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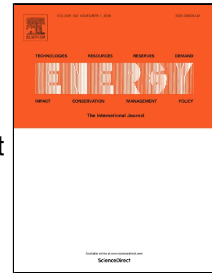
On the impact of safety requirements, energy prices and investment costs in street lighting refurbishment design

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## ON THE IMPACT OF SAFETY REQUIREMENTS, ENERGY PRICES AND INVESTMENT COSTS IN STREET LIGHTING REFURBISHMENT DESIGN

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### ABSTRACT

Street lighting is an indispensable feature for the night landscape of cities. It is important for road safety, users visual comfort, crime prevention and to augment the perceived personal safety. Realize and maintain an adequate street lighting service is very expensive for municipalities with significant impact on their budgets. For this reason, special attention should be paid to the design of new street lighting systems and to the refurbishment of existing ones, since many of them are inadequate. In light of this it is very important to implement street lighting designs that fulfil lighting requirements avoiding energy waste and light pollution and, at the same time, result economically sustainable for municipalities. In this paper, an original step by step methodology for the lighting, energy and economic analysis of street lighting refurbishment designs has been introduced and explained in detail. The methodology is suitable for use in cities of different sizes. As an applicative example, the methodology has been tested in the town of Pontedera (Italy) and the results are discussed, also providing a sensitivity analysis of the economic feasibility with respect to the variations of electricity prices and investment costs.

**KEYWORDS:** Street Lighting; Lighting refurbishment design; Energy efficiency; Lighting design economic feasibility; CO<sub>2</sub> emission reduction; Lighting simulation.

### 1. INTRODUCTION

Street lighting is very important for the urban night-time panorama because has the potential for improving the appearance of an urban environment and it helps in increasing the attractiveness of a city [1]. A well designed lighting system can guarantee an adequate comfort level and facilitate the use of the city, improving the quality of life for the citizens and avoiding over-illumination and light pollution [2]. It is important for crime prevention, for property and goods safety, for night-time orientation and obstacle avoidance [3]. Lighting is also important because reduce the fear of crime and darkness with an augmentation of the perceived personal safety [3, 4]. It is also proven that adequate lighting can reduce road accidents, allowing vehicles to proceed safely and providing visibility at a greater distance so that evasive action can be taken in good time without the risk of abrupt manoeuvres [5]. Light with a high Colour Rendering Index (CRI) and an appropriate colour temperature can enable a better vision, improving people visual comfort [6, 7]. Public lighting service has relevant costs: electricity consumption for urban lighting is often a very important share of the economic budget of municipalities, apart for environmental impacts of electricity uses and the possible contribution to light pollution [8–11]. In order to quantify the problem, it should be noted that public lighting (predominantly street lighting) contributes for 3% to the worldwide electricity consumption [12]. In 2005, in Europe, road lighting consumed approximately 35 TWh and the costs are generally charged

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