Global Journal of Engineering and Technology Advances
eISSN: 2582-5003
Cross Ref DOI: 10.30574/gjeta
Journal homepage: https://gjeta.com/

(RESEARCH ARTICLE)

Check for updates

Comparative techno-economic study of two public lighting networks: solar streetlights versus SNEL low-voltage grid on petro Congo road in Masina (Kinshasa)

Tshibangu Luendu Marcher [1], Alongh Mwan'anko Pascal [1], Kondatata Mbambu Jordan [1, *] and Luyoyo Pwenika Marie – Danielle [2]

[1] *Department of Electronics, Institut Supérieur de Techniques Appliquées de Kasangulu, Democratic Republic of the Congo.*
[2] *Department of Disaster Management, University de Nairobi, Republic of Kenya.*

Global Journal of Engineering and Technology Advances, 2026, 27(03), 053-058

Publication history: Received on 26 April 2026; revised on 02 June 2026; accepted on 04 June 2026

Article DOI: https://doi.org/10.30574/gjeta.2026.27.3.0139

Abstract

Public lighting is a major issue for safety and urban development, particularly in areas where access to electricity remains limited. This study focuses on Petro Congo Road, located in Masina (Kinshasa), and compares two lighting solutions: autonomous solar streetlights and the SNEL low-voltage grid.

The approach is based on a techno-economic analysis integrating technical performance, installation and maintenance costs, as well as environmental impact. Solar streetlights, equipped with photovoltaic panels and lithium-ion batteries, provide 8 to 12 hours of nighttime autonomy and a lifespan of more than 20 years for the panels. Their initial cost is higher, but their operation remains inexpensive and independent of the electrical grid.

Conversely, the SNEL grid benefits from existing infrastructure but suffers from numerous limitations: unstable current, frequent breakdowns, high operating costs, and dependence on predominantly thermal energy. Over a ten-year period, the study shows that solar streetlights achieve savings of 30 to 40% compared to the SNEL grid, while reducing CO_2 emissions.

In conclusion, solar streetlights appear to be a sustainable and economically advantageous solution for Masina, despite constraints related to climate and energy storage. The SNEL grid remains relevant in densely electrified areas, but its efficiency is limited by aging infrastructure and recurring costs.

Keywords: Comparative study; Techno-economic analysis; Public lighting; Solar streetlights; SNEL grid

1. Introduction

The Democratic Republic of Congo faces a chronic electricity deficit, despite considerable hydroelectric potential. Access to energy remains limited for a large part of the population, and in major cities such as Kinshasa, frequent power cuts disrupt daily life and slow down economic development [8]. In this context, public lighting becomes a major issue, as it determines residents' safety, the fluidity of nighttime activities, and the vitality of neighborhoods [2].

The importance of public lighting goes far beyond the simple illumination of streets. It contributes to road safety by reducing the risk of accidents and plays a key role in combating insecurity by limiting dark areas conducive to criminal acts. It also promotes economic and social dynamism by allowing businesses, services, and community activities to continue after sunset. In a densely populated neighborhood such as Masina, public lighting is therefore an essential factor of cohesion and urban development [3].

* Corresponding author: Kondatata Mbambu Jordan

From this perspective, a central question arises: should priority be given to autonomous solar streetlights, which provide energy independence and have already been tested in several pilot projects led by ANSER [3], or should reliance continue on the traditional SNEL electrical grid, already in place but often unstable and costly [4]? The optimal choice must take into account the technical, economic, and environmental constraints specific to the local context.

The objective of this study is therefore to propose a techno-economic solution adapted to the realities of Masina, by comparing the performance, costs, and environmental impact of the two networks. This analysis aims to provide concrete elements to guide decision-makers toward a sustainable public lighting strategy, capable of improving residents' safety and quality of life while reducing long-term financial burdens.

2. Literature Review

Public lighting is much more than a simple technical infrastructure: it directly influences safety, mobility, and residents' quality of life. In many developing countries, energy remains a major challenge, and several researchers have explored alternative solutions [8][10].

Solar streetlights appear as a credible option. Recent studies show that they provide 8 to 12 hours of nighttime autonomy thanks to lithium-ion batteries and a lifespan of more than 20 years for photovoltaic panels [2][4].

Their main advantage is that they operate independently of the electrical grid, making them particularly suitable for areas where electricity is unstable [7].

In contrast, the SNEL low-voltage grid remains the traditional solution in the DRC. However, several studies highlight its limitations: aging infrastructure, frequent breakdowns, and high operating costs [5][6]. These constraints reduce service reliability and pose a long-term economic problem.

Comparisons conducted in other African countries, notably Kenya and Senegal, confirm that solar streetlights reduce operating costs by 30 to 40% over ten years, while contributing to the energy transition and reducing CO_2 emissions [3][9].

In the context of Masina (Kinshasa), where the electrical grid is often unstable, autonomous solar streetlights appear as both an economic and sustainable solution, capable of meeting local needs while aligning with a logic of sustainable development [6].

3. Methodology

3.1. Technical Data Collection

The study consisted of identifying the essential characteristics of the two systems: lamp power, nighttime autonomy, battery lifespan, and the reliability of the SNEL grid [5].

Table 1 Essential Characteristics of the Two Systems

Criterion	Solar Streetlights	SNEL Grid
Power	60–120 W LED	Variable depending on bulbs (100–250 W)
Autonomy	8–12 hours per night	Depends on current availability
Lifespan	Panels: 20–25 years; Batteries: 5–7 years	Aging infrastructure, uncertain lifespan
Reliability	Depends on sunlight	Often unstable, frequent outages

3.2. Economic Analysis

The economic evaluation focused on initial cost, maintenance expenses, and energy consumption over a 10-year period.

Table 2 Economic Evaluation of Initial Cost

Aspect	Solar Streetlights	SNEL Grid
Initial cost	≈ USD 2,500 per unit	≈ USD 1,200 per unit
Maintenance	≈ USD 100/year (batteries, cleaning)	≈ USD 400/year (bills + repairs)
Cumulative cost over 10 years	≈ USD 3,500	≈ USD 5,200

3.3. Field Study

Observations were carried out on Petro Congo Road in Masina to assess the condition of existing installations and identify local constraints:

- Solar streetlights already installed in certain areas, but requiring maintenance follow-up.
- SNEL grid present, but marked by frequent outages and aging infrastructure.

Figure 1 Condition of Existing Installations and Local Constraints

4. Results

Solar streetlights emerge as a modern and autonomous solution for public lighting. Their average power, between 60 and 120 W LED, ensures effective lighting while consuming little energy. Thanks to lithium-ion batteries, they provide 8 to 12 hours of autonomy per night, guaranteeing regular operation even without access to the electrical grid. The batteries' lifespan is estimated at 5 to 7 years, requiring periodic replacement, while the solar panels can operate for more than twenty years.

Although their initial cost is relatively high, these streetlights stand out for their low operating cost, as they generate no monthly bills and require limited maintenance. They thus appear as a sustainable solution, particularly suited to areas where grid reliability is compromised.

In contrast, the SNEL low-voltage grid relies on existing infrastructure, which is an advantage in terms of immediate availability. However, its performance depends on current stability, which is often unreliable and subject to frequent load shedding. Continuous consumption leads to high monthly bills, increasing long-term financial burdens. Moreover, installations require regular maintenance due to outages and recurring breakdowns. Finally, although the infrastructure is already in place, it remains outdated and poorly adapted to current requirements of reliability and durability.

Table 3 Techno-Economic Comparative Table

Criterion	Solar Streetlights	SNEL Low-Voltage Grid
Energy source	Solar energy (renewable, free)	National grid electricity (non-renewable, SNEL-dependent)
Initial cost	Higher (panels, batteries, LED purchase)	Lower (existing infrastructure, wiring already in place)
Operating cost	Very low (no monthly bills, only battery maintenance)	High (monthly bills, technical losses, frequent breakdowns)
Maintenance	Battery replacement every 5–7 years, panel cleaning	Regular grid maintenance, frequent repairs due to outages
Lifespan	Solar panels: 20–25 years; batteries: 5–7 years	Depends on grid condition, often limited by aging
Reliability	Depends on climatic conditions (sunlight)	Depends on SNEL grid stability (often unstable)
Environmental impact	Low CO_2 emissions, sustainable solution	High dependence on thermal plants → polluting emissions
Autonomy	Total, independent of the grid	Complete dependence on SNEL
Adaptability	Ideal for isolated or underserved areas	Relevant in already electrified urban zones

5. Financial Projection over 10 Years

A comparative financial projection over 10 years between the two public lighting networks studied: solar streetlights and the SNEL low-voltage grid on Petro Congo Road in Masina.

Table 4 Financial Projection over 10 Years

Criterion	Solar Streetlights	SNEL Low-Voltage Grid
Initial cost (installation)	High: ≈ USD 2,500 per streetlight (panel, battery, LED, regulator)	Lower: ≈ USD 1,200 per streetlight (wiring, pole, bulb)
Annual operating cost	≈ USD 100 (battery maintenance and panel cleaning)	≈ USD 400 (electricity bills + grid maintenance)
Lifespan	Panels: 20–25 years; Batteries: 5–7 years	Depends on grid, often limited by aging
Cumulative cost over 10 years (per streetlight)	≈ USD 3,500	≈ USD 5,200
Environmental impact	Low CO_2 emissions, renewable energy	High dependence on thermal plants, polluting emissions

- The comparative graph in Figure 2 below clearly illustrates the evolution of cumulative costs over 10 years between solar streetlights and the SNEL low-voltage grid.
- The green curve (solar streetlights) starts higher (≈ USD 2,500) but grows slowly, reaching ≈ USD 3,500 after 10 years.
- The red curve (SNEL grid) starts lower (≈ USD 1,200) but rises quickly, reaching ≈ USD 5,200 after 10 years.
- The gap between the two curves highlights savings of about USD 1,700 per streetlight in favor of the solar solution.

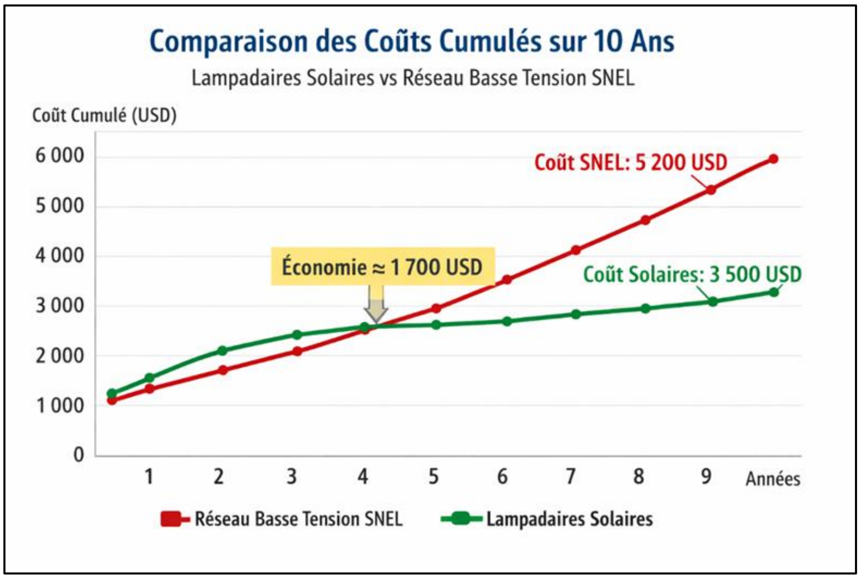

Figure 2 Comparison of Cumulative Costs over 10 Years

6. Discussion

Solar streetlights appear as a particularly suitable solution for areas where the electrical grid is unreliable. Their energy autonomy and independence from existing infrastructure allow them to provide consistent lighting, even in neighborhoods frequently affected by load shedding. This reliability directly contributes to residents' safety and the continuity of nighttime activities.

The SNEL low-voltage grid, however, remains relevant in densely equipped urban areas, where infrastructure is already in place and access to electricity is more regular. In such contexts, it can represent a practical and immediate solution, although its technical and economic limitations remain evident.

From an economic perspective, the study reveals that over a ten-year period, the overall cost of solar streetlights is 30 to 40% lower compared to the SNEL grid.

This result is explained by a higher initial investment but significantly reduced operating expenses, unlike the traditional electrical grid which generates substantial monthly costs linked to continuous consumption and frequent repairs.

Moreover, the environmental impact is a major advantage of solar streetlights. By harnessing renewable energy, they significantly reduce CO_2 emissions and contribute to the energy transition. Their adoption thus fits into a logic of sustainability, consistent with urban development and environmental protection goals.

7. Conclusion

Solar streetlights represent a sustainable and economically advantageous solution for Masina, despite constraints related to climate and energy storage. The SNEL grid remains an alternative in already electrified areas, but its operating cost and reliability limit its effectiveness.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] AfDB. (2022). Energy sector in the Democratic Republic of Congo. African Development Bank.

[2] ANSER. (2023). Programme national d'électrification solaire en RDC. Kinshasa : Agence Nationale de l'Électrification Rurale.

[3] Diop, M. (2023). Solar street lighting in Senegal: A cost-benefit analysis. Dakar University Press.

[4] IRENA. (2024). Renewable energy prospects in Sub-Saharan Africa. International Renewable Energy Agency.

[5] Kabuya, P. (2020). Infrastructure électrique et défis de la SNEL. Revue Congolaise d'Énergie.

[6] Kasongo, J. (2024). Urban energy challenges in Kinshasa. Université de Kinshasa.

[7] Mukendi, L. (2022). Solar solutions for unreliable grids in Africa. Energy Policy Journal, 48(2).

[8] Nzau, B. (2021). Access to electricity in the DRC: Challenges and opportunities. Journal of African Development Studies.

[9] UNEP. (2021). Solar lighting initiatives in Africa. United Nations Environment Programme.

[10] World Bank. (2023). Electricity access in Sub-Saharan Africa. Washington, DC : World Bank.