



ICT OUTPUT SPECIFICATIONS



About Smart EPC

Next generation of energy performance contracting – Smart EPC

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

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- **Funding Programme:** Horizon 2020 (call: H2020-LC-SC3-EE-2020-2)
 - **Topic:** LC-SC3-B4E-14-2020
Enabling next-generation of Smart energy services valorising energy efficiency and flexibility at demand-side
 - **Start/End:** 01 Feb 2022 / 31 Jan 2025
 - **Duration:** 36 months
 - **Grant Agreement No.** 101031639
 - **Budget:** 1.998.396,25 EUR



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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Introduction

Smart EPC output specification (e.g. **technical requirements**) represents an integral part of the Energy Performance Contract defining the technical requirements for the implementation of the measures for improving energy efficiency and standards that should be met by implementing additional energy and non-energy related services in public lighting system infrastructure. It also represents a set of functional requirements for implementation of the measures for improving energy efficiency together with additional energy and non-energy related services in public lighting that describe outputs required by the Contracting Entity. These output specifications are first to be revised and amended by Contracting Entities during the development of the Smart EPC project in accordance with their own needs. They will also be revised, if needed, after stakeholder workshops and market consultations, if service and technology providers have requirements for amendment of these specifications and if the reasons for these amendments are valid as well as if these specifications are obsolete (if service standards have changed and evolved).

When amending output specifications, Contracting Entities should try to avoid defining specific technologies if possible and should try to specify desired outputs of services in the form of required functionalities and quality of service. This should create surroundings for competitive tender procedure where different technologies and service providers would compete in delivering required outputs in the most reliable and affordable way. More detailed technical specifications and requirements should be limited to situations where certain preferred technologies are well known (e.g. LED technology) or where regulations dictate minimum requirements (e.g. illumination standards).

To help the Contracting Entity and service and technology providers navigate through the document, Smart EPC output specification (technical requirements) is divided into four key parts (A, B, C and D) following the logic of development of the project. These parts differ according to the specific requirements in each phase (period) of the EPC contract duration:

PART A – minimum technical requirements and service standards
(should be maintained in every phase of EPC contract implementation)

PART B – design and implementation phase

PART C – reconstruction and/or modernisation phase

PART D – use phase

Note: the texts in red distinguish aspects dependent on national context.

Part A of the Output specification

– minimum technical requirements and service standards

In this part of Smart EPC technology output specification, minimum technical requirements and service standards are set for every phase of the duration of the EPC Contract. EPC service Provider is obliged to maintain them during the entire duration of the EPC Contract.

1 Minimum technical requirements for equipment and material

Below listed are the minimum technical requirements that need to be met in all EPC contract implementation phases (periods). The minimum technical requirements refer to the subject of implementing the energy efficiency improvement measures.

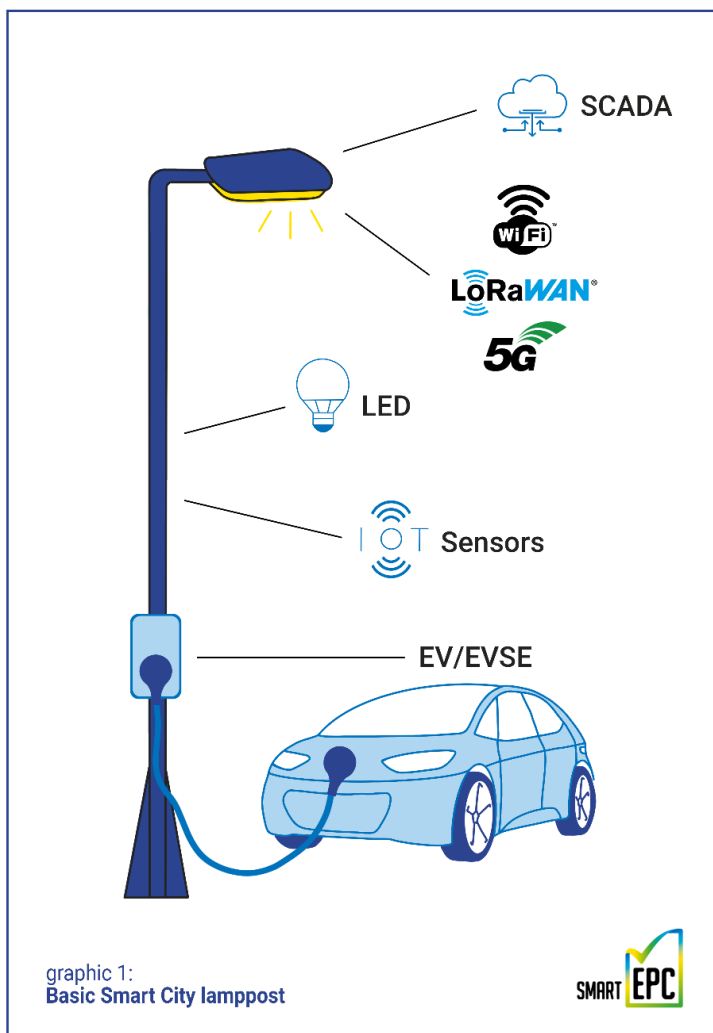


Image1.1 Overview of the subject of the implementation of the Measures for improving energy efficiency

Legend:

- A- Luminaire with equipment for post attachments (bracket/arm) and Communication module for two-way data transfer between the MCC and the luminaire.
- B- Management and Control Centre and the wireless network infrastructure for two-way data transfer between the MCC and the luminaire (hereinafter referred to as: MCC application)

1.1 Technical requirements for the luminaire and related luminaire equipment (A)

Table 1 A list of general technical requirements for the luminaires

Requirement number	Requirement description	Limitation
Requirement 1	General requirements for the luminaire	
1.1	Upward light output ratio (<i>ULOR</i>)	0%
1.2	Electric shock safety class	Class II for wooden and concrete poles Class I for iron poles
1.3	Inspection of products, manufacturers, manufacture process carried out, i.e. a certificate proving that the manufacture process is checked periodically and that it takes into account the manufacture verification test in addition to the verification of compliance of products with the requirements of the European safety standards harmonised with the requirements of European directives and standards	
1.4	Compliance with the Directive 2014/30/EU of the European Parliament and of the Council on the harmonisation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive, <i>Electromagnetic Compatibility</i>)	

Table 2 A list of technical requirements for the luminaire housing

Requirement number	Requirement description	Limitation
Requirement 2	Requirements for the luminaire housing	
2.1	Level of protection of the luminaire against the ingress of solid objects and liquids (IP protection code)	Min. IP66
2.2	Level of protection of the luminaire against mechanical impact (IK protection code)	Min. IK08
2.3	Integrated luminaire socket for connecting the communication module and/or sensor or actuator	Fitting in accordance with the Zhaga standard or equivalent ¹ with all necessary wiring
2.4		Min. two sockets - one on the top of the luminaire for the communication module and one

¹ In all parts of this document where the Zhaga standard is mentioned, the use of an equivalent or better connector is allowed, with the criteria for equivalence being:

- the possibility of connecting a communication module and sensor or actuator of a larger number of manufacturers;
- fitting the connectors prescribed by open standards accessible to everyone;
- fitting the connectors with min. 4 pins:
 - 24 VDC power supply
 - DALI 2.0, positive polarity,
 - joint pin for DALI 2.0 negative, power supply grounding, General Digital IO (input/output) grounding,
 - LSI (logical signal input).

		on the underside of the luminaire for the sensor or actuator
2.5		Supplied with weather-resilient covers, with min. IP66 protection level if the modules have not been fitted yet
2.6	Light source protection	Flat glass
2.7	Structure modularity	Luminaire housing service cover connected without a screw connection with the luminaire and possible to be opened without the use of tools. The cover does not detach itself from the housing when opened
2.8	Housing material	Diecast anti-corrosion aluminium with <0.5% copper content
2.9	Housing sealing ring	Silicone or PTFE or equivalent (thermal and chemical stability, elasticity) sealing ring
2.10	Housing volume	Enough space for separate surge protection device and two integrated sockets for connecting the communication module and/or sensor or actuator

Table 3 A list of technical requirements for the driver

Requirement number	Requirement description	Limitation
Requirement 3	Driver	
3.1	Input voltage	230 V AC \pm 10%
3.2	Frequency	50 Hz
3.3	Power factor	When luminaire is dimmed to 75% of the nominal luminaire power, $\cos \phi \geq 0,95$ is maintained
3.4	Lifetime at 10% failure (B10)	Min 100,000 hours
3.5	Nominal driver output current	≤ 750 mA
3.6	Constant Lumen Output within the luminaire lifetime (CLO)	
3.7	Compatibility with DALI 2.0 extended two-way communication protocol	
3.8	Available DC 24V supply for the communication module and sensor or actuator	
3.9	Possibility for simultaneously connecting the communication module and the sensor (i.e. actuator) module to the feeder (24 VDC) and communication (DALI 2.0) driver lines	
3.10	Possibility of a two-way transfer of data from the Management and Control Centre via the communication module to the driver and the sensor, i.e. the actuator, and vice versa	
3.11	Internal memory storing the measured data of enough storage capacity to be able to store 48 hour recorded data	
3.12	Installed surge protection at the input circuit	
3.13	Possibility of online access to the technical data of the driver via the Management and Control Centre	

3.14	Inrush current limitation circuit
3.15	Over temperature protection device that reduces the LED module supply current if the Tc temperature exceeds the nominal product values
3.16	Possibility of reading luminaire energy parameters (current, voltage, power, energy consumption, number of operating hours etc.), with the allowed uncertainty of measurement of maximum 1% for the measuring of active power

Table 4 A list of technical requirements for the LED module

Requirement number	Requirement description	Limitation
Requirement 4	LED module	
4.1	Corelated colour temperature	≤ 3000 K
4.2	Corelated colour temperature in Natural protected areas in compliance with the regulation	≤ 2200 K
4.3	Colour rendering index (CRI)	≥ 70
4.4	Environmental requirements	The newly fitted luminaires need to be classified into group RG0, RG1 or RG2 in compliance with EN 62471:2010 or equivalent. The RG2 group luminaires not be fitted into the positions where the distance between the luminaire height and the observer is smaller than the minimum safety threshold defined by the test report pursuant to IEC TR 62778:2014 or equivalent.
4.5	Environmental requirements	G – index ≥ 1.5 With exception G – index ≥ 2 in Protected areas in compliance with the regulation
4.6	Light source lifetime of L90 ²	Min. 100,000 hours
4.7	Possibility of thermal imaging of the module and the driver	
4.8	Automated LED bridge of a non-functioning module	

Table 5 A list of technical requirements for surge protection

Requirement number	Requirement description	Limitation
Requirement 5	Surge protection	
5.1	Integrated surge protection in the driver	Class III device pursuant to EN 61643-11 or equivalent with 6 kV protection

² The test report needs to show the lifetime of the LED light source at L90, by applying the methodology defined in the instructions within IES TM 21-2011 (Projecting Long Term Lumen Maintenance of LED Light Sources), or equivalent, with the parameters corresponding to the offered luminaires (colour temperature, LED module supply current, LED module operating temperature (tc)) at 25°C ambient temperature (ta).

5.2	Separate surge protection in the luminaire housing	Class II or Class II + III device pursuant to EN 61643-11 or equivalent with the protection of 10 kV
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Table 6 A list of technical requirements for the brackets/arms

Requirement number	Requirement description
Requirement 6	Luminaire brackets/arms
6.1	Surface protection done by hot-dip galvanisation
6.2	Maximum length up to 15% of the pole height Installation of the overweight is allowed only if the width of the illuminated area is larger than the product of the 1,3 factor and the height of the existing luminaire and in that case the overweight of a maximum height of 10% of the pole height is allowed.
6.3	Maximum arm inclination in relation to the horizontal plane +5°
6.4	Integrated attachment for installing plugs
6.5	Air network necessitates the installation of Plugs – male jacks for public lighting with minimum characteristics: - minimum IP66 protection, protection from unplugging the male jack from the plug, min 16 A max 250 V, connection with no possibility to replace contacts, cable installed – PP00 3x1.5 mm ² – 1.5 m

Specific technical requirements are defined for Urban luminaires in the table below (Table 7) In the case that the Specific technical requirements listed in the table below (Table 7) differ from the requests listed in the other tables (Table 1, Table 2, Table 3, Table 4, Table 5, Table 6, Table 8), the requests from the table below (Table 7) shall be applied. The above mentioned is only valid for Urban luminaires in accordance with the definition in Annex 1 of the Contract.

Table 7 A list of technical requirements for Urban luminaires

Requirement 7	Specific requirements for Urban luminaire	Limitation
7.1	Colour rendering index (CRI)	≥ 80
7.2	Light distribution	Possibility of fitting symmetric and roto-symmetric (circular symmetric) optics
7.3	Integrated luminaire socket for connecting the communication module	Fitting in accordance with the Zhaga standard or equivalent ¹ with all necessary wiring One socket for the communication module
7.4	Housing shape	In a horizontal cut view, the luminaire housing must be of a circular or elliptical shape

Table 8 A list of technical requirements for the communication module

Requirement number	Requirement description
Requirement 8	Communication module and antenna

8.1	Possibility of fitting onto the upper side of the LED luminaire housing via a Zhaga socket or equivalent ¹ , on condition of maintaining minimum IP66 housing protection against harsh weather conditions
8.2	Direct access and availability via wireless networks
8.3	24 VDC supply connector from the luminaire driver via integrated socket
8.4	Module electric power of up to 0.5W
8.5	Communication with the driver and the sensor, i.e. the actuator, via two-way DALI 2.0
8.6	Internal memory accessible through the Management and Control Centre with storing the measured data of minimum 2MB for saving recorded data from the driver and sensor and/or actuator
8.7	Two-way communication with the MCC (receiving orders from the MCC and access to the technical data from the driver through the Management and Control Centre)
8.8	Own identification address

The technical solution must have the possibility of subsequent sensor and/or actuator installation according to the plug and play principle without any additional costs of luminaire and communication module adjustment, i.e. without additional costs of wiring, supplying, reading data from the sensor and/or sending data to actuator and the Management and Control Centre.

1.2 Information on data transferred between the luminaire and MCC

Communication between each luminaire and MCC shall be two-way, i.e.:

- a) Sending data from the MCC to the luminaire
 - DATA TYPE
 - dimming regime (control of the output luminous flux of the luminaire),
 - controlling the luminaire (switch on/off/setting the time delay for switching on the luminaire),
 - driving the actuator;
 - FREQUENCY: irregularly as requested by the Contracting Entity;
- b) sending data from the luminaire to the MCC
 - DATA TYPE
 - Voltage (V);
 - Current (I);
 - current active power (W);
 - Cos fi;
 - Current dimming regime;
 - Luminaire diagnostics;
 - Exact time of data reading
 - other data from the luminaire as requested by the Contracting Entity;
 - data from the sensor that will be installed according to the Contracting Entity's needs.
 - FREQUENCY: minimum once in 24 hours, frequency of data transfer must be in accordance with internal memory of the control device where data stated above is stored (if internal memory is not big enough to store data stated above for 24 hours than data sending frequency must be more often)
- c) sending data from the luminaire to the third application which the Contracting Entity shall subsequently provide information on:
 - DATA TYPE

- Voltage (V);
- Current (I);
- Operating power (W);
- Cos fi;
- luminaire failure code;
- miscommunication;
- Current dimming regime;
- Exact data upload time;
- Luminaire diagnostics;
- record from the ripple control receiver on switching the Public Lighting System on
- data from the sensor that will be installed according to the Contracting Entity's needs.
- FREQUENCY: two times a day during the public lighting operating hours (around 750 times a year per luminaire).

The Contracting Entity retains the right to increase the data transfer quantity on particular luminaires on the account of the decreased data transfer quantity on other luminaires in the Public Lighting System, as long as the data transfer quantity stays within the limits set in this chapter.

1.3 Technical requirements for the Management and Control Centre (B)

1.3.1 Purpose of the Management and Control Centre (MCC)

The purpose of the Management and Control Centre (hereinafter referred to as: MCC) is to provide to the Contracting Entity and the Provider an access to relevant data that will enable the systematic monitoring and control of the Energy Performance Contract (proof of availability), an automated way of adjustment of the Fee in the Energy Performance Contract and enable dynamic control of the public lighting system management and regulation.

The MCC shall enable:

- Uploading of static data about the public lighting system;
- Uploading of dynamic data from luminaire communication modules;
- Archiving of all collected data;
- Display of uploaded and archived data (in line with the search by the user criteria);
- Sending data to luminaires for the purpose of managing and regulating the public lighting mode of operation (of single or grouped luminaires);
- Review, reporting and analysis of the uploaded data for the purpose of establishing the availability level (number of failures, number of luminaires operating on the power greater than guaranteed etc.);
- Calculation of fee adjustment based on the collected data;
- Supervision and reporting for the purpose of tracking work orders when the system is inaccessible (for example elimination of failures etc.) and obtaining automatic calculation of a fee adjustment;
- Planning and supervision of future public lighting maintenance, upgrade and expansion activities;
- Interactive user support for the Contracting Entity (24h a day all 365/6 days of the year) for the entire term of the contract;
- upgrading the software for uploading, analysing and reporting on the basis of data gathered from the sensor that will be connected to the integrated sockets on the luminaire;

- controlling actuators which will be connected to the integrated sockets on the luminaire;
- Integration of the Contracting Entity's existing software systems.

1.3.2 Application setup of the Management and Control Centre

The MCC has to be made with open source programmes that are based on use and support of open standards that enable connecting with other programme solutions of the Contracting Entity, as well as exchanging data between programme solutions between the Contracting Entity's various information systems. There has to be a possibility of using open source developing tools, due to the specificity of the application and the possibility of use on various operating systems; the software has to be multi-platform. (OPTIONAL - The MCC has to be based on open-source software, i.e. the Contracting Entity must have access to the source code and the ability of free use, study, modification and improvement of the original software code.)

As requested by the Contracting Entity, the MCC has to enable the integration of up to 250,000 of luminaires that are not in the scope of implementation of the Measures for improving energy efficiency, but with which the Contracting Entity shall have the same functionality with as with the luminaires in the scope of implementation of the Measures for improving energy efficiency of the Public Lighting System.

The system should be made in microservice architecture, i.e. based on smaller software components with clearly defined business functionalities with every action functioning individually. The gathered data from referential devices have to be stored in NoSQL type data base adjusted to store large quantities of data comprised of "time and value" pairs. System components (data base, channels, message, services) have to be made as distributed services with ensured ability of redundant operation (the system continues to operate in the event of a single network node crash) and horizontal scaling of each component depending on transfer volume. MCC architecture shall be a microservice architecture, with docker based installation approach onto the cloud data centre. The system should be executed as a series of modules that can be individually scaled in a horizontal way.

The system has to operate 24/7, therefore it is necessary to ensure redundant operating mode whose redundant modules shall ensure that the MCC continues to operate in the case of a primary module failure.

The use of globally accepted standards for central management sites of the interface for configuration, command, control and supervision of heterogeneous outdoor lighting networks is obligatory.

The MCC layering is planned in four abstraction layers:

- 1st level (equipment) – elements of the public lighting system and location data with descriptive attributes (lighting resources)
- 2nd level (application) – a communication system for remote measuring and control (information from the luminaire and management resources of the luminaire);
- 3rd level (application) – a business system for the planning, proactive maintenance and service management;
- 4th level (application) – presentation layer, i.e. business system for reporting, planning, control and management.

Application support comprises a number of mutually integrated layers, with each of the 'layers' being in charge of a specific segment in the value chain, while at the same time being accountable to some of the architecture levels. The basic, i.e. the lowest layer at which the processes take place represents the existing or future components of the asset (luminaires).

The first application layer covers the first level with a record of all public lighting system data (location, technical properties, maintenance records etc.), and the second level related to the supervision and control infrastructure with public lighting system elements, collecting data from the sensor, processing them in real time and monitoring the service parameters in line with the defined actions and algorithms. This layer initiates certain public lighting system management operations and/or actuators connected to the luminaire. This layer has a direct interface with management functions on the system monitoring and control devices.

The second application layer exchanges certain operational and business data with the first application layer, processes them, establishes their operational relevance, and on the basis of smart algorithms and defined contractual obligations undertakes operational steps it can send to the first application layer or to the Contracting Entity/Provider. This layer serves as an 'umbrella' for all operating processes and orchestrates the processes relevant for the delivery and maintenance of both basic and control infrastructure. The second application layer connects technical data and transforms them into business data used for calculations and reporting. The first and the second layer are used for real time reporting to the client.

The third application layer receives data from the second one and processes them in order to manage the supporting services. This layer covers contract management, alerts (defects, malfunctioning, deviations from parameters), maintenance (preventative and corrective) and space/location management. It needs to provide necessary access (API) to the rest of the Contracting Entity's systems, as well as the functionalities needed for visualisation, planning, control and management.

The fourth application layer is the presentation layer for the user used for reporting (report on operating power, report on the consumption of electrical energy, and other reports as requested by the Contracting Entity), planning (dynamic site planning and estimating the electrical energy consumption and costs on the basis of collected data), control (via user web portal) and management of the entire system and pertaining teams.

IP device communication with the application has to be supported. It is necessary to use standard communication protocols such as UDP, TCP, HTTP, MQTT, COAP, oneM2M.

1.3.3 Functionalities of the Management and Control Centre

This chapter lists the MCC application modules with the basic functionality that every module has to have. The MCC functionality stated in this chapter is reinforced with the Monitoring, measurement and verification (Annex 4 to the Energy Performance Contract).

- Module 1 – Static data
- Module 2 – Long-distance data reading
- Module 3 – Data archiving
- Module 4 – Data representation
- Module 5 – Sending data in order of managing operating and dimming regime of the public lighting
- Module 6 – Alarms
- Module 7 - Reports and calculations

- Module 8 – Control module
- Module 9 – Planning and supervision of the public lighting system
- **OPTIONAL**
 - Module 10 – Receiving and processing sensor applications data (parameters, consumption, working time, etc.)
 - Module 11 – Receiving and processing data from the EV chargers (consumption, working time, etc.)
 - Module 12 - Receiving and processing data from other consumers (5g, communication technologies, etc.) (consumption, working time, etc.)
 - Module 13 – Receiving and processing intelligent transport applications data (parameters, traffic congestion, street light data, power consumption, working time etc.)

1.4 Technical requirements for communication technologies

Minimum technical requirements for communication technologies (5G street side solutions) are listed below.

Requirement number	Requirement description	Limitation
Requirement 1	General requirements for the street radio station	
1.1	TX/RX	4T 4F FDD
1.2	LTE Carriers support	Up to 6 LTE Carriers
1.3	Band support	Separate radio cores for B2/25 and B66a
1.4	IBW	Full band support (70Mz, 65MHz for B66a and B2/25)
1.5	TCBW	Full band support
1.6	IP Rating	Min. IP 65
1.7	Operating temperature	-40°C to +55°C
1.8	NBIOT Support	In-band, Guard band and Standalone
1.9	Compact design	Virtually unseen from street level
1.10	Compatible power source	360M NEMA (or ZAGA) streetlights globally or equivalent
1.11	Dimension	Up to 414x239x99 mm
1.12	Weight	Up to 7.5 kg
1.13	Power supply	Nominal 110V to 480V AC 50/60Hz
1.14	Power source	Through ANSI C136.41 NEMA Connector , Thaga socket or equivalent
1.15	Avg. power consumption	Up to 120W
1.16	Integrated radio core	4T4R micro radio core inside
1.17	Integrated antenna	4x4 MIMO Antenna designed for streetlight deployment
1.18	Internal sensors	Tilt, vibration and ambient light
1.19	External sensor connectivity	Via DALI Interface or equivalent
1.20	Location awareness	Integrated GPS

In addition to the above, the street side solution should have the following programmable parameters, utility data module functions and power meter specifications

- Customer device management
- Scheduling controls
- Alert thresholds
- Photocell thresholds
- Fault detection
- Tilt detection
- Vibration detection
- Power loss after power failure
- Network communication failure
- Voltage swag and swell detection
- IOT data transmission & reporting
- Remote firmware upgrades
- Accuracy and verification
- Line voltage and accuracy
- Current accuracy
- Power
- Energy consumption
- On / off cycles
- Running hours

1.5 Technical requirements for integrated lamppost EV charging

Minimum technical requirements for EV charging are listed below.

Table 9 A list of technical requirements for the communication module

Requirement	EV charging
9.1	Operating voltage 230 V, single phase
9.2	Input frequency 50 Hz
9.3	Air cooled to protect the equipment against temperature hazards
9.4	Mushroom headed push button for emergency stop switch (OPTIONAL)
CHARGING POWER OUTPUT	
9.5	Sum of the power output of all chargers powered from same distribution cabinet must be lower than available power of the distribution cabinet
9.6	Chargers must have capabilities to be connected via load management software (directly through CPO and/or third-party load management system). The power output of each charger must be able to reduce depending on the available capacity (capacity from the distribution cabinet decreased by the power of working luminaires and other chargers)
COUPLER	

9.7	The point of connection to the EV (Coupler) is of robust design and compliant with IEC 62196-1 & IEC 62196-3 or equivalent or higher standards.
9.8	Not rated for disconnection under load: locking mechanisms are used to safeguard against this event alongside a timed turn off for unintended cut off.
9.9	Easy to use and ergonomic in design whilst offering reliability and resilience to their use.
9.10	The minimum service life is no less than 10,000 charging sessions.
9.11	Public metered AC outlet and the vehicle connector outlet to have provision for locking mechanism during charging to ensure the safety of the cable
CHARGE POST	
9.12	IP54 ingress protection or better (according to IEC 60529:1989) and an IK 10 impact rating or better
9.13	Equipped with tilt switches capable of safely shutting down and isolating all incoming electrical feeds to the charge post. (OPTIONAL)
9.14	Fitted with appropriate filters to combat EMC and EMI interferences. Appropriate filters should be used as part of the charge post design to afford protection against propagated emissions and common mode currents. As a minimum charge post must comply to IEC 618-51-21-2 or local equivalent standards or higher standards.
9.15	Provided with the facility to using either a wireless (SIM) or wired (LAN) configuration to provide connectivity to the internet. (OPTIONAL: PLC)
9.16	Capable of having firmware remotely updated
9.17	Compliant with OCPP 1.6 JSON communication protocols (and all future versions of such) to allow a charge post operator to perform at a minimum core, firmware management, smart charging, local auth list management, remote trigger and reservation profiles.
9.18	Capable of being remotely monitored, diagnosed and maintained by a suitable qualified charge post operator.
9.19	Metering device complies with all applicable regulations to include set functionality, accuracy, security and cybersecurity standards
9.20	2% accuracy according to EN 50470-1/3
9.21	Plug-and-charge ready, specifically in accordance with the requirements of ISO15118-1 and all future editions of such.
9.22	Payment via UPI compliant mobile application payment or via mobile phone application
9.23	On board connector Type 2
9.24	Charging mode 3 EN 61851-1

Technical Compliance Requirements

For charge posts complying to IEC Standards

IEC 61851-1:2010 Electric vehicle conductive charging system - Part 1: General requirements

IEC 60364-5-54:2011 Low-voltage electrical installations

IEC 61140 Protection against electric shock - Common aspects for installation and equipment

IEC 61439-1:2011 Low voltage switchgear and control gear assemblies

IEC 61557-8 Electrical safety in low voltage distribution systems up to 1000 V AC and 1500 V DC

IEC 61558-1:2005 Safety of power transformers, power supplies, reactors and similar products
IEC 62196-3 Plugs, socket outlets, and vehicle couplers - Conductive charging of electric vehicles
IEC 62196-3 Plugs & Couplers

For electrical equipment complying to IEC Standards

IEC 60076 Power transformers
IEC 60076-1, Power transformers Part 1: General
IEC 60076-2, Power transformers Part 2: Temperature rise for liquid-immersed transformers
IEC 60076-3, Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-5, Power transformers Part 5: Ability to withstand short circuit
IEC 60076-7, Power transformers Part 7: Loading guide for mineral-oil-immersed power transformers
IEC 60076-10, Power transformers Part 10: Determination of sound levels
IEC 60076-11, Power transformers part 11: Dry-type transformers
IEC 60076-12, Power transformers Part 12: Loading guide for dry-type power transformers
IEC 60085, Electrical insulation Thermal evaluation and designation
IEC 60270, High-voltage test techniques partial discharge measurements
IEC 60332-3-10, Tests on electric cables under fire conditions—Part 3-10: Test for vertical flame spread of vertically-mounted bunched wires of cables—Apparatus
IEC 60529, Degrees of protection provided by enclosures (IP Code)
IEC 60721-3-4, Classification of environmental conditions—Part 3: Classification of groups of environmental parameters and their severities—Section 4: Stationary use at nonweather protected locations
IEC TS 60815-1, Selection and dimensioning of high voltage insulators intended for use in polluted conditions Part 1: Definitions, information and general principles
IEC 61378-1, Converter transformers Part 1: Transformers for industrial applications
IEC 62271-202, High-voltage switchgear and control gear—Part 202: High-voltage/low-voltage prefabricated sub-station
ISO 12944-6, Paints and varnishes corrosion protection of steel structures by protective paint systems Part 6: Laboratory performance test methods.
IEC 60068-3-3, Environmental testing Part 3-3: Guidance seismic test methods for equipment
IEC 60071-1, Insulation co-ordination-Part 1: definitions, principles and rules
IEC 60071-2, Insulation co-ordination Part 2: Application guidelines
IEC 61439-1, Low-voltage switchgear and control gear assemblies Part 1: General rules
IEC 61439-2, Low-voltage switchgear and control gear assemblies Part 2: Power switchgear and control gear assemblies
IEC 61439-3, Low-voltage switchgear and control gear assemblies Part 3: Distribution boards intended to be operated by ordinary persons (DBO)
IEC 61439-6, Low-voltage switchgear and control gear assemblies Part 6: Busbar trunking systems (busways)
IEC 61439-7, Low-voltage switchgear and control gear assemblies Part 7: Assemblies for specific applications such as marinas, camping sites, market squares, electric vehicle charging stations
IEC 62271-1, Common specifications for AC switchgear & control gear
IEC 62271-100, AC circuit-breakers
IEC 62271-102, Alternating current disconnectors and earthing switches
IEC 62271-103, Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-200, AC metal enclosed switchgear and control-gear for rated voltages above 1 kV and up to and including 52 kV

IEC 62271-206, Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV
 IEC 61869-2, Additional requirements for current transformers
 IEC 61869-3, Additional requirements for inductive voltage transformers
 IEC 61243-5, Voltage detecting systems (VDS)
 IEC 60529, Degrees of protection provided by enclosures (IP Code)
 IEC 60376, Specification of technical grade Sulphur hexafluoride (SF6) and complementary gases to be used in its mixtures for use in electrical equipment
 IEC 60044-8, Instrument transformers - Part 8: low power current transducers
 IEC 60255, Measuring relays and protection equipment

1.6 Technical requirements for Smart City applications

Minimum technical requirements for environment sensors are given below.

Requirement number	Requirement description	Limitation
Requirement 1	General requirements for environment sensors	
1.1	Stations for monitoring air quality, weather and noise level must support sending data to a central system for collecting and storing readings via Ethernet, 3G/4G, Wi-Fi or 5G	
1.2	Measuring stations must support reading parameters at least every 60 seconds, and sending data to the central storage system at least every 15 minutes (variable from 1 min to 1 h).	
1.3	The measuring stations management system must provide access to the read data via a web service or programming interface (API).	
1.4	The measuring stations management system must support verification and automatic verification of read data in order to remove irregular or incorrect readings.	
1.5	Measuring stations must have an authorized service center on the territory of the EU.	
1.6	Statement on calibration of measuring stations on the territory of the EU, certified by the equipment manufacturer	
1.7	The bidder must provide service and technical support for the entire duration of the warranty period, and is obliged to respond to service intervention within 24 hours from the day of receiving the call for service intervention	
1.8	The bidder must ensure the replacement of defective electrochemical sensors and any malfunctions within 72 hours of the application.	
1.9	Stations for monitoring air quality, weather and noise level must support sending data to a central system for collecting and storing readings via Ethernet, 3G/4G, Wi-Fi	
1.10	Measuring stations must support reading parameters at least every 60 seconds and sending data to the central storage system at least every 15 minutes (variable from 1 min to 1 h).	
1.11	The measuring stations management system must provide access to the read data via a web service or programming interface (API).	
1.12	The measuring stations management system must support verification and automatic verification of read data in order to remove irregular or incorrect readings.	

1.13	Measuring station for air quality monitoring with a set of sensors for measuring concentrations of CO, NO, NO ₂ , SO ₂ , O ₃
1.14	Electrochemical sensors for measuring carbon monoxide (CO) concentrations in the air in the range from 0 to 10,000 ppb with a lower detection limit of at least 100 ppb and a minimum resolution of 1 ppb
1.15	Electrochemical sensors for measuring concentrations of nitrogen monoxide (NO) in the air in the range from 0 to 5,000 ppb with a lower detection limit of at least 10 ppb and a minimum resolution of 1 ppb
1.16	Electrochemical sensors for measuring concentrations of nitrogen oxide (NO ₂) in the air in the range from 0 to 5,000 ppb with a lower detection limit of at least 10 ppb and a minimum resolution of 1 ppb
1.17	Electrochemical sensors for measuring concentrations of sulfur dioxide (SO ₂) in air in the range from 0 to 5,000 ppb with a lower detection limit of at least 10 ppb and a minimum resolution of 1 ppb
1.18	Electrochemical sensors for measuring concentrations of ground ozone (O ₃) in the air in the range from 0 to 5,000 ppb with a lower detection limit of at least 10 ppb and a minimum resolution of 1 ppb
1.19	Measuring station for air quality monitoring with a set of sensors for measuring concentrations of CO, NO, NO ₂ , SO ₂ , O ₃
1.20	Electrochemical sensors for measuring carbon monoxide (CO) concentrations in the air in the range from 0 to 10,000 ppb with a lower detection limit of at least 100 ppb and a minimum resolution of 1 ppb
1.21	Measuring station for air quality monitoring with a set of sensors for measuring concentrations of PM ₁ , PM _{2.5} , PM ₁₀ in the air
1.22	Optical sensors for measuring concentrations of floating particles PM ₁ in the air in the range from 0 to 500 µg/m ³ with a resolution of 0.1 µg /m ³
1.23	Optical sensors for measuring concentrations of floating particles PM _{2.5} particles in the air in the range from 0 to 2,000 µg/m ³ with a resolution of 0.1 µg /m ³
1.24	Optical sensors for measuring concentrations of floating particles PM ₁₀ in the air in the range from 0 to 5,000 µg/m ³ with a resolution of 0.1 µg /m ³
1.25	Measuring station for measuring meteorological parameters (temperature, relative humidity and air pressure)
1.26	Sensor for measuring air temperature in the range from -25 to 85 °C with a resolution of 0.1 °C
1.27	Sensor for measuring relative air humidity in the range from 0 to 100 % with a resolution of 1% RH
1.28	Sensor for measuring air pressure in the range from 50 to 115 kPa with a resolution of 0.5 kPa
1.29	Module for measuring the noise level in the range 30 – 130dB(A), accuracy ±3 dBA and resolution of 0.1 dBA

2 Guaranteed standards of the EPC service

2.1. Energy requirements

In order to achieve the desired results of the reconstruction and/or modernisation of the Public Lighting System, the **Guaranteed nominal active power of the Public Lighting System must not be greater than the Maximum allowed nominal active power of the Public Lighting System defined in Annex 8. of the Energy Performance Contract (Reference data sheet, cell D12).**

The Provider is obligated to achieve the active power of the Public Lighting System in the nominal dimming regime that is equal or lower than the Guaranteed nominal active power of the Public Lighting System, while the nominal dimming regime shall be the one where the luminaire meets the lighting quality requirements referred to in this document. The Guaranteed nominal active power of the Public Lighting System is the sum of nominal active powers of all luminaires within the scope of implementation of the Measures.

The Provider is obligated to guarantee that the Guaranteed installed active power of the luminaire, for the entire duration of the Contract, equals the product of the Guaranteed nominal active power of the luminaire (power of the luminaire in the dimming regime where the luminaire meets the set lighting quality requirements) and the percentage of the luminaire dimming regime in the scope of 10% to 100% of the nominal active power of the luminaire. Guaranteed installed active power of the Public Lighting System is the sum of the Guaranteed installed active powers of all luminaires within the scope of implementation of the Measures for improving energy efficiency of the Public Lighting System.

The Provider is obliged to achieve the active power of the Public Lighting System which is equal to or lower than the Guaranteed installed active power of the Public Lighting System in all Dimming regimes. Otherwise, the Contracting Entity shall not approve the Adoption of the Public Lighting System.

After the Adoption of the Public Lighting System, i.e. in the Use Phase, in the case of deviation of the active power of the Public Lighting System from the Guaranteed installed active power of the Public Lighting System, a fee adjustment shall be carried out according to the calculations defined in the Contract and the Monitoring, Measurement and Verification Plan (Annex 4 to the Energy Performance Contract).

Fee adjustment in relation to the Guaranteed installed active power of the Public Lighting System is conducted only for the functional luminaires. While calculating the Guaranteed installed active power of the Public Lighting System for all non-functional luminaires, it is necessary to assume that the measured active power equals the Guaranteed installed active power of that luminaire.

INSTRUCTIONS FOR CALCULATING THE GUARANTEED POWER OF THE LUMINAIRES AND THE PUBLIC LIGHTING SYSTEM:

a) Guaranteed nominal active power of the luminaires

Calculated only if the Nominal active power of the Public Lighting System from the Design documentation is lower than the Guaranteed nominal active power of the Public Lighting System from the Tender. If this is the case then Guaranteed nominal active power of luminaire is increased in relation to standard (real) active power of luminaire considering the savings achieved within Designed documentation:

$$P_{Gn-Lum} = P_{n-Lum} * \frac{P_{Gn-System}}{P_{n-System}}$$

It is not allowed for the Nominal active power of the Public Lighting System from the Design documentation to be higher than the Guaranteed nominal active power of the Public Lighting System from the Tender, i.e. in the above mentioned case, the Contracting Entity shall not issue its Compliance with the design documentation (ZP-05).

b) Guaranteed installed active power of the luminaires

$$P_{Gi-Lum} = X * P_{Gn-Lum}$$

c) Guaranteed installed active power of the Public Lighting System

$$P_{Gi-System} = \sum_{j=1}^m P_{Gi-Lum-j} = \sum_{j=1}^m X_j * P_{Gn-Lum-j} = \frac{P_{Gn-System}}{P_{n-System}} \sum_{j=1}^m X_j * P_{n-Lum-j}$$

Whereas:

P_{Gn-Lum} – Guaranteed nominal active power of the luminaires;

P_{n-Lum} – Active power of the luminaire as in Design documentation;

$P_{Gn-System}$ – Guaranteed nominal active power of the Public Lighting System as in the Tender;

$P_{n-System}$ – Nominal active power of the Public Lighting System as in Design documentation;

P_{Gi-Lum} – Guaranteed installed active power of the luminaire;

$P_{Gi-System}$ – Guaranteed installed active power of the Public lighting system;

X – luminaire dimming regime (%);

m – Number of luminaires in the scope of implementation of the Measures for improving energy efficiency of the Public Lighting System

Graphic representation of luminaire power and power of the Public Lighting System with a link to the terms used in this document is provided in the following Image (Image 2.1). The image presents a triangle that represents the Guaranteed installed active power of the Public Lighting System, where the shorter leg represents the active power of the Public Lighting System and the longer leg the Public Lighting System Dimming regime. The relation between the shorter and the longer leg is not proportional to real quantities.

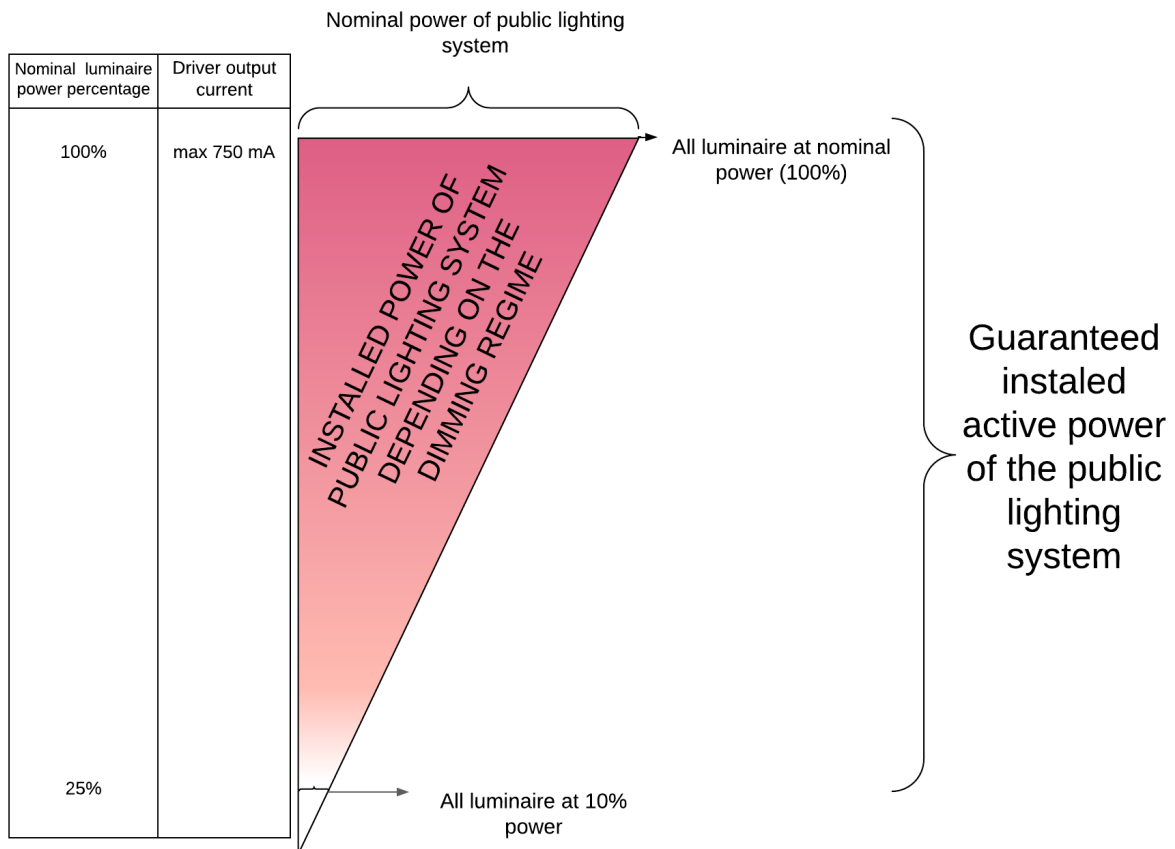


Image 2.1 Graphic representation of the active power of the luminaire and the Public Lighting System

Theoretical example of the calculation for Guaranteed installed active power of the Public Lighting System:

In the Public Lighting System there is a total of 10 luminaires and all luminaires with the power of 100W meet the required lighting quality conditions, i.e. the Nominal power of the luminaires is 100W. Guaranteed nominal power of the Public Lighting System is 1000W (100W x 10pcs). If the Contracting Entity regulates all luminaires at 10% nominal power, the Guaranteed installed power of the Public Lighting System is 100W (100W x 10pcs x 10%). If the Contracting Entity regulates 2 luminaires at 50%, 5 luminaires at 20% and other luminaires operate in the nominal operating mode, the Guaranteed installed power of the Public Lighting System is 500W (100W x 2pcs x 50% + 100W x 5pcs x 20% + 100W x 3pcs x 100%)

2.2. Lighting quality requirements

The proposed technical solution must satisfy all lighting quality requirements prescribed by the pertinent regulations, and EN 13 201-2: 2016 or equivalent with the exceptions defined in chapter 5.4.

2.3. Requirements in relation to the functionality of parts, elements and equipment

Upon implementing the Measures for improving energy efficiency of the Public Lighting System, the Provider must ensure that all parts, elements and equipment installed within the implementation of the Measures are fully functional and proper for the duration of the Contract. Should any element, part or equipment (e.g. a luminaire or MCC) installed under the

Measures for improving energy efficiency of the Public Lighting System be malfunctioning, defective or non-compliant with the Technical Requirements for a longer period than permitted, the Contracting Entity shall reduce the service fee in accordance with the Contract. The functionality of equipment and elements refers to determining whether all parts of the Measures for improving energy efficiency fulfil their task. The functionality of the equipment and elements with regard to functional units is divided into two basic parts: luminaires and MCC (detailed description of the functionality and working order of the parts, elements and equipment is provided in chapter 11.1.1 of this document). **The maximum allowed deadline for rectifying malfunctions of a non-functional or defective part, element or equipment is defined by the Contracting Entity in the table below (Table 9).**

Table 9 Maximum permitted deadline for rectifying a non-functional part malfunction

Management and Control Centre		
Permitted defect removal deadline		24 hours
Luminaires		
Lighting classes	Number of days	Number of days in case a greater number of luminaires is not functioning*
M1 / C0	5 days	1 day
M2 / C1	5 days	1 day
M3 / C2	5 days	1 day
M4 / C3	10 days	1 day
M5 / C4	10 days	1 day
M6	10 days	1 day
P1	5 days	1 day
P2	10 days	1 day
P3	10 days	1 day
P4	10 days	1 day
P5	10 days	1 day
P6	10 days	1 day
P7	10 days	1 day

* If six or more luminaires connected to the same metering point are not functioning

If luminaire illuminates areas with two different lighting classes, competent lighting class according to the table above is the class with higher lighting quality requirements.

3 Guaranteed standards of the SMART EPC additional energy and non-energy services

3.1 Integrated lamppost EV charging services requirements

In order to achieve minimal viable quality of provided EV charging services Provider is obligated to maintain and manage every integrated lamppost EV charger installed under **SMART EPC Contract**. Integrated lamppost EV charging service must be operational during the whole period of EPC Contract and maintained in accordance with minimum standards specified in Annex (...). Provider will be responsible and obligated to provide integrated lamppost EV charging service in accordance with all applicable regulations and legislation and will be solely responsible to third parties for any damages or claims in regard to provision of integrated lamppost EV charging service provided under this Contract.

Minimum quality standards specified under this EPC contract define minimum service standards at the time of signing of this Contract. Provider shall regularly update its services to be in accordance with industry standards and to provide maximum quality service to its customers regardless of this service specifications.

Minimum levels of service failures shall be:

KPI	Target
<i>Fault in charging post that disables charging of vehicles – failure shall be rectified in defined period</i>	<i>8 hours</i>
<i>Fault in payment systems that disables start of charging session – failure shall be rectified in defined period</i>	<i>8 hours</i>
<i>Fault in completing payment transactions – failure shall be rectified in defined period</i>	<i>4 hours</i>
<i>Uptime percentage per calendar month</i>	<i>98%</i>
<i>Helpdesk calls answering time</i>	<i>Average 1 minute, Maximum 3 minutes</i>
<i>Successful transaction completion</i>	<i>98%</i>

Provider shall authorize, start, stop and record customers charging sessions activated via MSP RFID card or tag, NFC credit or debit card, ad hoc payment websites accessed by a QR code displayed on the Charge post, or other payment or identification method as agreed with Contracting Entity from time to time.

Provider shall enable customer to pay for their use of the Charge post using the Mobile Service Provider (MSP). Provider shall establish a roaming interconnection with various MSPs and/or roaming hubs. Possible solutions include but are not limited to a direct Open Charge Point Interface (“OCPI”) interconnection or an interconnection via a roaming hub (such as HUBJECT and/or GIREVE).

3.2 Smart City applications requirements

In order to achieve minimal quality of provided environment sensors Provider is obligated to maintain and manage every environment sensor installed under **SMART EPC Contract**. Environment sensor operations dashboard service must be operational during the whole the whole period of EPC Contract and maintained in accordance with minimum standards specified in Annex (...). Provider will be responsible and obligated to provide Environment sensor operations dashboard service in accordance with all applicable regulations and legislation and will be solely responsible to third parties for any damages or claims in regard to provision of environment sensor operations dashboard service provided under this Contract.

Minimum quality standards specified under this EPC contract define minimum service standards at the time of signing of this Contract. Provider shall regularly update its services to be in accordance with industry standards and to provide maximum quality service to its customers regardless of this service specifications.

Minimum levels of service failures shall be:

KPI	Target
<i>Service and technical support as a respond to service intervention</i>	<i>24 hours</i>
<i>Replacement of defective and faulty sensors</i>	<i>72 hours</i>
<i>Uptime percentage per calendar month</i>	<i>98%</i>
<i>Helpdesk calls answering time</i>	<i>Average 1 minute, Maximum 3 minutes</i>

3.3 Communication technologies requirements

In order to achieve minimal quality of provided communication technology Provider is obligated to maintain and manage every street side antenna under **SMART EPC Contract**. Communication technology service must be operational during the whole the whole period of EPC Contract and maintained in accordance with minimum standards specified in Annex (...). Provider will be responsible and obligated to provide communication technology service in accordance with all applicable regulations and legislation and will be solely responsible to third parties for any damages or claims in regard to provision of communication technology service provided under this Contract.

Minimum quality standards specified under this EPC contract define minimum service standards at the time of signing of this Contract. Provider shall regularly update its services to be in accordance with industry standards and to provide maximum quality service to its customers regardless of this service specifications.

Minimum levels of service failures shall be:

KPI	Target
<i>Service and technical support as a respond to service intervention</i>	<i>24 hours</i>
<i>Replacement of defective and faulty street side antenna</i>	<i>10 days</i>
<i>Uptime percentage per calendar month</i>	<i>99%</i>
<i>Helpdesk calls answering time</i>	<i>Average 1 minute, Maximum 3 minutes</i>



Part B of the Output specification – requirements in design phase

In this part of Smart EPC technology output specification technical requirements for the design phase are set. It also defines the criteria for control of the developed design documentation and quality assessment of designed equipment.

Design Phase commences immediately upon Contract signing, and lasts until the design documentation acceptance (after it has been examined).

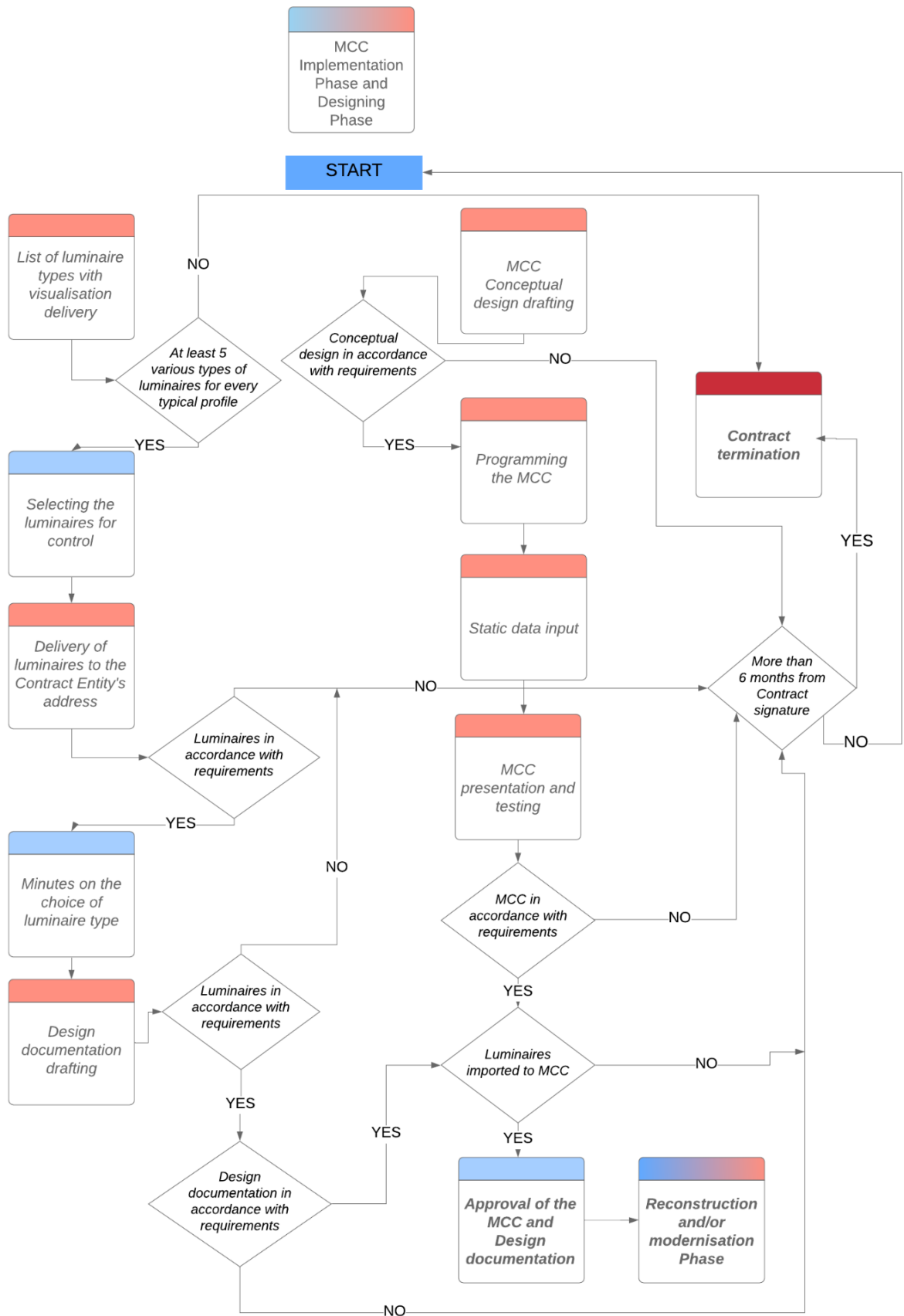


Image 2 Workflow of Management and Control Centre Implementation Phase and Designing Phase

4 Guidelines for the development of Conceptual design for the Management and Control Centre (MCC)

The drafting of Conceptual design for the MCC implementation is a necessary prerequisite for successful implementation, use and maintenance of the MCC. The Conceptual Design needs to comprise all of the MCC functional units, which includes hardware, software, communication with the luminaires, infrastructure, supporting systems and installations etc., while also designing them in detail. The Conceptual Design must be in accordance with the Contracting Entity's requirements defined in part A of this document and the Provider's tender.

The Conceptual design for the MCC also must contain the original programme code with the stated standards and protocols that are used and all other necessary information for possible subsequent expansions, upgrades or modifications of the MCC by the Contracting Entity or third person not involved in the implementation of the MCC.

The Conceptual Design needs to contain a detailed specification of necessary infrastructural system resources (hardware and software) for installing the MCC (e.g. CPR, RAM, disc, OS, surveillance, backup, base etc.).

The MCC Conceptual design needs to be delivered within the deadline defined by the Energy Performance Contract. In the case that the Conceptual Design is in accordance with the requirements set out in this document, the Contracting Entity shall provide its approval to the Conceptual Design which gives the Provider the authorisation to start programming the MCC. A template of the Approval of the Conceptual Design can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 03).

For the duration of the Contract, the Provider is obligated to perform maintenance of the MCC. During the Contract term, for every change in the original programme code in relation to the Conceptual design for the Management and Control Centre, the Provider is obligated to provide the Contracting Entity with a written detailed description of the changes with the updated programme code.

5 Guidelines for the development of Lighting design documentation

5.1 General requirements

Design documentation needs to be drafted in compliance with all relevant regulations and particularly the Light Pollution Act (Official Gazette no), subordinate acts referred to in Articles 9, 10 and 12 of the Light Pollution Act, in accordance with professional standards, Public Lighting Plan, Technical Requirements defined by this document and the Tender (Annex 6 to the Contract). If the design documentation has been drawn up in such a way, and if all necessary permits for the reconstruction and/or modernisation works have been obtained from relevant bodies and institutions, the Contracting Entity will approve the design documentation, and the Provider can start with the reconstruction and/or modernisation of the Public Lighting System, marking the beginning of the reconstruction and/or modernisation phase.

The design solutions within the design documentation need to contribute to achieving the following goals:

- a) Traffic safety;
- b) Environmental protection (protection of the environment, residential and commercial zones from light pollution, removal of harmful working fluids of the light source (mercury etc.), reduction of greenhouse gasses emissions);
- c) Increasing energy efficiency of the existing public lighting system.

The design documentation needs to ensure the implementation of an optimal technical, technological and economically viable solution to achieve the desired results:

- Electrical energy savings;
- Reduction of the level of CO₂ emissions;
- Compliance of the lighting quality parameters defined in EN 13201-2:2016 or an equivalent standard;
- Compliance with:
 - *The Commission Regulation (EU) 2019/2020 from 1 October 2019 on determining the requests for eco-design of lighting sources and independent luminaire control gear in accordance with the Directive 2009/125/EC of the European Parliament and the Council and repealing Regulation No. 244/2009 of the Commission (EC), (EC) No. 245/2009 and (EU) No. 1194/2012;*
 - *Commission delegated Regulation (EU) 2019/2015 of 11 March 2019 amending Regulation (EU) 2017/1369 of the European Parliament and Council regarding the energy efficiency labelling of lighting source and repealing the Delegated Regulation of the Commission (EU) No. 874/2012;*
 - *Directive 2014/53/EU of the European Parliament and the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to radio equipment on the market and repealing the Directive 1999/5/EC*
- Reduction of light pollution in accordance with the Light Pollution Act (Official Gazette no);
- Eliminating the use of hazardous substances and consequently the costs of disposal;
- Reduction of the public lighting system maintenance costs.

5.2 Defining typical profiles of illuminated areas

The Provider is obligated to determine typical profiles of all illuminated areas in the scope of implementation of the Measures within the Design documentation. One typical profile

comprises illuminated areas with similar geometric traits (surface width, pole/luminaire height, distance between poles etc.), **whereas the similar geometric trait is defined as the one where the average luminance (in road areas) or the average illuminance (in pedestrian areas) does not deviate by more than 10% from the average luminance (in road areas) or average illuminance (in pedestrian areas) of typical profile in the event of one or more parameters changing.**

If modification of one or more geometric parameters in the typical profile results in a change of the average surface illuminance by more than 10% from average illuminance of the typical profile, a new typical profile needs to be defined by the Provider.

The Contracting Entity has made its data available to the Provider in the form of a database in a table view with a set of properties and the geolocation of each illuminated area in accordance with the Project Scope (Annex 1 to the Contract). The above mentioned database was created based on an energy audit of the public lighting system by a legally authorised official for conducting energy audits and the Contracting Entity does not take over the risk related to the possible deviation of the data contained in the database from the actual state on site. While determining the typical profiles, the Provider shall establish them in accordance with the actual state on site at the time of creating the Design documentation.

The Contracting Entity will verify the selection of the typical profile. The Contracting Entity will not approve the design documentation (ZP – 05) should it consider that any of the typical illuminated area profiles has not been defined or if any of them has been described incorrectly.

The Provider is obligated to determine the typical profiles for all illuminated areas within the scope of implementation of the Measures in the design documentation, certifying this with the following statement:

The defined typical profiles comprise all illuminated areas in the scope of implementation of the Measures for improving energy efficiency, while the average luminance (in case of road areas) or average illuminance (in pedestrian areas) in all areas within the scope of implementation of the Measures is within 10% average luminance (in road areas) or average illuminance (in pedestrian areas) of one of the defined typical profiles.

By granting its approval of the design documentation (ZP – 05), the Contracting Entity does not take over the risk of meeting the lighting quality requirements in the future or any other technical requirements referred to in this document in on-site situations. The Provider's responsibility is to optimise and align the defined typical profiles with the on-site situation, while respecting the requirements referred to in this document.

5.3 Minimum requirements for the designed equipment and materials

In part A of this document, the Contracting Entity defined the minimum technical requirements for the subject of procurement. The design documentation shall only contain the technical solution that meets the requirements referred to in this document and the Tender.

In the Tender, the Provider has obliged to offer a certain number of different luminaire types. Every luminaire type needs to be able to meet the minimum technical requirements of the Contracting Entity referred to in this document and the Guaranteed nominal active power of the Public Lighting System.

The luminaires planned to be installed must have the light sources of adequate power and luminous flux distribution, depending on the intended installation location.

When permitted by the arrangement and feeder lines, the luminaires should be connected to the power supply in such a way that the load is distributed optimally across the power cable phases, ensuring symmetrical or approximately symmetrical load conditions across the phases. Furthermore, they should be connected to a feeder line of the air network via separate insulated terminals with a plug for public lighting without the possibility of replacing the contacts or a similar connection, to facilitate the connecting and disconnecting of the luminaires.

The Provider shall install an appropriate bracket/arm for each modernised luminaire. When reconstructing and/or modernising luminaires, the Provider shall check and, if necessary, adjust the overload, over voltage and short circuit protection system in the post distribution, if there is any. Spare parts for selected luminaires must be available for a period of at least 10 years from the date of acceptance of the Measures for improving energy efficiency of the Public Lighting System.

In the phase of drafting the Design documentation, the Provider is not allowed to change the luminaire type in relation to the luminaire type that the Contracting Entity selected in the Minutes on the choice of luminaire type. Changes of the luminaire type installation locations in relation to the originally defined locations by the Contracting Entity are only allowed upon obtaining written approval of the Contracting Entity and the Provider (ZP – 02):

5.4 Lighting quality requirements

The proposed lighting quality solution must satisfy all parameters prescribed by the relevant legislation (particularly the Light Pollution Act (Official Gazette no)) with related regulations), EN 13 201-2: 2016 or equivalent and the Lighting Plan. While drafting the lighting quality calculations for the new designed state, it is necessary to verify all typical cases, zones of conflict etc. while respecting the lighting quality values defined by the relevant legislation, EN 13 201-2:2016 standard or equivalent, on the entire public lighting route.

The Provider has the possibility to optimise the proposed technical solution in terms of proposed savings given the possible combinations of luminaire power, optics, head height or bracket length, with the aim of meeting the conditions set out in this document, while complying with the requirements for brackets/arms listed in part A of this document.

The luminaires need to be equipped with light sources and drivers of adequate power, as well as with optical devices with adequate light distribution in order to meet the lighting quality requirements, depending on the planned installation site.

The Provider is allowed to create one lighting quality calculation for several illuminated areas of the same lighting class with similar geometrical traits, i.e. the same typical profile, if the listed parts are illuminated by the same technical solution. The lighting quality calculations must be drafted in writing for each luminaire type (power and/or applied optics), lighting class and its typical profile.

Pursuant to the *Regulation on contracting and implementation of energy services in the public sector* (Official Gazette no), the Provider shall guarantee savings at least equal to or greater than the fee the Contracting Entity undertakes to pay to the Provider. Accordingly, there are no

grounds for upgrading the public lighting system by adding new luminaires in order to comply with the lighting quality standards (..... EN 13 201-2: 2016 or equivalent, in the case of road lighting, or EN 12 464 or equivalent, in the case of other external lighting). Due to the above mentioned reason, when drafting the design documentation and later during the Use Phase, certain parts of the Public Lighting System will not be able to meet the lighting quality parameters defined by the EN 13 201-2:2016 standard or equivalent. These parts of the Public Lighting System shall be determined exclusively according to the following criteria:

1. If the distance between the existing neighbouring luminaires is greater than the product of the 4.7 factor and the maximum possible height of luminaire installation;
2. If the distance between the luminaire's photometric centre and the opposite end of the illuminated area is greater than the product of the 1.3 factor and the maximum possible height of luminaire installation.

The maximum possible height of luminaire installation depends on the height of the pole and the possibility of positioning the bracket/arm/overweight.

The listed parts refer to the locations with unsatisfactory infrastructure.

In parts with unsatisfactory infrastructure where it will not be possible to satisfy the lighting quality parameters defined by the EN 13 201-2:2016 standard or equivalent, it is necessary to choose, design and implement a technical solution that will satisfy the marginal cases referred to in the points above (e.g. on 8 meter high poles, considering the supply network, the maximum possible height of the luminaire installation is 7.5 meters and the distance between the poles is 40 meters. In the case described, it is necessary to select a luminaire that, at the distance of 35.25 meters (4.7x7.5), satisfies the conditions of the EN 13 201-2:2016 standard or equivalent).

If a surface area is classified as P7, the installation of luminaires with the output luminous flux of less than 2,000 lm is not allowed.

In the case of upgrade of the surface areas not classified under EN 13 201 or equivalent (playgrounds, façades, etc.), the selection of a new technical solution must be based on maintaining the suitable output luminous flux, while choosing the appropriate optics. If not prescribed differently by the Contracting Entity, the satisfactory luminous flux and the appropriate optics is the one that meets the requirements of the respected standard (outdoor work areas according to EN 12464-2 or equivalent), i.e. that keeps the illuminance of the area as it was with the existing luminaire that is being modernised.

The lighting quality calculations must be made and attached in writing for each luminaire, and for the required lighting class and geometry, i.e. the applied optics. In locations with unsatisfactory infrastructure, in addition to the parameters set out by the above-referenced standard, it is also necessary to calculate horizontal illuminance and attach a table with both horizontal illuminance and luminance values at points as well as the parameters set out by EN 13 201-2:2016 standard or equivalent.

Intersections

With regard to the lighting quality requirements, intersections can be grouped into conflict areas. The Contracting Entity has specified the lighting classes for intersections. If no lighting class is specified, it shall be determined on the basis of the lighting class of the more important road in an intersection (e.g. the main road in an M1 intersection, intersections classified as C0, M2/C1, M3/C2, etc.).

Luminaire dimming regime

For every typical profile, it is necessary to conduct additional lighting quality calculations and, in accordance with the calculation, state the data on the dimming percentage of the luminaire power that is necessary to meet the requirements of the EN 13 201-2:2016 standard or equivalent **for one class up** (unless it is the M1, C1, P1 class), **for one class down** (unless it is the M6, P6, C6 class) and **for two classes down** (unless it is the M5, P5, C5 class).

Photometric files

It is necessary to deliver photometric files used in the lighting quality calculations in *.ldt format. A test report issued in accordance with EN 13032-1, EN 13032-4 and CIE 025/E:2015 standards by a laboratory accredited in accordance with EN ISO/IEC 17 025 must be submitted for the photometric files used in lighting quality calculations, the provision on equivalence applies to all the above mentioned standards and file types. It is necessary to deliver a confirmation of appropriate laboratory accreditation issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93.

The use of photometric files modified in comparison to those created in an accredited laboratory in accordance with EN ISO/IEC 17 025, or equivalent, is not allowed.

As an exception, if the used photometric files have been modified with regard to test reports on measuring the luminance intensity distribution in accordance with EN 13 032-1, EN 13032-4, IES LM 79-08 and CIE 121-1996 standards (the provision on equivalence applies to all the above mentioned standards), the following additional documentation must be submitted:

- Test reports on measuring the output luminous flux of a luminaire from the same type of luminaires and with the same optics (the same light distribution properties) by application of the relative measurement method showing the ratio of the output luminous flux of the luminaire to the output luminous flux of the light source used, i.e. the light losses of the luminaire. The light distribution properties of a luminaire whose photometric file has been modified must be identical to the light distribution properties of the luminaire for which a test report on measuring the luminance intensity distribution in accordance with EN 13 201-2:2016, EN 13 032-1, EN 13032-4, IES LM 79-08 and CIE 121-1996 standard has been submitted (the provision on equivalence applies to all the above mentioned standards).
- A test report on measuring the output luminous flux of a printed circuit board with LED light sources (PCB) used in a luminaire with modified photometric files.

The output luminous flux of the luminaire used in the calculations must include any optical losses (protective glass/lens).

The photometric file needs to be named in a way that the connection with the luminaire type in question is clear.

Calculation guidelines

Given that there is no exact data on the pavement/road surface category (R factor), R2 or R3 factor, $q_0 = 0.07$ needs to be used for the said road surfaces with lighting class from M1 to M6 for the road covering type.

It is necessary to attach to the design documentation an electronic record of the used IES or LDT files for the luminaires used in calculations, as well as electronic versions of lighting

calculations exported from Relux (version 2020.2.3.0 or newer) or Dialux evo (version 9.1.51242 or newer). The electronic records shall be delivered on a USB stick.

5.5 Energy requirements

Nominal active power of the Public Lighting System within the Design documentation must be lower than or equal to the Guaranteed nominal active power of Public Lighting System specified in the Tender (Annex 8 to the Contract, Tenderer's input data, cell D7). Nominal active power of the Public Lighting System equals the sum of nominal active powers of all luminaires, i.e. the sum of active electric powers of the luminaire including the energy losses in the luminaire (source of light; luminaire control gear) in the dimming regime in which the luminaire meets the set lighting quality requirements. In the design documentation, it is necessary to indicate the Nominal power of all luminaires in the scope of implementation of the Measures for improving energy efficiency, which the Provider is obligated to enter into the MCC.

In the Design documentation, the Provider is obligated to define the nominal active power of every luminaire type and configuration in the scope of implementation of the Measures for improving energy efficiency of the Public Lighting System, while **the sum of the nominal powers of all luminaires must be lower than or equal to the Guaranteed nominal active power of the Public Lighting System**. If the sum of the nominal active powers of the luminaires within the Design documentation is smaller than the Guaranteed nominal active power of the Public Lighting System, the MCC shall correct the Nominal active power of the luminaires in order for the sum to be equal to the Guaranteed nominal active power of the Public Lighting System.

5.6 Minimum contents of the Design documentation

5.6.1 Contents defined by the Act

The reconstruction and/or modernisation design documentation needs to be developed in accordance with the relevant legislation, in particular the Building Act (Official Gazette no), the Light Pollution Act (Official Gazette no), the Construction Products Act (Official Gazette no), the Act on the Chamber of Architects and Chambers of Engineers in Construction and Physical Planning (Official Gazette no), the Act on Efficient Energy Use in Direct Consumption (Official Gazette no), the Act on Physical Planning and Building Tasks and Activities (Official Gazette no), the Energy Efficiency Act (Official Gazette no), and other applicable laws and all by-laws, ordinances, technical regulations and standards, and the rules of profession valid at the moment of signing this Contract. Since energy service is the subject-matter of the Contract, the content of the design documentation needs to comply with the *Regulation on contracting and implementation of energy services in the public sector* (Official Gazette no). All provisions of the *Grid Code of the Distribution System* (Official Gazette no), need to be complied with, particularly with regard to a retroactive effect of the public lighting system on the grid.

The design documentation needs to precisely define the needed interventions into the public lighting system. The map scale for the design solution needs to be sufficient for unambiguously defining the luminaire positions, with a legend that will provide an unequivocal interpretation of symbols. The design documentation usually serves as construction design documentation as well, necessitating all detailed designs needed for the execution of works within the Measures for improving energy efficiency of the Public Lighting System (detailed

maps etc.), all in line with the *Ordinance on the mandatory contents and format of construction work designs* (Official Gazette no).

The documentation needs to be created in the form of the Main design of modernisation of public lighting, in accordance with the *Ordinance on simple and other buildings and works* (Official Gazette no)

and it is necessary to obtain a statement from the designer stating that, for the execution of works in accordance with the main design and the Ordinance on simple and other buildings and works, the above-mentioned act and permits are not necessary.

All materials, devices, technical solutions and calculations should be prioritised in accordance with the National technical standards (or equivalent) by way of which European standards have been accepted, European technical approvals, common technical specifications, international standards, other reference technical systems established by European standardisation bodies or if any of the above are not in place, with national standards, national technical approvals or national technical specifications related to the design, calculation and execution of works and the use of goods. The note on equivalence is applicable to all standards referred to in this document. If an equivalent standard is used, its content needs to meet all conditions required by national standards, EN or IEC standards (depending on the standard for which an equivalent standard is proposed). Since reconstruction and/or modernisation are carried out under the Energy Performance Contract, the Design documentation needs to be harmonised with the *Regulation on contracting and implementation of energy services in the public sector* (Official Gazette no).

If that is prescribed in accordance with legislation and/or with Contracting Entity’s contract with a third party (e.g. HEP), the Provider is obliged to obtain additional approvals for the implementation of the project referring to the design documentation.

5.6.2 Evidence of compliance with the minimum technical requirements

The Provider is obliged to attach to the Design documentation the required evidence of compliance with the technical and lighting quality requirements for each technical design solution. List of evidence proving that the drafted technical solution is in compliance with the Contracting Entity’s requirements with the number of the requirement referred to which is contained in the part A of this document is given in the table below (Table 10).

Table 10 List of evidence and technical requirements referred to

Evidence	Requirement number referred to in PART A of the Technical Requirements – Minimum Technical Requirements
ENEC certificate	1.3
Internet database accompanied by the list of certified DALI 2.0 products (D4i)	2.3, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 4.7, 4.8, 7.3, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6

Test report in accordance with IEC TR 62778:2014 issued by the laboratory accredited in accordance with EN ISO/IEC 17 025 or equivalent	4.4
Test report in accordance with IES LM 80-08 – Approved Method: Measuring Lumen Maintenance of LED Light Sources <i>Approved Method: Measuring Lumen Maintenance of LED Light Sources</i> or IES LM 80-15 – Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules) <i>Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules</i>) issued by laboratory accredited in accordance with EN ISO/IEC 17 025 or equivalent	4.6
Test report in accordance with EN 55015:2013, EN 61000-3-2:2006 + A1:2009 + A2:2009, EN 61000-3-3:2013, EN 61547:2009 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.4
Test report in accordance with EN 13032-1, EN 13032-4, CIE 025/E:2015 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.1, 4.1, 4.2, 4.3, 4.5, 7.1
Test report in accordance with EN 60598-1:2015, EN 60598-2-3:2009 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.2, 2.1, 2.5, 3.1, 3.2, 3.3
Test report in accordance with the EN 61643 standard published by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	5.1, 5.2
Test report in accordance with EN 62262:2008 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	2.2
Statement / Manufacturer's technical catalogue	Other
Field laboratory for testing the compliance of the technical solution with the EN 13 201-2:2016 standard or equivalent (the Contracting Entity is responsible for the testing area)	Lighting quality requirements

The evidence shall be submitted in National language. If written in another language, it needs to be translated into National language with the delivery of the translation and the original evidence.

The rule of equivalence is valid for all of the above standards, certificates and test reports; i.e. test reports drawn up in accordance with an equivalent standard may be submitted, with the equivalence criterion being the test procedure and instructions, requirements for the testing equipment and persons performing the tests, standardised test conditions and test reports.

For every delivered test report, it is necessary to provide appropriate accreditation of the laboratory that issued the test report. Accreditation must be issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC)

No 339/93. The accreditation must clearly show the scope of testing for which the laboratory is accredited.

5.6.3 Other requirements of the Contracting Entity

The design documentation shall contain a description of the energy service, a plan of implementation the Measures for improving energy efficiency, technical specifications of the equipment to be installed with a detailed quantity and cost calculation for the proposed Measures for improving energy efficiency of the Public Lighting System. A detailed specification of the equipment and works needs to be drawn up. The cost of the investments agreed upon, which includes all planned works and materials, needs to be estimated. The investment amount referred to above shall be in accordance with the procurement documentation Annex Investment Value (Annex 7 to the Energy Performance Contract).

The equipment must be designed in a way to facilitate inspection and maintenance. It must function correctly in all expected operating conditions, i.e. all expected conditions of use and all expected environmental conditions. When selecting a technical solution, *Directive 2009/125/EC establishing a framework for the setting of eco-design requirements for energy-related products* must be taken into account in terms of equipment quality and maintenance costs minimisation, which will also affect the additional energy consumption during maintenance. All equipment needs to have adequate protection in order to prevent any possible damage. Protection must comply with the relevant rules of the profession, occupational safety and fire protection.

While choosing the equipment its compliance with the following must be taken into consideration:

- The Commission Regulation (EU) 2019/2020 from 1 October 2019 on determining the requests for eco-design of lighting sources and independent luminaire control gear in accordance with the Directive 2009/125/EC of the European Parliament and the Council and repealing Regulation No. 244/2009 of the Commission (EC), (EC) No. 245/2009 and (EU) No. 1194/2012;
- Commission delegated Regulation (EU) 2019/2015 of 11 March 2019 amending Regulation (EU) 2017/1369 of the European Parliament and Council regarding the energy efficiency labelling of lighting source and repealing the Delegated Regulation of the Commission (EU) No. 874/2012;
- Directive 2014/53/EU of the European Parliament and the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to radio equipment on the market and repealing the Directive 1999/5/EC

All materials used should be of the highest quality and suitable for operation in expected conditions, so as to ensure safe and long-term operation. Particular attention should be paid to avoiding or preventing corrosion due to external factors, as well as ensuring simple disposal upon life cycle expiry. The equipment must be protected by high-quality coatings resistant to environmental influences. The Provider shall, at its own expense, eliminate any sign of corrosion at least for the duration of the contractual relationship (applicable only to the elements of the public lighting system covered by the Measures for improving energy efficiency).

Expected environmental conditions for the installation and correct functioning of the equipment:

- Operating temperature: -20/+35°C;

- Relative humidity: 100%.

When drafting the design documentation, the Provider must take into account that it is the Provider's responsibility to protect all equipment installed under the Measures for improving energy efficiency of the Public Lighting System from surges, i.e. from lightning and other transient surges that may occur in the part of the electricity system within the scope of implementation of the Measures for improving energy efficiency and thus increase the risk of damage and/or termination of operation of the installed equipment. The Provider will assume the risk of failure of the installed equipment due to a lightning strike (which does not represent a case of force majeure), and it may upgrade the surge protection in luminaires or in other parts of the Public Lighting System (by installing cathodic protection in the form of surge arresters etc.). The Provider will be responsible for obtaining approval of a third party (a distribution system operator or similar) should the planned works require so, with no interference from the Contracting Entity.

In addition to the design documentation, it is necessary to enclose an electronic data storage medium. Photometric files and files containing the lighting quality calculations must be stored in the data storage medium to enable the Contracting Entity to check calculations from design documentation. The files must be sorted and labelled in a transparent manner by the cost estimate item designation, so that they can be easily used to check each luminaire from the Design documentation. The Contracting Entity will use the photometric files attached herewith to check if the luminaire complies with the relevant requirements. Such files must be publicly available on the manufacturer's website.

Relevant supporting documentation must be enclosed with the design documentation, proving that all technical specifications set out herein have been met. It must be organised in such a way that it can be easily linked to the type of the technical design solution. For each type of luminaire, on the supporting documentation data sheets, it is necessary to include a designation from the cost estimate that will be equal to the photometric file designation (stored on digital media) to facilitate the search during the control performed by the Contracting Entity.

In addition to the legally prescribed elements, the Design documentation must contain the following:

- Energy balance sheet within the prescribed scope of the new lighting solution:
 - Electricity consumption of the existing public lighting system;
 - Estimated electricity consumption upon implementation of the Measures for improving energy efficiency;
 - Decrease in the annual consumption in kWh/y compared to the original state of the overhauled public lighting with the application of active adjustment regime;
 - Reduction of the annual emission of polluting gases in tonnes of CO₂/year compared to the original state of the overhauled public lighting³;
 - Public lighting system operating power in kW (rounded to two decimal places), given in a summary manner for each metering point – the value represents the Guaranteed active power;
 - Decrease in the installed operating power in kW compared to the Reference state of the overhauled public lighting;
- Thorough estimate of the planned overhaul investment with listed costs;
- Any necessary approvals required for the Project;

³ Specific emission factor CO₂ (conversion factor) for electricity: 0.23481 kg CO₂/kWh

- Lighting quality calculations with luminaire information (total installed luminaire active power (all losses included), luminous flux of the LED module (lm), luminous flux of the luminaire (lm), luminous efficacy (lm/W), correlated colour temperature (CCT), colour return factor (CRI), ULOR of the entire luminaire) for each typical profile. The lighting quality calculations must be made and attached in writing for each luminaire, and for the required lighting class and geometry, i.e. the applied optics. In addition to the parameters set out by the standard, it is also necessary to calculate horizontal illuminance and attach a table with both horizontal illuminance and luminance values at points as well as the parameters set out by the EN 13 201-2:2016 standard or equivalent.
- Any legally prescribed elements, including an Safety at work elaborate and a list of applicable laws, ordinances, technical provisions and standards, an overview of fire safety measures, a quality control and assurance programme, and general and specific execution conditions for the execution of works and the placing of electrical installations or any other parts required in line with the rules of the profession;
- Active power of all luminaire types,;
- Data on the formula for increasing the power of the luminaire for the purpose of meeting the criteria for Constant Lumen Output of the luminaire (CLO);
- List of sections where it is not possible to ensure compliance with the EN 13 201-2:2016 standard or equivalent through replacement of the luminaires one for one.

Additional specific requirements related to the source of financing

If the reconstruction and/or modernisation project is eligible for funding through available sources of financing or co-financing, the Provider shall grant to the Contracting Entity and/or a third person (e.g. to another design studio) the right to use, correct and amend the design documentation drafted by the Provider.

5.6.4 Import of luminaires into the MCC

Before obtaining approval of Design documentation (ZP - 05), the Provider is obligated to enter the designed solution, i.e. all planned luminaires with all the necessary static data and especially the Nominal active power of the luminaire. This way the Contracting Entity has insight into the work execution dynamics and the later monitoring of whether the Guaranteed standards of service are being met.

If the Nominal active power of the Public Lighting System within the Design documentation is lower than the Guaranteed nominal active power of the Public Lighting System (i.e. the power defined within the Tender), i.e. if the Provider has achieved Design documentation savings which are higher than the Guaranteed savings, the Provider shall, in accordance with the Contract, be entitled to a Fee increase.

Considering that the fee is adjusted via the MCC, the Provider shall enter the following data into the MCC:

- Nominal active power of the Public Lighting System referred to in the Design documentation;
- Nominal active power for each luminaire in the Public Lighting System referred to in the Design documentation;
- Guaranteed active power of the Public Lighting System referred to in the Tender,

and, on the basis of the entered parameters, the MCC shall automatically calculate the **Guaranteed installed active power of the luminaires** in a way that the Nominal active power of each luminaire shall proportionally increase in accordance with the difference between the

Guaranteed nominal power of the Public Lighting System referred to in the Tender and the Nominal active power of the Public Lighting System referred to in the Design documentation, according to the formula for calculating the guaranteed nominal active power of the luminaires referred to in chapter 2.1.

5.6.5 An example of the automated calculation of the Guaranteed nominal active power of the luminaire and the Guaranteed installed active power of the luminaire

E.g. ten thousand luminaires are the subject of the modernisation. The Provider has stated in the Tender that the Guaranteed nominal active power of the Public Lighting System is 1,000 kW, provided that the standards requested by this Contract are met with luminaires whose nominal power equals 100 W.

By detailed calculations during the drafting of the Design documentation, the Provider determined that all Guaranteed standards would be able to be met with luminaires whose Nominal active power equals 80 W, i.e. with the overall Nominal active power of the Public Lighting System being 800 kW, which is 200 kW less than the Guaranteed nominal active power of the Public Lighting System.

The Provider has entered 80 W luminaires into the MCC, as well as the 800 kW Nominal active power of the Public Lighting System and the 1,000 kW Guaranteed nominal active power of the Public Lighting System. In order to compare the measured active powers of luminaires with the correct value, the MCC will perform an automated calculation of the Guaranteed nominal active power of the luminaire and the Guaranteed installed active power of the luminaire based on the entered parameters in the following manner:

$$P_{z-Lum} = 80 W * \frac{1.000 kW}{800 kW} = 100 W$$

In accordance with the above mentioned, the MCC shall enter the value of 100 W for the Guaranteed nominal power of each luminaire.

The Contracting Entity has subsequently decided that, in particular time periods, the dimming regime shall be applied. In accordance with the dimming regime, the MCC shall perform an automated calculation of the value of the Guaranteed installed active power of the luminaires as the product of the Guaranteed nominal active power of the luminaires and the dimming regime percentage (Table 11).

Table 11 Example of calculation for Guaranteed Installed Active Power

Nominal active power of the luminaires (referred to in the Design documentation)	Guaranteed nominal active power of the luminaires (automated MCC calculation)		From (hours)	To (hours)	Dimming regime	Guaranteed installed active power of the luminaires (automated MCC calculation)
80 W	100 W	Period A	19:00	23:00	100%	100 W
		Period B	23:00	02:00	50%	50 W

		Period C	02:00	07:00	75%	75 W
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Fee adjustment shall be done by comparing the measured values with the Guaranteed installed active power of the luminaires. Measuring shall be done in a particular time interval; for the purpose of this example, we shall assume that the measuring takes place every 5 hours, i.e. 3 times during the night and that the calculation period is one night (Table 12).

Table 12 Example of calculation of the fee adjustment due to the difference in the Guaranteed installed active power and the measured active power of the luminaire

	Guaranteed installed active power of the luminaires (automated MCC calculation)	Measured active power of the luminaires	Difference in power	Fee adjustment
Period A	100 W	110 W	+10 W	0.01 kW x 1 HRK/kWh x 5 hours = HRK 0.05
Period B	50 W	45 W	-5 W	-0.005 kW x 1 HRK/kWh x 5 hours = HRK -0.025
Period C	75 W	75 W	0 W	0 kW x 1 HRK/kWh x 5 hours
OVERALL adjustment				HRK 0.025

*unit price of electrical energy is assumed to be 1 HRK/kWh

5.6.6 Change of luminaire installation location

The Contracting Entity retains the right to change the luminaire installation location in relation to the location defined in the Project Scope (Annex 1 to the Contract). If the Contracting Entity has delivered the Request to change the luminaire installation location (ZP - 16) to the Provider before the luminaire installation, the Provider is obliged to install the luminaire in the new location at its own expense, in accordance with the Contracting Entity's instructions contained in the request. The Contracting Entity retains the right to list the storage belonging to the Contracting Entity as the location for a maximum of luminaires, provided that, at the latest within two months before the end of the Reconstruction Phase, the Contracting Entity instructs the Provider on the exact installation location for the luminaires in the storage. The cost of installation of the luminaires at the new location shall be borne by the Provider. The new installation location shall be in the Contracting Entity administrative area. In the case of change of luminaire installation location, the Provider is not obliged to maintain the Guaranteed lighting quality conditions at the new location.

6 Guidelines for the development of EV charging design documentation

Within design documentation, Provider shall provide location assessment and design advice related to aspects of the infrastructure design. Location assessment criteria for assessing enquiries/applications are shown below:

1. There is no other public EV charging station within 50 m
2. There is considerable number of a garage/private parking bay orphans
3. There is considerable number of EVs in public charging demand.

Once the areas of focus were identified, the next step shall be to select the location of light poles that would have the EV chargers. To accomplish that objective defining the Lighting distribution cabinet is the priority. To define them the following steps were followed:

1. Review the inventory of the electrical light pole infrastructure,
2. Understand the physical status of the existing infrastructure,
3. Filtering the existing distribution cabinet that could be more suitable for the project,
4. Analysing the load capacity of the distribution cabinet pre-selected,
5. Analysing the capacity of protection in distribution cabinets,
6. Calculating the voltage drop on the light poles of the distribution cabinet selected,
7. Making sure that the Contracting entity has enabled 24/7 voltage on chosen lampposts to ensure charging service at all times.

When choosing locations for EV chargers Provider must be aware of the distribution cabinet and power line limitations:

- Maximum allowable ampacities of the existing cable;
- Maximum voltages drop of 3% for branch circuits.

Within design documentation Provider must prove that all selected locations are suitable for Charge posts implementation. Design shall include but not be limited to aspects of the infrastructure design that impact on the method of communication between the Provider and the Charge post (e.g. quality of 3G or 4G networks and considering wired communication in location where 3G or 4G networks are weak. Optionally, PLC communication might apply).

The design documentation shall contain a description of the service, a plan of implementation, technical specifications of the equipment to be installed with a detailed quantity and cost calculation. A detailed specification of the equipment and works needs to be drawn up. The cost of the investments agreed upon, which includes all planned works and materials, needs to be estimated.

In part A of this document, the Contracting Entity defined the minimum technical requirements for the EV chargers. The design documentation shall only contain the technical solution that meets the requirements referred to in this document and the Tender.

The equipment must be designed in a way to facilitate inspection and maintenance. It must function correctly in all expected operating conditions, i.e. all expected conditions of use and all expected environmental conditions. All equipment needs to have adequate protection in order to prevent any possible damage. Protection must comply with the relevant rules of the profession, occupational safety and fire protection.

Provider must also take into consideration works and material needed for upgrade of public lighting cabinet regarding the implementation of Charge posts (e.g. replacement or adding additional circuit breakers, overvoltage protection, emergency switches or other required equipment).

7 Guidelines for development of communication technologies design documentation

Within design documentation, Provider shall provide location assessment and design advice related to aspects of the infrastructure design. Location assessment criteria for assessing enquiries/applications are shown below:

1. There is power and lighting infrastructure suitable to fit street side antennas
2. There is a communication backbone within 50m

Once the areas of focus were identified, the next step was to select the location of light poles that would have the communication technology in a form of a street side antennas. To accomplish that objective defining the lamppost is the priority. To define them the following steps were followed:

3. Review the inventory of the electrical light pole infrastructure.
4. Understand the physical status of the existing infrastructure.
5. Filtering the existing lampposts that could be more suitable for the project.

Within design documentation Provider must prove that all selected locations are suitable for street side antenna implementation.

The design documentation shall contain a description of the service, a plan of implementation, technical specifications of the equipment to be installed with a detailed quantity and cost calculation. A detailed specification of the equipment and works needs to be drawn up. The cost of the investments agreed upon, which includes all planned works and materials, needs to be estimated.

In part A of this document, the Contracting Entity defined the minimum technical requirements for the street side antennas. The design documentation shall only contain the technical solution that meets the requirements referred to in this document and the Tender.

The equipment must be designed in a way to facilitate inspection and maintenance. It must function correctly in all expected operating conditions, i.e. all expected conditions of use and all expected environmental conditions. All equipment needs to have adequate protection in order to prevent any possible damage. Protection must comply with the relevant rules of the profession, occupational safety and fire protection.

Provider must also take into consideration works and material needed for the implementation of street side antennas (e.g. mounting brackets, power cabinets, backbone stretch cables etc.).

8 Guidelines for development of Smart City applications design documentation

Within design documentation, Provider shall provide location assessment and design advice related to aspects of the infrastructure design. Location assessment criteria for assessing enquiries/applications are shown below:

1. There is power and lighting infrastructure suitable to fit environment sensors
2. The lamppost is fit to cater power box and solar panel

Once the areas of focus were identified, the next step was to select the location of light poles that would have the communication technology in a form of a street side antennas. To accomplish that objective defining the lamppost is the priority. To define them the following steps were followed:

3. Review the inventory of the electrical light pole infrastructure.
4. Understand the physical status of the existing infrastructure.
5. Filtering the existing lampposts that could be more suitable for the project.
6. Analysing the load capacity of the distribution cabinet pre-selected.

Within design documentation Provider must prove that all selected locations are suitable for environment sensors implementation.

The design documentation shall contain a description of the service, a plan of implementation, technical specifications of the equipment to be installed with a detailed quantity and cost calculation. A detailed specification of the equipment and works needs to be drawn up. The cost of the investments agreed upon, which includes all planned works and materials, needs to be estimated.

In part A of this document, the Contracting Entity defined the minimum technical requirements for the street side antennas. The design documentation shall only contain the technical solution that meets the requirements referred to in this document and the Tender.

The equipment must be designed in a way to facilitate inspection and maintenance. It must function correctly in all expected operating conditions, i.e. all expected conditions of use and all expected environmental conditions. All equipment needs to have adequate protection in order to prevent any possible damage. Protection must comply with the relevant rules of the profession, occupational safety and fire protection.

Provider must also take into consideration works and material needed for the implementation of street side antennas (e.g. mounting brackets, power cabinets, solar panels etc.).

9 Control

In order to ensure the execution of the Contract in accordance with the standards defined in this document, during the MCC Implementation Phase and the Designing Phase, the Contracting Entity shall perform control in accordance with this chapter. In case that the control shows that the subject of control does not satisfy the Contracting Entity's requests, the Contracting Entity will not grant the appropriate approval, thereby precluding the Provider from continuing with the next phase, i.e. without the Approval of the design documentation, the Provider cannot begin with the Reconstruction and/or Modernisation Phase. If the control shows that the subject of control meets the Contracting Entity's requests, the Contracting Entity shall give the appropriate approval to the Provider. The Approvals that the Contracting Entity grants in the MCC Implementation Phase and the Designing Phase are:

- Approval of the MCC Conceptual Design (ZP - 03);
- Design documentation approval (ZP - 05).

The compliance of the Contracting Entity shall in no way increase the liability of the Contracting Entity and/or cause it to assume any related risks in the remaining Contract implementation periods.

The Provider shall not order luminaires and other parts, elements and equipment before obtaining the Contracting Entity's approval of the Design documentation (ZP - 05), i.e. the Contracting Entity shall not recognise any part, element or equipment costs that occurred before the Contracting Entity's approval of the Design documentation (ZP - 05).

9.1. Control of luminaire types

Before drafting the Design documentation, the Provider is obliged to provide the Contracting Entity with a list of luminaire types for typical profiles of illuminated areas in order for the Contracting Entity to choose the luminaires for specific installation locations. Along with the list of luminaires it is necessary to deliver a drawing, layout, side view and a 3D visualisation for every luminaire type from the list of luminaire types. **If the Provider does not offer 5 or more luminaire types for every typical profile of the illuminated area or if two or more offered luminaire types have the same stylistic features on the outside of the luminaire or if the offered luminaire types do not meet the requirements from this document, the Contracting Entity shall terminate the Contract due to the Provider's fault and collect the performance guarantee.**

Within 5 days after the delivery of the luminaire type lists, the Contracting Entity shall present the Provider with the request for delivery of all or particular luminaires (ZP - 17), which will be examined in accordance with the requirements referred to in this document. Within 15 days of receiving the request for delivery of particular luminaires, the Provider shall deliver samples of the luminaire types, along with the related documents that prove the compliance with the Contracting Entity's requirements referred to in this document to the Contracting Entity's address. The evidence shall be submitted in **National language**. If written in another language, it needs to be translated into **National language** with the delivery of the translation and the original evidence.

9.1.1. Control of compliance with the lighting quality requirements

In the phase of control and choice of luminaire type, the lighting quality calculations need to prove that typical sections comply with all conditions defined by the EN 13 201-2:2016 standard. Lighting quality calculations are carried out for each typical section in the Relux (version or newer) or Dialux evo (version or newer). The Provider is obliged to create and provide the Contracting Entity with the lighting quality calculations for every typical profile referred to in chapter 2.2 for every offered luminaire type. Along with the lighting quality calculations, the Provider shall deliver an electronic record with the IES or LDT files used in lighting quality calculations, as well as electronic versions of the lighting quality calculations exported from Relux (version or newer) or Dialux evo (version or newer) for each luminaire. The electronic records shall be delivered on a USB stick. A test report issued in accordance with EN 13032-1, EN 13032-4 standards issued by a laboratory accredited in accordance with EN ISO/IEC 17 025 must be submitted for the photometric files used in lighting quality calculations. It is necessary to deliver a confirmation of appropriate laboratory accreditation issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. The use of photometric files modified in comparison to those created in an accredited laboratory in accordance with EN ISO/IEC 17 025 is not allowed (the provision on equivalence applies to all the above mentioned standards).

As an exception, if the used photometric files have been modified with regard to test reports on measuring the luminance intensity distribution in accordance with EN 13 032-1, EN 13032-4, IES LM 79-08 and CIE 121-1996 standards (the provision on equivalence applies to all the above mentioned standards), the following additional documentation must be submitted:

- Test reports on measuring the output luminous flux of a luminaire from the same type of luminaires (the same light distribution properties) by application of the relative measurement method (showing the ratio of the output luminous flux of the luminaire to the output luminous flux of the light source used, i.e. the light losses of the luminaire). The light distribution properties of a luminaire whose photometric file has been modified must be identical to the light distribution properties of the luminaire for which a test report on measuring the luminance intensity distribution in accordance with EN 13 201-2:2016, EN 13 032-1, EN 13032-4, IES LM 79-08 and CIE 121-1996 standard has been submitted (the provision on equivalence applies to all the above mentioned standards).
- A test report on measuring the output luminous flux of the LED module used in a luminaire with modified photometric files.

9.1.2. Control of compliance with technical requirements

For each luminaire, it is necessary to provide evidence proving that the proposed technical solution meets the Contracting Entity's requirements. The evidence shall be delivered electronically on a USB stick (Table 13).

Table 13 List of evidence and technical requirements referred to

Evidence	Requirement number referred to in PART A of the Technical Requirements – Minimum Technical Requirements
ENEC certificate	1.3
Internet database accompanied by the list of certified DALI 2.0 products (D4i)	2.3, 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16, 3.17, 3.18, 4.7, 4.8, 7.3, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6
Test report in accordance with IEC TR 62778:2014 issued by the laboratory accredited in accordance with EN ISO/IEC 17 025 or equivalent	4.4
Test report in accordance with IES LM 80-08 - Approved Method: Measuring Lumen Maintenance of LED Light Sources <i>Approved Method: Measuring Lumen Maintenance of LED Light Sources</i> or IES LM 80-15 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules) <i>Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules</i>) issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	4.6
Test report in accordance with EN 55015:2013, EN 61000-3-2:2006 + A1:2009 + A2:2009, EN 61000-3-3:2013, EN 61547:2009 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.4
Test report in accordance with EN 13032-1, EN 13032-4, CIE 025/E:2015 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.1, 4.1, 4.2, 4.3, 4.5, 7.1
Test report in accordance with EN 60598-1:2015, EN 60598-2-3:2009 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	1.2, 2.1, 2.5, 3.1, 3.2, 3.3
Test report in accordance with the EN 61643 standard published by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	5.1, 5.2
Test report in accordance with EN 62262:2008 issued by laboratory accredited in accordance with EN ISO/IEC 17 025 (the provision on equivalence applies to all the above mentioned standards)	2.2
Statement / Manufacturer's technical catalogue	Other
Field laboratory for testing the compliance of the technical solution with the EN 13 201-2:2016 standard or equivalent (the Contracting Entity is responsible for the testing area)	Lighting quality requirements

The evidence shall be submitted in language. If written in another language, it needs to be translated into with the delivery of the translation and the original evidence.

The rule of equivalence is valid for all of the above standards, certificates and test reports; i.e. test reports drawn up in accordance with an equivalent standard may be submitted, with the equivalence criterion being the test procedure and instructions, requirements for the testing equipment and persons performing the tests, standardised test conditions and test reports.

For every delivered test report, it is necessary to provide a confirmation of appropriate accreditation of the laboratory that issued the test report. Accreditation must be issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. The accreditation must clearly show the scope of testing for which the laboratory is accredited.

9.1.3. Independent testing

If, during the control of luminaire types, the Contracting Entity should have any doubts in relation to the documents serving to prove that the minimum technical requirements under this Document have been met, it will request that such a technical solution be tested in an adequate laboratory, in line with this chapter. The Contracting Entity will express doubt if, in particular:

- The Provider does not deliver all necessary evidence for the minimum technical requirements in accordance with this Document or delivers documentation from which the compliance with the Contracting Entity’s requests is not clear;
- If the data in the delivered documentation is ambiguous (e.g. test report data differ from the data set out in the technical catalogues/online catalogues or in other parts of the tender documentation);
- If a submitted test report does not correspond to the proposed technical solution;
- If a submitted test report was not drawn up by an accredited laboratory in accordance with the criteria set out in the table below (Table 14);

The lighting quality and energy properties of the proposed solution will be subject to inspection for the luminaires of the Contracting Entity’s choice. If, during the process of control of the luminaire types, the Contracting Entity should have any doubts with regard to the delivered documentation, the Contracting Entity shall have the right to send a luminaire sample to the appropriate laboratory for verification of compliance with the requirements set out in this Document.

The Contracting Entity shall select an appropriate laboratory in accordance with the minimum eligibility criteria listed in the table below (Table 14).

Table 14 List of criteria which the laboratories for independent control have to meet

Description of laboratory	Requirement items referred to in Chapter 1 checked in the laboratory
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 13032-1, EN 13032-4 (the provision on equivalence applies to all the above mentioned standards)	1.1, 4.1, 4.2, 4.3, 4.5, 7.1

Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 55015, EN 61000-3-2, EN 61000-3-3, EN 61547 (the provision on equivalence applies to all the above mentioned standards)	1.4
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 60598-1, EN 60598-2-3 (the provision on equivalence applies to all the above mentioned standards)	1.2, 2.1, 2.5, 3.1, 3.2, 3.3
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 61643 (the provision on equivalence applies to all the above mentioned standards)	5.1, 5.2
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 62262 (the provision on equivalence applies to all the above mentioned standards)	2.2
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within IEC TR 62778 (the provision on equivalence applies to all the above mentioned standards)	4.4
Field laboratory for testing the compliance of the technical solution with the EN 13 201-2:2016 standard (the Contracting Entity is responsible for the testing area) (the provision on equivalence applies to all the above mentioned standards)	Lighting quality requirements

A 5% measuring tolerance is allowed for photometric testing of correlated colour temperature.

The rule of equivalence is valid for all of the above standards, i.e. a laboratory may be hired to perform relevant tests in accordance with an equivalent standard, with the equivalence criterion being the test procedure and instructions, requirements for the testing equipment and persons performing the tests, standardised test conditions and test reports.

Laboratory accreditation must be issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. The accreditation must clearly show the scope of testing for which the laboratory is accredited.

Should independent control show that the luminary fails to meet any of the specified requirements, the Provider shall select another technical design solution and submit all required documents proving that the specifications set out herein are met. In this case, the expenses of measurement and all related expenses shall be borne by the Provider.

9.2. Conceptual design of the Management and Control Centre

Verification of compliance of the conceptual design with the requirements set out herein is the first phase of the Management and Control Centre software implementation. The Contracting Entity will check the compliance with the requirements set out herein and grant the Provider approval of the Management and Control Centre conceptual design (ZP - 03). The Provider may then start developing the software solution. A template of the Approval of the MCC Conceptual Design can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 03).

9.3. Design documentation

The Contracting Entity will assess the eligibility of the design documentation in line with the criteria set out herein, as part of its approval of the design documentation (ZP - 05). All requirements set out herein must be fulfilled in order for the Contracting Entity to grant approval of the design documentation (ZP - 05), i.e. all items in the approval form must be marked "YES".

Before granting the said approval, the Contracting Entity will check if it fulfils all requirements set out by the Energy Performance Contract, with special regard to the:

- Compliance with the specified minimum content of the Design documentation;
- Specified typical profiles of illuminated areas;
- Fulfilment of the Contracting Entity's lighting quality requirements;
- Fulfilment of the Contracting Entity's energy requirements;
- Compliance of the technical design solution with the Contracting Entity's requirements.

If the drafted design documentation is not harmonised with the requirements set out herein, the Contracting Entity will not grant approval of the design documentation.

A template of the Approval of the Design documentation can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 05).

9.4. Inspection of designed luminaires

The Contracting Entity will check the compliance of the technical design solution with the requirements set out herein. If during the inspection, the Contracting Entity should have any doubts with regard to the technical design solution, the Contracting Entity shall demand that a luminaire sample be delivered to the appropriate laboratory for verification of compliance with the requirements set out herein. The Contracting Entity will express doubt if, in particular:

- The Provider does not deliver all necessary evidence for the minimum technical requirements in accordance with this Document or delivers documentation from which the compliance with the Contracting Entity's requests is not clear;
- If the data in the delivered documentation is ambiguous (e.g. test report data differ from the data set out in the technical catalogues/online catalogues or in other parts of the tender documentation);
- If a submitted test report does not correspond to the proposed technical solution;
- If a submitted test report was not drawn up by an accredited laboratory in accordance with the criteria set out in the table below (Table 15);

The lighting quality and energy properties of the proposed solution will be subject to inspection for the luminaires in the test field according to the Contracting Entity's request.

Upon the Contracting Entity's request containing the data about the luminaire type to undergo verification, the Provider shall send luminaire samples to the Contracting Entity's address. Should the Contracting Entity decide to exercise its right to check the technical properties of the luminaires in an appropriate laboratory, the Provider shall deliver a luminaire sample within 15 days from the date it receives a request to deliver the luminaire sample to the Contracting Entity's address. The Contracting Entity shall bear all costs related to the delivery and laboratory testing of luminaires.

The Contracting Entity shall select an appropriate laboratory in accordance with the minimum eligibility criteria listed in the table below (Table 15).

Table 15 List of criteria which the laboratories for independent control have to meet

Description of laboratory	Requirement items referred to in Chapter 1 checked in the laboratory
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 13032-1, EN 13032-4 (the provision on equivalence applies to all the above mentioned standards)	1.1, 4.1, 4.2, 4.3, 4.5, 7.1
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 55015, EN 61000-3-2, EN 61000-3-3, EN 61547 (the provision on equivalence applies to all the above mentioned standards)	1.4
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 60598-1, EN 60598-2-3 (the provision on equivalence applies to all the above mentioned standards)	1.2, 2.1, 2.5, 3.1, 3.2, 3.3
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 61643 (the provision on equivalence applies to all the above mentioned standards)	5.1
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 62262 (the provision on equivalence applies to all the above mentioned standards)	2.2
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within IEC TR 62778 (the provision on equivalence applies to all the above mentioned standards)	4.4
Field laboratory for testing the compliance of the technical solution with the EN 13 201-2:2016 standard or equivalent (the Contracting Entity is responsible for the testing area)	Lighting quality requirements

A 5% measuring tolerance is allowed for photometric testing of correlated colour temperature and luminous flux of the luminaire above the horizontal plane. A +0.5 measuring tolerance is allowed for photometric testing of luminous flux of the luminaire above the horizontal plane.

The rule of equivalence is valid for all of the above standards, i.e. a laboratory may be hired to perform relevant tests in accordance with an equivalent standard, with the equivalence

criterion being the test procedure and instructions, requirements for the testing equipment and persons performing the tests, standardised test conditions and test reports.

Laboratory accreditation must be issued by the national accreditation body in accordance with the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. The accreditation must clearly show the scope of testing for which the laboratory is accredited.

If independent testing shows that the luminaire fails to fulfil any of the specified requirements:

- The Provider shall bear all expenses of the independent testing;
- The Provider shall select another technical design solution and submit all required documents proving that the specifications set out herein are met.

9.5. Entering the design solution data into the Management and Control Centre

Upon approval of the MCC software solution (ZP - 04), the Provider can start entering static data related to the designed luminaires. Upon the acceptance of the MCC software solution and before obtaining approval of Design documentation (ZP - 05), the Provider is required to enter all designed luminaries within the scope of implementation of the Measures for improving energy efficiency of the Public Lighting System. The Contracting Entity will check if the data entered into the Management and Control Centre correspond to the design documentation, which will be one of the criteria for granting approval of the design documentation (ZP - 05).

9.6. Control of the design documentation of EV chargers

The Contracting Entity will assess the eligibility of the design documentation in line with the criteria set out herein, as part of its approval of the design documentation (ZP - 05). All requirements set out herein must be fulfilled in order for the Contracting Entity to grant approval of the design documentation (ZP - 05), i.e. all items in the approval form must be marked "YES".

If the drafted design documentation is not harmonised with the requirements set out herein, the Contracting Entity will not grant approval of the design documentation.

9.7. Control of the design documentation of communication technologies

The Contracting Entity will assess the eligibility of the design documentation in line with the criteria set out herein, as part of its approval of the design documentation (ZP - 05). All requirements set out herein must be fulfilled in order for the Contracting Entity to grant approval of the design documentation (ZP - 05), i.e. all items in the approval form must be marked "YES".

If the drafted design documentation is not harmonised with the requirements set out herein, the Contracting Entity will not grant approval of the design documentation.

9.8. Control of the design documentation of Smart City applications

The Contracting Entity will assess the eligibility of the design documentation in line with the criteria set out herein, as part of its approval of the design documentation (ZP - 05). All requirements set out herein must be fulfilled in order for the Contracting Entity to grant approval of the design documentation (ZP - 05), i.e. all items in the approval form must be marked "YES".

If the drafted design documentation is not harmonised with the requirements set out herein, the Contracting Entity will not grant approval of the design documentation.

Part C of the Output specification

– requirements during the reconstruction and/or modernisation phase

In this part of Smart EPC technology output specification technical requirements in the reconstruction and/or modernisation phase in accordance with the Energy Performance Contract are set.

The Reconstruction and/or Modernisation Phase spans from the moment of approval of the design documentation to the moment of acceptance of the Measures for improving energy efficiency of the Public Lighting System.

In addition to the technical properties and parameters, this part also sets out the procedures to be applied by the Contracting Entity and the Provider when checking the compatibility of the public lighting system with the technical requirements set out herein.

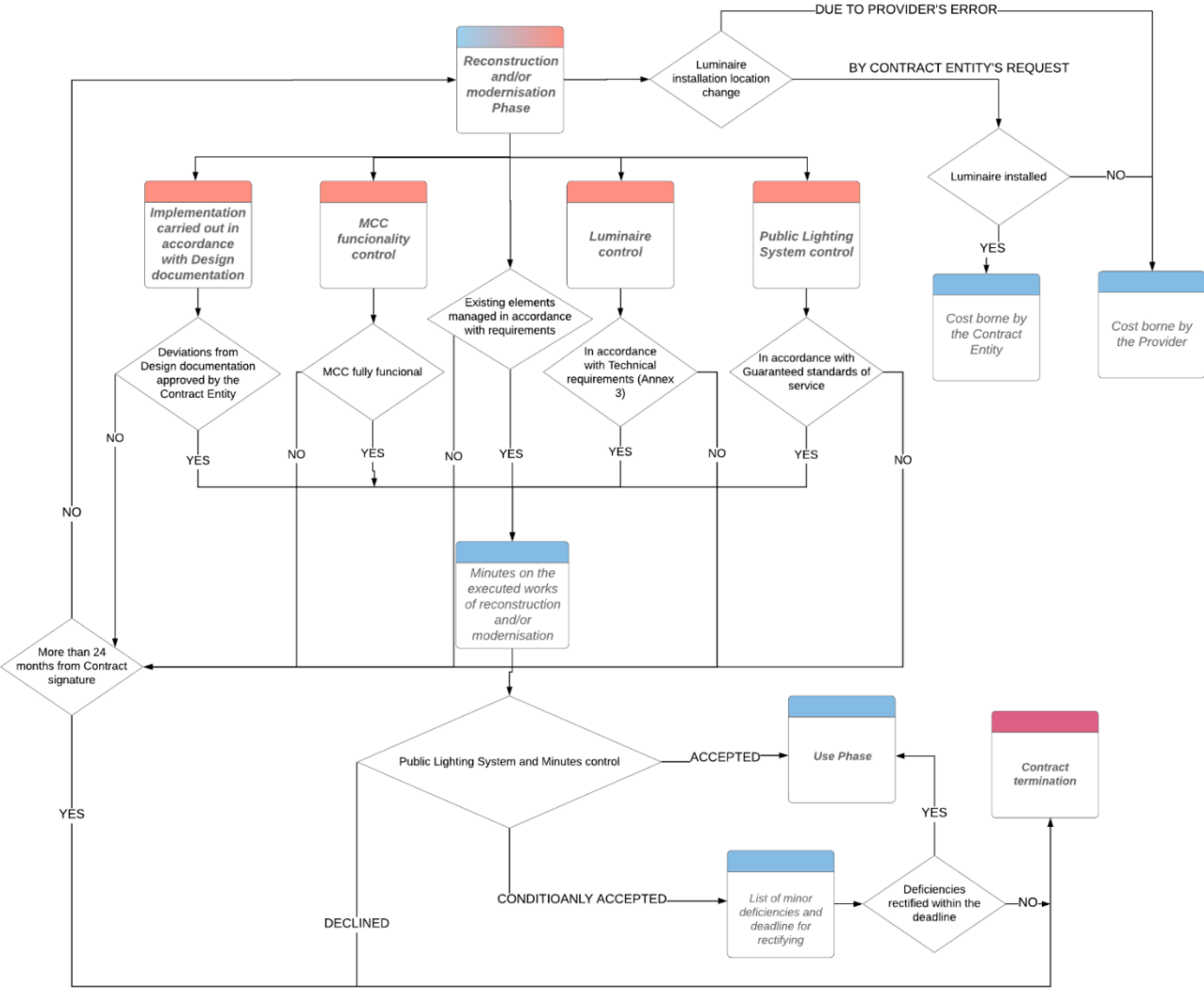


Image 3 Workflow in the Reconstruction and/or Modernisation Phase

10 Guidelines for programming and implementing the MCC

Upon obtaining the Contracting Entity's Approval (ZP - 03) of the Conceptual design for the Management and Control Centre, the Provider can start programming the MCC. Programming the MCC must be in compliance with the Conceptual Design and the requirements referred to in this document. All potential changes in terms of execution details of the MCC in relation to the Conceptual Design shall be recorded and approved by the Contracting Entity.

The Provider undertakes to submit and present fully functional MCC within the deadline defined by the Energy Performance Contract. If the MCC is fully functional, the Contracting Entity will grant approval to the Provider to start entering all necessary static data from the design documentation (Main project). A template of the Approval of the MCC programme solution can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 04).

Before obtaining approval of the Design documentation (ZP - 05), the Provider is obligated to enter the designed solution, i.e. all planned luminaires with the luminaire's basic technical data (static data). This way the Contracting Entity has insight into the works execution dynamics.

The Provider can elaborate on the MCC's smaller deficiencies, until the modernisation and/or reconstruction of the public lighting system is finished, i.e. until the Adoption of the Measures for improving the energy efficiency of the Public Lighting System. In case of significant MCC deficiencies, the Contracting Entity shall not approve the programme solution for the Management & Control Centre (ZP - 04). Significant deficiencies are the impossibility and/or non-functionality of static data entering, reading dynamic data or creating Reports defined by this document.

11 Minimum technical requirements

The Measures for improving energy efficiency of the Public Lighting System must be implemented in accordance with the design documentation for the public lighting system reconstruction and/or modernisation approved by the Contracting Entity. If during reconstruction and/or modernisation arises a need for unplanned but necessary amendments to the design documentation, the Provider shall notify the Contracting Entity thereof, and the Contracting Entity is required to approve any amendments in writing. An approval template for the deviations from the design documentation can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 06).

The implementation of the Measures for improving energy efficiency of the Public Lighting System and subsequent use of the public lighting system must not have a detrimental effect on people's lives and/or property. Working on live electrical equipment during the implementation of the Measures is not allowed. Any material used for modernisation must not have a detrimental effect on health and the environment. The works and activities must be performed in accordance with the *Health and Safety at Work Ordinance* (OG 105/20). The entire installation procedure must be carried out in accordance with the design documentation, attached drawings, the cost estimate, these terms and conditions and the applicable (i.e. local) technical regulations. Before the commencement of works and the supply of necessary materials, the Provider shall perform an on-site inspection. Given that under this Contract the Provider is also the investor, the Provider shall ensure that all relevant regulations of the Republic of are observed during the service delivery. If the inspection carried out before the commencement of works and the supply of materials shows that amendments to the design documentation are needed in terms of technical solutions and/or the choice of materials, the Provider shall notify the Contracting Entity and the Supervising Engineer thereof in writing, and obtain approval from the Contracting Entity.

The Provider shall be responsible for arranging the execution of works. A detailed works plan must be agreed upon with the Contracting Entity and other involved stakeholders (Local power utility company).

Before the commencement of works on the removal of luminaires and the installation of the new technical and technological solution, it is necessary to secure the site by disconnecting the power supply and to prevent the switching on or occurrence of voltage in the lighting circuit during the execution of works.

The persons working on the removal/installation of luminaires must be trained in safety and capable of working at height (special working conditions).

During reconstruction and/or modernisation, the Provider is obliged to ensure unobstructed traffic on the road section where the works are performed. They should be organised in such a way not to obstruct the traffic, or in a way that interruptions last as short as possible, without causing any traffic obstructions. After the works have been completed, the site shall be returned to its original state. Before putting the public lighting into operation, it is necessary to verify that all requirements for the safe operation of the public lighting system have been fulfilled.

Should the Provider, during the course of execution of works, due to technically justified reasons, not be able to install a luminaire type in accordance with the Minutes on the choice of luminaire type and/or design documentation, it shall inform the Contracting Entity thereon

and propose modifications. Before continuing the works, the Contracting Entity needs to give the Provider approval of the proposed modifications to the luminaire type (ZP - 02).

The works must be carried out in accordance with the drafted design documentation. Only materials that meet the necessary and the required quality level can be installed. For this reason, it is necessary to provide quality assurance evidence (National or equivalent) in accordance with legislation, technical regulations and the main design. All installed equipment must be delivered, tested and checked in accordance with regulations and standards ensuring the quality level required by this document. It is not permitted to install used luminaires and materials. The Provider shall perform functional and any other necessary system tests after the installation of new luminaires and draw up reports that will be attached to the Minutes on the executed works of reconstruction and/or modernisation (Annex 5 to the Energy Performance Contract, Report Content, ZP-07).

During the execution of works, the Provider shall correct or supplement the design documentation with any deviations therefrom. The Contracting Entity must approve any such deviations in advance. If the Contracting Entity fails to take a position within the agreed deadline, it shall be considered that it agrees with the deviations. Upon the completion of works, the Provider must perform all measurements and tests required by the applicable regulations for the installation in question and deliver verified test results to the Contracting Entity.

The Provider shall, during the execution of works, update the MCC data about the performed activities on a daily basis to enable the Contracting Entity to monitor the service delivery dynamics and quality.

The existing elements of the public lighting system that will be removed and replaced by new ones due to their age and inadequacy, as well as any other hazardous waste, need to be managed in accordance with the contractual provisions and the legislative framework in force.

Before putting into operation the public lighting system, it is necessary to thoroughly review and examine all elements which have been a subject of reconstruction and/or modernisation, as well as those that may have been affected by the reconstruction and/or modernisation activities. Valid certificates and protocols must be issued in relation to the tests performed. Upon completion of the construction works, the site must be restored to the original state.

The Contracting Entity has set out the acceptance dynamics of the implemented Measures for improving energy efficiency of the Public Lighting System in the Contract. The Contracting Entity shall start carrying out fee payments to the Provider upon acceptance of the Public Lighting System.

If, during the execution of works related to execution of works within the Measures for improving energy efficiency, the Provider detects any deficiencies of the Public Lighting System that is not in the scope of the implementation of the Measures, it shall notify the Contracting Entity thereof in writing. The Contracting Entity is responsible for taking further steps to remedy such deficiencies.

Listed below are some of the examples of Public Lighting System deficiencies falling outside the scope of implementation of the Measures for improving energy efficiency and requiring a written notification to the Contracting Entity:

- Defective public lighting cabinet equipment:
 - Defective or incorrectly adjusted control system (timer, light switch, etc.);

- Other irregularities of the equipment in public lighting cabinets;
- Feeder line deficiencies (line interruption, damaged insulation or any other feeder line deficiency that could pose a hazard to persons and/or equipment within the Public Lighting System;
- Luminaire post deficiencies (posts are not vertical or founded safely (unstable) or there is any other deficiency or damage to luminaire posts that could pose a hazard to persons and/or equipment within the Public Lighting System (its parts and elements)).

The Provider is obliged to protect all equipment installed under the Measures for improving energy efficiency of the Public Lighting System from surges, i.e. from lightning and other transient surges that may occur in the part of the electricity system covered by the Measures for improving energy efficiency and thus increase the risk of damage and/or termination of operation of the installed equipment. The Provider will assume the risk of failure of the installed equipment due to a lightning strike (which does not represent a case of force majeure), and it may upgrade the surge protection in luminaires or in other parts of the Public Lighting System (by installing cathodic protection in the form of surge arresters etc.). The Provider will be responsible for obtaining approval of a third party (a distribution system operator or similar) should the planned works require so, with no interference from the Contracting Entity. Taking the above mentioned into consideration, lack of surge protection in the Public Lighting System cannot be a Public Lighting System deficiency that the Provider alerts the Contracting Entity about.

11.1 Guaranteed standards of service

Service standards of the public lighting system contribute to its increased quality and availability as well as energy and cost savings. The Contracting Entity has outlined the minimum service standards, which refer to the:

- Functionality and correctness of the parts, elements and equipment;
- Guaranteed installed active power of the luminaires;
- Guaranteed lighting quality parameters of the area covered by the scope of implementation.

The Provider has outlined the guaranteed standards of service in both the Tender and the design documentation. The standards must be better than or equal to the minimum service standards that the Provider is required to maintain at the guaranteed level throughout the Contract duration.

In case of failure to meet even one of the three aforementioned guaranteed standards of service, it shall be considered that the reconstruction and/or modernisation has not been carried out according to these technical requirements and the Contracting Entity shall deny the Acceptance of the Measures for improving energy efficiency.

The Contracting Entity shall bear all measurement costs, except in case that the measurement shows that certain Guaranteed standards of service have not been met. In such a case, the Provider shall bear the a measurement.

11.1.1 Functionality and correctness of parts, elements and equipment

The Provider shall ensure that the parts, elements and equipment installed under the Measures for improving energy efficiency of the Public Lighting System are correct and fully functional

throughout the Contract duration. Should any element, part or equipment (e.g. a luminaire) installed under the Measures for improving energy efficiency of the Public Lighting System be malfunctioning, defective or non-compliant with the Technical Requirements for a longer period than permitted, the Contracting Entity shall reduce the service fee set out in the Contract. The Contracting Entity requires that the Management and Control Centre remain fully functional and available throughout the Contract duration.

The deadline for rectifying malfunctions of a non-functional or defective part, element or equipment is defined by this document. If the malfunctioning or defective part, element or equipment of the luminaire is not replaced within the specified period, the Contracting Entity shall reduce the service fee in accordance with the calculation defined in the Contract. A failure, defect or malfunctioning should be reported electronically (via the MCC). The deadline for rectifying malfunctions of non-functional or defective luminaire or Management and Control Centre begins to run in the moment of recording the malfunction.

Functionality of parts, elements and equipment refers to determination if the parts, elements and equipment installed under the Measures for improving energy efficiency of the Public Lighting System comply with applicable regulations, if they have all necessary certificates (stated in this document), if they are safe for use (i.e. they do not pose any risk to people, maintenance staff, cars and other means of road transport, other movable and immovable property of the Contracting Entity or any third party, etc.), as well as determining that they show no signs of corrosion or other structural and mechanical damage, and that they are fully functional and in compliance with these Technical Requirements.

The functionality of equipment and elements refers to determining whether all parts of the Measures for improving energy efficiency fulfil their task. The functionality of equipment and elements, regarding functional units, is divided into two basic parts: luminaires and communication equipment (A) and MCC (B).

In addition to the above conditions, the functionality of a luminaire also refers to determining if it produces the specified level of light and if it is correctly positioned at the luminaire post. A luminaire is considered to be non-functional in the following cases:

- The luminaire does not emit light;
- The luminaire is not correctly positioned at the pole location;
- The luminaire does not read and/or send the data to MCC or the sent data is wrong;
- The luminaire's arm is not of appropriate length;
- The luminaire does not comply with the Contracting Entity's Technical Requirements;
- The installed active power of the luminaire changed for more than 5% between two readings without changing the luminaire mode of operation;
- If the luminaire is repeatedly not functional for a shorter period of time and then, with no Provider intervention, it independently begins to function again (e.g. flickering, irregular submission of read data etc.);
- The dimming regime of the luminaire does not comply with the dimming regime parameters set within MCC ;
- Errors in the communication module of the luminaire (does not read/send necessary data, does not respond to data sent from the MCC etc.).

Via the ripple control receiver, the MCC will read the moment of switching on the public lighting. If the luminaire functioning is not registered in the MCC within 30 minutes of registering the switching on of the public lighting system, the luminaire shall be considered non-functional.

The functionality of the Control and Management Centre is manifested in the ability to use all programme features and modules in accordance with the Contracting Entity’s requirements referred to as specified this document and in the functional communication line between MCC and the luminaire communication module (wireless communication). If the MCC loses connection to more than 2% of the luminaires within the scope of implementation of the Measures for improving energy efficiency, the MCC shall be considered non-functional.

The Client will record the non-functionality of the Control and Management Centre automatically through the MCC or when that is not possible, due to the unavailability of the MCC, by hand and email.

The Provider shall bear the costs of rectifying any deficiencies of the elements, parts and equipment installed under the Measures for improving energy efficiency of the Public Lighting System i.e. the costs of replacing them with new, correct and functional equipment, parts or elements.

11.1.2 Guaranteed installed active power of the Public Lighting System

After the execution of works, the Nominal active power of the Public Lighting System shall be lower than or equal to the Guaranteed nominal active power of the Public Lighting System specified in the Tender and Design documentation (Annex 8 to the Contract, Tenderer's input data, cell D7).

After the execution of works, the measured Nominal active power of the Public Lighting System shall be lower than or equal to the Guaranteed installed active power of the Public Lighting System in all dimming regimes, ranging from 10% to 100% of the nominal active power.

11.1.3 Guaranteed lighting quality conditions

The Provider shall maintain the Guaranteed lighting quality conditions throughout the Contract duration, in line with the parameters given below (Table 16), respecting all relevant legislation and regulations in Republic

Table 16 List of parameters to be verified when checking the compliance with the Guaranteed lighting quality conditions.

ROAD LIGHTING (M lighting class)			
Parameter name	Code	Measurement unit	Equivalence criteria
Average luminance	L	Cd/m ²	Greater than or equal to
Overall uniformity	U ₀	-	Greater than or equal to
Longitudinal uniformity	U _l	-	Greater than or equal to
Relative increase of the threshold	f _{TI}	%	Less than or equal to
Lighting the surrounding area	R _{EI}	-	Greater than or equal to
PEDESTRIAN LIGHTING (P lighting class)			
Parameter name	Code	Measurement unit	Equivalence criteria
Average illuminance	E	lx	Greater than or equal to
Minimum illuminance	E _{min}	lx	Greater than or equal to

11.2 Change of luminaire installation location

The Contracting Entity retains the right to change the luminaire installation location in relation to the location defined in the Project Scope (Annex 1 to the Contract) or the Design documentation. If the Contracting Entity has delivered a request to change luminaire installation location (ZP - 16) to the Provider before the luminaire installation, the Provider is obligated to install the luminaire in the new location. All costs of removing the luminaire and installing it to the new location shall be borne by the Provider. In this case, the Provider is not obliged to maintain the Guaranteed lighting quality conditions at the new location. If the Contracting Entity has delivered a request to change luminaire installation location (ZP - 16) to the Provider after the luminaire installation, the Provider is obligated to enable the Contracting Entity instal the luminaire in the new location. All costs of removing the luminaire and installing it to the new location shall be borne by the Contracting Entity.

If, during the execution of filed works, the Provider detects any LED technology luminaires, which comply with the Project Scope (Annex 1 to the Contract), it shall warn the Contracting Entity thereof. The Contracting Entity shall give it instructions on whether to change the luminaires in question, i.e. instructions on possible change of installation location. In this case, the Provider shall install the location in a new location according to the Contracting Entity's instructions contained in the request. The new installation location shall be in the Contracting Entity administrative area. In this case, the Provider is not obliged to maintain the Guaranteed lighting quality conditions at the new location.

11.3 Implementation of EV chargers

Provider shall ensure that **positioning of electrical equipment is appropriately placed:**

- a. Substations, transformers and switchgear are positioned in locked, gated and fenced enclosures suitably located and positioned to restrict access for unauthorised personnel and are fitted with intruder detection, fire suppression and fire alarms systems.
- b. Enclosures are designed from a "Human Factors Engineering" perspective.
- c. All above-ground structures are positioned such that they are:
 - i. Away from vehicle routes to reduce risk from vehicular impact.
 - ii. Discouraging intention or inadvertent access by unauthorised personnel.
 - iii. Not preventing or restricting future developments of open site areas.
 - iv. Not detracting from the visible appearance of the branding.
 - v. Not reducing access or egress of distribution vehicles off-loading fuel or delivering goods.

Provider shall ensure that charge posts are positioned such that they are:

- a. Giving due consideration to the safety of all users of the site (including customers, other drivers and pedestrians) as customers approach, queue for, use and leave the charge post bay and otherwise move around the site and use the site facilities.
- b. Affording safe and easy operation by the customer, considering for example:
 - i. The size of the bay, which should match the size of EV expected and be at least 3.0m wide by 5.5m long
 - ii. The position of the charge post in relation to the bay, which should allow cables and connectors to reach the charging points of the majority of EV models available in the market without requiring the customer of the charge post to reverse into the bay or otherwise drive against the permitted traffic flow on the site.

Positioning of safety features

Provider shall ensure that the charge posts are adequately illuminated to at least 350 lux

Positioning of signage

Provider shall ensure that positioning of signage elements is in accordance with the instructions issued by The City from time to time

Provider shall ensure that the appropriate information stickers and SIM cards (if needed) are provided for insertion into or application onto the Charge post before or during commissioning. Provider shall ensure that the SIM card subscription (if needed) includes adequate data for both Provider's and Charge post manufacturer's data requirements.

Provider shall ensure that information for the customer directly related to charging activity including payment and usage instructions and their charging status is clearly and accurately displayed, within the scope of what is possible for the Charge post, on the Charge post in local language and English language.

11.4 Implementation of communication technologies

Provider shall ensure that **positioning of 5G street side antenna equipment is appropriately placed:**

- d. All antenna related equipment are in locked, gated and fenced enclosures suitably located and positioned to restrict access for unauthorised personnel and are fitted with intruder detection, fire suppression and fire alarms systems.
- e. Enclosures are designed from a "Human Factors Engineering" perspective.
- f. All above-ground structures are positioned such that they are:
 - i. Away from vehicle routes to reduce risk from vehicular impact.
 - ii. Discouraging intention or inadvertent access by unauthorised personnel.
 - iii. Not preventing or restricting future developments of open site areas.
 - iv. Not detracting from the visible appearance of the branding.
 - v. Not reducing access or egress of distribution vehicles off-loading fuel or delivering goods.

11.5 Implementation of Smart City applications

Provider shall ensure that **positioning of environment sensor equipment is appropriately placed:**

- g. Power box, solar panels and sensors are positioned in locked, gated and fenced enclosures suitably located and positioned to restrict access for unauthorised personnel and are fitted with intruder detection, fire suppression and fire alarms systems.
- h. Enclosures are designed from a "Human Factors Engineering" perspective.
- i. All above-ground structures are positioned such that they are:
 - i. Away from vehicle routes to reduce risk from vehicular impact.
 - ii. Discouraging intention or inadvertent access by unauthorised personnel.
 - iii. Not preventing or restricting future developments of open site areas.
 - iv. Not detracting from the visible appearance of the branding.
 - v. Not reducing access or egress of distribution vehicles off-loading fuel or delivering goods.

Positioning of safety features

Provider shall ensure that the charge posts are adequately illuminated to at least 350 lux.

Provider shall ensure that the appropriate information stickers and SIM cards (if needed) are provided for insertion into or application onto the environment sensor before or during commissioning. Provider shall ensure that the SIM card subscription (if needed) includes adequate data for both Provider's and environment sensor manufacturer's data requirements.

12 Content of the Minutes on the executed works of reconstruction and/or modernisation (ZP - 07)

Before acceptance of the public lighting system, the Provider shall deliver to the Contracting Entity any relevant data about the Measures for improving energy efficiency of the Public Lighting System. All relevant data needs to be submitted in the Minutes on the executed works of reconstruction and/or modernisation. The minimum contents of the Minutes can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract).

13 Control

13.1 Proving the functionality of the Management and Control Centre

The programming of the Management and Control Centre in line with the accepted conceptual design and the requirements set out herein is the second phase of the Management and Control Centre implementation. Upon completion of the said activity, the Provider needs to prove to the Contracting Entity that the Management and Control Centre is fully functional. If all the requirements set out herein are fulfilled, the Contracting Entity will grant the Provider approval of the Management and Control Centre software solution (ZP - 04). A template of the Approval of the MCC programme solution can be found in the Contents of reports, approval and minutes (Annex 5 to the Energy Performance Contract, ZP - 04).

13.2 Control of works execution dynamics

The Provider shall update the MCC data on the luminaires installed within the last 24 hours on a daily basis. This will enable the Contracting Entity to monitor the service delivery dynamics and to carry out the inspection of the luminaires installed.

13.3 Inspection of luminaires installed

The Provider is obliged to install the equipment specified in the design documentation approved by the Contracting Entity. If the Provider, after obtaining the design documentation approval (ZP - 05), introduces any changes in relation to the design solution, it shall inform the Contracting Entity thereof. If the design solution is modified during the execution of works, the Provider is obliged to submit evidence of compliance with the prescribed technical and lighting requirements for each modification to the design (newly proposed technical solution). The list of supporting documents proving that the modified technical solution fulfils the Contracting Entity's requirements is the same as in the design phase, as set out in Chapters 5 and 9.4. If during the execution of works, the Contracting Entity should have any doubts with regard to the compliance with the technical requirements outlined herein, the Contracting Entity will demand that a luminaire sample be delivered to an appropriate laboratory for verification of compliance with the requirements set out herein. Upon the Contracting Entity's request containing the data about the luminaire type to undergo verification, the Provider shall send luminaire samples to the Contracting Entity's address within 10 days from the date it receives a request to deliver the luminaire sample to the Contracting Entity's address. The Contracting Entity shall bear all costs related to the delivery and laboratory testing of luminaires. The Contracting Entity is entitled to select the luminaires at the installation site and carry out a laboratory test or test them at the installation site for the purpose of checking the compliance of the said sample with the requirements set out herein. The Contracting Entity will select an appropriate laboratory in accordance with the minimum eligibility criteria listed in the table below (Table 17).

Table 17 List of criteria which the laboratories for independent control have to meet

Description of laboratory	Requirement items referred to in Chapter 1 checked in the laboratory
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 13032-1, EN	1.1, 4.1, 4.2, 4.3, 4.5, 7.1

13032-4 (the provision on equivalence applies to all the above mentioned standards)	
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 55015, EN 61000-3-2, EN 61000-3-3, EN 61547 (the provision on equivalence applies to all the above mentioned standards)	1.4
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 60598-1, EN 60598-2-3 (the provision on equivalence applies to all the above mentioned standards)	1.2, 2.1, 2.5, 3.1, 3.2, 3.3
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 61643 (the provision on equivalence applies to all the above mentioned standards)	5.1, 5.2
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within EN 62262 (the provision on equivalence applies to all the above mentioned standards)	2.2
Accredited according to the requirements of the EN ISO/IEC 17 025 standard for testing according to methodology defined within IEC TR 62778 (the provision on equivalence applies to all the above mentioned standards)	4.4
Field laboratory for testing the compliance of the technical solution with the EN 13 201-2:2016 standard or equivalent (the Contracting Entity is responsible for the testing area)	Lighting quality requirements

A 5% measuring tolerance is allowed for photometric testing of correlated colour temperature and luminous flux of the luminaire above the horizontal plane.

If independent testing shows that the luminaire fails to fulfil any of the specified requirements:

- The Provider shall bear all expenses of the independent testing;
- The Provider shall select another technical design solution and submit all required documents proving that the specifications set out herein are met.

13.4 Control of the Public Lighting System

The Contracting Entity shall perform control of the Public Lighting System by choosing locations at random where the Guaranteed standards of service shall be tested. An expert engaged by the Contracting Entity shall test the Guaranteed standards of service.

13.5 Control of the Minutes on the executed works of reconstruction and/or modernisation

Following the reconstruction and/or modernisation of the Public Lighting System, the Contracting Entity will check the compliance of the Public Lighting System with the design

documentation, i.e. the requirements set out herein. Once the Provider submits the complete Minutes on the executed works of reconstruction and/or modernisation, the Contracting Entity will check the compliance of the technical solutions and documentation with the Provider's Tender, design documentation, Regulation on contracting and implementation of energy services in the public sector (Official Gazette no) and this Document. The Contracting Entity will carry out an on-site inspection of the works performed. The Contracting Entity reserves the right to check the luminaire samples installed before granting approval of the Minutes on the executed works of reconstruction and/or modernisation (ZP - 07), i.e. before accepting the Public Lighting System.

If the Minutes on the executed works of reconstruction and/or modernisation do not comply with the requirements set out herein, the Contracting Entity will decline the acceptance of Measures for improving energy efficiency of the Public Lighting System. If the Contracting Entity accepts the Public Lighting System, this will mark the beginning of the Use Phase.

If the control and tests determine that the Public Lighting System is functional, but it requires additional works and/or material for the system to fully meet the requirements and/or if minor deficiencies of the conditions listed in this document and other annexes to the Contract are observed, the Contracting Entity shall warn the Provider thereon and state the deadline for rectifying the determined deficiencies, which will mark the Conditional Acceptance of the Measures for improving energy efficiency.

13.6 Control of executed works of EV charger implementation

Following the implementation of EV chargers, the Contracting Entity will check the compliance of the implemented devices with the design documentation, i.e. the requirements set out herein. Once the Provider submits the complete Minutes on the executed works of EV charger implementation, the Contracting Entity will check the compliance of the technical solutions and documentation with the Provider's Tender, design documentation and Regulations and this Document. The Contracting Entity will carry out an on-site inspection of the works performed. The Contracting Entity reserves the right to check the equipment samples installed before granting approval of the Minutes on the executed works of reconstruction and/or modernisation.

If the Minutes on the executed works of EV chargers implementation do not comply with the requirements set out herein, the Contracting Entity will decline the acceptance of EV chargers. If the Contracting Entity accepts the implementation of EV chargers, this will mark the beginning of the EV charging billing.

13.7 Control of executed works of communication technologies implementation

Following the implementation of street side antennas, the Contracting Entity will check the compliance of the implemented devices with the design documentation, i.e. the requirements set out herein. Once the Provider submits the complete Minutes on the executed works of street side antennas implementation, the Contracting Entity will check the compliance of the technical solutions and documentation with the Provider's Tender, design documentation and Regulations and this Document. The Contracting Entity will carry out an on-site inspection of the works performed. The Contracting Entity reserves the right to check the equipment samples installed before granting approval of the Minutes on the executed works of reconstruction and/or modernisation.

If the Minutes on the executed works of street side antennas implementation do not comply with the requirements set out herein, the Contracting Entity will decline the acceptance of street side antennas. If the Contracting Entity accepts the implementation of street side antennas, this will mark the beginning of the street side antenna operation.

13.8 Control of executed works of Smart City applications implementation

Following the implementation of environment sensors, the Contracting Entity will check the compliance of the implemented devices with the design documentation, i.e. the requirements set out herein. Once the Provider submits the complete Minutes on the executed works of environment sensors implementation, the Contracting Entity will check the compliance of the technical solutions and documentation with the Provider's Tender, design documentation and Regulations and this Document. The Contracting Entity will carry out an on-site inspection of the works performed. The Contracting Entity reserves the right to check the equipment samples installed before granting approval of the Minutes on the executed works of reconstruction and/or modernisation.

If the Minutes on the executed works of environment sensors implementation do not comply with the requirements set out herein, the Contracting Entity will decline the acceptance of environment sensors. If the Contracting Entity accepts the implementation of environment sensors, this will mark the beginning of the environment sensors operation.

Part D of the Output specification

– requirements during the use phase

In this part of Smart EPC technology output specification technical requirements within the Use Phase in accordance with the Energy Performance Contract are set.

The Use Phase shall start with the acceptance of the Measures for improving energy efficiency upon the end of Reconstruction and/or modernisation Phase and last until the Contract expiry and the transfer of ownership rights of the Measures for improving energy efficiency of the Public Lighting System to the Contracting Entity. The day of accepting the Measures for the improvement of energy efficiency shall be recorded in the MMC and from that day the measuring and verification of all contractual standards shall begin, i.e. the availability analysis and the fee calculation (done automatically via MMC).

The Chapter below sets out the Contracting Entity's requirements during the Use Phase.

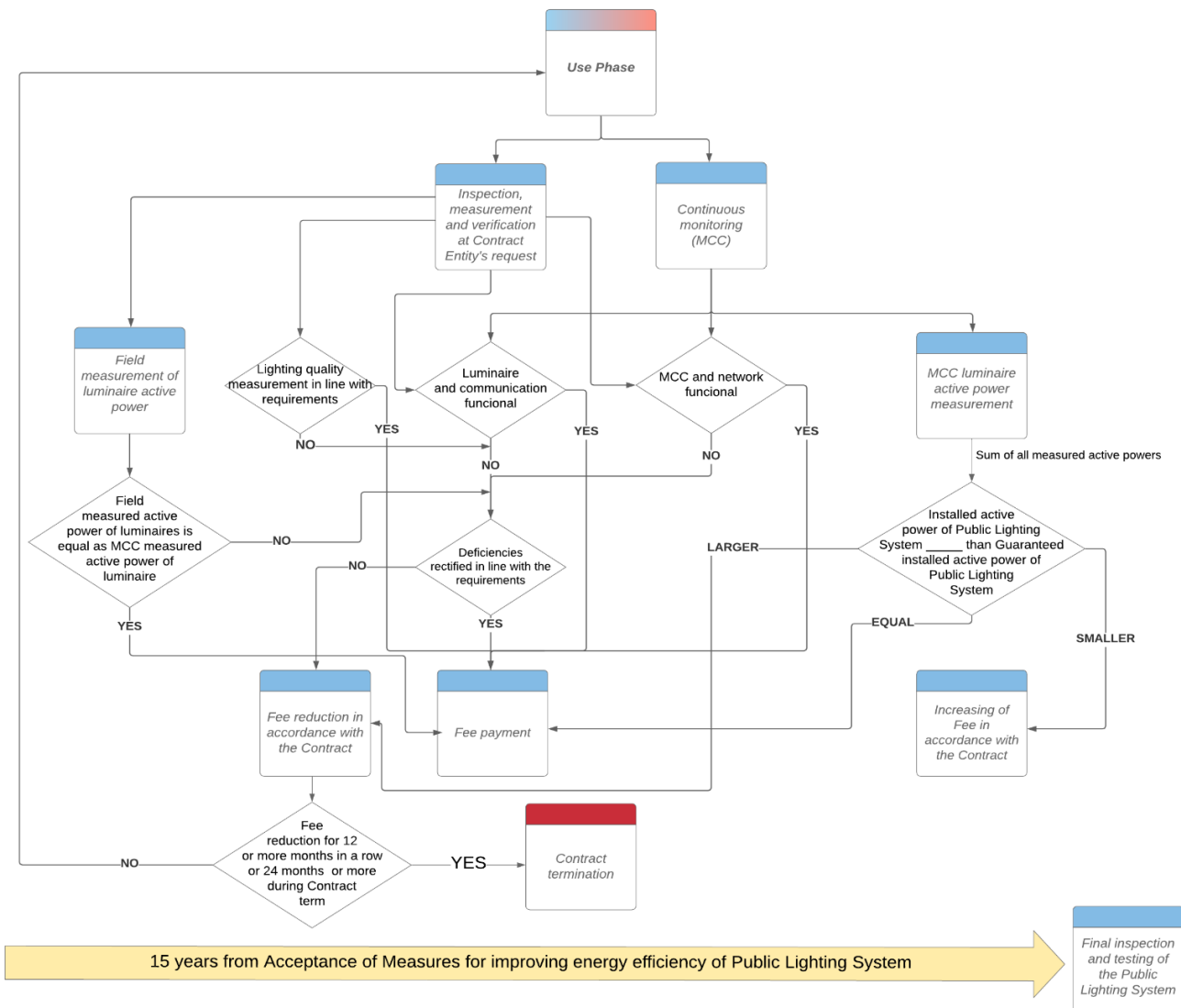


Image 4 - Workflow of the Contract execution within the Use Phase

14 Minimum technical requirements

14.1 Public Lighting System Maintenance

The Provider undertakes to ensure that any elements, parts and equipment installed within the Measures for improving the energy efficiency of the Public Lighting System are fully functional and correct throughout the Contract duration and warrants that no costs will be incurred to the Contracting Entity in relation to the maintenance of the parts, elements and equipment installed through the implementation of the Measures during the Contract term. The Provider shall cover the costs related to rectifying any deficiencies of the said elements, parts and equipment or those related to the replacement thereof with new, fully functional equipment, parts or elements. In the case that during the Use Phase, the luminaire type is being replaced, the Provider shall enable the Contracting Entity to choose the same or larger number of luminaire types then prescribed within this document that will be installed in accordance with this document and the Provider's Tender.

During the Contract term, the Contracting Entity is obliged to maintain the public lighting system elements not covered by the Measures for improving energy efficiency of the Public Lighting System, i.e. any parts, elements and equipment not installed in the scope of the Measures for improving energy efficiency of the Public Lighting System. The Contracting Entity shall maintain the said part of the Public Lighting System in line with the rules and standards of the profession and any applicable legal provisions. If due to a lack of maintenance, incorrectly performed maintenance or any other related negligence parts, elements or equipment installed by the Provider suffer damage, the Contracting Entity shall cover the repair costs. The surge protection system is excluded from the above due to the fact that the Contracting Entity has given the Provider an opportunity to install, modify and upgrade the surge protection system.

The Provider is obliged to protect all equipment installed under the Measures for improving energy efficiency of the Public Lighting System from surges, i.e. from lightning and other transient surges that may occur in the part of the electricity system covered by the Measures for improving energy efficiency and thus increase the risk of damage and/or termination of operation of the installed equipment. The Provider shall provide all necessary equipment for this purpose. As the Provider assumes the risk of failure of the installed equipment due to a lightning strike (which does not represent a case of force majeure), it may upgrade the surge protection (by installing cathodic protection in the form of surge arresters, etc.). The Provider will be responsible for obtaining approval of a third party (a distribution system operator or similar) should the planned works require so, with no interference from the Contracting Entity.

The Provider shall adhere to any applicable rules and regulations of the electricity distributor throughout the Contract duration and assume any associated costs (e.g. the cost of supervising the work of distributor's employees related to the replacement of defective luminaires, etc.) incurred during the fulfilment of contractual obligations.

Considering that the Provider guarantees for the proper functioning of the parts, elements and equipment (e.g. luminaires) during the term of this Contract, the Provider shall be obliged (and bear the expenses) to rectify the non-functional, defective parts, elements, equipment and those parts, elements and equipment which do not satisfy the Technical Requirements of this Contract and which have been installed within the scope of the Measures for improving energy efficiency of the Public Lighting System. The Provider shall ensure that all materials and elements that it uses are new and compliant with the certificates and the requests of manufacturers of other equipment and elements in the public lighting system. They must be

compatible with the public lighting system and fully compliant with the requirements of any applicable warranties and guarantees, and have all valid certificates and attestations.

In case of changes of the geometrical parameters and the ratio of the luminaire position and the illuminated surface during the Use Phase (e.g. relocation of the existing pole luminaire posts, surface repurposing, etc.) requiring an adjustment and/or replacement of the head luminaire, console and/or the luminaire, the Contracting Entity shall cover any such costs.

The Contracting Entity will exercise due care throughout the Contract duration in order to facilitate the execution of works by coordinating with the Provider all activities related to the public lighting system, in particular with regard to the traffic regulation (at the expense of the Provider) and safe traffic circulation. The Provider shall keep a record of the replacement of worn or defective elements and organise it in a way not to, or only minimally, affect regular and normal operations of the Contracting Entity and the traffic in the area with the public lighting system. Via the MCC, the Provider shall keep a record of all such replacement activities, together with the technical specifications of the installed parts, elements and equipment. **The Provider is obliged to keep a record of all activities carried out during the Contract term via the MCC.**

At any moment, the Contracting Entity has the right to upgrade the luminaire with sensors and/or actuators onto the connector on the underside of the luminaire at its own expense, while the cost of the transfer of data from the sensor in limits defined by this document shall be borne by the Provider.

14.2 EV charging post maintenance

Provider shall show a proactive attitude in identifying and responding to issues that undermine UPTIME, and shall work in a collaborative manner with all equipment manufacturers and all third-party service providers included in provision of integrated lamppost EV charging service to ensure that sustainable solutions are implemented to address such issues.

Provider's specific contribution to achieving this shared target shall include:

- **Proactive Real Time Remote Monitoring:** Provider shall perform proactive remote monitoring of the charging posts and initiate issue resolution in an appropriate and timely manner. Provider shall have an automatic monitoring system that will notify Provider if any error occurs and if EV charging service is unavailable at any post. Regardless of automatic monitoring system, Provider shall ensure alternative manually managed diagnostics check of charging posts and their full functionality. Frequency of manually managed diagnostics and protocols for that task will be developed by Provider before beginning of service provision and will be regularly updated during the period of Contract if needed (if number of non-functional EV charges or number of customer complaint rises).
- **Software Updates and Integration of Firmware Updates.** Firmware update means any change to the firmware of the EV charging post. Provider shall maintain their software and back-office connection to the EV Charging posts, updating as necessary to maintain agreed levels of service for customers. Such maintenance shall include appropriate testing and integration of any firmware update issued by the manufacturer of equipment to Provider. The process, including notice periods, timelines and responsibilities for such testing and integration shall be jointly agreed by Provider and the equipment manufacturers, and Provider shall develop such process in a manner

that is practical for both Provider and the equipment manufacturers and maintains agreed service levels for Customers.

Telephone HELPDESK: Provider shall provide a telephone helpdesk service which is staffed 24 hours per day, 7 days per week in in local language and which customers may contact in the event they have issues during charging attempts and the operation of the EV charging post.

- The helpdesk telephone number and EV charging post serial or identification number shall be clearly displayed on the EV charging post.
- Calls to the helpdesk shall be charged at local call rates, unless legislation requires otherwise. For avoidance of doubt, calls cannot be charged at premium or international rates.
- The maximum time a customer contacting the helpdesk shall be required to wait before first contact with helpdesk staff shall be three (3) minutes.
- Provider shall ensure that helpdesk staff are trained and able to perform the remote maintenance process and to help resolve any possible issues without referring customer to other contacts.
- If the incident is deemed by the Provider to represent an immediate risk of loss or damage to life and / or property, then Provider shall initiate all procedures necessary to resolve the issue and prevent any possible damage to life or propriety.

Remote Maintenance Process: Provider shall develop and execute a process for remote maintenance, which shall be constructed based on assessment of the likely root causes and appropriate resolution methods for issues commonly encountered by customers during charging attempts and the operation of the EV charging post. Such process shall:

- Be in accordance with any training or instructions provided by the EV charging post equipment manufacturer.
- Include the process for remote resets and restarts of EV charging post.
- Include the process for passing on issues that Provider is not able to resolve, either to the EV charging post equipment manufacturer or to reactive maintenance activities; If the issue is passed by the Provider to the EV charging post equipment manufacturer, Provider shall pay the all fees levied by the EV charging post equipment manufacturer for the remote maintenance services they perform (unless covered by the warranty provided by the EV charging post equipment manufacturer) in such cases no fee shall be charged to customer in any case;
- Include the process for provision of feedback, updates and advice to the customer.
- Be completed, which means the issue has either been resolved or passed on to the EV charge post equipment manufacturer, within 4 hours of Provider first identifying an issue through remote monitoring, or receipt of the first call to the helpdesk about the issue, whichever is first.

Activation of the Reactive Maintenance activities: Provider shall provide reactive maintenance service for any issue or fault which relates to the EV charging post that Provider is not able to resolve within the remote maintenance process. Personnel dedicated for reactive maintenance service shall respond to any call and should be on site of EV charger post that is in fault in period of maximum 30 min if there is any danger to health and safety of customers or third persons or property. In other cases, reactive maintenance personal shall be on site in time period of 4 hours from the time issue has been passed to them.

Time periods specified for rectification of errors and specified in this chapter and chapter 3.1 can be changed if Provider and Authority come to such agreement.

In that case, Provider shall develop a detailed Issue resolving procedures in which he will specify in more detail procedures for different categories of errors or faults. Rectification periods should be in accordance with industry standards and should provide customers with high quality service. Any change to rectification services should not result in higher volume of customer complaints and if number of complaints rises in 6-month period after they have been amended then Provider shall develop a revised Issue resolving procedures with new rectification periods and procedures with aim resolving customer complaints and achieving better overall customer satisfaction rate.

Provider shall provide 24/7 access to real-time data environment for nominated Contract Entity representatives for the purpose of observing current and historic performance and download of relevant data. Provider shall manage (add, edit, remove) access for nominated representatives on request from time to time, providing a process to apply appropriate user rights.

Provider shall, within X months of the effective date of the Contract (including retrospective data if services are provided to publicly available Charge post within such period), provide data in a format, frequency and mechanism specified by Contracting Entity. Provider shall respond constructively to requested changes and developments in relation to such from time to time.

Provider shall provide a daily status report on basic functions, including but not limited to, Charge post status, error Logs, charging performance and charge session success rate, through a format and channel to be agreed with Contracting Entity (e.g. emailed directly to Contracting Entity).

Provider shall provide the below monthly reports to Contracting Entity within 10 (ten) business days of the end of the respective calendar month. Additional information and analysis may be provided at Provider's discretion. The exact format of each report and method for provision shall be agreed by Provider and Contracting Entity from time to time.

- Charging Activity – for each charging sessions, provide charge post reference or identity number, location reference or identify number, kWhs, vehicle model, time of day, payment method, total transaction fees paid, duration of charge and total charging income received.
 - ii) Utilisation – actual time and kWhs delivered compared to maximum potential time and kWh delivery capacity, expressed per month
 - iii) Uptime percentage per Calendar Month – per charge post the actual percentage uptime which is defined as the number of minutes per month that the charge post is operationally and technically capable of being used to charge an EV, divided by the total number of minutes in the calendar month minus exceptional downtime.
 - iv) Downtime Analysis – assessment of the downtime which reveals how much downtime is exceptional downtime and describes the reasons for all downtime and exceptional downtime, with clear connection to the failure report.
 - v) Failures – per charge post the number of operational or technical failures including failed charges per month (meaning charge sessions initiated but not completed or terminated early) including the cause and duration of each failure to the extent that such information can be extracted from the charge post.
 - vi) Helpdesk calls – number received per charge post, per day, per issue type, average resolution time, number requiring resets or restarts of the charge post, number escalated to the charge post manufacturer for further remote maintenance, number escalated to the internal maintenance process

- vii) Customer Feedback – consolidation of customer comments (positive and negative) regarding the charge post offer that have been received via the helpdesk or other means.
- viii) Learning Log – recommendations of changes to be made (e.g. to processes, communication and design) to improve customer service and reliability and to reduce costs.

Integrated lamppost EV charging maintenance and management

Provider shall use all reasonable endeavours to co-operate fully with all equipment manufacturers and all third-party service providers included in provision of integrated lamppost EV charging service to achieve the maximum levels of uptime (minimum levels of service failures) and successfully completed transactions possible for all charging posts operated under this Contract.

Provider shall ensure that customers paying for their use of the Charge posts using NFC enabled credit or debit cards or an ad hoc payment website accessed via a QR code pay exactly the price stated in the tariff and that such customers have the opportunity to request a receipt for their transaction.

Provider shall collect monies from payment parties which equals customers' payments to payment parties for the use of the charge posts. in the case of third-party MSPs, such monies shall be calculated in accordance with the roaming agreement between Provider and the third-party MSP. Monies collected from payment parties shall be known as "charging income".

Provider shall pay the charging income in accordance with the invoicing arrangements for payment of charging income as described in Contract.

Provider shall pay payment parties any transaction fees and other fees payable in relation to customer payments using NFC enabled credit or debit cards and pass such in accordance with the prices. For the avoidance of doubt, such fees shall not be netted off the charging income.

Provider shall act transparently in regard to any fees or mark-up that are charged by Provider on or in roaming tariffs towards third party MSPs, providing information in advance of any charges to be applied and total fees generated periodically.

14.3 Communication technologies maintenance

Provider shall show a proactive attitude in identifying and responding to issues that undermine UPTIME, and shall work in a collaborative manner with all equipment manufacturers and all third party service providers included in provision of communication technology service to ensure that sustainable solutions are implemented to address such issues.

Provider's specific contribution to achieving this shared target shall include:

- **Proactive Real Time Remote Monitoring:** Provider shall perform proactive remote monitoring of the street side antennas and initiate issue resolution in an appropriate and timely manner. Provider shall have an automatic monitoring system that will notify Provider if any error occurs and if communications service is unavailable at any post. Regardless of automatic monitoring system, Provider shall ensure alternative manually managed diagnostics check of street side antennas and their full functionality. Frequency of manually managed diagnostics and protocols for that task will be developed

by Provider before beginning of service provision and will be regularly updated during the period of Contract if needed (if number of non-functional street side antennas rises).

- **Software Updates and Integration of Firmware Updates.** Firmware update means any change to the firmware of the street side antenna. Provider shall maintain their software and back-office connection to the street side antennas, updating as necessary to maintain agreed levels of service for customers. Such maintenance shall include appropriate testing and integration of any firmware update issued by the manufacturer of equipment to Provider. The process, including notice periods, timelines and responsibilities for such testing and integration shall be jointly agreed by Provider and the equipment manufacturers, and Provider shall develop such process in a manner that is practical for both Provider and the equipment manufacturers and maintains agreed service levels for Customers.

Telephone HELPDESK: Provider shall provide a telephone helpdesk service which is staffed 24 hours per day, 7 days per week in in local language and which customers may contact in the event they have issues during the operation of the communication technology.

- Calls to the helpdesk shall be charged at local call rates, unless legislation requires otherwise. For avoidance of doubt, calls cannot be charged at premium or international rates.
- The maximum time a customer contacting the helpdesk shall be required to wait before first contact with helpdesk staff shall be three (3) minutes.
- Provider shall ensure that helpdesk staff are trained and able to perform the remote maintenance process and to help resolve any possible issues without referring customer to other contacts.
- If the incident is deemed by the Provider to represent an immediate risk of loss or damage to life and / or property, then Provider shall initiate all procedures necessary to resolve the issue and prevent any possible damage to life or propriety.

Remote Maintenance Process: Provider shall develop and execute a process for remote maintenance, which shall be constructed based on assessment of the likely root causes and appropriate resolution methods for issues commonly encountered. Such process shall:

- Be in accordance with any training or instructions provided by the street side antenna equipment manufacturer.
- Include the process for remote resets and restarts of street side antennas.
- Include the process for passing on issues that Provider is not able to resolve, either to the street side antenna equipment manufacturer or to reactive maintenance activities; If the issue is passed by the Provider to the street side antenna equipment manufacturer, Provider shall pay the all fees levied by the street side antenna equipment manufacturer for the remote maintenance services they perform (unless covered by the warranty provided by the street side antenna equipment manufacturer)
- Include the process for provision of feedback, updates and advice to the customer.
- Be completed, which means the issue has either been resolved or passed on to the street side antenna equipment manufacturer, within 24 hours of Provider first identifying an issue through remote monitoring, or receipt of the first call to the helpdesk about the issue, whichever is first.

Activation of the Reactive Maintenance activities: Provider shall provide reactive maintenance service for any issue or fault which relates to the street side antenna that Provider is not able to resolve within the remote maintenance process. Personnel dedicated

for reactive maintenance service shall respond to any call and should be on site of street side antenna that is in fault in period of maximum 60 min if there is any danger to health and safety of third persons or property. In other cases, reactive maintenance personal shall be on site in time period of 24 hours from the time issue has been passed to them.

Time periods specified for rectification of errors and specified in this chapter and chapter 3.1 can be changed if Provider and Authority come to such agreement.

In that case, Provider shall develop a detailed Issue resolving procedures in which he will specify in more detail procedures for different categories of errors or faults. Rectification periods should be in accordance with industry standards and should provide customers with high quality service. Any change to rectification services should not result in higher volume of customer complaints and if number of complaints rises in 6 month period after they have been amended then Provider shall develop a revised Issue resolving procedures with new rectification periods and procedures with aim resolving customer complaints and achieving better overall customer satisfaction rate.

Provider shall provide 24/7 access to real-time data environment for nominated Contract Entity representatives for the purpose of observing current and historic performance and download of relevant data. Provider shall manage (add, edit, remove) access for nominated representatives on request from time to time, providing a process to apply appropriate user rights.

Provider shall provide a monthly status report on basic functions, including but not limited to, street side antenna status, error Logs, network performance and transmission session success rate, through a format and channel to be agreed with Contracting Entity (e.g. emailed directly to Contracting Entity).

Provider shall use all reasonable endeavours to co-operate fully with all equipment manufacturers and all third party service providers included in provision of communication service to achieve the maximum levels of uptime (minimum levels of service failures operated under this Contract).

14.4 Smart City application maintenance

Provider shall show a proactive attitude in identifying and responding to issues that undermine UPTIME, and shall work in a collaborative manner with all equipment manufacturers and all third party service providers included in provision of environment sensor service to ensure that sustainable solutions are implemented to address such issues.

Provider's specific contribution to achieving this shared target shall include:

- **Proactive Real Time Remote Monitoring:** Provider shall perform proactive remote monitoring of the environment sensors and initiate issue resolution in an appropriate and timely manner. Provider shall have an automatic monitoring system that will notify Provider if any error occurs and if communications service is unavailable at any post. Regardless of automatic monitoring system, Provider shall ensure alternative manually managed diagnostics check of environment sensors and their full functionality. Frequency of manually managed diagnostics and protocols for that task will be developed by Provider before beginning of service provision and will be regularly updated during the period of Contract if needed (if number of non-functional environment sensors rises).

- **Software Updates and Integration of Firmware Updates.** Firmware update means any change to the firmware of the environment sensors. Provider shall maintain their software and back-office connection to the environment sensors, updating as necessary to maintain agreed levels of service for customers. Such maintenance shall include appropriate testing and integration of any firmware update issued by the manufacturer of equipment to Provider. The process, including notice periods, timelines and responsibilities for such testing and integration shall be jointly agreed by Provider and the equipment manufacturers, and Provider shall develop such process in a manner that is practical for both Provider and the equipment manufacturers and maintains agreed service levels for Customers.

Telephone HELPDESK: Provider shall provide a telephone helpdesk service which is staffed 24 hours per day, 7 days per week in in local language and which customers may contact in the event they have issues during the operation of the environment sensors.

- Calls to the helpdesk shall be charged at local call rates, unless legislation requires otherwise. For avoidance of doubt, calls cannot be charged at premium or international rates.
- The maximum time a customer contacting the helpdesk shall be required to wait before first contact with helpdesk staff shall be three (3) minutes.
- Provider shall ensure that helpdesk staff are trained and able to perform the remote maintenance process and to help resolve any possible issues without referring customer to other contacts.
- If the incident is deemed by the Provider to represent an immediate risk of loss or damage to life and / or property, then Provider shall initiate all procedures necessary to resolve the issue and prevent any possible damage to life or propriety.

Remote Maintenance Process: Provider shall develop and execute a process for remote maintenance, which shall be constructed based on assessment of the likely root causes and appropriate resolution methods for issues commonly encountered. Such process shall:

- Be in accordance with any training or instructions provided by the environment sensors equipment manufacturer.
- Include the process for remote resets and restarts of environment sensors.
- Include the process for passing on issues that Provider is not able to resolve, either to the environment sensors equipment manufacturer or to reactive maintenance activities; If the issue is passed by the Provider to the environment sensors equipment manufacturer, Provider shall pay the all fees levied by the environment sensors equipment manufacturer for the remote maintenance services they perform (unless covered by the warranty provided by the environment sensors equipment manufacturer)
- Include the process for provision of feedback, updates and advice to the customer.
- Be completed, which means the issue has either been resolved or passed on to the environment sensors equipment manufacturer, within 24 hours of Provider first identifying an issue through remote monitoring, or receipt of the first call to the helpdesk about the issue, whichever is first.

Activation of the Reactive Maintenance activities: Provider shall provide reactive maintenance service for any issue or fault which relates to the environment sensors that Provider is not able to resolve within the remote maintenance process. Personnel dedicated for reactive maintenance service shall respond to any call and should be on site of environment sensors that is in fault in period of maximum 60 min if there is any danger to health and safety

of third persons or property. In other cases, reactive maintenance personnel shall be on site in time period of 24 hours from the time issue has been passed to them.

Time periods specified for rectification of errors and specified in this chapter and chapter 3.1 can be changed if Provider and Authority come to such agreement.

In that case, Provider shall develop a detailed Issue resolving procedures in which he will specify in more detail procedures for different categories of errors or faults. Rectification periods should be in accordance with industry standards and should provide customers with high quality service. Any change to rectification services should not result in higher volume of customer complaints and if number of complaints rises in 6 month period after they have been amended then Provider shall develop a revised Issue resolving procedures with new rectification periods and procedures with aim resolving customer complaints and achieving better overall customer satisfaction rate.

Provider shall provide 24/7 access to real-time data environment for nominated Contract Entity representatives for the purpose of observing current and historic performance and download of relevant data. Provider shall manage (add, edit, remove) access for nominated representatives on request from time to time, providing a process to apply appropriate user rights.

Provider shall provide a monthly status report on basic functions, including but not limited to, environment sensors status, error Logs, network performance and transmission session success rate, through a format and channel to be agreed with Contracting Entity (e.g. emailed directly to Contracting Entity).

Provider shall use all reasonable endeavours to co-operate fully with all equipment manufacturers and all third party service providers included in provision of environment sensors service to achieve the maximum levels of uptime (minimum levels of service failures operated under this Contract).

15 Requirements just before the expiry of the Energy Performance Contract

This chapter sets out the requirements related to the Final inspection of the public lighting system which will take place just before the Energy Performance Contract expiry and the transfer of ownership of the Measures for improving the energy efficiency of the Public Lighting System to the Contracting Entity.

15.1 Final inspection and testing of the Public Lighting System

In the moment of Contract expiry, the public lighting system must fulfil all requirements set out in this document. Therefore, the Contracting Entity will hire an independent expert to carry out a detailed inspection and testing of the entire Public Lighting System and determine its condition and technical functionality.

The Provider shall ensure that the Contracting Entity has the right to use (including the right to giving it for use to third legal entities and/or natural persons) the Management & Control Centre (MCC) (and all its improved versions and updates) which represents an integral part of the Measures for improving energy efficiency aimed at the further management of the Public Lighting System, i.e. the purpose for which it has been purchased and used.

The Provider shall also ensure that there are no hidden and/or abnormally high costs of maintenance and use of the aforementioned software or other computer programmes.

The Provider shall give the Contracting Entity a non-exclusive right to software use, unlimited in terms of content, time and space, without the right to its suspension and without the obligation to return it.

The MCC shall be an open-source software, i.e. the Contracting Entity shall have access to its original code and have the possibility of its free use, study, modification and improvement.

The Provider shall transfer the exclusive right to use the software used to deliver the services under this Contract without any fee payment obligation. At the date of expiry, as well as upon its termination, the Provider shall provide the Contracting Entity with software suitable for installation on the Contracting Entity's computer in digital form with all data, software modules, archive, upgrades and all other functions and data that were in the software and/or at the software's disposal for the duration of the Contract.

The Provider shall at its own expense ensure the MCC's availability to the Contracting Entity within the period of 30 days after the Contract expiry in order for the Contracting Entity to have enough time to ensure the necessary infrastructure and other requirements for using the MCC, and shall provide the Contracting Entity with the necessary information and technical support.

A detailed inspection and testing of the public lighting system will be carried out to check its compliance with the Contracting Entity's requirements on the Contract expiry date.

This means that the public lighting system must meet all of the guaranteed standards of service and any other technical requirements set out herein, in particular:

- Anti-corrosion protection functioning (no traces of corrosion on the luminaire);
- IP and IK protection level must comply with the requirements set out herein (the protective cover seal testing, etc.);
- Installed power of the Public Lighting System must be smaller than or equal to the Guaranteed installed active power.

If any of the specified service standards is not met at the time of detailed inspection and testing, the Provider shall take all necessary steps to ensure the compliance of the public lighting system with the above standards of service. The costs related to correcting the identified deficiencies of the parts, elements and equipment installed under the Measures for improving energy efficiency of the Public Lighting System shall be borne by the Provider.

A detailed inspection needs to be carried out 6 (six) months before Contract expiry. The detailed inspection and testing shall be carried out by an independent expert hired by the Contracting Entity. The costs of engaging an independent expert shall be borne by the Contracting Entity. An independent expert is a legal person with the technical and technological capacity to carry out all planned inspection activities, with relevant references and necessary authorisations and licenses. The Provider's and Contracting Entity's Authorised Representatives shall also have the right to be present at the detailed inspection. During the inspection, the Provider's and Contracting Entity's Authorised Representatives shall have the right to present their remarks, comments or objections in relation to the manner of execution of the inspection and/or the conclusions of the independent expert. The independent expert will list all such comments and/or objections in the Minutes on the performed final audit (Annex 5 to the Energy Performance Contract, Report Content, ZP - 19).

The independent expert will be required to draw up a draft of the Minutes on the performed final audit within 30 (thirty) days of the detailed inspection and deliver it to the Contracting Entity and the Provider both in written and electronic form.

Should they not agree with the content and conclusions of the proposed Minutes on the performed final audit, the Contracting Entity and the Provider have 15 days of the day of its receipt to make observations thereon in writing to the other contracting party and the independent expert. The independent expert shall have 15 days of the day of receipt of the Provider's and/or Contracting Entity's observations to accept or reject the objections of the dissatisfied contracting party.

Should the Independent expert accept the contracting parties' objections, he/she shall draft the final Minutes on the performed final audit within 15 days of the day of expiry of the term for submission of feedback to the Provider's and/or Contracting Entity's observations and deliver it to the contracting parties. Should the independent expert not accept the contracting parties' objections or there are no objections presented within the deadline defined by this Article, the submitted proposed Minutes on the performed final audit shall be the final Minutes on the performed final audit. Should the contracting parties be dissatisfied with the final Minutes (ZP - 19), the dispute shall be resolved in accordance with the provisions of the Energy Performance Contract (Dispute resolution).

If the inspection of the Public Lighting System carried out by the independent expert, the Provider and the Contracting Entity reveals irregularities and deficiencies of the parts, elements and equipment installed under the Measures for improving energy deficiency of the Public Lighting System, and if they are indicated in the Minutes on the performed final audit, the Provider shall rectify them immediately and carry out all required works and activities by the date of the Contract expiry to ensure that the elements, parts and equipment installed under the Measures for improving energy deficiency of the Public Lighting System are technically correct and fully functional, and in compliance with the lighting quality and energy efficiency standards and requirements set out in this Contract.

After the Provider rectifies all deficiencies indicated in the final Minutes on the performed final audit and ensures compliance with all requirements (especially the requirements related to

lighting quality and energy efficiency), it shall inform the Provider and the independent expert thereon in writing. The Contracting Entity, the Provider and the independent expert shall perform a second inspection of the Public Lighting System in order to ascertain whether the Provider has rectified all deficiencies. If the second inspection of the Public Lighting System shows that the Provider has performed all necessary activities and repairs, the independent expert shall issue a written statement on the full functionality of the Public Lighting System and deliver it to the Contracting Entity and the Provider.

The Provider shall carry out the above activities as soon as possible and no later than 2 (two) months before the Contract expiry. However, if the identified deficiencies pose a hazard to the safe operation of vehicle and pedestrian traffic, they must be remedied within three days from the date of receipt of the independent expert's written notice.

If the additional inspection shows that the Provider has failed to do this, i.e. that it has not obtained a written certificate of full functional capability of the Public Lighting System at least 1 (one) month before the Contract expiry, the Contracting Entity shall be entitled to activate available fee payment mechanisms.

The activity workflow for the Final inspection of the Public Lighting System is provided in the image below (Image 5).

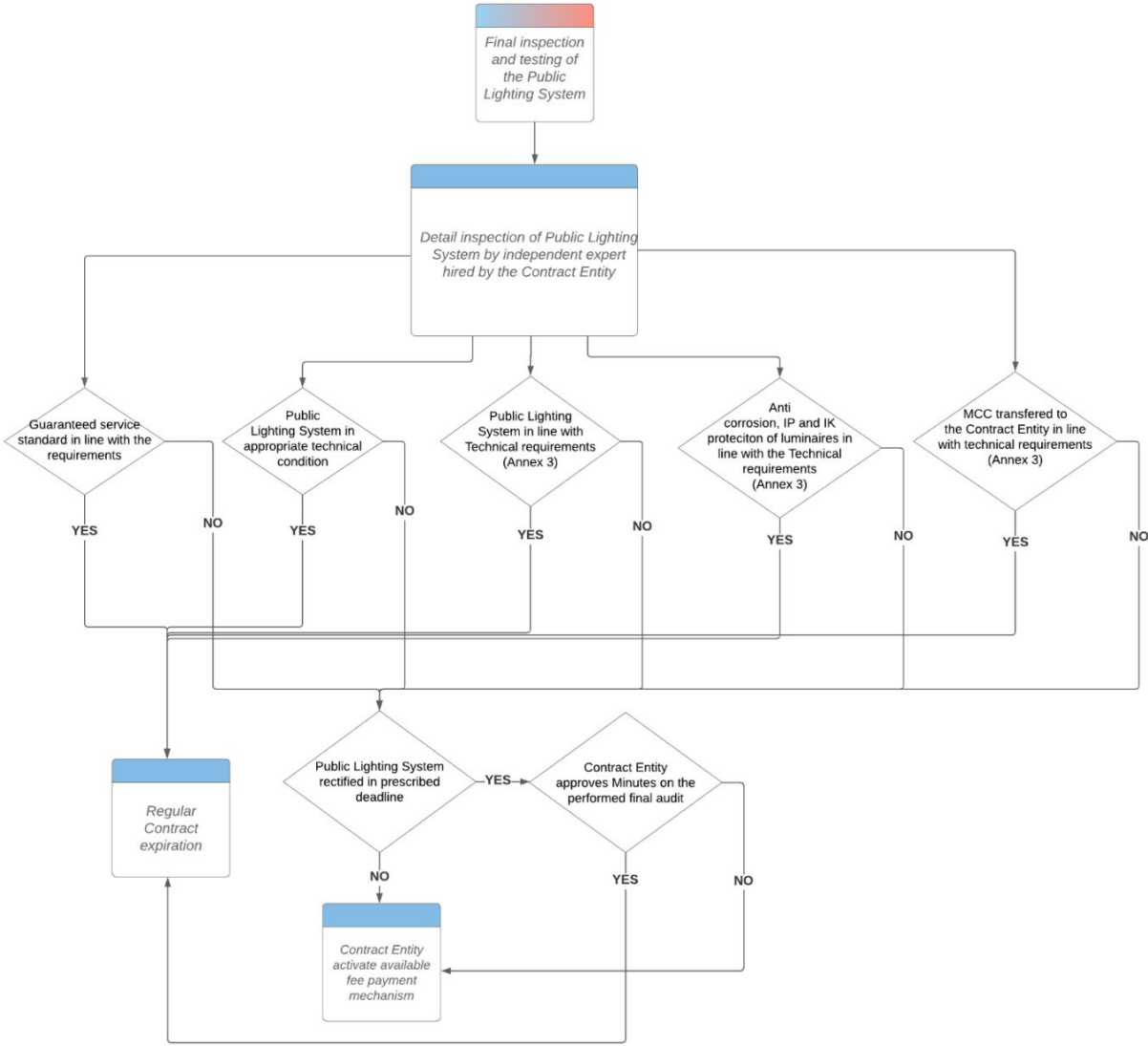


Image 5 Workflow during the Final inspection of the Public Lighting System

15.2 Detailed Maintenance Plan

The Provider shall, no later than two months before the end of the contractual period, provide a detailed description of the necessary and planned maintenance activities together with a list of spare parts and the details about their service life, a maintenance record during the Contract term, and plans and procedures in case of accidents or discontinuation of the lighting service.

The Public Lighting System maintenance must be planned in accordance with the technical specifications of the equipment, the manufacturer's instructions and good maintenance practice. The planned maintenance of each element of the public lighting system must be given in a table and described textually. The table must include the number of elements concerned as well as the predicted frequency of maintenance expressed in terms of a time unit (hour/day/month/year). The textual description of each element of the public lighting system must include a description of the activities and the minimum technical properties of the materials needed to perform the maintenance in accordance with the technical specifications of the equipment, the manufacturer's instructions and good maintenance practice. The Detailed Maintenance Plan must contain the total cost of the Public Lighting System estimated on the basis of the planned maintenance activities and service life of the equipment.

The maintenance plan must contain any relevant user manuals, technical information, and any upgrades or revisions of the software used (if any). The maintenance plan must be in language.

16 Control

In the Use Phase, the Contracting Entity will regularly monitor the Measures for improving energy efficiency of the Public Lighting System in accordance with the Monitoring, Measurement and Verification Plan (Annex 4 to the Contract).

Just before the Contract expiry, the Contracting Entity will hire an independent expert to carry out the Final inspection of the Public Lighting System.

