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Evaluation of PV microgeneration sytems and tariffs management on the energy efficiency of service builddings

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Introduction

The buildings' energy consumption increasing requires solutions to improve their energy efficiency, thus reducing the electricity bill's associated costs. The integration of PV systems in service buildings is one way to achieve this goal. This paper aims to study the load profiles of a service building and its optimization to reduce the costs related to electricity consumption.

The analysis of the building's consumption profiles allowed the PV system's dimensioning to eliminate power peaks, enabling a reduction in the contracted power.

Case study

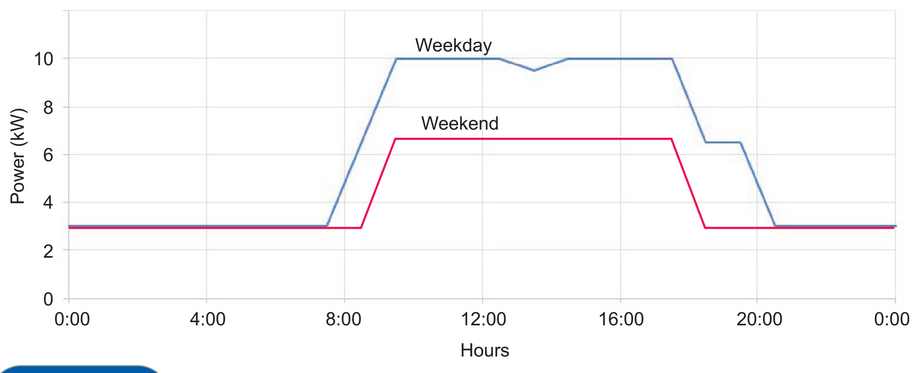

Fig.1 Voltage profile for a weekday and weekend day in a service building.

Methodology

The approach used to optimize building energy efficiency depends on several factors, such as the type of building, the atmospheric conditions, the location, the number of people and their permanence in the place, and the amount of electrical equipment being used.

The integration of renewable energy systems in buildings is an important measure to increase energy efficiency and is increasingly used, with an emphasis on PV systems.

The voltage and current corresponding to the maximum power of a PV panel are obtained by (1) and (2).

$$I_{tmax} = I_{max}(25ºC) \cdot [1 + \alpha(T_c - 25)] \quad (1)$$

$$V_{tmax} = V_{max}(25ºC) + \beta(T_c - 25) \quad (2)$$

Where:

I_{tmax} - Temperature-corrected maximum current (A);

V_{tmax} - Temperature-corrected maximum voltage (V);

α - Temperature-corrected maximum voltage (V);

β - Voltage temperature coefficient, V/ºC.

Therefore, the total energy produced by a PV panel is obtained by (3)

$$E_{daily} = HPD \cdot I_{tmax} \cdot V_{tmax} \cdot \eta \quad (3)$$

Where:

HPD - Number of hours of the day with 1000 W/m2 irradiance;

η - Inverter efficiency.

Scenario 1: All power comes from the power grid

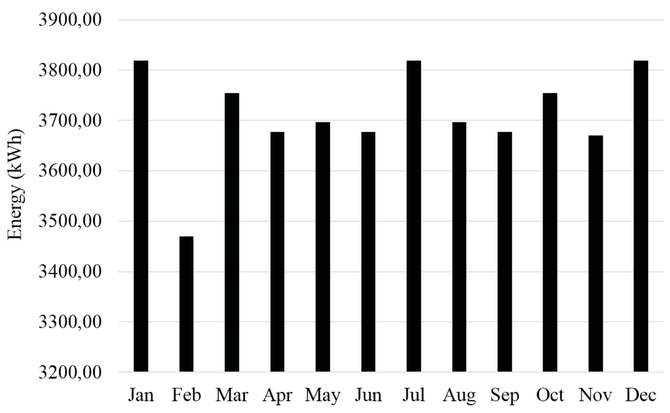

Fig.2 Building monthly electricity consumption.

Scenario 2: Peak shaving with PV system

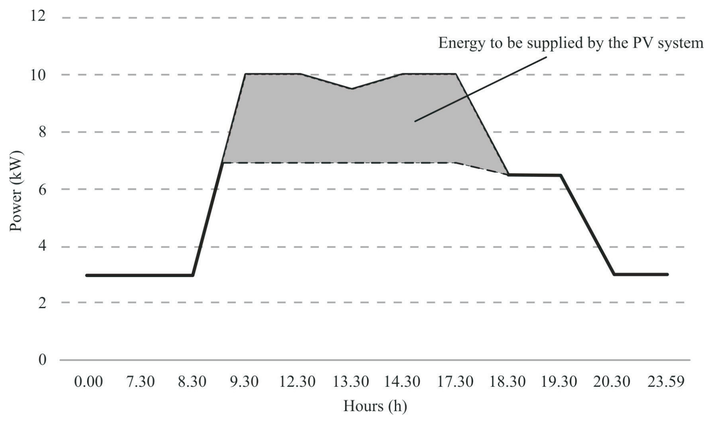

Fig.3 Energy to be supplied by the PV system (peak shaving).

In this paper, a peak shaving approach was used that allows reducing the contracted power. The aim is to reduce the contracted power to 6.9kVA, which will create a cut in the building's load profile for weekdays, as shown in Figure 3.

Results

Table I Energy Costs and savings for scenario 2

Month	Consump. (kWh)	PV Energy prod. (kWh)	Energy from grid (kWh)	Savings (€)
Jan	3819.51	827.63	2991.88	136.75
Fev	3469.54	793.72	2675.82	131.52
Mar	3754.70	1280.07	2474.63	206.56
Apr	3676.93	1314.72	2362.21	211.91
May	3696.37	1374.77	2321.60	221.18
Jun	3676.93	1557.65	2119.28	249.40
Jul	3819.51	1661.94	2157.56	265.49
Aug	3696.37	1538.52	2157.85	246.44
Sep	3676.93	1410.38	2266.55	226.67
Oct	3754.70	1088.63	2666.06	177.03
Nov	3670.45	719.22	2951.22	120.03
Dec	3819.51	625.63	3193.87	105.59
Total	44531.43	14192.89	30338.54	2298.56

The graph of Figure 4 shows the monthly evolution of costs for the two scenarios studied. It also shows the profits/savings obtained, taking into account scenario 2.

As can be seen, the profit increases in the summer months due to the PV system higher energy production, thus increasing the use and sale of energy to the grid.

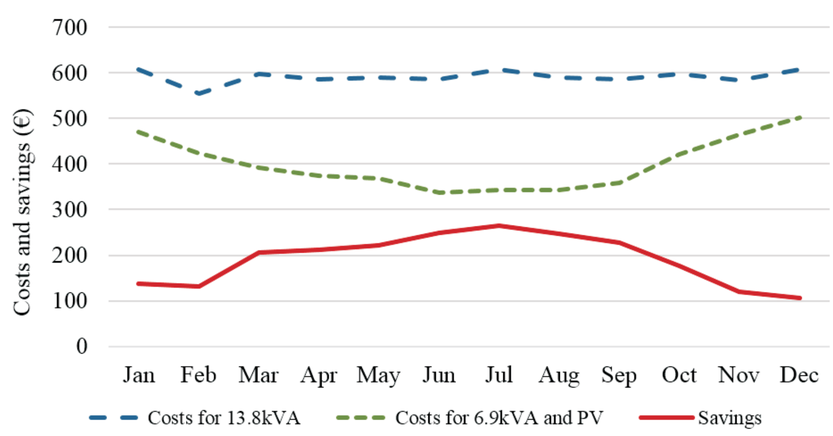

Fig.4 Results comparison between scenario 1 and scenario 2.

Conclusions

This study proves that the integration of PV systems in service buildings, where the predominant eletcricity consumption takes place during the day, proves to be a very energy efficient solution leading to significant annual bill savings, around 32.5%. Economic analysis show that the investment payback is around six years, which denotes the project viability.