
- EPC enables energy efficiency reconstructions without need for upfront investment
- EPC contract model provides guaranteed energy savings
- Energy savings are regularly measured and monitored
- EPC projects can be developed as "off balance sheet" investments for authorities
- EPC in public lighting is simpler then in buildings

Moles-Grueso, S., Bertoldi, P., Boza-Kiss, B. Energy Performance Contracting in the Public Sector of the EU – 2020, EUR 30614 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-30877-5, doi:10.2760/171970, JRC123985

5. Related EU projects and initiatives

Collaboration with other projects related to Smart EPC themes is expected to lead to new insights and knowledge/experience transmission, resulting in better view of the status quo and avoiding reinventing the wheel. The related projects are divided into two categories – ongoing projects and projects which are already completed. The cooperation is going to be established with the ongoing projects, while the results od the completed projects will be reviewed in detail, to learn from previously gained experience.





PROJECT NAME			ENERGY AND NON-ENERGY RELATED SERVICES IN PUBLIC LIGHTING						
Acronym	Full name	Objective	Public lighting	EV charging	5G cellular network technology	Smart city applications	Financing models (EPC)	Duration	Link
FINEST TWINS	Establishment of Smart City Center of Excellence	A globally unique focus on developing user-driven clean and sustainable smart city solutions that are "cross-border-by-default" in the context of emerging twin city between Tallinn and Helsinki				•		1/12/19 - 30/12/26	
ENLIGHTENme	Innovative policies for improving citizens' health and wellbeing addressing indoor and outdoor lighting	To develop a dedicated Decision Support System and guidelines and recommendation on the impact of lighting on health and wellbeing, proposing innovative lighting policies, measures, technologies and interventions aiming at improving citizens' health and wellbeing in cities	•					1/3/21 - 28/2/25	
URBAN TECH	Value chain innovations in emerging Health Tech, Smart City and Greentech industries addressing the challenges of smart urban environment	To support the acceleration of competitive success of European SMEs through market launch of new or significantly improved products and services with higher value in Health Tech, Smart City and Greentech industry sectors				•		1/9/21 - 31/8/24	
STARDUST	HOLISTIC AND INTEGRATED URBAN MODEL FOR SMART CITIES	To develop urban technical green solutions and innovative business models, integrating the domains of buildings, mobility and efficient energy through ICT.				•		1/10/17 - 31/3/24	
NEON	Next-Generation Integrated Energy Services fOr Citizen Energy CommuNities	To deliver next-generation integrated energy services for citizen energy communities to enhance the quality of life of building occupants, save energy along the value chain, and improve grid operation				•		1/9/21 - 29/2/24	
EUCF	European City Facility	To build a substantial pipeline of sustainable energy investment projects across cities in Europe					•	1/8/19 - 31/1/24	
iBECOME	intelligent Building Energy Assets Control for Comfort, Energy and Flexibility Optimisation	To increase intelligence, decarbonisation and decentralisation of the energy system by transforming building and operation data into products that can be profitable in the innovative business framework				•		1/6/20 - 30/12/23	

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Acronym	Full name	Objective	Public lighting	EV charging	5G cellular network technology	Smart city applications	Financing models (EPC)	Duration	Link
frESCO	New business models for innovative energy service bundles for residential consumers	To develop innovative business models on the basis of novel integrated energy service bundles that properly combine and remunerate local flexibility for optimizing local energy performance both in the form of energy efficiency and demand side management.					•	1/6/20 - 30/12/23	
IRIS	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities	To deliver energy and mobility services in the cities that are cheaper, better accessible, reliable, and that contribute to a better and more sustainable urban quality of life by demonstrating smart solutions that integrate energy, mobility and ICT				•		1/10/17 - 31/3/23	
IMPETUS	Intelligent Management of Processes, Ethics and Technology for Urban Safety	To address the growing security and ethical threats on smart cities, via developing an integrated toolkit that covers the complete physical and cybersecurity value chain (detection, simulation & analysis, intervention)				•		1/9/20 - 28/2/23	
RUGGEDISED	Ruggedised Rotterdam, Umea and Glasgow: Generating Exemplar Districts In Sustainable Energy Deployment	To create urban spaces powered by secure, affordable and clean energy, smart electro-mobility, smart tools and services				•		1/12/16 - 31/10/22	
MAtchUP	MAximizing the UPscaling and replication potential of high level urban transformation strategies	To transform cities by deploying novel solutions and technologies, focusing on the energy, mobility and ICT sectors				•	•	1/10/17 - 30/9/22	
mySMARTLife	Smart Transition of EU cities towards a new concept of smart Life and Economy	To develop an Urban Transformation Strategy to support cities in the definition of transition models, as a suitable path to reach high level of excellence in its development process, addressing the main city challenges and progressing to the smart people and smart economy concepts		•		•	•	1/12/16 - 30/9/22	

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SmartEnCity	Towards Smart Zero CO2 Cities across Europe	To develop a highly adaptable and replicable systemic approach towards urban transformation into sustainable, smart and resource-efficient urban environments in Europe through the integrated planning and implementation of measures aimed at improving energy efficiency in main consuming sectors in cities, while increasing their supply of renewable energy, and demonstrate its benefits		•		•		1/2/16 - 31/7/22	
ELIOT	Enhance Lighting for the Internet Of Things	To provide an open reference architecture for the support of IoT in the lighting infrastructure, build consensus reflecting the best architectural choices, contribute to standardization of lighting and telecom infrastructures in IEC, IETF, IEEE and ITU-T and provide a roadmap for IoT until 22 and beyond	•			•		1/1/19 - 30/6/22	
AmBIENCe	Active managed Buildings with Energy performaNce Contracting	To provide new concepts and business models for performance guarantees of active buildings, combining savings from energy efficiency measures with additional savings and earnings from the active control of assets, leveraging, for instance, price-based incentive contracts				•		1/6/19 - 31/5/22	
VisIoN	European Training Network on Visible light based Interoperability and Networking	To train a new generation of early-stage researchers (ESRs) in the emerging area of VLC. Targeted application areas include indoor and outdoor VLC access, smart transportation, and medical and manufacturing environments.	•			•		1/9/17 - 28/2/22	
Sharing Cities	Sharing Cities	To achieve scale in the European smart cities market, To adopt a digital first approach which proves the extent to which ICT integration can connect up existing infrastructure, To accelerate the market and trial business, investment, and governance models, to Share and collaborate and enhance mechanisms for citizens' engagement				•		1/1/16 - 31/12/21	
QoSIoTSmartCities	Quality of Service for the Internet of Things in Smart Cities via Predictive Networks	To enable the delivery of Quality of Service (QoS) for the Internet of Things (IoT) in smart cities				•		1/4/19 - 29/10/21	

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Smarter Together	Smart and Inclusive Solutions for a Better Life in Urban Districts	To develop ICT solutions for the energy transition in urban areas. A special focus will be on residential housing renovation, production and consumption of renewable energy and mobility				•		1/2/16 - 31/7/21	
CLASS	Edge and CLoud Computation: A Highly Distributed Software Architecture for Big Data AnalyticS	To develop a novel software architecture to help big data developers to combine data-in-motion and data-at-rest analysis by efficiently distributing data and process mining along the compute continuum (from edge to cloud) in a complete and transparent way, while providing sound real-time guarantees				•		1/1/18 - 30/6/21	
REPLICATE	REnaissance of Places with Innovative Citizenship and TEchnolgy	To demonstrate Smart City technologies in energy, transport and ICT	•	•		•		1/2/16 - 31/1/21	
SCOTT	Secure COnnected Trustable Things	To provide efficient solutions of wireless, end-to-end secure, trustworthy connectivity and interoperability to bridge the last mile to the market				•		1/5/17 - 31/10/20	
PrediSmart	AN INTELLIGENT PREDICTION SYSTEM FOR THE SMART EFFICIENT USE OF RESOURCES IN CITIES	An integrated scalable solution suitable for a broad range of end users such as Building Owners, FM companies, ESPCs & ESCOs, IoT platform suppliers and Utilities delivering Energy, Water and Waste collection services				•		1/12/17 - 31/7/20	https://cordis.europa.eu/project/id/745493
REMOURBAN	REgeneration MOdel for accelerating the smart URBAN transformation	To develop and validate a sustainable urban regeneration model that leverages the convergence area of the energy, mobility and ICT sectors in order to accelerate the deployment of innovative technologies, organisational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas		•		•		1/1/15 - 30/6/20	
NOVICE	New Buildings Energy Renovation Business Models incorporating dual energy services	Introducing new actors (aggregators) in building energy upgrade projects and fosters their collaboration with ESCOs, financing institutions, facilities management companies, engineering consultants to facilitate the roll out of the dual (grid services and energy efficiency) energy services model				•		1/6/17 - 31/5/20	

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Triangulum	Triangulum: The Three Point Project / Demonstrate. Disseminate. Replicate.	To demonstrate how a systems innovation approach based around the European Commission's SCC Strategic Implementation Plan can drive dynamic smart city development		•		•	•	1/2/15 - 31/1/20	triangulum DEMONSTRATE·DISSEMINATE·REPLICATE
GrowSmarter	GrowSmarter	To demonstrate smart integrated solutions for a wider market rollout	•			•		1/1/15 - 31/12/19	GrowSmarter
I3CP	Industrial and Infrastructure Investor Confidence Project	To extend the successful standardization approach of the Investor Confidence Project beyond buildings and into Industry and Infrastructure	•				•	1/5/17 - 31/10/19	I3CP
guarantEE	Energy Efficiency with Performance Guarantees in Private and Public Sector	To develop innovative business and financing models addressing and overcoming the split incentives dilemma in performance based ESCO projects					•	1/4/16 - 31/3/19	guarantEE Building Energy Services in Europe
A SOLAR URBAN HUB	A SOLAR URBAN HUB with integrated lighting and information system for optimal Smart Cities efficiency	A new concept of solar urban furniture which converts smart street lighting into an IoT enabling smart city tool	•			•		1/9/18 - 31/1/19	https://cordis.europa.eu/project/id/828485
ESPREssO	Enhancing Synergies for disaster PRevention in the EurOpean Union	To develop conceptual Smart Cities Information Framework, which consists of a Smart City platform and a number of data provision and processing services to integrate data, workflows, and processes in applications relevant for Smart Cities within a common framework				•		1/5/16 - 31/10/18	ESPRESSO
E-FREE (Smart Solutions)	Towards a more ECO, HEALTHY and SAFE environment in every single lighting scenario.	Solar Street Lights and add-on Systems on-line connected to Smart Cities and their frameworks	•			•		1/4/18 - 30/9/18	https://cordis.europa.eu/project/id/816397
EPC_PLUS	Energy Performance Contracting Plus	To overcome existing barriers and to simplify EPC models by creating and testing sample documents and finding new financing models					•	1/3/15 - 31/3/18	EPC Energy Performance Contracting Plus
SCCS	Smart City Control System (SCCS) For Green Lighting	To develop and commercialize an innovative, universal, multi-application Smart City Control System (SCCS) to be integrated with existing urban infrastructure	•			•		1/6/17 - 30/12/17	https://cordis.europa.eu/project/id/773360

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GHOST	Galileo EnHancement as BoOster of the Smart CiTies	To design, develop and validate at an operational environment a GALILEO-based intelligent system for vehicles	•			•		1/1/15 -31/12/16	https://cordis.europa.eu/project/id/641495
SENSEI	Making Sense of Human-Human Conversation Data	To design concepts and business models that will help: (a) generate new sources of benefits that increase the value of an energy retrofit project by enabling the compensation of energy efficiency as an energy resource, and (b) turn the project's value into an investable asset to attract private financing					•	1/12/13 - 31/10/16	
BESOS	Building Energy decision Support systems fOr Smart cities	To enhance existing neighborhoods with decision support system to provide coordinated management of public infrastructures in Smart Cities, and at the same time provide citizens with information to promote sustainability and energy efficiency	•	•		•	•	1/10/13 - 30/9/16	
LEDILSol	Multipurpose Cloud-Based Control Platform High Performance LED Lighting Solution for Smart Cities	To offer a smart and efficient control system to path the way towards more efficient cities and a power grid that improves the quality of life of citizens always targeting to achieve customer's loyalty through our management services	•			•		1/12/15 - 31/3/16	
PROMETHEUS-IOT	a versatile Platform foR delivering incremental, scalable and cOst-effective ad-hoc services froM hETErogeneoUS and collaborating objects in the Internet Of Things	The most used versatile WSAN platform available on the market	•			•		1/9/15 - 29/2/16	https://cordis.europa.eu/project/id/698534
ACCUS	Adaptive Cooperative Control in Urban (sub) Systems	To investigate requirements and defines a reference architecture for the integration of urban systems, based on semantic descriptions	•			•		1/6/13 -31/1/16	https://cordis.europa.eu/project/id/333020
INROADS	INtelligent Renewable Optical ADvisory System	To develop Intelligent Road Studs (IRS) combining LED lighting, sensor systems and communication technologies	•			•		1/12/11 - 31/5/15	https://cordis.europa.eu/project/id/285343
UNPLUGGED	Wireless charging for Electic Vehicles	To investigate how the use of inductive charging of Electric Vehicles (EV) in urban environments improves the convenience and sustainability of car-based mobility	•			•		1/10/12 - 31/3/15	https://cordis.europa.eu/project/id/314126