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Evaluating Electricity Bill Savings of Self-Consumption Pv in Italian Residential Sector

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ABSTRACT

The installation of PV systems in residential buildings has significantly increased in the last decade, thanks to national programs such as Feed-in Tariffs and Net Metering. To maximize their earnings from these systems, some users must boost their self-consumption. Various components have been successfully tested, but there are still several challenges to overcome before these technologies can become fully viable. An initial purchase of a photovoltaic system requires a significant investment. This article outlines the cost of installing and wiring solar panels, inverters and related equipment. Additionally, conventional academic sections are included, and the language remains formal with no biased or emotional language. Lastly, correct spelling, grammar, and punctuation are employed. The article aims to provide an economic assessment of potential electricity bill savings via self-consumption in the residential sector of Rome, limiting the solar panel capacity between 1 kWp to 4.5 kWp. Technical terms are explained upon first use, ensuring the logical flow of information throughout. To fulfill this objective, we compare the situation of a typical Italian household, which solely relied on purchased power from the grid, with a hypothetical circumstance in which the residence participated in a scheme to construct a photovoltaic self-generation system that can meet some or all of its energy requirements. In Rome, employing "PV 1 kWp", we obtained a commendable result (IRR = 26%) and the greatest NPV (€4438.046).

1. INTRODUCTION

For carbon emissions to be reduced, clean, renewable energy must be used. Technology advancements are required, though, to ensure their integration into the current power system. The long-term integration of all these sources into the current energy networks will require substantial construction and a new control technique. Photovoltaic systems are among the most important renewable energy sources contributing to today's energy concerns because of recent technological advancements and cost reductions [1].

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Many governments have developed policies to encourage the development of renewable energy sources (RES) to reduce greenhouse gas emissions and battle climate change. The European Union's environmental goals to attain net zero carbon emissions by 2050, as well as the European Green Deal, have raised the stakes for previously stated environmental goals. The Italian government met the 2020 objectives ahead of schedule and began work on the 2030 targets in 2017. Nonetheless, following the EU's Green Deal agreement, the plan was changed, and the Integrated National Energy and Climate Plan was issued, with the goal of establishing specific objectives to be met by 2030 in accordance with the European Union's policy. Wind and solar energy will play a major role in the Italian approach: the administration hopes to reach 51 GW of installed solar capacity from the 20.8 GW currently installed [1].

The aim of the article is to make an economic assessment of the electricity bill savings of self-consumption in the residential sector in Rome. With regard to the main issue of the article, it is important to overview the background of the research. The cost-effectiveness of residential PV self-consumption has piqued the research community's interest. Most of the latest reviews have focused on determining the viability of residential PV systems under various nations' regulations.

Table 1. background of research (author)

Year	Name of author	Summary of research
2017	[2] Bertsch, Geldermann and Lühn	compare the internal rates of return (IRR) of PV residential systems for different PV capacities in Germany and Ireland.
2017	[3] Lopez Prol and Steiningera	the impact of the recently abolished Spanish law on the profitability of residential, commercial, and industrial investors in contrast to alternatives
2017	[4] Camilo et al	the economic feasibility of various configurations of residential PV systems, including battery storage.
2018	[5] Abdin and Noussan	the operation of an electricity storage system in Italy
2019	[6] Tongsopit et al.	examined into the economics of three different PV self-consumption assistance systems in Thailand.
2019	[7] Thakur, and Chakraborty	impact of various compensation schemes on customer power costs.
2019	[8]Virtic and Lukman	Investigated a pilot PV installation for a business-residential company.
2020	[9] Lazzeroni et al	Present an economic assessment for PV installations in residential households using geographical information to include a variation of solar radiation.

Roldan Fernandez et al. [10] mentioned that many barriers have prevented the development of renewable self-consumption in Spain until October 2018, when a new regulation introduced the right to self-consume renewable electrical energy without charges. The aim of this research was to assess the profitability of residential PV self-consumption in Spain. Their findings highlight that a 1.5 kW-peak PV commercial self-consumption kit profits from an optimum net billing situation for an average dwelling, which means an effective saving of the previous electricity bill.

2. LITERATURE REVIEW

2.1. Self –consumption PV system

Because of the current paradigm shift in low voltage (LV) distribution networks, we are assisting in the expanding penetration of renewable micro-generation (mG) situated closer to the customers. The majority of these manufacturing facilities use rooftop photovoltaic (PV) systems with limited power capacities. PV microgrids typically have a power output of a few kW and are connected directly to the low voltage distribution network. This paradigm shift could benefit rural populations by improving the efficiency of the electricity that is provided.

Prosumers are consumers who can produce their own energy. The importance of prosumers can be addressed in the context of the ongoing paradigm shift in LV distribution networks, even though it may be both economically and environmentally interesting [11]. A prosumer can operate its PV system in several ways:

a) All PV output can be exported to the grid, and all power consumption can be imported from the grid. This does not lead to self-consumption in this instance.

b) It can sustain its own consumption by producing PV, exporting excess power to the grid, and purchasing deficit power from the grid. This self-consumes without any storage in this scenario.

c) It can use solar energy to meet its own requirements while storing extra electricity in batteries for eventual use. The grid is used to make up for the difference in power supply. This is self-consumption with storage in this situation.

The negative point of the first type (a) is that the cost of electricity exported (sold) to the grid from all the PV production is half of the cost of electricity imported (purchased) from the grid (based on the Italian electricity policies). Moreover, the negative point of type (c) is that the storage system can increase the expenditure cost and complexity of PV systems [4] and [5].

2.2. PV in Italy

Despite challenging market conditions on several fronts, including the ongoing detrimental impacts of COVID-19 on our everyday lives and PV product supply constraints and ensuing solar module price increases, solar power in the European Union once again showed a fantastic performance in 2021. The demand for solar energy is anticipated to increase dramatically in the European Union in 2021. A total of around 25.9 GW of new solar PV capacity was linked to the grids of the 27 countries of the European Union in 2021, a 34% increase over the 19.3 GW added the year before [12].

The Italian government projects that the share of renewable energy will rise from around 17.5% nowadays (the country has already surpassed the 2020 EU target of 17% in this area) to 27% in 2030. This is identical to the goal chosen by the European Commission for the entire EU in its Winter Package, even though the package does not include any legally binding targets for individual member states. With almost 50% of the recently elected capacity coming from solar energy sources, the 27% objective should be achieved. In actuality, the government anticipates that by 2030, PV energy output will have increased from the current 23 TWh to 72 TWh.

The Italian PNIEC 2021–2030 envisages that renewables contribute 30% to meeting total gross final consumption in 2030, with the share of renewable energy in electricity consumption set at 55%. Investments in renewable energy can have a strong positive impact on the Italian economy both directly and indirectly. A recent study highlights how renewables strongly influence employment performance, for PV plants [13].

The Italian government has implemented some initiatives to encourage the diffusion of photovoltaic systems, called “Conto Energia” (CE). The 1st CE program started in 2005. The development of PV in Italy was strongly conditioned by the incentives provided based on the energy produced. The “Conto Energia V”, unlike the “Conto Energia IV”, provided incentives based on the energy fed into the grid and a premium rate for self-consumed energy. After the end of the fifth CE program, feed-in-tariff and premium schemes were dropped, and a tax credit program was implemented in 2013 [14].

For residential customers, a subsidized tax deduction is set at 50% instead of 36%. However, in May 2020, the Italian government issued the “Revival Decree” (Decree Law 34/2020), in which a further increase of 110% was introduced. Depending on whether the installation is connected to energy saving measures or not, the 110% tax deduction can be applied to the entire investment (max 2400 €/kW) or otherwise only to a part of it (max 1600 €/kW).

The results of the economic calculations are applicable to Italy. The PV system's installation cost was targeted at 1800 EUR/kW, which is typical of home plants with capacities up to a few tens of kW, and its O&M cost was targeted at 10 EUR/kW/year. [42. European Commission. Regulation 2017/2195 of November 23, 2017 Establishing a Guideline on Electricity Balancing C/2017/7774 [15].

3. DATA COLLECTION

To achieve this purpose, the scenario of a representative Italian home that purchased all its power from the grid is contrasted with a hypothetical situation in which the dwelling was involved in a project to construct a PV self-production system to meet all or part of its energy consumption. Information on the hourly price of potential surplus energy provided and sold to the grid using a simplified compensation system. Therefore, the one-year period from

January 1, 2020 until December 31, 2020 has been considered in this work to assess the economic performance of the PV self-consumption project.

It requires the knowledge and appropriate integration of four key pieces of information: the dwelling energy demand, the price of the energy purchased from the grid, the PV self-production profiles, and the hourly price of the surplus energy delivered to the grid. The hourly demand of the dwelling for a whole year as well as the purchase price of the PVPC tariff price profiles have been retrieved from the web page of Terna S.p.A. (Terna.it), which is the Italian System Operator. On the other hand, the hourly PV self-production profiles have been elaborated based on the peak power of the PV self-consumption kit and the actual PV production records of PVGIS. When the hourly PV self-production is greater than the demand, the surplus production is delivered and sold to the grid according to the simplified compensation mechanism. The hourly price profile corresponding to the delivery and sale of the excess PV self-production has also been retrieved from the PVGIS web page.

4. DATA ANALYSIS

4.1. Economic Assessment

An economic evaluation and review of the appropriate project results is required before making a final decision on whether to invest in a project or not. This choice is based on a cost-benefit analysis of the project's feasibility, stability, and profitability. Before making a final investment decision on a project, certain crucial indications in assessing investment attractiveness should be evaluated [16].

In this work, economic evaluation parameters are: Net Present Value (NPV), Internal Rate of Return (IRR), Profitability Index (PI).

NPV can be defined as the sum of present values of incoming (benefits) and outgoing (costs) cash flows, over the period considered for the project. So, NPV can be computed by Eq. (1):

$$NPV = \sum_{J=1}^{n} \frac{RL_j}{(1+\alpha)^j} - \sum_{J=0}^{n-1} \frac{I_j}{(1+\alpha)^j} + \frac{V_r}{(1+\alpha)^n} \tag{1}$$

If the result is a positive NPV>0, then the project is accepted. If the result is negative NPV<0, the project is rejected.

In a capital expenditure budget, an IRR is a rate of return that is used to quantify and compare the investment's profitability. This is the same as saying that IRR is the rate of return for which the net present value is zero. Therefore, the equation of IRR is given in Eq. (2):

$$\sum_{j=1}^{n} \frac{RL_j}{(1+IRR)^j} - \sum_{j=0}^{n-1} \frac{I_j}{(1+IRR)^j} + \frac{V_r}{(1+IRR)^n} = 0 \tag{2}$$

If IRR > α, then the project is economically profitable; otherwise, it is not.

PI, also known as the benefit cost/ratio, is the ratio of the present value of an investment's estimated cash inflows to the present value of its estimated cash outflows (Riesz et al., 2015). The project can be accepted if PI is greater than 1; otherwise, it is rejected. PI is determined by Eq. (3):

$$PI = \frac{\sum_{j=1}^{n} \frac{RL_j}{(1+\alpha)^j} + \frac{V_r}{(1+\alpha)^n}}{\sum_{j=0}^{n-1} \frac{I_j}{(1+\alpha)^j}} \tag{3}$$

4.2. Residential PV System

After successful installation of the PV self-consumption system, it should operate to produce energy hourly, EPVh. Self-produced energy is totally or partially self-consumed, so that the amount of energy withdrawn and purchased from the grid reduces, while the surplus PV production is delivered to the grid, as shown in Fig 1. With regards to the hourly values of the residential demand being greater or lower than the self-produced hourly energy of the solar panel, the hours of the year, {h}, can now be demonstrated in two ways [10].

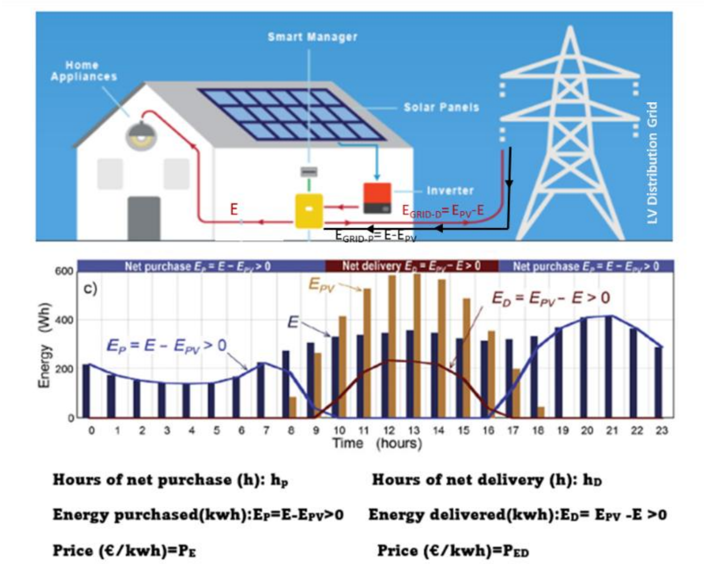

Fig. 1. 24 hours of electricity consumption on the first day of January [10]

The dwelling's total reduced cost of power, if purchased from the grid during net purchasing hours, $C_{P\,P}$, may be computed by considering the dwelling's hourly energy requirements throughout the year, E_h. and the energy purchase cost per hour, P_{Eh}, the yearly growth rate of the energy purchase price is ignored, and the annual growing ratio of the dwelling's energy demand is neglected. and the discount rate, k, as Eq (4).

$$C_{P\,P} = \sum_{n=1}^{N}\left(\sum_{\substack{h=1\\E\geq E_{pv}}}^{8760} E_h \bullet P_{Eh}\right)\frac{1}{(1+K)^n} = \sum_{n=1}^{N}\left(\sum_{h\in h_p}^{8760} E_h \bullet P_{Eh}\right)\frac{1}{(1+K)^n}$$
$$= C_{P\,P1} \bullet \sum_{n=1}^{N}\frac{1}{(1+K)^n} = C_{P\,P1} \bullet F_{CD}(K_E, N) \qquad (4)$$

Where the saving of the initial year, SSC P1, is shown in Eq. (5):

$$S_{SC\,P1} = \sum_{\substack{h=1\\E\geq E_{PV}}}^{8760} E_{PVh}\,P_{Eh} = \sum_{h\in hp} E_{PVh}\,P_{Eh} \qquad (5)$$

And the equivalent discount rate, k_{PV}, is shown in Eq. (6):

$$K_{PV} = \frac{1+K}{(1-\Delta E_{PV})} - 1 \qquad (6)$$

Consequently, for the hours of net purchase, h_P, the net cost of the electricity purchased from the grid, $C_{P\,PV}$, can be stated as the distinction in Eq. (7):

$$C_{P\,PV} = C_{P\,P} - S_{SC\,P} = C_{P\,P1}F_{CD}(K_E, N) - S_{SC\,P1}F_{CD}(K_{PV}, N) \qquad (7)$$

It is worth noting that without a PV system ($E_{PVh} = 0 = S_{SC\,P1}$), all the hours are of net purchase, $h = h_P$, as well as the initial, $C_{P\,P} = C_{P\,P1}.F_{CD}(K_E, N)$, would be equivalent to the cost of the electricity purchased from the grid in the BAU, $C_P = C_{P1}.F_{CD}(K_E, N)$. During the remaining hours of net delivery, h_D, the net cumulative discounted income due to selling of the surplus PV self-produced energy delivered to the grid. $I_{D\,PV}$, can be calculated as the difference between discounted income of selling the PV self-produced energy, E_{PVh}. as if all that electricity had been delivered to the grid, I_D, and the discounted cost (missing income). $C_{SC\ D}$, of the self-produced and self-consumed energy, E_h (see Eq. (8)):

$$I_{D\ PV} = I_D - S_{SC\ D} \quad (8)$$

It should be noted that, with the current regulations in Italy, surplus power can be injected into the grid without any remuneration.

4.3. Case Study Selection

In this thesis, we want to compute eight different power operating modes of residential PV systems configurations, namely, self-consumption, in Rome. This case study is a residential building which has PV systems installed on the roof. The total demand is 2400 (kWh) for a potential annual consumption of 8760 hours, the residential building is in the Castel Fusano neighborhood of southern Rome, with a latitude of 41.748, a longitude of 12.344, and a 9-meter elevation above sea level.

4.3.1 PV Kits

Typical PV power kits available in the market were selected:

PV 1 kWp, PV 1.5 kWp, PV 2 kWp, PV 2.5 kWp, PV 3 kWp, PV 3.5 kWp, PV 4 kWp and PV 4.5 kWp.

All other case study parameters, such as economic and operating factors (module, inverter, permits, profit margin, discount rate, inflation rate, price of purchased electricity, price of sold electricity, device replacement, maintenance, and VAT), are supposed to be the same in both cities, with only the PV profile power generation modifiable.

A webpage (https://re.jrc.ec.europa.eu/pvg tools/en/#PVP) should be used to acquire the PV production profile. This tool allows you to calculate the average monthly and annual energy production of a PV system that is linked to the power grid but does not have battery storage. Solar radiation, temperature, wind speed, and the kind of PV module are all factored into the computation.

The user has the option of mounting the modules in a building with predetermined degrees of inclination or orientation or in a free-standing posture with these angles chosen by the user. PVGIS is asked to determine the best slope and orientation for maximizing annual energy output in this test. The computations are performed using the solar radiation database's complete temporal coverage.

By using a multi-year time series of solar radiation and other meteorological factors, the monthly average values of PV system energy production and in-plane irradiation are calculated every month and for the whole year. The result also includes some more information about the calculation.

Figure 2: Example of power production, power consumption, and surplus power during a day with a 1 kWp PV system size The PV installation in Rome produces energy (4.553 kWh). Furthermore, self-consumption and excess power injection into the grid are 2696.05 Wh.

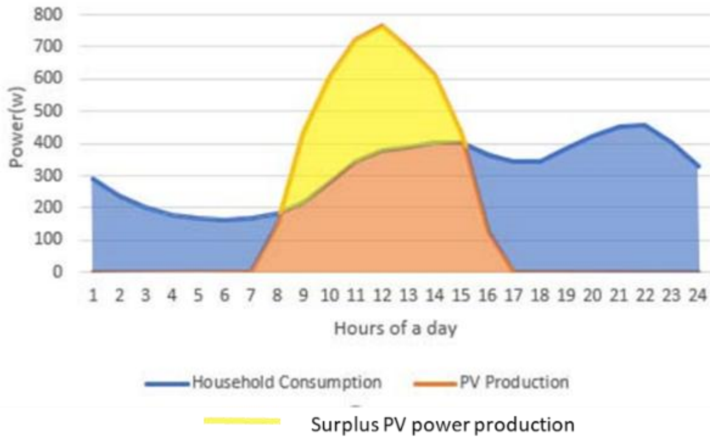

Fig. 2. Profile of 1kWp PV system in Rome (author)

4.3.2 Consumption and PV generation Profile

The economic study was based on average yearly consumption and micro-generation (mG) profiles made available by Terna S.p.A., the Italian System Operator (www.terna.it), and the JRC Photovoltaic Geographical Information System (PVGIS) of the European Commission. Fig. 3 presents the annual consumption profiles and illustrates the annual mG profiles (considering a PV system with 1 kW peak power as an example) for a typical consumer.

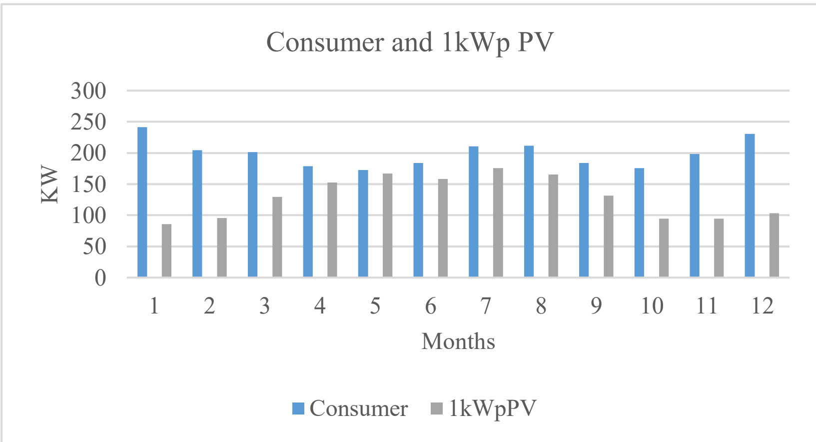

Fig. 3. 12 months of dwelling consumption & PV 1kWp production across the year (author)

4.3.3 Network Power and Purchase Tariffs

The Italian government has established that two types of prosumers included in the new rules, which are defined as energy communities. and self-consumption collectives, will be awarded a 25-year tariff of €0.11 and €0.10, respectively, for each kilowatt-hour of power that is shared among their members [17].

Self-consumption collectives are groups of consumers that live in the same building or complex, whereas energy communities are bigger entities that may include companies or government agencies located near a power plant. Surplus electricity may be fed into the grid without payment under the incentive plan, which is applicable to renewable energy systems with a capacity of less than 200 kW and is meant to boost the development of batteries. Self-consumed electricity is not subject to bill charges, but it is not granted a direct incentive. The indirect incentive is an avoided electricity cost of €0.20/kWh [17].

4.3.4 Economic Analysis Considerations

The following parameters were considered for economic analysis purposes: an investment period of 25 years, a discount rate of 4%, maintenance, and an average VAT of 10% of the total investment of the project (based on IEA-PVPS, 2020).

Table 2 lists the average price of the power kits, additional components, and factors investigated in this study. The following components are included in each PV power kit: PV module, micro-inverter, connecting direct current and alternating current (DC and AC) cables, and support structure for PV panel The costs of the following parameters are considered to determine the total price for each PV system: Shipping and travel, permits and commissioning, installation work, project margin, mounting material, and other electronics.

Table 2. Average price of PV system [18]

Cost category	**Average [€/W]**
Module	0.38
Inverter	0.14
Mounting material and other electronics	0.27
Installation work	0.09
Shipping and travel expenses to customer	0.03
Permits and commissioning	0.1
Project margin	0.32
Subtotal	1.33
Average VAT	10%
Total Price	1.463

4.3.5Proposed Scenario and Total Investments

A sample average house in Rome, Italy, was used as the case study in this research. In the first step, we analyzed a home without a solar panel system that drew all its power from the grid. In the second stage, we investigated a grid-connected home with a PV self-consumption kit, with peak power ranging from 1 to 4.5 kWp.

The solar PV sector aspires to lower prices while boosting cell efficiency. Component prices have decreased because of increased competition among manufacturers and the entry of new enterprises into the manufacturing industry. This was evident in the tender results, as competitors offered lower pricing than in prior years. The average cost of a PV system is considered in Table 3.2. It can be achieved at a total price of 1 kWp to 4.5 kWp by summing up all the parameters in the below table.

The hourly demand of the dwelling for a whole year is 2400 kwh, and the tariff to purchase all demand from the grid is €0.20/kwh for Rome, Italy, while the purchase price for the same demand in a self-consumption dwelling is €0.10/kwh.

Figure 4 shows that self-consumption results in bill savings. The yearly power expenditure for a building without a PV system is shown by the first bar. The following blue bars depict the annual electricity bill for the building with various PV system capacities installed. The savings are shown in green bars as compared to not having a PV system installed. These figures apply to the net power bill, excluding PV system investment expenses. The bar "PV 4.5 kWp" reflects the bigger power bill savings, as can be seen in the graph. However, once we look at profitability indicators at the conclusion of the PV system investment, this cannot be acceptable. Furthermore, the 1 kWp PV system saves the least amount of money, but it has the best profitability index at the conclusion of the examination. The economic index findings derived from simulations of all the investigated configurations are shown in the next subsection.

Table 3. Total price of different powers of PV system based on [18]

Cost category	Average [€/W]	1kWp	1.5kWp	2kWp	2.5kWp	3kWp	3.5kWp	4kWp	4.5kWp
Module	0.38	380	570	760	950	1140	1330	1520	1710
Inverter	0.14	140	210	280	350	420	490	560	630
Mounting material and other electronics	0.27	270	405	540	675	810	945	1080	1215
Installation work	0.09	90	135	180	225	270	315	360	405
Shipping and travel expenses to customer	0.03	30	45	60	75	90	105	120	135
Permits and commissioning	0.1	100	150	200	250	300	350	400	450
Project margin	0.32	320	480	640	800	960	1120	1280	1440
Subtotal	1.33	1330	1995	2660	3325	3990	4655	5320	5985
Average VAT	10%								
Total Price(€)	1.463	1463	2194.5	2926	3657.5	4389	5120.5	5852	6583.5

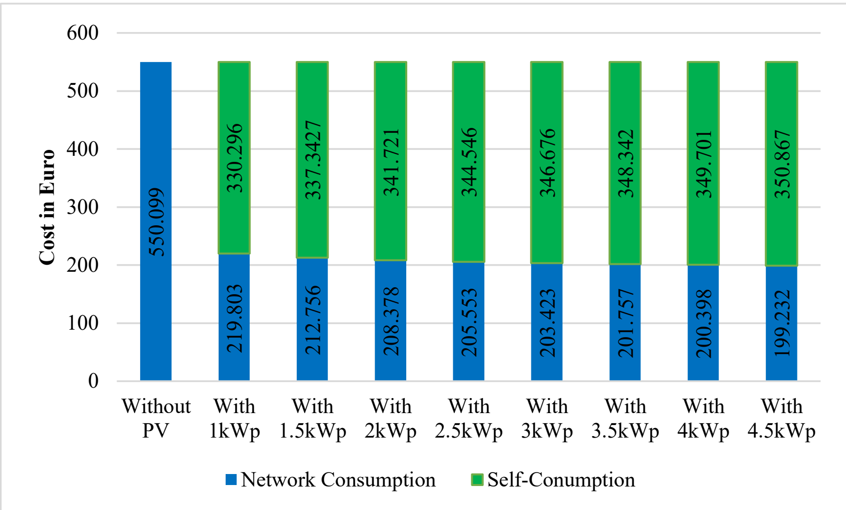

Fig. 4. Bill savings resulting in Rome (author)

As we look at the annual power cost, it comes to about 550 euros. By installing 1 kWp solar panels, we can save about 330 euros (or 60%) in Rome. Additionally, the results show that installing 4.5 kWp solar panels can save our yearly power costs by 350 (63%) euros.

Although these savings are appealing to all owners, the results of profitability indices for more than 4 kWp are not reasonable.

5. RESULTS AND DISCUSSION

5.1. Group I consumer without PV

The results of the economic analysis of group I (all consumption is fed from the grid) are presented in Table 4. This is explained by the fact that power purchased from the grid with a higher tariff (€0.20/kwh) is compared to the self-consumption prosumer tariff (€0.10/kwh).

Table 4. Economic results of group I (author)

Economic result group I				
System type	Yearly Demand(kwh)	Tariff (€/kwh)	Yearly Fixed Fee (€)	Yearly Bill (€)
Residential Consumption	2400	0.20	71.54	551.54

5.2. Group II self-consume

The impact of each parameter on the PV system's energy balance is the first factor to examine when doing an energy analysis. The simulation considers two important parameters: the geographical location and the size of the PV system. Fig. 5 reports the annual values of the energy flows for 1 kWp, 2 kWp, 3 kWp, and 4 kWp in Romehen doing an energy analysis. The simulation considers two important parameters: the geographical location and the size of the PV system. Fig. 5 reports the annual values of the energy flows for 1 kWp, 2 kWp, 3 kWp, and 4 kWp in Rome. The different shares of the energy consumed by the users' self-consumption are shown in green; the energy supplied from the grid is in black; and the energy surplus to the grid is in orange.

The size and price of the PV kit were set as the variation parameters, and the NPV and IRR were set as the objective parameters to study the project's profitability conditions. The results obtained for the eight different powers of the PV system are presented in Table 5 in Rome.

PV system configurations in this group are focused on determining self-consumption and surplus network insertion. Except for "PV 4.5 kWp," all PV system designs in this category are economically viable at various levels. It is shown that in Rome, a remarkable score (IRR = 26%) is inclusively obtained for "PV 1 kWp". Moreover, the highest NPV (€4438.046).

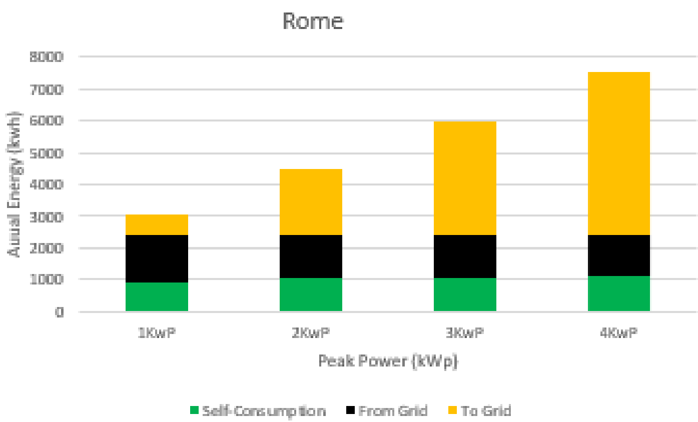

Fig. 5. Annual values of the energy flows for 1kWp, 2kWp, 3kWp, and 4kWp in Rome (author)

The results of the economic appraisal presented in this work lead to the conclusion that grid-connected PV self-consumption is profitable for an average dwelling in Italy. The following figure represents four indicators in Rome.

Table 5. Economic results of group II in Rome (author)

PV System Power	NPV (€)	IRR (%)	PI (%)
PV 1:0 kWp	4438.046	26%	4.034
PV 1.5 kWp	3816.638	17%	2.739
PV 2:0 kWp	3153.537	13%	2.078
PV 2.5 kWp	2466.167	10%	1.674
PV 3:0 kWp	1767.939	8%	1.403
PV 3.5 kWp	1039.582	6%	1.203
PV 4:0 kWp	307.848	5%	1.053
PV 4.5 kWp	-361.084	3%	0.945

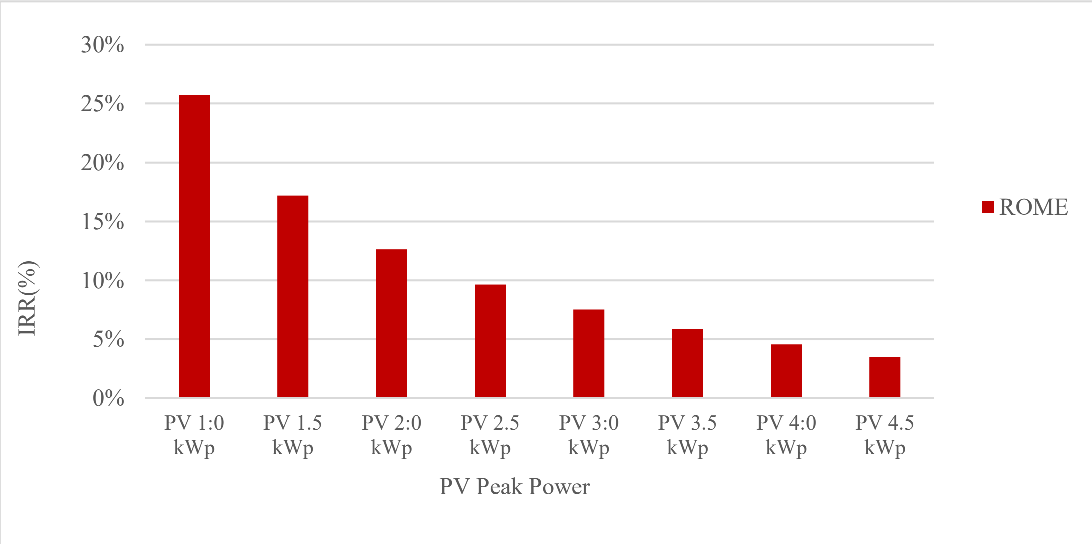

Fig. 6. IRR (%) for different PV in Rome (author)

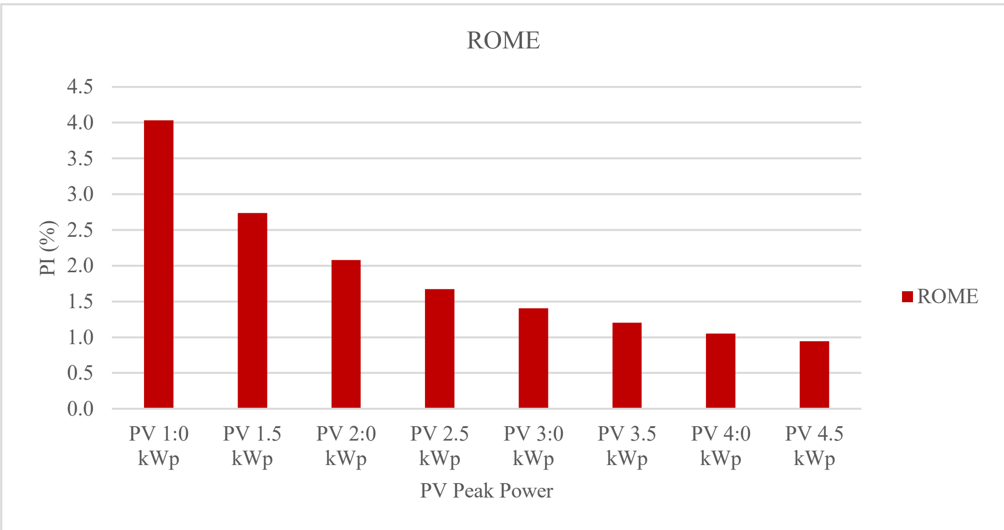

Fig. 7. PI (%) for different PV in Rome (author)

Figures 6 and 7 show that in financial analysis, the internal rate of return (IRR) and profitability index (PI) are statistics used to calculate the profitability of possible investments. It provides a benchmark for choosing whether to move forward with a project or investment. However, an IRR% above 4% is, nonetheless, regarded as acceptable.

The results indicate that using a 1 kWp solar panel system is the most lucrative choice when the IRR (%) for all the PV electricity at both sites is calculated. IRR (%) greater than 20% is considered lucrative, while (26%) the most profitable investment in the Rome location, according to the NPV, was 1 kWp, which saved €4438 after 25 years.

6. CONCLUSION

In accordance with the established rules (2020–2021), this study assesses the economics of the electricity bill savings of self-consumption in the residential sector in Rome. The solar energy market in Italy was the subject of this investigation. Italy has attained grid parity for solar energy, making it competitive with fossil fuels without the need for government subsidies. In this research, the PV peak power is changed with the goal of calculating the advantages of adopting self-consumption PV residential buildings to reduce and save on electricity bills over the chosen timeframe.

A possible scenario in which the home installed a grid-connected PV self-production household kit to meet all, or a portion of its energy needs is compared to the actual situation of a representative ordinary Italian home that acquired all its needed power from the grid. The key finding of the economic evaluation is that grid-connected PV self-consumption for a typical Italian home is financially advantageous under the laws as they currently stand. The net billing (simplified compensation) method provided by the existing rules can be linked to the profitability of PV self-consumption.

Rome was chosen as the study's geographic location, and the range of solar panels' capacities was 1 kWp to 4.5 kWp. The following results demonstrate the profitability of PV self-consumption installation:

- In Rome, using "PV 1 kWp", a respectable result (IRR = 26%), and the highest NPV (€4438.046).

Since self-produced energy does not need to be created or transferred, the growth of PV self-consumption may allow for the postponement of investments in bolstering or extending the generating capacity or the transportation and distribution infrastructure (transformers and lines). Lowering the overall demand might also reduce CO2 emissions and transmission and distribution network losses since less electricity would be delivered, reducing the risk of grid congestion and its associated expenses. It is crucial to consider how it influences job prospects in the area. Thus, a decrease in power costs is anticipated for all customers.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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