Using the private finance initiative for energy efficiency projects at the urban scale

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Introduction

Cities are responsible for consuming a large share of the global energy. Consequently, increasing energy efficiency at the urban scale is a way to substantially reduce resource consumptions and greenhouse gas emissions (Arnold and Barth, 2012) so that environmental impacts can be lessened and positive effects on the climate can be generated together with cost savings (Zanon and Verones, 2013; Keirstad *et al.,* 2012; Neirotti *et al.,* 2014). In this context, many studies have demonstrated that the potential for increasing energy efficiency is quite large with gains as high as 25 to 30% (Painuly *et al.,* 2003).

However, energy-efficiency urban initiatives often require important capital investments, long-term financial returns, and complex contract arrangements that often act as limiting factors to their development. Also, energy efficiency urban challenges often struggle against the motivations of utility companies that suffer from reduced revenue as a result of lower consumptions.

Moreover, in periods of bad economy, the shortage of public finance and binds imposed on public budgets in various countries force many cities to cut investments in energy saving projects. As a consequence, most cities face challenges to maintain and upgrade innovative policies and develop new initiatives (Komninos *et al.,* 2011). In fact, despite the large potential and interest on improved energy efficiency claimed by most municipalities and local public agencies, actual implementation of energy efficiency projects often falls short of financial viability (Dilip and Limay, 2011; Gynther *et al.,* 2012).

Therefore, energy efficiency projects should be developed in a way that their financial feasibility is assured. To this end, it appears essential to take advantage of the potential to create cost savings from the usage of new energy-efficiency technologies such as solar power and LED lighting.

A critical aspect to assure for the financial viability of energy-efficiency projects is inherent with the selection of sustainable funding mechanisms that would include both short and long-term financing facilities (Sun *et al.,* 2014). With this regard, viable financial schemes are welcome, such as Project Finance (PF), which are seen by many municipalities as a way for leveraging limited public funding and procuring desirable energy-efficiency projects with limited public spending and borrowing (Algarni *et al.,* 2007).

With this regard, Mostavi et al. (2014) highlight that traditional public finance-based approaches such as state grants funded by taxation are no more sufficient to address the existing needs for energy efficiency project developments, so that innovative financing mechanisms are necessary such as non-traditional sources of revenue, leverage of financial resources, public-private partnerships, new management techniques, and new institutional arrangements. Thus, the involvement of private capitals appears rather crucial together with long terms contracts to ensure the stability of the operations and maintenance activities (Link, 2012), incentives such as tax-free bonds, or tax exemption for private investors (Chen, 2002).

Indeed, PF contracts involve the planning, design, construction, operations and maintenance of public works or public services by a special purpose company or a consortium of private partners (Iossa *et al.,* 2007; Grimsey and Lewis, 2004). These are usually long-term contracts (Iossa and Martimort, 2009) and the public actor can benefit from the transfer of part of the risk to the private partner besides being relieved from budget constraints (Grimsey and Lewis, 2004).

In recent years, the PF has been appearing as an alternative and accessible financing scheme for public infrastructures, social facilities and innovation in urban development (Henjewele *et al.,* 2014). However, the concepts of PF are not yet standardized with respect to energy efficiency projects and limited funding is available from private financial institutions for this type of projects (Dilip and Limay*,* 2011).

With the purpose of stimulating the usage of PF in urban energy-efficiency projects, this paper explores the limits and advantages of the PF scheme by presenting the case study of a traffic lighting system renewal in the city of Turin, Italy. The study is an opportunity for testing the advantages and barriers that typically limit the development of energy saving projects in most cities in a period of financial shortage and for understanding the main aspects of the proposed PF solution, such as the apportion of private finance into utility projects, improved bankability, greater debt capacity, and reduced development failures. This study builds upon the existing body of research to further test the applicability of PF in order to explore its advantages and barriers for the development of innovative initiatives related to urban lighting systems.

This paper is structured as follows. In the next section pertinent literature is first reviewed. Then, some examples about the use of PF in street lighting systems are presented. After the methodological note, the case study of a street lighting renovation project is given together with the analysis of its main results. Then, discussion and implications are elaborated. Finally, conclusions are drawn about the feasibility of the PF funding mechanism for the case under analysis.

Literature Review

The lack of appropriate financing instruments has been one of the principal obstacles to wider investments into the renewable and energy-efficiency sectors (Bobinaite and Tarvydas, 2014). However, over the last years governments have been implementing many support policies seeking to increase the use of sustainable energy. In fact, from 2005 to 2011 the number of countries with some kind of financial support facility has increased from 55 to 119 all around the world (REN21, 2011). In this context, issues such as how energy-efficiency projects might be financed and the impacts of financing instruments are of great importance.

Financing mechanisms for energy efficiency projects

In periods of shortage of traditional public finance, energy efficient public projects can be funded using various financial mechanisms spanning from recent crowd funding (Yildiz, 2014) to more mature public subsidized facilities and various forms of public-private partnership (PPP).

Financial subsidies by governmental institutions have been some of the primary sources for financing energy-efficiency projects so far. Subsidies work on a volunteering basis, and require a great effort from the partners involved in terms of time, resources and administrative costs. Therefore, their potential is directly dependent on the value of the reward, which has to be as high enough as to compensate for a large portion of such costs (Tanaka, 2011).

In the European Union, financial instruments have been used to deliver structural funds since their first introduction, in the 1994-1999 program period. The European Investment Bank (EIB) was the institution in charge of designing financing instruments for energy-efficiency projects in the EU, as well as all activities of promotion and support to agencies receiving European public funds. The average investment size for energy-efficiency projects for the period 2000-2011 was 162 MLN €, although the size of 40% of awarded projects were below the €100 million threshold with an increased share of smaller projects (EIB, 2012).

For the current Cohesion Policy 2014-2020 program, the European Commission has drawn up new methodologies aiming at the usage of financial instruments for deploying more efficiently the resources allocated to the program. The financial instruments can be provided under the form of loans, guarantees or equity/venture capital, and can cover various types of cost expenditures ranging from payments to final recipients to management costs and fees (European Commission, 2014).

One of the investment's priorities pertaining to the Thematic Objective IV of the Cohesion Policy 2014-2020 is "supporting energy efficiency, smart energy management and renewable energy use in public infrastructure, including public buildings, and the housing sector" (European Parliament and Council, 2013). One of the main 2020 European targets is in fact a 20% increase in energy efficiency.

However, the financial instruments to energy-efficiency projects covered by the budget allocated to the European Horizon 2020 initiative are mainly designed for research and innovation projects and therefore their usage for an extensive deployment of energy-efficiency capital projects at the urban scale is rather debatable and forms of PPP are needed to raise larger equity and debt capitals.

In this context, many local public administrations look for debt capitals and associated forms of securitization of their energy efficient capital investments, through the transfer of the ownership, operations or the right to receive specific future revenues to another party. In such scenario, projects can be funded with asset-backed security bonds, through which lenders have a direct claim on the assets and on the project cash flows (Benito *et al.*, 2008).

An alternative PPP scheme for financing energy-efficiency initiatives in urban contexts is the Energy Service Company (ESCO) form of contracting. ESCOs are organizations devoted to planning, implementation and maintenance of energy-efficient equipment (Bertoldi *et al.,* 2006; Marino *et al.,* 2011; Vine, 2005). ESCOs can take a significant role in promoting energy efficiency and creating cost savings. The main contractual model, named Energy Performance Contract, states that the revenue generated by the ESCO's activities are linked to the actual energy savings of the owner. One important weakness arising with this business model is the inadequate level of asset guarantees usually provided by the ESCO, which makes lenders more selective (Cassa Depositi e Prestiti, 2013). Therefore, an ESCO assumes the performance risk (energy savings guarantee) of a project by applying energy performance contracting and this usually makes banks more hesitant in funding projects unless complex risk hedging instruments are used (Garbuzova-Schlifter and Madlener, 2013). The most developed ESCO market in Europe is certainly Germany. As a result of their preliminary analysis of the first European ESCO database, Rezessy et al. (2005) note that "the success of the German ESCO market has been driven by the financial and technical support for energy efficiency projects provided by the concerted effort of governmental action (e.g.: research and development programs, loan/funding schemes, and incentive programs for renewable energies) and non-governmental programs (e.g.: credit programs by eco-banks, efficiency checks by energy agencies, and boiler replacement by utilities)". An effective project that has shown the validity of the ESCO model is a project that is being carried out since 1996 by the city of Berlin's energy agency and the Berlin's Senate Department for Urban Development for energy saving measures. The project created 25 energy saving partnerships with 1,300 public buildings and more than 500 properties (Berliner Energieagentur, 2013). The ESCOs involved in the project were in charge of financing, planning, implementing and managing the energy saving measures, while the energy agency served as project manager for the PPP, in addition to providing consultancy to clients, drawing up contract models and technical-economic requirements (Berger 2011).

The ESCO industry in Germany is consistent even when it comes to street lighting renovation projects. For instance, the city of Halle replaced 22,000 streetlights achieving annual budget savings of around 37%, and the city of Lehrte achieved an even bigger improvement of 54% savings by replacing 4,500 streetlights (EPEC, 2013).

ESCOs have also experienced a significant growth in the US, far exceeding U.S. GDP growth from 2009 to 2011. This exceptional growth was mainly drawn by public and institutional markets, which accounted for 84% of the 2011 industry revenue (Stuart et al. 2014). Painuly et al. (2003) assert that the reason for the success of ESCOs in the US industry lie in the scope of the projects, which provide comprehensive solutions resolving issues such as productivity, indoor air quality, health/safety concerns, facility renovation and modernisation. Among the energy efficiency projects financed with the ESCO mechanism that included the upgrade of lighting systems, we find the example of the city of Henderson, Nevada. The project comprised the retrofitting of up to 28,000 streetlights with induction lighting technology, with approximately $800,000 estimated annual savings and a total project size of $23.1 million (Naesco, 2012).

Another financial instrument that can be used to develop energy-efficiency projects is the Project Finance (PF) scheme (Grell and Lang, 2008). PF is a mechanism to finance the design, construction, operations and maintenance of a public facility for a specified concession period. The initial investment is intended to be recovered through revenues from the service provided during the concession period, which is determined to sufficiently pay off debt incurred and earn an acceptable profit from the project cash flows (De Marco *et al.,* 2012a). Under a PF scheme, a special-purpose vehicle (SPV) company is created and financed via both investors' equity capital and non-recourse - or limited-recourse - debt provided by lending institutions.

PF has been recognized as an effective mechanism to facilitate private finance into large-sized infrastructure projects and, therefore, to develop desirable facilities with limited public spending. However, initial debt arranging fees and contractual transaction costs are often relevant due to perceived high risk associated to the unconventional returns expected from the project cash flows (Painuly, 2009).

From 2005 to 2009, more than 70% of the world total amount of bank loans for PF went to three sectors, namely power, transportation, and oil& gas, and around 40% were granted to projects sized $101-$500 million (Esty and Sesia, 2010). This feature has not significantly changed after 2009, as Thomson and Reuters reports (2012). In fact, the average project size was still very high, at roughly $365 million.

Thus, although the effectiveness of the PF mechanism has been extensively proven for large infrastructure projects, in recent years there has been a surge of interest for the application of this financing scheme to small and medium-sized energy-efficiency projects and, in particular, to urban-scaled projects, such as public lighting, power, and waste management systems. To this end, a deeper understanding of the applicability of PF to such new domains is needed. In the following literature sections, the general advantages and disadvantages of PF are first recalled and then some cases of renovations of public lighting system are proposed with specific regard to some successful UK's experiences.

Project Finance: general advantages and barriers

PF is notably applicable when a particular facility or a related set of assets is capable of functioning profitably as an independent economic unit (Finnerty, 2007). The main features of a PF can be identified as follows: i) the bankability of the project is linked to its ability to repay the debt contracted and not to the value of the assets or infrastructures used as collaterals (Gatti, 2008), ii) optimal risk allocation between the parties involved, iii) off balance sheet investments, iv) more financially sustainable investments, v) a more cost-effective management of the project, and reduced development failures (Vecchi, 2010). A lot of PF case-study projects can be found in the literature. The Quezon power plant in the Philippines demonstrates that, in a PF contract, the SPV's funding costs can be reduced by structuring contracts efficiently and through a proper risk allocation (Bonetti et al.2010). Mendoza *et al.* (1999) focus their attention on Highway 407 Express Toll Route in Canada and they highlight that: long concession periods create value, a simple regulatory structure is advisable, fast bidding processes produce more value, the commitment of the public authority is important, and a transparent bidding process is crucial for the success of the initiative. All the aspects related to the legislation body have proven to be critical in the development of the Santiago airport in Chile (Curtis, 2000).

However, this financial scheme presents some drawbacks. For instance, a PF initiative faces high transaction costs for small-medium sized projects that add up to 5-10% of the deal value (Corielli *et al.,* 2010), long time from project inception to physical development, political risk, and low-bid environment (Bonetti *et al.,* 2010).

Another negative factor is related to the reduced self-financing ability of many PF projects, such as social facility services requiring a shadow toll or unitary charge paid by the granting public authority with little user-generated commercial revenue to self-sustain the private portion of initial investment (Hellowell and Pollock, 2009).

Finally, an important feature and critical success factor for PF projects is the allocation of risk between the public and the private sectors, given that it is impossible for the private sponsors to retain all the risks of the project since the SPV's assets are specific to the project and they just serve the purpose of generating cash flows for the project (Finnerty, 2007).

Financing a Street Lighting Renovation Project Using the PF Scheme

Although there is a significant lack of literature on the effectiveness of financing street lighting initiatives in city roads through PF, several projects have been implemented in this field, especially in the United Kingdom. As of March 2013, the HM Treasury counts 32 street lighting PF initiatives in operation (HM Treasury, 2013). Some similarities emerge between these projects, leading to trace a blueprint that is likely to be applied to future projects. The involvement of private contractors in the street lighting field has been considered effective mainly for those projects encompassing a wide array of services offered to the public institution, including e.g. the installation of all kinds of lighting, such as lit signs, lit bollards, subway lighting, amenity lighting (Manchester City Council, 2012), or managing a centralized security unit and the related CCTV cameras (Sunderland City Council, 2012).

Moreover, these initiatives originate from the need of UK cities to renovate the entire lighting stock, meaning that the entire columns have been replaced instead of the lanterns. Traditionally, a Core

Investment Period of around 5 years is necessary to complete the first phase of installation, after which the service contract begins. Thus, the refurbishment is not usually related to the whole lighting system, but it is associated with the 60-70% of the network that needs more investments. Payments from the public institutions are delivered in form of yearly or monthly unitary charges, and start from the installation phase. A reduced unitary charge is due until the Core Investment Period has been completed, at the end of which the unitary charge increases steadily with inflation and other ratios stated in the contract. The average concession period equals 26 years, and the average size of the investment is about 45 MLN £.

Such projects have shown a lot of benefits for both the public authority and the citizens. In particular, the new technology is able to adapt the level of lighting reducing energy costs and CO2 emissions. Furthermore the use of LEDs on main roads could assist in the improvement of visibility of pedestrians, cyclists and drivers hence reducing crime and traffic accidents (Manchester City Council, 2012).

Also the city of Salford has recently implemented a pilot scheme for a retrofit-program related to the replacement of the lanterns, with new ones exploiting LED technology. The project was launched in 2011, and it provides for 2,000 new lamps. In the first operations year the project is expected to generate savings for as much as £80,000, in the light of lower energy and maintenance costs (Urban Vision, 2013).

Methodology

This study is conducted using an explanatory single case study approach. This research methodology is adopted in order to examine a contemporary phenomenon in its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. Moreover, an explanatory case study is usually used in order to find confirmation of theory and studying its reflection in an empirical case (Yin, 1981). Indeed, by using this empirical case, we want to discuss the barriers and advantages of the PF scheme in case of small and medium-sized urban projects of energy efficiency to be conducted in a period of bad economy and shortage of traditional public finance. The case study methodology applied in a PF initiative has been already proposed by Jefferies et al. (2002) who carry out an explanatory case study on the construction of a stadium to test a framework for critical success factors of the Build Own Operate and Transfer (BOOT) delivery system. In their research the case

study methodology, appears to be the most suitable. Also, the case study approach allows an in-depth discussion and understanding of the proposed model (Halawa et al., (2013).
Because of the intrinsic limitations related to the generalizability of results of a single case study methodology, the aim of this paper cannot be a statistical generalization of results (Yin, 2003), but its purpose is to examine how theory reflects in this empirical case and inform future researchers and practitioners about the barriers and advantages of using a PF scheme to fund an energy efficiency project. A single case study methodology is selected in order to assure a more in-depth analysis of the phenomenon under observation, collecting more detailed and richer data (Yin, 2003). This approach is also proposed by Jefferies et al. (2002) that consider the case study methodology as an instrument to test the validity of a theoretical framework, rather than to provide with a perfect and standardized model. The selection of the case is two-folded: it is part of an ongoing research project to which we participated as facilitators and consultants and it is the object of our theoretical interests (Siggelkow, 2007). Therefore, the given case is not intended to demonstrate neither that the PF scheme is an absolute best option, nor that it is dominant towards select alternative funding mechanisms. It is just presented as one of the ways to fund projects under given circumstances and case situations that make it particularly appropriate.

The organizations that contributed to this case study are: the Municipality of Turin, who is the owner of the traffic lighting system, Swarco Mizar SpA, a LED technology vendor acting as technical partner, Iride Servizi SpA as the operations and maintenance (O&M) contractor and utility service provider, Gianni-Origoni-Grippo & Partners as legal advisors, Equiter SpA as the investor, Cassa Depositi e Prestiti as the lending institution, and the Smart City Finance& Technology Research Program's scholars at Politecnico di Torino acting as workgroup facilitators and authors of this paper.

The authors collected data during two project collegial meetings and two one-to-one meetings. Table 1 specifies the schedule, attendees and the scope of the meetings.

Table 1 Schedule of project meetings

Each meeting was recorded and a report was shared to approve all main financial assumptions (Table 2) and input data (Table 3).

Finally, data were validated analysing commercial documents of the organizations involved into the project in order to diversify data sources and cross-validate information gathered during the meetings (Noor, 2008).

Based on collected information, we developed a spreadsheet in order to assess the economic and financial feasibility of the project. In order to check its reliability, we also performed a sensitivity analysis. Finally, results were discussed with participants to explore the weaknesses and strengths of the case PF implementation.

Case Study: PF street lighting system project

The case study refers to a pilot project, launched by the City of Turin in 2013. The aim of this pilot is to explore the applicability of PFI for the renovation of its traffic light of the City of Turin. Turin is located in the North-West of Italy which is is an interesting area of interest from different perspectives: first, it is one of the twelve Italian metropolitan cities; second, it is the only city in Italy that has established a strategic plan for making itself smarter, and energy efficiency is one of its priorities; third, it has a huge debt load that burdens the public budget and makes it difficult to invest traditional public finance to develop energy-efficiency projects.

Therefore, the purpose of this pilot project is to explore the suitability exploration of suing a PF mechanism in order to replace 14,000 traditional incandescence lights with up-to-date LED-based lamps and their associated energy consumption controls, in order to knock down energy and maintenance costs while increasing the reliability of the system.

Currently there is a worldwide tendency to replace urban lighting with energy-efficient lighting systems (Coureaux and Manzano, 2013). Investing in energy efficient lighting is one of the most effective ways to reduce CO_2 emissions (Dubois, 2011). Out of many available technologies, LEDs have shown a rapidly increasing trend with regard to their light efficacy (Ahn *et al.,* 2014). LED lamps present a lot of advantages in terms of light output, economics, health, and environmental impacts and the efficiency, as per lumens of light emitted per watt of power input, has increased dramatically in recent years (Sekyere *et al.,* 2012). Furthermore, LED lamps have 9-10 times longer lives than traditional lamps. Thus LED technology is being considered as the new generation of lighting (Pandharipande, 2011).

Organization and Capital Structure

The governance structure of the PF pilot scheme is described in Figure 1. It provides for the establishment of a separated SPV that is financed partly with equity and partly with long-term debt. The SPV contracts the services of a contractor charged with the responsibility of replacing the existing lanterns with new LED lamps and of an O&M contractor. The construction and the O&M entities also act as operating equity investors together with a financial investor.

For as long as ten years, the local government reimburses the SPV an annual fee (the unitary charge) in return for the electrical utility and O&M services. The fee equals the annual savings that are created by the energy efficiency originated by the LED technology. After the ten-year period, all savings are hold by the local government to reduce the public expenditure.

Figure 1: Governance structure of the pilot project

Main Assumptions

Table 2 shows data about the expected initial investment, approximately €10 million, over a three-years period. This information was collected during the first individual meeting.

Table 2: Expected Capital Expenditure [€]

The annual fee paid by the local government is proportioned to the development progress, i.e. 33% each year. After the investment period, a full constant annual fee of approximately €1.5 million, equal to the total savings created by the capital investment, is paid for ten years. At the end of the decade, the local government bears only the maintenance and utility costs, which result to be reduced by about 80% of the original expenditure due to gained energy efficiency.

The equity/debt ratio is set at a level of 20/80. The debt capital structure is composed of a senior debt facility and a VAT facility.

Table 3 reports some financial and fiscal assumptions related to VAT rates, annual inflation rate, cost of equity, cost of debt, weighted average cost of capital, and income tax.

Table 3: Select Assumptions

Table 4 shows data used to determine the unitary charge, as resulting from comparing the current costs versus the LED-technology cost. The data reported in Table 4 were collected during the meetings from informed project's participants.

Table 4: Estimated energy efficiency savings

Profitability and bankability of the pilot project

In order to evaluate the project's profitability, we calculated the Internal Rate of Return on Equity (IRRE). In energy-efficiency projects equity investors typically look for an IRRE greater than 11% (Easton *et al.,* 2002). For assessing the bankability of the project, the Debt Service Coverage Ratio (DSCR) is calculated, because it represents the capability of the project's cash flow to repay the debt service in each time-period of the project. In fact, at each time period, the DSCR equals the cash flow generated in that period in respect to the debt repayment in the same period. A bankable project typically has an average DSCR greater than a target DSCR imposed by the lending institutions. In the current practice, a desirable value for the average DSCR post-tax ranges from 1.2 and 1.3 (Potluri and Rajian, 2010). The project resulted in both profitability and bankability, as showed by an IRRE of 12.60% and post-tax average DSCR equalling 1.32.

Reliability of the pilot project

In order to verify the validity of the results and the robustness of the economic-financial model, a sensitivity analysis was carried out. Two different tests were made. The first was a univariate analysis, to verify the opportunity for the local government to retain, since the beginning, a certain percentage of savings. We considered the variation of the IRRE according to the total amount of the annual fee paid by the local government to the SPV and the resulting IRRE equals 12.60%. Then, a fee equal to only 99% of total savings was set, so that the municipality retains 1% of savings from the first year.. In this case, the IRRE equals 12.31%. Following this ratio, for the investors the project results still attractive even if a fee equalling 95% of the total savings is paid and the local government retains 5% of this benefit.

After that, a multivariate analysis was performed using the initial public funding and the payback period as main variables. This analysis allows evaluating a reduction in the time-span for the return on the investment. As a result, the reduction of the time period requires the introduction of an initial public funding, which allows a shorter payback period.

The reduction of all the parameters taken into account for just one year is critical for the IRRE index. In fact, it goes down under the threshold level of 11% and other forms of funding, such as public funding, are required in order to assure for a minimum attractiveness to the investors.

Our simulations show that a time span of 9 years requires about €350,000 of initial public funding for the project to be still profitable; 8 years require €900,000; 7 years require €1,300,000; for a break-even period of 6 years an external contribution of almost €1,700,000 becomes necessary.

Table 5: IRRE index according to Public Funding and Time Horizon

Discussion of results and implications

The case study's results suggest two subsets of considerations, namely those related to using the PF scheme to fund energy-efficiency projects and those associated with the specific case presented in this paper. The findings of this contribution provide some interesting insights to further develop the ideas around the PF field. In the case study under observation, the PF scheme was chosen after considering the advantages related to risk segregation, the insolvency of purchaser, cash flow separation, financial transparency, warranties and bonds, and cost of capital. Specifically, moving from the results of the case study under observation, the following considerations can be made.

First, this case study confirms that cost savings generated by energy efficiency project operations are quantifiable because they are primarily driven by technology. In other words, savings are obtained from the usage of a replacing measurable technology (Manchester City Council, 2012) and they can be predicted since this replacing technology is mature enough to provide historical series of data available for estimates.

Second, PF can effectively and beneficially support the development of energy-efficiency initiatives in a context of limited technical and productive competencies of the public sector. In fact, PF is based on the participation of the private sector not only from a financial point of view, but also from some technical, productive and managerial perspectives (Lattemann *et al.,* 2009). Indeed, it is acknowledged that the quickest improvements in energy efficiency are achieved through programs that can take advantage of the private sector' efficiency and capabilities in developing the capital investment and operating the service (Mallaburn and Eyre, 2014).

Third, another advantage that can be obtained from using a PF form of financing is related to the creation of a separate SPV entity that segregates risk from the shareholders because it is funded with either non-recourse or limited-recourse financing (De Marco *et al.,* 2012b). This, in turn, reduces risk for the shareholders and increases the collection of equity capital. Therefore, this aspect enhances the investment attractiveness in the eyes of various types of private investors, such as private equity funds, institutional funds, and investment banks (Bing *et al.,* 2005).

More generally, a PF arrangement to finance a measurable energy-efficiency project tends to mitigate risk so that greater degree of bankability is assured and higher debt leverage and reduced level of equity capital is obtained. In addition, the level of risk can be reduced by the injection of a portion of initial public funding into the total investment with subsequent higher profitability, quicker return and shorter concession periods (De Marco *et al.,* 2012a) in order to provide for even greater attractiveness for the private investors that typically seek for fast payback periods. However, this conflicts with the limited available public finance and reduced financial benefit for the public sector. This issue was confirmed by the sensitivity analysis that was carried out during the case study.

These sets of considerations generally apply to most kinds of Public-Private Partnerships (PPP) that can be used for financing and delivering utility services. In particular, using measurable cost savings that can be obtained from replaced energy-efficient technology allows for long-term repayment of private capitals and services without or with limited traditional public finance. This might suggest that PPP are likely to be suitable forms of fund raising to implement projects in periods of public budget cuts.

However, the PF mechanism also appears to be particularly appropriate compared to other forms of PPPs, such as for example the ESCO system, because of the third consideration regarding the reduced equity risk associated with the establishment of a separated SPV. In fact, the reduced equity risk results in reduced cost of capital and, in turn, a lower level of equity required: such factors contribute to ease the fund raising task for both the equity and debt portions of financing. On the contrary, private operators proposing an ESCO system may face restrictions to access capitals and incur in greater capital cost, which increases the cost of the service fee and could jeopardize the profitability and bankability of the project. In this given specific case study, the option of funding via an ESCO system would require a greater weighted average cost of capital by 2% with resulting equity profitability below the threshold of 11% for the IRRE that is usually expected by the market, with subsequent reduced attractiveness for the private investors and lower chances to implement the project.

Other points of discussion specifically related to the proposed case arose during the study. For instance, the SPV is just responsible for a scalable replacement of the old lamps with LED technology and the renovation of the existing control systems in a way that no other major infrastructure investment is made to replace the whole lighting system, such as the columns, connection grid, etc. This has two consequences. On the one hand, this issue, together with the limited technology risk inherent with the usage of the mature LED technology, results in substantially reduced construction risk for the project and rather short construction period. On the other hand, the construction period overlaps with ongoing current lighting operations so that the financial impact of the initial capital expenditure on the project cash flow is limited.

Finally, some aspects related to contract guarantees and risk allocation were crucial. The case study showed an unusual mechanism of mutual guarantees that have been required by the private sector to the public partner. Usually in PF contracts, only the Public Authority asks for guarantees to the private partner. Indeed, Asenova and Hood (2006) argue that the financial risk is to be entirely borne by the private sector. Also Akintoye and Chinyo (2005) state that PF transfers risks mostly from the public to the private sector. Other studies have highlighted that a mutual mechanism of guarantees can exist and some risks can be led back to the government. This means that not only the Public Authority requires performance bonds and bank guarantees, but also the private party can push for some kinds of warranties in order to cover the uncertainty of the cash flow. However, these authors mainly consider risks related to profitability, wherein the public sector ensures a minimum level of return to the private sector (Alonso-Conde *et al.,* 2007).

In addition to the profitability guarantees, in the proposed case study, the SPV requires some form of insurance on the insolvency risk of the public sector. Private investors appeared willing to receive a lower level of profitability in return for a solvency guarantee by the public agency. In particular, the SPV would have liked to receive a further commitment about timely payments by the Public Authority. These aspects are associated with some contextual factors. In fact, the Municipality of Turin is tired down by the high level of debt burden.

Conclusion

This work is a contribution to the development of PF in the field of energy-efficiency urban projects. As a matter of fact, in the light of the expected environmental and financial future challenges, improving energy efficiency is becoming a major issue for urban development (Arnold and Barth, 2012).

To this end, a framework for the application of the PF mechanism in a lighting system renovation project is proposed in this paper via presenting an informative case study. The project is related to the replacement of traditional traffic lights with LED technology. The initial investment is approximately worth €10 million over a three-year period with an equity to debt ratio of 80/20 and a concession period as long as 10 years. The IRRE equals 12.60% and the post-tax DSCR 1.32. These figures prove both profitability and bankability of the energy efficiency initiative. The proposed case study shows that the O&M cost savings associated with implementation of the projects are easy to predict and measure thanks to the maturity of the adopted LED technology.

Some considerations can arise from the case study and, in general, from the adoption of PF arrangements. First, from the private sector's point of view, the creation of a separate SPV entity that isolates risks allows for enhanced attractiveness of the project investment. Furthermore, the reduced construction risk related to the scalable replacement of the lamps can substantially reduce the concession period, thus enhancing the attractiveness of the project to the private investors. Then, the public authority is often called to participate to the project in term of financial support in order to enhance the profitability and, in turn, make the initiative more attractive. Finally, the attractiveness of the project is also related to the mutual guarantees that are required. In fact, in the proposed case study private investors have asked for forms of insurance on both the insolvency risk and timely payments from the public authority. These arrangements are crucial because the private partners could accept a lower IRRE in return for guarantees that are able to make the project more feasible and less risky. Future research is directed towards extending the present study to other cases and comparing the PF model with other alternative PPP financing mechanisms in order to formulate a framework to suggest the case-specific conditions and requirements that would make the PF model the most recommendable PPP form of financing among others.

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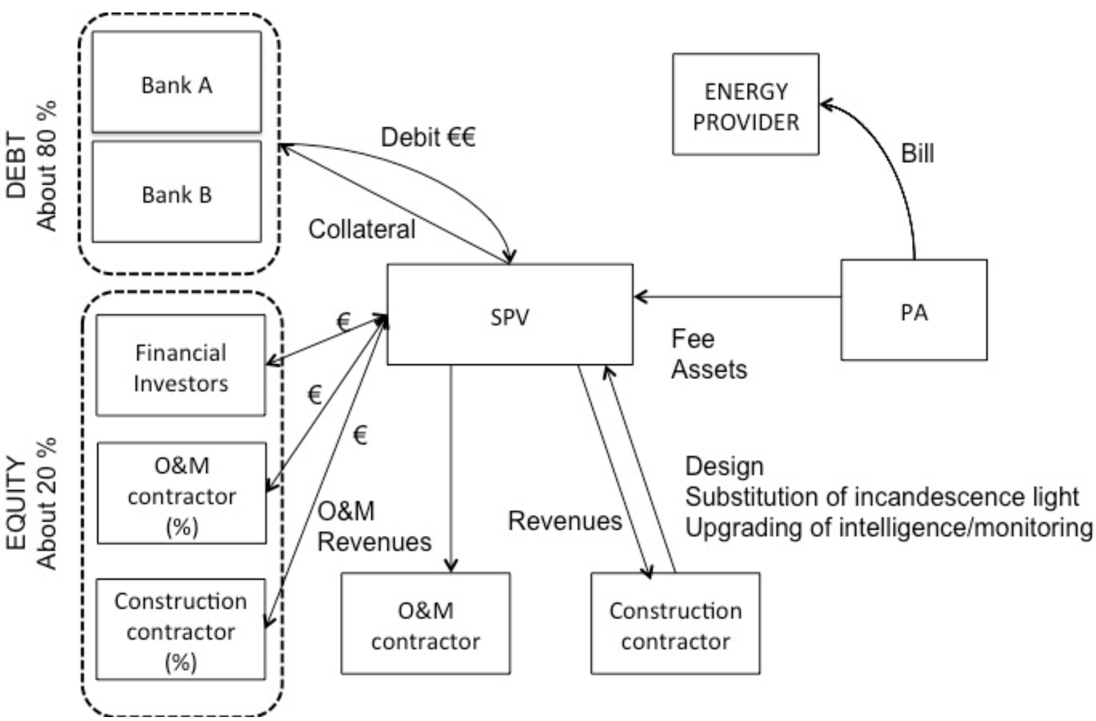

Figure 1: Governance structure of the pilot project

Table I. Schedule of project meetings

Date	Type of meeting	Participants	Scope of work
May, 2013	Collegial project meeting	All the actors involved in the project	Mechanism of engagement between actors
June, 2013	Individual project meeting	Swarco Mizar SpA and Politecnico di Torino	Data of input for the economic financial plan (costs, savings, number of lamps, revenues, fees, etc.)
June, 2013	Individual project meeting	Swarco Mizar SpA, Iride Servizi SpA and Politecnico di Torino	Data for the economic financial plan (costs, savings, number of lamps, revenues, fees, etc.)
July, 2013	Collegial project meeting	All the actors involved in the project	Economic and financial plan, risks and guarantees

Table II. Expected capital expenditure (€)

Expected capital xpenditure	Expenditure
Supply and installation of new LED lanterns	5,200,000
Supply and installation of control system	2,500,000
Design and consulting fees	1,100,000
General and administrative expenses	790,000
Asset acquisition	31,000
Total investment	9,621,000

Table III. Select assumptions

Selected assumptions	(%)
VAT rate	21
Annual inflation rate	2
Cost of equity	10
Cost of debt	8
Weighted average cost of capital	8.48
Tax on income rate	31.7

Table IV. Estimated energy efficiency savings

Estimated energy efficiency savings	Traditional (€)	LED (€)	Savings (€)	Savings (%)
Annual maintenance cost per lamp	17.62	11.15	6.47	37
Total annual maintenance cost	248,000	157,000	91,000	37
Annual utility cost per lamp	115.76	13.93	101.80	88
Total annual utility cost	1,600,000	196,000	1,404,000	88
Annual total cost per lamp	133.00	25.00	108.00	81
Total annual cost	1,848,000	353,000	1,495,000	81

Table V. IRRE index according to public funding and time horizon

Public funding (€)	10%	9%	8%	7%	6%
0	*12.60*	9.70	5.34	−0.65	−11.59
350,000	–	*12.13*	8.52	3.86	−3.36
900,000	–	15.54	*12.74*	9.29	4.48
1,300,000	–	17.81	15.41	*12.53*	8.64
1,700,000	–	19.95	17.87	15.40	*12.13*