Sustainable and Cost-Effective Configuration of Street Lighting System

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Abstract

Public street lighting (PSL) with its multiple roles, is nowadays a central concern in smart and sustainable cities, urban and rural area, and street planning. However, PSL consumes a considerable amount of energy. Energy efficiency and conservation (EE) as a component of demand side management (DSM) concept have emerged for electrical energy consumption management. This paper focuses in this context, addresses and discusses the DSM activities in the street lighting sector (SLS). Firstly, three scenarios of street lighting systems are simulated with the already used conventional lamp, i.e. High Pressure Sodium (HPS), namely solar islanded street lighting, solar/grid connected, and solar/storage/grid connected street lighting system. Secondly, the three scenarios are simulated using Light Emitting Diodes LED technology, which is used as a means of load management and energy efficiency measures. To determine the optimal configuration in each scenario and to find the best between these three scenarios, the technical-economic feasibility analysis based on the net present value (NPV) and cost of energy (CoE) is carried out by using HOMER software. Based on the results obtained, the public street lighting system that uses LED lamp in all scenarios has the lowest CoE, NPV, and consequently electricity bill cost, and their use reduces the energy consumption by 30%. The second scenario is the most economical one with NPV($), CoE($/kWh), RF(%) and annual electricity bill cost ($) of (2033-1053), (0.091-0.19), (129,948-82,46) and (78.3-47.6), when using HPS and LED technologies.

Keywords: Energy efficiency, Street lighting, DSM activities, Sustainability, Solar-LED, NPV-CoE cost

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1. Introduction

The economic activity and world population growth is leading to an increase in energy demand, which is a very important factor for socio-economic, sustainable development and quality of human life improvement[1].

However, about 77.2% of the total world energy comes from fossil fuels, and their use causing many problems such as global warming and environmental degradation due to the CO_2 emissions [2, 3].

Noting that the progressive depletion of these fossil fuels has given place to other energy sources for clean and sustainable energy generation from renewable energy sources (RES) and have increased worldwide and received considerable attention in recent years [4-6].

Among these sources, and around the world, solar energy has attracted a lot of interest, which have two types of conversion: into electricity by photovoltaic (PV) solar systems, and by solar thermal systems [7].

As we all know, Algeria has enormous potential in the field of renewable energies (RE), in particular solar PV energy, the creation of new energy policies to diversify the national economy based on renewable energies is becoming a necessity and has already been launched in 2011 in response to the steady and rapid growth in the electrical energy consumption of the country [8-10]. Electrical energy is consumed in several sectors such as buildings, industry, lighting and transport and other applications.

In urban and rural areas, street lighting is an important and necessary element for the safety of people on the streets, is one of the sectors that consumes a significant amount of energy.

In global, lighting load in residential, commercial and industrial, i.e. street lighting accounts for about 10-38% of the total energy consumption in large cities and covers about 23%-40% of the total world energy consumption [11, 12].

However, mainly the majority of public lighting systems in Algeria are composed of inefficient lighting fixtures, supplied by the electricity grid and/or diesel generators, and this requires looking for ways to reduce energy consumption in this and other sectors.

For example, in Algeria country, 80% of the total energy consumption of each municipality is devoted to public lighting, which makes it necessary to promote "cheaper lighting", as the director of Energy and Mines of the province of Algiers said:

Street lighting consumes a large part of each municipality's budget, hence the need to rationalize energy consumption by replacing conventional light bulbs with LED or sodium bulbs, thus considerably reducing the electricity consumption in this sector.[13].

2. Demand Side Management DSM in Street Lighting

Load management activities (LMA) or demand side management (DSM) which are given for this objective, used in order to reduce electrical energy consumption and consequently electricity bill cost.

DSM concept is defined as demand-side measures and activities aimed at influencing the behaviour of electricity consumption in order to modify the load curve profile in terms of timing and/or the level of consumed energy. DSM is ensured by the development of energy-efficient appliances and equipment and by the promotion of energy-saving measures, etc., in buildings, industries, lighting, etc [14].

Several demand side management strategies are available in literatures including peak clipping, valley filling, load shifting, strategic conservation, strategic load growth and flexible load shape [14, 15].

According to [16], the concept of DSM is divided into two basic categories which are demand response (DR) and energy efficiency and conservation (EEC).

The author in paper ref [18], energy efficiency is defined as a form of demand side management because it reduces energy consumption, thus leading to the optimization and saving of available energy resources, increasing the penetration of renewable energies.

As all countries of the world, Algeria has also adopted energy policies to promote energy efficiency measures and renewable energies technologies use.

The Commissioner for Renewable Energy and Energy Efficiency CEREFE (Commissariat aux Énergies Renouvelables et à l'Efficacité Énergétique) as its name indicates is created recently for this purpose in 20 October 2019.

The CEREFE agency is an instrument to support the implementation, monitoring and evaluation of national policy in the field of renewable energy (RE) and energy efficiency (EE) [19].

In terms of demand-side management activities in SLS, her is some of the energy efficiency measures can be used in the street lighting sector on the supply and demand side are as follows:

- Lighting control to ensure that lighting is provided only when needed.
- Replace traditional inefficient lamps with energy-efficient technologies.
- Using efficient lighting such as LED technology, which has a longer lifetime than traditional bulbs.
- The use of the most available and economical power supply system.
- The promotion of low-emission energy systems.

On the power supply side, LED technologies are coupled with the use of photovoltaic power generation that reduces consumption, the cost of electricity grid construction, CO_2 emissions, electricity bill cost and operating costs can be reduced by up to 60% according to [11].

With regard to the power supply of street lighting systems SLS, there are several studies in the literature about the integration of solar energy into public SLS as an alternative to conventional systems and have proven their technical and economic feasibility [20-26].

Depending on the study area and the local solar radiation at the site, the energy consumption of the solar street lighting system is significantly reduced with different amounts depending on the region.

Simulation and optimization of energy generation from renewable and conventional sources requires the development of simulation tools for the technical, economic and environmental assessment of different configurations.

HOMER (Hybrid Optimization Model for Electric Renewable) software, which is developed by the National Renewable Energy Laboratory (NREL), is one of the most widely used tools for the study and simulation of renewable energy systems [27-29].

According to the literature, particularly in Algeria, there is no paper dealing with the subject of street lighting system SLS in terms of simulation, feasibility assessment, demand side management activities in this sector and comparison between configurations of SLS.

However, this research paper outlines and discusses the technical and economic feasibility of using photovoltaic energy to power energy-efficient street lighting system through simple economic measures and demand side management activities.

Three configurations are simulated using Light-Emitting Diode (LED) and High Pressure Sodium (HPS) lamps which are: isolated street lighting system, grid-connected street lighting system with storage and grid-connected street lighting without storage.

A weather conditions of a small village in M'sila, Algeria is chosen as a case study in this paper.

The comparative analysis of technical and economic feasibility between different simulated configurations is based on several factors, including the total net present value (NPV), the cost of energy (CoE) and the cost of the electricity bill.

3. Case Study and Research Methodology

The study and simulation of several configurations of public street lighting systems under the weather conditions of M'sila in Algeria are carried out in this paper.

The study is performed by the HOMER software after obtaining the necessary elements such as site selection, power demand, metrological data, technical and economic details, system components modelling and the constraints.

The methodology adopted in this paper with simulation and optimization steps are shown Figure 1.

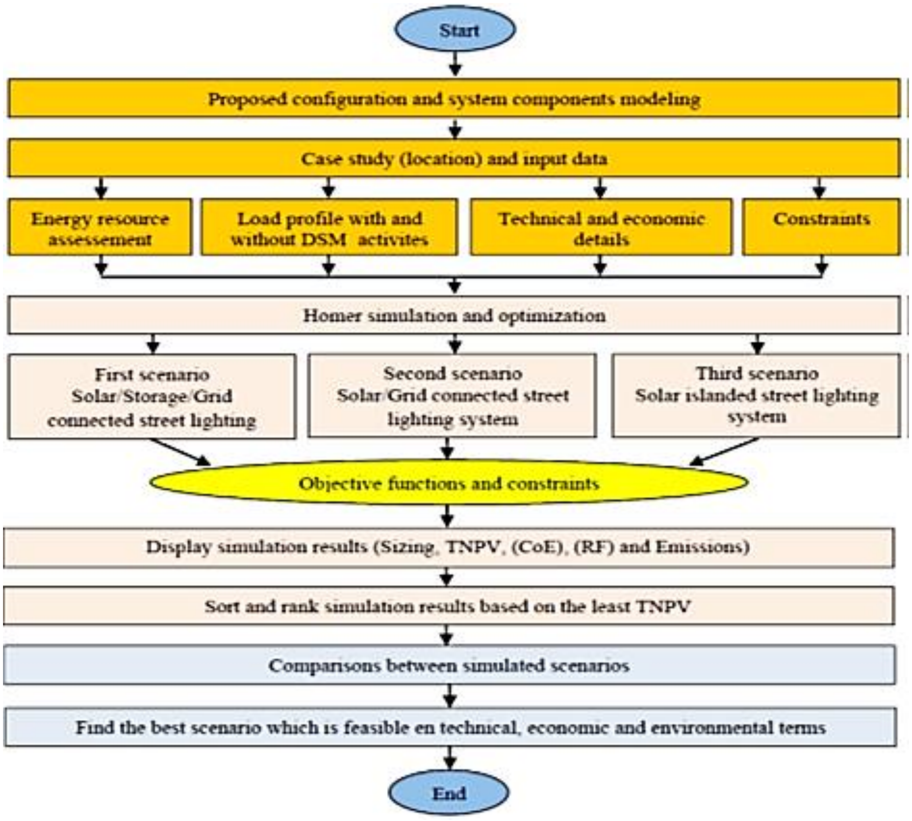

Figure 1. Flowchart of research methodology adopted in this study

3.1. Site location and solar resources assessment

The site selected for the study in this paper is located in the central of Algeria country, have the geographical details of (latitude 35.67°N and longitude 4.87°E), and has a high potential of solar energy.

It is clear that the choice of the system to be used for electricity generation, i.e. solar generator in this case is depends on the resource available on site, and the energy yield of the PV system depends on the amount of solar irradiation and ambient temperature.

The study and evaluation of solar resources is therefore an important step in the design and simulation of renewable energy systems. The monthly solar irradiation data and the clearness index of the investigated site are obtained from the national aeronautics and space administration database (NASA) via the internet by using geographic coordinates of the site (Latitude and longitude) [30].

The solar irradiation data are shown in Figure 2.

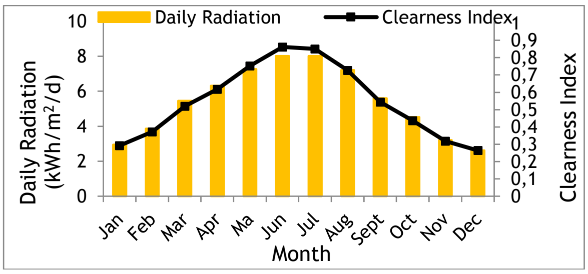

Figure 2. Monthly variation of solar irradiation and clearness index

As shown in Figure 2, the solar data including the solar radiation and clearness index ranges from 2.620 kW/m^2/day to 8.020 kW/m^2/day and from 0.264 to 0.862, respectively. The highest value of solar radiation with 8.020 kW/m^2/day is given for the month June and July, however, the month of December have the lowest solar radiation.

The same, maximum and minimum of clearness index is observed to be in the months of June and December month, and the annual values are 5.43kW/m^2/day and 0.542, respectively.

3.2. Electric load profile

The electricity consumption profile development is necessary for the simulation of electrical energy systems. In this paper, the system is simulated under two different lamps, which are the conventional high-pressure sodium HPS lamp and the lighting-emitting diodes LED technology.The traditional HPS lamps already used are replaced by an LED lamp that is more efficient than the old one but has the same equivalent luminance. The rated power (W), daily consumption (kWh/day) and peak load (kW) are (400-100), (4.77-1.19) and (0.771-0.193) for conventional HPS and LED technologies, respectively as shown in Figure 3.

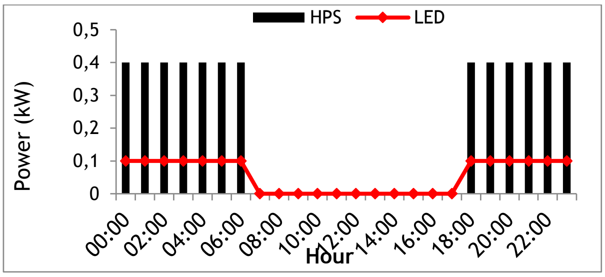

Figure 3. Daily load profiles for LED and HPS lamps

4. Studied Configurations of Street Lighting System

The different simulated configurations are discussed in this section, as shown in the Figure 4, the system generally includes: photovoltaic panel, a battery as an electricity storage system, power grid, the inverter that converts direct current electricity into alternating current (AC) and AC bus, and the load.

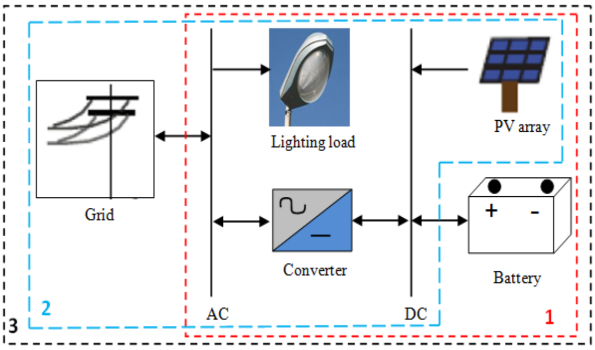

Figure 4. Street lighting system configurations, solar islanded system (1), solar/grid connected (2), and solar/storage/grid connected system (3)

The simulation was conducted for the three following scenarios of public street lighting system that are:

- *First scenario*: Solar islanded street lighting system
- *Second scenario*: Solar/Grid connected street lighting system
- *Third scenario*: Solar/Storage/Grid connected street lighting system

The technical, economic viability and comparison between different configurations is carried out by the HOMER software based on the following criteria of total net present value (NPV), energy cost (CoE), renewable fraction (RF) and electricity bill cost.

4.1. System components modelling

The modelling of system components is given in this section, including solar PV generator, storage battery and inverter.

4.1.1. PV array

The photovoltaic system is used as the primary source of energy generation in the first scenario, the output power of the PV generator depends on the solar radiation profile and the ambient temperature at the installation site.

The output power is calculated using Eq. (1) [31].

$$P_{PV} = P_{PV} f_{PV} \left(\frac{G_T}{G_{T,STC}}\right)\left[1+\alpha_p\left(T_c - T_{c,STC}\right)\right] \quad (1)$$

where:

Y_{PV} in (kW) is the rated capacity of PV panel,
f_{PV} in (%) is the de-rating factor,
G_T in (kW/m^2) is the solar radiation on the PV panel,
$G_{T,STC}$ in (kW/m^2) is solar radiation on the PV panel at the standard test condition,
a_p is the temperature coefficient (%/°C)
$T_{c,STC}$ is the temperature under the standard test condition (25 °C).
T_c in (°C) is temperature on the module cell given by Eq. (2) [32].

$$T_C = T_a + \left(\frac{NOCT-20°C}{G_r}\right) * \overline{G_T} \quad (2)$$

where:

T_a in (°C) is the ambient temperature,
NOCT in (°C) is the normal cell temperature
G_r is the reference irradiance.

4.1.2. Battery bank storage

Due to the intermittent nature of renewable energy, the battery bank is used for energy storage in order to use it in case of insufficient and/or there is no energy from PV power system.

The storage capacity of the system (B_{SC}) is calculated by using Eq. (3)[33].

$$B_{SC} = \frac{DL * BA_d}{\eta_{Ba} * DoBD * V_{sn}} \quad (3)$$

where:

DL is the load demand,
BA_d is days of battery autonomy,
η_{Ba} is the round-trip efficiency of the battery,
DoBD is the depth of battery discharge,
V_{sn} is the nominal voltage of the system.

The problem of over charge and discharge of battery storage system is expressed by Eq. (4) and (5).

$$B_{s.min} < B_s < B_{s.max} \quad (4)$$

$$B_{s.min} = (1 - DoD_{max}) * B_s = (SoC_{min}) * B_s \quad (5)$$

where:

$B_{s.min}$ is the minimum battery size,
B_s is the size of battery,
$B_{s.max}$ is the maximum battery size,
DoD_{max} is the maximum depth of discharge
SoCmin is the minimum state of charge.

The constraint of the battery state of charge is given by Eq. (6).

$$SoC_{min} < SoC(i) < SoC_{max} \quad (6)$$

4.1.3. Converter/inverter

The role of Converter in this system is to transform the direct current at the DC bus into alternating current in the AC bus.

The inverter efficiency is defined as the ratio of the power on the load side (kW) and the power at the inverter input, as given in Eq. (7) [34].

$$P_{in} = \frac{P_{out}}{\eta_{inv}} \quad (7)$$

where:

P_{in} (kW) is the DC power at the inverter input,

P_{out} (kW) is the alternating output power

η_{inv} (%) is the inverter efficiency.

4.2. Simulation and input data

The technical and economic inputs of the system components are also required for system simulation and optimization.

All this information, including technical specifications, capital cost ($), replacement cost ($), and O&M (operating and maintenance) cost ($/yr) of PV array, battery and converter, are summarized in Table 1.

Table 1. Street lighting system components prices inputs [35]

Photovoltaic panel	
Nominal PV power (P_{PV})	1 kW
PV panel cost (C_{PV})	1176 $
Replacement PV panel cost	1176 $
Annual maintenance cost of PV	0 $/year
PV efficiency (η_{PV})	20%
PV lifetime	20 years
Tracking system	No
Battery (Hoppecke 16 OPzS 2000)	
Battery cost (C_{Ba})	276 $
Replacement cost of Battery	276 $
Nominal capacity of Battery	2000 Ah
Battery lifetime	10 years
Operation and maintenance cost ($C_{O\&M}$)	20 $/year
Converter	
Nominal converter power (P_{Conv})	1 kW
Converter cost (C_{Conv})	341 $
Replacement cost of converter	341 $
Operation and maintenance cost ($C_{O\&M}$)	3 $/year
Converter lifetime	15 years
Converter efficiency (η_{Conv})	90%

4.3. Techno-economic performance analysis

The feasibility analysis and comparison between the different simulated scenario are based on economic results over their lifetime, i.e. 20 years, which is based on several criteria givens as fellow.

4.3.1. Net present value (NPV)

The first parameter used is the net present value (NPV), which is also called the life cycle cost of the system.

The NPV represents all costs over the lifetime of the project, including initial investment cost in the system, replacement cost, maintenance and fuel cost, and can be calculated using Eq. (8) [36].

$$C_{NPV} = \frac{C_{ann,tot}}{CRF(i, Y_{proj})} \quad (8)$$

$$CRF(i, Y) = \frac{i(1+i)^{Y_{proj}}}{(1+i)^{Y_{proj}}-1} \quad (9)$$

where:

$C_{ann,tot}$ in ($/year) is the system annual total cost,

i in (%) is the real interest rate,

Y_{proj} in (years) is the system lifetime.

CRF(i, Y) is the capital recovery factor which is a ratio used to calculate the present value of an annuity, expressed as in Eq. (9).

4.3.2. Cost of energy (CoE)

The cost of energy (CoE) is the second parameter used in this paper or also called the Levelized Cost of Energy (LCOE), defined as the unit cost of one kilowatt-hour produced by the simulated system, which is the ratio between the total annual cost and the total energy produced.

The CoE is calculated by HOMER tool using Eq. (10) [37].

$$CoE = LCOE = \frac{C_{ann,tot}}{E_{AC}+E_{DC}+E_{grid,sale}} \quad (10)$$

where: $C_{ann,tot}$ is the total annualized cost ($/year), E_{AC}, E_{DC} and $E_{grid,\ sale}$ in (kWh) are the total AC load, the DC load and the amount of electricity sold by the system to the grid, respectively.

4.3.3. Electricity bill cost

The annual electricity bill cost (EBC) of consumed energy by each type of lamps is calculated using Eq. (11) and Eq. (12).

$$EBC_{HPS}(\$) = EC_{HPS} * CoE_{HPS} \quad (11)$$

$$EBC_{LED}(\$) = EC_{LED} * CoE_{LED} \quad (12)$$

where: EBC_{HPS} and EBC_{LED} in ($) are the cost of electricity bill for HPS and LED lamps, respectively. EC_{HPS} and EC_{LED} are the electricity consumption when using HPS and LED lamps, and CoE_{HPS} and CoE_{LED} are the cost of one kilowatt-hour obtained in HPS and LED street lighting system, respectively.

5. Results and Discussion

The results of sizing, simulation and optimization are presented and discussed in detail in this section. Various indicators are used when analysing and comparing different configurations such as: net present value NPV ($), cost of energy CoE ($/kWh), electricity generation, purchased and energy sold, and annual electricity bill cost ($).

Each scenario is analysed for both types of load, i.e. without (HPS lamp) and with load management activities and energy efficiency measures promoted by the use of LED technology.

Finally, a general comparison between three simulated scenarios is also conducted.

5.1. First scenario: Islanded solar street lighting system

The technical and economical results of the optimal configuration for the first scenario, i.e. the islanded solar street lighting system are summarized in Table 2.

Table 2. Technical and economic results for first scenario

Technical results		
Type	LED 100 W	HPS 400 W
PV array (kW)	0.8	1.5
Number of batteries	2	2
Converter size (kW)	0.5	1
Economic results		
Operating cost ($/yr)	62	117
Net present value ($)	2,456	4,158
Annualized cost ($/yr)	192	325
Cost of energy ($/kWh)	0.442	0.228
System operation		
PV array production (kWh/year)	1,268	2,378
Excess electricity (kWh/year)/(%)	710/56	540/22.7

For street lighting that uses HPS 400 W, 1.5 kW PV and, 2 batteries with a nominal inverter power of 1 kW is the optimal configuration of the first scenario. However, each complete street lighting unit for 100 W LED technology is consists of a PV module 0.8 kW, 2 batteries of 2000Ah-2V and a 0.5 kW as a nominal power of inverter.

From an economic point of view, the optimal configuration has the energy cost and NPV of (0.228-0.442) and (4158-2456) when using HPS lamp and LED technology, respectively.

The monthly electricity production of solar system in the optimal configuration is shown in Figure 5, which is always higher in the case of the HPS lamp due to the size of the photovoltaic generator, i.e. 2378 kWh/year in comparison with the case of system with LED lamp with 1268 kWh/year.

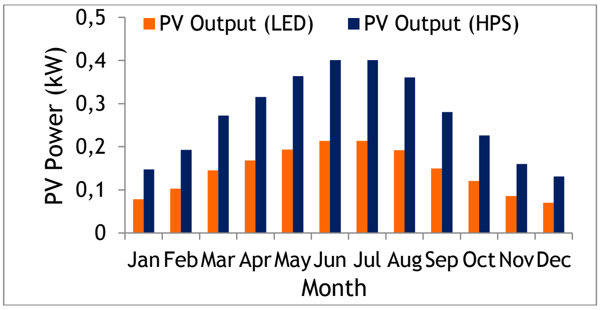

Figure 5. Monthly PV generator output for the first scenario

In this street lighting system with both cases (LED and HPS lamps), electricity production is highest for the months of June and July, and lowest for the months of January and December, due to the low existing solar potential. The excess energy from this configuration is 540 kWh/year and 710 kWh/year, which represents 22.7% and 56% of total energy production respectively when using HPS and LED technologies.

5.2. Second scenario: Solar/grid-connected street lighting system

Similarly, the results of the second scenario in technical and economic terms are given in this section. We note that in this scenario, there are no storage batteries and the electrical power grid is added in the configuration. With regard to the system size in this scenario, it is assumed to be the same as in the first scenario when using LED technology. Economically, the configuration for the HPS lamp gives an NPV of 2033 $ and a CoE of 0.091 $/kWh. However, 1053 $ and 0.190 $/kWh are the NPV and CoE, respectively when using LED technology.

Renewable energy fractions (RF) for this configuration are 0.476% and 0.783% respectively when using HPS and LED technologies.

5.3. Third scenario: Solar/storage/grid connected street lighting system

The proposed system size for this third scenario using HPS and LED technologies is composed of 1 kW of PV panels, 2 batteries type Hoppecke 16 OPzS 2000 and 1 kW nominal power of inverter. Economically, this configuration leads to an NPV of 3,174 $ with a CoE of 0.143 $/kWh for system with HPS lamp, and 2,193 $, 0.395 $/kWh are respectively the NPV and cost of energy when using LED. However, the NPV of system using HPS lamp is 51.79% higher than those of system with LED technology.

In term of system productivity, Figure 6 shows the energy purchased from the power grid and sold to the grid from system for both LED and HPS technologies.

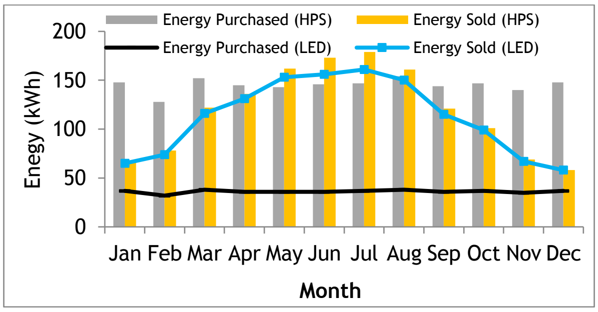

Figure 6. Monthly profile of electricity purchases and sales

The energy sold depends on the energy produced by the solar PV system, which also depends on the solar radiation received on the site. As shown in Figure 6, there is an energy exchange with the electrical grid when using a conventional HPS lamp of 400 W, the annual energy produced is 1427 kWh/year and is then sold to the grid with the monthly profile as shown in the same figure.

The monthly distribution of purchased energy from the power grid, which depends on lamp consumption is approximately constant over the year, i.e. about (1741 kWh/year). The maximum energy sold is observed in July with 179 kWh followed by the month of Jun with 173 kWh, and minimum in December, i.e. 58 kWh. The total net energy purchases are evaluated with 314 kWh.

When using LED technology as a DSM tool, the annual energy sold to the grid varies throughout the year, its maximum is seen in summer, i.e. 161 kWh in July month and the minimum in winter months, i.e. January with 65 kWh. However, a constant amount of purchased energy is observed over the year, i.e. about 37 kWh/month. In this case, total net energy purchases are estimated at -910 kWh, the negative sign (-) means that the sum of energy sold to the grid is greater than the sum of purchased energy.

The power grid contribution and the solar system to the coverage of energy consumption for street lighting system using LED and HPS technologies is also analysed.

For the street lighting system that use HPS lamp, the solar contribution is estimated with a percentage of 48% which represents 1585 kWh, the rest is coming from grid purchases with 1745 kWh at a percentage of 52%, and both contribution represents the total system production, i.e. 3330 kWh.

However, when using LED technology, a significant contribution of the solar PV generator is observed and estimated at 1585 kWh which accounts for 78% of the total energy produced 2025 kWh. Finally, the contribution of energy purchased from the electricity grid is estimated at 440 kWh, i.e. 22% of total electricity generation.

On the consumption side, and in the case of HPS street lighting system, 3169 kWh, 1741 kWh (55%) and 1428 kWh (45%) are the total energy consumed, electric load of HPS lamp and energy sales to the power grid, respectively.

However, in the case of system with LED, the total energy consumption is estimated at 1782 have the load consumption of LED lamp, i.e. 434 kWh (24%) and the remaining sales to the power grid 1782 kWh (76%).

5.4. General comparison

A general comparison between the three simulated street lighting scenarios is made for the two types of LED and HPS lamps, taking into account the net present values, the cost of energy, system renewability and the annual electricity bill cost, as shown in Figures 7 and 8.

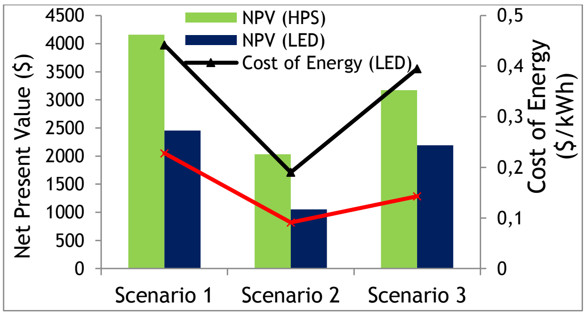

Figure 7. Results of total net present value (NPV) and cost of energy for each simulated scenario

As shown in Figure 7, the first scenario has the highest NPV followed secondly by the third and second scenarios. The values of NPV in ($) for both types of lamps, i.e. LED and HPS are (2456-4158), (1053-2033) and (2193-3174) for the first, second and the third scenario, respectively.

In addition, energy costs in the first scenario are the highest, followed by the third scenario, the second scenario has the lowest values of energy costs for both types of lamps. The energy cost for the optimal system using an LED lamp is 0.442 $/kWh, 0.19 $/kWh and 0.395 $/kWh for the first, second and third scenarios, respectively. However, 0.228 $/kWh, 0.091 $/kWh and 0.143 $/kWh are the energy costs for the first, second and third scenarios when HPS lamps is used.

As a comparison between HPS and LED technologies under the three simulated configurations, the street lighting system with LED has the lowest NPV compared to the system that using HPS lamp, however it has the highest costs of energy (CoE).

The final indicator used for the economic analysis is the electricity bill cost. Finally, the annual electricity bill cost for different simulated scenarios and for both types of lamps which is calculated using Eq. (11) is shown in Figure 8.

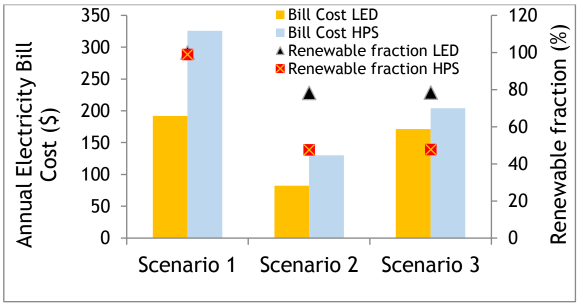

Figure 8. Electricity bill cost for and renewable fraction for each scenario

We can see that, the annual electricity bill cost varies from one scenario to another, with the street lighting system with the HPS lamp having the highest cost for the three simulated scenarios compared to the system that using LED lamp. The costs of electricity bill for LED and HPS lamps are (191.828-325.584), (82.46-129.948) and (171.43-204.204) for the first, second and third scenario, respectively. On this basis, the second scenario is the most economical one, and we can say that the use of LED technology is seen as a demand side management tool in public street lighting as it reduces and saves energy consumption and by about 30%, in addition to the decrease in annual electricity bill cost.

Finally, the renewable fraction index (FR) is used to assess the renewability of the street lighting system, which is equal to 100% in the first scenario as shown in Figure 8, while 78.3% and 47.6% are the RF for the remaining two scenarios respectively when using LED and HPS.

6. Conclusions

The analysis of technical and economic viability of various configurations of public street lighting systems based on simulation by Homer software is performed in this paper, a small village in Brabra, M'sila, Algeria, is selected as a case study. The street lighting system is simulated under the conventional and existing HPS lamp of 400 W, then under LED technology of 100 W which is assumed as a load management activity in the public street lighting sector.

Three scenarios are simulated and compared including the first scenario: Solar islanded street lighting system, second scenario: Solar/Grid connected street lighting system and the third scenario: Solar /Storage /Grid connected street lighting system. The comparative analysis between different scenarios from a technical and economic point of view is based on such indicators as the net present value (NPV), cost of energy (CoE) and also the electricity bill cost. Based on the optimization results obtained, street lighting system using LED technology in the second configuration is found to be the most economical one in comparison to the system that uses the HPS lamp, with a NPV, CoE and electricity bill cost of 1,053 $, 0,190 $/kWh and 82,46 $.

The use of LED technology as a means of energy efficiency and load management activities will reduce energy consumption, NPV and electricity bill cost by 30%, 51% and 63.45%, respectively.

Finally, due the large amount of energy consumed in the public street lighting sector, load management activist integration in street lighting sector, promotion of energy efficiency and the use of LED technology in street lighting system at this location (M'sila) is observed cost-effective, sustainable and environmentally friendly solution.

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