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DYNAMIC LIGHT

STRATEGY TO FACILITATE THE INTEGRATION OF DYNAMIC LIGHTING FROM A LEGAL PERSPECTIVE AND GUIDELINES FOR FINANCIAL MODELS

DYNAMIC LIGHT—TOWARDS DYNAMIC, INTELLIGENT AND ENERGY EFFICIENT PUBLIC LIGHTING

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DYNAMIC LIGHT

STRATEGY TO FACILITATE THE INTEGRATION OF DYNAMIC LIGHTING FROM A LEGAL PERSPECTIVE

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Dynamic Light

The project in brief

The Dynamic Light project focusses on the reduction of CO_2-emissions and enhancement of energy efficiency in public lighting. Public lighting causes ca. 6% of the global CO_2-emissions. Many conventional lighting fixtures need to be changed to energy efficient lights. However, public authorities lack a strategic approach to convert their lighting infrastructure. Dynamic lighting has the potential for even higher energy efficiency, because the dynamic lighting solutions: 1) implement state-of-the art technology in luminaires; and 2) use diming and adaptive control systems. The current challenges of dynamic lighting are a missing legal framework for dynamic dimming of lights and higher initial costs compared to standard LED lights. Therefore, municipalities hesitate to invest in dynamic lighting. But the uprising topic of light pollution and a necessary improvement of quality of public lighting brings dynamic lighting on the agenda, which can contribute to increase both energy efficiency and the quality of stay in city areas. The main objective of the project is to make a shift from municipal light infrastructure planning towards a modern energy efficient and demand-oriented lighting design and better light and energy management. The expected result is to get the best relation between highly energy efficient public lighting infrastructure and the quality of stay in urban areas through better light quality. This implies also to harmonise public lighting standards and norms to better meet social needs and make the application of dynamic lighting possible. It furthermore needs capacity building and awareness-raising for dynamic lighting and energy-saving potentials. The project will demonstrate the process of how a city can implement energy efficient lighting starting from the idea and analysis, GIS data mining, strategy development until financial models, procurement rules, implementation and evaluation. This goes hand in hand with the joint implementation and testing of pilot demonstration investments to proof the benefits and increase acceptance of energy-efficient lighting among end users and town planners.

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Foreword

Implementing and upgrading public lighting infrastructure is a challenging process for all stakeholders involved. Moreover, implementing new technologies in the public lighting infrastructure for tapping in the benefits from dynamic lighting could be demanding from the legal, technological, and financial perspectives. A lack of capacities and knowledge regarding the public procurement process among decision-makers and practitioners is commonly cited as a significant barrier for promoting dynamic, intelligent, and energy-efficient public lighting. This report tackles this barrier by providing a guideline for implementing public dynamic lighting infrastructure. It focuses on countries of Central Europe, namely Austria, Croatia, the Czech Republic, Germany, Italy, Poland, and Slovenia, and refers to the experience of municipalities involved in the Dynamic Light project that implemented public lighting infrastructure, in pilot basis, financed by INTERREG Central Europe.

The main audience for this guideline is decision-makers within the local public sector responsible for the public lighting infrastructure, namely municipal staff of lighting departments, procurement officers, urban planners, and public service providers. The contents are also relevant for other stakeholders involved in the public lighting planning and implementation, namely lighting designers, architects and urban planners, advisory engineers, lighting industry, and other sector organisations of the civil society such as NGOs and local citizens.

Implementing a dynamic lighting project is a complex process, as it presents stakeholders with many challenges of technical and legal nature. On the other hand, smaller municipalities in particular may lack the necessary personal capacity and expertise in these fields. Especially the rules for (green) public procurement[1] are complex. Unlike private actors, public authorities may not freely choose their contract partners. To prevent corruption and guarantee equal access of economical actors to public contracts, contracting by public authorities is ruled by provisions of public procurement law. In EU countries, this legal field is quite complex, as it is primarily ruled by provisions of EU law which are themselves transposed by the Member States in their respective legal orders. Relevant provisions therefore entail both EU directives and provisions of national law.[2]

This document introduces the relevant stakeholders to the necessary steps and possible legal challenges that they might encounter while developing a dynamic lighting concept and provide them with practical recommendations that will facilitation its implementation.

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[1] In the following, the general term “public procurement” is used as an overarching concept for both public procurement and concessions contracts. For the distinction between public procurement in a stricter sense and concessions contract, see below under “Nature of the contract: public procurement or concession?”.

[2] For a description of the relevant legal framework, see Deliverable [EU Report].

Finally, certain links provided in this document connect to internet websites maintained by third parties over whom the authors have no control. The authors make no representations as to the accuracy or any other aspect of information contained in internet websites.

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1. Introduction

Globally, cities account for more than 70% of global CO_2 emissions and over two-thirds of the world's energy consumption, according to the C40 Cities network.[3] Moreover, they are a focal point of energy consumption and offer, therefore, a significant potential for emission reduction. The public street lighting infrastructure is accountable for a significant share of cities' energy consumption. According to the Streetlight-EPC project[4], street lighting consumes a significant amount of electricity in Europe, where there are more than 56 million street lighting luminaires in operation, with an estimated electricity consumption of 35 TWh.

The state of the arts of the public street lighting technologies influences significantly its electricity consumption. For municipalities with older, inefficient systems, street lighting can account for 30-50% of their total electricity consumption and have significant environmental impacts, such as light pollution. However, the energy saving potential is enormous: with current technologies 30-70% energy savings are generally possible, according to the Streetlight-EPC project.

Implementing dynamic lighting solutions in the public lighting infrastructure could support municipalities within the EU to achieve its energy saving potentials and emission reductions targets. Nonetheless, the benefits of implementing dynamic lighting are broader than the energy savings and tackling climate change. Due to its comprehensive nature, implementing dynamic lighting aims at improving the quality of the urban lighting infrastructure and generating economic savings, by reducing energy costs for the municipality. Moreover, implementing dynamic light solutions could improve the quality of life of citizens, since the design of lighting considers their specific social needs.

What is dynamic lighting?

During the project, the following definition was elaborated by the project partners:

> *"Dynamic lighting is adaptive lighting, i.e. it is being provided where and when it is needed depending on different variable conditions, such as travelling speed, traffic volume and/or composition, ambient luminance, weather and other exterior factors in a way that it reduces light pollution as well as energy consumption; beyond that it recognises varying human and social needs, such as aesthetics or feeling of safety, as a basic concern and key factor in the design of adaptive public lighting."*[5]

Within the Dynamic Light project, a wide variety of pilot actions are implemented in municipalities within partner countries. The whole process of implementing dynamic lighting solutions delivers practical experience for municipal staff, infrastructure and service providers, and energy agencies. For choosing the pilot actions, the involved municipalities analysed different opportunities within the municipal public lighting infrastructure.

Pilot installations within the project range from pedestrian lighting in public parks, like in Cesena and Mantova (Italy) to lighting of public buildings and heritage sites, like in Susice (Czech Republic). The pilot installations could also serve for introducing new lighting solutions on city centre streets, like the installation in Cakovec (Croatia) or for demonstration of a small-scale dynamic lighting solution, like in city of Rostock (Germany). The latter highlights innovation as a key future for dynamic lighting solutions. Moreover, since the Dynamic Light project also relates to research and innovation, other pilot installations aim at technology testing in the public lighting infrastructure. An example can be found in the pilot

[3] Source: https://www.c40.org/.

[4] Source: http://www.streetlight-epc.eu/the-project/.

[5] Source: Deliverable D.T4.2.1 – Comparative inventory.

installation in the city of Glienicke/Nordbahn (Germany), where research on the effects of various scenarios of adaptive street lighting, reacting to the presence of cars, cyclists or pedestrians, is to be conducted.

An overview of the pilot actions implemented in the project in shown in the following table 1.

	Country	City	Aim
PA1	IT	Mantova	improving public lighting in a green area in Mantova
PA2	HR	Cakovec	introducing new lighting solutions on city centre streets
PA3	DE	Glienicke/Nordbahn	upgrading of existing street lighting infrastructure
PA4	CZ	Susice	upgrading the lighting of heritage site in the town
PA5	IT	Cesena	updating public lighting in a park area
PA6	SL	Gorenjska region	installation of dynamic lighting in small municipalities
PA7	DE	City of Rostock	demonstration of a small-scale dynamic lighting solution
PA8	PO	Poland	demonstration of a small-scale dynamic lighting solution
PA9	AT	Guessing Castle	upgrading the lighting of heritage site in the town

Table 1. Dynamic Light project - pilot installations.

Source: Interreg.[6]

The number of system components, as well as their technical specifications, varies from project to project based on the complexity of the dynamic lighting solution. In general, the lighting system consists of two main components: 1) the public lighting network; and 2) a dynamic monitoring and control system. In the pilot installations implemented within the project, different technological innovations have been made in the system components of each pilot action.

As an example, based on the experience of the pilot installation in the city of Mantova, the box below shows the main innovations made in the lighting system of the park.

Technical description of the installation in Mantova

The pilot installation in Mantova implements a smart network integrating four systems, namely:

1) one new public lighting system, energy efficient (LED tech based) and intelligent (based on human presence);

2) one WI-FI network;

3) one video surveillance system;

4) two interactive information panels (one at the beginning and one at the end of the fitness trail).

[6]INTERREG Central Europe, Dynamic Light project, "Pilot installations", available at: https://www.interreg-central.eu/Content.Node/Dynamic-Light/Pilot-Actions.html (accessed 14 January 2019).

2. Implementing a dynamic lighting project: where to start?

The implementation of a dynamic lighting solution involves many steps, from the conception of the project to the end of the contractual period. A municipality must first assess its concrete needs, possibly develop a concept of its own, and find the right financing and contractual partner in case it lacks the necessary financial and personal resources for the implementation of the project (figure 1).

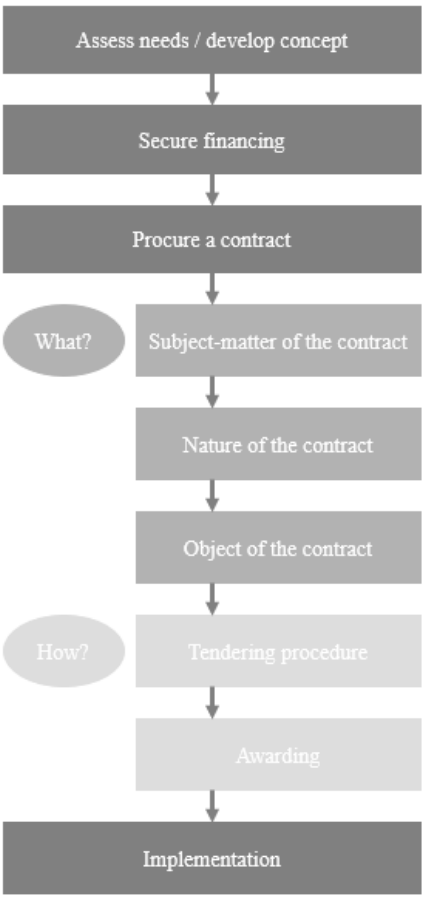

Figure 1. Milestones of a dynamic lighting concept.

Source: own elaboration.

How to address the identified needs with dynamic lighting solutions? How to come with a concept?

Implementing dynamic lighting solutions could be very beneficial for municipalities. The experience in the implementation of the pilot actions of the project shows that municipalities in the EU have specific needs that can be meet through the implementation of dynamic lighting solutions. In general, one of the most relevant necessities is to reduce the energy consumption in the public lighting infrastructure and, therefore, to reduce their CO_2 emissions. This would allow municipalities to implement climate action plans and to meet climate targets. Furthermore, municipalities may also have environmental goals, such as the reduction of light pollution in cities. The implementation of appropriate technologies in luminaires and systems for reducing light intensity according to specific needs depending on the use and time of different public spaces (for example, in the early morning hours when a minimum intensity is needed due to security issues) can help municipalities meet environmental and nature protection goals. Finally, dynamic lighting solutions

could enable higher energy efficiency in the public lighting designed to enhance the aesthetics of public buildings.

Once concrete needs are identified, a project's concept can be elaborated. The European Commission publishes best-practice examples for projects, for example regarding the green public procurement of street lighting and traffic signals.[7] These can serve as an example to inspire future project developers and contracting authorities. The concrete implementation of the concept by an external (private) actor further necessitates to **secure the necessary financing** and to **tender the relevant contractual relationships** under consideration of the applicable public procurement rules. Furthermore, the contracting authority must ensure that it has the **competence** to modify or upgrade the infrastructure; ownership issues for example might lead to the necessity for the contracting authority to purchase the ownership of infrastructure elements belonging to third parties.

Assess the state of the existing infrastructure

The development of a dynamic lighting project may require upgrading the technology of the luminaires or even redesigning the entire lighting infrastructure. An assessment of the **condition of the existing infrastructure**, such as number and state of the luminaires, technology used, etc., is necessary.[8] This allows to better foresee the needs in terms of materials, services and investment costs for the project implementation.

Finance a project

The implementation of a dynamic lighting project may bring **high investment costs** which must be eventually carried by the municipality. Different financing models are presented below in the section "Financing a project".

Assess the necessary human resources

The question is particularly relevant since in most of cases a public actor will not be able to develop an ambitious project with solely internal resources. Where external support is necessary, part or all the components of the project's implementation will be **entrusted to a third party, usually an economic operator**. The contractual relationship between the public authority and the economic operator will be ruled by a contract following a tendering procedure.

[7] European Commission, "GPP Good Practice", 19 November 2018, http://ec.europa.eu/environment/gpp/case_group_en.htm (last accessed 17 December 2018).

[8] This praxis is for example recommended in Italy by the Ministerial decree of 28 March 2018 on "Minimum environmental criteria for public illumination services" in GU Serie Generale n.98 of 28-04-2018 and by the new "EU green public procurement criteria for road lighting and traffic signals", available at: http://ec.europa.eu/environment/gpp/pdf/toolkit/181210_EU_GPP_criteria_road_lighting.pdf (accessed 10 January 2019).

3. Project design

Dynamic Light project design involves an intervention in the public space. Besides technical considerations related to public lighting, it is necessary to consider the **social needs of the end-users or beneficiaries**, the **environmental impacts of the intervention**, and the **legal and regulatory frameworks that affect urban planning**. The latter emphasises the need to contemplate in detail the compliance of the intervention with current legal framework in relevant aspects, such as public lighting standards, transportation and street infrastructure, land use planning, and security, to name a few. The innovative nature of dynamic lighting solutions, which search for more energy efficient alternatives, represents an appreciable added value compared to a simple upgrade of luminaires in the public space. Depending on the existing internal capacities in the municipality, an external entity may be hired to design the project.

Based on the experience gained through the project implementation of pilot actions, the design of the project is a joint effort between the **municipality**, in its role as the public authority, and the **private developer**, who generally has the experience and technical capacities. The conception of the project could emerge either from the municipality or the private developer. Nevertheless, the experience gained when implementing the pilot actions within the Dynamic Light project has shown that the **private developers are often the project initiators**. In the pilot action in the city of Mantova (Italy), for example, TEA Reteluce, a TEA Group subsidiary subject to TEA S.p.A., redeveloped the public lighting network for the purpose of energy usage optimisation, energy saving, environment protection, and the upgrade of all lighting points in the pilot action.[9]

Moreover, since the main aspect of a Dynamic Lighting project is without question the public lighting infrastructure, **private companies innovating in the field** are potential project initiators and could propose to any given municipality a dynamic lighting concept for an intervention in a public space, through technological innovation in the public lighting system.

Regardless of where the initiative of implementing a dynamic lighting solution is emerging from, in general the process of design and conception of a project considers consecutive steps that can be applied to the different types of interventions in the public lighting infrastructure. As an example, the main steps of the design of the pilot action in the city of Cesena were the following:

1. Analysis of the specific lighting situation of the intervention area;
2. Site specific analysis;
3. Light network description;
4. Identification of specific social needs;
5. Analysis of the site legal framework;
6. Planning and Development.[10]

The modalities of the project condition the later contractual relationship between the public authority and the project developer. The contractual concept – and subject-matter of the contract – will condition the contract's object, value and duration, and the relationship between the parties. It has a direct effect on the applicable public procurement rules.[11]

[9] For further inquire regarding the technical partners involved in the Pilot Action in the City of Mantova, see the Deliverable D.T.3.1.4 – Planning of intelligent light concepts: Technical Partners Selection & Engagement Report.

[10] For further inquire, see the Deliverable D.T.3.1.3 - Analysis of the specific lighting situation – CESENA.

[11] See below under "Procuring a contract".

4. Financing a project

Although upgrading street lighting would cut energy costs, many areas of Central Europe have not yet taken measures to improve their lighting infrastructure. **Budgetary constraints** on owners, which are often municipalities, are commonly cited as a reason for this inaction. Among its various tasks, the Dynamic Light project examined **financing energy efficiency upgrades of street lighting infrastructure in municipalities of Central Europe**. Numerous potential funding sources were identified that could cover the costs of installing energy-efficient street lighting without depleting municipal resources, as presented in figure 2 below.[12]

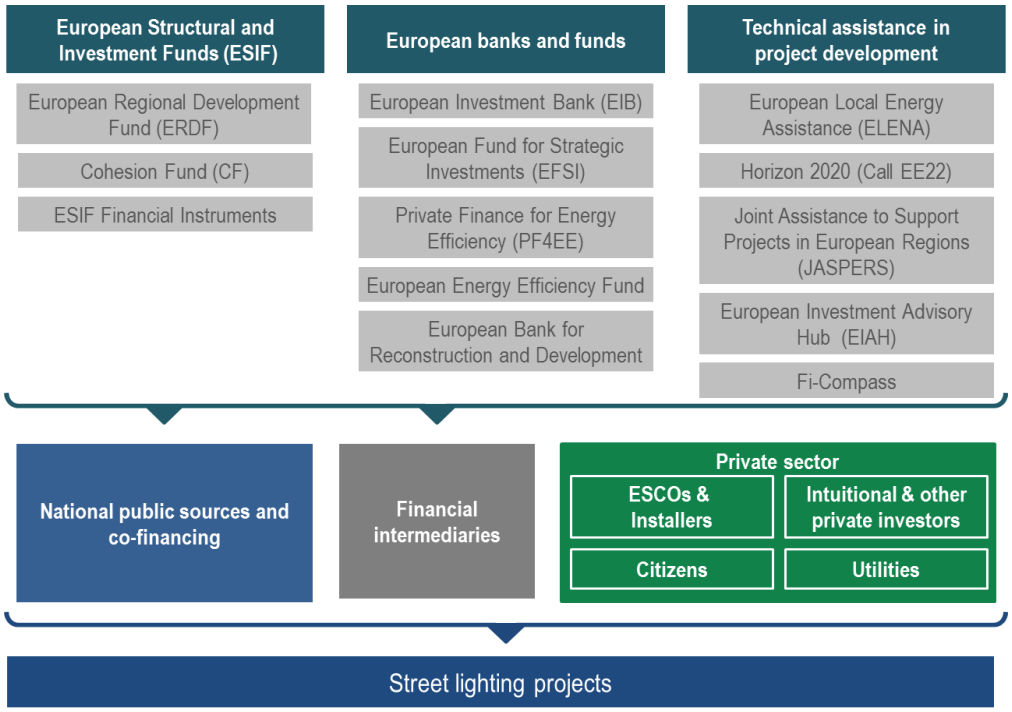

Figure 2. Funding sources for energy-efficient street lighting in Central Europe.

Source: Novikova et al. (2017), adapted from Covenant of Mayors for Climate & Energy (2016).

4.1 European funding sources

A number of **EU funds and intermediaries** could provide financing for preparation and actual implementation of the project. For instance, the European Structural and Investment Funds (ESIF) channel their resources to the Member States through operational programmes designed by each country according to its policy priorities. Its two funds, the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), cover multiple energy efficiency measures, including street lighting. Furthermore, the European Fund for Strategic Investments (EFSI), Private Finance for Energy Efficiency (PP4EE), and the European Energy Efficiency Fund (eeef) managed and/or co-financed by the European Investment Bank (EIB) provided support for street lighting projects. The European Bank for Reconstruction and Development (EBRD) channels

[12] The project's Deliverable D.T2.3.2 "Analysis of funding sources" (Novikova, A., Stelmakh, K., Hessling, M., Emmrich, J., and Stamo, I. 2017. Guideline on finding a suitable financing model for public lighting investment: Deliverable D.T2.3.3 Best practice guide. Report of the EU funded project "INTERREG Central Europe CE452 Dynamic Light", October 2017. URL: http://www.interreg-central.eu/Content.Node/Dynamic-Light/CE452Dynamic-Light-D.T2.3.3-Best-Practice-Guide-final.pdf) summarised the results of research into potential funding sources. Please consult the deliverable for the information on eligible measures, beneficiaries and conditions for each individual fund. The report also describes the application process for each of them, necessary links and contacts, examples of successful project and additional reading materials.

its support through credit lines to local commercial banks, which ultimately disburse funds to municipal lighting projects. in Croatia, Hungary, Poland, Slovakia, and Slovenia.

EU-funded technical assistance in project development is available through the European Local ENergy Assistance (ELENA) programme, the Joint Assistance to Support Projects in European RegionS (JASPERS) initiative, and Horizon 2020 Project Development Assistance (Call EE-22-2016-2017). In addition, the European Investment Advisory Hub (EIAH) and fi-compass advisory service practical support, including expertise and skills training.

4.2 National funding sources

Each Member State uses ESIF funding to operate and co-finances multiple support programmes. Many countries offer additional options for support from the national budget, including grants or low-interest rate loans, and channel assistance through national environmental funds, national development banks, or other intermediaries.

In some countries, such as Germany, **national public funding** far exceeds support from EU funds. Subnational governments often administer **regional support programmes**. The main programmes are listed in the following table 2.[13]

Country	Programmes
Austria[14]	Der Klima- und Energiefonds (Climate and Energy Fund) Energiesparen in Gemeinden (Energy Savings in Local Communities) Energiesparen in Betrieben (Energy Savings in Industry and Commerce) 'Energie-Contracting-Programme' of Upper Austria
Croatia	Regional Energy Efficiency Programme for the Western Balkans (REEP) Green for Growth Fund Southeast Europe (GGF) Environmental Protection and Energy Efficiency Fund (FZOEU)
Czech Republic	National Environmental Programme implemented by the Ministry of the Environment Programme with support from the State Environmental Fund Programme EFEKT of the Ministry of Industry and Trade
Germany	Programmes of the Kreditanstalt für Wiederaufbau (KfW)[15] National Climate Initiative (NKI), implemented by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
Hungary	The European Bank for Reconstruction and Development (EBRD) and the International Finance Corporation (IFC) provide credit line through local financial institutions.
Italy	Electricity generators and distributors are obliged to deliver energy efficiency, where street lighting is eligible, under White certificate scheme.

[13] More details about the programs including applications conditions, further links and contacts are available in Deliverable D.T2.3.2 "Analysis of funding sources".

[14] Regional programmes to support energy savings exist in all regions of Austria; comprehensive programme descriptions (including application criteria, conditions and contacts) is available in the publication 'Support for environmental and energy consulting: Examples of successful joint federal/regional consulting programmes' [Förderungen für Umwelt-und Energieberatungen Erfolgsbeispiele aus den gemeinsamen Beratungsprogrammen von Bund und Ländern].

[15] Municipalities or municipal enterprises can receive funding for street lighting through two main programmes, IKK [Investitionskredit Kommunen (208)] and IKU [Investitionskredit Kommunale und Soziale Unternehmen (148).

Poland	National Fund for Environmental Protection and Water Management – programme 'Intelligent energy networks (smart grid)'
Slovakia	Municipalities can apply to SlovSEFF for funding with ESCOs that are willing to develop street lighting projects and upgrade energy efficiency in cities and town.
Slovenia	Slovenian Environmental Public Fund (Eco Fund) Energy efficiency obligation scheme Slovene Export and Development Bank (SID Bank)

Table 2. National and local financing programmes.

Source: own elaboration based on Novikova et al. (2017).

Municipalities can establish a **revolving fund** to multiply available capital. Figure 3 illustrates a revolving fund organised for energy efficiency projects. A municipality invests capital (e.g., equity or debt) into a project (e.g., a street lighting upgrade). The project saves energy, which translates into energy cost savings that free up some of the budget resources previously used to cover utility bills. These funds, in turn, can be used to repay the initial investment and/or reinvest in new projects, thus creating a revolving model.

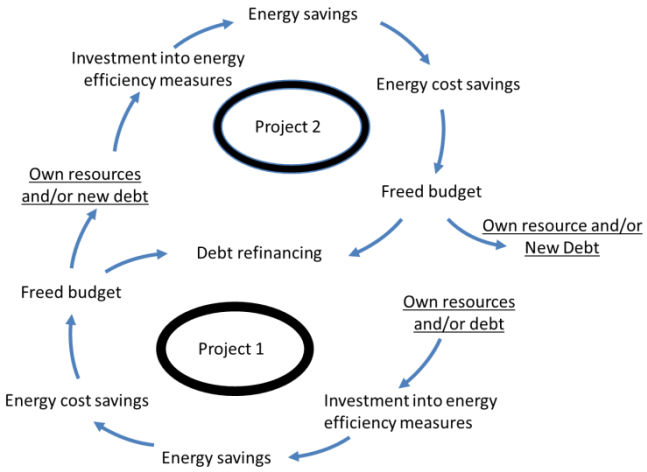

Figure 3. Capital flow in a revolving fund.

Source: Novikova et al. 2017.

4.3 Financing by a private contractor

Municipal actors can also **reallocate to third parties the burden of financing street lighting infrastructure**. For instance, financing can be covered by a private partner, which delivers the upgrade works, is usually not responsible for the energy supply and therefore cannot use energy savings for its financing needs. The private partner finances the street lighting project from their own funds or obtains funds from third parties. For their services, the contractor receives a payment from municipalities. If the contractor obtains financing from additional third parties, they repay the debt to them. The municipal payment to the contractor and the contractor's payments to a lender are not contingent on energy savings.

Alternatively, financing can be provided by a private partner, which delivers the upgrade works, makes payments on the basis of the energy savings achieved, and uses these payments to make the project investment. This model is referred to as **'energy performance contracting' (EPC)** and the private actor is referred to an **'energy savings company' (ESCO)**. There are different descriptions and models of EPCs. The basic element of all EPC models, however, is that cost savings achieved by reducing energy consumption are used to finance the investment.

In EPC models, the municipality or a private partner is responsible for the energy supply. In the end, however, it is always the municipality that pays for the services (including energy supply, planning, financing and installing the new equipment), either separately or as a lump sum. In the model shown in figure 4, future municipal costs (consisting of energy costs plus regular payments to the private partner) are identical to municipal energy costs paid before the modernisation took place. When state-of-the-art LED luminaires with 'intelligent' controls replace old lighting technology, such upgrades can deliver energy savings of up to 80% or more. In this case, municipalities can use a significant portion of the cost savings to cover EPC fees to the service provider. This arrangement can either shorten the length of the contract or reduce the municipality's regular payments, allowing for immediate savings even during the contract term. One of the major benefits of such a financing model is that a municipality may transfer all of the risks related to implementation, design and maintenance of new street lighting technologies to an ESCO and eventually benefit from its experience and capabilities.[16]

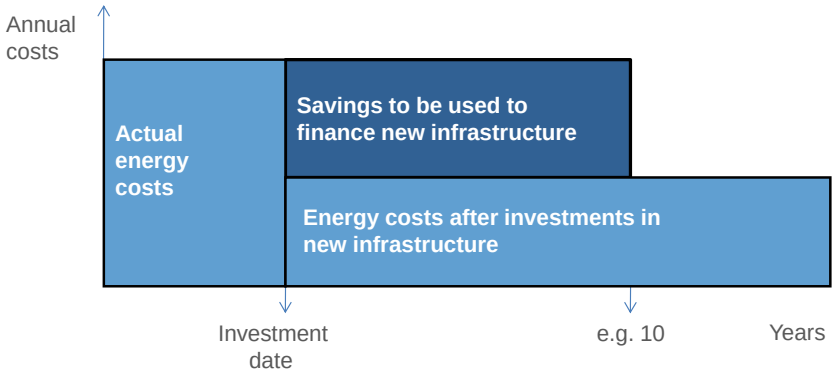

Figure 4. EPC guaranteed savings model.

Source: Novikova et al. 2017.

[16] There are numerous case study of ESCO models used for street lighting projects throughout Europe. For more details, please see Deliverable D.T2.3.2 "Best practice guide" (Novikova, A., I. Stamo., Stelmakh, K., Hessling, M., 2017. Guideline on finding a suitable financing model for public lighting investment. Analysis of funding sources. Deliverable D.T2.3.2 of the Dynamic Light project of INTERREG CE platform. URL: http://www.interreg-central.eu/Content.Node/Dynamic-Light/Dynamic-Light-D.T2.3.2-Novikova-et-al.-2017-Financing-Model-.pdf). The report provided an overview of each model, identified the projects to which it could be applied, specified its advantages and disadvantages, and provided a relevant case study.

5. Procuring a contract

Due to lacking resources, a public actor may need to resort to external support to concretely implement a project. Unlike private economical actors, which may choose a contract partner freely on the market, public bodies must comply with **public procurement rules**. The aim of these rules is to ensure the transparency of public actors' choices in contractual partners and to avoid distortions of competition on a free market, considering the considerable weight of public procurements on the market (15-20% of the global GDP with an estimated volume of 1.3 trillion Euro).[17]

According to public procurement rules, public actors must usually perform a **tendering procedure** to procure a contract. After the procedure is performed, the public actor enters a contract with the successful bidder. The provisions governing public procurement procedures are set by a complex set of rules at EU and national level. The EU has established a general framework on public contracts in the Member States, which provides a common legal pattern which may be found in the EU countries: the directive on public procurement[18] (hereinafter: "PP Directive") and the directive on the award of concession contracts[19] (hereinafter: "Concessions Directive"). However, these directives are respectively transposed by the national legislators in the legal orders of the Member States. Therefore, the concrete design of public procurement rules may vary from one country to another.

Applicable public procurement rules

It would go beyond the scope of this report to elaborate on the national public procurement rules of all countries represented in the project. In the following, the European framework for public procurement is used as a common denominator. It is essential for contracting authorities to verify the respectively applying national public procurement rules for possible discrepancies with the European framework.

Tendering is a complex process consisting in several steps that go throughout the procurement procedure and project life. Typical procedure stages for public procurements are shown in figure 5.

[17] European Commission, DG GROW, "Public procurement", available at: https://ec.europa.eu/growth/single-market/public-procurement_en (accessed 18 December 2018).

[18] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC, *OJ L 94, 28.3.2014, p. 65–242*.

[19] Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of concession contracts, *OJ L 94, 28.3.2014, p. 1–64*.

1. Preparation and planning	2. Publication and transparency	3. Submission of tenders, opening and selection	4. Evaluation and award	5. Contract implementa-tion
» Detect future need » Engage stakeholders » Analyse market » Define the subject matter » Choose the procedure	» Draft specifications including criteria » Prepare procurement documents » Advertise the contract » Provide clarifications	» Receipt and opening » Apply exclusion grounds » Select suitable tenderers	» Evaluate tenders » Award and sign the contract » Notify tenders and publish the award	» Manage and monitor the execution » Issue payments » If needed, deal with modification or termination of contract » Close the contract

Figure 5. Typical public procurement procedure stages.

Source: European Commission (2018)[20]

Who must tender?

Both the PP Directive and Concessions Directive apply to procurement by **"contracting authorities"**.[21] Therefore, all these contracting authorities must comply by public procurement rules.

Contracting authorities are defined as "*the State, regional or local authorities, bodies governed by public law or associations formed by one or more such authorities or one or more such bodies governed by public law*".[22]

Bodies governed by public law are defined as "*bodies that have all of the following characteristics:*

(a) they are established for the specific purpose of meeting needs in the general interest, not having an industrial or commercial character;
(b) they have legal personality; and
(c) they are financed, for the most part, by the State, regional or local authorities, or by other bodies governed by public law; or are subject to management supervision by those authorities or bodies; or have an administrative, managerial or supervisory board, more than half of whose members are appointed by the State, regional or local authorities, or by other bodies governed by public law".[23]

Entities falling under these definitions must therefore perform tenders when necessary. In some cases, the performance of a tendering procedure by a contracting authority is not necessary.

[20] European Commission (2018), *Public procurement guidance for practitioners on avoiding the most common errors in projects funded by the European Structural and Investment Funds*, available at https://ec.europa.eu/regional_policy/sources/docgener/guides/public_procurement/2018/guidance_public_procurement_2018_en.pdf (accessed 17 December 2018).

[21] The Concessions Directive also refers to "contracting entities", these are however only relevant for the award of concessions in the energy, postal or transport sector, which is not relevant to this report.

[22] Art. 2 par. 1 (1) PP Directive; Art. 6 par. 1 Concessions Directive.

[23] Art. 2 par. 1 (1) PP Directive; Art. 6 par. 4 Concessions Directive.

When is it not necessary to tender?

Public bodies are not always required to tender their contracts. Tendering procedures are not required when one of the conditions is fulfilled:

1) When the contract is procured in-house

This refers to contracts **between entities which are part of the same administrative apparatus**. In this scenario, the contracting authority exerts such strong influence on the other party that it can cannot be considered external to the awarding administration. The contract can be **directly awarded**. The contracting partner can be a legal person governed by private or public law, as long as all the conditions for an in-house procurement are fulfilled. According to the European directives[24], this is the case when:

a) the contracting authority exercises over the legal person concerned a control which is similar to that which it exercises over its own departments;

b) more than 80% of the activities of the controlled legal person are carried out in the performance of tasks entrusted to it by the controlling contracting authority or by other legal persons controlled by that contracting authority; and

c) there is no direct private capital participation in the controlled legal person with the exception of non-controlling and non-blocking forms of private capital participation required by national legislative provisions, in conformity with the Treaties, which do not exert a decisive influence on the controlled legal person.

2) When the contract is non-pecuniary

A "*contract for pecuniary interest*" is a contract by which the parties undertake to provide a service in exchange for another. The object of the exchange does not necessarily involve a payment; it can also consist in the provision of advantages of another nature from the side of the contracting authority. In the absence of any kind of reward for the provided service, the contract falls outside the scope of the public procurement rules.

3) When the contract's value is below the relevant procurement threshold

In cases when the estimated value of a contract is below the applicable threshold[25], the contracting authority may directly award the contract. In this respect, the thresholds set by the European directives are minimal standards; the Member States are free to impose **lower thresholds** on contracting authorities. Therefore, it is important to ultimately **verify the thresholds which are set by national provisions**.

What rules need to be respected?

Even when it is not necessary to tender, basic rules for fair competition must be respected. The application of transparency and non-discrimination principles must always be guaranteed.[26] This means for example to not discriminate against businesses based on nationality, not refer to specific brands, trademarks or patents, or to accept documentation issued by other EU Member States if they offer the same level of guarantee as national documentation.

[24] Art.12 PP Directive; Art. 17 Concessions Directive.

[25] For general information about thresholds, see below under "Find the relevant threshold and tendering procedure".

[26] European Commission (2018), "Tendering rules and procedures", available at: https://europa.eu/youreurope/business/selling-in-eu/public-contracts/rules-procedures/index_en.htm (accessed 09 January 2019).

How to tender?

A contract can be procured by a public authority under **different procedures**. In order to identify the right procedure, the contracting authority must assess several elements which are conditioned by the subject-matter of the contract. The **nature and object of the contract** condition the relevant threshold for procuring and applicable procedure. The project's concept will also condition the content of the tender and the criteria for awarding the tender. The applicable tendering procedure for public procurements is set by national law, whether the tendered contract's value is below or above[27] the thresholds of the PP Directive. For tendering contracts with value below the thresholds of the EU Directives, national law may prescribe specific procedures. In Italy for example, a set of rules were issued for the procurement of contracts which value is lower than the thresholds of the EU Directives; however, a direct award is possible for contracts which value does not exceed 40,000.00€.[28] Contracting authorities must therefore verify the relevant provisions set by national law.

As for concessions, the contracting authorities chooses freely how to structure the tender – in observance of general rules concerning selection and award criteria and procedural guarantees.[29] Concessions require a higher flexibility due to the complexity, the high-value and the duration of these contracts.[30]

The following table 3 provides a general overview of the different procurement procedures set by the PP Directive.[31]

Procedure	Description
Open procedure	Any interested economic operator may submit a tender without prior selection.
Restricted procedure	Any interested economic operator may submit a request to participate in the call; after a qualitative selection of at least five candidates, only the pre-selected participants will be able to submit a tender.
Competitive procedure with negotiation	Any interested economic operator may submit a request to participate in the call; after a qualitative selection of at least three candidates, only the pre-selected participants will be able to submit a tender which will form a basis for subsequent negotiations. During the negotiations, the candidates may submit revised tender which are assessed in the final phase.
Competitive dialogue	Any interested economic operator may submit a request to participate in the call; after a qualitative selection of at least three candidates, the contracting authority engages with the pre-selected participants in a dialogue in order to identify its needs and define the means best suited to satisfying them. Once the solutions are identified, the candidates submit final tenders which are assessed in the final phase.

[27] Art. 26 par. 1 PP Directive.

[28] Art. 36 D. lgs. 50, 2016, G.U. n. 91 of 19 April 2016; the thresholds for direct awarding have been provisionally increased by the act n. 145 on 30 December 2018 (from 40,000.00€ until 150,000.00€ a contract can be directly awarded prior to consultation with at least three operators).

[29] Art. 30 Concessions Directive.

[30] Directive of the European Parliament and of the Council on the award of Concession Contracts – Frequently Asked Questions, available at: http://europa.eu/rapid/press-release_MEMO-14-19_en.htm?locale=en (accessed 07 December 2019).

[31] The different procedures are described in detail in Art. 27 and following of the PP Directive.

	This procedure is suited to the tendering of complex contracts such as large infrastructure projects where the contracting authority does not have the ability to define technical specifications prior to the procedure.[32]
Innovation partnership	Any interested economic operator may submit a request to participate in a call where the contracting authority identifies the need for an innovative product that cannot be met by purchasing products already available on the market. After a qualitative selection of at least three candidates, the pre-selected participants may participate in the procedure. The contracting authority may then set up innovation partnerships with one or several partners.
Negotiated procedure without prior publication	The contracting authority invites a limited number of participants, at least three, to negotiate the terms of the future contract. This procedure may only be performed in specific cases, for example if no suitable tenders or requests to participate have been submitted in response to an open procedure or a restricted procedure, if the contract's object can be supplied only by a particular economic operator, or for reasons of extreme urgency.

Table 3. Procedures for tendering public procurements according to the PP Directive.

Source: own elaboration.

An exception to these rules is provided for R&D services, which may be procured by performing a regular open procedure via a **pre-commercial procurement**.[33] However, this does not apply to the subsequent purchase of newly created product or services, which requires a regular tendering procedure.

Publication duties

When the tendered contract's value lays above the thresholds of the directives, or when it has a potential cross-border interest[34], it must also[35] be advertised in the Supplement to the Official Journal of the European Union (OJEU)[36]. Three types of notices may be published:

- the **prior information notice** (PIN), with which the contracting authority informs of its intention to procure;
- the **contract notice** (CN), which contains the tendering documentation and launches the procedure, and;
- the **contract award notice** (CAN), which sets out the decision of the contracting authority on the results of the procurement procedure.

[32] European Commission, "Tendering rules and procedures", last updated 13 November 2018, https://europa.eu/youreurope/business/selling-in-eu/public-contracts/rules-procedures/index_en.htm (accessed 11 January 2019).

[33] Recital 47 PP Directive.

[34] See n° 1.3 "Relevance to the Internal Market" of the Commission interpretative communication on the Community law applicable to contract awards not or not fully subject to the provisions of the Public Procurement Directives, *OJ C 179, 1.8.2006, p. 2-7*.

[35] The notices may also be advertised in other international, national or local official journal, but never before the publication in the OJEU. For further information see OECD/SIGMA (2016), *Public procurement Brief 6, Advertising*, available at: http://www.sigmaweb.org/publications/Public-Procurement-Policy-Brief-6-200117.pdf (accessed 8 January 2019).

[36] The supplement of the European Official Journal is also electronically accessible as a free online version called "Tenders Electronic Daily (TED)", available at: https://ted.europa.eu/TED/main/HomePage.do (accessed 8 January 2019).

Only the publication of the contract notice and contract award notice are mandatory.[37] The European legal framework provides standard forms for these publications[38]; they may be published in any of the languages of the EU, and a summary of the important elements of the notices must be published in the other official languages of the institutions of the Union.[39] As far as concessions are concerned, the Concessions Directive requires[40] the publication of a concession notice and of a concession award notice[41] not later than 48 days after the award of the concession. The annex V of the PP Directive and the annex V of the Concessions Directive set out a detailed list of the information to be included in the different notices.

5.1 Nature of the contract: public procurement or concession?

Depending on the project's design, two types of contracts can be tendered: **public procurements** or **concessions**. These two contract types are exclusive, so that a public procurement can never be a concession as well, and vice versa.

The Concessions directive defines concessions as contracts for pecuniary interest, "***the consideration for which consists either solely in the right to exploit the works*** *that are the subject of the contract* ***or in that right together with payment***".[42] The concessionaire is (mostly) remunerated by being entitled to commercially exploit the provided works or services.[43] Characteristic for a concession is therefore the transfer to the concessionaire of an **operating risk** in exploiting the procured works or services. This risk encompasses demand or supply risk or both.

How to assess whether the public contract transfers an operating risk?

According to the Concessions directive, a concessionaire is deemed to assume an operating risk where, "*under normal operating conditions, it is not guaranteed to recoup the investments made or the costs incurred in operating the works or the services which are the subject-matter of the concession*".[44] The transferred risk must involve "*real exposure to the vagaries of the market, such that any potential estimated loss incurred by the concessionaire shall not be merely nominal or negligible*".[45] In practical terms, the concessionaire is not guaranteed to recoup the investments made or the costs incurred in operating the works or the services which are the subject-matter of the concession.

[37] Art. 49 and art. 50 PP Directive.

[38] Commission Implementing Regulation (EU) 2015/1986 of 11 November 2015 establishing standard forms for the publication of notices in the field of public procurement and repealing Implementing Regulation (EU) No 842/2011, *OJ L 296, 12.11.2015*, p. 1–146. Standard forms are also provided by the European Union to facilitate practitioners in the official publication. European Commission, SIMAP, "Standard forms for public procurement", available at: http://simap.ted.europa.eu/en/web/simap/standard-forms-for-public-procurement (accessed 8 January 2019) and European Commission, DG GROW, "Innovation partnerships keep public services up to date", 3 March 2016, available at: https://ec.europa.eu/growth/content/8699-innovation-partnerships-keep-public-services-date_en (accessed 9 January 2019).

[39] Art. 51 par. 3 PP Directive.

[40] Art. 31 Concessions Directive.

[41] Art. 32 Concessions Directive.

[42] Art. 5 (1) Concessions Directive.

[43] Art. 5 (1) Concessions Directive.

[44] Art. 5 (1) Concessions Directive.

[45] Art. 5 (1) Concessions Directive.

Concessions represent a **particularly attractive solution to implement dynamic lighting projects**, as they mobilise private capital and know-how to supplement scarce public resources.[46] They are often described as "**public-private partnerships**" (**PPP**). However, a PPP is **not necessarily a concession**.

Public-private partnerships

PPPs are defined by the OECD as "*long term contractual arrangements between the government and a private partner whereby the latter delivers and funds public services using a capital asset, sharing the associated risks*".[47] The respective risks should be borne by the party best suited to manage them, so that an optimal balance is obtained between risk shifting and compensation for the risk-bearing party.[48] Depending on the share of risk borne by the contracting partner, the contract will be qualified as a public procurement or as a concession. There are many different forms of PPP, so that theoretically determining what contract type PPPs are is not possible. The nature of the contract will depend on the concrete design of the contract and the risk-sharing between the parties, so that an evaluation of the contractual nature on a case-by-case basis is necessary.

5.2 Object of the contract: works, supply of goods or supply of services?

The threshold for a procurement procedure is also conditioned by the **object of the contract**.[49] Therefore, accurately identifying the object of the contract is essential for the legality of the tendering procedure. Among the variants which are relevant for dynamic lighting projects, three types of objects appear in the European public procurement directives: **works**, **supply of services** and **supply of goods**. Per definition, the object of a concession contract can be a work or supply of services, but never a supply of goods.

How to determine the object of the contract

The EU legal framework provides the following definitions[50], which must be complied with by the Member States:

Works means public contracts having as their object one of the following:

- the execution, or both the design and execution, of works related to one of the activities within the meaning of the Annexes of the directives, for example the general construction of buildings and civil engineering works, building installations or building completions;
- the execution, or both the design and execution, of a work;
- the realisation, by whatever means, of a work corresponding to the requirements specified by the contracting authority exercising a decisive influence on the type or design of the work;

Supply of services means public contracts having as their object the provision of services other than those referred to in the work definition;

[46] European Commission, DG GROW, "Concession contracts - partnerships between the public sector and a private company" available at: http://ec.europa.eu/growth/single-market/public-procurement/rules-implementation/concessions_en (accessed 17 December 2018).

[47] OECD, "OECD Principles for Public Governance of Public-Private Partnerships", http://www.oecd.org/gov/budgeting/oecd-principles-for-public-governance-of-public-private-partnerships.htm (accessed 20 December 2018).

[48] European Court of Auditors (2018), *Special Report | Public Private Partnerships in the EU: Widespread shortcomings and limited benefits*, available at https://www.eca.europa.eu/Lists/ECADocuments/SR18_09/SR_PPP_EN.pdf.

[49] See section below "From there: find threshold and relevant procedure".

[50] Art. 2 (4) PP Directive; art. 5 (1) Concession Directive.

Supply of goods means public contracts having as their object the purchase, lease, rental or hire-purchase, with or without an option to buy, of products; a contract for the supply of goods "*may include, as an incidental matter, siting and installation operations*".[51]

How to determine the object of the contract

In order to determine in a concrete case if the object contract will be works, supply of services or supply of goods, the contracting authority must make use of the definitions above. Guidance is also provided by the EU that has established in the **Annexes of the directives** a detailed, though not exhaustive, list of activities which contracts must to be considered as works and tendered consequently. The in**stallation of illumination and signalling systems for roads, railways, airports and harbours** for example, must be tendered as a works contract.[52]

The types of contract are mutually exclusive: the same activity cannot be deemed a work and a supply of services at the same time. However, the implementation of a project often requires performing several activities which belong to different categories. In this case, a **mixed contract** will have to be procured.[53]

5.3 Find the relevant threshold and tendering procedure

The nature and object of the contract allows to determine the applicable threshold and tendering procedure.[54] The contracting authority must look at the threshold which is applicable to the contract it wants to procure. According to the EU directives, the contract must be the object of a tendering procedure **if its value, net of value-added tax (VAT), is estimated to be equal or greater to the corresponding threshold**. The contracting authority must thus estimate the value of the procured contract. The directives provide methods for this calculation, such as considering the total amount payable, net of VAT, for a public procurement, or the total turnover of the concessionaire generated over the duration of the contract, net of VAT, for a concession.[55]

The applicable thresholds pursuant to the EU Directives are presented in the following table 4.

[51] Art. 2 (8) PP Directive.

[52] Annex II PP Directive and Annex I Concession Directive, listed under the subject "Other building installation".

[53] See below under "Thresholds for mixed contracts".

[54] The thresholds set by the PP and Concessions directive have been modified in 2017 by the Commission Delegated Regulation (EU) 2017/2365 of 18 December 2017 amending Directive 2014/24/EU of the European Parliament and of the Council in respect of the application thresholds for the procedures for the award of contracts, *OJ L 337, 19.12.2017, p. 19-20,* and by the Commission Delegated Regulation (EU) 2017/2366 of 18 December 2017 amending Directive 2014/23/EU of the European Parliament and of the Council in respect of the application thresholds for the procedures for the award of contracts *OJ L 337, 19.12.2017, p. 21-21.*

[55] See for further details Art. 5 PP Directive and Art. 8 Concessions Directive.

	Public procurement	Concessions
Works	5,548,000.00 Euro	5,548,000.00 Euro
Supply of services to central authorities[56]	144,000.00 Euro	5,548,000.00 Euro
Supply of services to sub-central authorities	221,000.00 Euro	
Supply of goods to central authorities	144,000.00 Euro	-
Supply of goods to sub-central authorities	221,000.00 Euro	

Table 4. Procurement thresholds according to the EU directives.

Source: own elaboration.

Some contracts combine works, supply of services and/or supply of goods ("**mixed contracts**"), which makes determining the applicable threshold for procurement complex.

Thresholds for mixed contracts

The determination of the relevant threshold will depend on the nature and object of the contract, and on whether these objects are **objectively separable**.[57] The directives provide no method for determining objective separability and only refers to EU case law, recommending an examination on a case-by-case basis in which the "*expressed or presumed intentions of the contracting authority to regard the various aspects making up a mixed contract as indivisible should not be sufficient, but should be supported by objective evidence capable of justifying them and of establishing the need to conclude a single contract*".[58]

1) If the different objects of the contract are objectively separable

If the elements of the contract can be separated, the contracting authority may choose to award the single parts in separate contracts or the whole in a single contract.[59] For separate awards, the usual procedure applies. In a single contract, the contracting authority can consider either which object is the most essential to meet its needs, or which object has the highest value. The Commission provides the following guidance:

[56] An exhaustive list of central authorities is provided by the PP Directive in its Annex I.

[57] Art. 3 PP Directive.

[58] Recital 11 PP Directive.

[59] Art. 3 par. 4 PP Directive.

Situations	Criteria to determine the type of contract
Works + Supplies	Main subject of contract
Works + Services	Main subject of contract
Services + Supplies	Highest value
Services + Services under the light regime	Highest value

Figure 6. Criteria to determine the contract type in mixed contracts.

Source: European commission (2018)[60]

2) If the different objects of the contract are not objectively separable

In this case, only one contract can be awarded in a single procedure. The applicable legal regime is based on the main subject-matter of that contract.[61] For this matter, the above-presented criteria for single contracts apply.

3) If the different objects of the contract fall under different directives

In the case of contracts containing elements of public procurements and of concessions, the thresholds from the PP directive apply provided that the value of the elements of public procurements is equal or greater than the relevant threshold from the PP Directive.[62]

If the value of the contract falls below the thresholds of the EU directives, it does not necessarily mean that no tender has to be performed. As previously mentioned, some Member States have set stricter standards for the procurement of public contracts.

5.4 Content of the tender

5.4.1 Description of the contract's subject-matter

The tender documentation must precisely describe the contract's subject-matter. Possible contractual services are for example the design and project of a dynamic lighting concept, or in an even earlier project phase the assessment of the specific needs of the municipality, as was the case in a pilot project in the municipality of Cesena (Italy).[63] Another important aspect which the contracting authority must bear in mind is the necessity to perform maintenance works in the new infrastructure after it is commissioned. If personal or technical resources are lacking, maintenance must also be contracted.

Though the typical contract consists in the external partner solely implementing an innovation concept and upgrading the infrastructure on the sake of the contracting authority, other models are also conceivable

[60] European Commission (2018), *Public procurement guidance for practitioners on avoiding the most common errors in projects funded by the European Structural and Investment Funds*, available at https://ec.europa.eu/regional_policy/sources/docgener/guides/public_procurement/2018/guidance_public_procurement_2018_en.pdf (accessed 17 December 2018).

[61] Art. 3 par. 6 PP Directive.

[62] Art. 3 par. 4 PP Directive.

[63] For further information, see the Pilot Action called '*Green areas lit on a human scale*' from the Municipality of Cesena; available at https://www.interreg-central.eu/Content.Node/Dynamic-Light/Pilot-action-description-CESENA-1.pdf.

which combine the implementation of an investment project and the operation of the lighting infrastructure. For example, a municipality can tender a contracting model, in which the external partner will take over the whole operational management of the lighting infrastructure, including maintenance, upgrade investments and electricity provision. Other types of public-private partnerships may involve the external partner to first upgrade the infrastructure in an investment phase of several years before operating it, with the municipality paying the contracting party only after the commissioning of the upgraded infrastructure.[64]

Example case: Dynamic Light pilot actions in Slovenia[65]

For the purpose of the implementation of a pilot actions in Slovenia within the Dynamic Light project, three different tenders were initiated:

1. First, to contract an expert for the conception and design of the project, with the aim of preparing a list of the works and services to be contracted;
2. Second, to contract legal support for performance of the subsequent tendering procedure;
3. Third, to tender external partners to implement the project by installing equipment in three different municipalities; this tender was divided in three lots.

It is necessary that the description of the contract's subject-matter is clearly understandable for potential tenderers. The **common procurement vocabulary (CPV)[66]** provides a detailed description of the different subject-matters a contract can have.[67] All subjects are listed in the vocabulary associated to a code, by which can be precisely identified the single purchasing. Consulting this list can also help to identify the object of the contract. Any tender above the directives thresholds must refer to this classification system when describing the subject of the procured contract.[68] Codes which are usually related to the development of a lighting projects are for example 45316110-9 for the **installation of street lighting equipment**, 50232100-1 for **maintenance services of street lighting equipment**, 50232200-2 for **maintenance services of signaling equipment**, 50232110-4 for the **commissioning of public lighting installations** and 65320000-2 for the **management of electrical installations**.

5.4.2 Technical specifications

Qualitative technical specifications are an essential part of the tendering documentation, as they allow the contracting authority to accurately describe their needs and enable tenderers to provide offers of satisfying quality. When drawing up the technical specifications, a contracting authority may use diverse approaches.[69]

Input-based specification: the contracting authority may provide a series of detailed instructions on how to practically implement the tendered services. This type is not recommendable for tendering a dynamic

[64] Dr. Roman Ringwald, Meike Weichel, in: Ringwald, Rönitzsch, Riedel, Praxishandbuch öffentliche Beleuchtung – Wirtschaftlichkeit, Recht, Technik, Beuth, 2013, p. 96-99.

[65] For further information about the pilot actions implemented within the Dynamic Light Project, see: https://www.interreg-central.eu/Content.Node/Dynamic-Light/Pilot-Actions.html.

[66] Regulation (EC) No 2195/2002 of the European Parliament and of the Council of 5 November 2002 on the Common Procurement Vocabulary (CPV), *OJ L 340, 16.12.2002, p. 1*.

[67] European Commission, "Common procurement vocabulary", https://ec.europa.eu/growth/single-market/public-procurement/rules-implementation/common-vocabulary_en (accessed 17 December 2018).

[68] Art. 23 PP directive; art. 27 Concession Directive.

[69] SPP Regions (Sustainable Public Procurement Regions) (2017), *Performance/Output Based Specifications, Best Practice Report*, available at: http://www.sppregions.eu/fileadmin/user_upload/Resources/POBS_Best_Practice_Report.pdf; (accessed 14 January 2019).

lighting project, as it leaves tenderers no room to propose their own innovative solutions. Furthermore, all the burden of designing and planning the project lies on the contracting authority.

Output-based specification: in drafting these types of specification, the focus is shifted on the desired outputs instead than on the detail technical specifications of its implementation. This allows tenderers to bring added values in the process in terms of innovation and solutions that maybe were not considered by the contracting authority.

Outcome-based specification: it is usually structured as a detailed description of the needs to be met and the expected benefits that the contract will bring. It is the easiest specification model to draft, but also the hardest to evaluate and monitor.

These two last approaches are an advisable choice due to their flexibility and the openness to innovative inputs. Specifications based on outputs or outcomes leave space for variants in submitting the tenders. An economic operator may propose **different approaches and alternative solutions** to address the same needs. While drafting the tender criteria, the contracting authority must be careful not to draft requirements which would exclude possible variants or alternative solutions. However, the more "creative space" is left to the tenderers to design and shape the project, the more difficult it becomes to evaluate applications.

5.4.3 Relevant criteria for dynamic lighting solutions

Tendering criteria represent the backbones of a tender. They are the filters with which an offer will be evaluated. Through their preparation, the contracting authority specifically determines what characteristics it expects the future project to have and what conditions the tenderer must fulfil. The publication of criteria in the tender notice allows tenderers to tailor their offers to what is sought and expected by the public authority. Moreover, it ensures **fairness** and **transparency** in the choice of the winning offer.

Of particular relevance for dynamic lighting procurement is the concept of **Green Public Procurement (GPP)** as elaborated by the European Commission, where public authorities "*seek to purchase goods, services and works with **a reduced environmental impact throughout their life-cycle** compared to goods, services and works with the same primary function which would otherwise be procured*".[70] In order to achieve this goal, GPP criteria may be directly included in the tender documentation.[71]

In order to provide stakeholders with guidance in this respect, the European Commission has published criteria for 20 different products groups, among which the **Criteria for Street Lighting & Traffic Signal**.[72] These include criteria on the equipment, design and installation of street lighting infrastructure. Among other criteria, the luminaire efficacy (expressed as lm/W), the dimming control compatibility, the Annual Energy Consumption Indicator (AECI) and the Ratio of Upward Light Output (RULO) are listed as relevant criteria. GPP criteria may also be issued by the Member States, as for example in Italy.[73]

Furthermore, European standards and labels on lighting products and equipment also provide a reliable and measurable way to verify compliance with minimum requirements. These may be used as technical criteria in tendering procedures. The Commission regularly updates a list of European and international eco-labels.[74]

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[70] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Public procurement for a better environment {SEC(2008) 2124} {SEC(2008) 2125} {SEC(2008) 2126} /* COM/2008/0400 final */.

[71] See section 6.5 "Awarding procedure: weighing criteria to assess the offers".

[72] Commission staff working document - EU green public procurement criteria for road lighting and traffic signals, SWD(2018) 494 final, available at: http://ec.europa.eu/environment/gpp/pdf/toolkit/181210_EU_GPP_criteria_road_lighting.pdf (accessed 11 January 2019).

[73] Ministerial decree of 27 September 2017, GU Serie Generale n.244 del 18-10-2017 - Suppl. Ordinario n. 49 and ministerial decree of 28 April 2018, GU Serie Generale n.98, 28-04-2018.

[74] European Commission, DG ENV, List of existing EU and international eco-labels, available at http://ec.europa.eu/environment/gpp/pdf/ecolabels.pdf (accessed 11 January 2019).

Therefore, a wide variety of dynamic lighting solutions may be implemented in municipalities depending on their needs. Specific criteria in the tender regarding the technical standards should be tailored to the specifics of the intervention that the municipality is planning on a **case-by-case basis**.

Example case: Dynamic Light pilot action in Cesena (Italy)

In a project's pilot installation seeking to achieve good pedestrian lighting design within public parks in the city of Cesena, several issues and relevant technical standards were considered. A particular constraint was to use dynamic lighting to overcome issues with lighting pollution regulations.

The law of the Emilia Romagna Region against lighting pollution[75] addresses a broad range of issues caused by light pollution, mainly by controlling the emission of light above the horizontal and limiting LEDs source with CCT above 4000K. The main requests are:

- a maximum emission of 0.49 cd/klm above 90° (or 2250 lm above 90° for lighting installation made by 1500 lm flux or below luminaires);
- correlated colour temperature (CCT) below 4000K.

This regulation contrasts with the Italian GPP scheme for limiting light pollution, because it has a near zero relative limitation for every area. However, in such a case, a luminaire's throw angle would not be high enough to provide good vertical illuminance.

Within this context, a dynamic lighting solution could help to achieve good pedestrian lighting design and at the same time could be compliant to both Emilia Romagna law and the Italian GPP criteria. The maximum requirement of Italian GPP for protection zone (U1, that is UH = 40 lm and UL = 40 lm) for a typical low mounting luminaire – that is roughly 1.90 cd/klm over 90° for a 70W SHP lamp (which could be considered as a "standard" lamp for pedestrian areas) could be used.

Since the dynamic luminaire will stay at maximum power for about 5% of the time, the minimum power needed to achieve 0.49 cd/klm in total will be:

- X cd/klm * 95% time + 1.90 cd/klm * 5% time = 0.49 cd/klm
- X = 0.42 cd/klm that is 0.42/1.90 = 22% power.[76]

5.5 Awarding procedure: using criteria to assess the offers

The offers are evaluated according to three types of criteria:

- **Exclusion grounds**: grounds leading to the exclusion of an economic operator from the procedure,
- **Selection criteria**: minimum criteria for assessing the suitability of an offer, mostly concerning the ability of tenderers to properly perform the contract, and
- **Awarding criteria**: criteria for weighing the quality of an offer in order to determine the most economically advantageous tender.

[75] Law n. 19/2003 published on BUR n.147/2003.

[76] For further details on the technical part, see: 'Deliverable D.T3.1.3 – Analysis of the specific lighting situation – CESENA'.

5.5.1 Exclusion grounds

According to the directives[77], an economic operator must be excluded from participating in a tender procedure when the following circumstances occur:

- participation in a criminal organisation,
- corruption,
- fraud,
- terrorist offences or offences linked to terrorist activities,
- money laundering or terrorist financing, or
- child labour and other forms of trafficking in human.

In addition, national law may establish other exclusion grounds related to, for example, non-compliance with environmental, social or labour law, bankruptcy, professional misconduct, distortion of competition, conflict of interest etc.

5.5.2 Selection criteria

The selection criteria serve the purpose of selecting tenderers based on their **professional suitability**, their **economic and financial capacity** and **technical ability**. These minimum requirements ensure that the tenderer will be suited to perform the awarded tasks. The **number of years of experience in the relevant field** and **number of similar projects already performed** can be a suitable parameter for assessing the professional competence of the tenderers.

Allowed selection criteria

Selection criteria must be "***related and proportionated to the subject matter of the contract***".[78] For example, requiring from the tenderers a minimum yearly turnover which is disproportionately high compared to the estimated value of the contract would not be reasonable.

Moreover, the selection criteria must comply with the European principles **of fairness in competition** and **non-discrimination**. Referring to particular technological or professional standards is permitted. However, a contracting authority must always complement these references with the wording "or equivalent" to avert the risks of discriminative criteria.

The European legislator aimed at reducing the administrative burden for tenderers. Contracting authorities must accept a self-declaration, the **European Single Procurement Document (ESPD)**, from the tenderers as preliminary evidence that they abide by exclusion and selection criteria.[79] The provision of the ESPD takes place in electronic form and substitutes the submission of other documentations and certificates during the tendering phase.[80] These documents must be presented only by the winner of the tender. The European Commission has provided a tool for helping procurement practitioners to create their ESPD.[81] The single e-procurement platform present at national or local level shall also include a tool for developing the ESPD.

[77] Art. 57 PP directive; Art. 38 Concessions Directive.

[78] Art. 58 par. 1 PP Directive and recital 63 Concessions Directive.

[79] Art. 59 PP Directive.

[80] European Commission (2017), DG GROW, European Single Procurement Document and e-Certis, available at: http://ec.europa.eu/growth/single-market/public-procurement/e-procurement/espd/ (accessed 9 January 2019).

[81] European Commission (2017), ESPD, available at: https://ec.europa.eu/tools/espd (accessed 9 January 2019).

Selection criteria can also concern the object of the contract by **defining minimum technical criteria which must be respected by an offer in order to be considered**. For example, the municipality of Cascais (Portugal) used as a selection criterion for tendering a new energy efficient lighting system the implementation of acknowledged environmental management systems such as EMAS, ISO 14001 or equivalent measures.[82]

5.5.3 Award criteria

Once the eligible tenderers have been selected, the contracting authority ranks the offers using award criteria. The contract will be awarded to the **most economically advantageous tender (MEAT)**.[83] This prevents contracting authorities to base their procurement only on not-economic criteria. The cost aspects may be weighed while assessing the offers, or be fixed by the contracting authority, who then assesses the best offers for this fixed price. In this case, the competition aspect is shifted to the quality of the delivered works, services or products. In order to assess the most economically advantageous tender, several approaches are admissible.

Cost-effectiveness approach/life-cycle costing: the tenders are evaluated in terms of total cost. Life-cycle costing means that the tenders are evaluated considering all the costs of the works, goods or services purchased throughout their life-cycle. The purchasing price is only one of the parameters considered. LCC calculation tools has been developed in the past years by several European or national bodies.[84]

Best price-quality ratio: the winning tender will offer the best value for money as this approach allows to combine economical and qualitative criteria. Qualitative criteria must be related to the subject matter of the tendered contract and they may comprise sub-criteria such as technical merit, environmental and innovative conditions, functional characteristics, etc. This approach is suitable to cases where a simple cost assessment is not sufficient to evaluate the tenders. The quality of the services purchased might be particularly important for contracts involving the design of works and the installation and/or the maintenance of specialised products and services. It will therefore be appropriate to weigh elements other than costs when assessing tenders. That makes this the most advisable approach when drafting the awarding criteria for a dynamic lighting project. In this approach, the criteria must be scored by **assigning each criterion and sub-criterion a specific weighting**. These can either be expressed as a percentage or stated in quantifiable scores. The specific criteria and their weighting must be defined by the contracting authorities when the tender is drafted and must then be clearly indicated in the tender documents. The following table 5 lists examples of criteria that may be used.[85]

Criteria	Sub-criteria
Costs	Investment costs
	Life-cycle costs
Quality	Technical merit, for example lighting technology, light colour, light temperature

[82] European Commission, "GPP in practice - Purchasing energy-efficient outdoor lighting in Cascais", http://ec.europa.eu/environment/gpp/pdf/news_alert/Issue7_Example18_Cascais_Lighting.pdf (accessed 10 January 2019).

[83] Art. 67 PP Directive.

[84] See for example: http://www.smart-spp.eu/index.php?id=6988, https://www.upphandlingsmyndigheten.se/en/subject-areas/lcc-tools/ (including a specific tool for outdoor lighting procurement), http://ec.europa.eu/environment/gpp/pdf/09_06_2015/Life_cycle_costing_calculation_tool.pdf.

[85] Concrete technical aspects and values for LED street lighting, for example, can be found under: Premium Light Pro (2017), *Procurement criteria for LED Street Lighting*, available at: http://www.premiumlightpro.eu/fileadmin/user_upload/Guidelines/Procurement_Criteria_Outdoor.pdf (accessed 11 January 2019).

	Functionality, for example distance of pillars, adaptive technology
	Social, environmental and innovative aspects
	Design/aesthetic characteristic
Performance of other services	Delivery conditions
	Maintenance
	Technical assistance

Table 5. Examples of best price-quality ratio award criteria for tendering dynamic lighting projects.

Source: own elaboration based on Art. 67 PP Directive and EU GPP Criteria for Street Lighting & Traffic Signals.

The criteria are directly related to the specific subject-matter of the contract and must be determined on a case-by-case basis. In the case of dynamic lighting projects, GPP criteria as provided for example by the European Commission may be used.

6. Conclusion

The document aims at providing guidance to public actors and potential developers of dynamic lighting solutions for public lighting infrastructure. It presents the different steps to be taken from the design of the project to its implementation, namely design, financing and procurement. This guideline was developed thanks to the close interaction between theory and practice. On the one hand, the review of the relevant regulatory frameworks at European and national level; on the other hand, the recovery of empirical information through discussion with internal and external experts to the project and use of the project's deliverables.

The participation of the project partners was fundamental for elaborating this guideline. The project partners participated, 1) through the provision of policy and legal information from each partner country, and 2) by providing detailed information on the pilot actions implemented in each city. This valuable contribution will enable sharing the experience gained with the Dynamic Light project with other municipalities within the central-east European region which are interested in implementing dynamic lighting solutions.

Through the pilot installations, energy consumption and CO_2 emissions may be reduced in the future. A precise assessment of the costs and benefits of dynamic lighting solutions will only be possible on the longer-term, when precise statistical information is available. However, the documentation of the project's pilot actions already provides promising figures and scenarios for the reduction of energy consumption and CO_2 emissions in the pilot installations. This information and the transfer of knowledge amongst municipalities could lead in the future to a broader adaptation of dynamic lighting solutions beyond the project.

This guideline stresses that municipalities should seek expert advice in the different stages of the project. Thus, legal advice should be sought in order to comply with requirements pursuant to EU and respective national law when procuring public contracts and implementing the projects.

Useful links

Procurement documents and tools

Public procurement: https://ec.europa.eu/growth/single-market/public-procurement_en

Tendering rules and procedures: https://europa.eu/youreurope/business/selling-in-eu/public-contracts/rules-procedures/index_en.htm

Common procurement vocabulary: https://ec.europa.eu/growth/single-market/public-procurement/rules-implementation/common-vocabulary_en

European Single Procurement Document: https://ec.europa.eu/tools/espd

SIMAP: http://simap.ted.europa.eu/home **SIMAP** home page: http://simap.ted.europa.eu/home

Standard forms for public procurement: http://simap.ted.europa.eu/en/web/simap/standard-forms-for-public-procurement

Tenders Electronic Daily: https://ted.europa.eu/TED/main/HomePage.do**Tenders Electronic Daily** (TED): https://ted.europa.eu/TED/main/HomePage.do

Public procurement guidance:
https://ec.europa.eu/regional_policy/sources/docgener/guides/public_procurement/2018/guidance_public_procurement_2018_en.pdf

Guidelines on (green) public procurement

EU green public procurement criteria for road lighting and traffic signals:
http://ec.europa.eu/environment/gpp/pdf/toolkit/181210_EU_GPP_criteria_road_lighting.pdf

Lighting standards and labels: https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products/lighting_en

List of existing EU and international eco-labels:
http://ec.europa.eu/environment/gpp/pdf/ecolabels.pdf

Procurement criteria for LED Street lighting:
http://www.premiumlightpro.eu/fileadmin/user_upload/Guidelines/Procurement_Criteria_Outdoor.pdf

GPP Good Practice: http://ec.europa.eu/environment/gpp/case_group_en.htm

Handbook on green public procurement: http://ec.europa.eu/environment/gpp/pdf/Buying-Green-Handbook-3rd-Edition.pdf

Guidelines and tools on funding

Guideline on financing model for public lighting investment: http://www.interreg-central.eu/Content.Node/Dynamic-Light/CE452Dynamic-Light-D.T2.3.3-Best-Practice-Guide-final.pdf

List of relevant EU funding: https://europa.eu/european-union/about-eu/funding-grants_en

Life-Cycle Costs calculation tools

Tool for calculating Life-Cycle Costs and CO_2 Emissions: http://www.smart-spp.eu/fileadmin/template/projects/smart_spp/files/Guidance/Final_versions/EN_SMART_SPP_Tool_User_Guide_2011_FINAL.pdf

LCC-tools (including a specific tool for outdoor lighting procurement): https://www.upphandlingsmyndigheten.se/en/subject-areas/lcc-tools/

LCC calculation tool: http://ec.europa.eu/environment/gpp/pdf/09_06_2015/Life_cycle_costing_calculation_tool.pdf

Research projects

Dynamic Light: https://www.interreg-central.eu/Content.Node/Dynamic-Light.html

Premium Light Pro: http://www.premiumlightpro.eu/

Smart SPP: http://www.smart-spp.eu/index.php?id=6988

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Novikova, A., Stelmakh, K., Hessling, M., Emmrich, J., and Stamo, I. (2017), *Guideline on finding a suitable financing model for public lighting investment*: Deliverable D.T2.3.3 *Best practice guide*. Report of the EU funded project "INTERREG Central Europe CE452 Dynamic Light", October 2017, available at:

http://www.interreg-central.eu/Content.Node/Dynamic-Light/CE452Dynamic-Light-D.T2.3.3-Best-Practice-Guide-final.pdf (accessed 14 January 2019)

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DYNAMIC LIGHT

GUIDELINES FOR FINANCIAL MODELS

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GUIDELINES FOR FINANCIAL MODELS

DYNAMIC LIGHT

The project in brief

The Dynamic Light project aims to demonstrate the importance of providing light under a variety of circumstances and to examine who uses lighting at what time and for how long. Differences in public lighting systems are examined under conditions typical of European municipalities. The project explores strategies for introducing energy-efficient lighting in urban areas and identifies the steps required to translate strategies into action, from the initial idea through the analysis, use of geographical information systems for spatial data mining, strategy development, financial modelling, procurement process, implementation, and evaluation. Such strategies are intended to improve the quality of dynamic light and adapt it to social needs. Fulfilment of these objectives is expected to facilitate investment in pilot and demonstration projects that bolster acceptance of energy-efficient lighting among end-users and urban planners.

Consortium

Hochschule Wismar	DE	Ernst-Moritz-Arndt-Universität Greifswald	DE
BSC, Poslovno podporni center d.o.o. Kranj	SL	SWARCO V.S.M. GmbH	DE
PORSENNA o.p.s.	CZ	Deutsche Lichttechnische Gesellschaft e.V.	DE
Međimurska energetska agencija d.o.o.	CR	Hansestadt Rostock	DE
Comune di Cesena	IT	Poltegor-Instytut, Instytut Górnictwa Odkrywkowego	PL
TEA SpA	IT		
Fondazione Bruno Kessler	IT	Grad Čakovec	CR
Spath MicroElectroni cDesign GmbH	AT		

Associated partner
Institute for Climate Protection, Energy and Mobility (IKEM) DE

DELIVERABLE D.T2.3.4

GUIDELINES ON FINDING A SUITABLE FINANCING MODEL FOR PUBLIC LIGHTING INVESTMENT

Investment in energy efficiency upgrades of street lighting infrastructure reduces energy costs and carbon dioxide emissions. It is also highly cost-effective and has a short payback period. In spite of these advantages, much of the lighting infrastructure in many Central European countries requires refurbishment. As the final deliverable for Project Task 2.3, this report provides guidelines for identifying appropriate financing models for public street lighting and is intended as a resource to assist Central European municipalities (namely, those of Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia) in developing funding strategies. The report summarises the three preceding deliverables on baseline conditions, funding sources, and potential financing models for street lighting upgrades.

This report should be cited as
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2. Key stakeholders and investment barriers 4
3. Funding sources 6
4. Financing models for street lighting upgrades 8
5. Guide to selecting a relevant financing model 12
6. References 14

Abbreviations

CF	Cohesion Fund
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
eeef	European Energy Efficiency Fund
EEOs	Energy Efficiency Obligation Schemes
EFSI	European Fund for Strategic Investments
ELENA	European Local Energy Assistance
ERDF	European Regional Development Fund
ESIF	European Structural and Investment Funds
EIAH	European Investment Advisory Hub
EPC	Energy Performance Contracting
ESCO	Energy Service Company
EU	European Commission
JASPERS	Joint Assistance to Support Projects in European Regions
PPP	Public-private partnership
PP4EE	Private Finance for Energy Efficiency
SPV	Special-purpose vehicle

1. Introduction

Investment in energy efficiency upgrades significantly reduces energy costs and carbon dioxide emissions. It is also highly cost-effective and has a short payback period. In spite of these potential advantages, many areas of Central Europe have not taken measures to improve lighting infrastructure. The Dynamic Light project, funded through the INTERREG Central Europe programme of the European Regional Development Fund, explores strategies for introducing energy-efficient, dynamic lighting in urban areas. The project explores strategies for introducing energy-efficient lighting in urban areas and identifies the steps required to translate strategies into action, from the initial idea through the analysis, use of geographical information systems for spatial data mining, strategy development, financial modelling, procurement process, implementation, and evaluation. The project examines the implementation of public lighting under conditions typical of European municipalities.

The present document, the final deliverable of Project Task 2.3 on financing public street lighting, provides guidelines for identifying appropriate financing models for public street lighting and is intended as a resource to assist Central European municipalities (namely, those of Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia) in developing funding strategies. The report summarises the three preceding deliverables:

1) Deliverable 1, a baseline inventory (Novikova et al. 2017a), identified the obstacles to infrastructure improvement in Central European areas. A survey of public and private actors examined stakeholder knowledge and past experience relevant to various funding sources and financing models for energy efficiency upgrades of street lighting. The survey identified the existing funding sources in target countries, as well as existing and potential financing models that were the subject of further analysis in subsequent project deliverables. The inventory also provided ideas and recommendations for the development of guidelines to assist municipalities in selecting appropriate models.
2) Deliverable 2, an analysis of funding sources (Novikova et al. 2017b), summarised the results of research into potential funding sources for energy-efficient street lighting projects in the focus countries. It reviewed available EU funding and assistance programmes, national public funding sources, multi- and bilateral financial intermediaries, and private-sector funding. These were assessed using a common framework. The deliverable examined objectives, financial instruments, funded activities, beneficiaries, and the application process for public funding sources.
3) Deliverable 3, a best practice guide (Novikova et al. 2017c), reviewed existing financing models, including self-financing, debt-financing, financing by a private contractor, financing by a private contractor through energy savings, financing by public-private partnerships, financing by utilities, and financing by citizens. The report provided an overview of each model, identified the projects to which it could be applied, specified its advantages and disadvantages, and provided a relevant case study.

2. Key stakeholders and investment barriers

In this section, we examine the reasons for low upgrade rates of street lighting infrastructure. We identify the key public and private actors responsible for providing street lighting, as well as those involved in street lighting asset ownership, operation, maintenance, and investment. Based on the results of two online questionnaires, we examine barriers to investment by these actors and assess their knowledge and past experience relevant to financing models for energy-efficient street lighting.

Key stakeholders in energy efficiency street lighting investment

From the stakeholder survey responses, we conclude that, in the majority of Central European countries, municipalities are legally responsible for providing street lighting. The legal responsibility can often be transferred under a concession agreement. In some countries, it is also possible to transfer the legal responsibility under energy performance contracts (EPCs) and through public-private partnerships (PPPs). In multiple countries, private capital cannot be used to upgrade public street lighting; this is clearly problematic, as it means that other finances must be leveraged for these upgrades.

We also conclude that the fragmented structure of the street lighting supply chain often poses a split-incentive barrier for upgrades. The countries covered by our surveys have a wide variety of policies in place for ownership, maintenance, operation, and upgrades of street lighting assets. The results of the survey show that the legal responsibility to ensure proper public street lighting, ownership of street lighting assets, maintenance and operation, and actual investment decisions are often divided amongst several stakeholders. This creates a split-incentive problem: those required to upgrade street lighting do not accrue the benefits of this investment.

Barriers to energy-efficient street lighting investment

Survey responses showed that the strongest barriers to investment in energy-efficient street lighting upgrades were financial and economic obstacles (specifically, insufficient financial resources). In addition to the shortage of financial resources, municipalities expressed a desire for greater public funding from national and regional budgets. Small municipalities are also more likely than larger municipalities to struggle with small budgets.

Barriers related to policy and awareness were given lower importance than were financial barriers. The greatest barrier identified in the policy category was 'poor enforcement for energy efficiency policies, even though these exist', and the greatest barrier in the awareness category was unfamiliarity with and/or reluctance to introduce new contractual and financing mechanisms. The barriers related to implementation capacity were rated as less significant than were the financial barriers, but greater than those related to policy and awareness.

The perceived relative importance of different barriers varies across respondent groups. For instance, researchers, energy service contractors (ESCOs) and energy service companies, and energy and development agencies most often believe that the lack of skills and experience in municipalities' implementation of street lighting projects presents high or high-medium barriers, whereas municipalities themselves perceive these barriers as less significant. In addition, municipalities see upfront costs as a substantial barrier and do not believe that low energy cost savings are due to low energy prices. By contrast, energy service contractors and ESCOs do not perceive upfront costs as high but recognise low energy cost savings as a more significant problem stemming from low energy prices. These examples show the asymmetry in these actors' perception of the relative significance of various barriers and demonstrate their different experiences.

Table 1 shows the three barriers in each category that were identified as most significant by the survey respondents. It is important to note that the table includes the average perception of barriers among all respondents. Therefore, it does not reflect the variation in the perceived relative importance of different barriers across respondent groups. Of all barriers listed in the table, the most significant (average response: high-medium) are insufficient own funds, a lack of skills and experience among municipalities, insufficient national or regional public funding, and a lack of human resources in the municipality.

Awareness and experience relevant to financing energy-efficient street lighting

We identify a gap in knowledge of existing public and private funding sources. Many respondents from municipalities do not have relevant experience and are not aware of available funding sources from the EU and national budgets, even though they often lack sufficient capital of their own to finance certain

projects. Therefore, there is a need to raise awareness of potential public and private funding sources who may invest in energy-efficient street lighting.

We also recognise a gap in knowledge of potential financing models for leveraging greater private finance. This is critically important because the public budget cannot provide the finances to realise the full energy efficiency potential of the public sector, given that there are also other important economic, social, and environmental priorities.

Table 1: Three most significant barriers to energy-efficient street lighting investment by category

Barrier group			
Financial and economic	Policies and frameworks	Awareness, access to information and past experience	Implementation capacity and procedures
• Insufficient own financial resources • Insufficient national or regional public funding • High upfront investment cost	• Lack of guidance on the national level • Poor enforcement of energy efficiency policies • Energy efficiency is not a priority on the municipal level	• Unfamiliarity and reluctance to introduce new contractual and financing mechanisms • Lack of awareness of potential funding sources • Lack of awareness of potential energy savings	• Lack of skills and experience among municipalities • Lack of human resources in the municipality • Project complexity, including multiple stakeholders

Source: Survey results produced by the authors

3. Funding sources

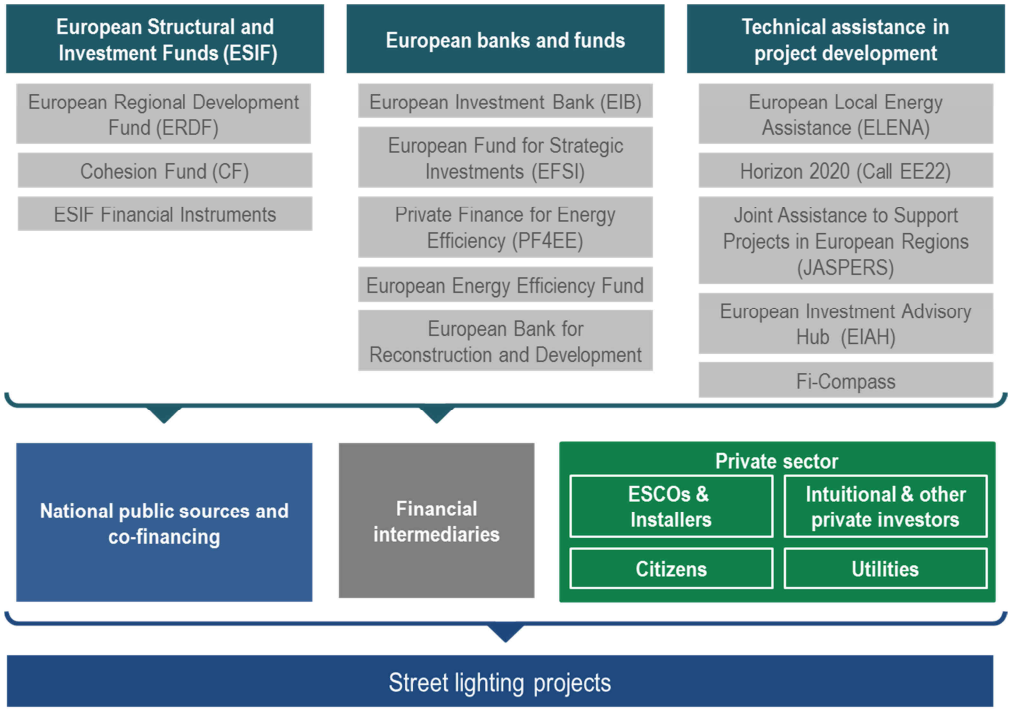
Although upgrading street lighting would cut energy costs, many areas of Central Europe have not yet taken measures to improve their lighting infrastructure. Budgetary constraints on owners (often municipalities) are commonly cited as a reason for this inaction. This report examines potential funding sources that could cover the costs of installing energy-efficient street lighting without depleting municipal resources. Figure 1 identifies available external funding sources from EU institutions, national sources, and the private sector. The subsequent analysis focusses on the countries of Central Europe, namely Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia and Slovenia.

European funding sources

European funds and financial institutions offer substantial funding and technical assistance. The European Structural and Investment Funds (ESIF) channel their resources to the Member States through operational programmes designed by each country according to its policy priorities. The European Regional Development Fund (ERDF) and The Cohesion Fund (CF), both of which fall under the ESIF umbrella, cover multiple energy efficiency measures, including street lighting. In the project deliverable analysing funding sources (Novikova et al. 2017b), sections on individual countries provide a list of national operational programmes relevant to municipal energy efficiency upgrades. Municipalities interested in accessing ERDF and CF resources should review the details of the operational programmes available in their jurisdictions.

ERDF and CF support is offered in the form of grants or loans. However, the European Commission (EC) strongly encourages Member States to use more innovative financing instruments. ESIF provide Member States with technical assistance to reduce the share of grant financing and introduce other financing instruments (including loans, equity, and guarantees) that can mobilise additional private investment.

Figure 1: Funding sources for energy-efficient street lighting in Central Europe



Source: Adapted from Covenant of Mayors for Climate & Energy (2016).

The European Investment Bank (EIB) has identified energy efficiency finance as one of its priorities. It offers multiple instruments to both the public and private sector, including dedicated credit lines through local financial intermediaries or direct framework loans to promote projects. EIB also manages and/or co-finances several funds and facilities, such as the European Fund for Strategic Investments (EFSI), Private Finance for Energy Efficiency (PP4EE), and the European Energy Efficiency Fund (eeef).

The European Bank for Reconstruction and Development (EBRD) has extensive experience in financing energy efficiency and municipal infrastructure projects in transition economies, including in Central and Eastern Europe, with investments in Croatia, Hungary, Poland, Slovakia, and Slovenia. The EBRD channels its support through credit lines to local commercial banks, which ultimately disburse funds to municipal lighting projects.

EU-funded technical assistance in project development is available through the European Local ENergy Assistance (ELENA) programme, the Joint Assistance to Support Projects in European RegionS (JASPERS) initiative, and Horizon 2020 Project Development Assistance (Call EE-22-2016-2017). In addition, the European Investment Advisory Hub (EIAH) and fi-compass advisory service practical support, including expertise and skills training.

National funding sources

Each Member State uses ESIF funding to operate and co-finances multiple support programmes. Many countries offer additional options for support from the national budget, including grants or low-interest rate loans, and channel assistance through national environmental funds, national development banks, or other intermediaries. In some countries, such as Germany, national public funding far exceeds support from EU funds. Subnational governments often administer regional support programmes. Country sections of the project deliverable on funding sources examine national funding options available in greater detail.

Financial intermediaries

Financial intermediaries play a crucial role in financing energy efficiency investments. As energy efficiency objectives are high on the EU and national agendas, many commercial banks have dedicated credit lines or other financial products for funding energy efficiency measures—including street lighting—implemented by municipalities or the private sector. More often, local financial institutions channel and co-finance resources from national and development banks or funds (such as the EIB, EBRD, or eeef), which enable these entities to offer finances at a lower cost. In Hungary and other countries where national and EU funding for street lighting is limited, low-cost credit lines are the main funding source for municipalities.

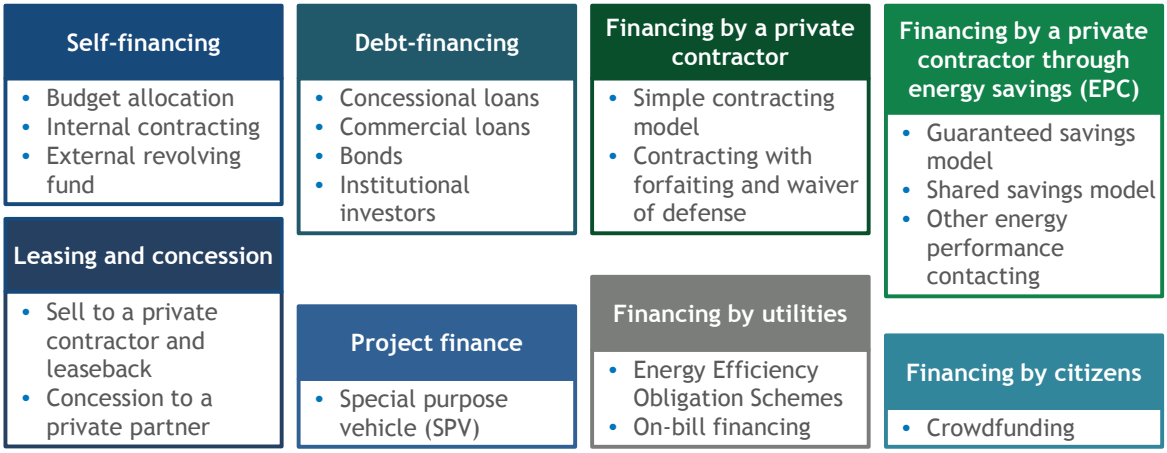
Private sector

Finally, multiple private sources can be utilised for lighting projects. First, energy service companies and contractors that provide upgrades can finance the upfront investment costs, for example through energy performance contracting. In energy performance contracts (EPCs), municipalities repay the upgrade costs over time through energy savings. Second, in countries with utility obligation schemes in place, utilities finance street lighting upgrades and other energy efficiency measures in end-use sectors. Finally, municipalities can raise finances through crowdfunding and engage with institutional investors. The details of private-sector financing models for street lighting upgrades are summarised in the following section and discussed in detail in Project Deliverable 3, the best practice guide (Novikova et al. 2017c).

4. Financing models for street lighting upgrades

There are multiple models for financing street lighting upgrades. These include self-financing, debt-financing, financing by a private contractor, financing by a private contractor through energy savings, financing by public-private partnerships, financing by utilities, and financing by citizens (Figure 2).

Figure 2: Financing models for public street lighting investment



Source: Author's research results

Self-financing. Under most straightforward financing model, municipalities pay for street lighting upgrades from own funds or through grants available from the national or EU programmes. To minimise the burden on taxpayers, the public sector can design and implement additional schemes to help raise funds, for example through internal performance contracting or a designated revolving fund.

Debt-financing. Many municipalities with limited own funds issue debt, which is subsequently repaid from tax revenue and/or saved energy costs. In addition to issuing municipal bonds, municipalities can finance infrastructure projects by obtaining a concessional loan from available public lending programmes or a commercial loan from a commercial bank.

Financing by a private contractor. Perhaps the most promising option for municipal actors is to transfer the responsibility for street lighting infrastructure funding to third parties, e.g., by contracting an energy service contractor. There is considerable variation between such contracts. Under a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing, and carrying out the infrastructure retrofit (providing for a profit). In a more complex model with forfaiting and waiver of defence, the roles of the city and contractor are similar to the simple contracting model, but in this case, the bank enters into agreements with the contractor and with the city.

Financing through energy savings. The energy performance contracting (EPC) model can be applied when a municipality or contracted party finances the energy supply. Under this model, street lighting retrofits are financed through the cost savings accrued from reducing energy consumption. Typically, the contracted energy service company guarantees a certain level of energy savings. In shared savings EPC models, the municipality and the contractor share any energy savings in excess of the guaranteed level.

Leasing or concession to a private partner. Leasing models are also used to finance street lighting upgrades. Under a leasing model, a municipality transfers infrastructure ownership rights to a private contractor, which is responsible for upgrading, operating, and managing the assets for the length of the contract period. The municipality then leases the infrastructure from the private contractor for a fixed fee for the contract term, after which the ownership rights are transferred back to the municipality. Under a concession contract, a private partner is granted rights to operate and maintain street lighting and accrue all benefits resulting from the energy efficiency upgrades.

Project finance. The project finance model is often used to raise private capital for large, bankable projects with capital costs over approximately €20 million. Under this model, a special purpose vehicle (SPV) is created that facilitates financial objectives while minimising the parent company's risk exposure. Because the SPV balance sheet documents project expenditures, enabling municipalities and private investors to fund projects off balance sheet.

Financing by utilities. As of October 2017, Energy Efficiency Obligation Schemes (EEOSs) are operational in 11 EU Member States: (Denmark, UK, Ireland, France, Spain, Italy, Latvia, Poland, Bulgaria, Austria, and Slovenia. EEOSs are policy mechanisms that require energy providers and/or distributors included in the scheme to meet certain energy savings targets by investing in eligible end-use energy efficiency measures. Street lighting may be eligible for such funding in certain countries, depending on the provisions of national laws. In the case of on-bill financing, a utility provides a loan to a municipality to cover the upfront investment, and the municipality repays the cost through its energy bills. On-bill financing is more common in the United States than in Europe.

Crowdfunding. Crowdfunding is a relatively new financing option most often used by young, innovative companies and startups for small or medium-scale projects. It refers to the collection of relatively small amounts of money from a large number of individuals or small-scale investors, usually via online platforms, and the subsequent use of those funds to finance a project. Crowdfunding creates a community around the project, as a result, people can become engaged in the process and provide insights and ideas that are useful for project development. Use of this mechanism to finance community and city projects has become more common (European Commission 2016b).

Table 2 summarises the advantages and disadvantages of each model and identifies the models most suitable for specific project types. Deliverable 3, the best practice guide (Novikova et al. 2017c), provides further detail on the key design features of each model and presents relevant case studies.

Table 2: Key features of financing models for energy efficiency upgrades of street lighting

Model	Good for municipalities, as they	Not perfect for municipalities, as they	Projects financed
Self-financing			
Municipal budget	1. own and design the project; 2. pay no interest on capital; 3. receive fully saved energy costs;	1. must finance all upfront costs; 2. bear all investment risks; 3. may lack the capacity; 4. May lack the transparency;	1. any type given the budget availability and expertise;
Internal revolving funds (Intracting)	1. can reuse capital; 2. do not need external capital; 3. cooperate within their units; 4. pay no interest on capital;	1. must finance all upfront costs; 2. bear all project risks; 3. may be less efficient than a private actor in project implementation;	1. any project, including small-scale and not attractive to private investors;
External revolving funds	1. can reuse capital; 2. can design a self-sustaining fund with a long-term orientation; 3. may attract private investment;	1. face high transaction costs for the fund setup; 2. must allocate manpower for the duration of the whole project; 3. may experience tensions if private and public capital is merged;	1. long-term projects with multiple objectives in medium to large size municipalities; if municipalities are small, they can merge their funds;
Debt financing			
Concessional loans from public banks	1. pay low-interest rates 2. can access capital 3. can combine this model with others (e.g., a revolving fund)	1. still pay interest on capital	1. particularly accessible for public energy efficiency projects;
Commercial loans from banks	1. can access capital 2. can combine this model with others (e.g., a revolving fund)	1. obtain conventional debt based on their credit record 2. pay interest at market rates 3. do not have access to special conditions for energy-saving projects	1. financially sustainable infrastructure projects of various sizes;
Municipal bonds	1. can access capital at a lower cost than that available from commercial bank loans;	1. carry costs of extensive preparation 2. needs either a good credit rating or access to a bond agency;	1. medium- to large-scale financially sustainable projects;
Institutional investors	1. enjoy a low cost of capital because institutional investors are long-term orientated and risk-averse;	1. may need to deal with a lack of experience of institutional investors in sustainable projects; 2. carry high transaction costs;	1. large projects are competitive in terms of financial risks and return;
Financing by a private contractor			
Simple contracting model	1.can use off-balance sheet financing; 2.can select specialised companies through a tendering process;	1. may incur higher financing costs than those charged for concessional loans; 2. may have limited access to public support;	1. medium- to large-scale projects;
Model with forfaiting and waiver of defence	1. and 2. are the same as in the previous model; 3. pay lower interest rates than those incurred under the simple contracting model;	1. face higher interest rates than in concessional loans; 2. must contend with highly complex financing arrangements; 3. must provide a guarantee for a bank;	1. medium- to large-scale projects;
Private-partner financing through energy saving			
EPC – guaranteed savings	1. obtain new infrastructure without peaks in their spending; 2. outsource risks to contractors; 3. pay constant bills during the contract, possibly lower than before; 4. enjoy low operating costs once the contract expires;	1. may face a problem to attract private partners if a project is too small; 2. may face low financial performance in case energy prices are low; 3. face a lack of motivation by private partner to reduce energy demand more than guaranteed in the contract;	1. projects with the potential to accrue high energy cost savings; 2. municipalities should have sufficient financial resources to pay the fees specified in the contract;
EPC – shared savings	1., 2., 3., and 4. are the same as in the previous model; 5. receive a share of any excess energy cost savings 6. accrue additional energy savings due to incentives to both sides	1. and 2. are the same as in the previous model;	1. and 2. are the same as in the previous model;

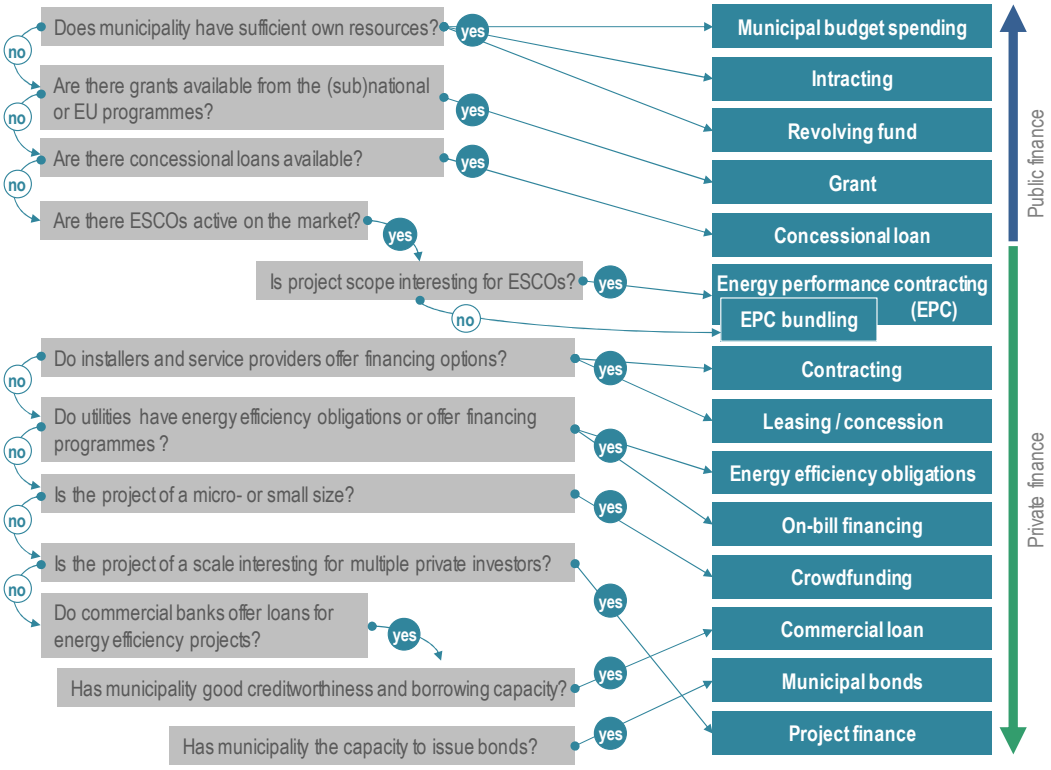
Model	Good for municipalities, as they	Not perfect for municipalities, as they	Projects financed
EPC - related payments	1., and 2. are the same as in the previous model; 3. benefit from a mechanism enabling more accurate quantification and verification of energy;	1., and 2. are the same as in the previous model;	1. and 2. are the same as in the previous model;
EPC - immediate savings	1., and 2. are the same as in the previous model; 3. realise maximum energy savings immediately;	1. and 2. are the same as in the previous model; 3. have relatively old infrastructure by the end of the contract;	1. and 2. are the same as in the previous model; 3. projects with very old and inefficient infrastructure;
EPC - staggered savings	1., and 2. are the same as in the previous model; 3. enjoy relatively modern infrastructure for the length of the contract;	1. and 2. are the same as in the previous model; 3. obtain access to all energy savings at a later stage;	1. and 2. are the same as in the previous model; 3. projects in which age and technology vary among existing luminaires;
Public-private partnership			
Sell to a private partner and leasback	1. spread financial risks and costs over time; 2. outsource technical risks to the private sector; 3. enjoy new infrastructure without increasing their debt;	1. may pay higher costs to lease than to self-finance in the long term; 2. may have less control over assets;	1. projects with high upfront costs;
Concession to a private partner	1., 2., and 3. are the same as in the previous model; 4. can set standards in the concession agreement;	1. must contend with complex setup and administration; 2. must provide adequate project oversight;	1. projects with high upfront costs;
Project finance	1. isolate project risks within a special purpose vehicle; 2. may deduct or withhold a certain amount from payments or impose penalties if private partners fail to deliver agreed services;	1. encounter high transaction costs for the preparation and implementation of the special purpose vehicle;	1. large projects (>€20m); 2. a consortium of several municipalities and investors/financiers;
Financing by utilities			
Energy efficiency obligation schemes (EEOS)	1. benefit from the pressure created by a EEOS on utilities to meet targets through financial penalties; 2. do not bear high upfront investment costs;	1. need a strong regulatory framework; 2. need strong governance;	1. possible in countries that have implemented EEOS;
On-bill financing	1. repay investments through energy bills; 2. enjoy a relatively simple implementation process;	1. may encounter challenges arising from a lack of experience because the model is rarely implemented in Europe;	1. small to medium-sized projects;
Financing by citizens			
Crowdfunding	1. can attract substantial private investment from a large pool of backers;	1. lack a guarantee that sufficient funding will be raised; 2. may encounter problems resulting from investor experience; 3. may encounter investors who wish to exit; 4. must contend with a lack of regulation; 5. may find it challenging to fulfil responsibilities to a multitude of small investors;	1. small to medium-sized projects.

Source: Author's research results

5. Guide to selecting a relevant financing model

Figure 3 presents a decision-making tree to assist municipalities in selecting an appropriate financing model. Key considerations include the availability of public policies and funding, project size and bankability, the maturity of the market for ESCO and energy service providers, the municipality's borrowing capacity, and the availability of financial instruments from commercial financial institutions.

Figure 3: Decision-making tree for selecting a financing model



Source: Authors' own illustration adapted from ESMAP (2014)

Availability of public policies and funding

Many European or national funding programmes offer finances at a lower cost than those available from commercial sources, e.g., through grants or concessional loans. Specific programmes or funds can finance projects that correspond to their funding priorities and application criteria. Projects, whose risk profile or size is not attractive to private investors can often obtain funding from these programmes.

Depending on the funding source, municipalities can use payments to finance project costs directly or to design a revolving scheme to multiply and leverage additional private capital. National incentives and policies like EEOSs are an alternative funding mechanism for street lighting projects that involves the participation of utilities or other actors in the scheme. If available public funding is insufficient, municipalities can consider working with the private sector and commercial finance providers.

Project size and bankability

The larger the project, the greater the need to obtain external funding and private sector engagement. In addition, the complexity of financing arrangements may increase with project size. In contrast to public

funding, private investors have specific risk-return requirements for projects. Street lighting projects offer more advantages than do other energy efficiency investments. Street lighting projects incorporate homogeneous technology, generate high energy savings, and have a short payback period. Therefore, such projects are usually attractive to ESCOs or other private investors. Various financial instruments (including loans, bonds, equity, and models, including EPC, leasing, and concession) are available and widely used.

If the project has high risks and/or does not generate sufficient cash flows, it will be challenging to leverage private capital. This is often the case for small-scale projects. The solution may be to bundle multiple small projects in several municipalities into one investment package. Alternatively, small community-scale projects can explore crowdfunding opportunities to engage citizens.

Maturity of the market for ESCO and energy service providers

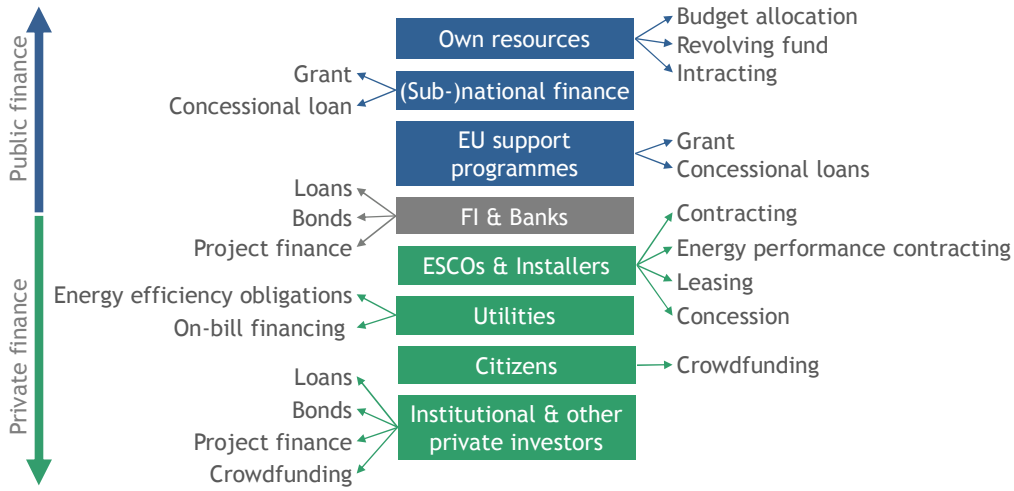
If energy service providers and ESCOs are active on the local market, they can offer advantageous terms for EPC, leasing, and concession models, including options for bundling several small-scale projects. To be attractive for ESCOs, the projects must deliver high energy savings and municipalities must be able to pay contract fees over time. Using ESCOs or other models to outsource services allows municipalities to upgrade street lighting by transferring investment risks to the private partner while avoiding sharp upticks in budget spending. However, if the ESCO market is not mature enough or the project scale, energy savings, or payback period for ESCO interest is unsatisfactory, other debt instruments can be explored.

Municipality's borrowing capacity and availability of commercial financial instruments

Commercial loans, project finance, equity, and other financial instruments are offered by the banks and other investors. To access commercial debt or equity, projects must be financially sustainable. In addition, the municipality should have a credit profile and decision-making authority to issue debt. If the municipality has sufficient technical and institutional capacity or access to a bond agency, it can also issue municipal bonds. The cost of capital will depend of the project profile, type of financial instrument, and maturity of the local banking sector. It is generally higher than the cost of capital available through public support programmes, such as concessional loans and credit lines. Loans are available for projects of various sizes. Equity, bonds, and project finance are normally used for medium-sized and large projects.

Figure 4 summarises the linkage between funding sources and financing instruments and models that provide capital for investment in street lighting infrastructure.

Figure 4: Funding sources, financing instruments, and models for investment in street lighting infrastructure



Source: Author's research results

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