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Evaluation of financing models for energy-efficiency upgrades of street lighting

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ABSTRACT

Urban street lighting infrastructure is responsible for about 40 % of the total energy consumption in European cities. Investment in its upgrade offers energy savings of 50-70%; it is also usually very cost-effective and has a payback period of only 3-5 years. In spite of these arguments, a large share of the infrastructure in many European countries requires an upgrade. The budgetary constraint of its owners, who are often municipalities, is a common reason. To overcome it, creative financing models are required to attract private investors and overcome the barrier of high up-front investment costs.

The paper presents the results of a piece of research, which aimed to identify financing models available for energy efficiency upgrades of street lighting and guide municipalities of Central Europe how to make a choice among them. The research represents one of the tasks of the Dynamic Light project, which aims to promote dynamic, intelligent and energy efficient urban lighting and which is supported by the Interreg Central Europe platform.

The paper identifies twenty financing models, falling into the categories of self-financing, debt-financing, third party financing, public-private partnerships, financing by utilities, or by citizens. It evaluates the models using a common framework pointing to model's advantages and disadvantages from the municipality point of view. The paper further presents a decision-making tree and discusses such key decision factors as availability of public funding, project size and bankability, maturity of the energy service market, municipality's borrowing capacity, availability of financial instruments from commercial financial institutions, and others. The paper concludes with the key messages of the paper.

Introduction

Urban street lighting infrastructure is responsible for about 40 % of the total energy consumption in European cities (Ożadowicz and Grela 2017). Investment in its upgrade may reduce energy consumption by up to 50-70%; it is usually highly cost-effective and has a short payback period of 3-5 years[1] (E-street project 2008; European Commission 2013). In spite of these advantages, a large share of the infrastructure in many European countries requires refurbishment. Budgetary constraints

[1] The cost-efficiency and cost-effectiveness indicators depend on energy (typically, electricity for street lighting) prices of a country.

on infrastructure owners, who are often municipalities or municipality-owned companies, is frequently cited as a reason for inaction.

Many municipalities and municipality-owned utilities retrofit the street lighting infrastructure from own resources. However, because they often lack sufficient capacity and/or funds for the upgrade, they frequently seek support from public sources, usually in the form of grants or concessional loans. In turn, these resources are also often not enough leading to the need of leveraging finance from other sources, in particular, private finance. Attracting these parties will require creative financing models.

The paper presents the final results of a piece of research, which aimed to assist the decisions of municipalities in Central Europe on financing energy efficiency upgrades of street lighting. The task was to identify financing models available and guide municipalities how to make a choice among them. The geographical focus is on the countries of Central Europe including Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia. The research represents one of the tasks of the Dynamic Light project[2], which aims to promote dynamic, intelligent and energy efficient urban lighting and which is supported by the Interreg Central Europe platform[3].

The paper identifies and reviews twenty models which rely on financing from own resources, debt, private contractors, public-private partnerships, utilities, and citizens. It also evaluates advantages and disadvantages of these models using a common framework. Based on this information, the paper further designs a decision-making tree and discusses the key decision factors.

The main target audience of the paper is the organizations that own, operate, and take decisions on the upgrade of street lighting infrastructure in Central Europe, e.g. municipal governments, municipally owned utilities, and the private or partially private companies delivering these functions. It could also be useful for the organizations that play a role in financing the street lighting upgrades, such as the operators of European Union (EU) funds and federal support schemes, public and commercial banks, energy service companies, manufacturers of advanced lighting solutions, and institutional investors interested in diversifying their portfolios as well as expert and research community.

Methodology

Data collection from Internet search and literature

There have been several data collection approaches, which we relied on. Above all, we gathered information available in the public domain. In particular, we identified and learned the documentation of projects, which have already conducted similar studies in the past. We also gathered other information available, e.g. from reports, articles, interviews, and internet websites. Finally, we used the extensive experience of SWARCO V.S.M. GmbH[4], who was a partner in our project consortium, as a manager of street lighting infrastructure in a large number of cities.

From our review, we concluded that so far there has been no recent comprehensive catalogue of the financing models and their applications for energy efficient street lighting in Europe. Therefore, we decided to design a survey to gather additional information.

[2] Please see more information about the Dynamic Light project at http://www.interreg-central.eu/Content.Node/Dynamic-Light.html

[3] Please see more information on INTERREG Central Europe at http://www.interreg-central.eu/

[4] Please see more information on SWARCO V.S.M. GmbH at https://www.swarco.com/svsm

Data collection through survey

Aiming to design high quality and the most useful survey, we applied a two stage approach. First, we conducted a survey among project partners using an online-based questionnaire. After the analysis of this internal survey, we further improved the questionnaire, and sent it out to the expert community and stakeholders related to street lighting beyond our consortium. For this, we identified the contacts of thirty four municipal, city, town, and county associations in Central Europe and asked them to forward our survey to their members, e.g. municipalities, cities, towns, and counties. We also identified the contacts of around 300 key stakeholders and sent them invitations to fill out the survey. These stakeholders included representatives from regional or national energy agencies, utilities, product manufactures, engineering service providers, energy services companies, and researchers. Finally, we also sent out the survey through the global mailing list Climate-L[5].

Our survey was answered by fifty nine respondents. Out of these, fifty five respondents were from the EU countries. These were the representatives of fifteen municipalities, two associations of municipalities including the Association of Cities of the Republic of Croatia; the Association of Polish Cities, four regional energy and development agencies including the North-West Croatia Regional Energy Agency, the Energy Agency for Southeast Sweden, the APE FVG Energy Management Agency of Friuli Venezia Giulia, and AGIRE Energy Agency of the Province of Mantova of Italy; five lighting product manufactures; three energy service contractors and/or energy service companies and/or their associations; twenty one research organizations or consultancies, and six consumers.

To identify financing models and their applications, we asked survey respondents which of the financing models they have knowledge of, have used, or have knowledge of a case study. To help answer this question, we provided a choice of common models, as well as an option to name additional models not included in the provided list. In the latter case, we asked for the additional contacts to request more details. The questionnaire and detailed results are presented in a dedicated report "Baseline inventory" (Novikova et al. 2017a).

Data analysis and validation

Each financing model identified was analyzed in a common framework. First, we provided a model overview drawing its schematic structure e.g. its key actors and their roles. Second, we analyzed the types of projects, which could be financed using these models. Third, we argued about the advantages and disadvantages of the models. Finally, for each business model we provided a selected case study, for which we went even into deeper details of the model context, scope, stakeholders, implementation experience, and outcomes.

To validate our results, we contacted experts, who were involved into the implementation of case studies and conducted their email or phone interviews. These experts represented such organizations as municipalities, their companies, and financing intermediaries as listed in the acknowledgment section.

Above all, we focused on the financing models and their case studies in Central Europe. However, when a useful model was identified but was available only outside Central Europe, we include such case studies prioritizing such from the EU, then from Europe, and finally worldwide.

The present paper analyzes and evaluates the models pointing to model's advantages and disadvantages from the municipality point of view. It also discusses such key decision factors for choosing the most relevant model as availability of public funding, project size and bankability, maturity

[5] For more information on Climate-L list please see http://sdg.iisd.org/sdg-update/about-the-sdg-update-newsletter/

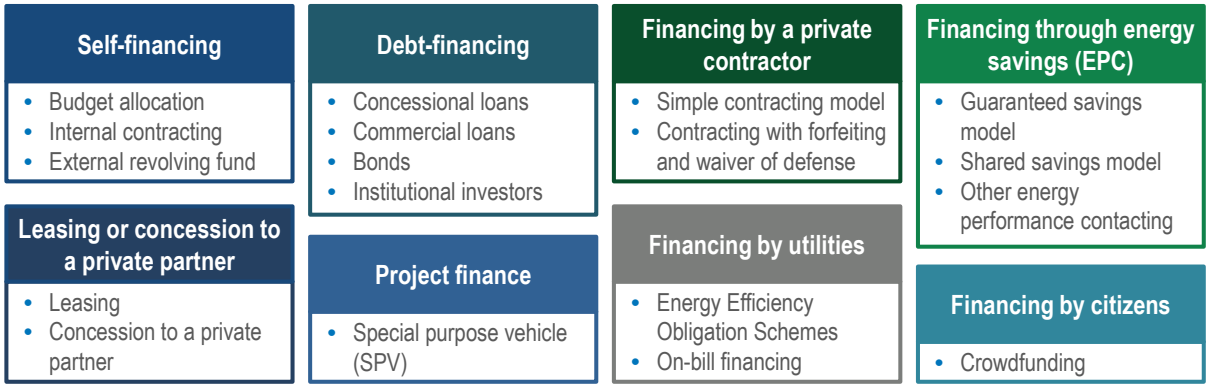
of the energy service market, municipality's borrowing capacity, availability of financial instruments from commercial financial institutions, and others.

Review and assessment of financing models

Review of financing models

As a result of our research, we identified many models to organize financing for the upgrade of street lighting infrastructure. These include different alternatives of self-financing, debt-financing, third-party financing, and financing using public-private partnerships as it is presented in Figure 1. Further, we briefly describe each of these categories.

Figure 1. Financing models for street lighting infrastructure by type of financing



Source: Novikova et al. 2017b.

Self-financing. In the most straightforward financing model, street lighting upgrades are paid for from own funds of municipalities or through grants available from national or EU programmes. To minimize the burden on taxpayers, the public sector can help raise funds by designing and implementing additional schemes (for example, an internal performance contracting or designated revolving fund).

Debt-financing. Many municipalities with limited own funds issue debt, which is then paid back from the tax revenue of municipalities and/or saved energy costs. Municipalities can issue municipal bonds or obtain a concessional loan from available public lending programmes or a commercial loan from a commercial bank.

Financing by a private contractor. Municipal actors can reallocate the burden of financing street lighting infrastructure to third parties, for example by entering into an agreement with an energy service contractor. There is wide variation among such contracts. In a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing and executing the infrastructure retrofit, including the margin. In a more complex model with forfeiting and waiver of defense, the roles played by the city and the contractor are similar to those under the simple contracting model, but a bank enters into agreements with the contractor and the city.

Financing through energy savings. The other configuration to engage private finance is energy performance contracting (EPC) models, which can be implemented when the municipality or contracted party pays for its energy supply. In this model, the energy costs saved by reducing consumption are used to finance the street lighting retrofit. Typically, the contracted energy service company guarantees a certain target level of energy savings. In shared savings EPC models, additional energy savings achieved on top of the guaranteed level are shared between the municipality and the contractor.

Leasing or concession to a private partner. Leasing models are also used to finance street lighting upgrades. Leasing entails the sale of street lighting infrastructure ownership rights by a municipality to a private contractor, conditional on the upgrade, operation, and management of that infrastructure by the contractor. The municipality then leases it from a private contractor for a fixed fee over a set period, after which the ownership rights are transferred back to the municipality. In the case of a concession contract, a private partner is granted rights to operate and maintain street lighting and accrues all benefits resulting from the energy efficiency upgrades.

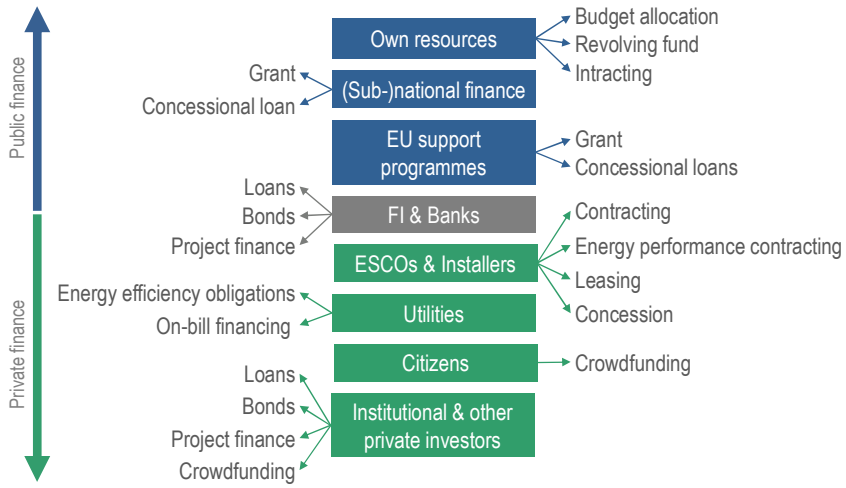
Project finance. Project finance is often used to raise private capital for large bankable projects with capital costs over approximately EUR 20 million. In this model, a special-purpose vehicle (SPV) is established, which carries the investment project on its balance sheet. SPV structure is an important advantage for both municipalities and private investors, because it removes the burden from the balance sheets and isolates project risks within the SVP.

Financing by utilities. Energy Efficiency Obligation Schemes (EEOSs) are operational in eleven EU Member States[6]. EEOS is a policy mechanism that requires energy providers and / or distributors covered by the scheme to meet certain energy saving targets through investments into eligible end-use energy efficiency measures. Depending on the specific country provisions, street lighting is also an eligible measure. In the case of on-bill financing, utility provides a loan to a municipality for the upfront investment and the municipality repays the cost through its energy bills. On-bill financing is not common in Europe, but more spread in the United States.

Crowdfunding. Crowdfunding is a relatively new financing option and most often used by young innovative companies and start-ups for small or medium-scale projects. It implies raising funds from a large number of individuals or small-scale investors via online platforms. Crowdfunding creates a community around the project, where people can be more involved and provide useful insights and ideas to the project. Many community or city projects are also increasingly using this instrument.

Figure 2 presents a summary linking the funding sources discussed with the financing models which unlock the capital for investment into street lighting infrastructure.

Figure 2. Decision-making tree for selecting a financing model



Source: Novikova et al. 2017c.

[6] Denmark, UK, Ireland, France, Spain, Italy, Latvia, Poland, Bulgaria, Austria, and Slovenia

Comparative assessment of the models

The suitability of a financing option depends, in part, on its specific advantages and disadvantages, as well as on the existing economic, market and legal conditions. As a part of our research, we analyzed each identified model going into details of its architecture, projects to which it could be applied, advantages and disadvantages. For each model, we provided at least one case study, for which we went even into deeper details of the model context, scope, stakeholders, implementation experience, and outcomes. This assessment is presented in "Best practice guide" to be issued later this year (Novikova et al. 2017c).

Table 1 provides a summary of this research placing a special focus on the comparison of the advantages and disadvantages of each model as well as projects for which it is suitable for. For example, off-balance-sheet financing of street lighting upgrades reduces the burden on municipal budgets but is contingent on project size and cash flows and may result in a loss of full project ownership and increase the complexity of project implementation. Therefore, the appropriateness of a model will depend on the specific characteristics and needs of the municipality.

Table 1. Key features of financing models from the perspective of municipality

Model	Advantages	Disadvantages	Projects financed
Self- financing			
Municipal budget	-owns and structures project -pays no interests on capital -receives saved energy costs fully	-carries fully up-front cost -bears all investment risks -may lack capacity	-any type given the availability of the budget and expertise
Internal revolving funds (intracting)	-can reuse capital -do not need external capital -cooperate within their units -pay no interests on capital	-carry fully up-front cost -bear all project risks -may be less efficient than a private actor	-any type, including small and not interesting for private investors
External revolving funds	-can reuse capital -may involve private investors -may merge its funds with other municipalities, if small -may design a self-sustaining fund	-carries high transaction cost of a fund set up -carries high labor costs -may experience tensions if private & public capital is merged	-medium to large size municipalities -long-term multi-aimed oriented
Debt-financing			
Concessional loans from public banks	-pays low interest rates -may have special conditions for energy efficiency projects -can combine this model with another one (e.g. a revolving fund)	-pays interests on capital	-especially accessible for public funding
Commercial loans from banks	-can combine this model with another one (e.g. a revolving fund)	-obtains conventional debt based on their credit record -pays interest at market rates -has no special conditions	-financially feasible -any size
Municipal bonds	-can access capital at a lower cost compared to lending from commercial banks	-carries costs of preparation -needs either a good credit rating or access to a bond agency	-medium to large -financially feasible

Model	Advantages	Disadvantages	Projects financed
Debt-financing (continuation)			
Institutional investors	-pays low cost of capital as institutional investors are long-term orientated and risk averse	-may need to deal with a lack of experience of institutional investors in sustainable projects -carry high transaction costs	-large and competitive in terms of financial risks and return
Financing by a private contractor			
Simple contracting model	-does not carry project costs on their balance sheet -can select a contractor via tender	-may face higher financing costs compared to concessional loans -may face restrictions on access to public support	-medium to large
Model with forfeiting and waiver of defense	-the same as in the previous model, as well as -pays lower interest rates than in the simple contracting model	-pays higher interest rates than for concessional loans -has to deal with complexity -provides a guarantee to a bank	-medium to large
Financing by a private contractor through energy savings – Energy performance contracting (EPC)			
EPC with guaranteed savings	-has no peaks in public spending -outsources risks to contractors -pays a constant bill over the project period -pays lower operation costs once the contract ends	-may not find a contractor if a project is too small (*) -has poor financial performance if energy prices are low (**) -faces no motivation by the private partner to deliver more energy savings than guaranteed	-with high saved energy costs (***) -municipalities must have resources to pay the fees as set in the contract (****)
EPC with shared savings	-all as listed in the previous model, as well as -receives a share of additional energy cost savings	-as (*) and (**) in the previous line	-as (***) and (****) in the previous line
EPC immediate savings	-achieves maximum energy savings as soon as possible	-as (*) and (**) in the model above -will have relatively old street lighting by the contract end	-as (***) and (****) in the model above -projects with very old inefficient infrastructure
EPC staggered savings	-achieves a reasonably modern lighting through the contract	-as (*) and (**) in the model above -will achieve the whole amount of energy savings at a later stage	-as (***) and (****) in the model above -projects with luminaries of different age
EPC with related payments	-obtains more accurate quantification of energy savings -receives a share of additional energy cost savings	-all as in the previous model	-all as in the previous model

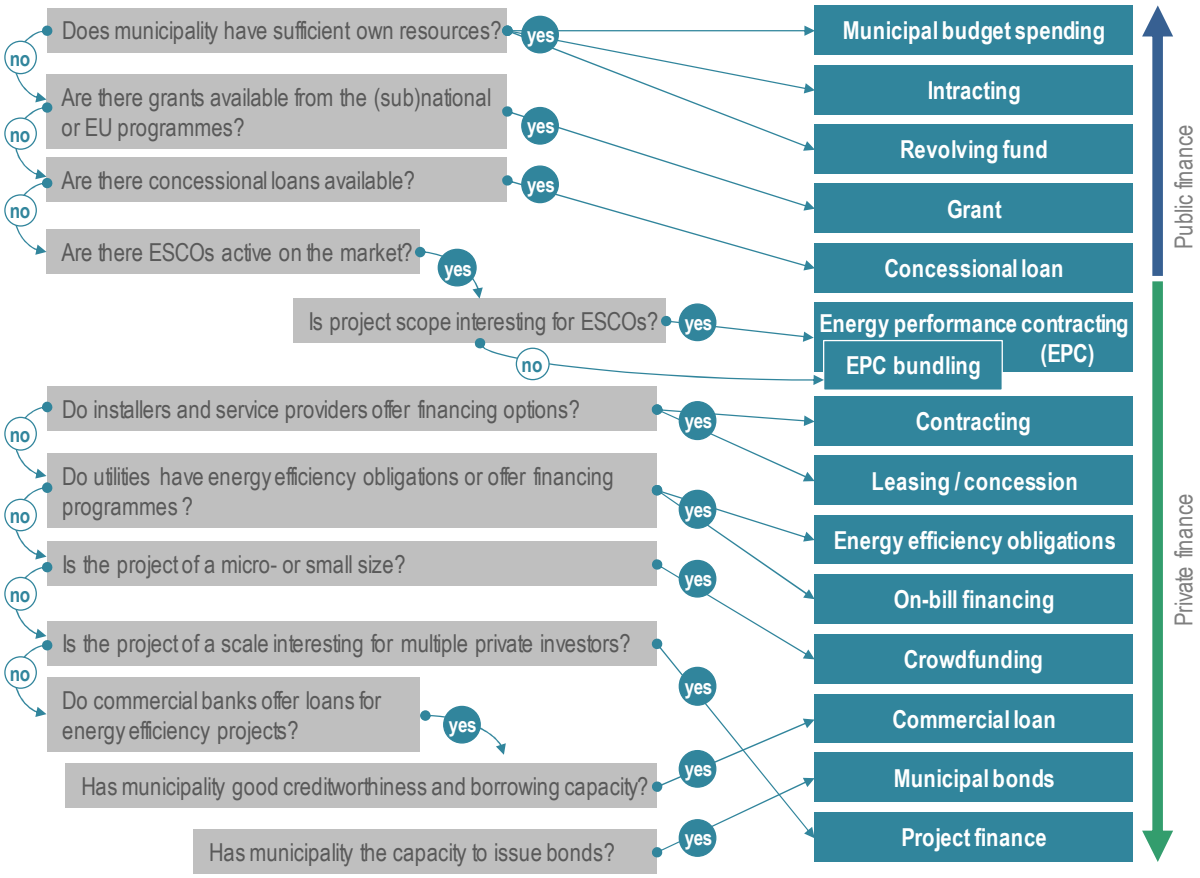
Public-private partnerships			
Leasing by a contractor to municipality	-spreads financial risks and costs over time (*****) -outsources technical risks to a contractor (******) -has no increase in its debt	-may run in higher costs of leasing vs self-financing in the long term -may have less control over the assets	- with high up-front cost
Concession to a private partner	-as (*****) and (******(in the model above -able to set standards in the concession agreement -has no increase in its debt	-may run in higher costs of leasing vs self-financing in the long term -needs good oversight of the project	- with high up-front cost
Project finance	-isolates project risks within a special purpose vehicle (SPV) -may apply penalties if the SPV fails to deliver the services	-faces high transaction costs related to the preparation and implementation of the SPV	-large projects -a consortium of investors & municipalities
Financing by utilities			
Energy efficiency obligation schemes (EEOS)	-benefits from the pressure created by EEOSs on utilities to meet their targets -reallocates the burden of investing into energy efficiency	-needs strong regulatory framework -needs strong governance	-possible in countries adopted EEOs
On-bill financing	-repays investment through its energy bills -enjoys relatively simple implementation	-faces lack of experience as the model is rare in Europe	-small to medium size
Financing by citizens			
Crowd-funding	-enjoy additional private investors	-has no guarantee that sufficient funding will be raised -may face investors' inexperience -may face the situation when investors wish to exit -faces a lack of regulation -may face various issues with responsibilities towards multitude of small investors	-small to medium size

Source: authors' results based on the analysis of a set of literature (ATEE 2015; Bonetti et al. 2010; Climate Bonds Initiative 2017; De Marco et al. 2016; EnergyCities 2016; Bulgarian Energy Efficiency And Renewable Sources Fund 2017; EPEEF 2017, n.d.; ESCAP 2008a, 2008b; ESMAP 2014; Esty and Sesia 2010; European Commission 2016a, 2016b, 2016c, 2017a, 2017b; Geissler 2013; IIGCC 2015; Irrek et al. 2005; Junghans and Dorsch 2015; Kaminker et al. 2017; Kidney et al. 2015; Kinzey 2015; LBNL 2012; Limaye et al. 2014; Limaye and Limaye 2010; Link 2012; Makumbe et al. 2016a, 2016b; ManagEnergy 2017; Mendoza et al. 1999; Oxfam 2017; RAP 2012; Rosenow and Bayer 2016; Rosenow 2017; Scottish Futures Trust 2013; Seifried 2011; Schaefer et al. 2017; Schilken and Wysslin 2013; Smart Cities Council 2015; Spillers 2000; Sustainable Energy Authority of Ireland n.d, 2014; The Climate Group 2013; US DOE 2016; WBG 2016a, 2016b; Zirkwitz 2016).

Making decision on a relevant model and key deciding factors

Some of the key considerations in choosing a financing model are availability of public policies and funding, project size and bankability, maturity of the market of energy service companies (ESCOs) and energy service providers, municipality's borrowing capacity, and availability of financial instruments from commercial financial institutions. Figure 3 presents a decision-making tree for municipalities for selecting a relevant financing model based on these factors. Further, we explain each of deciding factors in detail.

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



Source: authors' illustration of the guide for street lighting adopted from ESMAP (2014).

Availability of public policies and funding

Many European or national funding resources and programmes offer finance at the lower cost compared to commercial options, e.g. grants or concessional loans. A project that corresponds to the funding priorities of a specific programme or fund can get financed conditional to the compliance with their application criteria. Often those projects, whose risk profile or size are not interesting for private investors, could also obtain funding from these programmes.

Depending on the funding source, municipalities can use it to finance project costs directly or to design a revolving scheme to multiply and leverage additional private capital. National incentives and

policies like energy efficiency obligation schemes offer an option to finance street lighting projects with the help of utilities or other actors participating in the scheme. If available public funding is not sufficient, municipalities can consider working with the private sector and commercial finance providers.

Project size and bankability

The larger the project is, the higher is the need for external funding and private sector engagement. Also, complexity of financing arrangements may increase with the project size. In contrast to public funding, private investors have specific risk-return requirements for projects. Street lighting projects have more advantages compared to other energy efficiency investments, e.g. in buildings. They have homogeneous technology, typically generate high energy savings and have a shorter payback period as it is illustrated by implementation of city and municipal energy efficiency program throughout Europe (Diputación de Huelva 2016; Paulík email com). Therefore, street lighting projects are usually interesting for ESCOs or other private investors. Various financial instruments, e.g. loans, bonds, equity, energy performance contracting models, leasing or concession models 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 can be bundling multiple small projects in several municipalities into one investment package. Alternatively, small community-scale projects can also explore crowdfunding opportunities to engage the citizens.

Maturity of the ESCO and energy service providers market

If ESCOs and energy service providers are active on the country market, they can offer advantageous terms for energy performance contracting (EPC), leasing or concession models, including options for bundling several small-scale projects. To be attractive for ESCOs, the projects must deliver high energy savings and municipalities need be able to pay the contract fees over time. Using ESCOs or other service outsourcing models allows upgrading street lighting without peaks in budget spending and with transferring investment risks on the private partner. However, if the ESCO market is not mature enough or the project does not offer sufficient scale, energy savings or payback period for ESCO interest, 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, the projects need be financially sustainable. Furthermore, municipality should have a credit profile and decision-making authority allowing obtaining debt on the municipality's balance. If municipality has sufficient technical and institutional capacity or can access a bond agency, it can also issue municipal / green bonds. The cost of capital will depend of the project profile, type of financial instrument and maturity of the local banking sector. However, it will be most probably higher than public support programmes, e.g. concessional loans and credit lines. Loans are available for projects of various sizes. Equity, bonds and project finance are normally used for medium-to-large and large projects.

Conclusion

Even though the upgrade of street lighting offers high energy savings, its upgrade rate is low in many geographical jurisdictions in Central Europe. High up-front investment costs are among the highest barriers for municipalities to upgrade street lighting. Under the Dynamic Light project, the authors of the paper reviewed and analysed different financing options.

The most straightforward financing model is to pay for street lighting upgrade from the own funds of municipalities. To minimize the burden on tax payers, the public sector could design and implement additional schemes which help raise the funds to the budget, in particular the revolving scheme. Many municipalities, whose own funding resources are limited, obtain debt which is then be paid back from the tax revenue of municipalities and/or saved energy costs. Thus, the municipalities could obtain a low interest loan from a public lending program, a commercial loan from a commercial bank, obtain capital from institutional investors, or it could issue municipal bonds.

Municipal actors can involve private sector and reallocate the upfront burden of financing street lighting infrastructure on third parties. Variety of such contracts includes a simple contracting model or forfeiting and waiver of defense, energy performance contracting models linked to energy savings, leasing or concession to a private partner, and project finance.

In countries with utility obligation schemes in place, the burden of energy efficiency upgrades may be reallocated to utilities. The utilities need to meet certain energy saving targets and street lighting could be an eligible measure. Furthermore, a municipality may obtain a loan from its utility for the upfront investment and repay it through its energy bills. Finally, municipalities can raise finance through crowdfunding.

Each of the models has its advantages and disadvantages as well as constraints to do with the economic, market, and legal conditions in which it could be applied. Some of the key considerations in choosing a financing model are availability of public policies and funding, project size and bankability, maturity of the ESCO market and energy service providers, municipality's borrowing capacity, and availability of financial instruments from commercial financial institutions. Therefore, the choice of model should be made according to the specific conditions in each municipality.

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